HIGH SEAS, HIGH RISK: A GLOBAL EVALUATION OF THE EFFECTIVENESS OF REGIONAL FISHERIES MANAGEMENT ORGANIZATIONS

by

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Abstract

The global decline in coastal fisheries has led to fisheries expansion into high seas. Unlike the majority of fisheries within national jurisdiction, high seas fisheries are managed by intergovernmental entities called ‘regional fisheries management organizations’ (RFMOs). The role of RFMOs is generally that of conserving and managing various stocks and/or species, as is mandated by the United Nations Convention on the Law of the Sea. Here, we examine the global effectiveness of RFMOs as they fulfill this role. The assessment of the world’s current 18 RFMOs is achieved through a two-tiered approach. First, we assess RFMO effectiveness in theory, as determined by their stated commitment to RFMO best practices. Second, we assess RFMO effectiveness in practice, as determined by the state of their managed stocks. Results reveal that, overall, RFMOs are lacking in commitment to best practices. Additionally, out of the 48 stocks that were assessed which are under RFMO management, 32 have critically low biomass and/or are being overfished. Taken together results indicate that RFMO effectiveness is poor, highlighting the need for increased RFMO accountability and performance.

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List of acronyms

AMSY	Average maximum sustainable yield
Blim	Biomass limit
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCBSP	Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CL	Conservation Limits
DFO	Fisheries and Oceans Canada
DWFN	Distant Water Fishing Nation
EBM	Ecosystem Based Management
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
FFA	South Pacific Forum Fisheries Agency
GFCM	General Fisheries Commission for the Mediterranean
HSTF	High Seas Task Force
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICES	International Council for the Exploration of the Sea
IOTC	Indian Ocean Tuna Commission
IPHC	International Pacific Halibut Commission
ITLOS	International Tribunal for the Law of the Sea
IUU	Illegal, Unregulated, Unreported
IWC	International Whaling Commission
MSY	Maximum sustainable yield
NAFO	Northwest Atlantic Fisheries Organization
NASCO	North Atlantic Salmon Conservation Organization
NEAFC	North East Atlantic Fisheries Commission
NGO	Non-governmental organization
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPAFC	North Pacific Anadromous Fish Commission
PSC	Pacific Salmon Commission
RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organization
RFO	Regional Fisheries Organization
SEAFO	South East Atlantic Fisheries Organization
SIOFA	South Indian Ocean Fisheries Agreement
SPRFMO	South Pacific Regional Fisheries Management Organization
TAC	Total allowable catch
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNCLOS	United Nations Convention on the Law of the Sea

UNSFA	United Nations Straddling Fish Stocks and Highly Migratory Fish Stocks Agreement
WCPFC	Western and Central Pacific Fisheries Commission
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund

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My supervisor, Professor Daniel Pauly, is a co-author on chapters 2 and 3 of this thesis.

The concept of this thesis was established by Dr. Pauly and myself. The methodology for chapter 2 was identified by Dr. Pauly. All research and analyses were performed by myself. The thesis was written up by myself and revised by Dr. Pauly.

Chapter 1

Introduction

Arguably, the expansion of commercial fisheries into deepwater areas, especially those outside the jurisdiction of current management agencies, is one of the most worrying developments in recent years.

Watson and Morato (2004)

1.1 Problem statement

Humans have depended on the oceans for a long time. Some of the oldest fishing villages on the Northeast pacific coast date back 9,000 to 11,000 years (Glavin, 2000), and early pictographs of whaling- the world's oldest industry (Roberts, 2007) - have roots back 6,000 to 1,000 BC (Lee & Robineau, 2004). For millennia, fishing has occurred all over the world, across continents from Europe to Asia to Africa to the Americas (Sahrhage & Lundbeck, 1992). The industrialization of fisheries began in the 19th century and by the mid-20th century commercial fisheries were in full swing: with the advent of new technologies and access to fossil fuels to power their boats (Pauly *et al.*, 2002), what was initially a local practice quickly expanded to distant water fishing, or fishing overseas. No longer limited to coastlines, boats began leaving the safety of their ports and coasts, and headed out into deeper, unpredictable waters.

Historically, oceans were open access (Bjorndal *et al.*, 2000), meaning they belonged to everyone, i.e.: everyone had the right to exploit them. Incongruously, one had rights to those waters, but no responsibility to them. In the 18th century, after the creation of the '3 nautical mile cannon-shot rule' (3 nm being the effective range of cannons), open access was still accepted and practiced beyond the 3 nm boundary (Sahrhage & Lundbeck, 1992). Then, after the Second World War and spearheaded by the USA, many coastal countries began claiming control over the valuable resources in adjacent maritime waters, including fish (Anand, 1982). This led to the establishment of Exclusive Economic Zones (EEZs) of 200 nm from coastal countries' shores (Bjorndal *et al.*, 2000) at the United Nations Conference on the Law of the Sea in 1977.

Note that, historically, it has always been the coastal state which establishes how fish stocks within its jurisdiction are managed, including determining the total allowable catches (TACs), optimum utilization, enforcement, and other capacities (United Nations, 1982). On the other hand, prior to the Convention, the high seas remained 'un-owned' and unmanaged. Even in the 1970s, it would have been difficult to foresee the colossal expansion of fisheries across oceans that was about to ensue, more difficult still to envision the battles over fish in such previously inaccessible waters. Freedom to fish on the high seas remained.

Today, close to 60% of the oceans are outside EEZs, i.e., considered to be high seas (Sumaila *et al.*, 2007). Although the high seas comprise over half the world's ocean by surface area, they are far less regulated than EEZs (Gjerde & Kelleher, 2005).

While fishing effort was historically concentrated along coastlines (Roberts, 2007), it has now increased on the high seas. Currently, an estimated 85% of global commercial catch comes from within EEZs. In weight, this is equivalent to 77.5 million tonnes, greatly exceeding the 9.5 million tonnes caught in high seas (see www.seaaroundus.org). However, this large disparity in catch between regions is slowly diminishing: in 1950, 9% of global marine landings were caught in the high seas; in 2003, this had grown to 15% (both because of decreasing catches within EEZs and because of increasing catches in the high seas). In 2004, export value of high seas stocks totaled $7.3 billion, a 14-fold increase from 1976 (United Nations, 2006). Indeed, fish from the high seas are often of extremely high value, including tuna (Safina, 1993), certain billfish (Webster, 2006), toothfish (Riddle, 2006), and sharks (Stevens *et al*., 2000). These top predator fish are in high demand, and drive the incentive for high seas fishing (Riddle, 2006).

Acknowledging that even a fishery under individual quota management can face obstacles—e.g., corruption, mismanagement, overexploitation, social equity dilemmas (see Clark *et al*., in press; Sumaila, submitted)— we can assume that a resource under some ownership is better off than one without (Bratspies, 2001; Hoel & Kvalvik, 2006; Waters, 1991). Hardin (1998) writes: "Now the once unlimited resources of marine fishes have become scarce and nations are coming to limit the freedom of their fishers in the commons. From here onward, complete freedom leads to tragedy."

As stocks dwindle along coastlines, fisheries are not stopping, they are simply pushing out: fishing is occurring more and more in non-jurisdictional waters and in deeper seas (Roberts, 2002). Without regulation, the prognosis for sustainable fishing in these areas is dim.

1.2 Background and literature review

1.2.1 Defining Regional Fishery Management Organizations (RFMOs)

To assess the effectiveness of regional fishery management organizations (RFMOs) in this study, it was necessary to first define what would qualify as an RFMO in order to differentiate between the various current types of international fishery organizations. It must be noted that regional fisheries bodies (RFBs) differ from regional fisheries organizations (RFOs), which again differ from regional fisheries management organizations (RFMOs). RFBs are typically used as an umbrella term for regional or sub-regional fisheries organizations, while RFOs are similar to RFMOs, except that they lack management authority and conservation goals (Lodge *et al.*, 2007). Depending on the source, one can find a total of 30 RFBs (www.savethehighseas.org), 38 RFBs (FAO, 2007; Lodge *et al.*, 2007), 43 RFBs (www.fao.org), or even 50 RFBs (Molenaar, 2005) worldwide- hence the importance of a clear definition. According to Sydnes (2001), three types of RFOs— which are not mutually exclusive— exist: those focusing on scientific research (e.g., International Council for the Exploration of the Sea, ICES), those which look at regional coordination and development (e.g., Latin American Organization for Fisheries Development, OLDEPESCA), and finally, RFMOs (as analyzed here; see Figure 1.1).

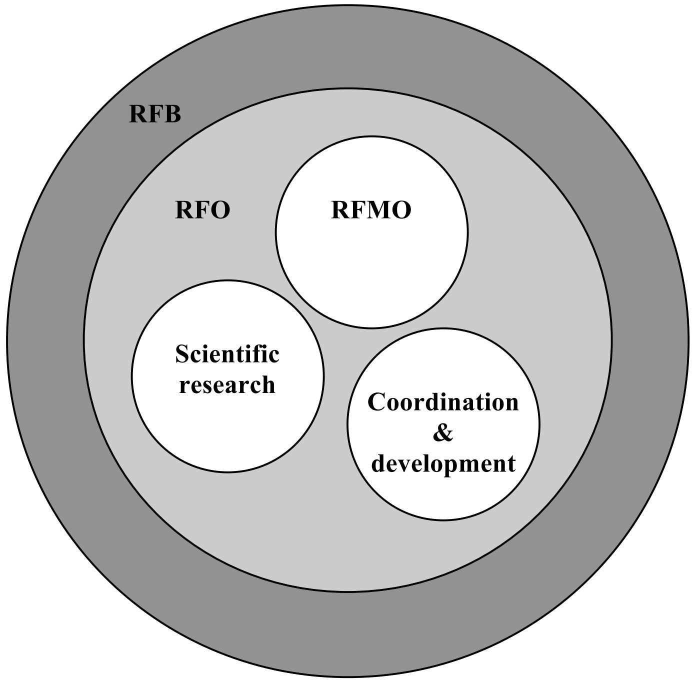

Figure 1.1 Relationships between fisheries bodies, including RFMOs.

Currently, RFMOs cover the majority of global oceans. Some RFMOs have substantial overlap of their convention areas (Figure 1.2).

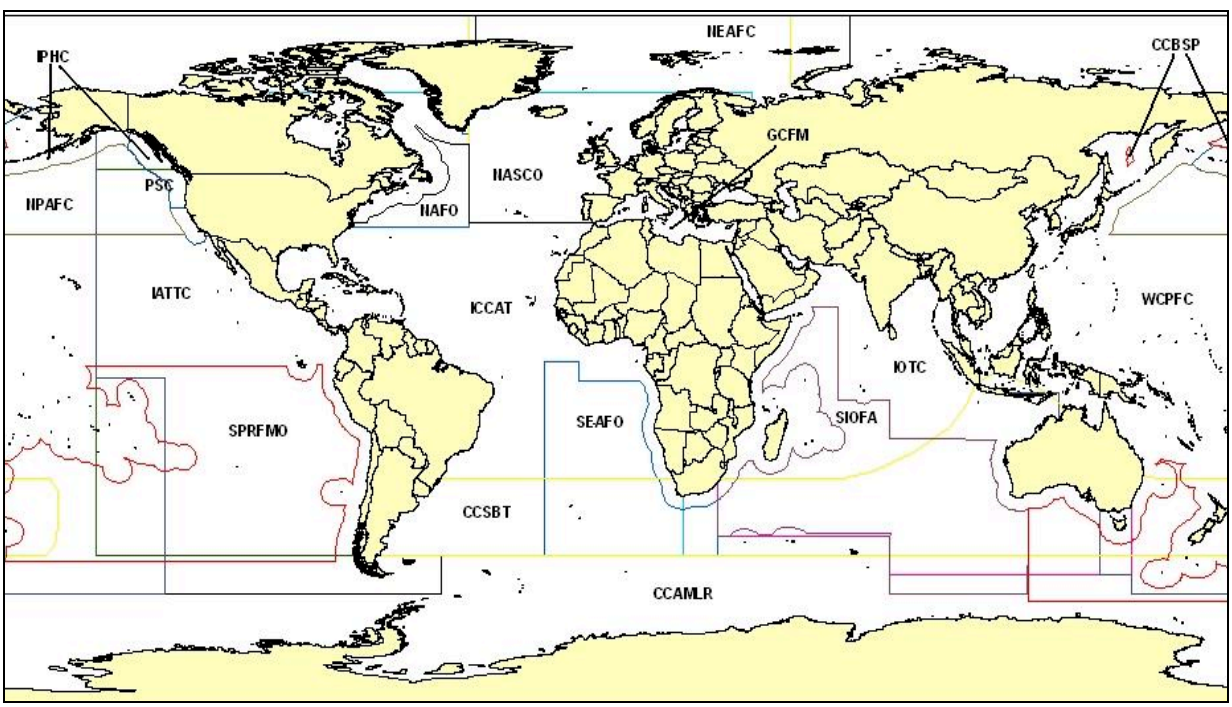

Figure 1.2 The global distribution of RFMOs. Note: IWC covers entire ocean.

For this study, we coupled the vague definition of RFOs from the 1982 United Nations Convention on the Law of the Sea (from hereon referred to as the Convention) with key aspects defining RFMOs from the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (from hereon referred to as the Agreement). Regional fisheries management organizations are therefore defined here as international bodies, made up of more than one country or state, which manage a defined area of the ocean, as it relates to a specified stock or stocks, either within EEZs or in the high seas. Management is defined here as any direct action taken towards organizing, supervising the exploitation of, or conserving, marine stocks. Excluded from this study are bodies purely advisory in nature. This definition resulted in 18 RFMOs[1], listed in Table 1.1. Details on these 18 RFMOs are included in Appendix A.

Table 1.1 The 18 RFMOs included in this study.

Acronym	Full name
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCBSP	Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
GFCM	General Fisheries Commission for the Mediterranean
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IPHC	International Pacific Halibut Commission
IWC	International Whaling Commission
NAFO	Northwest Atlantic Fisheries Organization
NASCO	North Atlantic Salmon Conservation Organization
NEAFC	North East Atlantic Fisheries Commission
NPAFC	North Pacific Anadromous Fish Commission
PSC	Pacific Salmon Commission
SEAFO	South East Atlantic Fisheries Organization
SIOFA	South Indian Ocean Fisheries Agreement
SPRFMO	South Pacific Regional Fisheries Management Organization
WCPFC	Western and Central Pacific Fisheries Commission

[1] This is the same list of RFMOs as described by FAO (www. fao.org), and Zino (2007).

1.2.2 The Law of the Sea and the birth of RFMOs

In 1973, the third United Nations Convention on the Law of the Sea convened. This conference ended with a treaty to establish how people were to utilize the world's oceans and their resources (Rayfuse, 2007). Nine years later, one of the outcomes of that treaty was the first mention of 'regional fisheries organizations'. The importance of such organizations was made clear: "States shall cooperate with each other in the conservation and management of living resources in the areas of the high seas. States whose nationals exploit identical living resources, or different living resources in the same area, shall enter into negotiations with a view to taking the measures necessary for the conservation of the living resources concerned. They shall, as appropriate, cooperate to establish subregional or regional fisheries organizations to this end." (United Nations, 1982).

The Convention was not without flaws (Bateman, 2007; Munro, 2001). Among them was a failure to foresee a future where significant catches would originate from the high seas. As a result, little attention was devoted to high seas stocks and the specific duties of those who were to manage them (Munro, 2001). It was not until 1995, with the development of the Agreement[2], that the function and responsibility of regional fisheries management organizations, RFMOs, in particular, was made manifest (Chand *et al.*, 2003). This accord was created because of pressure resulting from both the depletion of high seas stocks, and the confusion generated from the open access nature of high seas (Brasao *et al.*, 2001). It was this Agreement that first specifically addressed the importance of the role of RFMOs, and expressed that these organizations were the means by which the Agreement would be met (Morling, 2004). The Agreement notes: "Coastal

[2] The Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

States and States fishing on the high seas shall, in accordance with the Convention, pursue cooperation in relation to straddling fish stocks and highly migratory fish stocks either directly or through appropriate subregional or regional fisheries management organizations or arrangements, taking into account the specific characteristics of the subregion or region, to ensure effective conservation and management of such stocks" (United Nations, 1995).

The Agreement expanded on the Convention's simple mention of regional fisheries organizations and became the first document to refer to regional fisheries management organizations. The Agreement outlined the necessity of their implementation and their responsibilities on the seas (United Nations, 1995). Notably, the term 'management' was a crucial addition to the definition of these organizations, though the interpretation of this word would later prove contentious.

The last part of the 20th century underwent a surge in developments and key international agreements relating to worldwide fisheries (Table 1.2). Indeed, it wasn't until the mid 1990s that high seas were given international attention, which highlights the relative newness of high seas management issues.

Table 1.2 Timeline: international agreements and other key events that ultimately led to the creation and best practices guide of RFMOs.

Year	Event
1609	Hugo Grotius' *The Free Sea (Mare liberum)*
1700s	Creation of the 3nm cannon shot rule
1884	Thomas Huxley: "probably all the great sea fisheries are inexhaustible"
1902	International Council for the Exploration of the Sea (ICES) is formed
1911	North-Pacific Fur Seal Convention
1945	Truman Proclamation
	United Nations (UN) established
1958	United Nations Conference on the Law Of the Sea I
1958-1976	Cod wars
1960	United Nations Conference on the Law Of the Sea II
1965	Food and Agriculture Organization's (FAO) Committee on Fisheries (COFI), established
1972	United Nations Environment Programme established
1973-1982	United Nations Convention on the Law Of the Sea III (the Convention)
1977	Precursor to Sea Shepherd Conservation Society established ("Earth Force Society")
1987	Brundtland Report
1992	United Nations Conference on Environment and Development, Agenda 21
1993	FAO Compliance Agreement signed
1994	The Convention comes into force
1995	UN Straddling Fish Stocks and Highly Migratory Fish Stocks Agreement (the Agreement)
	FAO Code of Conduct for Responsible Fishing
1996	Sustainable Fisheries Act (USA)
	International Tribunal for the Law Of the Sea established
2001	The Agreement comes into force
	IPOA[3]-IUU established
2002	World Summit on Sustainable Development
2003	High Seas Task Force is formed
2005	Ocean Policy Summit

1.2.3 What's law got to do with it?

..the freedom of fishing exists generally in the modern world. But it has become a conditional freedom.

Lodge *et al*. (2007)

To understand how much legal responsibility RFMOs possess, we must first have a basic understanding of international law, for the extent of RFMO accountability lies in how we interpret the legal frameworks that shape them.

Historically, ocean policies were created by various maritime sectors and at various times, through raising concern over a sector of interest (e.g., fishing, oil, navigation), and then fitting it

[3] FAO-COFI's International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.

within the government's legal framework. Predictably, this led to a very sectoral system. It wasn't until the 1970s, that integrated policies were given much contemplation (Haward & Vince, 2008). The Convention was the beginning of such a policy.

The Convention is part of public international law, which is responsible for creating international regulations and agreements that are binding to member states (Joyner, 2005). Based on customary law and by instruments, such as treaties, that force it towards becoming binding to parties who accept it, the Convention is "hard law" (Haward & Vince, 2008), obligation, precision and delegation being the defining characteristics of such hard law[4] (Abbott & Snidal, 2000). Treaties, therefore, are essentially contracts between states that are party to them (McNair, 1961). In 1996, the International Tribunal for the Law of the Sea (ITLOS) was formed and was given jurisdiction to interpret the Convention if disputes arose between states. When the Convention entered into force in 1994, member parties who wanted to settle disagreements, or whose activities contravened this document, could therefore take their case either to the ITLOS, a general or specialized arbitral tribunal, or the International Court of Justice, the ICJ (Buergenthal & Murphy, 2007).

RFMOs are bound to the Convention, obliged to cooperate and work as decreed by the treaty. However, because of the inarticulate statements in the Convention in relation to governing the high seas and the duties of RFMOs, along with other conspicuous limitations, the Convention was a weak form of accord to begin with (Bjorndal & Munro, 2003).

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[4] "Soft law" is law without one or more of the three characteristics of "hard law" (Abbot & Snidal, 2000).

The 1995 Agreement, created in an attempt to correct for that weakness, is also hard law (Haward & Vince, 2008). In theory, by breaching these UN protocols, one breaks international law, and accordingly should be held accountable in the ICJ or another analogous tribunal. This should, in theory, create a real disincentive to violate such protocols.

From the timeline depicted in Table 1.2, of note is how recently high seas management has become a topic of concern. Such historical context allows us to better understand the basis for current marine regulations on the high seas, including best practices guidelines for RFMOs.

1.2.4 Problems

Not only do high seas fisheries highlight many of the political and biological challenges inherent in transnational environmental problem-solving generally, they take those challenges to their logical extreme: how to regulate when there is no sovereignty at all.

Bratspies (2001)

Recall from the previous section that RFMOs have legal authority to impose restrictions on non-abiding states and that therefore, theoretically, we should see few infringements on the high seas. However, in practice, this is not the case: illegal fishing (i.e., fishing contrary to RFMO conventions) is still rampant on the high seas (Gianni & Simpson, 2005; Rayfuse, 2007; Stokke, 2009). Indeed 'pirate fishing' has been estimated to account for half of global high seas catches (Roberts, 2007). Therefore, if RFMOs are responsible for managing the high seas, why have they failed?

The first thing to acknowledge is the characteristics of high seas: vast, rough, and far from coasts. The inherent properties of the high seas make them difficult to monitor, much less to regulate.

Beyond these physical properties of high seas, there are practical problems with management, due to the very features of RFMOs. One such problem lies with creating consensus between member nations, nations which can have widely different backgrounds and goals (Burke, 1994). Imagine, for example, the difficulties involved in coming to an accord with over 80 member states- such is the reality for the International Whaling Commission (IWC). The formation of RFMOs at various times throughout the 20th century and into the 21st century creates yet another problem: depending on when an RFMO is created, different protocols and regulations will be in place, resulting in a patchwork of RFMOs, each adhering to policies and recommendations that pertain to different eras (Sydnes, 2001). For instance, the policies that were in place when the International Pacific Halibut Commission (IPHC) was established in 1923 will be far different from those that will be in place for the South Indian Ocean Fisheries Agreement (SIOFA) or the South Pacific Regional Fisheries Management Organization (SPRFMO) when they finally come into force.

Another problem is that according to the Convention, RFMOs must allow any state willing to abide by their regulations who have a ‘real interest’ in that fishery to become a member (United Nations, 1982). This has been termed the “new entrant problem” by Kaitala and Munro (1993) and, if we are to assume that new entrants receive obvious benefits such as a total allowable catch[5], allows for the overexploitation of the resource of interest.

Yet the most fundamental problems associated with RFMOs are embedded in the very open access nature of high seas. Although RFMOs have been 'given the right' to enforce regulations on the high seas through the 1982 Convention, the conflicting statute of the 'Freedom To Fish' lives on. In addition, the Convention is absolutely dependent on cooperation creating yet another conflict: because treaties (such as the Convention) are enforceable only on member states, this means that essentially, non-member states are not bound to any regulation (Kaye, 2001). RFMOs thus become vulnerable to the "interloper problem" (Bjorndal & Munro, 2003), also known as Illegal, Unreported and Unregulated (IUU) fishing[6]. Such conflicting terms are addressed by Rayfuse (2007).

Though many agreements have been created and many international meetings convened (see Table 1.2), there exists no single, comprehensive, legal establishment responsible for high seas fisheries that actively regulates and enforces[7]. It is relevant to note a few distinct organizations outside of RFMOs that aim to uphold international law, such as the ministerially run High Seas Task Force, which focuses on uniting and strategizing against IUU fishing (see www.high-seas.org), and the provocative non-profit organization, Sea Shepherd Conservation Society, which actively (and extra-legally) enforces the law on the water (see www.seashepherd.org). However, RFMOs remain the only legally recognized form of management on the high seas.

[5] Pertaining to those RFMOs with TACs.
[6] The high degree of reflagging of fishing vessels on the high seas is indicative of considerable IUU fishing activity.
[7] As there exists with the International Sea Bed Authority, which monitors the international sea bed and its resources (Henriksen, 2009)

1.3 Research objectives

As the only currently recognized, legitimate form of management on high seas, it is important to determine if RFMOs are indeed effective management organizations (Sydnes, 2001). The first RFO, ICES, was formed at the beginning of the 1900s (Sydnes, 2001), and the International Pacific Halibut Commission (IPHC), an RFMO, has been around since 1923 (Hoag *et al.*, 1993); in other words, such organizations have been around long enough for us to gauge their success. The purpose of RFMOs should be conservation and management, as stated in the Convention (United Nations, 1982); a global assessment would reveal whether or not these organizations are indeed achieving these objectives.

In the concluding paragraph, Sydnes (2001), states: "While [his] article has provided some answers, a number of outstanding issues remain. For example, what factors influenced the formation and efficiency of different types of RFOs? According to what criteria should RFOs efficiency be evaluated? How compatible are international instruments with the scopes and authorities of established RFOs? These issues, and others, open broad agendas for further research. Thus, the ability of RFOs to be 'vehicles of good governance' to secure sustainable management has to be proven." This contribution will address such questions.

Despite the relatively recent public interest in RFMOs, there is a surprisingly large amount of information on these management bodies. However, while many studies have depicted the successes and failures of various regional fisheries bodies (see Alder & Lugten, 2002; Henriksen, 2009), as well as offered hypotheses to help explain the reasons behind these accomplishments and disappointments (see Jacobson, 1995; Pintassilgo & Duarte, 2001), a quantifiable, standardized scoring scheme has yet to be developed and tested to assess the current effectiveness of each RFMO. Such a scheme could reveal, for example, where RFMOs are weakest, which weaknesses are shared across all RFMOs, which RFMOs perform similarly, which criteria have the most varied scores, how much scores vary across RFMOs, etc. In addition to these issues, this contribution will address fish stock status in relation to RFMO management. Thus, here the global evaluation on the effectiveness of RFMOs will be based on a two tiered system[8]: 1) theoretically, i.e., how well RFMOs meet standards as set by Lodge *et al.* (2007) and as measured by the comprehensiveness of available information (chapter 2 of this contribution); and 2) empirically, i.e., RFMO performance as measured by biomass trends of managed stocks through time (chapter 3 of this contribution).

Recently, a map was published that illustrated the negative anthropogenic influences (e.g., fishing, pollution, climate change) on the global oceans (Halpern *et al.*, 2008). The depiction is bleak: there remains no area in the global ocean left untouched by humans. However, there are areas of the ocean that have been affected less than others: the high seas. And, as stated by Laffoley (2005), "… a key advantage we have right now for the high seas, and one that we never took full advantage of on land, is the ability to act before it is too late."

This year, the urgency of assessing management on the high seas was reinforced. Sutherland *et al.* (2009) identified the 100 most important questions to the conservation of global biological diversity, and one of the questions was: "Which mechanisms are most effective at conserving biodiversity in ocean areas occurring outside the legal jurisdiction of any single country?"

[8] As described by Zino (2007).

By knowing the weaknesses and strengths of these management systems, we will be better able to understand and improve on them, and eventually contribute to strengthening management in the least affected areas of the ocean.

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Chapter 2

A theoretical approach to assessing current RFMO effectiveness[9]

2.1 Introduction

Although Hugo Grotius' 17th century principle of 'The Free Sea' now seems outdated (as reflected in the establishment of the 200 nautical mile Exclusive Economic Zones, EEZs, for coastal states in the 20th century), the high seas, for the most part, are still thought of as 'open access'. Hence, serious problems on the high seas prevail. In addition to problems common to many coastal waters, such as overfishing, Illegal, Unreported and Unregulated (IUU) fishing, vessels flying flags of convenience, and high rates of bycatch, the high seas experience the most basic of fisheries dilemmas: the freedom to fish in a global commons (Morling, 2005).

Fishing on the high seas has increased substantially in recent years[10] (Sumaila *et al.*, 2007). And with the intensification of fisheries resources caught from the high seas, comes the more recent increase of other forms of damage in these areas, such as pollution (Yamashita & Tanimura, 2007) and habitat destruction: over 80% of groundfish caught from the high seas are taken by trawlers, large unselective fishing contraptions that cleave up the ocean floor and damage unique environments (Gianni, 2004). Consequently, there is an urgent call for improved management.

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[9] A version of this chapter will be submitted for publication. Cullis-Suzuki, S., and Pauly, D. A theoretical approach to assessing current RFMO effectiveness.
[10] This is relative to fishing in the EEZ of maritime countries.

Currently, regional fisheries management organizations (RFMOs) are the legal entities responsible for managing and conserving resources on the high seas (United Nations, 1995). The term 'RFMO' originated in the mid-1990s[11], although some RFMOs date back much earlier than this (see Appendix A for a complete list of RFMOs and defining characteristics), thus allowing us an insight into their management performance. What is now needed is a global assessment comparing the management practices of all current RFMOs with the present state of their stocks.

In the last ten years, there has been much interest in the performance of RFMOs. Indeed, since the 1995 Agreement, the importance of RFMO reviews has been emphasized. Of particular relevance to our study are several reports mentioned next, in chronological order.

Alder *et al.* (2001) assessed various instruments and bodies central to management (including RFMOs) in the North Atlantic. Their methodology, as implemented in this study, will be elaborated on further in this chapter. Rayfuse (2004) documented the characteristics and practices of 13 RFMOs (primarily in relation to non-flag state enforcement) in a comprehensive book, although no quantitative analysis was carried out. Small (2005) reviewed in detail the performance of six RFMOs in relation to seabird bycatch, principally albatrosses, posing a series of questions and scoring them appropriately. More recently, two important assessments were conducted: one by Mooney-Seus and Rosenberg (2007) and the other by Zino (2007). The former report provided a thorough description of performance in relation to the precautionary principle and ecosystem-based management for 13 RFMOs. Using 18 criteria, scores were determined for each RFMO, and they ended up with a dataset representing how well those

[11] The Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (aka: 'the Agreement'), was the first document to refer explicitly to RFMOs.

RFMOs implemented the above protocols. The latter study focused on the actual criteria used for performance reviews, evaluating their practicality (Zino, 2007). That same year the Chatham House Report by Lodge *et al.* (2007) was published, which documented current best practices and expectations of RFMOs; this report strongly influenced our study, and will be detailed further in this chapter. Finally, it is also important to mention the performance reviews conducted by RFMOs themselves: so far, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC), and the North East Atlantic Fisheries Commission (NEAFC), have carried out such reviews, and more are forecasted to occur within the next few years (all but NEAFC's 2006 review have been conducted since 2008).

2.2 Materials and methods

In this study, we included the 18 current global RFMOs to test our scoring criteria, as well as two outgroups: the National Marine Fisheries Service (NMFS)[12], the national fisheries management agency of the USA; and the World Wildlife Fund (WWF), an environmental NGO involved in fisheries management issues (see Table 2.1). The 18 RFMOs we analyzed here were those characterized by FAO (see www. fao.org) and Zino (2007), and pertain to all current, practicing regional fisheries organizations that have management power.

[12] NMFS is part of the National Oceanic and Atmospheric Administration, NOAA.

Table 2.1 The 20 organizations included in this study.

Acronym	Full name
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCBSP	Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
GFCM	General Fisheries Commission for the Mediterranean
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IPHC	International Pacific Halibut Commission
IWC	International Whaling Commission
NAFO	Northwest Atlantic Fisheries Organization
NASCO	North Atlantic Salmon Conservation Organization
NEAFC	North East Atlantic Fisheries Commission
NMFS	National Marine Fisheries Service (Outgroup)
NPAFC	North Pacific Anadromous Fish Commission
PSC	Pacific Salmon Commission
SEAFO	South East Atlantic Fisheries Organization
SIOFA	South Indian Ocean Fisheries Agreement
SPRFMO	South Pacific Regional Fisheries Management Organization
WCPFC	Western and Central Pacific Fisheries Commission
WWF	World Wildlife Fund (Outgroup)

Our methodology for evaluating RFMO performance was based on Alder *et al.* (2001), which focused on countries' compliance to various fisheries and related instruments, specifically with regard to the North Atlantic. Because the current goal of such instruments is that of sustainable use, Alder *et al.* (2001) hypothesized that if nations were complying with these treaties, then, in principle, they should achieve the goal of sustainability of resources.

Similarly, the goal here was to evaluate the effectiveness of all RFMOs as determined by how their Conventions and other written texts scored against a set of criteria. Therefore, the framework presented in Alder *et al.* (2001) was implemented here by applying and expanding it to fit the global scale required for this study.

The criteria used for scoring were based on the Chatham House report 'Recommended Best Practices for Regional Fisheries Management Organizations' by Lodge *et al.* (2007). Co-written by lawyers, fisheries scientists and economists (aka: "the panel"), the document was born from a recommendation from the High Seas Task Force[13]. The Chatham House document describes an inclusive document on what is expected of RFMOs, how their practices can be improved, and addresses emerging issues. Prior to the Lodge *et al.* (2007) report, there existed no comprehensive record detailing the duties and responsibilities of RFMOs. Indeed, the Convention has been termed limited and inadequate (Bateman, 2007; Munro, 2001), the FAO Code of Conduct "largely ignored" (Ardron *et al.*, 2008; Pitcher *et al.*, 2009) and the Agreement, not comprehensive (Lodge *et al.*, 2007). The need for an all-encompassing, modern, usable document was evident for high seas management. Since its publication, Lodge *et al.* (2007) has been distributed to all RFMOs, obligating RFMOs to now recognize their role in conservation and to address fundamental issues in management (G. Munro, pers. comm., University of British Columbia, 2008). The panel has also described issues that affect RFMO success in further documents, such as the implementation of ecosystem-based management and the precautionary approach (Mooney-Seus & Rosenberg, 2007), bioeconomics (Bjorndal & Martin, 2007), and the non-member issue (Owen, 2007), all of which were of help to this study.

Using Lodge *et al.* (2007) as a framework, it was possible to formulate a series of criteria for RFMOs upon which to base an assessment. Taken together, the amassed list of 26 criteria represents the core components of a competent RFMO. The criteria were then grouped into five general categories, presented here in Table 2.2:

[13] The High Seas Task Force (HSTF) is a ministerially-run group formed to initiate an action plan against IUU fishing on the high seas.

Table 2.2 List of the 26 criteria upon which this analysis is based.

Category	Criteria	General question
General Information and Organization	1. Area covered	Are clear boundaries stated?
	2. Species of concern	Which species are managed by the RFMO?
	3. Contracting parties	Who is party to the RFMO?
	4. General organization of Commission	How is the organization of the Commission itself?
	5. Commitment to conservation and management	Is the RFMO committed to conservation and management?
	6. Commitment to the Convention and to the Agreement	Is the RFMO committed to the Convention and the Agreement?
	7. Budget	How is the budget allocated?
	8. Data	How are their data collected, compiled and distributed?
Compliance and Enforcement Measures	9. Flag state duties	What are the duties of flag states?
	10. Promoting compliance (i.e., incentives)	What does the RFMO do to promote compliance?
	11. Deterring non-compliance (disincentives/penalties)	What schemes does the RFMO have in place to deter non-compliance?
	12. Enforcement and surveillance	What mechanisms does the RFMO use to enforce its regulations?
Conservation and Management	13. Precautionary Approach (PA) and uncertainty	Is the PA and the acknowledgment of uncertainty evident in their mandate?
	14. Set targets (if applicable)	What are their catch/research targets?
	15. Bycatch, threatened species, habitats, trophic relationships	How does the RFMO address bycatch, threatened species, habitats and ecological interactions?
	16. Rebuilding strategies, new fisheries and adaptation to changing fishery dynamics	How robust are their management and adaptation strategies?
	17. IUU fishing prevention	What are they doing to prevent IUU fishing?
	18. Science	Do they have scientific advice?
Allocation	19. New members	How does the RFMO deal with new members?
	20. Developing states	Does the RFMO acknowledge the disparity between developing and developed states?
Cooperation and Resolutions	21. Transparency	Is transparency practiced?
	22. Full member participation	Is full member participation encouraged?
	23. Working/cooperating with other RFMOs	Does the RFMO work with other RFMOs?
	24. Cooperation with other organizations/bodies (not RFMOs)	Does the RFMO work with other organizations/bodies?
	25. Mandate strengthening	Does the RFMO have mandate strengthening plans?
	26. Assessments and reviews	Have performance reviews been created?

Data for the assessment were taken from available mandates, stock assessments, reports, and other information from each RFMO (for a study that used an analogous methodology, see Sydnes, 2001). For this reason, this study is also inherently a reflection on how RFMOs are communicating their information. Notably, the degree of importance of a criterion to the corresponding RFMO seemed to correlate with its occurrence in available literature. For example, if there was no mention of the precautionary approach in the available information, it was assumed that such a subject was not deemed relevant by the organization and hence a low score would be allocated for that criterion. Alder *et al.* (2001) note this effect in their study.

In our assessment, scores for each criterion ranged from 1 to 10, i.e., there were ten possible scores for each criterion. Shown in Table 2.2 is the list of criteria along with the column entitled "General question": by asking ten different questions per criterion, we were effectively able to obtain a 'yes' or 'no' answer for each criterion, moving up (i.e., on to the next question within the criterion) if the answer was 'yes', and allocating a corresponding score if the answer was 'no' (see Zino, 2007, for the rationale behind this methodology). Table 2.3 offers an example:

Table 2.3 Example of scoring (Criterion # 2: Species of interest; Category: General information and general practice).

Score	Question
1	No mention whatsoever of species of interest?
2	Is there a vague mention?
3	Do they mention organism groups (e.g., whales)?
4	Are species mentioned by common name?
5	Are species mentioned by scientific name (including groups, i.e., tuna-like species)?
6	Are all species named by both scientific and common names?
7	6 + Are there management distinctions between stocks (if applicable)?
8	7 + Is there any mention of other possible fish affected?
9	8 + Are the scientific names/details of the other fish affected mentioned?
10	9 + Is there a description of bycatch?

Generally, RFMO scores followed this sequential system, each question building upon the previous, and thus the scoring was straightforward. Occasionally, however, when the questions did not necessarily chain in a sequential fashion (e.g., when an RFMO could not meet the requirement expressed by a lower ranked question, but could meet that of a higher ranked question), a point system was typically implemented, where each question answered positively was given one point- these points then added up to form the final score. Appendix B presents the set of ten questions for each of the 26 criteria[14].

Small (2005) reviewed the performance of six RFMOs in relation to occurrence of seabird bycatch, and scored criteria between 0 and 1, with four possible scores for each criterion (i.e., 0, 0.5, 0.75 and 1). In the same way, Mooney-Seus and Rosenberg (2007) analyzed the performance of RFMOs in relation to whether or not they had relevant, up-to-date conservation measures (specifically in relation to the precautionary approach and ecosystem-based management) in place in their mandate; each criterion was scored out of three. As mentioned above, Alder *et al.* (2001) used a scoring system out of three. For our study, we concluded that, to make answers both easier to classify and more exact, it was necessary to have a larger scoring range (e.g., a criterion with only three possible scores would not be as precise). Therefore, a score between 1 and 10 was recorded for each of the 20 organizations (including NMFS and WWF), for each of the 26 criteria, creating a matrix of 520 data scores.

It must be noted that scores were not weighted for this assessment. The number of criteria included in this assessment would make such a process difficult. Furthermore, determining which criterion should be given more weight than others could be subjective, depending on the evaluator and the focus of the research. Studies using a similar methodology to ours, i.e.,

[14]Of these 26 criteria, nine could be scored additively rather than sequentially.

quantitatively answering questions by way of a scoring system, also chose not to weight their scores (see Caddy, 1996; Pitcher *et al*., 2008).

After the overall performance score was taken for each RFMO, an average score was computed. The initial data matrix was then divided up into five general categories as shown in Table 2.2 (i.e., General Information and Organization, Compliance and Enforcement Measures, Conservation and Management, Allocation, and Cooperation and Resolutions). These categories were based on the principal themes presented in Lodge *et al.* (2007), and then modified slightly (i.e., related themes were combined to reduce the number of categories). Categorizing in this way illustrated trends in RFMO performance as they related to various key, overarching topics.

The next step was to find patterns in the data by grouping RFMOs according to their similarity. Since the investigation was exploratory, a Hierarchical Cluster Analysis was performed using the statistical program PRIMER 5. First, a similarity matrix was created, analyzing between objects (RFMOs)[15]. From the similarity matrix, a dendrogram was plotted[16], first with outgroups and again without. These methods and the creation of a dendrogram were repeated in another program, SPSS. Next, in PRIMER 5, an Ordination Analysis was computed using Multi-Dimensional Scaling (MDS) to visually illustrate, both in 2-dimension and in 3-dimension, how similar the RFMOs were. A SIMPER analysis was next employed to quantitatively describe and explain the similarity within and between RFMOs. And finally, a correlation analysis was run in SPSS (without the outgroups), to test which, if any, variables were correlated.

[15]The Bray-Curtis measure was implemented in the creation of this matrix. Also, presented in this contribution are results from non-transformed data; the analysis was also run with transformed data, using the square root and log(x+1) methods.
[16]'Group average' was used as cluster mode.

2.3 Results

All criteria scores for each RFMO are shown in Table 2.4. The variance amongst scores was greatest for the 'IUU fishing prevention' criterion, and smallest for 'Science' (see Table 2.5).

Table 2.5 Variation of scores between RFMOs by criterion.

Criterion	SD	Criterion	SD
IUU fishing prevention	2.89	New members	2.23
Precautionary approach	2.75	Working/cooperating with other RFMOs	2.21
Set targets	2.74	Species of concern	2.17
Rebuilding strategies	2.62	Conservation and management	2.12
Schemes to deter non-compliance	2.58	Area covered	2.02
Cooperation with other organizations	2.58	Commitment to Convention and Agreement	1.98
Bycatch, threatened spp., habitats, troph. rel.	2.57	Flag state duties	1.92
Provisions for developing states	2.54	Contracting parties	1.91
Strengthening mandate	2.52	Mechanisms for enforcement and surveillance	1.78
Assessments and reviews	2.38	Organization	1.75
Budget	2.35	Schemes to promote compliance	1.70
Transparency	2.32	Data collection, compilation and distribution	1.24
Full member participation	2.32	Science	1.10

The final scores for overall RFMO performance ('P' scores) varied from 43% (PSC) to 74% (WCPFC), with the average score being 57% (0% being worst possible performance, and 100% being perfect performance). See Table 2.6 for final RFMO P scores.

Table 2.6 Overall performance ('P') scores.

RFMO	P Score (%)	RFMO	P Score (%)
WCPFC	74	ICCAT	57
GFCM	64	SPRFMO	57
IWC	63	NPAFC	55
NAFO	63	IPHC	52
NEAFC	63	NASCO	52
SEAFO	63	SIOFA	47
IATTC	60	CCBSP	46
IOTC	58	CCSBT	44
CCAMLR	58	PSC	43
Average			57

Table 2.4 Results from scoring assessment: presented are the 20 organizations evaluated against the 26 criteria. See Appendix B for criteria definitions.

Criterion	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
CCAMLR	10	9	7	9	10	1	6	6	5	1	4	10	7	9	7	7	9	9	6	1	1	2	4	3	2	5
CCBSP	6	9	7	4	9	3	1	2	2	6	6	5	9	6	5	7	2	8	5	1	4	2	1	1	3	1
CCSBT	2	5	10	8	7	3	6	6	2	4	3	2	5	4	1	6	5	8	4	1	1	2	5	5	4	5
GFCM	10	8	8	9	8	6	10	7	2	8	5	5	4	3	5	7	7	5	6	6	4	2	8	9	9	5
IATTC	8	6	8	9	9	7	8	6	4	5	2	7	6	9	1	6	6	8	2	5	6	7	8	3	7	4
ICCAT	9	10	9	8	2	2	10	2	1	5	3	3	7	7	4	8	8	7	6	5	2	2	7	5	9	7
IOTC	8	8	9	9	6	3	9	8	2	2	1	2	4	9	6	6	8	8	5	7	3	2	7	5	10	5
IPHC	10	8	8	8	8	2	5	2	1	6	4	3	9	6	8	8	1	8	1	2	2	10	5	2	6	2
IWC	10	10	7	8	10	5	6	4	2	8	4	8	8	8	8	7	2	8	4	8	5	5	5	5	9	1
NAFO	10	9	8	9	9	4	6	6	2	9	5	6	9	4	5	8	8	7	8	2	5	2	3	8	8	5
NASCO	6	4	6	8	6	2	6	6	2	2	3	9	1	3	10	9	4	7	3	1	4	2	6	9	6	3
NEAFC	8	6	9	9	7	4	6	6	4	8	6	5	7	2	4	5	9	6	9	1	7	2	7	9	9	10
NPAFC	8	8	7	10	6	3	6	6	4	6	8	1	1	3	9	8	9	9	3	1	2	4	7	7	6	1
PSC	8	8	6	9	8	1	8	5	1	1	1	3	1	3	9	9	1	8	1	2	1	5	1	1	8	2
SEAFO	10	8	8	5	10	7	7	6	5	4	5	6	5	5	5	9	7	7	5	5	6	2	4	9	8	5
SIOFA	8	3	7	4	4	4	3	8	6	5	3	5	3	2	3	6	2	6	7	5	5	6	4	8	4	1
SPRFMO	8	4	1	8	8	5	6	6	4	5	4	7	3	8	4	9	5	7	6	6	8	5	4	4	10	3
WCPFC	9	5	8	8	7	7	10	8	6	9	5	10	6	8	7	8	7	9	6	7	8	5	8	7	10	4
NMFS	5	1	1	4	4	5	8	1	1	1	6	1	5	1	1	7	7	4	1	1	2	1	10	1	1	1
WWF	1	1	1	1	1	1	5	1	1	1	1	1	1	1	5	1	1	4	1	1	1	1	4	8	1	1

Notes on data:

-Criterion 9 scores low overall: most RFMOs do not have adequate schemes to promote compliance.

-IPHC, Criterion 22: Unlike most RFMOs, full member participation is required in this organization because there are only two members. From the 1979 Protocol: "All decisions of the Commission shall be made by a concurring vote of at least two of the Commissioners of each Party."

-CCBSP, Criterion 24: No mention of working with other organizations, as is confirmed by CCBSP member, who says they do not collaborate with other organizations- they are a very small organization (P. Niemeier, pers.comm., NMFS, 2008).

-Outgroups (i.e., non-RFMOs), are bolded.

Once the data were broken into five different categories, we examined the trends in each category (Table 2.7): the overall strongest (i.e., highest scoring) category for all RFMOs, by far, was that of 'General Information and Organization,' with a 70% average score. The overall worst scores across RFMOs were those in the 'Allocation' category, which had an average score of 43%. The overall single highest individual score in a category belonged to CCAMLR, which scored an 83% in the category of 'Conservation and Management'. WCPFC was the most consistently high scoring RFMO across all categories, and thus received the highest overall score, too.

Table 2.7 Overall RFMO scores (in %) in five categories: GenInfo (General Information and Organization), Comp&Enforce (Compliance and Enforcement Measures), Cons&Manage (Conservation and Management), Allocation, Coop&Resol (Cooperation and Resolutions).

GenInfo		**Comp&Enforce**		**Cons&Manage**		**Allocation**		**Coop&Resol**	
GFCM	**79**	WCPFC	**70**	CCAMLR	**83**	WCPFC	**65**	NEAFC	**73**
IWC	**79**	NEAFC	**66**	IWC	**80**	GFCM	**60**	WCPFC	**70**
SEAFO	**79**	NPAFC	**66**	WCPFC	**78**	IOTC	**60**	GFCM	**62**
WCPFC	**79**	NAFO	**60**	NASCO	**73**	IWC	**60**	IATTC	**58**
NAFO	**78**	GFCM	**58**	IPHC	**65**	SIOFA	**60**	SEAFO	**57**
IATTC	**77**	SEAFO	**54**	CCBSP	**63**	SPRFMO	**60**	SPRFMO	**57**
CCAMLR	**76**	CCAMLR	**50**	NAFO	**60**	ICCAT	**55**	ICCAT	**53**
IOTC	**73**	SIOFA	**48**	IATTC	**58**	NAFO	**50**	IOTC	**53**
ICCAT	**72**	SPRFMO	**48**	SPRFMO	**55**	NEAFC	**50**	NAFO	**52**
IPHC	**72**	IATTC	**46**	ICCAT	**53**	SEAFO	**50**	IWC	**50**
NPAFC	**72**	IOTC	**42**	IOTC	**53**	CCAMLR	**35**	NASCO	**50**
PSC	**72**	CCSBT	**40**	SEAFO	**53**	IATTC	**35**	SIOFA	**47**
NEAFC	**67**	IWC	**40**	NEAFC	**45**	CCBSP	**30**	IPHC	**45**
SPRFMO	**62**	ICCAT	**38**	GFCM	**43**	CCSBT	**25**	NPAFC	**45**
CCSBT	**61**	CCBSP	**36**	PSC	**40**	NASCO	**20**	CCSBT	**37**
CCBSP	**60**	NASCO	**34**	NPAFC	**35**	NPAFC	**20**	PSC	**30**
NASCO	**60**	IPHC	**28**	SIOFA	**33**	IPHC	**15**	CCAMLR	**28**
SIOFA	**50**	PSC	**18**	CCSBT	**30**	PSC	**15**	CCBSP	**27**
Average	**70**		**47**		**55**		**43**		**50**

The results from the PRIMER 5 analysis[17] are shown in dendrogram format in Figure 2.1. Note that outgroups are included, though including or excluding the outgroups from the analysis did

[17]It should be noted that the same analysis was repeated using the SPSS software; the SPSS results were similar to those presented in Figure 2.1.

not affect the other clusters. The results show, as expected, that the outgroups, NMFS and WWF, fall outside the range for RFMOs.

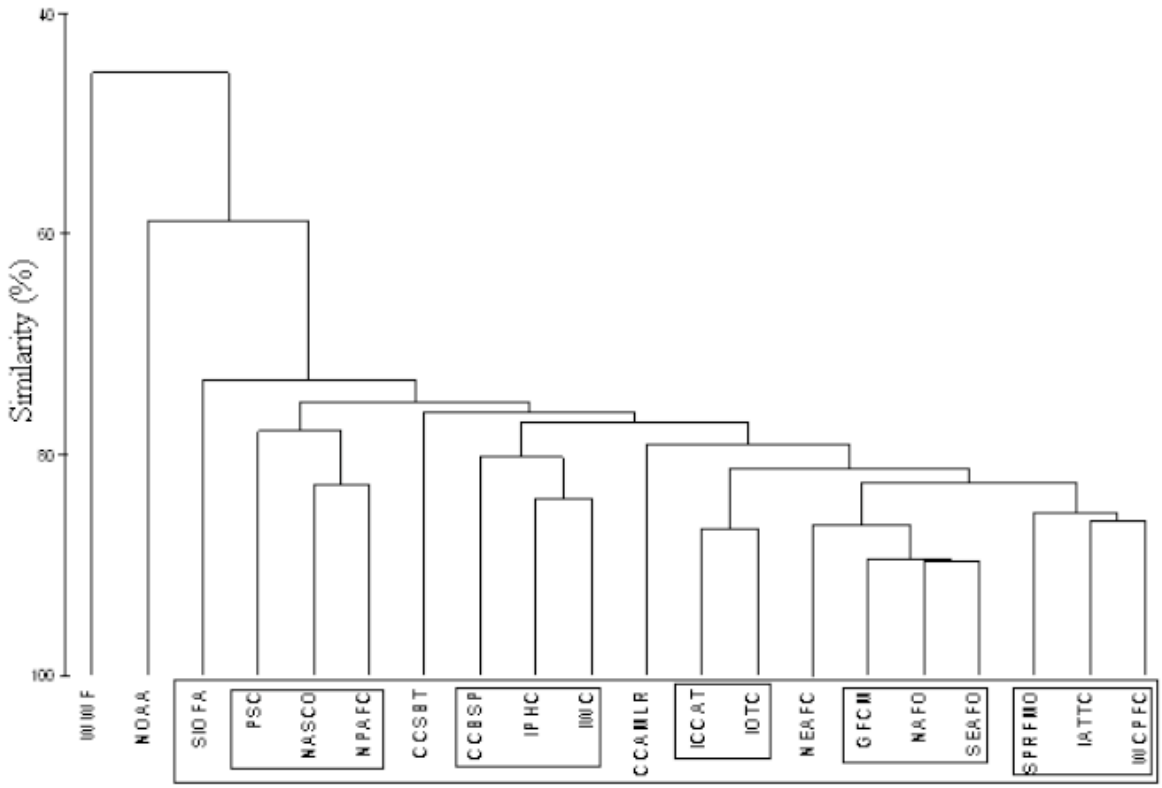

Figure 2.1 Dendrogram from SIMPER analysis, depicting the clustering of RFMOs and two outgroups. Boxes denote cluster groups.

Beyond this, clusters, though small, did occur, and are identified in boxes in Figure 2.1. The main cluster group is represented by the largest box in Figure 2.1 and encompasses all of the RFMOs (while excluding NMFS and WWF, as expected). From the dendrogram, we can see that SIOFA appeared to be the least similar to other RFMOs. Conversely, GFCM, NAFO and SEAFO were the most similar RFMOs and together formed a tight cluster. As noted in the Materials and Methods section, the similarity matrix was created first using non-transformed data and then again using transformed data to test whether the results were affected; the results were then compared and shown to be very similar[18].

Using SIMPER, it was possible to pinpoint which criteria scored similarly between RFMOs. Conversely, it was also possible to analyze which criteria caused RFMOs to differ from each other, and by how much. Table 2.8 shows the SIMPER results for the most similar cluster group, GFCM, NAFO and SEAFO, whose average similarity was 89.5%; for most criteria, these three RFMOs scored either identically or very similarly to each other.

Table 2.8 SIMPER results for most similar cluster group, GFCM, NAFO and SEAFO. Criteria shown are the main contributors of similarity within the cluster (for the list of all criteria see Appendix B). Average similarity within criterion: 89.5%.

Criterion	Av.Abund	Contrib%	Cum%
Area covered	10.0	6.8	6.8
Stated commitment to conservation & mgmt	9.0	5.7	12.4
Working/cooperating w/ other organizations	8.7	5.7	18.1
Strengthening of mandate	8.3	5.4	23.5
Species of concern	8.3	5.4	29.0
Contracting parties	8.0	5.4	34.4

From the correlation analysis, the variables that were highly significant (i.e., $p < 0.01$) and most highly correlated (i.e., $r > 0.65$), are shown in Table 2.9 below:

Table 2.9 Results from correlation analysis.

Variable a	Variable b	r value
Transparency	Commitment to the Convention and the Agreement	0.76
Science	Bycatch, threatened species, habitats, trophic relationships	0.68
Species of concern	Area covered	0.68
Strengthening of mandate	Provisions for developing states	0.68
Flag state duties	Schemes to promote compliance	0.67
Assessments and reviews	IUU fishing	0.66

[18]The only minor difference was that the results from transformed data showed a greater similarity between IPHC and PSC than the results from non-transformed data.

2.4 Discussion

The highest scoring RFMO in overall performance was WCPFC at 74%, scoring 10% higher than the next most effective RFMO, GFCM (see Table 2.6). Established in 2004, WCPFC is currently the newest functioning RFMO, and it is likely that the newer the RFMO, the more likely it will conform with the newest regulations (see Table 1.2 from chapter 1 for how regulations have developed through time). Of particular note are the regulations pertaining to conservation measures, which have changed significantly through the years, and which affected many of our criteria. Therefore, it is possible that WCPFC is more up to date than the other RFMOs, which led to a better score in effectiveness (in contrast however, SEAFO, which came into force in 2003, scored quite a bit lower at 63%).

PSC had the overall lowest score at 43%. Notably, PSC and IPHC (the latter which scored 52%) are limited to just two contracting parties, Canada and the USA. In addition, they are also the only two RFMOs that function primarily within national jurisdiction. These organizations scored poorly in part because they do not fit the ‘typical’ RFMO framework.

CCAMLR scored highest in the category of ‘Conservation and Management’, which was perhaps unsurprising since this organization has been lauded as one of the better managed RFMOs (Dunn *et al.*, 2007), as well as progressive in implementing conservation measures (see Probert *et al.*, 2007). Indeed, CCAMLR scored 89% in a study determining RFMO performance in relation to bird bycatch, far higher than any other RFMO assessed (Small, 2005).

Out of the five categories (i.e., 'General Information and Organization', 'Compliance and Enforcement Measures', 'Conservation and Management', 'Allocation', and 'Cooperation and Resolutions'), 'General Information and Organization' scored highest across all RFMOs. This is likely because it is the most straightforward to explain and interpret, and it is time-independent (i.e., such information was always fundamental in an RFMO, irrespective of whether or not the newer regulations were in force at the time of the RFMO's inception).

In terms of the lowest scoring category, this fell to 'Allocation'. Problems with this category are attributable to the two criteria that they house: 1. New Members, and 2. Developing States. RFMOs generally did not score highly when it came to the New Members criterion, with exceptions being NAFO and NEAFC. The 'new member' problem has received a lot of criticism in the literature (see Bjorndal *et al.*, 2000; Pintassilgo & Duarte, 2001), and, while RFMOs may not be specifically acknowledging these criticisms, there is clearly ambiguity around the topic. It was therefore not surprising that RFMOs lacked adequate information on this topic and hence scored poorly overall in this criterion. In terms of the Developing Countries criterion, many RFMOs did not even mention the subject, or if they did, only minimally. All but two RFMOs have developing countries among their members, yet many still failed to mention their importance. In other instances, developing countries were acknowledged but there was no mention of provisions for them; exceptions were ICCAT and IWC, both by far the largest RFMOs in terms of number of member states, with 45 and 83 members, respectively. They are also the two organizations with the largest number of developing countries, likely why they have well-documented processes and provisions on this subject.

The high variance among scores related to IUU fishing prevention reveals the lack of consistency across RFMOs in addressing the issue. Though this problem has been deemed one of the most crucial to tackle if effective fisheries are to exist, it is also one of the most difficult to address (e.g., it will vary in extent from region to region and depend on the countries involved, etc.). The complexity of IUU fishing and the lack of a collective solution likely explain the variation among RFMO scores in this criterion. The low variance amongst scores relating to Science, however, is encouraging as the scores were mostly high; this reveals that RFMOs understand the importance of science in their management, and a methodology is consistent across them.

The cluster analysis reveals that although these 18 RFMOs differ in size, organization and scope, they are mostly similar as a conglomerate in relation to the core components of an operational RFMO. While certain individual criteria might differ markedly between RFMOs, no one RFMO is exceptionally different from the rest. In essence, they all fall within one cluster, with an average similarity of about 78%, the least similar RFMO still sharing about 73% similarity. This is in contrast with WWF and NMFS: from Figure 2.1 we see that WWF and NMFS are markedly different from the RFMOs, WWF being the least similar. This confirms that indeed not all organizations are the same (i.e., that they do not all follow the same practices as RFMOs): WWF is an international NGO that focuses on conservation, while NMFS is a national organization that manages fisheries within the USA; both WWF and NMFS were included in this analysis to represent entities other than RFMOs. While certain characteristics of the outgroups (WWF and NMFS) overlap with RFMO characteristics (e.g., structural features common to most organizations), there was a clear division between the groups. In the case of WWF, the majority of criteria evaluated were irrelevant (e.g., Total Allowable Catches, Flag state duties, Monitoring for IUU, etc.), while for NMFS, although questions were more relevant, it was still difficult to score well as a national marine organization in an international fisheries organization assessment. The results show that although RFMOs score poorly overall as management organizations, they still score higher than non-relevant organizations. This suggests that, as a minimum, they have some fundamental, unifying structures in place.

Upon comparing the three most similar RFMOs – GFCM, NAFO, and SEAFO – there appears to be no obvious connection between them: each manage different oceans, were established at different times, and vary in number of member states and species targeted as well as types of species targeted (see Appendix A for RFMO characteristics). However, other small clusters from the dendrogram in Figure 2.1 reveal groups with more apparent similarities. For example, the cluster including PSC, NASCO and NPAFC is most notable in that these three organizations all focus on salmon stocks, and none of them have commercial fleets in their Convention areas. Rather they provide management advice, scientific research, and sometimes enforcement.

CCBSP, IWC and IPHC formed a small cluster and, though differing in targeted species, area covered and size of organization, they all share a distinguishing characteristic: none of them have active commercial fishing fleets within their convention area. CCBSP has closed its pollock fishery in the Bering Sea Donut Hole due to the fishery's collapse; IWC has had a moratorium on whaling since 1986; and IPHC recommends TACs but does not have commercial fleets itself – it is a management body only.

The most distinct RFMOs (i.e., the least similar to others), were SIOFA, CCSBT and CCAMLR, and to a lesser extent, NEAFC. SIOFA, CCSBT and CCAMLR each have apparent individual characteristics that could separate them from the others. SIOFA has not yet come into force as an organization[19]; CCSBT was established in response to the collapse of the Southern bluefin tuna stock, a stock which has not, since CCSBT's establishment, recovered; and CCAMLR is the only RFMO to focus on the Antarctic region and puts a greater emphasis on conservation and ecology than the others.

The correlation analysis revealed which variables were significantly connected. Table 2.10 shows the six most correlated pairs (r >0.65) with high significance, along with a brief speculation on the cause of their correlation.

Table 2.10 The six most highly correlated variables in the assessment, and possible explanations for their correlation.

Variable a	Variable b	Possible explanation for correlation
Transparency	Commitment to the Convention and to the Agreement	Convention and Agreement stress transparency in processes of organizations; therefore it follows that if an organization abides by these treaties, it should be transparent.
Science	Bycatch, threatened species, habitats, trophic relationships	If the science of an RFMO is thorough, comprehensive data on these interactions would thus be included.
Species of concern	Area covered	These two variables are the most straightforward criteria and the most basic.
Strengthening of mandate	Provisions for developing states	A strong mandate would mean it is current, and a current mandate should inherently have a good description of provisions for developing states.
Flag state duties	Schemes to promote compliance	This association is hopeful: if flagstate duties are well-defined, perhaps compliance will be greater within RFMOs.
Assessments and reviews	IUU fishing prevention	RFMOs that did not have any assessments or performance reviews did not have any mechanisms to deal with IUU fishing. Performance reviews and procedures to combat IUU are recent phenomena, perhaps explaining their connection. In addition, reviewing performance could instigate a plan to deal with IUU fishing.

[19] SPRFMO has not, like SIOFA, yet come into force; however SPRFMO has made more progress towards ratification than SIOFA.

Perhaps the more subtle and more interesting correlations from Table 2.10 are the ones that could have greater implications for RFMO management. For instance, the correlation between ‘Schemes to promote compliance’ and ‘Flag state duties’ implies that if duties are well-defined, RFMO compliance has a better chance. Another example shows that if frequent assessments and performance reviews are carried out, as a consequence, processes to deal with IUU fishing could emerge. Finally, one example illustrates that strong mandates could produce better provisions for developing states. These correlations could indicate that when required to assess certain key organizational characteristics, RFMOs are inherently forced to consider other central matters; such ‘influential’ criteria should be of primary interest in RFMO management.

One of the difficulties with a group of organizations as diverse as RFMOs, is that it is hard to come up with criteria that are equally relevant to them all. That all of these RFMOs score so similarly is interesting, given their distinct backgrounds and mandates. While there has been no real ‘template’ for RFMO establishment or methodology, the majority still follow a certain format. This offers optimism in that a more current approach, such as is offered by Lodge *et al.* (2007), could indeed be implemented. However, as their overall low scores reveal, these organizations have a lot to learn from best practices.

2.5 Shortcomings and pitfalls

The most obvious limitation of this study is that the method of data collection was open to error and subjectivity on the part of the collector. Although the format of posing questions for each criterion cut down on ambiguity, there was always the possibility that available information was misinterpreted, bypassed or simply not found by the collector, and that scores would therefore not accurately reflect the organization. However, the advantage lay in the consistency of the collector (there was only one data collector, and any difficulty in scoring would therefore likely be consistent across organizations), and consistency of the method (i.e., across criteria and across RFMOs).

Another potential problem with this study is the criteria upon which we based the effectiveness of an RFMO. There is the possibility that the criteria we chose for this study are not adequate in determining RFMO effectiveness. In addition, the criteria for best practices will always be changing, as our knowledge about the high seas and management increases, and as unforeseen events dictate new policies. However, the nature of management must be dynamic, and the best practices Chatham House report forms a solid, and much-needed, baseline.

Lastly, it is understood that because the collected information was based on reports and descriptions from the assessed RFMOs themselves, there exists the likelihood of potential bias: ideally, data would be taken from a third party database with relevant information on global RFMOs; however, no such database currently exists. Thus, the method of data collection employed was the only way we could have assessed all the criteria, and importantly, it was consistent across RFMOs. Also, as mentioned above, none of the RFMOs scored very high, which indicates that either it is unlikely their information is very biased, or that they are completely oblivious to best practices. However, the potential for bias reinforces the importance of the second part of our study: the effectiveness of RFMO management as determined by the state of their stocks.

2.6 Conclusion

It is clear from our results that RFMOs today do not conform with current best practices. The Lodge *et al.* report came out in 2007, and, therefore, it is possible that RFMOs are simply in transition. Unfortunately, we must also note that most of the concepts and principles upon which these practices were based have been in place for over a decade, often longer.

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Chapter 3

State of the stocks: Adding an empirical approach to the overall evaluation of the effectiveness of RFMOs[20]

Fishing is transforming the high seas. Giant predatory fish are today following the fate of the great whales, disappearing place by place, species by species.

Roberts (2007)

3.1 Introduction

Because fisheries have historically concentrated along coasts (Jackson *et al.*, 2001), the majority of documented fishery collapses have occurred within national jurisdiction. Yet the high seas fisheries are emerging as more vulnerable to overexploitation than their coastal neighbours. High seas fish stocks are mostly deep-sea species – about 87% of the high seas is deeper than 1000 metres (Roberts, 2007) – and are typically long-lived and late-spawning (Roberts, 2002), making them more vulnerable to extinction (Roberts & Hawkins, 1999). In addition, the life-histories of many stocks — as well as knowledge of those ecosystems (Cheung *et al*., 2005) — are relatively poorly understood (Koslow, 2007); and finally, the high seas are harder to regulate than national waters (due to size, environment, nature of international waters- see chapter 1 of this research), and consequently, less regulated (Gjerde & Kelleher, 2005).

[20] A version of this chapter will be submitted for publication. Cullis-Suzuki, S., and Pauly, D. State of the stocks: Adding an empirical approach to the overall evaluation of the effectiveness of RFMOs.

Whereas the effects of fishing have been documented in coastal areas, the consequence of biomass loss in the high seas is not known (Myers & Worm, 2003). The considerable vulnerability of these stocks, coupled with recent overfishing patterns, make high seas stock evaluations particularly critical. While certain high seas stock declines have been documented and even publicized – Patagonian toothfish, orange roughy, bluefin tuna, for example – many of the high seas and deep sea species have yet to be identified (Koslow, 2007), let alone evaluated in a stock assessment. For those stocks with available information, assessments are key: not only do they tell us about the stock at hand, they could also help set potential precautionary limits for related stocks with little information.

As catches for many large predator fish on the high seas decline (Myers & Worm, 2003), and as many of these stocks appear to be in jeopardy (Roberts, 2007), the effectiveness of RFMOs – currently the only legally accepted form of management on the high seas – has been brought into question.

The focus of this chapter is to assess the state of stocks under RFMO management as reflected by stock biomass. While catch data are commonly used in fish stock assessments, such data offer limited information. A basic way to gauge the effect of an RFMO on its resources is to measure how much of those resources remain. Therefore, stock biomass of primary species managed was selected as our stock status indicator: a higher relative stock biomass was equated with good management, whereas a lower stock biomass was equated with poor management.

Of course, some factors that affect stock biomass are outside the control of RFMOs (foremost, environmental changes). Fishing pressure, however, is a controllable parameter with a large influence on stock biomass. Overfishing jeopardizes the health of a stock but can be prevented through proper management; in this study, therefore, we focus on biomass as it relates to fishing mortality rates. Time-series biomass data were also collected to examine historical trends in stocks in relation to RFMO establishment, and thus strengthened our conclusions.

Moreover, this study was carried out as the second phase of a broad assessment looking at the effectiveness of RFMOs. Whereas the results of chapter 2 correspond to the theoretical effectiveness of RFMOs, this chapter examines the effectiveness of RFMOs in practice, by evaluating the health of their resources. Combined and compared together, these results become the most concrete, current assessment of the overall effectiveness of global RFMO management to date.

3.2 Materials and methods

3.2.1 Trends through time

Biomass data, through time, of the primary specie(s) under management were collected for each RFMO[21] (see Table 3.1). This was done to obtain a visual trend of each stock, specifically in relation to RFMO establishment; in this way, it was possible to infer the effects of RFMO management on their various stocks[22]. Species assessed were chosen by importance to the respective RFMO (i.e., they comprised the majority of that RFMO's catch, or the RFMO was

[21] Dependent on available information.
[22] See Fromentin (2009) for the importance of time-series data in understanding fish stocks.

established to manage them); however, assessments were principally restricted to those species with available biomass information[23].

Table 3.1 List of species assessed in this study.

RFMO	Species assessed
1. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)	Krill, Patagonian toothfish.
2. Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea (CCBSP)	Pollock.
3. Commission for the Conservation of Southern Bluefin Tuna (CCSBT)	Southern bluefin tuna.
4. General Fisheries Commission for the Mediterranean (GFCM)	Anchovy, Sardine.
5. Inter-American Tropical Tuna Commission (IATTC)	Bigeye tuna, Skipjack tuna, Yellowfin tuna.
6. International Commission for the Conservation of Atlantic Tunas (ICCAT)	Albacore tuna, Atlantic bluefin tuna, Bigeye tuna, Skipjack tuna, Yellowfin tuna.
7. Indian Ocean Tuna Commission (IOTC)	Albacore tuna, Bigeye tuna, Yellowfin tuna.
8. International Pacific Halibut Commission (IPHC)	Pacific halibut.
9. International Whaling Commission (IWC)	Blue, Bryde's, Fin, Humpback, Minke, Right, Sei, Sperm whale[24].
10. Northwest Atlantic Fisheries Organization (NAFO)	American plaice, Cod, Greenland halibut, Redfish, Shrimp.
11. North Atlantic Salmon Conservation Organization (NASCO)	Atlantic salmon.
12. North East Atlantic Fisheries Commission (NEAFC)	Blue whiting, Haddock, Herring, Mackerel, Redfish.
13. North Pacific Anadromous Fish Commission (NPAFC)	Chum, Pink, Sockeye.
14. Pacific Salmon Commission (PSC)	Chinook, Chum, Coho, Sockeye.
15. South East Atlantic Fisheries Organization (SEAFO)	RFMO too recent- not assessed.
16. South Indian Ocean Fisheries Agreement (SIOFA)	RFMO too recent- not assessed.
17. South Pacific Regional Fisheries Management Organization (SPRFMO)	RFMO too recent- not assessed.
18. Western and Central Pacific Fisheries Commission (WCPFC)	Albacore tuna, Bigeye tuna, Skipjack tuna, Yellowfin tuna.

As is evident from Table 3.1, the number of stocks assessed in this study varied across RFMOs. Out of the 15 RFMOs that had available biomass data, the minimum number of species assessed

[23] Congruently, those stocks with available biomass information were usually the species of main importance to the RFMO.
[24] In the case of IWC, biomass information was collected only for the 'great whale' species, and from there the nine whale species with largest abundance were included in the study.

was one, and the maximum was nine[25]. The three RFMOs whose biomass data were not assessed, were SEAFO (established in 2003), SIOFA (not yet established) and SPRFMO (not yet established); these RFMOs were considered too recent to be adequately evaluated with the others, and were therefore not included in the assessment[26]. In addition, the length of the time series varied for each stock assessed (see Appendix A), and was determined by data availability. The longer the time series, the more informative the trend, thus longer time-series were sought.

The methodology for data collection in this study was based on Alder *et al*. (2001). Most time-series of biomass were taken from stock assessments and annual reports available from RFMO websites. Occasionally, information was taken from the International Council for the Exploration of the Sea, ICES, if RFMO stocks fell within its study area; other times, when asked, RFMO staff sent us biomass data directly. Lastly, there were two species whose biomass trends were collected through altogether different means: krill, managed under CCAMLR, and pollock, managed by CCBSP. Krill biomass data were taken from a peer-reviewed paper (see Siegel *et al.*, 1998), and pollock biomass data were compiled from qualitative descriptions of abundance (see FAO, 1994; Ianelli *et al*., 2006; Kang *et al*., 2006; L.Loh-Lee, pers. comm., NMFS, 2008), and evaluated by implementing the methodology explained in Palomares *et al*. (2006).

It must also be noted that obtaining an accurate biomass estimate for the entirety of a species' range (which sometimes comprised the majority of the global ocean, such as for tuna and whales), is challenging at best; therefore it was the pattern of biomass through time (i.e., the

[25] Note: IWC was the only organization to reach this maximum.
[26] It should be noted that WCPFC, established in 2004, was also considered to be too recent to be assessed- however its species' biomasses were included in Appendix A simply due to data availability.

relative trend), that was prioritized in this study. (For example: if data on the entire species' population did not exist, then an indicator stock was used, i.e., a stock whose biomass fluctuations were representative of the larger population).

3.2.2 Current state of stocks

The next step in this study was to gauge the current state of each stock under RFMO management. In total, 48 stocks across 14 RFMOs were assessed, and the status of these stocks is shown in Appendix A. Three RFMOs were too new to be assessed: SEAFO, SIOFA, and SPRFMO[27], while PSC was also not assessed due to data constraints[28]. It is important to emphasize that this part of the assessment was performed to determine the health of the stocks, not to measure how RFMOs have responded to low biomass levels (the latter analysis could be performed using a different scoring system, and will be explored in the Discussion section). To do this, we graphed F/Fmsy against B/Bmsy, where F is current fishing mortality rate, Fmsy is the fishing mortality rate which can maintain MSY, B is current biomass, and Bmsy the biomass that can sustain MSY. This methodology is used in ICCAT stock assessment reports (for examples see ICCAT, 2008), and is illustrated in Langley *et al.* (2009), and in Worm *et al.* (2009) (in the latter case, U, exploitation rate, replaces F). Ideally, in fisheries, both ratios (i.e., F/Fmsy and B/Bmsy) would be 1, meaning that F and B are at the very points which produce MSY, therefore maximizing catch while not jeopardizing the future state of the stock. However, if F/Fmsy>1, then the stock is overfished; likewise, if B/Bmsy<1, then biomass is critically low.

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[27] WCPFC, though also recently established, was included in this assessment; see the Discussion section of this chapter.

[28] Although salmon biomass information was obtained from PSC, catch data are not documented by PSC. While DFO and NOAA have salmon catch data, they do not present them consistently with PSC data (i.e., by same streams within watersheds, etc.); therefore, it was not possible to determine accurate stock statuses for PSC.

The results were described through phase plots, wherein four quadrants depicted the condition of the stock[29] (Figure 3.1).

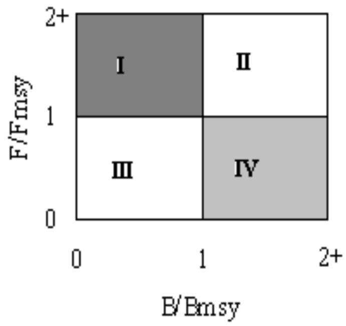

Figure 3.1 Example of a phase plot.

In Figure 3.1, the upper left grey quadrant I corresponds to the ‘worst’ quadrant: the stock is both overfished and has critically low biomass (i.e., F/Fmsy>1 and B/Bmsy<1). The lower right grey quadrant IV corresponds to the ‘best’ scenario: the stock is not overfished and has high biomass (i.e., F/Fmsy<1 and B/Bmsy>1) (‘best’ being based on ICCAT’s objectives; see FIRMS, 2007). The other two quadrants, the white upper right quadrant II and bottom left quadrant III, correspond to stocks that are overfished and have critically low biomass levels, respectively.

A phase plot was created for each of the 48 stocks, and, depending on which quadrant the data point fitted, the RFMO obtained a corresponding score between 0 and 3: if the stock fell within quadrant I, the RFMO scored a 0, if the stock fell within quadrant II or III, the RFMO scored a 1, and if the stock fell within quadrant IV, the RFMO scored a 3[30]. The scores were added up for all stocks within each RFMO, and then divided by the maximum possible score, resulting in a final ‘Q’ score.

[29] FIRMS (2007) and Zino (2007) further detail this methodology.
[30] Though other scoring keys were tested, this method best represented the circumstances for this study; an alternative key will be described in the Discussion section.

This methodology was best suited for tuna RFMOs, as the majority of tuna RFMOs present information in an analogous fashion, or present data which is easily converted to the phase plot format. The majority of the data required for this research was taken from stock assessment reports available from RFMO websites. While many RFMOs (mostly non-tuna) lacked the specific B/Bmsy and F/Fmsy parameters in their stock assessments, they had similar constraints. Therefore, with the information given, phase plots were recreated in these instances, resulting in plots that were, while not the same, comparable. In the cases where Bmsy was not given, a proxy of 35% initial or "pristine" biomass, Bo, was used (see Clark, 1991). Other times, Bmsy was presented as Blim or Bref (F was often represented the same way); in these cases, the Blim or Bref was used in place of Bmsy (see Beddington *et al*., 2007). When Fmsy was not estimated, and no Flim or Fref was given, Fmsy was taken for that species from FishBase (see www.fishbase.org). Other changes to the phase plot template occurred as dictated by data availability, and are presented in Appendix A. Still, while data availability was, again, the limiting factor, Appendix A depicts informative scenarios regarding the relationships between F and B.

3.2.3 Combining results

Recall that chapter 2 evaluated the theoretical effectiveness of RFMOs, i.e., their performance in relation to a best practices guide. Here, the results from chapter 2 are shown again in Table 3.2:

Table 3.2 Final performance scores ('P' scores).

RFMO	P Score (%)	RFMO	P Score (%)
WCPFC	74	ICCAT	57
GFCM	64	SPRFMO	57
IWC	63	NPAFC	55
NAFO	63	IPHC	52
NEAFC	63	NASCO	52
SEAFO	63	SIOFA	47
IATTC	60	CCBSP	46
CCAMLR	58	CCSBT	44
IOTC	58	PSC	43
Average			57

The final scores from chapter 2 and from this chapter were compared, and finally, added up for a grand total score ('T' score), representing the overall effectiveness of each RFMO.

3.3 Results

3.3.1 Trends through time

The general trend in biomass for most species within management under RFMOs is that their stocks have declined (see Appendix A). Indeed, the overwhelming majority of stocks assessed have undergone severe declines, from which few have recovered to pre-exploitation levels, one obvious exception being NEAFC's Norwegian-spawning herring (Figure A.12).

In relation to RFMO establishment, the majority of RFMOs did not seem to have a visible positive effect on the stocks; indeed for certain RFMOs, notably IWC and ICCAT, the establishment of the RFMO was followed by a further depletion of stocks.

Population sizes of certain stocks fluctuated enormously through time, particularly those of anadromous fishes.

3.3.2 Current state of stocks

Of the 48 stocks assessed, sixteen are not at critically low biomass levels nor being overfished, amounting to 33% of all stocks assessed. Six stocks are currently being overfished only, while 18 stocks have low biomass, accounting for 13% and 38% of all stocks assessed, respectively. Finally, eight stocks have low biomass levels and are currently being overfished, amounting to 17% of all stocks. The final Q score for each RFMO is shown in Table 3.3. Notably, the marks are all low; only one RFMO, CCAMLR, received a perfect Q score (and only one stock was evaluated for this RFMO).

Table 3.3 Breakdown of Q scores, including number of stocks per quadrant. Q score = Avg. score/Max. score.

RFMO	Total # stocks	Quad I	Quad II & III	Quad IV	Total (after weighting)	Max. score	Total Q score (%)
Weighting		**0**	**1**	**3**			
CCAMLR	1	0	0	1	3	3	100
CCBSP	1	0	1	0	1	3	33.3
CCSBT	1	1	0	0	0	3	0.00
GFCM	2	0	2	0	2	6	33.3
IATTC	3	2	0	1	3	9	33.3
ICCAT	8	3	3	2	9	24	37.5
IOTC	3	0	1	2	7	9	77.8
IPHC	1	0	1	0	1	3	33.3
IWC	9	0	9	0	9	27	33.3
NAFO	5	1	2	2	8	15	53.3
NASCO	1	0	1	0	1	3	33.3
NEAFC	6	1	1	4	13	18	72.2
NPAFC	3	0	1	2	7	9	77.8
WCPFC	4	0	2	2	8	12	66.7
Average							48.9

3.3.3 Combining results

The last part of the assessment involved comparing the P scores each RFMO received in chapter 2 to the Q scores they received in this chapter (Figure 3.2).

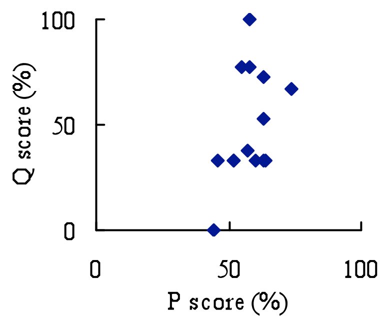

Figure 3.2 Linear regression between P and Q scores.

Figure 3.2 shows a bivariate plot of the Q versus the P scores, which has a positive correlation (r=0.45), but was not significant (p=0.11). A weighted regression was also carried out, and the results were not significant. A multiple regression analysis was performed, the results of which showed 'IUU fishing prevention' as the criterion accounting for the largest variance explained around the Q score, at $r^2 = 0.43$ (which was not significant). Finally, the P and Q scores were summed up for a final, total score (T score), as shown in Table 3.4:

Table 3.4 Combining results from chapters 2 and 3 for total 'T' scores: avg(P+Q) = T. Scores expressed in %.

RFMO	P score	Q score	T score
CCAMLR	58	100	79
WCPFC	74	67	70
IOTC	58	78	68
NEAFC	63	72	68
NPAFC	55	78	66
NAFO	63	53	58
GFCM	64	33	49
IWC	63	33	48
ICCAT	57	38	47
IATTC	60	33	47
IPHC	52	33	43
NASCO	52	33	43
CCBSP	46	33	40
CCSBT	44	0	22
SEAFO	63	-	N/A
SPRFMO	57	-	N/A
SIOFA	47	-	N/A
PSC	43	-	N/A
Average			53

Certain RFMOs scored similarly on both assessments, with three RFMOs scoring within 10% between assessments. CCAMLR had the overall highest Q score at 100%, which differed markedly with its P score of 58%. CCSBT had an overall T score of 22%, the lowest total score of all, followed by CCBSP, NASCO and IPHC. Of note is WCPFC, which scored relatively high P and Q scores.

3.4 Discussion

...the reduction of fish biomass to low levels may compromise the sustainability of fishing…

Myers & Worm (2003)

One way of identifying whether or not an organization is based on "dead letter provisions" – essentially terms that the organization supposedly abides by but are in fact, never put to use (Sydnes, 2001) – is to compare their performance assessment with the state of the stocks they are to manage. The question is then: do they match up? Indeed, we could go further and ask: does the score of an RFMO in relation to best practices guidelines determine the state of their stocks? The main conclusion based on our results is that RFMO management on the high seas is inadequate. From our results, we see that 67% of stocks under RFMO management either have low biomass, are overfished, or both (see Appendix A). Such a finding is in line with FAO (2009), which states that: "In the case of straddling stocks and of other high seas fishery resources, nearly two-thirds of the stocks for which the state of exploitation can be determined were classified as overexploited or depleted. These high seas fishery resources constitute only a small fraction of the world fishery resources, but they can be considered key indicators of the state of a major part of the ocean ecosystem." The verdict: the majority of high seas fish stocks under RFMO management are under threat.

Though it was the current state of stocks that was evaluated against the RFMOs' theoretical performance, the biomass trends through time of managed species were also informative. Certain exceptional cases stuck out: pollock in the Bering Sea Donut Hole for instance, which were overfished in just a few years. The Southern bluefin tuna is yet another example: managed under CCSBT, this stock has undergone a slower (but just as clear), decline. The examples of thriving or rebuilding stocks were much less numerous, though NEAFC's Norwegian-spawning herring fishery is one such example and is discussed in chapter 4.

Because interpretations of current stock health are dependent on the baseline year for which we compare them, selecting this baseline is pertinent to our analysis. Unfortunately, a consistent baseline year of data across all stocks and RFMOs does not exist: within RFMOs, time-series data rarely begin at the same year, or even within the same decade. However, the majority of time-series data included in this research presents biomass trends dating back to at least the 1960s or 1970s. As high seas fishing only truly commenced midway through the 1900s, such baseline years likely reflect the relatively unexploited state of the stocks. Of course, some of the stocks assessed straddle the coasts and high seas or migrate between the two, and intensive coastal fishing would undoubtedly affect their abundance. The most obvious example is that of whales: for some populations, overfishing occurred prior to the 1900s (see Baker & Clapham, 2004). Therefore, it was appropriate that the data we used for whales date back to 1800.

For those RFMOs whose establishment resulted in severe depletion of a stock (as is visible in Appendix A), this brings into question their commitment to management and conservation. ICCAT perhaps best illustrates this, and specifically, the case of bluefin tuna. As Figure A.6

depicts, both the west and eastern Atlantic bluefin stocks declined steadily after 1969, the year ICCAT was established. The short-term gains of harvesting tuna became more enticing to ICCAT than the long-term benefits of preserving the resource, and conservation measures became secondary concerns (Normile, 2009).

Yet what is nearly as worrying, especially for those species undergoing precipitous declines, is the lack of change in species biomass trends after RFMO implementation. This was by far the main pattern seen across species, and implies that the effect of management on the stocks they control has, so far, been negligible.

Upon comparing historical biomass trends to the current state of stocks, one discouraging finding is that they do not necessarily coincide. For instance, IOTC had the second highest Q score (see Table 3.2), with two healthy stocks (Bigeye and Albacore tuna placed within the 'best' quadrant IV), and one overfished stock (Yellowfin ended up in quadrant II). However, upon comparing these findings with the relative biomass trends, we see a potentially different scenario for Bigeye and Albacore tuna: declining biomass trends of both these stocks raise questions about the long-term, and even immediate, health of these fisheries (Figure 3.3).

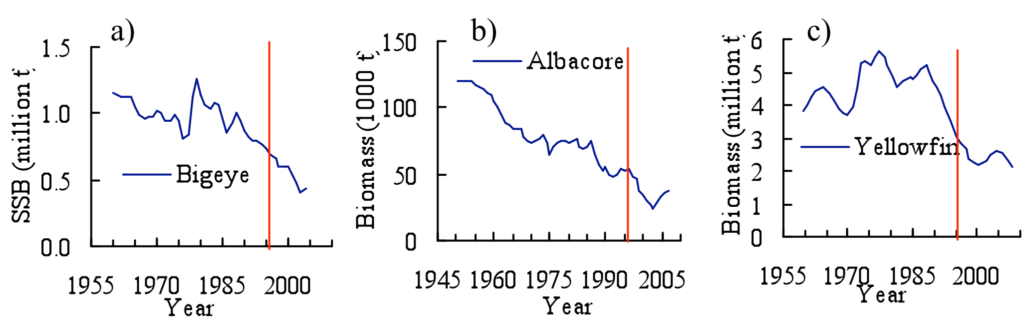

Figure 3.3 Time series of the biomass of three main tuna species under management of IOTC. Line denotes establishment of IOTC (2006). See Appendix A for details.

In this example, the data for both historical and current biomass trends were taken from the same report (see IOTC, 2006). The report contains five different stock assessments which were performed on the same population of Bigeye tuna within the IOTC commission area. Each assessment resulted in a different outcome; only one was chosen to reflect the overall population. Clearly, the conclusions drawn about the state of the stock depends on which assessment is selected. This example highlights the variability involved in stock assessments, and as such, must be considered when interpreting results. Ultimately we are reminded that stock assessments do not necessarily mirror what is actually in the sea; running the two biomass assessments added perspective to our results.

This study represents a broad diversity of species over a large area. While certain anadromous stocks reveal highly fluctuating biomasses over the years (due, most likely, to biological and life history characteristics), the global trend in high seas biomass across species is overwhelmingly one of decrease. Indeed, while a stock that placed within quadrant I is deemed to be in very poor shape, it must be noted that a stock that scored within quadrants II and III also implies inadequate management. A score within quadrant II suggests that current high fishing pressure may lead to a low biomass in the future, while a score within quadrant III suggests that overfishing has occurred in the past. While in the latter case, the potential to rebuild a depleted stock exists, past incidents reveal decreases in fishing pressure rarely lead to actual biomass increases (Worm *et al*., 2009).

In addition, none of the final T scores of RFMOs were very high. The non-significance of the linear regression analysis between final P scores and final Q scores suggests a disparity between current commitment of RFMOs in theory, and in practice, though overall low P and Q scores indicate general RFMO inadequacy. However, since the best practices guidelines we base our study on were created in 2007, there is the possibility that, in time, best practices will be adopted by RFMOs, and stock status will improve as a result. How much time we have, though, is questionable.

3.5 Shortcomings and pitfalls

3.5.1 Data

Data availability was the limiting feature of this study. Many species under RFMO management did not have biomass estimates, while others were very crude. Also, within species, generally numerous stocks exist; each stock has different characteristics and sometimes life parameters, therefore extrapolation from one stock to the larger population could lead to misleading results. For this reason we emphasized trends of abundance, rather than hard biomass numbers. Anadromous fish introduced further constraints: one species of salmon could consist of hundreds of stocks, each stock generally returning to one river within a watershed; such a specific pattern is therefore descriptive of one stock, but not the entire species. Extrapolation is thus problematic.

Because biomass data were only evaluated for those stocks with available information, only stocks of foremost importance to RFMOs were included in this study. While 'less valuable' species are nonetheless affected by RFMO fisheries, most lacked stock assessments, and were hence not accounted for in this research. Therefore, our results describe only a small proportion of high seas stocks. Worm *et al.* (2009) confront and discuss similar limitations in extrapolating to the global scale from a non-random, small sample of fish stocks. However, for the most part in our research, stocks with available data tended to be those of primary importance to the RFMO, thus still a good indicator of their management. Clearly, though, the more stocks with available information, the more stocks under RFMO management are explained, and the more accurate the description of that RFMO's overall management.

Of particular concern is the potential that our results are overly optimistic: occasionally, if there is contention around the state of a stock because it faces collapse, stock assessments are not made publically available (G. Ishimura, *pers. comm*., WCPFC, 2009). Thus, as this study was dependent on publically accessible data, such a circumstance could produce misleading results. Again, the limitations of current data as well as the need for more stock assessments and greater transparency are made clear.

In this study, the longer the biomass time-series, the more informative the pattern. Certain RFMOs lacked consistent time-series biomass data, GFCM, IATTC, and IWC[31] being the most notable cases. Because data on the majority of high seas fish stocks is still so limited, RFMOs sometimes offer this 'information void' as a justification for the lack of stock assessments. Regardless of the abundance of data, failure to act in a preventative manner counters the basis of the Precautionary Approach (see United Nations Environment Programme, 1992), and data deficiencies should not be an excuse for conservation inaction. While most RFMOs have accessible stock assessments, many lack the parameters upon which to gauge stock status.

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[31] Although biomass data in Appendix A for IWC dates back the furthest, this data was not taken from IWC (IWC only presents current estimates of whale abundance; see www.iwcoffice.org).

This study was best suited to the tuna RFMOs, as they had available and relevant stock assessment information and were consistent in their data representation. Again, this has to do with the relatively large amount of data these organizations have, compared to the other RFMOs. Regardless, data availability or thoroughness did not necessarily equate with healthier stocks, as can be seen by the low Q scores of tuna RFMOs.

3.5.2 Study

This study assessed the current state of stocks as they relate to certain key reference points, such as Bmsy and Fmsy. While the success of using MSY as a (limit) reference point in fish stock assessments has been disputed (Die & Caddy, 1997; Larkin, 1977; Punt & Smith, 2001), MSY is still commonly used for such purposes. However, other reference points could be more appropriate in determining the health of the stock. One such reference point is Maximum Economic Yield (MEY), which is more precautionary than MSY because it is achieved at a higher stock biomass (and at lower effort). For this research, had MEY been used in place of MSY, the results would have been more severe: more stocks would have received low scores, and RFMOs would score lower overall in effectiveness. The MEY methodology could yield a more accurate reflection of the current state of stocks. However, data enabling the MSY-to-MEY modification are not available. While currently, MSY remains the major practical reference point for global research, more up-to-date, relevant reference points would strengthen future evaluations such as the one presented here.

Other methods could be employed to evaluate the current state of stocks that RFMOs are supposed to manage. One such approach would be to assess the rate of change of a stock's biomass before and after establishment of the RFMO, i.e., rate of decline or recovery. This method would eliminate the need for reference points such as Bmsy and Fmsy.

The impetus for RFMO establishment (or, correspondingly, the state of the stock before RFMO establishment), could potentially determine an RFMO's Q score, a factor that was not accounted for in this study. For example, some RFMOs were established early on, prior to apparent fishing impacts on their stock of interest. Other RFMOs were established in response to the collapse of a stock, such as CCSBT and CCBSP; notably, these two RFMOs received low Q scores, this, in large part because their single stock of interest was depleted before management was put in place. Indeed, the biology of a species influences how well that stock can recover from overfishing, and consequently, how quickly fishing can resume.

Therefore it is not only management and fishing pressure that dictate the outcome of a stock. For instance, IWC has been under a global moratorium for over 20 years, and yet the great whales do not show the same trend in recovery as the Norwegian-spawning herring over the same amount of time (see Appendix A, Figures A.9 and A.12). Of course, illegal fishing has continued by certain member states, in blatant defiance of the moratorium, both under objections (Herrera & Hoagland, 2006), and under the guise of 'scientific data collection,' or 'research whaling' (Sand, 2008). But regardless, whales are not herring, and do not rebound as such.

Another issue with the scoring system of the phase plots regards the interpretation of which quadrant is 'best'. We chose quadrant IV as 'best' based on ICCAT's objectives (see FIRMS, 2007). There are, however, other methods of interpreting the quadrants, and this would depend on the objective. If, for instance, the objective was to gauge the effectiveness of an RFMO as determined by how it reacts to low biomass levels, the phase plot scoring system could look something like this:

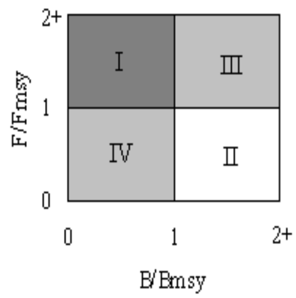

Figure 3.4 Example of a phase plot measuring RFMO response to changes in stock biomass.

In this example, the phase plot in Figure 3.4 represents an alternative scoring system in which a low F/Fmsy and a low B/Bmsy (i.e., quadrant IV) translates to a high score, as does quadrant III; quadrant I remains the lowest scoring quadrant, while quadrant II is in between. This classification scheme is better suited to represent the response of RFMOs (i.e., through adjustment of fishing rate) in relation to stock biomass, rather than as an indicator of current stock conservation. This example of an alternate phase plot highlights the need to clearly define the objective of the analysis before creating the scoring key of a phase plot.

As RFMOs have two main objectives, i.e., conservation and management, an approach that could increase the precision of this study would be to create two phase plots instead of one. Each phase plot would then represent one objective, and each would have a different numbering system, reflecting that objective (Figure 3.5):

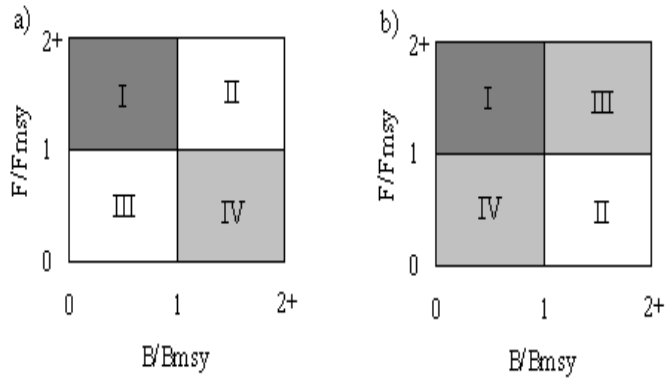

Figure 3.5 Possible scoring system for double phase plot assessment, evaluating conservation and management outcomes of RFMOs separately. a) Phase plot describing RFMO's effectiveness in conservation; scoring system same as Figure 3.1. b) Phase plot describing RFMO's effectiveness in management; scoring system same as Figure 3.4.

Transferring continuous data into categorical measures implies loss of information. Other approaches could help mitigate this loss. In our phase plots, given that (1,1) is the limit coordinate (for fisheries that employ MSY as their reference points), one such method would be to define an area around (1,1) that encompasses a target range. For example, if the range for both x and y-coordinates was between 0.9-1.1, any datum point that fell within this range would be given the same, high score. In this way, the relative distance from (1,1) becomes relevant and more information is retained. Without this target range, a datum point that does not fall exactly on (1,1) could be given a score that is too low.

A different approach could be implemented in place of the quadrant scoring scheme. One example is that described in Luck *et al.* (2009), which was based on objective functions and employed priority schemes, focusing specifically on human needs. A similar methodology could be beneficial in determining performance of RFMOs.

It must be emphasized that this assessment defines the success of an RFMO by how well it scores with regards to conserving its principal stocks. There are further ways to monitor the effect of RFMOs (e.g., state of the bycatch stocks, state of habitat). For example, while NAFO did not score a high Q score, it was still above average at 53%- yet their bycatch record is very poor. In 2008, NAFO exceeded the bycatch target by 70%, while in 2003, they exceeded the target by over 80% (WWF-Canada, 2009). Other studies have assessed RFMO effectiveness as they relate specifically to the state of their bycatch (see Small, 2005, for an analysis of RFMO performance in relation to seabird bycatch), but this was beyond the scope of our research.

Another concern with this method lies with comparing the results of the two quantitative assessments (one of which is based on qualitative data), as the quantitative categorizations of these two studies differ substantially. The first assessment focuses on 26 criteria, whereby an RFMO is assigned a score between 1 and 10 for each criterion. The second assessment, which focuses on fish stocks, assigns scores to RFMOs between 0 and 3. Therefore, there is a difference in precision between the two scoring systems. This problem can be partly overcome by increasing the number of quadrants in the second evaluation. For example, we could increase the number of quadrants from four to nine (Figure 3.6).

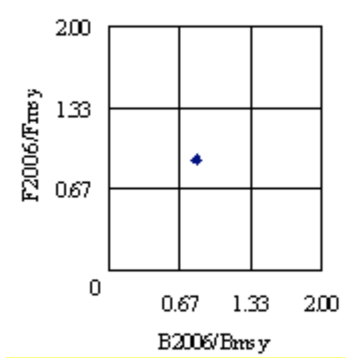

Figure 3.6 Example of a nine-quadrant phase plot. This example shows ICCAT's yellowfin tuna.

While the middle quadrant would likely be associated with the highest score (i.e., within the 1,1 range), this nine-quadrant phase plot assessment would ultimately depend on how the rest of the quadrants were scored. Example 3.6 shows ICCAT's yellowfin tuna stock point in the nine-quadrant format. In this example, the point ends up in the middle quadrant, and receives the highest possible score; these results differ from our initial findings, which assigned ICCAT's yellowfin tuna a lower score. This nine-quadrant phase plot will likely be used in the published version of this thesis.

Finally, because information was, for the most part, collected from the RFMOs themselves (i.e., from their websites), this raises the possibility that RFMOs could present biased or misleading information. However, the first thing to acknowledge is that none of the RFMOs scored very highly overall (see Table 3.4), suggesting that their information is likely a relatively candid reflection of their management. Also, stock assessments are harder to place bias on than other documents, as their primary function is to present data.

3.6 Conclusion

In order to gauge the effectiveness of an RFMO, we must consider whether or not the RFMO has met its main goals. Looking back at RFMO objectives (see Appendix A), they appear quite uniform across RFMOs, each including a specific emphasis on a commitment to the conservation of their stock(s) of interest, as seen here in NAFO's objectives: "…to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the Convention Area" (NAFO, 2004). If we are to measure their success in this regard, we see that RFMOs have failed. Certain RFMOs highlight this case in point: NASCO, for instance, states its objective, "…to conserve, restore, enhance and rationally manage Atlantic salmon through international cooperation taking account of the best available scientific information" (see www.nasco.int). However, their stocks show a different reality: while in recent years NASCO has reduced fishing due to small stock sizes, historical data reveal a steep decline in salmon biomass over the entire course of NASCO's management (Figure 3.5).

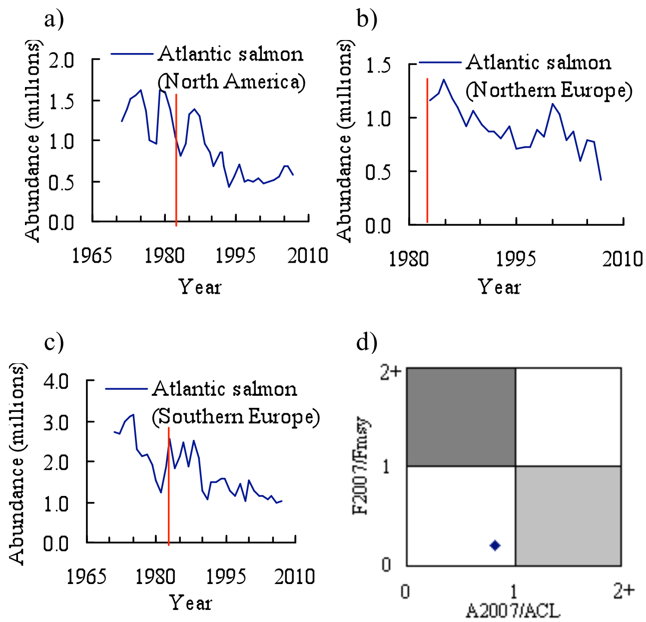

Figure 3.7 Example: Atlantic salmon under NASCO management. a-c) Time series of the biomass of the three stocks of Atlantic salmon; line denotes establishment of NASCO (1983). d) Current state of the North American Atlantic salmon stocks. Data from ICES (2009) and NASCO (2008); see Appendix A for details.

It is evident from our results that the priority of RFMOs – or at least of their member countries – has been first and foremost to exploit fish stocks. While conservation is part of nearly all of their mandates, they have yet to demonstrate a genuine commitment to it on the water.

With the overwhelming majority of fish stocks on the high seas in decline, close to 30% of which are currently being overfished, the symptoms point to serious mismanagement. IUU fishing, exceptionally prevalent on the high seas, is indisputably part of the problem that is contributing to overfishing. Another distressing reality is the frequent amplification of fishing pressure at each level down the fisher chain: "…the EU's scientists recommend a bluefin catch one and a half times as big as it should be; the European Commission then doubles it and the fishermen then take twice as much as the Commission allows" (Monbiot, 2009). This has predictable results on fish biomass.

The results from this contribution indicate the very real urgency for the implementation of actual incentives and effective penalties for fishers on the high seas. The lack of consequence given to stock overexploitation on the high seas is concerning, and must change if high seas fishing is to continue. While international agreements and multilateral treaties could take years to implement, it is up to the members of RFMOs to unite and strengthen themselves to become the conservation-oriented organizations they state themselves to be.

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Chapter 4

Conclusion

No consideration of the paths to sustainability can be complete without international fisheries. The existing governance regimes for high seas fisheries have failed totally.

Hilborn (2007)

4.1 Discussion

The results from this study indicate that the effectiveness of RFMOs as fisheries management bodies on the high seas is inadequate. The two assessments together reveal RFMOs as, by and large, weak in best practices, and their primary stocks under management, in poor health. Two key questions emerge: will best practices ever be comprehensively adopted by RFMOs[32]? And, if all RFMOs were to adopt and comply with best practices, would this be enough? The likely answer to both these questions is 'no' (chapter 2 of this study; Mooney-Seus & Rosenberg, 2007; Alder & Lugten, 2002). Best practices, though essential, remain as only part of the solution to effective high seas management. A diversity of factors must occur for such a wholesale transformation in global fisheries management to transpire (Berkes *et al*., 2006). Here, further to RFMO best practices, we explore other areas in which RFMOs could help improve high seas management.

[32] The results from chapter 2 indicate that the majority of RFMOs with low P scores have existed for at least a decade (PSC, which scored the lowest P score, was established in 1923); such results question the likelihood that RFMOs will implement best practices in the future.

It is commonly understood that the third and most recent Law of the Sea Convention, which came into force in 1994, is both flawed and outdated (Bjorndal *et al.*, 2000; Christie, 2004). Updating the Law of the Sea to include current knowledge and practices would be a central step towards improving high seas management (Crothers & Nelson, 2007; Hilborn, 2007). However, the third Conference on the Law of the Sea occurred over the span of nine years, after which it took 12 years for the Convention to come into force (Vallega, 2002). Though the prospect of establishing a fourth Convention seems discouraging, it is not worth discounting in the future (Crothers & Nelson, 2007; Hilborn, 2007): "The time has come for a new integrated international legal instrument covering all aspects of fisheries management" (Pitcher *et al*., 2009).

In the meantime, there are other avenues to increasing high seas management success. Recently there have been appeals to create high seas Marine Protected Areas (MPAs) (see Kelleher & Gjerde, 2005; Roberts, 2002); indeed, some have already been implemented, with others poised to come into effect (see Ardron *et al*., 2008; Pala, 2009). As the benefits of MPAs have been documented both for conservation (Agardy, 1999), and for fisheries (Roberts *et al.*, 2001), the potential for such tools in high seas management is apparent. Roberts *et al.* (2006) describe how and where a system of no-take high seas MPAs (HSMPAs) could be established. Cheung *et al.* (2005), also describe areas of priority for high seas protection based on species diversity[33]. Blocked off entirely from fishing, these areas would also eliminate altogether the allocation problems that face RFMOs. Increased and improved technology such as satellites would allow reliable surveillance of vast areas of HSMPAs, and would be integral both in gaining information and in implementing a surveillance system (Ardron *et al*., 2008; C. Roberts, pers.comm., University of York, 2009); RFMOs would be central in executing such a system.

[33] Their study concluded that the Indo-Pacific would be of highest priority (Cheung *et al*., 2005).

The success stories of RFMOs can also offer insight into competent RFMO management, the most apparent being the recovery of NEAFC's Norwegian-spawning herring fishery (Bjorndal *et al*., 2000). A large part of NEAFC's success lay in combating two major (and related) problems associated with RFMOs: the interloper and new members dilemmas (Munro, 2001). The interloper problem (i.e., IUU fishing), pertains to non-members who fish for resources under RFMO management, and have no interest in becoming members. The new entrants dilemma refers to the current practice in which any state with "a real interest[34]" can become a member to the RFMO (Kaitala & Munro, 1993). In doing so, these states gain access to organization benefits, such as fishing allocations; in a limited space with limited resources, the outcome for the stocks is predictable. NEAFC is currently a closed group of five members (simulated in the game model in Arnason *et al*., 2001). In addition to being a small organization, they successfully stopped IUU fishing through, some describe, sheer "clout:" NEAFC is comprised of powerful nations, and it was not worth it for other nations to interfere (G. Munro, pers.comm., University of British Columbia, 2009). This strong cohesion between the contracting parties within the RFMO ultimately increased their power[35]. In addition, cooperation between the nations was more profitable than not cooperating (Bjorndal, 2009). Note, however, that the Norwegian-spawning herring fishery is the only one of NEAFC's five that is considered "sustainable" (Bjorndal, 2009). Still, this case offers an example of what could be achieved through the resolution of the new entrants and interloper problems.

[34] As is outlined in the Convention (United Nations, 1982).

[35] Note: such strength in unity is not limited to wealthy or powerful nations: the alliance of Pacific Island nations through the FFA (the South Pacific Forum Fisheries Agency), gave such Island nations a voice and control, who were thus able to influence the actions of distant water fishing nations fishing in their EEZs (Riddle, 2006).

Other possible strategies for increasing the effectiveness of high seas management focus on human behaviour to guide social change, including exploiting the influence of reputation (Milinksi *et al.*, 2002), and using public shaming mechanisms (Le Gallic & Cox, 2006). One such an example involves Norway, who fished illegally in Antarctic waters. In response, ISOFISH, the International Southern Oceans Longline Fisheries Information Clearing House, shamed Norway through various publications and drew public attention to their illegal practices. Concerned about their reputation, which would invariably influence the sales of their fish stocks, Norway ceased IUU fishing in Antarctica (Stokke & Vidas, 2004). Unfortunately, as the case with IWC indicates, the results of this scheme are not always certain: though whaling is heavily frowned upon by the international community, IWC member states continue to whale in clear defiance of their own moratorium, or under "convenient provisions" (Iliff, 2008). However, under the right circumstances such mechanisms can work, a phenomenon recently described as "the contagiousness of international cooperation" (Riddle, 2006).

Yet what all of these measures and regulations have in common and depend on, are appropriate incentives and effective penalties; see Grafton *et al.* (2006), and Hilborn (2007), for the importance of incentives in sustainable fisheries, and Erceg (2006) for examples of harsh – and thereby effective – sentences in response to IUU fishing. Currently, incentives and penalties are not given enough weight in RFMO management and must be prioritized.

4.2 Strengths, weaknesses and future work

One of the strengths of this analysis was the two-tiered approach: assessing the effectiveness of RFMOs in theory, as well as in practice. In addition, the global scope of the project provided an important perspective, and inferences about management could be drawn on the macro level. However, the global scope was simultaneously an impediment, as obtaining consistent, detailed data across RFMOs was difficult. The 18 RFMOs varied greatly, and as a result, their data and their data's availability varied, too. Overall, data availability was the limiting factor in this study. A baseline of publically accessible data and basic information should be set for RFMOs; in the future, maintaining this standard should be a requirement of all RFMOs.

Another strength of this study was comparing a non-governmental organization (WWF) and a national fisheries organization (NMFS) to RFMOs. These outgroups were chosen because they were reflective of two very different types of organizations: one governmental on a national scale, the other non-governmental on an international scale. This was important to determine if RFMOs differed inherently from other organizations, and thus if RFMOs as a group shared some overarching characteristics.

Other future studies could consider finances: how much do RFMOs spend a year, and on what? How does this compare to their profits? A comparison between budgets of RFMOs and spending patterns would be informative when gauging the effectiveness of the organizations.

Finally, such a study was completely dependent on the level of verity to which each RFMO subscribed[36]: because data was collected from the RFMOs themselves[37], the opportunity for RFMOs to relay incorrect information was a valid concern. However, no comparable,

[36] As described in chapter 2 and 3.
[37] The vast majority of information came from literature and stock assessments researched and made available by the RFMOs themselves; when such data could not be found, they were collected elsewhere.

comprehensive, impartial database currently exists— such a system would offer critical information (Rochette & Bille, 2008), and its establishment is highly recommended.

Although the comprehensive impact of RFMOs on the high seas has yet to be measured, this study was the first step in gathering information and evaluating trends on the macro level. In the near future, the various management approaches mentioned above could be considered as additional support to RFMO best practices guidelines; however, the guidelines are current, have already been disseminated to RFMOs, and remain the best immediate structure to influence high seas management.

Encouragingly, today RFMOs are being paid more and more attention. Indeed, during the course of conducting this research, issues surrounding RFMOs and high seas management have exploded: influential discussions about their roles and duties have been occurring at local and international levels (see Langley *et al*., 2009; Tuna RFMO, 2009), and are bound to gain momentum. As climate change shifts oceanic boundaries (Anisimov, 2007), issues surrounding sovereignty and ownership are heating up, and the function and responsibilities of RFMOs will become increasingly profound.

With the World Summit on Sustainable Development meeting fast approaching[38], we hope that discussions on these issues will continue.

[38] The WSSD's implementation cycle for topics 'Oceans and seas and marine resources,' amongst others, is scheduled to occur 2014/2015 (United Nations Environment Programme, 2005).

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Appendices

Appendix A. RFMO attributes and state of stocks

Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR):
Date entered into force: 1982
FAO association: No.
Area: High Seas of Southern Ocean, around Antarctica.
FAO statistical area: 88,48,58.
Contracting parties: 26 total: Argentina, Australia, Belgium, Brazil, Chile, China, EU, France, Germany, India, Italy, Japan, Korea, Namibia, New Zealand, Norway, Poland, Russia, South Africa, Spain, Sweden, Ukraine, UK, USA, Uruguay.
Primary species: Antarctic toothfish, Krill, Mackerel icefish, Patagonian toothfish (biomass of underlined species presented in Figure A.1.2).
Commission's objectives: "…to conserve marine life of the Southern Ocean. However this does not exclude harvesting carried out in a rational manner."

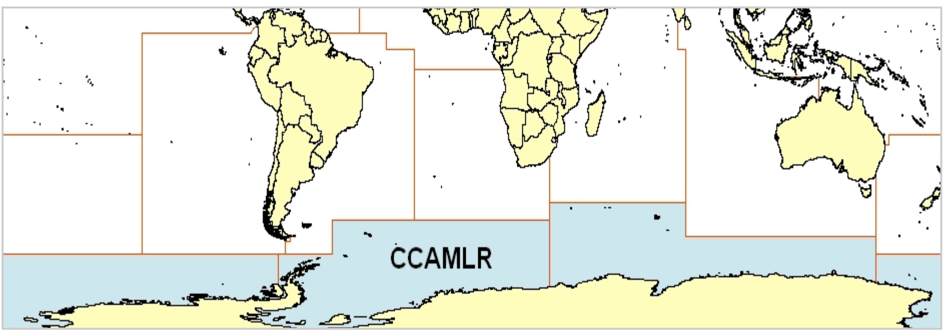

Figure A.1.1 CCAMLR convention area.

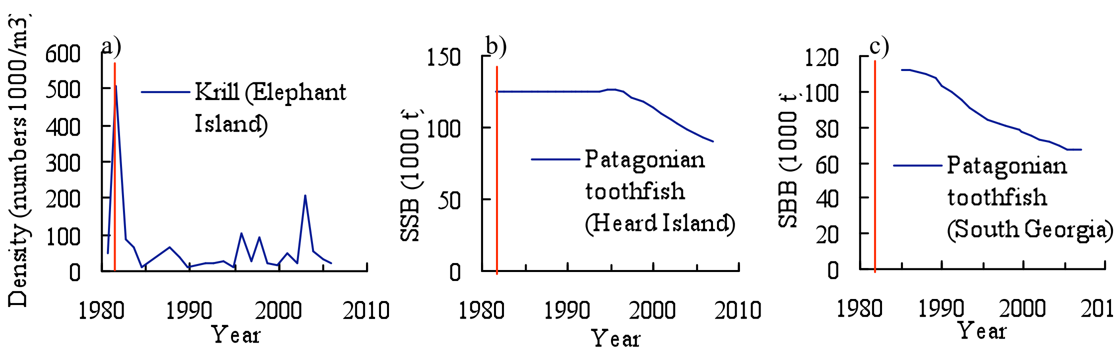

Figure A.1.2 CCAMLR: Time series of biomass of three main species under CCAMLR management. Line denotes establishment of CCAMLR (1982). Krill a) was assessed because it was the species of most concern to CCAMLR when the organization was established; data taken from Reiss *et al.* (2008); Patagonian toothfish b-c) were assessed because they comprise the largest catch (after krill); data: from CCAMLR (2007a) and from CCAMLR (2007b), respectively.

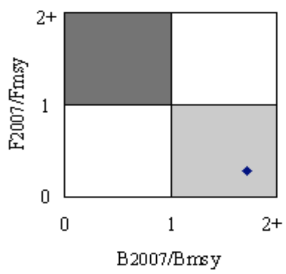

Figure A.1.3 CCAMLR. Patagonian toothfish (South Georgia stock). The x-axis represents current biomass (B_{2007}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2007}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Data from CCAMLR (2007b); FishBase (see www.fishbase.com); and Clark (1991).

Convention on the Conservation and Management of the Pollock Resources in the Central Bering Sea (CCBSP):
Date entered into force: 1995
FAO association: No.
Contracting parties: 6 total: China, Japan, Republic of Korea, Republic of Poland, Russian Federation, USA.
Area: High seas of the Bering Sea.
FAO statistical area: 61,67.
Primary species: Pollock (perceived abundance of pollock presented in Figure A.2.2).
Commission's objectives: "…to establish an international regime for conservation, management, and optimum utilization of Pollock resources in the Convention area…"

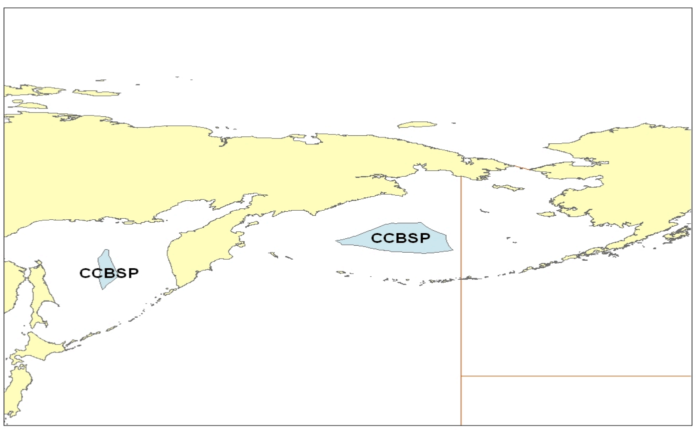

Figure A.2.1 CCBSP convention area.

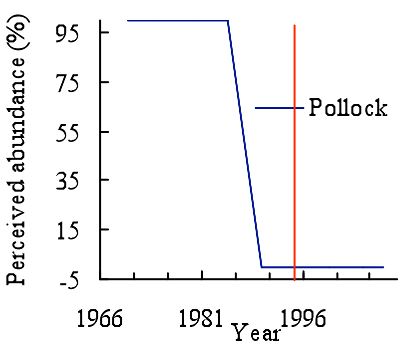

Figure A.2.2 CCBSP: Time series of biomass of pollock, the species under CCBSP management, in the Donut Hole region. Line denotes establishment of CCBSP (1995). Pollock were assessed because they are the primary species under CCBSP management. Data: from qualitative information from L. Lee-Low, pers.comm., CCBSP, 2008, and from http://www.afsc.noaa.gov/refm/cbs/convention_description.htm.

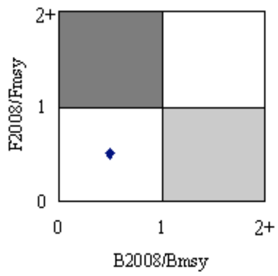

Figure A.2.3 CCBSP. Pollock. The x-axis represents current biomass (B_{2008}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2008}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Note: quadrant selection based on qualitative data; exact location of data point is arbitrary. Qualitative data from L. Lee-Low, pers.comm., CCBSP, 2008, and http://www.afsc.noaa.gov/refm/cbs/convention_description.htm.

Commission for the Conservation of Southern Bluefin Tuna (CCSBT):
Date entered into force: 1994
FAO association: No.
Contracting parties: 6 total: Australia, Indonesia, Japan, Korea (Republic of), New Zealand, Taiwan.
Area: The entire geographical range of Southern bluefin tuna.
FAO statistical area: 41, 47, 51, 57, 81.
Primary species: Southern bluefin tuna (biomass presented in Figure A.3.2).
Commission's objectives: "…to ensure, through appropriate management, the conservation and optimum utilisation of the global SBT fishery. The Commission also provides an internationally recognised forum for other countries/entities to actively participate in SBT issues."

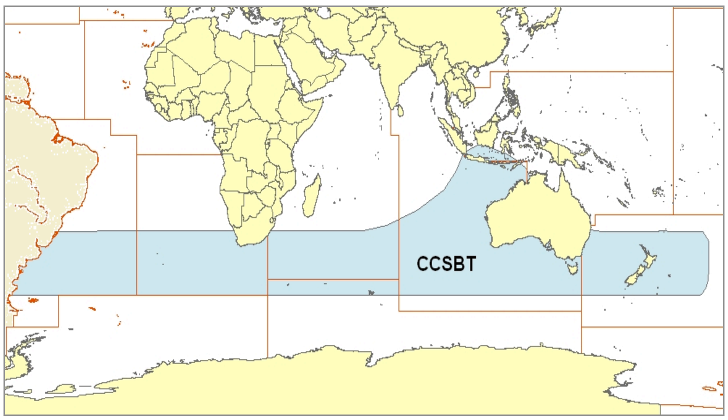

Figure A.3.1 CCSBT convention area.

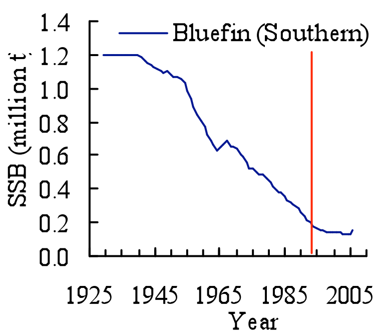

Figure A.3.2 CCSBT: Time series of biomass of Southern bluefin tuna, the species under management of CCSBT. Line denotes establishment of CCSBT (1994). Southern bluefin tuna were assessed because they are the primary species under CCSBT management. Data: from CCSBT (2006).

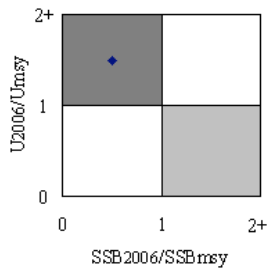

Figure A.3.3 CCSBT. Southern bluefin tuna. The x-axis represents current spawning stock biomass (SSB_{2006}) over spawning stock biomass at maximum sustainable yield (SSB_{msy}); the y-axis represents current exploitation rate (U_{2006}) over the exploitation rate that produces maximum sustainable yield (U_{msy}). See text for scoring details. Note: quadrant selection based on qualitative data; exact location of data point within quadrant is arbitrary. Data available at CCSBT (2006); and CCSBT (2008).

General Fisheries Commission for the Mediterranean (GFCM):
Date entered into force: 1952
FAO association: Yes.
Contracting parties: <u>24 total:</u> Albania, Algeria, Bulgaria, Croatia, Cyprus, EU, Egypt, France, Greece, Israel, Italy, Japan, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Romania, Slovenia, Spain, Syria, Tunisia, Turkey.
Area: The Mediterranean, Black Sea and connecting waters.
FAO statistical area: 37.
Primary species: Albacore, Angler, Atlantic bluefin tuna, Atlantic mackerel, Beluga, Blackbellied angler, Blackspot seabream, Blue and red shrimp, Blue shark, Blue whiting, Bluefish, Bogue, Common cuttlefish, Common dolphinfish, Common Pandora, Common sole, Common spiny lobster, Danube sturgeon, Deepwater rose shrimp, <u>European anchovy</u>, European eel, European hake, <u>European pilchard</u> <u>(Sardine)</u>, European sprat, European squid, Giant red shrimp, Horned octopus, Mediterranean horse mackerel, Musky octopus, Norway lobster, Pink spiny lobster, Porbeagle, Red mullet, Round sardinella , Shortfin mako, Starry sturgeon, Sturgeon, Surmullet, Turbot, Whiting (biomass of underlined species presented in Figure A.4.2).
Commission's objectives: "…to promote the development, conservation, rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture in the Region."

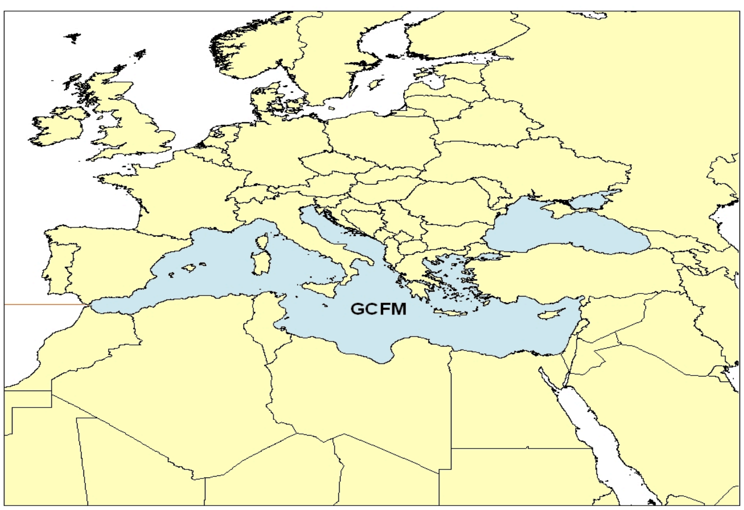

Figure A.4.1 GFCM convention area.

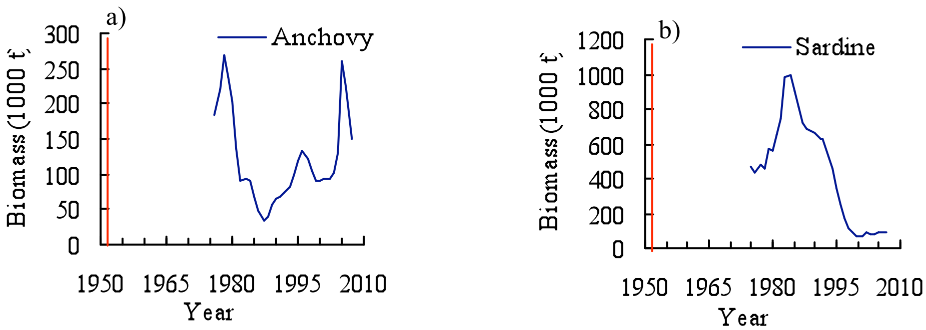

Figure A.4.2 GFCM: Time series of the biomass of two main species under management of GFCM. Line denotes establishment of GFCM (1952). Anchovy a) and sardine b) were assessed because they comprised a majority of their catch and were the two species for which there are the most available data. Data: for both species, from GFCM (2008), and http://151.1.154.86/meetingdocs/2008/SEP_(Izmir)%20%20SCSA%20WG%20on%20Small%20Pelagic%20Species%20including%20joint%20Stocks%20Assessments/Presentations/Anchovy%20and%20Sardine%20Stock%20Assessment%20in%20the%20GSA%2017%20(1975-2007).ppt#380,13,Slide 13.

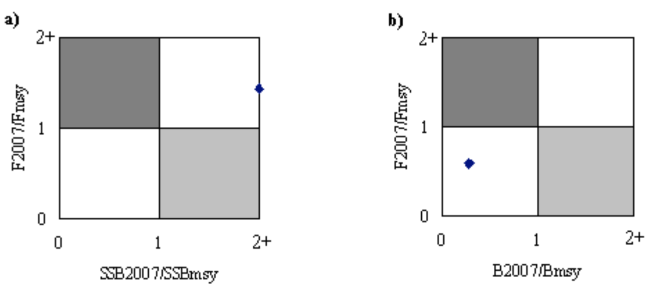

Figure A.4.3 GFCM. a) Anchovy (northern Adriatic Sea stock, GSA 17); the x-axis represents current spawning stock biomass (SSB_{2007}) over spawning stock biomass at maximum sustainable yield (SSB_{msy}); the y-axis represents current fishing mortality (F_{2007}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Data from GFCM (2008). b) Sardine (northern Adriatic Sea stock, GSA 17); the x-axis represents current biomass (B_{2007}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2007}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Data from GFCM (2006), GFCM (2008), and Clark (1991).

Inter-American Tropical Tuna Commission (IATTC):
Date entered into force: 1950
FAO association: No.
Contracting parties: 16 total: Columbia, Costa Rica, Ecuador, El Salvador, France, Guatemala, Japan, Mexico, Nicaragua, Panama, Peru, Republic of Korea, Spain, USA, Vanuatu, Venezuela.
Area: Eastern Pacific Ocean
FAO statistical area: 87, 77, 67.
Primary species: Albacore, Bigeye tuna, Black skipjack, Black marlin, Blue marlin, Bonitos, Carangids, Dolphin fish, Striped marlin, Pacific bluefin tuna, Indo-Pacific sailfish, Skipjack tuna, Shortbill spearfish, Swordfish, Yellowfin tuna (biomass of underlined species presented in Figure A.5.2).
Commission's objectives: "…responsible for the conservation and management of fisheries for tunas and other species taken by tuna-fishing vessels in the eastern Pacific Ocean."

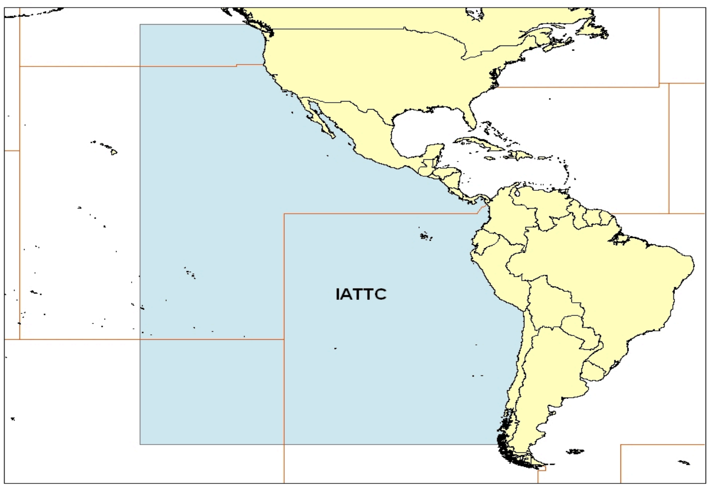

Figure A.5.1 IATTC convention area.

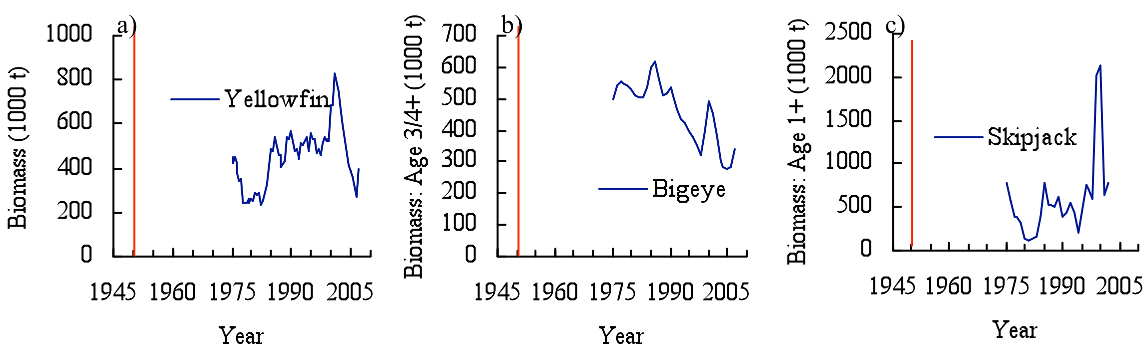

Figure A.5.2 IATTC: Time series of the biomass of three main tuna species under management of IATTC. Line denotes establishment of IATTC (1950). Data: a) from Maunder (2007), b) Aires-da-Silva and Maunder (2007), and c) Maunder and Harley (2004).

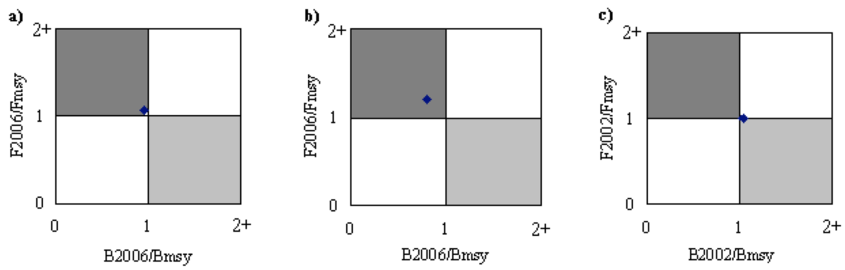

Figure A.5.3 IATTC. a) Yellowfin tuna; note: x-axis reflects stock size in relation to Amsy; data point is running average of three years (2004-2006). Data from Maunder (2007). b) Bigeye tuna; note: x-axis reflects stock size in relation to Amsy; data point is running average of three years (2004-2006). Data from Aires-da-Silva and Maunder (2007). c) Skipjack tuna; data from Maunder and Harley (2004), FishBase (see www.fishbase.com) and Patterson (1992). The x-axis represents current biomass (B_{2006} or B_{2002}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2006} or F_{2002}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details.

International Commission for the Conservation of Atlantic Tuna (ICCAT):
Date entered into force: 1969
FAO association: No.
Contracting parties: 48 total; Albania, Algeria, Angola, Barbados, Belize, Brasil, Canada, Cap-Vert, China, Cote d'Ivoire, Croatia, Equatorial Guinea, Egypt, EU, France (St-Pierre et Miquelon), Gabon, Ghana, Guatemala, Guinee Rep, Honduras, Iceland, Japan, Korea (Republic of), Libya, Maroc, Mauritania, Mexico, Namibia, Nicaragua, Nigeria, Norway, Panama, Philippines, Russia, Sao Tome E Principe, Senegal, Sierra Leone, South Africa, Syria, St. Vincent & the Grenadines, Trinidad & Tobago, Tunisia, Turkey, UK, USA, Uruguay, Vanuatu, Venezuela.
Area: Atlantic Ocean and adjacent seas.
FAO statistical area: 41, 47, 48, 31, 34, 21, 27.
Primary species: Albacore, Atlantic bluefin, Bigeye tuna, Billfishes (white marlin, blue marlin, sailfish and spearfish), Mackerels (spotted Spanish mackerel and king mackerel), Skipjack, Small tunas (Black skipjack, Frigate tuna, and Atlantic bonito), Swordfish, Yellowfin (biomass of underlined species are presented in Figure A.6.2).
Commission's objectives: "…conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas."

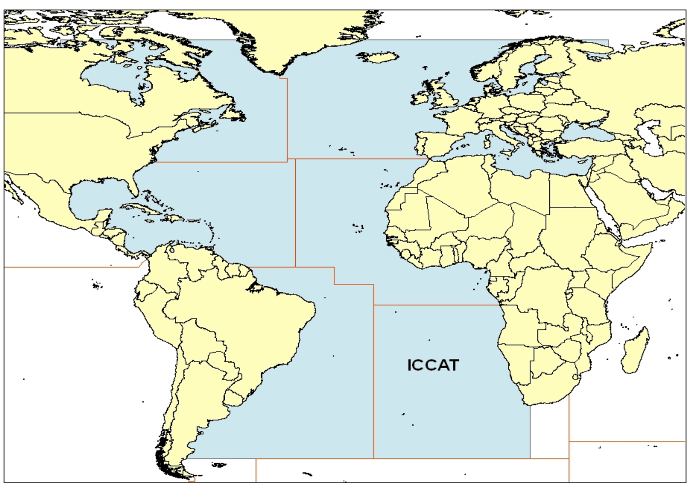

Figure A.6.1 ICCAT convention area.

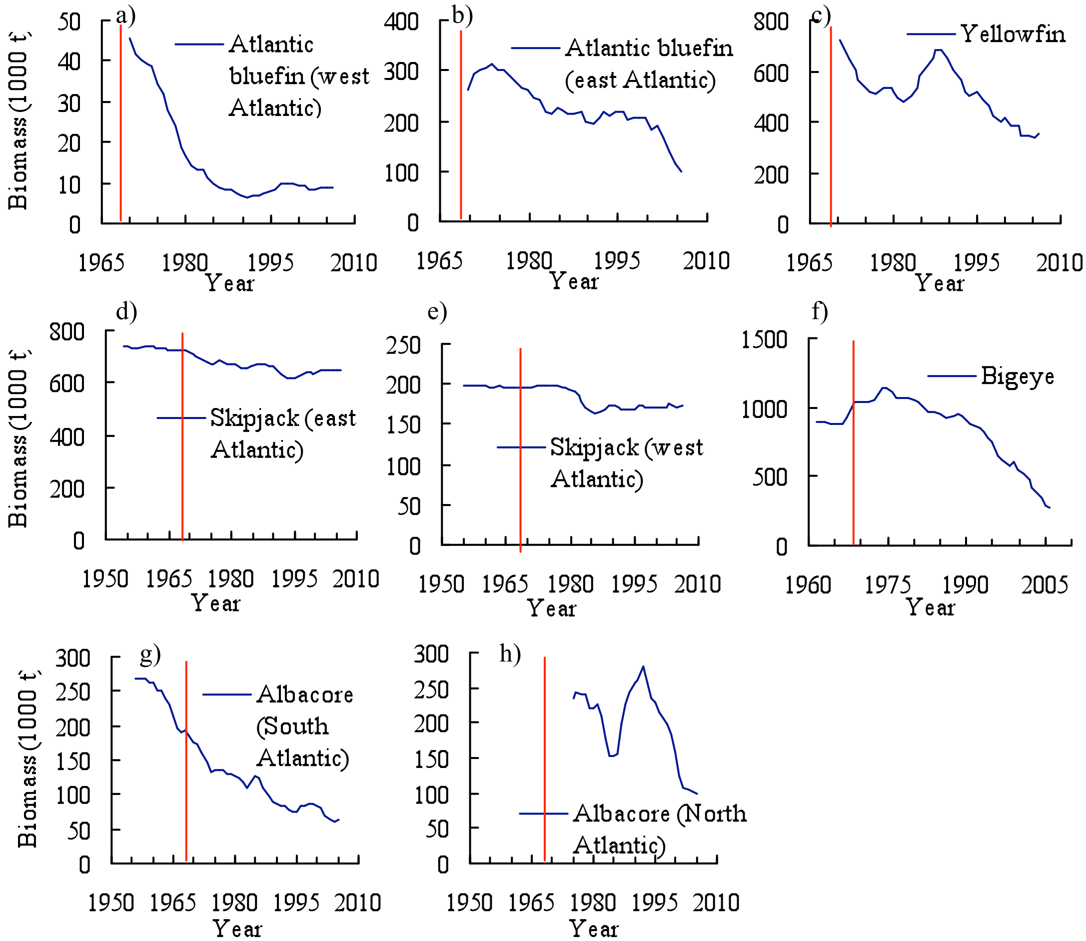

Figure A.6.2 ICCAT: Time series of the biomass of tuna species under management of ICCAT. Line denotes establishment of ICCAT (1969). Species assessed comprise the "major tuna" that ICCAT manages. Data: a) from ICCAT (2008a), b) ICCAT (2008b), c-e) ICCAT (2008c), f) ICCAT (2008d), g-h) ICCAT (2008e).

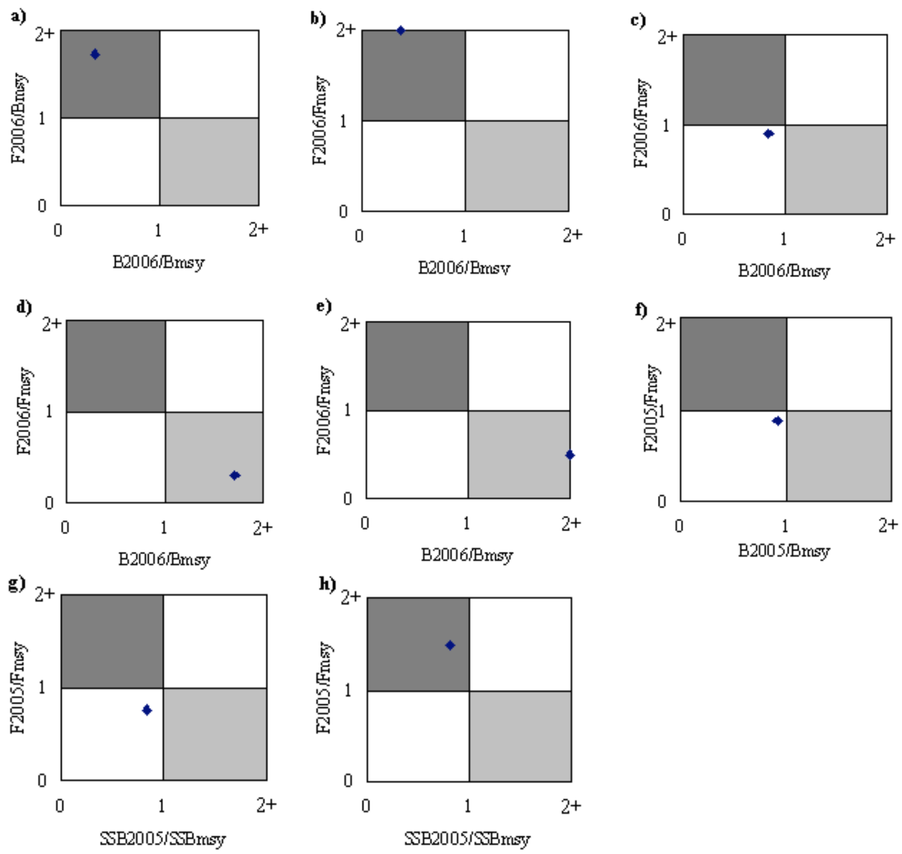

Figure A.6.3 ICCAT. a) Bluefin, west: data from; see ICCAT (2008a). b) Bluefin, east; data from ICCAT (2008a). c) Yellowfin; data from ICCAT (2008c). d) Skipjack, east; data from ICCAT (2008c). e) Skipjack, west: based on year 2006; see ICCAT (2008c). f) Bigeye; see ICCAT (2008d). g) Albacore, south: data from ICCAT (2008e). h) Albacore, north; data from ICCAT (2008e). The x-axis represents current biomass (B_{2006} or B_{2005}) or current spawning stock biomass (SSB_{2005}) over biomass at maximum sustainable yield (B_{msy}) or spawning stock biomass at maximum sustainable yield (SSB_{msy}); the y-axis represents current fishing mortality (F_{2006} or F_{2005}) over fishing mortality that produces maximum sustainable yield (F_{msy}) or spawning stock biomass that produces maximum sustainable yield (SSB_{msy}). See text for scoring details.

Indian Ocean Tuna Commission (IOTC):
Date entered into force: 1996
FAO association: Yes.
Contracting parties: 27 total: Australia, Belize, China, Comoros, Eritrea, EU, France, Guinea, India, Indonesia, Iran, Japan, Kenya, Republic of Korea, Madagascar, Malaysia, Mauritius, Oman, Pakistan, Philippines, Seychelles, Sri Lanka, Sudan, Tanzania, Thailand, UK, Vanuatu.
Area: The Indian Ocean (FAO statistical areas 51 & 57) and adjacent seas, north of the Antarctic Convergence.
FAO statistical area: 51, 57.
Primary species: Albacore tuna, Bigeye tuna, Black marlin, Bullet tuna, Frigate tuna, Kawakawa, Longtail tuna, Indo-Pacific blue marlin, Indo-Pacific king mackerel, Indo-Pacific sailfish, Narrow barred Spanish mackerel, Skipjack, Southern bluefin tuna, Swordfish, Striped marlin, Yellowfin tuna (biomass of underlined species presented in Figure A.7.2).
Commission's objectives: "…to promote cooperation among its Members with a view to ensuring, through appropriate management, the conservation and optimum utilisation of stocks and encouraging sustainable development of fisheries based on such stocks."

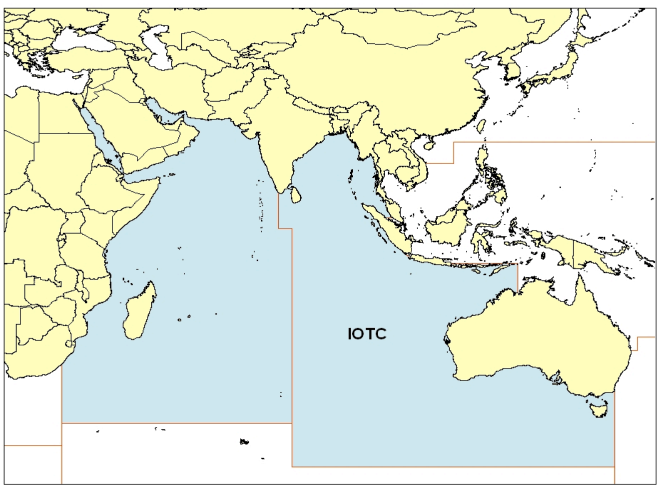

Figure A.7.1 IOTC convention area.

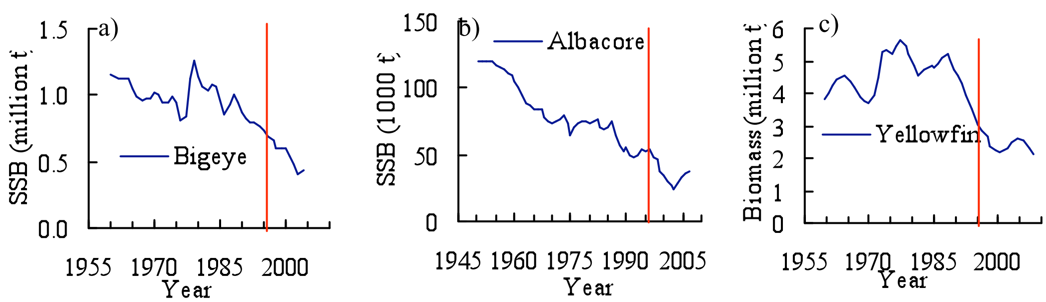

Figure A.7.2 IOTC: Time series of the biomass of three main tuna species under management of IOTC. Line denotes establishment of IOTC (1996). These three tuna species had the most biomass information available, and make up a large proportion of IOTC's catch. Data: a) from IOTC (2006), b) IOTC (2008a), c) IOTC (2008b).

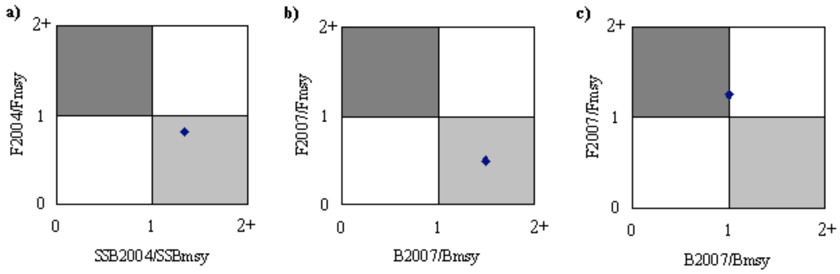

Figure A.7.3 IOTC: State of primary stocks under IOTC management. a) Bigeye. The x-axis represents current spawning stock biomass (SSB_{2004}) over spawning stock biomass at maximum sustainable yield (SSB_{msy}); the y-axis represents current fishing mortality (F_{2004}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Data from IOTC (2006). b) Albacore. The x-axis represents current biomass (B_{2007}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2007}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Data from IOTC (2008a). c) Yellowfin. The x-axis represents current biomass (B_{2007}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2007}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Data from IOTC (2008b).

International Pacific Halibut Commission (IPHC):
Date entered into force: 1923
FAO association: No.
Contracting parties: 2 total: Canada, USA.
Area: Within EEZs of Canada and USA.
FAO statistical area: 67.
Primary species: Pacific halibut (biomass presented in Figure A.8.2).
Commission's objectives: "…research on and management of the stocks of Pacific halibut (*Hippoglossus stenolepis*) within the Convention waters of both nations."

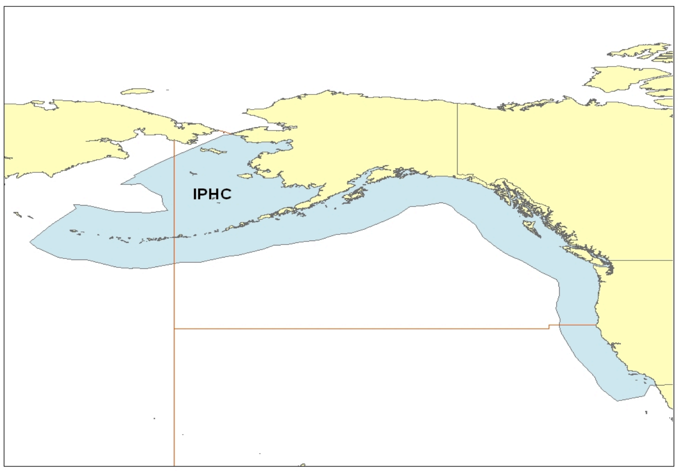

Figure A.8.1 IPHC convention area and various characteristics of the RFMO.

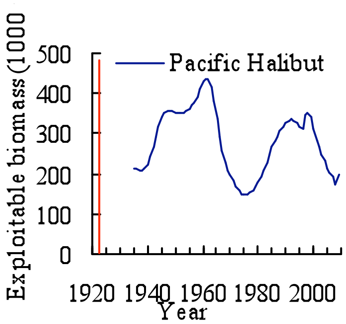

Figure A.8.2 IPHC: Time series of the exploitable biomass of Pacific halibut, the species under management of IPHC. Line denotes establishment of IPHC (1923). Data: from S. Hare, unpublished data, IPHC, 2008; data scaled with those from IPHC (1985), and http://www.iphc.washington.edu/halcom/pubs/annmeet/1997/bluebook/PopulationAssessment1996.htm.

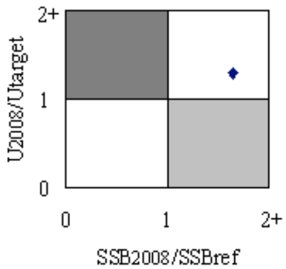

Figure A.8.3 IPHC. Pacific Halibut: the x-axis represents current spawning stock biomass (SSB2008) over spawning stock biomass at SSBref (which is IPHC's reference point for halibut); the y-axis represents current exploitation rate (U2008) over exploitation target rate (Utarget). See text for scoring details. Data available at IPHC (2008) and at http://www.iphc.washington.edu/halcom/pubs/annmeet/2009/presentations/sa08-public.pdf.

International Whaling Commission (IWC):
Date entered into force: 1946
FAO association: No.
Contracting parties: 86 total: Antigua & Barbuda, Argentina, Australia, Austria, Belgium, Belize, Benin, Brazil, Cambodia, Cameroon, Chile, China, Congo (Republic of), Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominica, Ecuador, Eritrea, Estonia, Finland, France, Gabon, The Gambia, Germany, Ghana (Republic of), Greece, Grenada, Guatemala, Guinea (Republic of), Guinea-Bissau, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Kenya, Kiribati, Korea (Republic of), Laos, Lithuania, Luxemburg, Mali, Marshall Islands (Republic of), Mauritania, Mexico, Monaco, Mongolia, Morocco, Nauru, Netherlands, New Zealand, Nicaragua, Norway, Oman, Palau, Panama, Peru, Poland, Portugal, Romania, Russian Federation, San Marino, Senegal, Slovak Republic, Slovenia, Solomon Islands, South Africa, Spain, St. Kitts & Nevis, St. Lucia, St. Vincent & the Grenadines, Suriname, Sweden, Switzerland, Tanzania, Togo, Tuvalu, UK, USA, Uruguay.
Area: Global oceans.
FAO statistical area: All areas.
Primary species: All cetaceans (biomass of nine great whale species of greatest abundance presented in Figure A.9.2).
Commission's objectives: "…to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry."

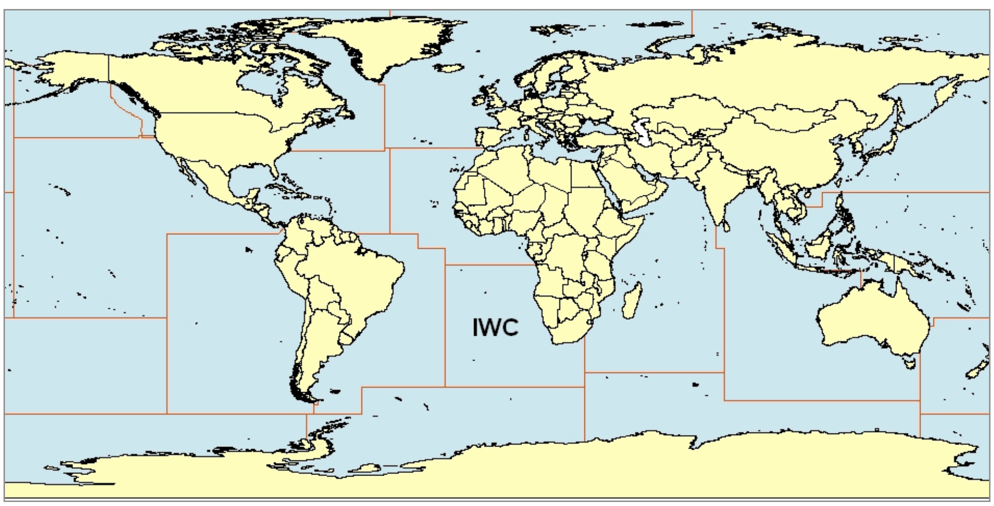

Figure A.9.1 IWC convention area and various characteristics of the RFMO.

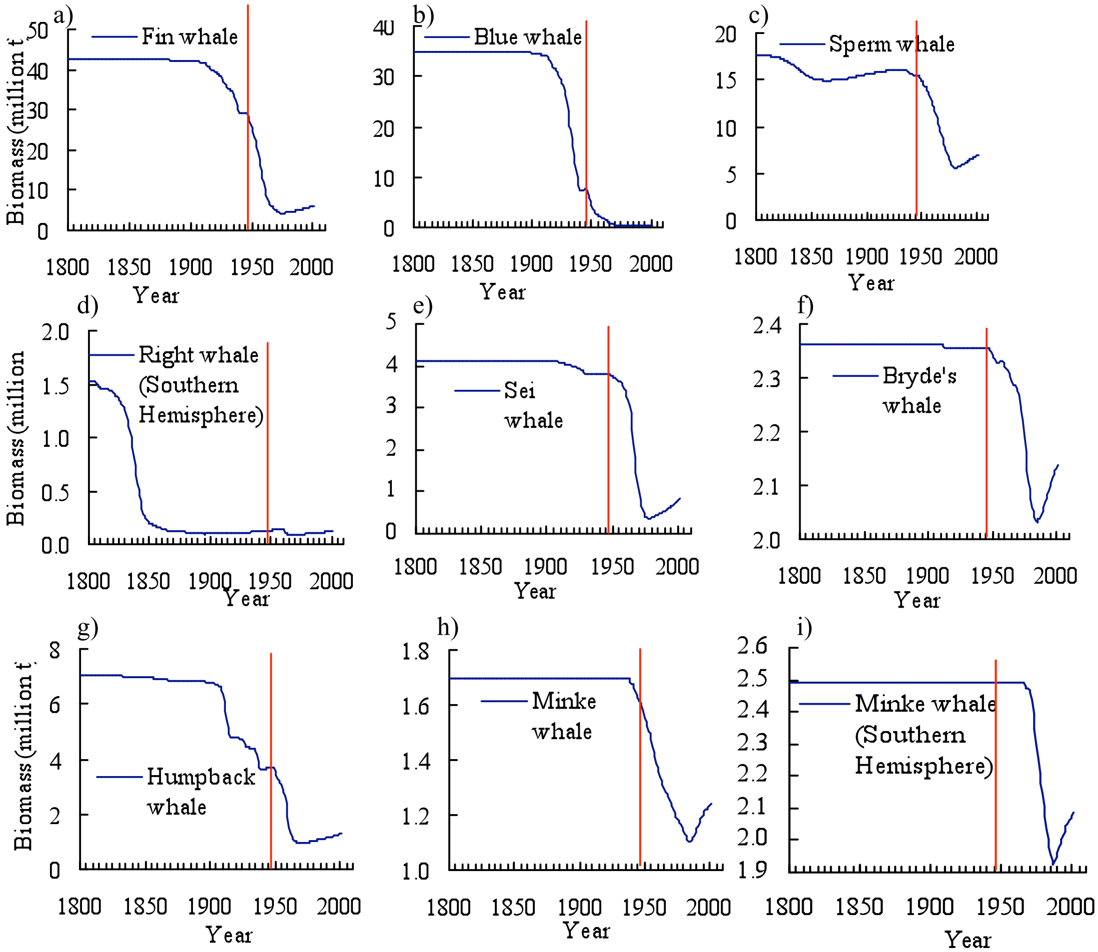

Figure A.9.2 IWC: Time series of biomass of the nine great whale species with greatest abundance under the management of IWC. Line denotes establishment of IWC (1946). Data: from L. Christensen, unpublished data, University of British Columbia, 2008.

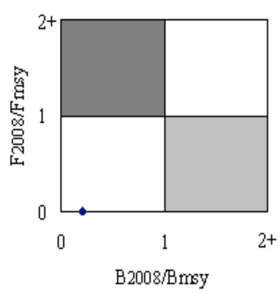

Figure A.9.3 IWC. The x-axis represents current biomass (B2008) over biomass at maximum sustainable yield (Bmsy); the y-axis represents current fishing mortality (F2008) over fishing mortality that produces maximum sustainable yield (Fmsy). See text for scoring details. Note: quadrant selection based on qualitative data (see http://www.iwcoffice.org/commission/iwcmain.htm#conservation and http://www.iwcoffice.org/_documents/commission/scheduletables.pdf); exact location of data point within quadrant is arbitrary. This figure represents all nine IWC whales stocks included in this assessment (they all follow the same pattern).

Northwest Atlantic Fisheries Organization (NAFO):
Date entered into force: 1979
FAO association: No.
Contracting parties: 12 total: Canada, Cuba, Denmark (Faroe Islands & Greenland), EU, France (Saint Pierre et Miquelon), Iceland, Japan, Korea (Republic of), Norway, Russian Federation, Ukraine, USA.
Area: Northwest Atlantic.
FAO statistical area: 21.
Primary species: American plaice, Atlantic cod, Atlantic redfish, Capelin, Greenland halibut, Northern shrimp, Shortfinned squid, Thorny skate, White hake, Witch flounder, Yellowtail flounder (biomass of underlined species presented in Figure A.10.2).
Commission's objectives: "…to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the Convention Area."

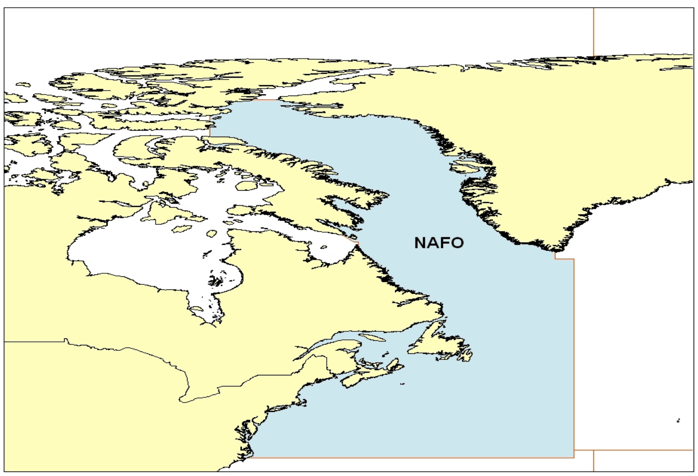

Figure A.10.1 NAFO convention area and various characteristics of the RFMO.

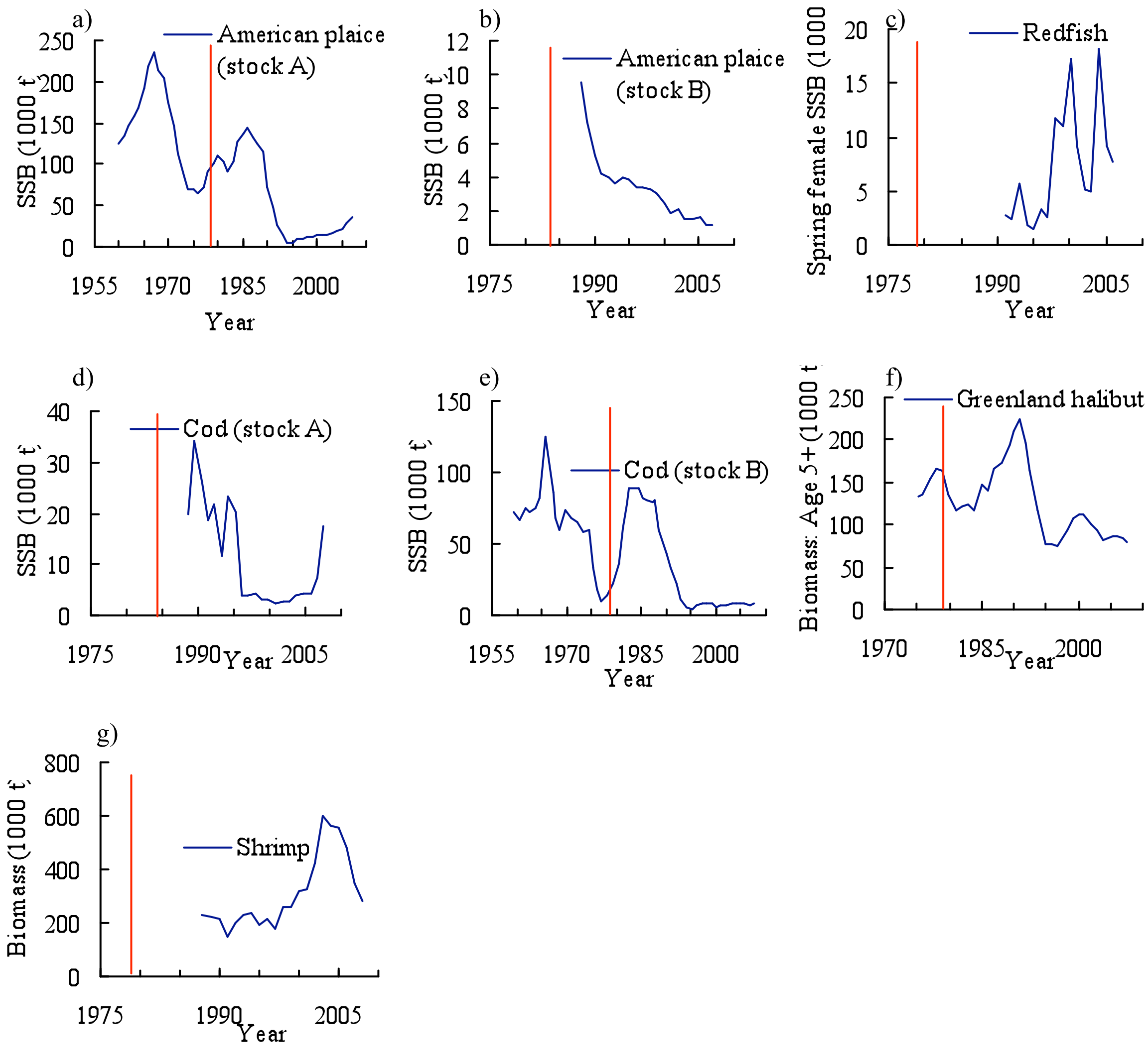

Figure A.10.2 NAFO: Time series of the biomass of five main species under management of NAFO. Line denotes establishment of NAFO (1979). These species comprise a large proportion of NAFO's catch, and had the most biomass data available. Data: a) American plaice (Div 3LNO), from NAFO (2008a); b) American plaice (Div 3M), from NAFO (2008a); c) Redfish (Div 3LN) from http://www.nafo.int/fisheries/frames/fishery.html; d) Cod (Div 3M) from NAFO (2008a); e) Cod (Div 3NO) from http://www.nafo.int/fisheries/frames/fishery.html; f) Greenland halibut (Div 3KLMNO) from NAFO (2008a); g) Shrimp (Subareas 0 and 1), from http://archive.nafo.int/open/sc/2008/scs08-25.pdf.

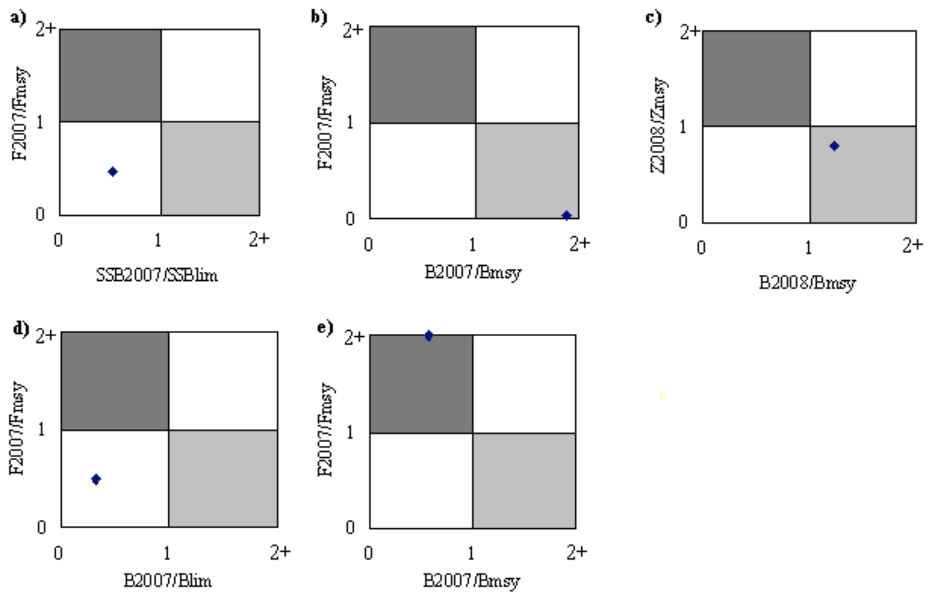

Figure A.10.3 NAFO. The x-axis represents current biomass (B_{2007} or B_{2008}) or current spawning stock biomass (SSB_{2007}) over biomass at maximum sustainable yield (B_{msy} or SSB_{lim}); the y-axis represents current fishing mortality (F_{2007}) or total mortality (Z_{2008}) over fishing mortality or total mortality that produces maximum sustainable yield (F_{msy} or Z_{msy}). See text for scoring details. a) Cod (Div. 3M); data from NAFO (2008b); note: Flim = Fmsy (Mooney-Seus & Rosenberg, 2007); x-axis represents B relative to Blim. b) Redfish (Div. 3M); data from NAFO (2008b). c) Shrimp: Z represents total mortality; data available from NAFO (2008b). d) American Plaice (Div. 3M); data from NAFO (2008b). e) Greenland Halibut (Div. 3KLMNO); data from NAFO (2008b).

North Atlantic Salmon Conservation Organization (NASCO):
Date entered into force: 1983
FAO association: No.
Contracting parties: 7 total: Canada, Denmark (Faroe Islands and Greenland), EU, Iceland, Norway, Russian Federation, USA.
Area: East coast EEZs of Canada & USA; EEZs West of Greenland, west of a line along 44°W longitude south to 59°N latitude, thence due east to 42°W longitude and thence due south; Maritime waters east of the line referred to in previous.
FAO statistical area: 27, 21.
Primary species: Atlantic salmon (biomass presented in Figure A.11.2).
Commission's objectives: "…to conserve, restore, enhance and rationally manage Atlantic salmon through international cooperation taking account of the best available scientific information."

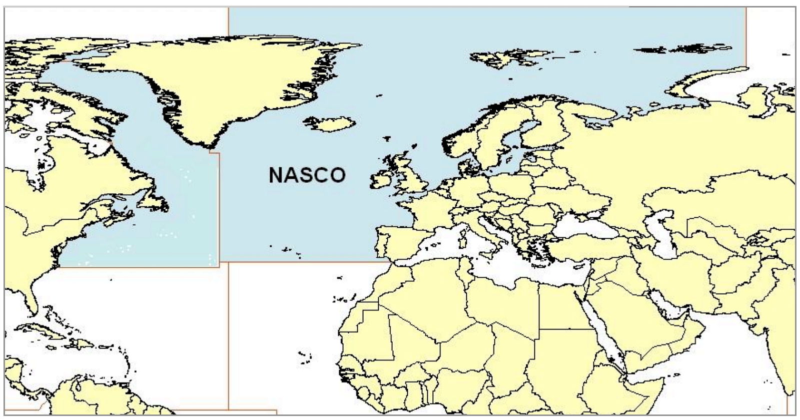

Figure A.11.1 NASCO convention area.

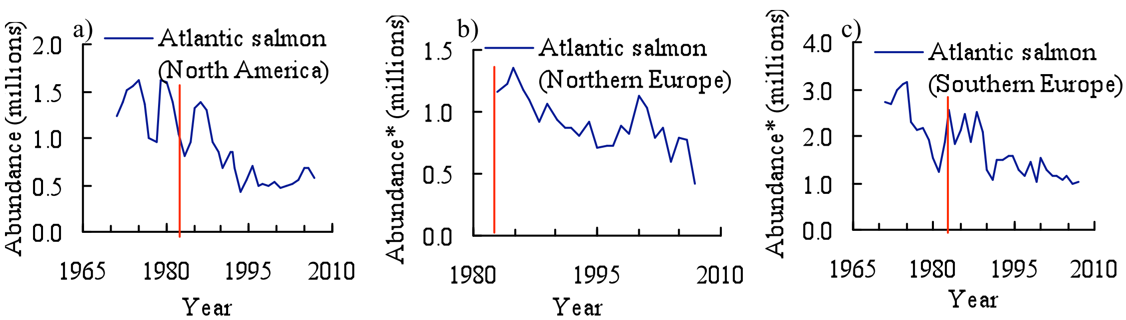

Figure A.11.2 NASCO: Time series of the biomass of the three stocks of Atlantic salmon under management of NASCO. Line denotes establishment of NASCO (1983). Data from NASCO (2008).

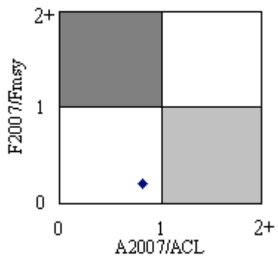

Figure A.11.3 NASCO. The x-axis represents current abundance (A2007) over conservation limit abundance (ACL); the y-axis represents current fishing mortality (F2007) over fishing mortality that produces maximum sustainable yield (Fmsy). See text for scoring details. Atlantic salmon, North America (large salmon only). A= abundance, CL = Conservation Limits. Data from ICES (2009) and NASCO (2008).

North East Atlantic Fisheries Commission (NEAFC):
Date entered into force: 1982
FAO association: No.
Contracting parties: 5 total: Denmark (Faroe Islands & Greenland), EU, Iceland, Norway, Russian Federation.
Area: Atlantic and Arctic Oceans.
FAO statistical area: 27.
Primary species: Blue whiting, Deep-sea species, Haddock, Herring, Mackerel, Redfish (biomass of underlined species presented in Figure A.12.2).
Commission's objectives: "…to recommend measures to maintain the rational exploitation of fish stocks in the Atlantic and Arctic Oceans."

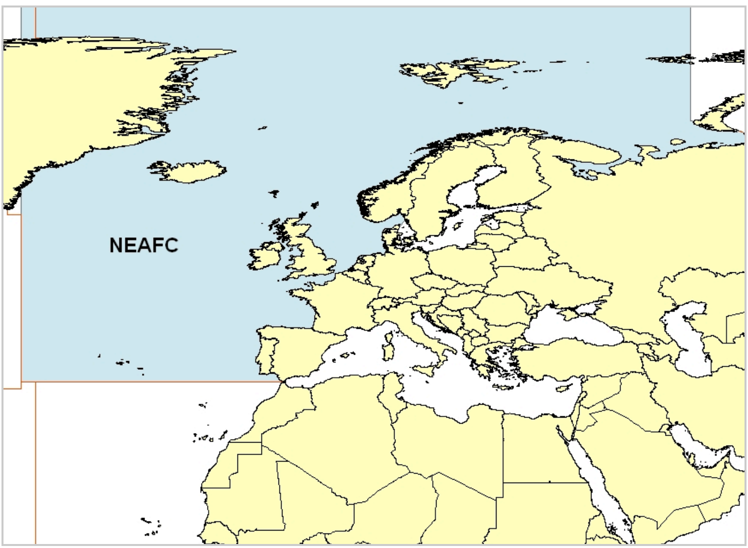

Figure A.12.1 NEAFC convention area.

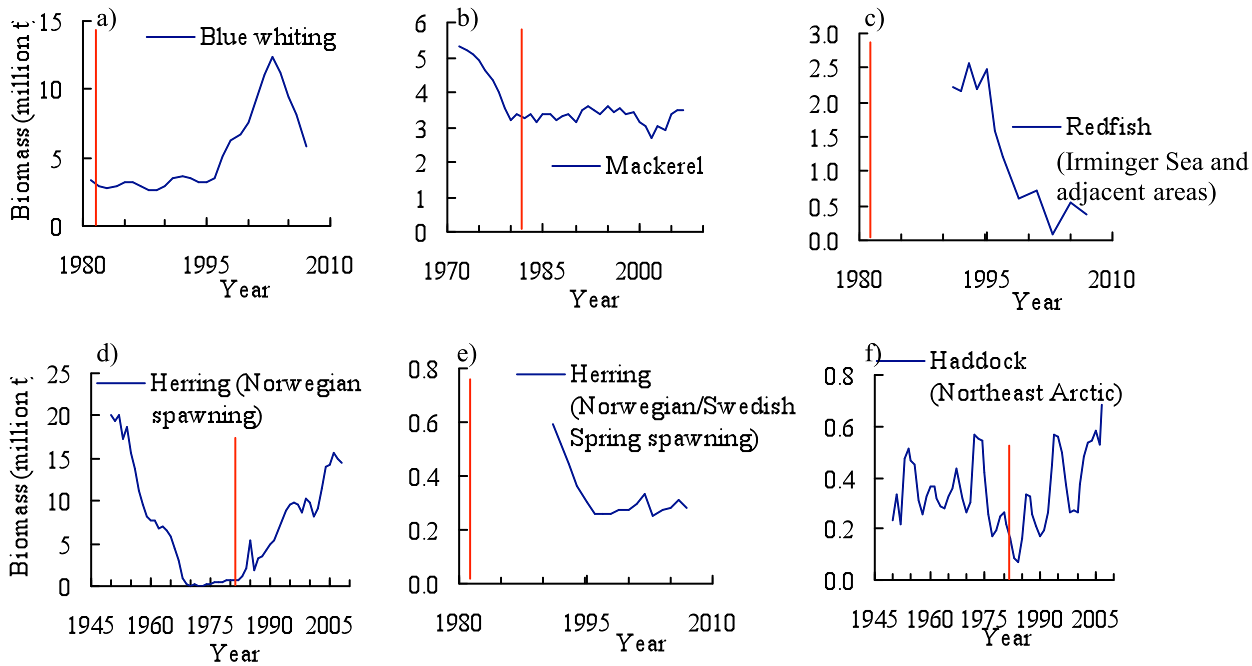

Figure A.12.2 NEAFC: Time series of the five main species under management of NEAFC. Line denotes establishment of NEAFC (1982). Data: a-b) and d-f) from ICES database (see http://www.ices.dk/datacentre/StdGraphDB.asp); c) Redfish (Irminger Sea and adjacent areas) from http://www.ices.dk/reports/ACOM/2008/NWWG/Sec-19%20Pelagic%20Sebastes%20mentella.pdf.

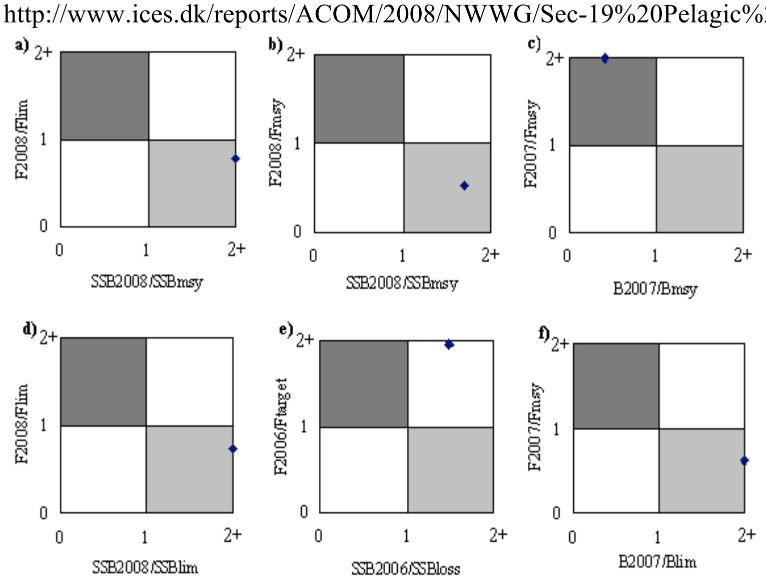

Figure A.12.3 NEAFC. The x-axis represents current spawning stock biomass (SSB2008 or SSB2006) or biomass (B2007) over spawning stock biomass or biomass at maximum sustainable yield (SSBmsy, Bmsy, SSBlim, Bloss, Blim); the y-axis represents current fishing mortality (F2008, F2007 or F2006) over fishing mortality that produces maximum sustainable yield (Fmsy, Flim or Ftarget). See text for scoring details. a) Blue Whiting. Data from ICES (2008c). b) Mackerel. Data from ICES (2008c). Note: for all relevant graphs, Blim= "critical level" (see Mooney-Seus and Rosenberg, 2007). c) Redfish. Data from http://www.ices.dk/reports/ACOM/2008/NWWG/Sec-19%20Pelagic%20Sebastes%20mentella.pdf, NOAA (2007), and Clark (1991). d) Herring, Norwegian-spawning. Data from ICES (2008c) (note: Bpa = very close to F2008; exact location of data point within quadrant is somewhat arbitrary). e) Herring, Norway-Sweden stock. Ftarget: above this there is no increase in long-term yield; SSBloss: equal to lowest observed SSB in the time-series. Data from ICES (2008a). f) Haddock; data from ICES (2008b), and from http://www.ices.dk/datacentre/StdGraphDB.asp.

North Pacific Anadromous Fish Commission (NPAFC):
Date entered into force: 1993
FAO association: No.
Contracting parties: 5 total: Canada, Japan, Korea (Republic of), Russian Federation, USA.
Area: High seas only of the North Pacific Ocean and its adjacent seas, north of 33 degrees North Latitude.
FAO statistical area: 67, 61, 77.
Primary species: Cheery salmon, Chinook salmon, Chum salmon, Coho salmon, Pink salmon, Sockeye salmon, Steelhead trout (biomass of underlined species presented in Figure A.13.2).
Commission's objectives: "…to promote the conservation of anadromous stocks in the Convention Area."

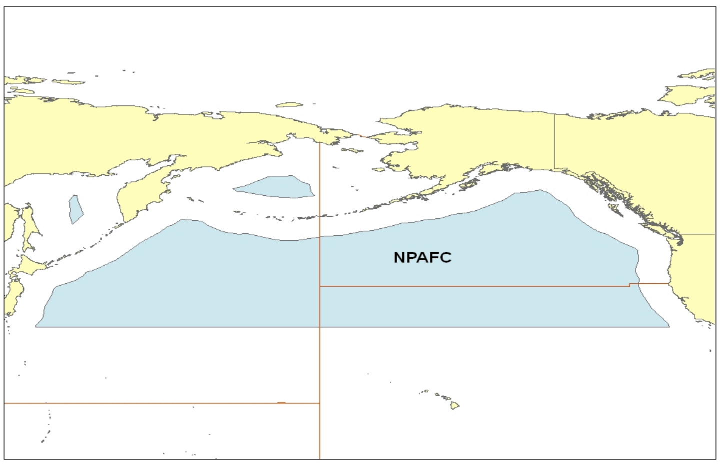

Figure A.13.1 NPAFC convention area.

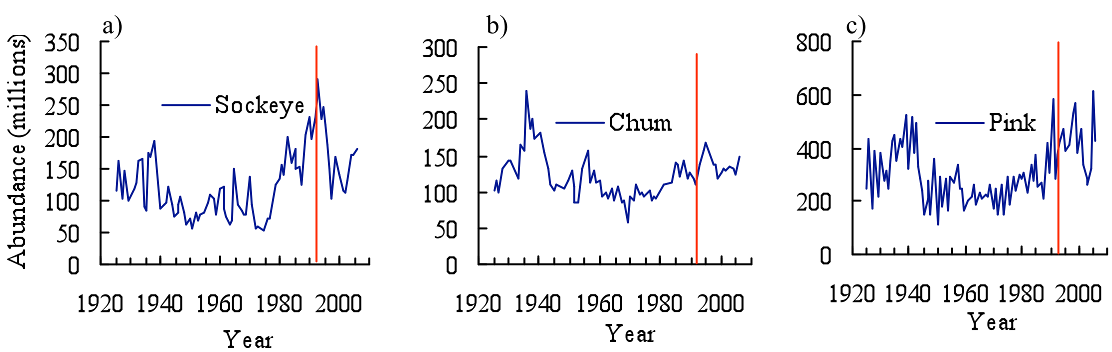

Figure A.13.2 NPAFC: Time series of biomass of three main salmon species under management of NPAFC. Line denotes establishment of NPAFC (1993). These three species comprise the majority of NPAFC's catch. Data from www.npafc.org/new/events/symposium/BASIS%202008/PPT/Keynote-4(Kaeriyama).pdf.

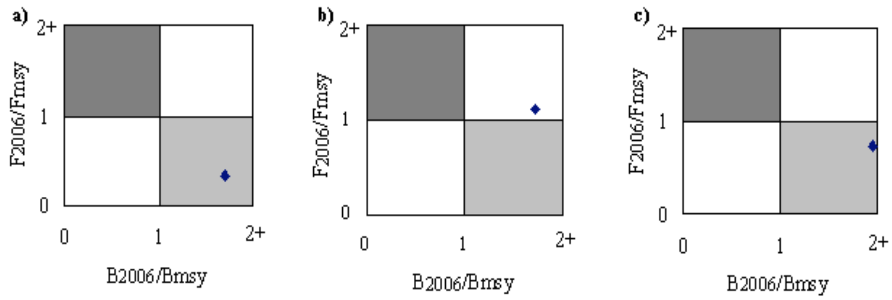

Figure A.13.3 NPAFC. a) Sockeye b) Chum c) Pink. The x-axis represents current biomass (B_{2006}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2006}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. Data from www.npafc.org/new/publications/Annual%20Report/2007/15th%20Annual%20Meeting/CSRS.htm, and Clark (1991).

Pacific Salmon Commission (PSC):
Date entered into force: 1995
FAO association: No.
Contracting parties: 2 total: Canada, USA.
Area: EEZs of Canada and USA.
FAO statistical area: 67.
Primary species: Chinook salmon, Chum salmon, Coho salmon, Pink salmon[*], Sockeye salmon (biomass of underlined species presented in Figure A.14.2)[**].
Commission's objectives: "…to carry out their [Canada and USA] salmon fisheries and enhancement programs so as to: prevent over-fishing and provide for optimum production, and ensure that both countries receive benefits equal to the production of salmon originating in their waters."

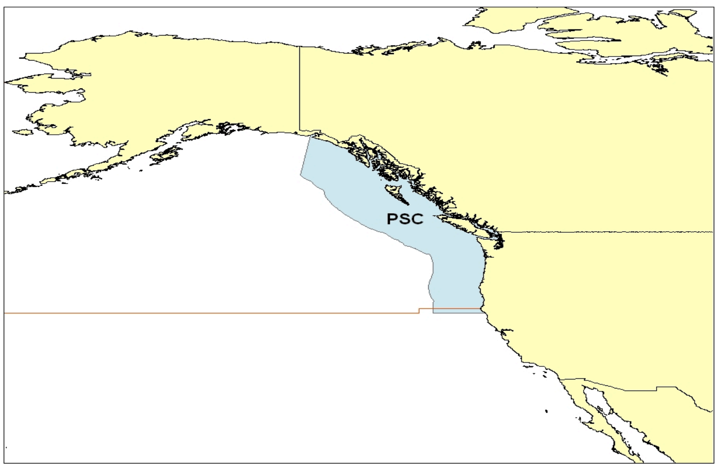

Figure A.14.1 PSC convention area.

[*] Pink salmon did not have current biomass estimates available.
[**] Current stock status data for PSC salmon was not available.

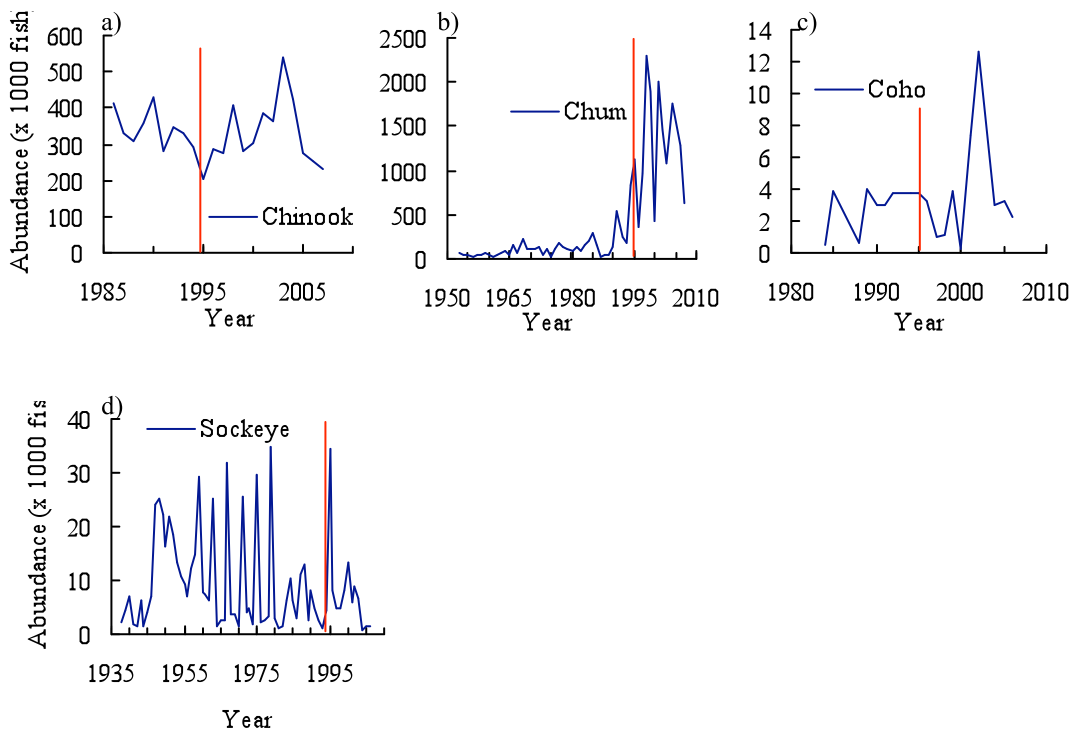

Figure A.14.2 PSC: Time series of biomass of four main salmon species under management of PSC, minus Pink salmon. Line denotes establishment of PSC (1995). Data: a) Chinook from PSC (2008a); b) Chum (Harrison River indicator stock) from A. Rushton, unpublished data, PSC, 2009; c) Coho (Stikine) from PSC (2008b); d) Sockeye (Upper Fraser indicator stock) from C. Michielsens, unpublished data, PSC, 2009.

South East Atlantic Fisheries Organization (SEAFO):
Date entered into force: 2003
FAO association: No.
Contracting parties: 5 total: Angola, EU, Namibia, Norway, South Africa.
Area: Southeast Atlantic high seas.
FAO statistical area: 47, 34.
Primary species: Alfonsino, Armourhead, Cardinal fish, Chub mackerel, Deepsea crab, Deepwater hake, Horse mackerel, Octopus, Orange roughy, Oreodories, Patagonia toothfish, Skates, Squid, Wreckfish[*].
Commission's objectives: "…to ensure the long-term conservation and sustainable use of the fishery resources in the Convention Area through the effective implementation of the Convention."

Figure A.15.1 SEAFO convention area.

[*] Note: at the time of research, SEAFO did not yet have species biomass information available.

South Indian Ocean Fisheries Agreement (SIOFA):
Date entered into force: Still waiting.
FAO association: Yes.
Contracting parties: 23 total: Australia, China, Comoros, Cook Islands, EU, France, Iran, Japan, Kenya, Korea (Republic of), Madagascar, Maldives, Mauritius, Mozambique, Namibia, New Zealand, Russia, Seychelles, Somalia, South Africa, Tanzania, UK, Yemen.
Area: South Indian Ocean, outside national jurisdictions.
FAO statistical area: 51.
Primary species: Fishery resources other than tuna in areas that fall outside national jurisdictions in South Indian Ocean*.
Commission's objectives: "…at ensuring the long-term conservation and sustainable use of fishery resources other than tuna in areas that fall outside national jurisdictions."

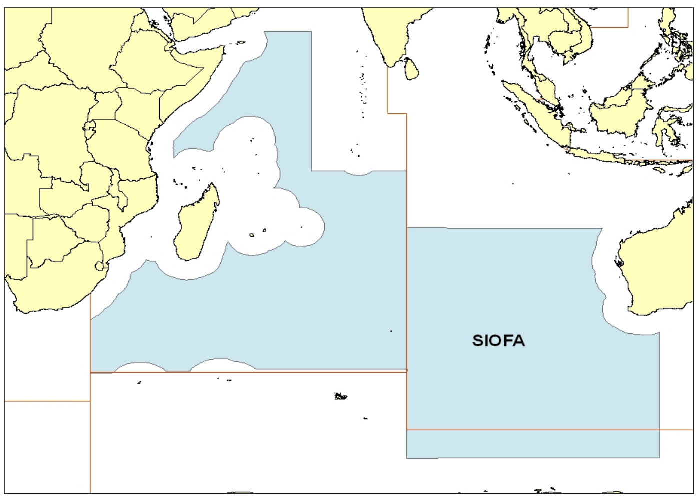

Figure A.16.1 SIOFA convention area.

* Note: at the time of research, SIOFA did not yet have species biomass information available.

South Pacific Regional Fisheries Management Organization (SPRFMO):
Date entered into force: Still waiting.
FAO association: No.
Contracting parties: 4 total: Australia, Chile, EU, New Zealand.
Area: High seas of South Pacific Ocean (from the most eastern part of the South Indian Ocean through the Pacific towards the EEZs of South America.
FAO statistical area: 81, 71, 57.
Primary species: Discreet high seas stocks and straddling stocks*.
Commission's objectives: "…to ensure the long-term conservation and sustainable use of fish stocks and to protect biodiversity in the marine environment."

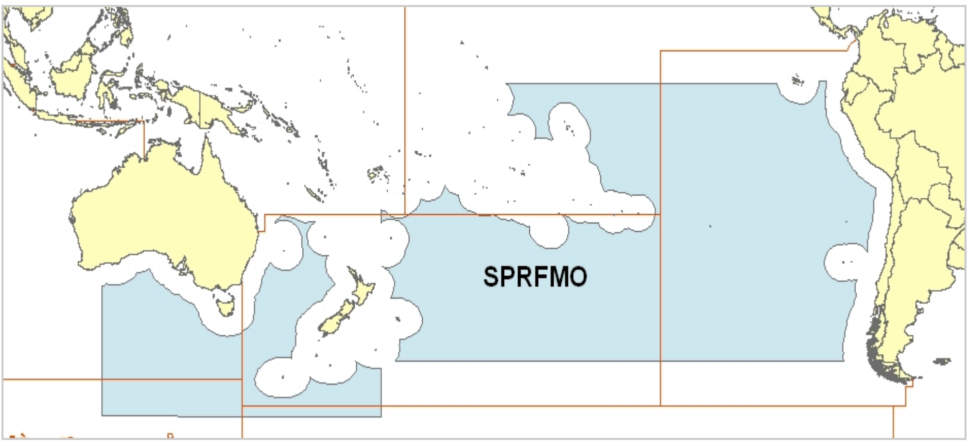

Figure A.17.1 SPRFMO convention area.

* Note: at the time of research, SPRFMO did not yet have species biomass information available.

Western and Central Pacific Fisheries Commission (WCPFC):
Date entered into force: 2004
FAO association: No.
Contracting parties: 25 total: Australia, Canada, China, Cook Islands, European Community, Federated States of Micronesia, Fiji, France, Japan, Kiribati, Korea, Marshall Islands (Republic of), Nauru, New Zealand, Niue, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, USA, Vanuatu.
Area: Western and Central Pacific Ocean.
FAO statistical area: 81, 71, 61, 67, 77.
Primary species: All species of highly migratory fish stocks within the Convention Area, except sauries (biomass of four main species presented in Figure A.18.2).
Commission's objectives: "…to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the western and central Pacific Ocean in accordance with the 1982 United Nations Convention on the Law of the Sea and the 1995 UN Fish Stocks Agreement."

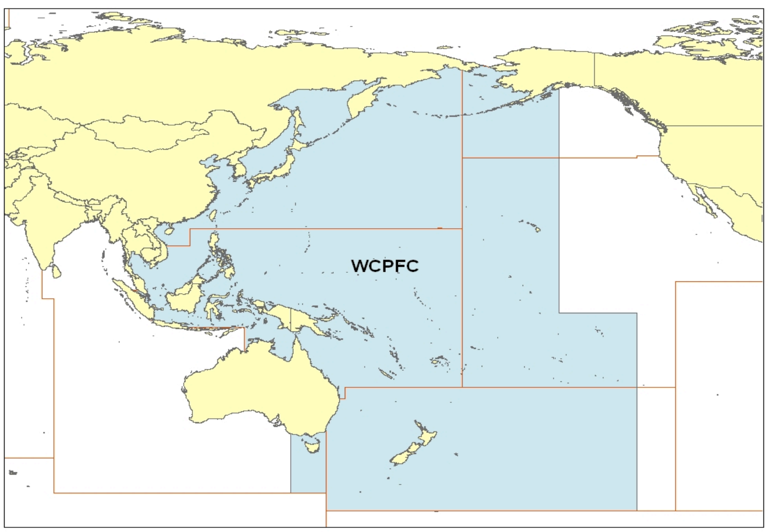

Figure A.18.1 WCPFC convention area.

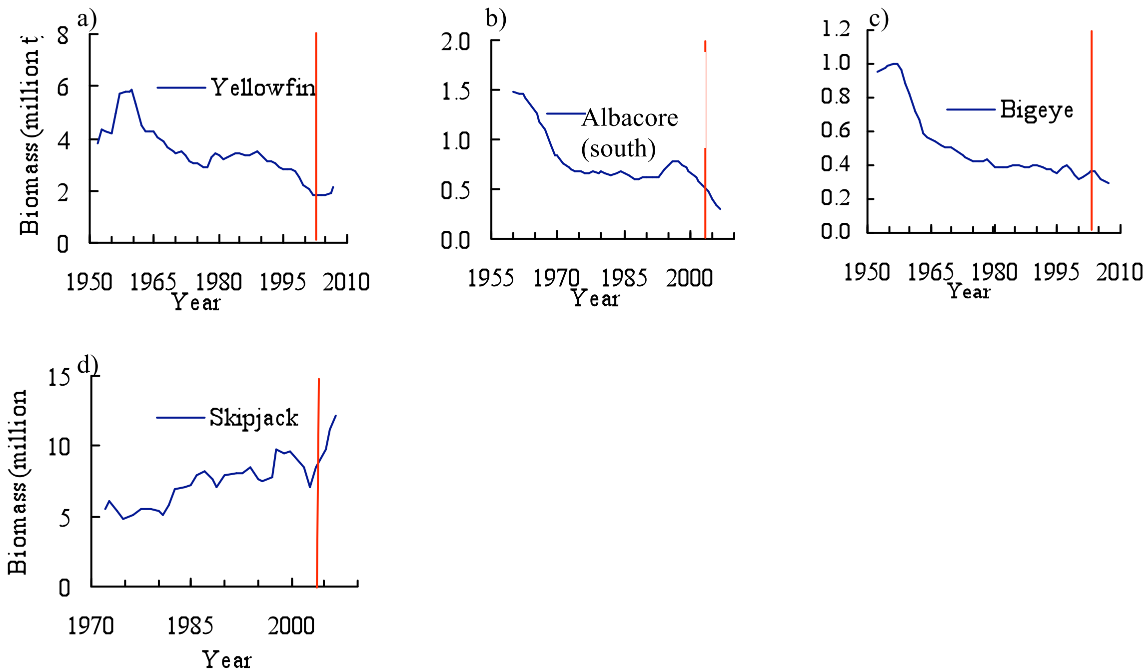

Figure A.18.2 WCPFC: Time series of biomass of the four main tuna species under management of WCPFC. Line denotes establishment of WCPFC (2004). These four species are the main commercial species caught in the WCPFC area. Data: a) Yellowfin from WCPFC (2007); b) Albacore from WCPFC (2008a); c) Bigeye from WCPFC (2008b); d) Skipjack from WCPFC (2008c).

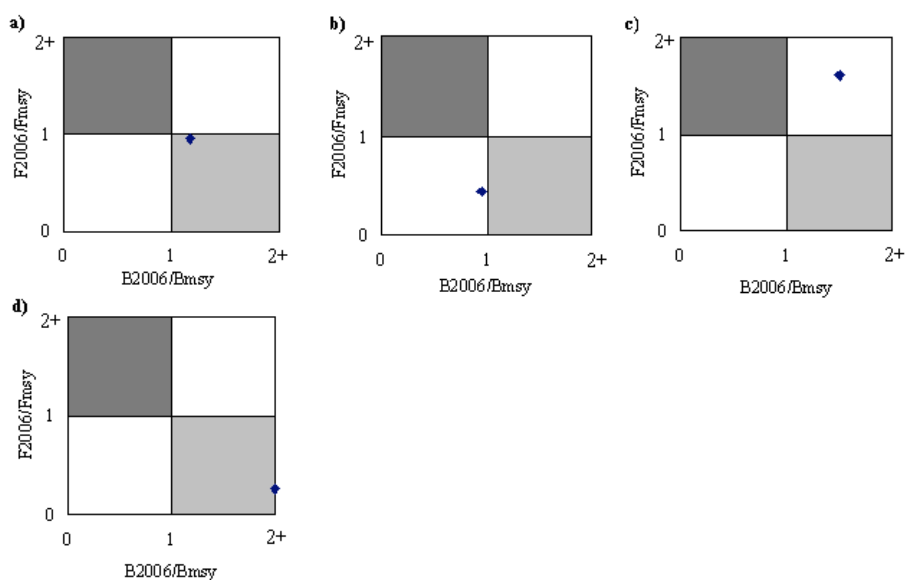

Figure A.18.3 WCPFC. The x-axis represents current biomass (B_{2006}) over biomass at maximum sustainable yield (B_{msy}); the y-axis represents current fishing mortality (F_{2006}) over fishing mortality that produces maximum sustainable yield (F_{msy}). See text for scoring details. a) Yellowfin. Data from WCPFC (2007). b) Albacore, south; data from WCPFC (2008a). c) Bigeye; data from WCPFC (2008b). d) Skipjack; data from WCPFC (2008c).

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Appendix B. Scoring system for theoretical performance

Table B. Breakdown of scoring system: list of criteria developed to assess theoretical effectiveness of RFMOs.

CATEGORY	**GENERAL INFORMATION AND ORGANIZATION**
Criterion 1	**Area covered**
Question	**Are clear boundaries stated?**
1	No mention of Convention area at all?
2	Is there a vague mention?
3	Does the RFMO state which ocean is protected?
4	Are FAO statistical areas mentioned?
5	Are specific boundaries stated (without coordinates)?
6	Are exact coordinates stated?
7	6 + Is there a map?
8	7 + Is there a global map overlayed with designated Convention areas?
9	8+ Are priority areas mentioned?
10	9 + Is there a detailed description of areas?
CATEGORY	**GENERAL INFORMATION AND ORGANIZATION**
Criterion 2	**Species of interest**
Question	**Which species are managed by the RFMO?**
1	No mention of species at all?
2	Is there a vague mention?
3	Does the RFMO mention organism groups (e.g., whales)?
4	Are species mentioned by common name?
5	Are species mentioned by scientific name (including groups, ie, tuna-like species)?
6	Are all species named both scientifically and by common names?
7	6 + Are there management distinctions between stocks (if applicable)?
8	7 + Is there mention of other fish possibly affected?
9	8 + Are the scientific names/details of the other fish affected mentioned?
10	9 + Is there a description of bycatch?
CATEGORY	**GENERAL INFORMATION AND ORGANIZATION**
Criterion 3	**Contracting parties**
Question	**Who is party to the RFMO?**
1	No mention of contracting parties at all?
2	Does the RFMO mention the date the Convention was signed?
3	Does the RFMO mention the date the Convention was ratified?
4	Does the RFMO have only an outdated mention of countries?
5	Are the main contracting countries named?
6	Is each current, contracting party named?
7	Are contracting and cooperating parties named?
8	Are contracting parties presented with dates they signed Convention?
9	8 + Do they have notes on termination of membership?
10	7 + Are cooperating parties presented along with dates signed Convention?
CATEGORY	**GENERAL INFORMATION AND ORGANIZATION**
Criterion 4	**Organization**
Question	**How is the organization of the Commission itself?**
1	No mention of general information and Commission organization at all?
2	Is there a mandate available (downloadable/visible)?
3	Does the RFMO have annual meetings?
4	Is there a flow chart/other descriptive method showing organization of Commission?
5	Is there a description of general organization, Secretariat and mention of annual meetings?
6	5 + Does the RFMO have >1 meeting once/year?
7	5 + Does the RFMO mention having many meetings per year?

8	6 + Does the RFMO have specifics on at least one meeting?
9	8 + Does the RFMO have specifics on many meetings a year?
10	9 + Are the names of commissioners (heads, directors of each country) available? Other notes?
CATEGORY	**GENERAL INFORMATION AND ORGANIZATION**
Criterion 5	**Stated commitment to the overriding objective of conservation and management**
Question	**Is the RFMO committed to conservation and management?**
1	No mention at all?
2	Is conservation important inherently through their stated commitment to the Convention/the Agreement?
3	Is conservation mentioned (minimally) on their website?
4	Is there an appropriate commitment to conservation and management on their website?
5	Is there an appropriate commitment to conservation and management in their mandate?
6	Are there stated limits to their fish catch?
7	Do they have details of conservation and management criteria available?
8	Have they closed fishing or a small area for a short amount of time?
9	Do they employ the EBM Approach? Or is closing fisheries a viable option for dwindling stocks?
10	9 + Is the area closed to unsustainable fisheries (if applicable) or do they have MPAs?
CATEGORY	**GENERAL INFORMATION AND ORGANIZATION**
Criterion 6	**Commitment to the Convention and the Agreement**
Question	**Is the RFMO committed to the Convention and the Agreement?**
1	No mention at all?
2	Does the RFMO make reference to the Convention?
3	Does the RFMO mention that its mandate does not interfere with the Convention?
4	3 + Does the RFMO mention that it does not interfere with the Agreement?
5	Does the RFMO have a stated commitment to the Convention?
6	Does the RFMO describe how their mandate is in line with the Convention?
7	Does the RFMO have a stated commitment to the Convention and the Agreement?
8	5 + Does the RFMO mention which countries have signed on to the Convention?
9	Does the RFMO describe how their mandate incorporates the Agreement?
10	8 + Does the RFMO state which countries have signed on to both treaties?
CATEGORY	**GENERAL INFORMATION AND ORGANIZATION**
Criterion 7	**Budget**
Question	**How is the budget allocated?**
1	No mention at all?
2	Does the RFMO mention that they have a budget?
3	Does the RFMO mention some areas of funding (e.g., projects that need funding)?
4	Does the RFMO describe where the money comes from?
5	Is there a description of where money comes from and how it's divided up/allocated for different operations?
6	Is there a description of how the RFMO pays human resources (e.g., secretariat)?
7	5 + Does the RFMO mention developing states?
8	5 + Does the RFMO have detailed provisions for developing states?
9	Does the RFMO have a detailed plan for developing states?
10	6 + 8
CATEGORY	**COMPLIANCE AND ENFORCEMENT MEASURES**
Criterion 8	**Flag state duties**
Question	**What are the duties of flag states?**
1	No mention at all?
2	Does the RFMO allude to flag state duties (although none are available)?
3	Does the RFMO have a statement of duties that are simply those of the Convention or the Agreement?
4	Does the RFMO have a weak statement of general duties?
5	Does the RFMO have an appropriate statement of general duties?
6	Does the RFMO have a detailed list of general duties?

7	Does the RFMO have a detailed list of general and specific duties (e.g., for developed vs developing countries)?
8	Does the RFMO describe duties of specific sectors within the RFMO (e.g., port state, developing state, non-member state, etc.)?
9	Does the RFMO outline duties in detail, specific to each country?
10	Does the RFMO outline duties in detail specific to each country with clear repercussions if not followed?
CATEGORY	**COMPLIANCE AND ENFORCEMENT MEASURES**
Criterion 9	**Schemes to promote compliance (ie: incentives)**
Question	**What does the RFMO do to promote compliance?**
1	No mention at all?
2	Does the RFMO mention that RFMOs must comply?
3	Does the RFMO merely mention that there are incentives to join?
4	Are there implied incentives?
5	Is there a general list of appropriate incentives for member nations?
6	Is there a detailed list of appropriate incentives for member nations?
7	6 + Any additional elements?
8	Are the benefits distinguished between developed and developing nations?
9	Are appropriate incentives stated and are membership advantages presented?
10	Have the incentives to join the RFMO led to a cease in IUU fishing?
CATEGORY	**COMPLIANCE AND ENFORCEMENT MEASURES**
Criterion 10	**Schemes to deter non-compliance (disincentives/penalties for violators)**
Question	**What schemes does the RFMO have in place to deter non-compliance?**
1	No mention at all?
2	Is surveillance mentioned?
3	Does the RFMO state that non-compliance is not to be tolerated?
4	Does the RFMO mention that each party will take appropriate measures to deter non-compliance (without an extrapolation)?
5	Does the RFMO mention appropriate penalties resulting from non-compliance?
6	Does the RFMO detail a list of appropriate penalties?
7	6 + Is there an explanation of what constitutes as non-compliance?
8	7 + Is there an explanation of an appropriate monitoring system?
9	8 + Do they provide an example of a nation who has been caught violating before?
10	Are there severe and effective (clearly appropriate) penalties, with details on enforcing such measures?
CATEGORY	**COMPLIANCE AND ENFORCEMENT MEASURES**
Criterion 11	**Mechanisms for enforcement and surveillance**
Question	**What mechanisms does the RFMO use to enforce its regulations?**
1	No mention at all?
2	Is enforcement mentioned as important?
3	Are some weak enforcement measures mentioned?
4	Does the RFMO mention specific duties regarding surveillance and enforcement (e.g., observers)?
5	Is there a list of appropriate enforcement measures?
6	Are appropriate enforcement measures detailed to specific non-compliance acts?
7	6 + Are appropriate enforcement measures between different nations explained?
8	7 + Are appropriate, detailed enforcement measures differentiated between developed and developing states?
9	8 + Is there a VOI (a list of vessels of interest) to share info with other organizations?
10	Has the enforcement scheme led to the termination of illegal fishing?
CATEGORY	**CONSERVATION AND MANAGEMENT MEASURES**
Criterion 12	**Precautionary Approach (PA) and acknowledgement of uncertainty**
Question	**Is the PA and the acknowledgment of uncertainty evident in their mandate?**
1	No mention at all?
2	Is there an acknowledgement of uncertainty in the data?

3	Do they mention PA in their approach?
4	Do they mention the preventative measures the RFMO takes (but not PA explicitly)?
5	Do they mention implementation of PA in their mandate?
6	Do they explain the importance of PA in their mandate?
7	Does the RFMO have PA and does it outline uncertainty?
8	7 + Does the RFMO detail uncertain areas?
9	7 + Does the RFMO give examples and a detailed list of PA within their organization?
10	Is the RFMO a model for PA? (i.e., could it act as a template for other organizations?)
CATEGORY	**CONSERVATION AND MANAGEMENT**
Criterion 13	**Set targets**
Question	**What are the TACs?**
1	No targets at all?
2	No targets mentioned?
3	Does the RFMO state that they have targets but doesn't make them available?
4	Does the RFMO mention the main species targeted in outdated years?
5	Does the RFMO mention the main species targeted for present year?
6	Do the main species have stated catch limits, and do the other species have a mention (all for present year)?
7	Do the main species targeted have stated catch limits (from establishment of RFMO to present year)?
8	Do the main species and some other species targeted have stated limits (including the majority of years from establishment of RFMO to present year)?
9	Do the main and some other species targeted have stated limits (from establishment of RFMO to present year)?
10	Do all species harvested have a stated target (with data from establishment of RFMO, on)?
CATEGORY	**CONSERVATION AND MANAGEMENT**
Criterion 14	**Bycatch, threatened species (TS), habitats, trophic relationships (TR)**
Question	**How does the RFMO deal with bycatch, threatened species and habitats and ecological interactions?**
1	The RFMO has no relevant information on this topic?
2	Are one of the four topics mentioned?
3	Are all of the four topics mentioned save bycatch?
4	Does the RFMO admit to bycatch?
5	In the RFMO, is bycatch not concealed, do they mention main bycatch species involved?
6	Does the RFMO mention its most threatened species of bycatch?
7	5 + Does the RFMO mention trophic relationships?
8	6 + Does the RFMO mention the importance of a healthy habitat?
9	6 + Is there any elaboration/more detail?
10	Are the bycatch stats given, with an emphasis on TS, and the importance of habitat and TR?
CATEGORY	**CONSERVATION AND MANAGEMENT**
Criterion 15	**Rebuilding strategies, new fisheries and adaptation to changing fishery dynamics**
Question	**How robust are their management and adaptation strategies?**
1	The RFMO has no relevant information on this topic?
2	Does the RFMO acknowledge the importance of rebuilding?
3	Does the RFMO mention it will rebuild its stocks (but no details given)?
4	Is there a weak outline of a rebuilding plan?
5	Is there a detailed plan of a resource (of focus) being rebuilt?
6	5 + Does the RFMO mention adaptation to change?
7	6 + Is there any elaboration/more detail?
8	6 + Does the RFMO acknowledge climate change?
9	8 + Does the RFMO have hatcheries or release fry, or other similar programs?

10	Does the RFMO have a detailed management plan (w/ heavy PA slant), a plan for adapting to potential changes in fishery (such as climate change), and an openness to new fisheries (or at least mention possibility of)?
CATEGORY	**CONSERVATION AND MANAGEMENT**
Criterion 16	**Data collection, compilation and distribution**
Question	**How are their datum collected, compiled and distributed?**
1	Do they mention anything about data collection?
2	Do they state where they get data from?
3	Is there a pattern/logic to their methods of data collection?
4	Is there a loose methodology to their data collection?
5	Is an adequate data collection described?
6	Is there a reputable datum collection described?
7	6 + Is data distributed to all those relevant (including public)?
8	7 + Is there a description of why this data collection was chosen?
9	8 + Is there a mention of data compilation procedures?
10	Is there a detailed, respectable data collection, and a description of person/committee who assembles data; distribute datum to all relevant; immediately available to public?
CATEGORY	**CONSERVATION AND MANAGEMENT**
Criterion 17	**Illegal, Unreported and Unregulated (IUU) fishing prevention**
Question	**What is the RFMO doing to prevent IUU fishing?**
1	The RFMO has no information on this topic?
2	Does the RFMO mention illegal fishing?
3	Does the RFMO acknowledge that IUU fishing is a concern to be addressed?
4	Does the RFMO have a weak plan to deal with IUU fishing?
5	Does the RFMO have an adequate plan to deal with IUU fishing?
6	Does the RFMO have a detailed plan to deal with IUU fishing?
7	6 + Is the RFMO in the process of compiling a list of IUU fishing boats/has a temporary list?
8	6 + Does the RFMO have a list of IUU fishing boats available to public and other RFMOs?
9	8 + Does the RFMO have the number of IUU fishing boats caught through the years on their website?
10	9 + Does the RFMO have a description of what each member country is doing to combat IUU?
CATEGORY	**CONSERVATION AND MANAGEMENT**
Criterion 18	**Science**
Question	**Do they have scientific advice?**
1	There is no information on this topic?
2	Does the RFMO offer only a mere mention of science?
3	Is science included in the RFMO?
4	3 + Are there any additional details?
5	Do scientific results dictate the catch of the RFMO?
6	5 + Does the RFMO have a scientific body/committee?
7	Does the RFMO state the importance of unbiased data, etc.?
8	Does the RFMO have catch trends available?
9	Is the RFMO’s science thorough?
10	9 + Is there a list of all scientists that make up the scientific body?
CATEGORY	**ALLOCATION**
Criterion 19	**New Members**
Question	**How does the RFMO deal with new members?**
1	No information on this topic?
2	Is there any mention of this topic?
3	Is there the mention of new members (but no details)?
4	Does the RFMO mention that new members are allowed, and provide some key details (i.e., who can apply for membership)?

5	Is the process of acquiring membership outlined?
6	5 + Is there any timeline reference regarding membership?
7	6 + Does the RFMO explicitly state how long it will take for membership to occur?
8	7 + Is a detailed process of acquiring membership described?
9	8 + Is there a strategy to deal with new members in relation to fluctuations in stock size?
10	9 + Does the RFMO acknowledge stock health in relation to new members (i.e., increased allocation increases pressure on the stock)?
CATEGORY	**ALLOCATION**
Criterion 20	**Provisions for developing states**
Question	**Does the RFMO acknowledge developing and developed states' disparity?**
1	No information at all?
2	Is there no mention and the RFMO does not have developing states in the Commission?
3	Does the RFMO state they take developing states into account in any way?
4	Is there a noted difference in allocation or fees between developing and developed states?
5	Is there a process to aid developing states financially?
6	Is there a detailed process to deal with the financial disparity between developed and developing nations?
7	6 + Is there explicit criteria of what constitutes a developed nation?
8	6 + Do they have a fund for developing nations?
9	8 + Are roles and duties of developed states defined?
10	9 + Is there a special allocation for developing states?
CATEGORY	**COOPERATION AND RESOLUTIONS**
Criterion 21	**Transparency (in all processes)**
Question	**Is transparency practiced?**
1	No mention at all?
2	Is transparency obvious? (But no mention of its importance).
3	Does the RFMO allude to transparency through the the Convention/the Agreement statements?
4	Does the RFMO offer an explanation of transparency?
5	Is there some acknowledgement of the importance of transparency or are the general areas of RFMO transparency outlined?
6	Is there a detailed list of transparent areas within the RFMO?
7	6 + Does the RFMO highlight the processes of greater transparency?
8	7 + Are there any additional details?
9	Is most information available to public?
10	Is there a striking effort to make all areas of RFMO transparent?
CATEGORY	**COOPERATION AND RESOLUTIONS**
Criterion 22	**Full member participation**
Question	**Is full member participation encouraged?**
1	No mention at all?
2	Is there any mention of this topic?
3	Does the RFMO mention the importance of full member participation?
4	Does the RFMO mention the participation of major states?
5	Is full member participation stated and encouraged?
6	Is the importance of full member participation explained?
7	6 + Does the RFMO describe specific areas or events that need full member participation?
8	7 + Are there any additional details?
9	Does the RFMO express that states with more at stake have an appropriate say in the decision processes?
10	Is full member participation enforced?
CATEGORY	**COOPERATION AND RESOLUTIONS**
Criterion 23	**Working/cooperating with other RFMOs**

Question	Does the RFMO work with other RFMOs?
1	No mention at all?
2	Does the RFMO mention other RFMOs?
3	Does the RFMO state the importance of working with other RFMOs?
4	Does the RFMO have stated plans to work with other RFMOs?
5	Has the RFMO had meetings with other RFMO(s) with similar interests?
6	5 + Are the details from those meetings available?
7	Has the RFMO worked with another RFMO(s)?
8	Does the RFMO collaborate often with other RFMO(s)?
9	Has the RFMO met with each RFMO of relevance to it (i.e., same area, species, etc.)?
10	Has the RFMO had meetings with all RFMOs?
CATEGORY	**COOPERATION AND RESOLUTIONS**
Criterion 24	**Cooperation with other organizations/bodies (not RFMOs)**
Question	**Does the RFMO work with other organizations/bodies?**
1	No mention at all?
2	Does the RFMO mention other organizations?
3	Does the RFMO state the importance of working with other appropriate organizations?
4	Does the RFMO have stated plans to work with other appropriate organizations?
5	Has the RFMO had meetings with appropriate organizations with similar interests?
6	5 + Are there details from the meeting(s) available?
7	Has the RFMO worked with an appropriate organization(s)?
8	Does the RFMO collaborate often with other appropriate organization(s)?
9	Is an appropriate organization a permanent part of this RFMO?
10	Is more than one appropriate organization an integral part of this RFMO?
CATEGORY	**COOPERATION AND RESOLUTIONS**
Criterion 25	**Strengthening of mandate**
Question	**How does the RFMO strengthen its mandate?**
1	No mention at all?
2	Is there any mention of this topic?
3	Does the RFMO state the importance of mandate strengthening?
4	Does the RFMO have plans to strengthen its mandate or does it provide a few strengtheners?
5	Does the RFMO have appropriate mandate strengthening?
6	Does the RFMO list the details of appropriate mandate strengthening?
7	Does the RFMO have an appropriate, current mandate?
8	7 + Does the RFMO have all mandate documents complete with updates/changes (previous and current)?
9	8 + Does the RFMO have any additional details?
10	Does the RFMO strengthen the mandate by making appropriate yearly changes?
CATEGORY	**COOPERATION AND RESOLUTIONS**
Criterion 26	**Assessments and reviews (i.e., performance, etc.)**
Question	**Have performance reviews been created?**
1	No mention at all?
2	Does the RFMO mention performance reviews as necessary?
3	Is the RFMO in the process of reviewing/planning on a review?
4	Has the RFMO had meetings with other RFMOs to discuss performance reviews?
5	Has a performance review been created (at least one)?
6	Has a performance review been executed?
7	Are the details of the review available?
8	7 + Does the RFMO guarantee implementation of relevant changes pending the results of the review?
9	Has the review led to any changes in the RFMO?
10	Has the review led to the implementation of tangible, positive changes in that RFMO?