SUSTAINABLE SEAFOOD

IN AN ERA OF OVERFISHING

by

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DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Interdisciplinary Studies)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

September 2015

ABSTRACT

People derive benefits from the seafood trade including food security, work and profits. As trade increases worldwide, the impacts of seafood production increase and are known to include overfishing and labour abuses in distant source areas, including the developing countries that provide most of the world's seafood. Over the past decade, as demand for sustainably certified wild-caught seafood has begun to increase, seafood buyers, sellers and NGOs have taken voluntary measures to encourage sustainable seafood production, but without knowledge of the effects. What kinds of effects result from voluntary industry measures for sustainable seafood? Do the effects improve the social and environmental impacts of seafood production? Drawing from quality assurance methods and sustainability theory, seven voluntary measures taken in the private sector between 2008 and 2014 were evaluated for their effects against ten qualitative attributes said by sustainable seafood scholars to be necessary conditions for stewardship of common pool natural resources. Results indicate that the seven measures led to new forms of industry self-regulation that help to control some input variables of overfishing and to some increased compliance across supply chains. New empirical information was produced by the measures to determine where change is needed to solve conflicts and to reduce risks where they occur in seafood production. Some measures made access to resources more secure for business. Others provide diagnostic tools to reduce risks for overfishing, illegal fishing and forced and trafficked labour in seafood supply chains. Overall the measures helped the private sector to see and understand what is happening in source fisheries and to agree on ways to fix unsustainable practices.

PREFACE

Publications arising from work presented in the thesis: Two co-authored articles were published from work in the thesis: (1) Pramod G, Nakamura K, Pitcher T and L Delagran (2014) Estimates of illegal and unreported fish imports to the USA. Marine Policy 48:102-113 and (2) Bartram P, Kaneko J and K Kucey-Nakamura (2010) Sea turtle bycatch to fish catch ratios for differentiating Hawaii longline-caught seafood products. Marine Policy 34:1:145-149.

Ethical Review: The research conformed to University Policy 89 and its exemption criteria for ethical review.

Statement of Co-Authorship: I conceived and wrote all chapters in this dissertation. I performed the assessments and contributed to the implementation of each of the seven measures studied. I completed the evaluation independently and retrospectively over a one-year period from February 2013 to February 2014. Limited co-authored materials are included in chapters 3 and chapter 5 as examples of measures prepared for the seafood industry. The industry measures described in Chapters 2, parts of 3, and 4 were prepared while working for the Sustainable Fisheries Partnership, a US-based non-profit conservation organization. The measures described for bigeye tuna in Chapter 3 were prepared for the Hawaii Seafood Council with Dr. John Kaneko and for the supplier Seafood Hawaii in fulfillment of product requirements for Sam's Club. The research in Chapter 5 was prepared for the World Wildlife Fund. The work in Chapter 6 was conceived independently. The original version was written by this authour without any institutional support. However the work led to funding

from the US foundation Humanity United in late September 2013 and later versions were influenced by progress made on the project due to that support.

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ACKNOWLEDGEMENTS

For inspiring intellectual exchange I express thanks to James Tansey, Amanda Vincent, Gary Bull, Harry Nelson, Graham Auld, Lori Bishop, John Kaneko, Cathy Dichmont, Monica Jain, Pramod Ganapathiraju, Sompong Srakaew, Rebecca Surtees, Trevor Ward, Iain Pollard, Tony Pitcher, Jim Cannon, Shelley Clarke, Kenichi Ito and Kengo Morimoto.

The work towards industry measures for Mediterranean bluefin tuna, sustainable shrimp metrics and BC wild salmon was sponsored by the Sustainable Fisheries Partnership. Pedro Sousa provided an analysis of the significance of scientific recommendations for Mediterranean bluefin tuna that was helpful for writing the briefs that supported the industry measure. Fisheries experts Reg Watson, Daniel Pauly, James Nance, Juan-Manuel Caudillo Garcia, Clive Turnbull, and Dessy Anggraeni contributed concepts and fishery-level insights for warm water wild shrimp.

The Responsible Fishing Assessment and bycatch research on Hawaii's longline fisheries was funded by Cooperative Agreement Number NA17RJ1230, between the Joint Institute for Marine and Atmospheric Research (JIMAR) and the National Oceanic and Atmospheric Administration (NOAA) through PacMar Inc. and the Hawaii Seafood Council under the direction of Dr. John Kaneko with assistance on the quantification of fishery bycatch impacts from Dr. John Sibert, formerly of the Pelagic Fisheries Research Program and Dr. Martin Hall of the Inter-American Tropical Tuna Commission. The paper on illegally-fished seafood imports to the USA was sponsored by the World Wildlife Fund. Team members Trevor Ward, Pramod Ganapathiraju and Iain Pollard contributed ideas to the Labour Safe Screen concept but the original idea and all writing about it in the grant proposal and here are my own.

I would like to acknowledge the patience of my supervisor James Tansey, whose excellent work on risk as politics / culture as power was the inspiration for my application to UBC. Amanda Vincent provided considerate and tough comments that improved the manuscript tremendously. Special thanks for undying support are due to Hillel Goelman, Enid Ho and Rebecca Pouilot at the Interdisciplinary Studies Graduate Program at UBC. I would like to

acknowledge Sam Sheps for his excellent advising and co-authorship of a 2008 review paper with Dr. Petra Arck and I. Petra saw a spark in me at the beginning of my PhD process that I am only today beginning to actualize, and I will never forget her support and nudge forward.

To Robert the love of my life and provider of its beauty and to my friends Angela, Tanya and Kathy I thank you for your loving support.

Normally it's the mother who encourages the child to persevere through life's new challenges. In this case my son, Kaze, stood by me from beginning to end and helped me most to see this through. Kaze, your steadfastness and beautiful mind inspire awe in me every day and I love you. You are the reason I undertook this inquiry into solutions for some of the most complex problems on the planet and you are the reason I could complete it. I hope to inspire you to exercise your curiosity in this world and to strive to reach the heights of your talent.

1. Introduction: Sustainable seafood in an era of overfishing

People derive benefits including food security, work and profits from the seafood trade. Yet, the effects from increased seafood trade are unclear in distant source areas (Smith et al 2010) including the developing countries that supply sixty five to seventy percent of seafood exports (FAO 2014). Seafood exports exceed the value of coffee, rubber, cocoa, tea, tobacco, meat and rice combined and their production is unique for being dependent on the wild capture of marine resources (Smith et al 2010) because even farmed fish are fed with feed made from wild stocks. Overfishing of common pool resources has caused ecosystem level effects including collapse of Atlantic cod stocks and diminishment of shark and billfish populations worldwide (Essington et al 2013; Pikitch 2012; Polovina et al 2011; Smith et al 2010; Pauly 2008; Worm 2008). Seafood sustainability, in the face of increasing international trade, hinges on the ability of institutions to improve the impacts of seafood production (Sampson 2015, Micheli 2014) particularly in regions that are developing or unregulated (Smith et al 2010). Meeting human needs while sustaining ecosystems and the benefits they provide is a global challenge and coastal marine systems present a particularly important case (Leslie et al 2015). Over the past decade, increasing demand for sustainably certified wild-caught seafood has begun to shape global seafood markets through retailer conditions for procurement—but without knowledge of whether the conditions are effective (Sampson et al 2015). Retail grocers have added conditions to seafood purchasing that include stipulations for seafood sellers to invest in measures for progressive improvements in fisheries (Sampson et al 2015). Do they hold promise for sustaining the benefits? A premium is seldom added in the market for sustainable production and this makes it difficult for consumers to distinguish sustainable versus unsustainable products (Roheim et al 2011, Roheim et al 2008) and for scholars to recognize market-driven impacts.

What a consumer can find, in any grocery store in North America, is a claim of sustainability affixed to a seafood product. Testing the claims is challenging. Between 2008 and 2014, hundreds of measures to improve fisheries were undertaken by seafood sellers and by conservation non-governmental organizations (NGO) via programs funded by US philantrhopic donors (MSC 2014; WWF 2014; FIP Directory 2014; Sustainable Fisheries Partnership 2014; FishWise 2014; FishChoice 2014). The effects of these measures are

difficult to study due to scant publication in the public domain and little academic attention to the initiatives or their effects. Curious about the effects and working within this domain, this author reviewed the landscape in 2010. NGOs and corporations created partnerships to deliver sustainable seafood to North American tables (David and Lucile Packard Foundation 2012). NGOs and industry organizations appeared to be pursuing different effects however and were providing different qualities of assurance. Where was the evidence that the measures were improving the social and environmental impacts of seafood production? Were the conditions of seafood production being improved in any measurable way? Were specific institutional arrangements recognizable behind impactful measures or, what systems are behind them? What qualities of sustainability are assured and what is provided as the proof? These questions led to a formal investigation into the kinds of effects produced by a group of industry-led versus NGO-led measures for sustainable seafood.

Collecting information from the private sector was a significant challenge in the process of meeting the research goal. As a result, evaluative research methods were selected within the quality assurance approach (ISO 2013) because they are recognized in an industrial setting. Evidence of impact was sought in published materials rather interviews, in order to comply with the standards for third party verification (ISO 2013). It was a challenge to find sufficient information to assess for changing conditions. As a result in 2011 seven measures were selected where this author had a leading role and access to primary information.

A commitment to procure seafood only from certified or improving fisheries has been published by over 25 retailers worldwide[1]. Some retailers report publicly on progress against the commitment for example, more than 90% of the fresh and frozen farmed and wild seafood sold by retail chains Walmart US, Sam's Club, and ASDA has earned Marine Stewardship Council or Best Aquaculture Practices certifications or is engaged in a Fishery Improvement Project (Walmart 2014). In 2014, 322 fisheries were certified by the Marine Stewardship Council (MSC) program as sustainable, up from 38 in 2008 (MSC 2014; Ward and Phillips 2008). Additionally, several seafood retailers purchase seafood from 84 fishery improvement projects worldwide in order to meet their procurement stipulations for

[1] Albertsons, Aldi US, Aldi UK & Ireland, Aldi Australia, Aramark, ASDA, BJ's Wholesale Club, Compass

sustainability. According to its own review, the Marine Stewardship Council program has produced real environmental performance for wild capture fisheries correlated with increased scores assigned by auditors over time for higher stock biomass, new protected areas, or better information systems (Martin et al 2012). A recent study in the journal Science indicates that fishery improvements projects tend to stall in early stages (Sampson et al 2015). Beyond MSC and fishery improvement projects (FIPs), measures for sustainable seafood are taken independently within the private sector. The effects of independent measures for sustainable seafood taken by companies and NGOs have not been published.

The purpose of this thesis is to evaluate the effects from seven measures for sustainable seafood taken independently by the private sector in the period 2008-2014. The evaluation criteria were drawn from an interdisciplinary literature review into seafood sustainability in an era of overfishing. They are qualitative attributes of sustainable seafood drawn from scholarly perspectives on sustainability in fishing and seafood production, overfishing, the economics of stewardship, ecolabels, and corporate sustainability. These perspectives are presented in this chapter along with a summary of attributes for assessment, which may or may not overlap with the working model of sustainable seafood in the private sector. In total, ten evaluation questions are drawn from the sustainability literature. In subsequent chapters, the answers to these evaluation questions provide new scholarly knowledge about the effects of private sector measures for sustainability for seafood production and raise new questions about causality, competing versus common goals, and accountability for impacts.

1.1 Which fish does sustainable seafood include?

Seafood production involves a chain of enterprises that transform a fish or crustacean into a product for sale in a market. After fishing, seafood supplies are split and lumped together repeatedly to make orders for the next buyer in the chain. A company that removes heads and guts from salmon for example may buy fish every day of the week in season. The salmon come from different types of producers using purse seine, gill net and troll fishing gear or stationary nets and are sold to different types of buyers for different destinies as fresh fish, canned products or frozen fillets. Salmon supplies from Canada, the USA or

Russia may be combined at a distribution hub to be resold to another processor in China. Tuna supplies caught from waters near Yemen, Sri Lanka, Papua New Guinea and Kiribati may be combined at a distribution hub at sea before being purchased and processed by a company in Thailand then exported to North America, Japan or Europe. Comprised of fish from multiple origins and jurisdictions of governance for fisheries, the impacts of production from a single seafood product for oceans and people are uneven. Some of the seafood content in one product may come from a highly managed fishery and some part from untraceable origins that may include supplies that were fished in unmanaged waters or illegally. In one week, the operators of a trans-shipping vessel on the high seas may buy seafood from fifteen vessels with crew who are migrant workers holding contracts and paid fairly and from another four vessels with migrant workers held captive and unpaid onboard. Feed for aquaculture products like shrimp is sourced from local and international sources. It is made from several ingredients derived from various waste products from seafood processing facilities mixed with fresh cheap fish. If the feed was made in Thailand it is likely to include supplies from trawl and purse seine fisheries, where 17% of crew work under conditions of forced labour (ILO 2013). The combination of supplies in production makes it difficult to trace the fishing origins accurately for everyday seafood products in the grocery store like fresh wild salmon, king crab, canned tuna or frozen shrimp. Yet in North America, the NGO-led sustainable seafood movement is defined around the Marine Stewardship Council program for certifying a single fishery of origin. Certification requires an independent body to provide a written assurance (a certificate) to a client company that a product meets specific requirements (ISO 2014). Seafood labeled with its logo has origins in a fishery that meets the MSC standard (MSC 2014). Critics of the MSC's global standards approach to sustainable seafood have argued the standard poses a fixed bar with difficult-to-reach goals for developing countries (Micheli et al 2014; Froese and Proelss 2012; Jacquet et al 2010; Jacquet and Pauly 2007). The mixed origins of day-to-day food products on tables in North America should raise additional questions for sustainability scholars, as should the disconnection between the institutional arrangements for certifications, as private voluntary arrangements in the free market, and fisheries, as sets of fixed regulatory arrangements governed by public institutions. Some regulatory institutions including the National Marine Fisheries Service of the US National Oceanic and Atmospheric Administration refuse to participate in private certification schemes for sustainable fisheries (NOAA 2013).

Over the study period the status of sustainable seafood expanded from fisheries certified to the MSC standard to fisheries where an NGO or seafood buyer operates a project. The projects harness the power of the private sector to incentivize positive changes toward sustainability, according to the Conservation Alliance for Seafood Solutions. Suppliers, retailers, and food-service companies can support the efforts of their source fisheries by participating in or buying products from fishery improvement projects (CASS 2014). The Conservation Alliance for Seafood Solutions is a host organization for five Canadian and eleven American conservation organizations including the World Wildlife Fund and Monterey Bay Aquarium. It published guidelines in 2012 for its members and the seafood industry to use for supporting fishery improvement projects. The guidelines, which function like a standard for sustainable seafood (Sampson et al 2015), call for use of the MSC standard as a tool for measuring the performance of fisheries and the progress fishery improvement projects make over time (CASS 2014). Yet, there is a fundamental difference between seafood from a fishery that is MSC certified and seafood sold by a seller or NGO operating a project to improve fishery. MSC certified seafood carries a promise from the certificate holder to meet the sustainability thresholds of a global standard for excellence in fisheries management. Uncertified seafood does not trace back to a certificate holder who is a signatory to this promise. When it is said to be in a fishery improvement project, uncertified seafood from any fishery in the world can be sold as sustainable seafood even if it does not trace back to any particular goals or thresholds of achievement for social and environmental impacts, so long as the NGO or seafood seller host of the project reports on who the participants are, meetings, and work planning on a project website. The guidelines are process- not outcomes-oriented (see CASS 2014). Retailers with a sustainable seafood policy that includes fishery improvement projects may purchase uncertified seafood just like certified seafood to fulfill their goals. This is the basis for claims like Walmart's that 90% of its seafood is sustainable. The theory is that mass-buying, leverage will drive improvement across more fisheries worldwide including with the worst environmental impacts (David and Lucille Packard Foundation 2015; McDonalds 2014; Sustainable Fisheries Partnership 2013; Walmart 2011).

Improving fisheries is the goal of the MSC product certification and fishery improvement projects but improving seafood production across the supply chain is not. Is overfishing the major threat to seafood sustainability? Can it be improved by voluntary measures? Does the notion of sustainable seafood include products made of content from the +/- 400 single origin fisheries overseen by NGOs or the MSC only? Or are other things happening to cause shifts within seafood production to improve its impacts? In the remainder of this chapter I review the primary literature related to these issues and generate a series of questions, which will provide the central focus for the analysis in this thesis.

1.2 Overfishing

Overfishing is a term from the United Nations Convention on the Law of the Sea of 1982, a legal instrument that gives each maritime nation sovereign rights to the water column and continental shelf extending out 200 nautical miles from shore with obligations to take up regulatory provisions to sustain fisheries in their waters (UN 1982). Some migratory species that are important commercially and swim across national waters and in the high seas, like tunas and billfishes, are managed by Regional Fishery Management Organizations with conservation and management measures governed by agreements of fishing countries. The management units are political, for example the International American Tropical Tuna Commission oversees tuna populations in the Eastern Pacific on the eastern side of a line running North-South and on the other side tuna is overseen by the Western Central Pacific Fishery Commission—although tunas are known to cross the line (Hampton et al 2005). Management authorities set objectives for the size of the target stock and a total allowable catch (TAC) for the year to maintain it, with variations around this approach. When the catch rate is higher than can be sustained because the TAC is not respected by fishermen or is inadequately enforced by authorities, then widespread illegal overfishing can occur (Beddington, Agnew and Clark 2007). There are different types of overfishing but where an excessive rate of fishing produces an excessive decline of the spawning stock it may lead to a temporary or long-term collapse of the stock (FAO 1993). Marine ecologists have pointed out that the conventional approach to fisheries science and management still largely excludes the broader effects of fishing on the entire ecosystem, including declines of other fish and

marine animal species (Pikitch 2013). The ecosystem approach to fisheries takes a wider view that expands fisheries governance to be responsive to environmental changes (Garcia 2003) like food web shifts from the depletion of marine predators and outbursts in alien species due to intense fishing (Polovina et al 2011; Daskalov et al 2007; Essington et al 2006; Pauly et al 2005; Myers and Worm 2003; Pauly et al 2002). For example, the marine food web around the Hawaii longline fleet in the Pacific Ocean has shifted as a result of intense fishing and lancet fish has surpassed the target species, bigeye tuna, as the species with the highest annual catch rate (Polovina et al 2013).

For the majority of world fisheries, serious depletions are the norm worldwide (Pitcher and Cheung 2013). Recent global estimates suggest that anywhere between 30% and 60% of global fish stocks are overfished and between 7% and 24% of fish stocks have collapsed from overfishing (low estimates by Branch et al 2011 and high estimates by Pitcher and Cheung 2013). Law and regulations have not controlled long-term increases in fishing effort on common property (Waters 1991). Most species are on a continuing trajectory of decline (Costello et al 2013; Pikitch 2013). Catch per effort is still declining (Pitcher and Cheung 2013). Ecosystem-level effects are occurring in plain sight but are rarely accommodated in stock assessment (Pitcher and Cheung 2013). Efforts to recognize and halt the depletion of species from fishing have been taken by the International Union for the Conservation of Nature, which publishes a Red List of Threatened Species (IUCN 2014). The Convention on International Trade in Endangered Species lists species threatened with extinction unless trade is closely controlled. Species listed on Appendix I may not be traded internationally. Species listed on Appendix II may be traded with an export permit or re-export certificate (CITES 2014).

Criminal exploitation of human resources is significant in fishing fleets in 51 countries (US State Department 2014a) and well documented at every level of seafood production (ILO 2013; IOM 2012, Accenture 2012, Robertson 2010) but only four prosecutions and two convictions were recorded worldwide in 2014 (US State Department 2014a). Slavery exists in seafood production with, for example, 17% of crew in the Thai fishing fleet found to be working under forced and trafficked conditions in 2013 (ILO 2013).

Overfishing is a very clear example of the way in which a human activity can undermine its own viability (World Ocean Assessment 2015). From the perspective of supply and demand, overfishing poses a direct threat to seafood procurement. According to Nobel prize-winning economist Elinor Ostrom (2008) humans have failed to halt the tragedy of massive overfishing of the oceans because it has proved to be more difficult to establish effective governance arrangements on a global scale than on a local scale. No individual owns the ocean or the fish in it. Fish are caught on a first-come-first-served basis by anyone with appropriate gear, subject to existing regulations established by state and federal governments as trustees of the common property and this creates a situation where what is optimal for the individual fisherman is not always optimal for all fishermen combined (Waters 1991). Fish stocks can be depleted faster than regulatory agencies can respond (Berkes et al 2006). Fish stocks can be depleted faster than regulatory agencies can respond (Berkes et al 2006). Social causes of the global overfishing crisis, both Elinor Ostrom and Fikret Berkes have emphasized, occur within the interplay between local impacts and global trade. Seafood is the world's most traded commodity (FAO 2014). Trade can be the solution as much as the problem. In tens of thousands of cases worldwide, producers with some degree of self-regulation over the management of the resource have proven to be effective stewards (Ostrom 2009).

Private regulation has emerged to safeguard economic, environmental and social sustainability in producer countries and along the value chain, where compliance of actors across supply chains is the defining feature (Wahl and Bull 2013). The focus on compliance may help to explain why industry and NGO approaches to sustainable seafood do not square with overfishing statistics from science. Reporting on its own progress across 198 fisheries worldwide, the MSC has stated that the fishing companies that undertook pre-assessments to the MSC standard contributed to a 16% increase in the proportion of performance indicators scoring at the best practices level over a period of five years (Martin et al 2012). The Conservation Alliance for Seafood Solutions presents six NGO-corporate partnerships on its 'Success Stories' page (CASS 2014). Neither organization offers any empirical description of a fishing environment and how the real world impacts of production have been improved by its programming against any independent benchmarks like the Millenium Ecosystem Goals for reducing overfishing (GIWA 2013). Both organizations

report any increasing compliance by seafood companies with their programs as impact. It is not surprising that this type of claim has provoked serious challenges from the scientific community. The MSC logo has been granted to fisheries that are understudied (Jacquet et al 2010) and overfished (Proelss and Froese 2013). In part this reflects philosophical gaps between business, charitable, scientific, environmental and socio-economic concerns with the meaning and practice of sustainability. In part it might also reflect a lack of integration of science in NGO and charitable environmental programming and a lack of integration of a supply chain frame of inquiry in sustainability science as it pertains to seafood production.

In scholarly debates over sustainable seafood, the most visible gap is within the marine scientists themselves, who differ in approaches between an ecosystem view of fishing impacts and a single target fish stock view. Nearly 15 years ago Jeremy Jackson of the Scripps Institute said that ecological extinction due to overfishing was disturbing coastal ecosystems worldwide (Jackson et al 2001). Ransom Myers and Boris Worm of Dalhousie University then published research indicating that large predators in coastal regions were declining on a global basis with potentially serious consequences for ecosystems (Myers and Worm 2003) and Daniel Pauly from the University of British Columbia and others described significant adverse impacts on marine ecosystems from fishing (Pauly et al 2003). A second paper by Worm and others in 2006 forecast all fished populations would collapse by the year 2048 due to the overfishing of large marine predators (Worm et al 2006). These assertions sparked a reaction from respected fisheries scientists who challenged the rigor and accuracy of the predictions (see for example Hampton et al 2003 and Hilborn 2012) who argued that the overfishing problem is a policy not scientific problem because effective management requires only an understanding of how the fishery system is performing relative to reference points that define overfishing for the target species (Beddington et al 2007).

This rich scientific debate directed attention to the challenges of ending overfishing and rebuilding supporting ecosystems (Pauly et al 2003, Hilborn et al 2006). A détente in 2009 between Ray Hilborn and Boris Worm led to the formation of a working group of scientists to examine the uncertain status of fisheries and to determine what to do about it (Stokstad 2009). The results showed that 63% of assessed fish stocks worldwide require rebuilding. Even lower exploitation rates are needed to reverse the collapse of vulnerable species (Worm

et al 2009). More scientists published views of the global picture that suggest somewhere between 30% (Branch et al 2011) and 60% (Pitcher and Cheung 2013) of the world's fish stocks are overfished.

Drawing from these perspectives, the first and central evaluation question is, did these measures reduce overfishing?

1.3 What makes seafood unsustainable? Economic perspectives

Fishery scientists have argued that overfishing can be prevented with strong central governments enforcing conservative catch regulations (Beddington et al 2007; Hilborn 2007) by predicting the aggregate behavior of fishing fleets and managing them with appropriate incentives (Hilborn 2007), while economists have said that there are fundamental economic incentives to overfish (Ostrom 2009; 2008). Economists have described overfishing as an externality that subverts the incentives to save fish for future harvest (Libecap 2009; Bell 1972). Public regulation of marine fisheries appears necessary to overcome the incentives to overfish, but traditional methods of managing a fishery, for example with catch limitations, are often unenforceable (Waters 1991). Whether the limitations are direct, like gear restrictions, or indirect, like quotas, trip limits, size limits, and seasonal and area closures, any short-term improvements that can be measured biologically come paired with economic inefficiencies by forcing fishermen to adopt less productive and less profitable harvesting techniques and to incur higher costs to comply with or react to the regulations (Waters 1991). When private decision makers do not consider or internalize social benefits and costs in their production or investment actions, the gap between private and social net returns results in externalities in the form of harmful effects on third parties (Libecap 2009). Certain resources such as marine fish are scarce and have remained common property because the costs of defining and enforcing a claim of ownership are higher than the expected benefits (Cheung 1970). In one way or another, all environmental and natural resource problems associated with overexploitation or under provision of public goods arise from incompletely defined and enforced property rights (Libecap 2009). When the responsibilities relative to

use rights are unclear it weakens the license to operate. From an economic perspective, seafood is unsustainable when the producers' stake is insecure.

Drawing from these perspectives, the second evaluation question is, did the measure make access to resources more secure for the producer?

1.4 What makes seafood unsustainable? Perspectives on enforcement vs self governance

The speed of resource exploitation often overwhelms the ability of governance institutions to respond (Berkes 2007). The imperiled status of global fish stocks offers clear evidence of the comprehensive failure of national governments to provide coherent management to protect those stocks, according to Daniel Bromley an economist at the University of Wisconsin (Bromley 2011). New markets can develop so rapidly that little attention is paid to the critical impact of sequential exploitation and the spatially expanding depletion of harvested species (Berkes 2007). In Canada, the federal government failed to curb overfishing despite fishery scientists' clear advice to do so to prevent the demise of cod stocks on the Atlantic coast and salmon productivity on the Pacific coast (Gallagher et al 2013; Walters and Maguire 1996). Historically, rules for fisheries have attempted to constrain the behavior of the commercial agents in the system with policies based on meeting biological goals for fish stocks (Berkes et al 2006). However, fishers may not see overfishing impacts in a cause and effect manner because fish stocks may be larger than commercial fishing areas and many boats contribute to cumulative impacts. Fishery managers may not see all of the various contributions to fishing mortality on a fish stock from different commercial fleets. Fishery scientists cannot model the size of fish stocks effectively when illegal and unreported fishing are rampant and climatic and food web changes are not taken into account. Total allowable catch quotas have failed the environment and communities in terms of their effects, for example widespread dumping of unwanted fish, misrepresentation of catches, and ultimately closure of the ground fishery in 1995 resulted from this policy after it was established by the Canadian government for the west coast of Canada (Ostrom 2009; Clark 2006). Poor governance is the main threat to the seafood sector's ability to satisfy the future demand for fish (FAO SOFIA 2014). When

fishers fail to comply with fishing rules and fishery managers fail to comply with scientific advice then seafood is unsustainable (Beddington et al 2007).

Drawing from these perspectives, the third evaluation question is, did the measure increase compliance with scientific advice?

1.5 Toward voluntary self-regulation in fisheries and seafood production

The major obstacle to effective governance of fisheries is the complex problem-structure of marine resources (Kalfagianni and Pattberg 2013). Simple blueprint policies have not worked to reduce overfishing (Ostrom 2009). There is an inherent complexity to overfishing that is not amenable to agreement on fixed thresholds let alone controlled testing. When it comes to measuring the impacts, global industrial fishing may have too many influences for any specific measure for sustainability to claim a direct connection between cause and effect. Although scientific, economic and governance perspectives in scholarship have described the structural reasons why overfishing is inevitable in common pool marine resources, voluntary measures are emerging in seafood supply chains and more broadly in the private sector to improve the social and environmental impacts of seafood production. Innovations in seafood sustainability are occurring as seafood companies face declining supplies, insecure trading relationships, and business risks like importing products linked to crime. Beyond seeking the certification of fisheries to a global standard, some firms handle sustainability through supplier contracts and traceability schemes (Nestle 2014; Mars 2014) and others through intra-industry warranties or legality verification (McDonalds 2008, AIPCE 2008).

Given the interconnectedness between fishing and processing and other major industrial impacts on oceans it is difficult to tell if market measures are effective for halting overfishing and where they are effective it could take decades for some fish stocks to turn around. Some fish stocks may not bounce back. For every market innovation in the seafood sector that creates downward pressure on overfishing there may be another practice creating upward pressure somewhere else. Nations and regional governance organizations have been

unable to control the input variables that sustain overfishing (Waters 1991). When resource users operate in a global market they may lose a vested interest in the maintenance of local resources (Ostrom 2009). Distant water fleets and mobile traders can operate like roving bandits because global markets often fail to generate the self-interest that arises from attachment to place (Ostrom 2009; Berkes 2007; Olson 2000). Seafood impacts can also be transferred by sustainability measures, for example fishing pressure was transferred from dolphins to juvenile tunas by one US federal program and from sea bottoms to estuarine areas by another federal program administered internationally by the US government[2].

Diverse perspectives on overfishing contribute to a transitional and interdisciplinary theoretical environment for sustainability scholarship. It is clear that what makes seafood unsustainable from a theoretical viewpoint are unclear responsibilities relative to rights; what Libecap called incompletely defined and enforced property rights (2009). Theory suggests compliance and good leadership at the top are needed to make seafood sustainable. When scientific evidence stimulates decisions that make sense to resource users and their input factors into changes, then compliance is made more attractive and desired socio-economic outcomes are achieved more easily than when those decisions are imposed (Osterblom et al 2011).

Drawing from these perspectives, the fourth evaluation question is, did the measure include arrangements for self-regulation by the users?

1.6 What makes seafood sustainable? Market perspectives

Sixty percent of consumers in North America are willing to pay more for socially responsible products and that includes a 17% premium for goods with a social or environment benefit and a 9% margin for goods that provide benefits to humans such as good labor practices (SeafoodSource.com 2013). Until recently, accepted theory has suggested that resource users

[2] All US tuna imports with origins in purse seine fisheries must carry a Dolphin Safe certificate (NOAA 2014a). The US has a trade ban on shrimp imports from countries not certified as having a regulatory regime in place to prevent the killing of sea turtles in the course of wild shrimping (NOAA 2014b, Charnovitz 2002).

will never self-organize to maintain their resources and governments must impose restrictions, despite the fact that research in multiple disciplines has found some government policies accelerate resource destruction, whereas some resource users have invested their time and energy to achieve sustainability (Ostrom 2009). Cinner et al (2014) found clear evidence of resource users' ability to overcome the 'tragedy of the commons' locally, for example, by making and enforcing their own rules for managing 42 coral reef fisheries (Cinner et al 2014). Reductions in overfishing were tied very closely to market access and tended to benefit wealthier resource users (Cinner et al 2012). In long-surviving resource systems the institutions that have succeeded employ a wide diversity of rules and this has been shown in comparative studies across sectors and regions of the world (Ostrom 2009). For example, allowing the introduction of private property rights to the groundfish fishery in British Columbia resulted in improvements in even the most difficult management problems including by-catch, equity concerns, concentration of quota holdings and vessel overages, showing overfishing can be mitigated with the appropriate mix of incentives, monitoring and enforcement (Grafton, Nelson and Turris 2005). Adding individual transferable quotas to fisheries might eliminate overfishing (Costello et al 2013) however the strategy of simply adding this right to fisheries to trigger market and environmental gains has been questioned (Sumaila 2010; Pinkerton and Edwards 2009).

Ostrom has argued that at a global scale the reciprocity norm is ineffective because fishermen are compelled to harvest as quickly as possible to keep up with their competitors when private property rights are too weak to exclude others from using a resource they are not willing to pay to use (Ostrom, 2008). Hundreds of thousands of fishers work for successful seafood companies that operate globally in compliance with traceability and assurance programs however. Selling fish involves buyers and contracts. Contracts and buying policies are mechanisms for accountability across supply chains. When sustainability requirements are added to a sales contract or buying policy then a reciprocity norm is built into the deal between buyer and seller. This makes seafood sustainability plausible in a market.

Limitations to supply chain approaches for seafood sustainability reflect how seafood is traded in a free market. Seafood is consigned in large shipments from mixed origins and

traded by companies operating on the basis of competitive trade principles. Most countries have agreed on the principles of free and fair trade (WTO 2014). Imposing trade measures contingent on the production process, known as 'Process and Production Methods', is one of the most knotty controversies in the debate over trade and the environment (Charnovitz 2002). The issue is whether it is appropriate, fair and legal to impose trade measures contingent on the production process (Charnovitz 2002) when this may favor some producers over others and distort free trade. This can lead to monopolies and anti-trust issues in the market. Product certification is a voluntary measure that companies participate in to add value to their products while avoiding anti-trust. It is distinguished from lobbying or any initiative that aims to change policy for the benefit of a private company, even for a goal like sustainability. Product certification is an attribute that can be added to a sales order or contract. Contracts are a vehicle for sustainable resource use (Libecap 2009; Cheung 1970). If a customer will only buy seafood that is certified or from an improving fishery then the supplier must show how these attributes are delivered at the sales transaction or in an audit for quality assurance. Causality between the actions and the impacts is not linear however because a number of factors influence the outcomes of voluntary initiatives, including their cross-boundary nature and the extent to which economic behavior is embedded in structures of social relations (Wahl and Bull 2013). As Wahl and Bull have pointed out, private regulation is the outcome of political conflicts involving companies, states and NGOs with other non-market actors and is designed to solve collective action problems like reputation and loss of competitiveness. To maintain their position in the private sector, market measures must demonstrate increased social capital in the form of respect for environmental and social values in business practices (Vurro et al 2010; Bostrom and Hallstrom 2013). Showing positive impact is sustainable from a market perspective.

Drawing from these perspectives, the fifth evaluation question is, did the measure gain positive recognition in the market?

1.7 Corporate-NGO partnerships for seafood sustainability

Traditional regulatory arrangements face serious legitimacy problems because they fail to deal adequately with urgent global problems and NGOs have turned attention to the private sector for reform (Cashore, Auld and Newsom 2004). These arrangements lack the traditional enforcement capacities of a sovereign state (Cashore, Auld and Newsom 2004). As the traditional custodians, governments and regional fisheries management organizations were slow to react, a niche opened for environmental and non-profit groups to become increasingly active through eco-certification and sustainability ranking programs (Shelton 2009). By definition, private voluntary measures are detached from the bounds of representative democracy and must gain support for their activities (Bostrom and Hallstrom 2013). Legitimacy is earned only when collaboration produces outcomes desired by all participants, and since this is nearly impossible to achieve and sustain over time, multi-stakeholder initiatives for sustainability can attain a fragile authority at best (Hallstrom and Bostrom (2010). Today NGOs play a significant role leading the work of improving fisheries (Conservation Alliance for Seafood Solutions 2014).

The dynamic between environmental NGOs and seafood companies is a major driver of seafood sustainability that deserves scholarly attention. By blending market and moral authority, corporate-NGO partnerships can result in a license to operate that may open new markets and attract more investment (Hallstrom and Bostrom 2013; Bostrom and Hallstrom 2010; Cashore, Auld and Newsom 2004). When NGOs put their name to market measures for seafood sustainability, as is typically the case for improving fisheries, it may lead to the acquisition of new territories and new markets for seafood and good business opportunities to drive out competitors with NGO help. On the flipside, NGO-corporate partnerships may also create a steady stream of new issues to solve. For companies, ignoring new issues raised by an NGO partner may put the benefits of the partnership at risk.

Drawing from these perspectives, the sixth evaluation question is, did the measure address the concerns of environmental and social NGOs concerned with sustainable seafood?

1.8 Product certifications for seafood sustainability

Major global brands have been called into question concerning practices associated with their production and certified products are often presented as part of the solution (Cashore et al 2012). Over 1000 private codes and standards for sustainability have developed through collaboration between companies, industry associations, and NGOs (Wahl and Bull 2013; Smith and Feldman 2003). These approaches hold great promise because they create incentives for managing natural resources sustainably but also allow fisheries or aquaculture operations to be certified despite degradation of marine ecosystems, loss of income among local people, and negative social impacts from the non-certified operations overlapping production (Micheli et al 2014). Seafood sustainability should be promoted for entire production systems instead, (Micheli et al 2014). This statement is significant because, even though the bulk of seafood sustainability measures concern 'fisheries', the seven cases of in this thesis show measures in a broader light. The cases reveal organizations trying to solve problems and to advance their positions across a wide array of issues and parts of production.

In a global review of scholarly work on sustainability in global value chains, where companies and their partners adopt new rules on a voluntary basis, Wahl and Bull found that research topics and theories span economic sectors but are studied less for seafood and most for agriculture, forestry and apparel sectors. Scholars have paid more attention to effects on economic, labour and social conditions and to the emergence of private regulation and the role of the state. Less attention has been paid to effects on the environment, to corporate strategies in private regulation, and to examining how economic, social and environmental performance can be integrated into private codes and standards (Wahl and Bull 2013). All three are important drivers for seafood sustainability, as are scholarship focused on market drivers and benefits. Cathy Roheim from the University of Idaho and team found a price premium exists for MSC products in metropolitan London (Roheim et al 2011) but other scholars have not found a price premium. Chen, Innes and Tikina, who looked into private cost-benefits for voluntary forest product certification, found little evidence to verify that consumers will pay any premium for certified forest products (Chen et al 2010). They found market access and improved public image to be effective drivers in the market.

With respect to effects on the environment, in 2012 the Packard Foundation sponsored a large assessment of certification impacts worldwide involving academics Ben Cashore (Yale University), Michael Vandenburgh (Vanderbilt University), Louis Lebel (Chiang Mai University), Tom Lyon (University of Michigan), Kira Matus (London School of Economics) with input from industry leaders from Unilever, Mars Incorporated, and Marks and Spencer and from the World Wildlife Fund, Soil Association and Rainforest Alliance. The assessment produced reasonable evidence to suggest significant, though not universal, positive changes in near-term ecological, social, and economic well-being resulting from standards-compliant practices, although literature clearly attributing large-scale sustainability impacts to standards and certification systems is rare and moreover, rigorously designed studies do not always find the impacts expected (Cashore et al 2012). The major conclusion of the assessment is that systems affect the practices and performance of producers, leading to impacts beyond the farm or enterprise level. These broader impacts affect other stakeholders, either by influencing the uptake of certain practices or by affecting the broader economy or society. These direct effects, in turn, affect the attitudes and behaviors of stakeholders, consumers, and businesses, which influence how they engage with producers. Cashore's team advised that it is too early to look for large-scale impacts. Practitioners and enterprises considering certification can anticipate the near-term outputs and outcomes from the adoption of standards-compliant practices, but those who seek answers to questions about certification as a tool to drive large-scale change will find little empirical evidence regarding whether such change has occurred (Cashore et al 2012).

With respect to performance, company activities spreading over a large number of countries and constituencies has led to the search for new coordination and control systems and to the formulation and implementation of codes of conduct across business sectors (van Tulder et al 2009). Product certifications like the one offered by the Marine Stewardship Council program have criteria based on fixed thresholds for performance indicators that are reasonable for single fisheries in developed countries but may also greatly limit the range of candidates when multiple activities or issues outside their scope are considered (Micheli et al 2014). Looking only at global impacts in the short-term, overfishing worldwide continues despite a proliferation of private codes and standards (Jacquet and Pauly 2007). The Marine

Stewardship Council program has not ended overfishing (Froese and Proelss 2012). The MSC annual reports describe a growing percentage of commercial seafood inside their branded program worldwide (MSC 2014) but do not acknowledge still only 8% comes from developing countries (Micheli 2014).

While fisheries certification alone is not likely to arrest the decline of fish stocks, assessment of fisheries against a global benchmark has produced positive unanticipated effects like the increase in adoption of fishing reference points in fisheries participating in the Marine Stewardship Council program (Gulbrandsen 2009).

With respect to corporate strategy, it is possible to view the limits to product certifications as indicative of the issues companies have decided they can address to create value, versus what they cannot. The scope of the MSC standard includes the exploitation of marine resources from commercial fishing but not other issues at the fishing stage (Thrane et al 2009). Only the Swedish KRAV seafood eco-label addresses a wide variety of issues of sustainability in the whole life cycle of the product, including marine pollution, energy consumption and chemicals (Thrane et al 2009). This reflects a difference in the definition of sustainability in the Swedish versus global market for seafood. Social impacts of fishing are not included in the MSC program either. Conditions of fishing livelihoods are not in scope despite the importance of fisheries to food security in developing countries (FAO 2014) and in spite of the weight of evidence showing fleets worldwide regularly use trafficked labour (Stringer et al 2014, ILO 2013, IOM 2012). These omissions reveal what is saleable in a global market and might reflect corporate strategy. In the United States the definition for human trafficking covers all the activities involving holding a person in a condition of compelled service (US State Department 2014a). In June 2014, US Ambassador Luis CdeBaca gave testimony to the Tom Lantos Human Rights Commission wherein he asked US companies to strengthen crime prevention in procurement rather than wait for an eco-label to solve the problem. Companies can "drive out of a supply chain the patterns of vulnerabilities to forced labour", he said. "Certifications and labels exist to inform customers whether seafood is sustainably caught, and yet, those seals-of-approval while fostering increased transparency and driving consumers to reward companies that engage in good corporate citizenship, they all seem to assume that the hands that pull the net, are not enslaved. We

know that assumption is non-operative" (US State Department 2014b). This appeal shows a crack in the system, in that even the most severe illegal practices can occur in certified fisheries when that issue is out of scope of a voluntary standard. Despite its magnitude and history, a review of all fishery standards and sustainability rankings found that fishing boat slavery is not part of any standard for seafood sustainability at this time, including Best Aquaculture Practices, the Seafood Watch program of the Monterey Bay Aquarium or the new Fair Trade USA standard. Late in 2014 the Fair Trade USA fisheries label certified its first 'fair trade' fishery on the remote island of Ambon in Indonesia, coincidentally the most notorious location for fishing boat slavery in the world and at the same time as 500 enslaved fishing boat workers were found there by reporters (Associated Press 2015; Bangkok Post 2014; Fair Trade USA; Labour Rights Promotion Network 2014).

Drawing from these perspectives, the seventh evaluation question is, did the measure create empirical information to judge where change is needed to improve impacts?

1.9 Seafood sustainability outside of eco-labels

Voluntary measures are most effective as part of a suite of integrated public and private sustainability tools (Cashore et al 2012). They can bring about rapid changes in production practices when used by firms to support better practice and performance by their suppliers and can complement regulation by filling gaps and introducing mechanisms for adapting to technological and social change. What drives corporate engagement in market measures for seafood sustainability outside of eco-labels? In the United States the seafood sector is being called upon to take preventative measures to reduce risks of importing illegal products to limit corporate exposure and liability and at the same time push back on overfishing. In the United States fish stocks are being rebuilt with strong federal legislation (NOAA 2014a, Oceana 2014) but the US government cannot rebuild international fisheries without enlisting help from US seafood corporations (NOAA 2014a). A 2014 Presidential Memorandum for "Establishing a Comprehensive Framework to Combat Illegal, Unreported and Unregulated Fishing and Seafood Fraud" established a Presidential Task Force to produce

recommendations for enforcement, partnerships and traceability from harvest to entry in the United States (NOAA 2014b).

Drawing from these perspectives, the eighth evaluation question is, did the measure reduce risks for illegal fishing or forced and trafficked labour in seafood production?

1.10 Corporate sustainability

A growing number of firms have taken to 'greening' initiatives as their strategic weapons, realizing sustainability can drive the improvement of the company's bottom line through cost savings, improved market share and stronger brand images (Min and Kim 2012). When environmental issues are added to purchasing it concerns supplier-buyer relationships, supplier selection and certifications, and sourcing decisions that are environmentally sound. The major drivers are the incorporation of eco-efficiency, links among supply chain activities of sourcing, making and delivering and externalities influencing those activities (Min and Kim 2012).

Further, corporate sustainability is a competitive strategy. The growing visibility of misconduct in boundary-less industries is contributing to the search of innovative approaches to supply chain management both in research and practice (Vurro et al 2014). Studies have started to show the benefits associated with long-term buyer-supplier relationships based on the ability to share knowledge and competences among partners (Vurro et al 2009), raising opportunities for organizational capital accumulation due to easier knowledge exchange, improved coordination, higher innovation potential, higher value delivered to final markets (Vurro et al 2014). The search is concerned not only with better logistics but with the broad and beneficial impact of implementing social and environmental practices across organizational boundaries through collaborative practices aimed at strengthening trust, reciprocity, and reducing the unbalanced use of power among firms in the supply chain (Vurro et al 2014).

Corporate sustainability is a valuable source of competitiveness for companies through the integration of social and environmental sensitivity in corporate operations and interaction with stakeholders. Combining economic prosperity, social cohesion and environmental protection, corporate sustainability supports companies' ability to identify, protect and give value to inimitable resources like skills and competences, knowledge and values, legitimacy, trust and reputation in the stakeholder network. Discretionary investments in non-profit organizations are acknowledged to increase a company's competitive potential (Porter and Kramer 2002) especially in terms of relational and situational capital accumulation.

Trust- and legitimacy-based linkages can lower transaction costs (Vurro et al 2014). Nobel prize winning economist Oliver Williamson said in his 2009 prize lecture that it is in the economic interest of organizations to lower transaction costs with credible commitments, "scaling up from toy models to the real world phenomenon of interest and natural progression from informal to pre-formal to semi-formal to fully formal" (Williamson 2009). Williams' work examines mutual gains in trade. Like Gary Liebcap, he is concerned with the contract and the innovative use of organization by people, including firms, to accomplish better ends; as such Williamson is concerned with strategic behavior and adaptation as they play out across organizations in different trade contexts in perceptions of risk or security in markets and in hierarchies like a vertically integrated industry or in a supply chain. Governance is the mechanism serving to infuse order, mitigate conflict and realize mutual gain, and the transaction is the basic unit of analysis (Williamson 2009). In her prize lecture Elinor Ostrom emphasized the central role of trust in coping with resource dilemmas (Ostrom 2009). No matter the governance regime, Ostrom said, net benefits for resource sustainability arise commensurately with levels of cooperation and levels of trust, which are affected by communication, reputation, high marginal return, entry and exit capability and agreement on sanctions, among other factors.

Corporate commitment to strengthen environmental performance is linked to better, long-lasting relationships with stakeholders due to lower perceived risks and stronger legitimacy, according to Perrini and Vurro (2010) who describe the intangible asset accumulation by firms that are increasing the role of corporate sustainability in their business model for competitive advantage. Strategic alliances serve an important legitimating function for firms

and this role, mediated by preferences for selecting partners and the governance arrangements for alliances, has a significant influence on firm and alliance performance (Dacin et al 2007). A collaborative approach with communities has been showed to have a positive impact on leveraging company image and reputation, conveying that the license or freedom to operate, which can support company operations and survival in the long haul (see Googins and Rochlin 2000 and Wartner and Sullivan 2004). Partnerships and community engagement have the potential to support firms in the development of a proactive attitude toward their context of reference, helping them to foresee dynamics of change and potentially risky challenges (Kanter 1999). Nonprofits may be much closer to the producers than companies and can also support business partners in testing new technologies (Kanter 1999). Nonprofits' technical expertise and knowledge about communities have the potential to accelerate innovation by reassuring business partners about the existence of unmet needs (Vurro et al 2014). Empirical research has shown that companies implementing procedures to reduce environmental impacts acts a reputation signaling exercise that may be crucial to opening up new markets (Vurro et al 2010).

Drawing from these perspectives, the ninth evaluation question is, did the measure contribute to better oversight for production's impacts by authorities or independent parties? The tenth question is, did the measure have effects that help make traders more accountable to social and enviromental impacts from seafood sourcing?

1.11 Research questions and methods

What kinds of effects have resulted from voluntary industry measures for sustainable seafood? Specifically, did they:

- reduce overfishing?,
- make access to resources more secure?,
- increase compliance with scientific advice?,
- include arrangements for self regulation by users?,
- gain positive recognition in the market?,

- address concerns of NGOs?,
- create empirical information to judge where change is needed?,
- reduce risks of illegal fishing or forced labour in seafood production?,
- contribute to better oversight by authorities or independent parties?, or
- make traders any more accountable to the impacts of sourcing?

These ten questions were drawn from scholarly scientific, economic and business perspectives on sustainable seafood. They capture the richly diverse perspectives behind a broad and interdisciplinary notion of sustainable seafood concerned with the conditions for stewardship of common pool resources (including human resources) in seafood production.

The research had three phases. First, the author played the lead role in preparing and implementing each measure. Second, each case was evaluated to identify local outcomes and the significance to global issues. Empirical findings of largely qualitative outcomes were compiled for each measure relative to thirty indicators for a broad system wide assessment of sustainability in seafood production (Table 1.1). The indicators are broadly based on the premise that even seafood production systems that are extremely data-poor or face tremendous conservation or social challenges can participate in sustainability programs, provided that there is the capacity for improvement (Micheli et al 2014). Third, a deep review of the scope and meaning of seafood sustainability was performed with the scholarly literature and the above ten questions were drawn for a scholarly evaluation of the measures' effects. Additionally, the evaluation looked at the systems behind the measures for institutional arrangements that helped improve social and environmental impacts.

The outcome evaluation was performed in the manner specified by the Impacts Code of the International Alliance for Social and Environmental Standards, to "shed light on the progress towards specific outcomes against initial targets, and accounting for unintended effects arising from efforts to change social and environmental impacts" (ISEAL 2013). The data collection protocol involved specifying initial targets, baseline values and indicators and specifying the responsible parties and sources of data (ISEAL 2013). To increase reliability and validity a wide range of methods, some generic and some proprietary, were used to

collect data on identified indicators. Primarily external data was used to identify effects. This included publications on the Internet, because web publication is the primary means of communicating fishery improvements outcomes between conservation NGOs and the seafood industry.

The findings contribute new texture and substance to the notions of sustainable seafood and voluntary regulation in scholarship and respond to the assertion that, in the face of increasing demand for fish in international trade, seafood sustainability depends on the ability of institutions to protect and improve human benefits and ecosystem health (Smith et al 2010). New information from the findings also fills gaps in sustainability theory on effects, performance, and corporate strategy as identified by Wahl and Bull (2013).

Table 1.1: Criteria and indicators for sustainability in seafood production (Micheli et al 2014)

Governance	*Socioeconomic*	*Ecological*
1. Leadership	11. Equity	21. Water quality
2. Legislation	12. Free labour	22. Native biodiversity
3. Enforcement of regulation	13. Compliance	23. Habitat integrity
4. Governance structure and function	14. Socioeconomic development	24. Food web integrity
5. Incentives	15. Education	25. Resilience
6. Management plan	16. Fair wages and benefits	26. Stock abundance
7. Harvest control	17. Occupational health and safety	27. Interaction with endangered species
8. User involvement mechanisms	18. Fair conditions of employment	28. Connectivity
9. Defined boundaries and access rights	19. Traceability	29. Bycatch
10. Presence of Marine Protected Areas	20. Diversification	30. Chemicals/drugs/pesticides

The measures address overfishing problems largely outside of the MSC scope in order to explore the less-seen and less obvious dimensions of seafood sustainability, for example fishing impacts on food webs, illegal fishing and slavery. Knowledge of the measures and access to information about their goals and effects was a selection factor. The author played a leading role in developing each of the measures between 2008 and 2013 and as a result of that self selection the measures are linked in many ways including by a common a goal to increase the private sector's stake in positive outcomes by setting new scientific benchmarks for sustainability across the fishing sectors not yet in the MSC program.

The author was a participant observer in the implementation of the cases. Sheila Jasanoff advised a generation of scientists to get involved and try methods with first hand engagement -- "speaking truth to power without offering practical alternatives and incentives is unlikely to change the world" (The Guardian 2013). The trade-offs with this level of access to information were influence on the outcomes and biases affecting the analysis. Only published materials and data were utilized and not interviews. Private quotes or insights are not attributed to any individuals to protect the confidentiality and proprietary nature of market data. As a participant observer the author was able to secure an insider perspective and access to the private sector (otherwise unavailable) for a full view of the measures from start to finish. The author is experienced in handling the suite of roles (first, second and third party) associated with quality assurance.

The remainder of this introductory chapter describes the real world context of private sector measures for sustainable seafood and the structures that help to explain it. The second chapter presents the evaluation results. The third chapter explores new metrics for sustainable seafood for demonstrating effects and performance. The fourth chapter offers a discussion on future design and scholarly perspectives on sustainability that include voluntary measures.

1.12 Rise of the Marine Stewardship Council program

An eco-labeling program is a voluntary system used to create a market-based incentive to encourage products that can demonstrate they are produced in an ecologically sustainable manner (Ward and Phillips 2008). An eco-label is a mark, logo, label or product endorsement affixed to a product at a point of sale that implies to a purchaser that the product has been produced through ecologically sustainable methods. It may be applied to a product after it has been certified as being in compliance with the rules and criteria of an eco-labeling program and is sometimes published as a 'standard' (Ward and Phillips 2008). The Marine Stewardship Council (MSC) program offers certification to seafood companies for their products. It is a product certification, which is the provision by an independent body of written assurance (a certificate) that the product in question meets specific requirements (ISO 2014). Product certifications help downstream companies like grocer-retailers to associate positive values with their reputation in the market. When a retailer publishes a sustainability policy on its corporate website to say it preferentially sources MSC certified products, as Walmart and McDonalds say they do (Walmart 2014; McDonalds 2014), then seafood suppliers have no choice but to show the products they sell into that retailer are compliant with the program. If the certification systems can be shown to translate into real reductions in fishing pressure, this could be an effective approach.

In order to comply with the MSC standard, fisheries must undergo assessment and absorb licensing costs. The MSC assessment process lasts about 12 months (Gulbrandsen 2009) but may take up to 5 years (MSC 2014) to generate the information needed and to improve the fishery to meet the standard and pass the audit. Uniquely, although the MSC offers a certification program for seafood products it is the fisheries that need to show compliance with the standard. Other product attributes than fishery of origin are not considered. The MSC standard, revised for the first time in 2014, has 29 indicators under three principles for assuring the sustainability of exploited fish stocks, maintenance of the ecosystem on which the fishery depends, and effective and responsible management (MSC 2014). To pass the first audit, the fishery must reach combined scores of 80 for each principle (MSC 2014). In addition, the client must often implement a number of costly changes in their operations—changing gear, reducing by-catches of non-targeted species, and disbanding fishing units, for

example—which may far exceed the short-term costs of the assessment process (Gulbrandsen 2009). Participating in the MSC certification scheme is an expensive investment costing US$80-300,000 or more to complete the assessment and certification (Intertek Moody 2012).

By the end of 2008, 38 fisheries were certified and another 88 were in the assessment stage, accounting for 7% of all wild-caught seafood sales (Ward and Phillips 2008). Three fisheries in developing countries were certified, including only one small-scale fishery for clams in Vietnam (Jacquet et al 2010). Most certifications were in Europe and North America (Gulbrandsen 2009). A similar pattern exists in forestry even though forest certification first developed to encourage sustainable forest management in tropical countries (Wahl and Bull 2013). In 2008 the MSC program had not certified most top seafood products in North America: wild shrimp, tuna, and wild salmon other than Alaska salmon (author's own review). Starting in 2010 many new fisheries entered the program and became certified by the certification body Moody Marine on much shorter timetables than in the past. Detailed analysis of every new certification report by this author 2009-11 showed that fisheries were obtaining passing scores far more quickly and based on promises by the client to complete corrective actions once a certificate is granted (author's own review). Passing scores (80) were given on indicators even where the fishery currently did not meet the indicator and this was a change from the past. Several MSC indicators require information to show fishing impacts are not significantly adverse at the population level of the species concerned, as defined by the precautionary approach, however in many instances that information is not readily available. In the earlier days of the MSC the certification was not awarded until the information was produced and the average time in the full assessment stage prior to certification was three years. Completing the bulk of the assessments, Moody Marine reduced the average to 18 months starting around 2010. Some reports contained a redefinition of the precautionary approach to say risk could not be presumed in the absence of information (Moody Marine 2010). Normally the absence of information in any audit would result in a citation of higher risks. Certifications may be granted if the fishery is shown to meet the 80 scores in general at the level of three principles, rather than indicators, and it became common to defer research needed to pass until after the certification. Passing with conditions is a normal practice in product certifications. The certificate holder warrants

that all conditions shall be closed in five years. The auditor (certification body) is responsible for monitoring the fishery and its progress on an annual basis. The auditor is independent from the MSC program and accredited by Accreditation Services International, an independent organization providing program oversight to hold the MSC accountable to its own rules and procedures.

By 2014, 338 fisheries were certified representing 10% of the supply of the world's food (MSC 2014) however only small volumes of tuna from the Pacific Islands and US west coast and wild shrimp from Oregon and northern Australia were certified. This volume was not sufficient to support the buying needs of major global retailers, and also most Alaskan salmon had dropped out of the program (ASMI 2012). The MSC standard does not handle legality and labour abuse through certification, even though these issues rose in prominence in the market in 2014 due to media reporting (Associated Press 2014; The Guardian 2014). Following much discussion and debate about scope, the MSC chose a narrow environmental definition of sustainability that excludes social issues (Gulbrandsen 2009). As a result, broader ecosystem and social aspects of overfishing continue to lack clear targets for collaborative action. In 2014 the MSC board voted against expanding the scope of the standard despite pressure from the seafood industry to add legality and human rights for fishers (MSC 2014).

Important commercial seafood imports to North America and Europe come from unregulated fisheries and from fisheries otherwise deficient to the global sustainability standard of the Marine Stewardship Council. In the face of heavy industrial fishing for exports developing countries, which will continue to play a dominant role in the supply of fish for global human consumption, providing around 67% of the total through 2022, often lack comparable regulations and resources for managing marine resources sustainably (FAO SOFIA 2014). The trade-induced increases in demand for fisheries resources have resulted in increasingly serious ecological and management problems (Berkes et al 2006). Many developing country fisheries do not possess the type of detailed and comprehensive scientific information that may be required by certification bodies for MSC assessments (MSC 2013). Fisheries wishing to achieve MSC certification, but not having formal management strategies in place may fall short of meeting the MSC Standard. The MSC

explains that for developing country fisheries, getting certified can sometimes be complex for a number of reasons. These reasons may include data deficiency, inadequate institutional support for sustainable fisheries, poor fisheries management and limited knowledge and awareness of certification and how it works (MSC 2013). Partnerships have shown to be important to help fisheries embark on the certification process and ultimately become MSC certified (MSC 2013).

Voluntary standards and certification appear to be most effective as part of a suite of public and private sustainability tools, by filling gaps and introducing mechanisms for adapting to technological and social change (Berkes 2007). The MSC program arose from a corporate-NGO partnership between the World Wildlife Fund and Unilever (Gulbrandsen 2009; Cummins 2004). Through its Major Buyer Strategy, the World Wildlife Fund works with fisheries around the world to help prepare them for MSC certification. Taking a stepwise approach to MSC certification is recognized in today's market as a "fishery improvement project" (FIP). It is recognized as a way to put all kinds of seafood, even products from fisheries that are not good candidates for MSC certification, onto a sustainability track.

1.13 More fisheries need assessment and better management

More than 80% of the world's fisheries are poorly understood (Costello et al 2013). This poses a dilemma for marine conservation and the seafood industry alike. Recent analysis of data from previously un-assessed fish populations revealed them to be in much worse shape than the relatively well-studied fisheries on which previous global reviews of the status of fisheries have relied (Hilborn et al 2013). The vast majority of exploited fish populations worldwide have been depleted to levels well below those recommended by conventional management guidance (Costello et al 2013). However, Ray Hilborn and Daniel Ovando from the University of Washington have argued that fish stocks that are scientifically assessed are in better shape. Managed stocks are not typically declining but rebuilding and improving, and unmanaged fish stocks are not (Hilborn et al 2013). The answer to ending overfishing risks is simple: more fisheries need assessment and better management (Hilborn et al 2013). Christopher Costello at the University of Santa Barbara took this idea to US

philanthropic donors and today it shapes their investment in seafood sustainability (see ChartingACourse.org). This notion is playing out in the form of a large private investment in the improvement of fisheries from the David and Lucille Packard Foundation, Walton Family Foundation, Oak Foundation and the Gordon and Betty Moore Foundation (ChartingACourse.org, 2013). This private sector investment is interesting because it goes to the core tension between certification approaches and science. This investment has not been audited to examine its effect, to this author's knowledge, and that was a key driver in this research.

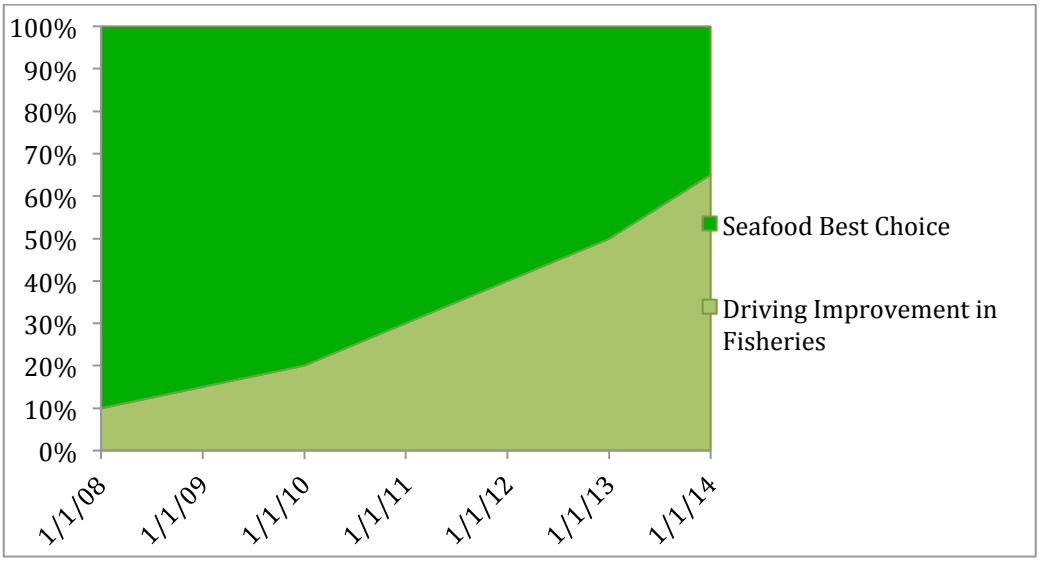
1.14 Philanthropic investment in corporate-NGO partnerships

The David and Lucile Packard Foundation aimed to have three quarters of major U.S. and Canadian grocer retailers strengthen their commitment to sustainable seafood by 2017 and for one-third of the volume of wild caught seafood to come from well-managed, sustainable fisheries by 2022, or from fisheries in the process of rebuilding (David and Lucile Packard Foundation 2014). Each commitment refers to a working partnership for sustainable seafood with a respected conservation non-governmental organization (NGO) funded at least in part by the David and Lucile Packard Foundation. The majority of the top 20 supermarkets in North America had commitments to source sustainable seafood by 2014 (David and Lucille Packard Foundation 2014).

The 'sustainable seafood movement' in North America is a financial investment made by the David and Lucile Packard Foundation, Walton Family Foundation and Gordon and Betty Moore Foundation (family foundations associated with the Hewlett-Packard Corporation, Walmart Corporation and Intel Corporation) in a number of NGOs including the Seafood Watch ratings program of the Monterey Bay Aquarium in California, the Marine Stewardship Council, World Wildlife Fund, Sustainable Fisheries Partnership, New England Aquarium, David Suzuki Foundation, Canadian Parks and Wilderness Society and the many other member organizations belonging to the Conservation Alliance for Seafood Solutions (CASS 2014; Packard Foundation 2014). Their investment is in a future in which businesses that buy and sell seafood and conservation organizations are active partners helping to achieve

sustainable fisheries management and aquaculture production, because partnership is a critical element to achieving the long-term viability of the seafood supply that is essential for business and that all people depend on as a global community (CASS 2014). The different groups within the alliance have different positions on the promotion of seafood sustainability in the market. Before the alliance was formed in 2008 most seafood NGOs recommended consumers avoid eating seafood not meeting best choice criteria, but by 2014 the majority of groups promoted consumption of the seafood products sold by their corporate partners. That meant promoting the origins of the products as improving fisheries (CASS 2014; SFP 2014; WWF 2013).

Figure 1.1: NGOs with a best choice strategy versus improving fisheries



1.15 Rise of NGO ratings for sustainable seafood

As the assessment of overfishing became a politically charged scientific endeavor, NGOs including Greenpeace and the World Wildlife Fund published their own studies about worldwide overfishing. The Sustainable Fisheries Partnership and Monterey Bay Aquarium began to rate the sustainability status of fisheries online with their own criteria (see FishSource.com and SeafoodWatch.org). Today, hundreds of US seafood purveyors follow the seafood ratings by the Monterey Bay Aquarium including Whole Foods and US

foodservice companies Aramark and Compass Group (Seafood Watch 2014). The ratings have resulted in major changes in consumption patterns and demand because these companies procure seafood rated of green "best choice" or yellow "good alternative". This means red rated seafood is diverted elsewhere. MSC certified products are rated as a "good alternative" (Seafood Watch 2013) and its users like the Vancouver Aquarium's Ocean Wise program. This is the result of a benchmarking exercise in 2012 where the MSC standard achieved a score of 2.38 and does not quite meet the Ocean Wise line of 2.8 for a best choice rating (Ocean Wise 2014). The MSC standard does not sufficiently account for fishing impacts to other species, habitat and ecosystem (Ocean Wise 2014).

Fishery ratings by the Sustainable Fisheries Partnership (SFP) on FishSource.com provide the basis for fishery improvement projects led by SFP on behalf of its corporate partners (FishSource 2014). Each fishery is scored on five questions based on common measures of sustainability as used by the International Council for the Exploration of the Sea, US National Marine Fisheries Service, and the MSC among others (SFP 2014c). Since 2006, SFP has been carefully creating a portfolio of fishery improvement projects (FIPs) to help promote industry leadership around the world (SFP 2013). In 2014 SFP operated 40 fishery improvement projects worldwide (SFP 2014a). Twenty major global seafood retailers including McDonald's, Nestle and Walmart use SFP's fishery ratings to support their sustainable seafood procurement policies (SFP 2014b).

The World Wildlife Fund also operates fishery improvement projects for its corporate partners, however it assesses fisheries against the Marine Stewardship Council standard (WWF 2013). The gaps to passing scores are used to plan fishery improvements for seafood products that are important to its major corporate partners including Krogers, Albertsons, Costco and Supervalu in the USA and Loblaws in Canada. The ultimate goal is to create measurable change and ensure the long-term sustainability of the fishery (WWF 2013). WWF developed its Major Buyer Partnerships program to work with seafood buyers to source sustainable seafood, provide technical assistance to achieve fisheries certification, and work with industry to create science-based standards (WWF 2012).

1.16 Seafood sustainability claims versus evidence

Scholarly attention has been paid to the rise of the Marine Stewardship Council (MSC) program for certifying fisheries and particularly to the sustainability claims of the MSC versus its outcomes (Proelss and Froese 2012, Jacquet et al 2010; Gulbrandsen 2009; Shelton 2009; Ward and Phillips 2008). For example, Proelss and Froese found that some stocks certified as 'sustainable' are overfished (Proelss and Froese 2012) to which the MSC retorted the scientists were attempting to redefine the term 'overfished' (Nature 2012). Just one small-scale fishery from a developing country was MSC certified by 2010, when the MSC was already 12 years old, and none of MSC's thirteen board members were from developing countries—as compared to five of nine on the Forest Stewardship Council board (Jacquet et al 2010). Kalfagianni and Pattberg (2013) found discrimination for civil society organizations and Southern actors in the MSC program and significant variation in quality across audits.

Scholars have criticized the sustainability outcomes produced by the MSC program, perhaps expecting the same kind of sustainability outcomes expected from state measures and looking for balanced representation and a comprehensive and incremental approach. Frank Biermann and team asked how voluntary governance arrangements for sustainability can resolve deficits in public government, meaning deficits in regulations, implementation, and participation, when they may also favor the more powerful actors (Biermann et al 2007)? Peter Vandergeest (2012) has written critically about power imbalances between eco-certification agents who claim rule-making authority across the globe in certification territories and likening seafood eco-labeling to colonialism to protect valued subjects in inadequate states. He describes strong resistance to seafood eco-labeling from important source countries like Thailand. Stefano Ponte describes the MSC program as protectionist for developed countries and marginalizing for developing countries, describing the case for South Africa (2008). It is not clear if these authors also considered any market advantages for uncertified products, like cost savings and a lower burden for suppliers permitted to stay out of the eco-labeling sphere when a retailer accepts an exclusion for a region or product category. Until 2011 Walmart excluded canned tuna producers, based mainly in Thailand, from compliance with its sustainable seafood commitment for example (Walmart 2008).

1.17 Conclusion

Seafood producers, exporters, retailers and often conservation NGOs must combine forces to improve fisheries (Darden 2013). Private regulation in the form of codes and standards has emerged (Wahl and Bull 2013) alongside increasing scientific concerns about fish stocks, endangered species and marine ecosystems. Compliance is the defining feature of private regulation and depends on voluntarily supplied participation, resources and consensual actions among firms acting alone or with governments (Wahl and Bull 2013; Vogel 2008). Is there evidence to support the notion that measures for sustainable seafood that increase compliance across supply chains also improve impacts for example more compliance with scientific advice for sustainability and less overfishing? As a relatively new type of license to operate, measures for sustainable seafood are meant to bring new people together over environmental and social goals and can cause shifts in thinking that may shift production into a better direction. The measures support the sustainability claims made by seafood retailers like McDonalds and Walmart. Outside of MSC certifications, what kinds of effects have resulted? Evaluation results for seven voluntary industry measures for sustainable seafood are presented in the next chapter.

2. Effects from seven voluntary industry measures for sustainable seafood

Although McDonalds, Walmart, and others had sustainability policies in 2008 requiring MSC certified seafood (McDonalds 2008, Walmart 2008) no fisheries for wild tropical shrimp, tuna, and salmon (outside of Alaska) were MSC certified at that time. This gap in the market was met with measures for sustainable seafood from industry and conservation NGOs. Seven such measures taken between 2008 and 2014 were evaluated for their effects.

A summary of the measures:

1. Metrics for sustainable wild shrimp, prepared 2008-9
2. A no-buy policy to reduce overfishing of the Mediterranean bluefin tuna catch, 2009-2010
3. Voluntary regulations in a longline tuna fishery to reduce impacts on turtles and to comply with the UN Code of Conduct for Responsible Fisheries, 2008-2014
4. Support to implement Canada's Wild Salmon Policy to conserve salmon productivity, 2010-2012
5. Investigation into best practices for reducing fishing impacts on marine food webs, 2012-2013
6. Estimation of US seafood imports associated with illegal fishing for 30 top product/country combinations, 2012-2013,
7. A risk screen for forced and trafficked labour in seafood supply chains, 2013-2014

Each of the seven measures is summarized and presented with its outcomes and effects in this chapter, which concludes with the comparative results of evaluating the measures against attributes for sustainability drawn from the scholarly literature.

The seven measures selected for inquiry were led by different parties but shared an orientation and similar developmental process. They addressed sustainability concerns outside of the market range of the Marine Stewardship Council (MSC) program at the time. Some of the measures were efforts to get hard-to-certify products like wild shrimp recognized as sustainable in the market. Others sought to show due diligence for complex

problems being associated with seafood products like illegal fishing, human trafficking on fishing boats, and fishing impacts on food webs. The measures were exploratory and engaged seafood companies by asking them to voluntarily increase regulations on their production outside of a standards program, without knowing the destination, rewards or risks of exposure. This was challenging in a market where a single program was already perceived as the 'correct standard', as the MSC program was in 2008-2011 (SFP 2008, WWF 2008). The measures set benchmarks the seafood industry could see and work to around best practices in the sectors of seafood left out from the MSC program at that time. In agriculture benchmarking is used to bring up all farmers to the same standard in production (Roling 2004). In some cases the Marine Stewardship Council standard was used as a basis for assessment in order to see the gaps. In other cases the activities were driven by market promotions.

In all seven measures, the first step was to gather and review the scientific evidence on impacts from fishing and seafood production. Fishery scientists were key informants. The second step was discussion and consideration of the results by the stakeholders to decide on an agenda and support the needed changes. The results included scientific findings and technical how-to recommendations. The stakeholders were predominantly lay people working at NGOs, in seafood companies and philanthropic organizations. The third step was market promotion of the results.

The various outcomes and effects from the measures, after they were publicized, are summarized in this chapter. The breadth of effects is checked against 30 system wide indicators for sustainable seafood production (Micheli et al 2014; see Table 1). The chapter concludes with a comparison of the measures for their effects against ten evaluation questions drawn from the sustainability literature. Did the measure result in:

1. Reduced overfishing?
2. Access to resources was made more secure for business?
3. Compliance with scientific advice?
4. Self-regulation by users?
5. Positive recognition in the market?

6. Addressed NGO concerns?
   New and objective information to help determine where changes occurred?
7. Less risk of illegal fishing or forced labour in production?
8. Better oversight by authorities or independent third parties?
9. More accountability in seafood business for the impacts of sourcing?

2.1 Metrics for sustainable shrimp

Shrimp trawling impacts the sea bottom, which is host to diverse types of marine ecosystems from silt to reef to sea grass nursery areas. Complexes of marine species caught in trawls as bycatch during shrimp fishing vary with environmental conditions and depth, making the waste cost to ecosystems from trawling difficult to measure and to compare across fisheries. Bycatch in large trawl fisheries is usually discarded overboard and the trawl discard rate is 50% according to Kelleher (2005). Tropical shrimp trawl fisheries contribute 27% to total global discards (Kelleher 2005). In 2008 the FAO had not yet developed a bycatch monitoring protocol for wild shrimp or a program for ecosystem impact research (Westlund 2006) although some mortality rates of finfish bycatch in trawls have been published (Suuronen 2005). The discard of finfish particularly juveniles has adverse impacts over time for trophic webs and for other valuable non-shrimp fisheries. In some instances the capture of these animals in shrimp trawl bycatch is illegal and in any case their waste is counterproductive to sustaining fisheries (Eayrs 2007).

Wild shrimp trawl fisheries are multi-species fisheries because the trawl gear picks up the living things in its path. To understand what sustainability means in shrimp trawl fishing means to understand how the ecosystem is responding to fishing. Metrics for sustainable shrimp must account for fishing impacts on multiple species. These include benthic (bottom dwelling) species like rays as well as large slow-growing fish and small, fast-growing fish, their juveniles, and protected or endangered species. Shrimp resources are also driven by environmental change (Okey 2004). The abundance of shrimp in a given year may be only partly related to fishing mortality (Gribble 2003). Some trawling produces more shrimp by

removing shrimp predators from the sea bottom at a higher rate of removal than for shrimp (Okey 2004; Gribble 2003).

To handle these factors, metrics for sustainable shrimp must be nuanced and ecosystem-based. As of 2008 the FAO had identified three problem areas related to tropical wild shrimp trawl fisheries as priorities for States: capture of juvenile food fish (FAO 2008b), discards (FAO 2008b), and trawl impact to the sea bottom (FAO 2006). In 1999, 126 UN member states participated in the unanimous adoption of a commitment to implement the Code of Conduct for Responsible Fisheries (FAO 1999). Article 7.2.3 stipulates that States should assess the impacts of environmental factors on target stocks and species belonging to the same ecosystem or associated with or dependent upon the target stocks, and assess the relationship among the populations in the ecosystem (FAO 1995) in order to further the ecosystem approach to fisheries (Garcia et al 2003).

Despite being the number one seafood product consumed in 2008 in the USA (NFI 2013) not a single wild warm water shrimp trawl fishery had been certified as sustainable by the Marine Stewardship Council program or was even participating in the program. Consumer attention had been alerted to the waste of charismatic species like sea turtles, sharks, rays, sea horses, and coral from tropical shrimp trawling. In 2008 both Greenpeace UK and the Environmental Justice Foundation launched global campaigns to popularize the notion that trawl fishing was having serious irreversible adverse impacts on marine biodiversity and oceans (Greenpeace UK 2008; Environmental Justice Foundation 2008a). Many conservation NGOs advised consumers to avoid wild, tropical, and particularly "imported" wild shrimp products (Environmental Justice Foundation 2008b; Audubon Society US 2008; Environmental Defense Fund 2008; Seafood Choices Alliance 2008; Sea Choice 2008; WWF 2008; Marine Conservation Society UK 2008; Monterey Bay Aquarium 2008). These campaigns served many good interests but not the gap in the market for sustainable shrimp. As the number one seafood in American diets there was an opportunity in 2008 to improve the sustainability of fisheries for wild warm water shrimp. Some grocer-retailers saw this opportunity, but did not know how they could act to improve shrimp trawl fisheries. At that time Walmart and Sam's Club had made a public commitment to procure only Marine Stewardship Council (MSC) certified seafood products (Walmart 2008). They needed

shrimp supplies that were on the way to MSC certification. Even if the fisheries were still far from a pass of the MSC standard they needed their suppliers to commit to improving the fisheries in a stepwise manner over time to ready them for MSC certification. In Europe grocer-retailers needed seafood products to comply with the Food and Agriculture Organization's Guidelines for Eco-labeling of Fish and Fishery Products from Marine Capture Fisheries (FAO 2009; 2005). In 2009 for example the Netherlands passed legislation to make it mandatory by 2012 for all retail seafood products to be certified to a third party eco-label compliant with these FAO guidelines.

In 2008 it was impossible to add an eco-label to wild shrimp because it was still not clear how the sustainability of shrimp trawl fisheries could be evaluated on a global basis in any manner that was fair and inclusive and also not a contributor to false claims of sustainability. The Marine Stewardship Council faced this problem because the standard accommodated only fisheries managed on the basis of biological reference points and not environmental conditions, as shrimp trawl fisheries often are in tropical environments. The US Gulf of Mexico trawl fisheries for brown, pink and white shrimp are managed on the basis of tidal water height in marshes, ocean temperature and salinity (Nance 2006), for example. This made the seafood products ineligible for MSC certification and ineligible for seafood procurement by Walmart, Walmart Canada, Loblaws and many other grocer-retailers with an MSC-only policy for sustainable seafood. Excluding shrimp, as the number one seafood product consumed in the US in 2008 (NFI 2008), put pressure on seafood policies and threatened the value of corporate investment in MSC (SFP 2008).

All imported wild trawled shrimp was rated red in 2008 in the traffic light ratings of the Seafood Watch program of the Monterey Bay Aquarium. Shrimp from the US Gulf of Mexico fisheries was rated yellow because the fisheries' bycatch to catch ratio was 4:1, relatively low compared to the more than 18:1 ratio in Thailand in 2008 (Seafood Watch 2008). However, 100% of bycatch was discarded at sea in the Gulf of Mexico resulting in full mortality and zero utilization for the all non-shrimp species caught in shrimp trawls. By contrast the Thai fisheries had nearly zero discards and full utilization of bycatch species, which is not to say that is preferable environmentally only that the waste component of discarding at sea was not a factor in the traffic light ratings. This is an illustration of the

need for the metrics of success for seafood sustainability to be nuanced enough to account for interaction effects, including social factors. Wild shrimping is a mainstay of fishers' livelihoods and national economies in many developing countries (Eayrs 2007; Josupeit 2004).

To be able to insist on better impacts from shrimp trawl fisheries from fishing interests in the private sector, better metrics were needed for sustainable shrimp. To address the market gap the Sustainable Fisheries Partnership (SFP) sought to develop targets that seafood buyers could require their suppliers to meet to improve shrimp trawl fisheries. SFP sponsored a review of best practices in shrimp trawl fisheries worldwide in early 2008. This was an early experience for the organization with setting industry benchmarks for fisheries improvements in a major seafood product sector like shrimp. Clearly benchmarking for fisheries improvements is not management in the manner that a public agency would lead. The goal was not managing fisheries. The goal was to manage expectations in the private sector and shift them to a higher consistent standard of care in fishing for all seafood sources worldwide.

The review of best practices in shrimp fisheries worldwide exposed a range of approaches to fisheries sustainability. A sustainable catch has more shrimp, less bycatch, and fishing controls in place to regulate shrimp size and abundance, bycatch of finfish, protected, elasmobranch and teleost species, as well as a formal bycatch management plan and mandatory turtle exclusion and bycatch reduction devices (TEDs and BRDs). The experiences of multi-species shrimp fisheries utilizing precautionary management for stock recovery are relevant if not directly transferable to finfish fisheries. Shrimp fishers all over the world, including in developing countries, are reducing bycatch with low headline height trawls to minimize fish catches, using ground chain arrangements that reduce the amount of seabed animals and debris taken, avoiding fishing grounds where bycatch is known to be high including grounds where coral, sponges and rocks are present, using of trawl mesh sizes big enough to allow some small animals to escape, and improving the use and enforcement of turtle exclusion and bycatch reduction devices (Eayrs 2007). The degree to which these mitigation measures are restraining ecosystem impact is unknown and under-studied but ongoing fishery improvement efforts of this kind are being made and should be recognized

and supported. In 2008 the outcomes from Australia's Northern Prawn fishery (NPF) showed biomass targets for shrimp that were higher than average to support a goal of sustaining a maximum economic yield at 1.2 to 1.7 the value of a biomass-only target for a maximum sustained yield. NPF's approach included bycatch, habitat and other ecosystem impacts and had a successful track record. Fishery dependent and independent data confirmed that the local populations of numerous species caught in fishing trawls were being sustained by the fishing rules and management practice (NPF 2008). Still, these shrimp products were rated red by the Seafood Watch program and lumped in with all imported products.

The purpose of sustainable shrimp metrics was to offer a scoring grid to check the status of a shrimp fishery in order to distinguish its seafood products in the market. A checklist was developed for fishery managers to use for self-assessment and a complete scoring grid, referenced to the Marine Stewardship Council standard, was produced to support an independent audit against a global benchmark. The metrics results might best be regarded as 'MSC Plus' because they include not only the fishing target species but also bycatch, benthic and ecosystem attributes of the fishery, in order to encourage an ecosystem based approach to fisheries. The entry-level pass for these metrics is a firm requirement that a fishery must not be overfished with overfishing occurring and it must show evidence of bycatch reduction and monitoring, for example mandatory use of turtle exclusion device (TED)s or bycatch reduction devices (BRD) use program. This is a lower benchmark than the MSC 60% but represents the US import requirement for wild warm water trawled shrimp therefore represents a real world market hurdle for products from wild penaeid fisheries. To score at the 80% scoring level a fishery must have bycatch monitoring and fisheries should meet the FAO recommendations for: (1) mandatory use of turtle exclusion devices, (2) widespread or mandatory use/testing of bycatch reduction devices, (3) widespread or mandatory use/testing of juvenile trash fish exclusion devices or a secondary BRD, and (4) zoning or area closures to restrain seabed impact (Eayrs 2007). With increasing scores more is expected by way of verifiable improvement toward more precautionary fishing, for example on mesh size, type and size of trawl doors, or type, size and weight of foot rope. At the 100% scoring level a fishery must show that it is actively reducing its impacts to target, bycatch and benthic species, to the sea bottom and ecosystem.

2.1.1 Outcomes from sustainability metrics for shrimp

The Marine Stewardship Council certified Australia's Northern Prawn Fishery in November 2012. As arguably the most successfully managed tropical shrimp fishery the NPF engaged in a suite of new measures to obtain MSC certification (MRAG 2012). This had global significance as the first certified tiger and banana prawn products reached the global market. It had local impact due to the new measures.

The metrics and the supporting review of best practices were submitted to Fish and Fisheries for consideration for publication in 2009. The two reviewers commented that the research was novel and important for publication however the associations made to the Marine Stewardship Council standard for sustainable fisheries made the results unfit for the journal, because they argued that MSC standard is not scientifically-derived.

The results of this measure were meant to encourage the Marine Stewardship Council to include tropical wild shrimp in its program to create demand for wild shrimp through sustainable seafood policies and procurement. The metrics were made available publicly in 2010 to encourage buyers of wild shrimp from trawl fisheries to commit to putting their source fisheries on to a trajectory for continuous improvement. Walmart's policy supported the MSC certification of Atlantic seabob (Xiphopenaeus kroyeri) from Suriname in 2011. That fishery also made significant improvements in order to meet the MSC standard, adopting for example a code of conduct for the fleet and adding bycatch reduction devices with escape panels to the trawl gear (Food Certification International 2011). Surveys showed the measures contributed to a reduction in bycatch down to 34% (Food Certification International 2011).

The local effects on the host organization, the Sustainable Fisheries Partnership (SFP), included more shrimp fisheries profiled on FishSource.com, a database of the sustainability status of fisheries worldwide that supports a dashboard view of seafood sustainability for SFP's retailer partners. An overview of the metrics was shared with major US shrimp buying companies as a best practices report. Shrimp procurement guidance was published as well (SFP 2011). Next SFP hosted fishery improvement projects for shrimp fisheries in the Gulf

of Mexico and Gulf of California, being important sources for the US market. Supermarket chain Giant Eagle and its supplier National Fish today lead the Gulf of Mexico projects. Supermarket chain Publix and its supplier Cox Wholesale Seafood have a project in Florida and conducted a preliminary assessment of the fishery to the MSC standard in 2012 as the basis for an improvements program (SFP 2012). The metrics for sustainable shrimp serve as an interface between these fisheries and the MSC standard, they provide a way to align and harmonize the very different management metrics used by the different programs.

2.2 Three industry-led measures for fishery improvements

Three measures were taken to show the seafood industry's performance at improving tuna and salmon fisheries, 2008 to 2013. In recent years the seafood industry has engaged in measures for fishery improvements and in some instances the leadership has come from seafood companies. Industry organizations developed measures for Mediterranean bluefin tuna, British Columbia wild salmon, and Hawaii tuna and swordfish. These fisheries are already highly managed. In fact, each is governed at two levels by regulatory bodies nationally and internationally. Adding a new layer of private sector measures to the existing regimes for managing these fisheries is a complex endeavor. The industry organizations did so to respond to controversies about declining fish stocks when bad press raised questions that challenged their access to supplies and markets.

The organizations leading these measures had a direct stake in seafood access. Conservation NGOs raised the issues and were consulted but ultimately the measures taken were by industry groups unilaterally and independently. The results show another view of the dynamics around sustainable seafood in particular how the dynamic relationships between conservation NGOs and seafood companies can lead to market measures that change fishing impacts in unexpected ways. Are the consequences different for fisheries when the leadership of a measure for fishery improvements is taken by industry instead of conservation NGOs? It is often assumed that industry leadership on sustainability leads to 'green-washing' meaning false claims. NGO questions were drivers of the industry response in these three cases. When conservation NGOs pointed out overfishing problems, the

seafood industry listened but ultimately took measures independently. Although these fisheries were governed by mature regulatory regimes with two layers of oversight at State and international levels, all three fish stocks were declining. Industry organizations endeavored to improve fisheries by assisting the normal regulatory processes, as opposed to partnering with conservation NGOs to create a new layer of organization. In all three cases the Sustainable Fisheries Partnership was the only NGO to recognize industry efforts as legitimate market responses that help to improve fisheries.

2.3 Mediterranean bluefin tuna

In March 2010 a vote was taken to ban the international trade of products made from Mediterranean bluefin tuna (East Atlantic/Mediterranean stock). The vote occurred at a meeting in Doha, Qatar to consider new listings to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix 1. CITES currently regulates the international trade of very few marine fish species, by listing them in its Appendices (Vincent et al 2014). The possible outcomes of the meeting were (1) a total prohibition of the export trade by listing the fish stock on Appendix I of CITES, (2) a new requirement for catch verification at export by listing the stock on Appendix II, or (3) no change to trade requirements. Rapid depletion of the bluefin stocks by illegal overfishing was the motivation behind the ban. Industrialized fishing and tuna-ranching operations in the Mediterranean harvest bluefin tuna at a rate that exceeds the reproductive capabilities of the existing stock and may lead to the collapse of this fishery. Production has been reorganized, including the labour process, the capture of fish, and the lifecycles of bluefin tuna, as the trap fisheries that operated for centuries have diminished (Longo and Clark 2012). It is very well known that introduction of fattening and farming activities into the Mediterranean in 1997 and good market conditions resulted in rapid changes in Mediterranean fisheries for bluefin tuna mainly due to increasing purse seine catches, according to ICCAT, and in the last few years nearly all of the declared Mediterranean bluefin fishery production was exported overseas (ICCAT 2014). Information available has demonstrated that catches of bluefin tuna from the East Atlantic and Mediterranean were seriously under-reported between the mid 1990s through 2007 and this lack of compliance

with TAC was a major cause of stock decline over that period (ICCAT 2014). Mediterranean bluefin tuna stocks are likely to collapse unless the portion of the total fishing catch that is illegal, unreported and unregulated is radically reduced or eliminated. Illegal overfishing is estimated as being 44% greater than the maximum legal catch (Gargern 2013).

A listing on CITES Appendix I means the legal part of the export trade is prohibited. It would ban all international trade and especially targeted trade to Japan where 80% of Mediterranean bluefin is exported, about 25,000 tons (Gagern et al 2013). In this manner CITES action could complement and support other international fisheries management measures (Vincent et al 2014). However in order for the resolution to pass, the countries concerned with trade must support it. In the lead up to the vote the countries affected by the trade lobbied each other very heavily. There were several proposals to soften the impacts of a total ban on trade, including a proposal by European countries to continue to allow the trade within Europe and including a proposal for a moratorium on fishing by Japan and the USA (ICCAT 2009). In November 2009 the International Commission for the Conservation of Atlantic Tunas held a special meeting in Recife, Brazil to attempt to lower catch limits down to a level more in line with scientific recommendations for recovery. That effort did not succeed (ICCAT 2009). Legal fishing catch levels remained three to four times higher than can support recovery of the fish stocks. At that meeting Japan proposed a moratorium on fishing. The USA backed it but the proposal failed in voting (ICCAT 2009). Shortly thereafter in Doha, Qatar the proposal to list Mediterranean bluefin tuna on CITES Appendix 1 also failed (CITES 2010). The possibilities ended for regulatory measures to reduce overfishing by banning the international trade to depress demand.

In 2009 the movie 'End of the Line: Imagine a Future Without Fish' blamed Mitsubishi Corporation for the depletion of Mediterranean bluefin tuna stocks. The conservation NGO the Sustainable Fisheries Partnership prepared a series of briefs on the issue of a possible CITES listing for Mediterranean bluefin tuna and predicting the initiative would likely fail. Bluefin needed protection regardless of the outcome of the listing so the focus of the briefs was to advocate for an alternative private sector solution. An intra-industry warranty for tuna traders was recommended to warrant that no products would be bought and sold where legal documentation was not available to confirm the fish were traceable

back to the legal fishing quota. The briefs recommended recovering the depleted stock by setting catches at levels capable of rebuilding stocks in 10 years with a 90% certainty. This would require a no-fishing moratorium of one to three years (SFP 2010). The briefs were shared with Mitsubishi Corporation of Japan in Summer 2009. Mitsubishi Corporation of Japan is the largest buyer and would be hit hardest by a ban on trade. That resulted in an invitation to SFP to meet at their headquarters in Tokyo in August and October 2009 to discuss how an intra-industry warranty could eliminate the trade in illegally fished products.

In order to reduce overfishing impacts the warranty would need to be taken up by a large number of purchasers of the end products. Enough supplies would need to be covered by the warranty, at least 65% for example, to prevent a simple redirection of illegal products through non-warranted buyers and sellers to other markets. As the largest single buyer and reseller of bluefin tuna Mitsubishi Corporation (MC) was a natural target for SFP to contact to talk to about the warranty. SFP suggested that Mitsubishi Corporation lead an intra-industry warranty to verify products are legal and caught in quota. The scheme would apply to all wild import products including the flow of juvenile tuna into Mediterranean-based farms and out again when fattened enough for export. The scheme would need to include the other leading importers of bluefin tuna to Japan. The warranty would require participants to refuse shipments comprised of mixed sources where parts but not all of the supplies had clear origins back to the legal fishing quota. Participants need to agree to purchase supplies only from:

-- vessels and facilities in full compliance with legal programs for catch verification,
-- suppliers with full traceability of their bluefin products,
-- vessels not on a blacklist, and
-- vessels not from countries with a notorious record of negligence on illegal trade.

Major buyers of Mediterranean bluefin tuna like Mitsubishi Corporation can help to promote recovery of the stock by advocating for catches to be reduced to levels capable of rebuilding stocks in 10 years with a 90% certainty. Ultimately Mitsubishi Corporation did not lead the intra-industry measure as proposed. However Mitsubishi Corporation did release a statement advocating for catch levels to be reduced to levels sure to promote recovery. Some recommendations from SFP's briefings were incorporated into their revised

buying policy for Mediterranean bluefin tuna in July 2010, for example to say the catch needs to be lowered to the levels recommended by scientists for fish stock recovery: "We therefore support and urge that, as a minimum, scientific recommendations are strictly followed in the management of tuna populations. Sound scientific-based management is of the highest priority. We will continue our support of scientific research wherever possible. To the extent we believe measures need to be taken above and beyond International Commission for Conservation of Atlantic Tunas (ICCAT) agreed upon actions to protect the long-term sustainability of the bluefin tuna population, we will take those measures voluntarily and unilaterally. As part of this effort Mitsubishi Corporation has taken steps to reduce its purchase of bluefin tuna caught in 2010 to a level that is more than proportional to the reduction in TAC (Total Allowable Catch) from 2009 to 2010" (Mitsubishi Corporation 2010).

Although Mitsubishi Corporation did not take up SFP's idea of leading a new initiative among competitors for verifying the legality of imports, their own buying policy now states that the legal catch must be verified: "We regularly review and evaluate our suppliers' practices to ensure that their operations comply with applicable laws and regulations" (Mitsubishi Corporation 2010). Mitsubishi Corporation called "on the Japan Fisheries Agency to not back down from the leadership role that the global community now expects it to fulfill in order to ensure that a new and more responsible ICCAT emerges and implements the scientifically validated measures necessary to ensure the sustainability of the bluefin tuna fishery in the long term" (Mitsubishi Corporation 2010).

2.3.1 Outcomes for Mediterranean bluefin tuna

SFP advised Mitsubishi Corporation to stop buying Mediterranean bluefin tuna from unregistered catches. This was expressed as a sure way to reduce pressure on the stock by depressing demand for illegal fishing without a CITES listing. Catch verification is the only way to shut down the illegal trade to reduce overfishing (Mitsubishi Corporation, 2013; Sustainable Fisheries Partnership 2009). In two meetings at their headquarters in July and October 2009 between SFP and the tuna procurement and CSR teams, the message from

Mitsubishi Corporation was they could not work on issues pre-competitively alongside other importers but would work on issues directly through the Government of Japan. In March 2010 the CSR director shared a domestic announcement by the Government of Japan on the issue of tuna overfishing worldwide and delivered by the Minister of Agriculture, Forestry and Fisheries. The announcement was published in major newspapers in Japan and advocated for responsible stewardship of fish resources worldwide through a combination of science-based management of global fish stocks, full traceability of seafood products, and respect for fish in Japanese culture. It called upon Japanese fish buyers to procure only 'fish with paperwork' (Japan 2010).

Some new measures for catch verification have been implemented by the International Convention for the Conservation of Atlantic Tunas (ICCAT) for example trans-shipment at sea is prohibited, fishery management plans are required by countries with catch allocations, farm management plans are required, and provisions are now in place for monitor transfers of Mediterranean bluefin tuna on and off boats at ports and farms (ICCAT 2013). In 2013 Mediterranean bluefin tuna was still depleted and overfished. The legal catch on the stock in 2013 is 13,400 t/year (ICCAT 2013). This catch level complies with a probability that recovery will occur in 15 years of 60%.

Under reporting has ended, according to ICCAT. During the CITES controversy, the Commission established a recovery plan with the goal of achieving a biomass at maximum sustainable yield through 2022 with at least 60% of probability (ICCAT 2014). The total allowable catch was reduced in 2010 to between 12,900 t and 13,500 t since 2010 (ICCAT 2014). The spawning stock biomass (SSB) shows clear signs of sharp increase, up to almost 585,000 t in 2013. The SSB peaked over 300,000 t in the late 1950s and early 1970s and then declined to about 150,000 t until the mid 2000s. The rebuilding of eastern bluefin tuna could be achieved, according to ICCAT, with a probability of at least 60% before 2022 with annual catches up to 30,000 t (ICCAT 2014). ICCAT increased catches on Mediterranean bluefin tuna in 2014. ICCAT members did not act on illegal fishing of bluefin tuna but did take steps to improve monitoring and surveillance to eliminate some illegal fishing that goes undetected (Pew 2014).

2.4 British Columbia wild salmon

In July 2010 British Columbia sockeye salmon was 'certified sustainable' by the Marine Stewardship Council (MSC) despite poor stock status in all three previous years. Then pink and chum salmon fisheries were certified (Marine Stewardship Council, 2010a, 2011, 2012) despite significant stock status issues and insufficient management also in those fisheries. All three MSC certifications were conditional to major fisheries management changes requiring new harvest control rules, fishing reference points, and recovery programs for depleted stocks (Marine Stewardship Council, 2010a, 2010b, 2011, 2012). Most of the recommendations pointed to the implementation of Canada's 2005 Wild Salmon Policy as the vehicle for the changes needed to sustain BC wild salmon populations and biodiversity. The action plans attached to the MSC certificates stated that most conditions would be satisfied through the implementation of the policy in five years. The action plans were written by Canada's Department of Fisheries and Oceans and signed by the client group of salmon buying companies in BC (MSC 2010a, 2010b, 2011, 2012). It was known at that time that the federal regulatory environment for fisheries was fragile and facing significant budget cuts. In Fall 2010 to try to create more priority for wild salmon in federal fisheries management, Sobeys Canada and other grocer-retailers communicated their expectation that Canada's Wild Salmon Policy be implemented immediately (Sobeys 2011). The Sustainable Fisheries Partnership offered to help the client group of BC salmon buyers to start a fishery improvement project as a way to help the Department of Fisheries and Oceans to do the work needed to meet the conditions attached to the Marine Stewardship Council certificates in a systematic manner over the five-year certificate term. Initially BC salmon companies promoted the Wild Salmon Policy.

With new research showing that ever more BC sockeye salmon populations were unstable (Grant et al 2012) and with similar results expected for pink and chum salmon, it made sense that industry's stance might change on the conservation issue. The notion that MSC certification of BC salmon fisheries was a good lever to force the implementation of Canada's Wild Salmon Policy had not produced results and made less sense. SFP's assistance to industry to promote the policy 2010-2012 was a test case to see if a fishery improvement project was an effective vehicle to fulfill MSC conditions. It did not work. Rather as SFP

reported on the project on its website over time, as fishery conditions worsened rather than improved, some individuals in the client group asked that reporting be discontinued.

Impacts for fish from the MSC certifications and from the fishery improvement project were unclear in 2012. A rapid appraisal was performed to check the status of the salmon stocks covered by the MSC program. Two questions were researched independently of SFP and the salmon industry. First, are the stocks verifiably healthy today? Second, are they likely to be healthy in the future? The results are presented in chapter three.

2.4.1 Outcomes for BC wild salmon

The results of an independent review of the status of all Pacific wild salmon fisheries showed that sixteen of the thirty-seven salmon units in the MSC program did not have a healthy status at the time of assessment. The status of another sixteen has attributes indicating the populations are unlikely to healthy in the future. The review utilized the published information used in the MSC certification reports. Two of the units were still in assessment and not yet certified at the time of the review in January 2013. Excluding for these two the results suggest that fourteen of thirty seven or 38% of "certified sustainable" wild Pacific salmon come from stocks that are not in good shape now and are unlikely to be healthy in the future.

SFP's assistance to industry to promote the policy 2010-2012 was a test case to see if a fishery improvement project was an effective vehicle to fulfill MSC conditions. It did not work. In 2012 new research showed that nearly 50% of wild sockeye populations were in poor shape and needed recovery, meaning less fishing (Grant et al 2012). By late 2012 it was clear that the productivity of BC sockeye salmon was in serious decline. As SFP reported on results like these on the project website over time, as fishery conditions worsened rather than improved, some individuals in the client group asked that reporting be discontinued.

MSC products were evaluated previously for impacts to fish stocks (Froese and Proelss 2012; Cambridge et al 2011; Agnew et al 2006). However these are the first results for wild

salmon, which was excluded from other studies. Froese and Proelss (2012) found that the percentage of moderately exploited, healthy stocks is 3-4 times higher in seafood certified by the Marine Stewardship Council program compared to non-certified seafood. However 31% of fisheries certified by the Marine Stewardship Council were on overfished stocks with ongoing overfishing occurring (Froese and Proelss 2012). Evaluations by the Marine Stewardship Council of the program's environmental benefits were completed in 2006 and 2011. The 2011 study excluded wild salmon even Alaska salmon despite that fishery's long record of participation in the MSC program and the abundance results available in nine surveillance audits available online. Earlier results for Alaska salmon indicated no environmental gain from certification (Agnew et al, 2006).

The measure did succeed in raising attention to Canada's Wild Salmon Policy from salmon buyers. Grocery retailer Meyer wrote a letter to the Prime Minister of Canada that said investing in wild salmon conservation, by fulfilling the policy, was good business. The video series by Sobeys Canada raised the profile of the Wild Salmon Policy through its investment in consumer promotions. Conservation NGOs like the David Suzuki Foundation started tracking progress on MSC conditions and on implementation of Canada's Wild Salmon Policy in 2012.

On October 31, 2012 the Cohen Commission of Inquiry into the Decline of Sockeye Salmon on the Fraser River confirmed it and offered 75 recommendations for fishery improvements (Cohen Commission, 2012). The Cohen Commission took three years, 2,145 exhibits, 892 public submissions and 138 days of hearings with 180 witnesses to create its report, but a year later salmon still face an upstream battle (Suzuki 2003). Politicians say they are taking action but the few steps they have taken, such as providing grants for research projects, miss the mark (Suzuki 2013).

2.5 Hawaii bigeye tuna and swordfish

Overfishing of bigeye tuna is occurring in the Pacific Ocean. The mortality of bigeye tuna from fishing is higher than the stock can sustain over time, based on mathematical models of

the abundance of bigeye populations and a sustainable yield (WCPFMC 2012). The Hawaii fleet targeting bigeye tuna and swordfish is the most intensively monitored and participates in the most highly managed pelagic longline fisheries in the world. In the pelagic (open ocean) environment baited longline fishing gear attracts sharks, sea birds and sea turtles. The Hawaii Longline Association (HLA) was sued fourteen times by Turtle Island Restoration Network and Earth Justice over the fleet's fishing impacts mainly to sea turtles. One suit resulted in a closure to the swordfish segment of the fishery from 2001-2004 (Kobayashi and Polovina 2005). To re-open it the fleet took up a voluntary suite of measures including a commitment to 100% observer coverage such that all swordfish fishing trips would have an independent person on-board to observe sea turtle interactions with longline gear. Two new and major changes to fishing were the replacement of all fishing hooks from J-hooks to circle hooks to help avoid hooking sea turtles and a hard cap on the total number of interactions allowed between fishing gear and endangered loggerhead and leatherback sea turtles (Bartram et al 2010; Gilman et al 2008). Working together with the regional fishery council and federal fishery regulator the fleet adopted strategies to radically reduce fishing impacts on sharks, sea birds and marine mammals. Measures to reduce bycatch were taken up voluntarily by both the shallow swordfish segment and the deeper tuna-fishing segment of the fleet (Bartram et al 2010; Gilman et al 2008). Shark impacts targeted by a federal finning ban in 2002 (NOAA 2002) were improved further with the fleet's adoption of practices for live release at sea (Walsh 2009) and further yet with a Hawaii State ban on selling shark fins in 2010. Vessels that make sets north of the Equator must use circle hooks and mackerel-style bait (not squid) to avoid the incidental capture of turtles, sea birds and marine mammals. The fisheries had made significant progress with an 89% reduction in bycatch per unit effort, down to 0.019 in 2004-2006 from 0.174 during 1994-1999 (Bartram et al, 2010). Fishery interactions with loggerhead and leatherback turtles had been capped at 16 maximum interactions with leatherback turtles and 17 with loggerhead turtle annually and if the cap is exceeded in the calendar year then the fishery is closed. In the swordfish fishery, every trip must have an observer onboard (100%) specifically to monitor interactions of sea turtles, sea birds and marine mammals. The requirement for tuna trips is 20% observer coverage (Gilman et al 2008).

Fishing impacts to sea turtles, sea birds, and marine mammals were being reduced (Beverly and Chapman, 2007; Gilman et al 2006). The Hawaii Seafood Council completed a detailed assessment of the fisheries against the UN Code of Conduct for Responsible Fisheries in 2006 and found good compliance.

The Seafood Watch program of the Monterey Bay Aquarium published a red rating for the Hawaii pelagic longline fisheries in 2008 despite the major fishery improvements after 2004. The red rating surprised fisheries stakeholders in Hawaii. Seeking to respond to the red rating in 2008 the Hawaii Seafood Council repeated the Responsible Fisheries Assessment and published a score of 93% compliance. The council also developed a 'relative turtle bycatch' metric to communicate the relatively lower bycatch impacts in Hawaii fisheries compared to other longline fisheries in the Pacific. The Hawaii Longline Association partnered with the Sustainable Fisheries Partnership to complete a preliminary assessment to the Marine Stewardship Council standard in 2009 (Hawaii Seafood Council 2014).

The Hawaii Seafood Council published a paper in the journal Marine Policy to show the reductions in bycatch impacts that were due to the improvements. It related the fishing impact to sea turtles per pound of fish caught by various pelagic longline fisheries in the Pacific. The research results included a metric that can be used to portray fishing impacts to sea turtles in longline fisheries worldwide. In 2013 the Hawaii Seafood Council produced the information needed to fulfill the criteria for a fishery improvement project to help a Honolulu seafood vendor to meet Sam's Club's sustainable seafood criteria. The preliminary assessment of the fishery to the MSC standard was repeated in 2010, 2013 and 2014. In early 2013 the information published on the Hawaii Seafood Council website was rejected for being "not credible" by the Sustainable Fisheries Partnership, leading to advice to Sam's Club to remove all seafood products from the Hawaii fleet from the grocery shelves, to be replaced with imported seafood. The fishery was low scoring (60%) in ratings published by the Sustainable Fisheries Partnership (FishSource 2013).

In early 2012 the Seafood Watch rating for seafood products from the Hawaii pelagic longline fisheries changed from red to yellow. Grocer-retailer Whole Foods had announced that it would no longer sell any seafood products from fisheries rated red by Earth Day on

April 23, 2012 (Whole Foods 2012). Hawaii tuna, swordfish and other pelagic seafood products from the fishery remained for sale in the fish case on April 24.

2.5.1 Outcomes for Hawaii tuna and swordfish

The 2010 Marine Policy article introduced a new metric for measuring fishing impacts to sea turtles, a bycatch to catch ratio, and has been cited seven times.

Improvements made in the Hawaii pelagic longline fisheries prior to 2008 included changes to gear that have drastically reduced bycatch of sharks, seabirds, sea turtles and marine mammals in the Hawaii longline pelagic fisheries over the past fifteen years (Gilman 2011, Gilman et al 2008, Beverly and Chapman 2007). The 2004 requirement for 100% observer coverage on fishing trips for swordfish and 20% on trips for tuna the fisheries created the largest source of observer data for sea turtle bycatch in longline fisheries in the Pacific Ocean (Beverly and Chapman 2007). These achievements may not have been recognized by conservation NGOs but are widely published and influential to the practices of other longline fisheries around the world. The fishery was one of the first to stop shark finning, to adopt circle hooks and tori (bird) lines, to resuscitate and release incidentally caught sharks, and to have on-board observers to monitor wildlife interactions with longlines. Many of these measures were taken up as conservation and management measures for all fleets operating in the Western and Central Pacific Ocean (WCPFC 2008).

The 2014 results of the preliminary assessment of the Hawaii longline pelagic fisheries against the MSC standard show that the fishery meets 29 of 31 indicators of the standard, recognizing there is overfishing on bigeye tuna in the Western and Central Pacific Ocean and that the catch composition is changing due to ecosystem effects (Hawaii Seafood Council 2014; Polovina et al 2013). The MSC standard was used to communicate the standing of the fishery in a manner recognizable to NGOs, in other words as a metric of seafood sustainability, and the results are presented in chapter three. Completing the assessments and posting the results on the internet helped the Honolulu-based seafood vendor to meet the sustainable seafood requirements of Sam's Club in Hawaii, which require the vendor to

show all seafood is MSC certified or has origins in a fishery undergoing improvements (Sam's Club 2014).

The Seafood Watch program rated the fishery red in early 2015 (Seafood Watch 2015).

2.6 Minimizing fishing impacts to marine food webs

In 2011 the British grocer retailer ASDA made a pledge to support a shift in fisheries toward an ecosystem-based model (ASDA 2011). A research series was sponsored by ASDA to promote best practices in ecosystem-based fisheries management. ASDA asked the Sustainable Fisheries Partnership (SFP) to prepare the research series. The purpose was to offer to its seafood supply chain some guidance on the kinds of management practices needed worldwide to support sustainable fisheries. This author as an independent researcher completed one report in the series. It looked at ways that seafood industry can improve fishery supplies over time by specifying best practices in fishing for marine food webs. An initial scan of the research literature showed that fishing impacts on marine food webs are well documented however cases of fisheries being managed for food web impacts are not found in marine science publications. The original outline for the report had presumed that real world cases were available to support a review of best practices, when what was available were sophisticated modeling forecasts of fishing impacts on food webs. Interviews with fisheries scientists known globally for their work on fishing impacts on ecosystems compensated for a dearth of published research. Interviewees included Doctors Tim Essington, Daniel Schindler, Robert Olson, Andre Punt, Catherine Dichmont, and Eugene Sabourenkov. Keith Sainsbury provided peer review.

The main findings are:

1. Disruption to marine food webs occurs when the trophic structure of the fishing environment is steadily altered beyond the capacity of the food web to compensate and maintain its necessary structure and function.

2. New and modified fisheries management plans can improve fishing to minimize the alteration of the trophic structure of marine ecosystems.

3. Better integration of fishing in marine food webs requires the alignment of catch levels with environmental targets to conserve trophic structure, including sensitive species and habitat.

The study's objectives were to (1) review the state of the science, (2) present case studies of leadership by fisheries, and (3) identify practical actions that can be taken by the seafood industry to support best practices in fisheries for conserving food webs.

Reviewing the state of the science identified eight key scientific concepts:

1. *Fishing Down the Food Web* Declines were reported in the mean trophic level of the species groups in global fisheries statistics 1950-1994. This reflected a gradual transition in landings from long-lived, high trophic level fish to short-lived and low trophic level invertebrates and planktivorous pelagic fish (Pauly et al. 1998). This concept has been disputed recently (Essington et al 2011, Branch et al 2010) but Mean Trophic Level is often used as an indicator. Even though this effect has been seen in some ecosystems but not in others it is to be avoided.

2. *Multi-species Management Understanding* and making trade-offs between the overall ecosystem yield and the status of individual species in the ecosystem is an approach seen in multi-species fisheries management, where the relationship between the yield and the relative depletion of species in ecosystem is considered (Myers and Worm 2009). There is a need to make explicit and well informed decisions on the balance, and not to deplete any species to the point where irreversible or slowly reversible change happens (for example by recruitment overfishing, extinction or near extinction or loss of key ecological processes);

3. *Fishing Through the Food Web* The most common mechanism underlying declines in mean trophic levels in marine ecosystems is the serial addition of low trophic-level fisheries (Essington et al. 2006). Fishing low trophic species at conventional maximum sustainable

yield (MSY) levels can have large impacts on other parts of the ecosystem, particularly when they constitute a high proportion of the biomass in the ecosystem or are highly connected in the food web (Smith et al. 2011);

4. *Adjusting Fishing Presssure Downward to Meet Biomass Targets that may Help Conserve Food Webs* Halving exploitation rates in low trophic fisheries can result in much lower impacts on marine ecosystems while still achieving 80% of MSY (Smith et al. 2011);

5. *Predator-Prey Ratios Determine Ecosystem Stability* Optimizing stability in the marine environment means conserving the smaller interactions like breadth of diet (how many species consumed) and length of food chain (how many species comprise one chain), to offset fishing impacts that are certain to reduce the predator-to-prey mass ratio (Planck and Law 2012);

6. *Ecological Indicators for Monitoring Fishing Impacts* Ecosystem type, fisheries enforcement, primary production, sea temperature, and fishing type were important variables explaining the ecological indicators and reflecting different changes and processes in the ecosystems (Coll et al. 2010);

7. *Steady Deterioration of Marine Ecosystems Linked to Fishing* Fifteen of nineteen marine ecosystems investigated for fishing impacts were found to have deteriorated from an already impacted state and several also exhibited specific combinations of trends indicating 'fishing down the food web: reduction in size structure, reduction in diversity and stability, and changed productivity (Bundy et al 2010); and

8. *Knowledge of a fishery's context (ecological, environmental, historical) is critical to the interpretation* of indicators correctly, while disentangling the effects of fishing and of the environment.

Outstanding scientific issues pose challenges to improving fishing impacts to marine food webs at this time. These include:

1. Theoretical models are available to describe the status of marine ecosystems on the basis of their food web components; however, it is still uncommon for fisheries to define environmental targets and ecological indicators for those targets;

2. Fisheries management advice requires accepted models that incorporate the important interactions at specific stages and scales in order to supplement the information provided by single-species models and to understand tradeoffs between fishery yields, biodiversity, food webs and the state of seabed habitat. Models have been available for years but have not been accepted widely for management use, often because the level of proof needed to justify taking a management action is very high;

3. Multispecies models are needed to generate better estimates of natural mortality and recruitment in order to better understand spawner–recruit relationships, variability in growth rates, to incorporate alternative views on biological reference points, and to develop a framework for evaluating ecosystem properties; and

4. Assessment of fishing mortality for rare and sensitive species remains a significant challenge requiring detailed knowledge of food web dynamics. This would require a high level of science input. Alternatively, the lessons and direction of change are clear in the scientific literature, and what is missing is a better understanding of precaution in fisheries management with respect to sustaining food webs.

Five case studies of leadership by fisheries on marine food webs included the krill fishery in the Southern Ocean and Antarctic marine food web, North Atlantic cod, tuna fisheries in pelagic food webs in the Eastern Pacific Ocean, wild Pacific salmon fisheries in the Arctic ecosystem of the Bering Sea, and forage fish food webs worldwide. Summarized findings from the five case studies include the following:

1. Fishing impacts may serve as a 'keystone predator' by causing cascading effects through trophic levels that restructure marine food webs;
2. Overfishing on Atlantic cod resulted not only in the virtual elimination of large bodied predators that had dominated the ecosystem for centuries north of 44 degrees latitude

but also in a collapse of benthic species. The food web changed rapidly and dramatically. Today, populations are increasing for small pelagic fishes and benthic macro-invertebrates like snow crab and northern shrimp that formerly were the primary prey of benthic species. Food web differences, probably oceanographically driven, appear to have made cod stocks south of 44 degrees latitude more resilient to overfishing;

3. Diets are changing in pelagic food webs in the Eastern Pacific Ocean. Prey species are increasing and apex predators appear to be decreasing at the population level;
4. Diet plays an important role in regulating tuna populations. Sharks and billfishes consume a wide size range of tunas including sub-adults important to the reproductive output of tuna populations. If shark populations are being overfished it should reflect in the yellowfin and skipjack populations as less predation;
5. Improved depictions of trophic links and biomass flows for food-web models are effective tools to evaluate climate and fishing effects on exploited ecosystems;
6. Many food web models are available for fisheries management, but to employ them managers require a high level of proof of fishing impacts on other species at the population level.
7. In general fisheries management has yet to establish clear goals for fishing interactions with other species and for sustaining marine food webs. Goal setting is needed to make management precautionary. The best available science suggests that defining environmental targets and ecological indicators is a sound approach;
8. Features of the food web, habitat and oceanographic conditions are known to be key factors in the status of wild Pacific salmon populations but these factors had not previously been codified as environmental targets and ecological indicators. Ecological indicators for Bering Sea wild salmon fisheries are available to support an ecosystem approach to salmon fisheries management;
9. Conserving biomass is a good target for fisheries management. Fisheries scientists recommend ratcheting down fishing effort with biomass targets as a straightforward approach. The Lensfest Task Force has proposed a "dependent predator performance criterion" for fisheries management to ensure that predators do not become vulnerable to extinction with 95% confidence.

The results from a review of best practice indicates that fishing impacts on marine food webs are only starting to become a factor in integrated fisheries management. Predator-prey relationships are not commonly factored into harvest scenarios, even though mortality rates are predator-, prey- and fishery-dependent (Overholtz and Link 2007). The interviewees shared an opinion that this omission has contributed to sub-optimal management planning and trophic declines in ecosystems.

Disruption to marine food webs occurs when the trophic structure of the fishing environment is steadily altered beyond the capacity of the food web to compensate and maintain its necessary structure and function. To sustain marine food webs fisheries management will require (1) improved depictions of trophic links and biomass flows for food-web models, (2) a management framework with environmental targets and ecological indicators for meeting those targets, and (3) alignment of harvest scenarios and catch levels with environmental targets. Incorporating these tools into fisheries management will conserve sensitive species and habitat over time and contribute to conservation of the food webs needed to sustain target stocks. Working within the current state of the science it is possible to update conventional fisheries management with new and modified fisheries management plans that can minimize the impacts of fishing activities on the trophic structure of marine ecosystems.

Food web impacts should be factored into harvest planning. Environmental targets will be needed and ecological indicators to meet those targets. Fisheries in sensitive environments, for example krill fisheries in polar environments, need biomass targets that are sufficient to meet food web nutritional and energetic needs throughout the year including the dark six months when the availability of algae diet of krill is very low. Fisheries in equatorial or sub-tropical environments, for example the forage fisheries in South American waters, need catch limits that protect the fish populations that predate on small pelagics to ensure that biomass targets are sufficient to sustain food web structure in spite of heavy fishing impacts. In marine ecosystems with many overlapping fisheries, for example for tunas and salmon, there is a need for broad agreement on sustaining food webs with precautionary management and catch limits that account for fisheries interactions. The models available today can help managers to optimize fishing yield with a more accurate understanding of

biomass constituents: diet, condition, survival, distribution, abundance, and variation in each over time. But it is not the case that the only approach to sustaining food webs is more and closer monitoring. As in CCAMLR and in fisheries with low information tiers it is the case that a highly precautionary harvest rate can be set which has a very high probability of being safe for the stock and the food web. Management and the fishery can keep to those settings safely without additional information. Where there is a desire to fish more aggressively then extra information is needed.

The overall message from the findings is a simple one. With adequate precaution for sustaining marine food webs safe-harvesting rates can be implemented, even where data are limited. Seafood buyers can support best practices in fisheries to conserve food webs with the following practical actions:

1. Identify products where fishing impacts to food webs are a concern.
2. For products of concern, look into the fisheries to see if any progress is being made toward an ecosystem approach.
3. Encourage fishery regulators to be precautionary. Let buyers know that your company supports the regulation of fisheries in a precautionary manner to better sustain marine food webs.
4. Encourage fishery regulators to set goals for fisheries interactions with non-target species, and to set environmental targets and ecological indicators where they do not already exist.
5. Communicate your concerns to the regulators and other stakeholders where a fishery of interest is not making progress along these lines.
6. Communicate your company's support for sustainable fisheries that include ecosystem considerations in setting fishery management measures, indicators and targets that consider the food web effects when making these decisions.

2.6.1 Outcomes from ASDA's Report

The report, "Minimizing and managing the impact of fisheries on marine food webs", sponsored by ASDA, was published on the website of the Sustainable Fisheries Partnership

on June 5, 2014.[3] It was the subject of a full article in Undercurrent News, a major source of seafood media, on the same day.[4] The report follows up on commitments ASDA made on its website in 2012 to promote 'ecosystem improvements' in fishing and seafood (ASDA 2013).

A broad set of marine scientists from different organizations around the world participated in the research series. All participants were part of a unique opportunity to discuss from their perspective how fishing impacts to marine food webs can be managed better. The results of that discussion are now available in the public domain and are easily accessible to seafood companies operating partnerships with the Sustainable Fisheries Partnership.

2.7 Estimates of illegal and unreported fish in seafood imports to the USA

Where illegal fishing represents a significant portion of the catch then a fish stock cannot be managed sustainably (Agnew et al 2009). Illegal fishing undermines the scientific management of fisheries because obtaining accurate information on total catch is essential. Illegal, unreported and unregulated (IUU) fishing is a significant global problem jeopardizing ecosystems, food security, and livelihoods around the world (Pramod et al 2014). Regulatory measures may not be enough to end illegal activities in fishing and the trade in products from illegal activities. Kleiven et al. (2012) showed how the total catch of a marine species Red-Listed as endangered by the International Union for the Conservation of Nature could easily be an order of magnitude higher than official data. Osterblom et al. (2011) have argued that illegal activities that are systematic, well organized and designed to avoid regulation while exploiting ecosystems should be regarded as organized crime. "Environmental crime" has become a priority for the Interpol and World Bank in response to rampant poaching in wildlife for international trade in wildlife products (World Bank, 2013).

[3] https://www.sustainablefish.org/publications/2014/06/03/sfp-best-practices-report; see https://www.sustainablefish.org/news/articles/2014/06/05/report-identifies-wider-impacts-of-fishing-on-marine-ecosystems

[4] See news story: "Asda-sponsored report exposes wider impact of fishing on marine ecosystems"

In the United States the import and mislabeling of seafood with origins in illegal and unreported (IU) fishing contravenes the US Lacey Act. Prosecutions of seafood trading companies against the Lacey Act help to prevent the re-labeling of products from one country as product of another (Colbourn, 2011). A recent investigation from the U.S. Government Accountability Office revealed that only 2 percent of imported seafood is ever inspected. More than 90% of U.S. seafood is imported (NFI 2013) and up to one-third of the seafood products are mislabeled (Barrionuevo 2007; Jacquet and Pauly 2008). A recent study by Pramod et al, where Nakamura was second authour, found that currently very few tools exist to monitor the extent of seafood from illegal, unreported and unregulated catches entering USA through fish imports. U.S markets are unable to track the extent of mislabeling of seafood products imported through U.S. ports or by domestic suppliers and retailers. It is not possible presently to differentiate farmed versus wild catches entering U.S. markets using existing U.S. trade data. Penalties for mislabeling and fraud are grossly inadequate in most U.S. states to deter seafood retailers and suppliers from continuing these practices (all statements from Pramod et al 2014).

The policy branch of the World Wildlife Fund, located in Washington DC, hosted research in 2012/3 to raise awareness of the environmental, economic and social impacts of illegal fishing. They sought to build a base of evidence to support a call for new federal legislation to ban seafood imports with origins in illegal and unreported fishing. This author and a colleague were hired as contractors to quantify the magnitude of the illegal seafood trade within the United States seafood industry. This version of the results presents results of the research produced by this author. This author collected and filtered NOAA data and researched the provenance of 30 top product/country combinations, being the top three products from the top ten countries exporting seafood to the United States. The author's role was to conceive of a method for estimating product-level estimates from country-level estimates. Risk scores were prepared for the three leading seafood import products from each of the top ten importing nations to the U.S. based on 2011 trade data. The method was estimation of risks across several risk factors. Each risk factor was parameterized to a presence/absence question (binary scoring). The parameters were assigned equal weights and summed to 36. The risk factors were trading characteristics found across seafood supply chains worldwide. The major nodes of seafood supply chains were included through

fishing vessels and ports extending to U.S. grocer-retailers. The results are presented in chapter three.

Typically illegal and unreported fishing are grouped with unregulated fishing, known as IUU fishing (FAO 2013; Agnew et al 2009). This study utilized the broader definition of IUU used by the Food and Agriculture Organization of the United Nations in the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (FAO 2001). "Illegal" catches are catches by national or foreign fishing vessels in contravention of State and International laws while fishing within the Excusive Economic Zone; vessels flying the flag of contracting parties that contravene regulations of RFMO or violate international laws by flying the flags of co-operating states while fishing within the RFMO jurisdictions. "Unreported" catches are defined as catches that are not reported or misreported by national or foreign fishing vessels while fishing within an EEZ and the misreporting or underreporting of catches while fishing contravening reporting procedures of the RFMO concerned (FAO 2001). In the present study estimates of discards and unregulated artisanal catches were excluded, effectively excluding "Unregulated" from the analysis.

NMFS Trade data shows that for the year 2011, USA imported 2,379,939 tonnes of edible seafood products valued at $16.5 billion USD from 120 countries. Freshwater, non-edible and declared farmed seafood products catches were excluded from total catches in order to get an estimate of total imported marine capture catches of 1.4 million (1,422,522) tonnes worth $10 billion ($10,046,142,977 USD). The top 10 countries exporting the highest volume of seafood into USA in 2011 and the top 3 seafood products for each country were selected for analysis. This comprised an estimated 0.5 million tonnes of seafood products worth 3.7 billion USD in the year 2011. Farmed shrimp were excluded from the declared catches to get the total wild caught fishery products that entered into USA from the top 10 exporting countries in 2011. Although shrimp comprises the bulk of exports to USA both in volume and value, such products were excluded from the IUU analysis for many of the top 10 countries including Thailand, China, Indonesia and Vietnam because most (but not all) of the shrimp imports are farm-origin. Pursuant to U.S. Public Law 101-162, which aims to reduce incidental capture of sea turtles in shrimp trawl fisheries, in the year 2012 the US

Department of State certified 13 nations for using Turtle Excluder Device (TED), and the list does not include Thailand, India and Vietnam (U.S. Dept. of State 2012).

In the year 2011 for a total exported catch of 545,000 tonnes by the top 10 countries (for top 30 seafood products by volume), the estimated illegal and unreported (IUU) catches ranged from 122,000 to 225,000 tonnes, with a IUU range of 22-41% and valued at US$ 862,761,421 – US$ 1,590,373,411 (Pramod et al 2014). For estimated wild exports of 1,189,969 tonnes, the estimated IUU catches are 261,793 to 487,887 tonnes, valued at US$ 1,848,836,016 to US$ 3,445,558,350, for seafood exports to USA in the year 2011 (Pramod et al 2014).

Quantitative IUU estimates were constructed from fishery-level data based upon the trading characteristics of vessels. However there are also IUU hotspots onshore in supply chains that add to product risks. The provenance for each of 30 top seafood products imported to the USA in 2011 was researched in detail to establish the species, fishery sources, trading characteristics in the export country, provenance measures and enforcement in the export country, trade flows to U.S. retailers, and IUU impacts. Information for each product served as a base for tracing trade flows from export countries to destinations in the USA and for scoring each product/country combination for IUU risk. The risk scores provide another level of insight into the profiling of illegal and unreported proportions associated with each product/country combination in 2011. In general higher scores indicate higher risks from mixed sources, less-developed regulatory regimes for seafood in exporting countries and low exposure of U.S. buyers.

To provide context for the estimates, the research also looked into economic impacts from illegal and unreported fishing worldwide. The results pointed to several key drivers of illegal and unreported fishing in export countries that create negative economic consequences for US seafood importers, including:

1. Uncertain access to seafood supplies as resources diminish due to a lack of control and fisheries management. Fishery resources cannot be sustainably managed when the total catch is under-estimated due to under-reporting, misreporting and non-reporting (example:

Russian pollock and salmon) and scant catch monitoring (examples: Indonesia tuna and wild shrimp) for both domestic and foreign fleets;
2. Industry pressure on governments to stall or avoid legal consequences for illegal fishing (example: Russian pollock);
3. Absence of regulation leading to unaccounted catches and population-level impacts like declining size (example: crab in Russia, Indonesia, Thailand, Philippines, Vietnam and also octopus and squid populations in India and the Philippines);
4. Depletion of domestic wild fish stocks and subsequent expansion of fishing effort outside the EEZ, including topping up with foreign supplies purchased at sea outside of fishing agreements (example: Thai and Vietnam tuna);
5. Fishing pressure due to illegal fishing by artisanal fleets and near shore competition from industrial fleets (example: Mexico shrimp); and
6. Offshore trans-shipping and purchasing of mixed origin supplies at sea by foreign carrier vessels, leading to gains for processing in many countries (example: Thai tuna, crab and shrimp) and losses to some domestic processing sectors due to unavailability of raw material (example: Indonesia tuna, crab and shrimp).

Economic incentives are one of the major drivers of illegal fishing. The main incentives are cheaper costs for production and labor. Vessels fishing illegally have better margins than vessels fishing legally by savings on license costs, fees and taxes, as well as crew costs related to upholding labor laws and safety standards. Illegal fishing vessels profit more when stocks decrease and prices increase because their competitive advantages are unfettered by the fishing rules and catch reductions that affect the licensed fleets. Illegal and unreported fishing has a price deflation effect on the global seafood industry that is hard to stop with regulatory measures because of the access and price advantages that illegal and unreported fish products offer to processors and exporters. Using a conceptual model to estimate the costs and benefit aspects of the risk inherent in illegal, unreported and unregulated (IUU) fishing, Sumaila *et al.*, (2006) found that the expected benefits from IUU fishing far exceed the expected cost of being apprehended. For an assumed 1 in 5 chance of being apprehended, the reported fines for vessels apprehended would have to be increased by 24 times for the expected cost to be at least as much as the expected benefits. A more recent study on illegal fishing penalties using 1211 IUU incidents for 109 countries from 1982-2010

shows that low penalties are one of the major drivers of illegal fishing in both artisanal and commercial fisheries worldwide (Pramod 2012).

Jagers *et al.* (2012) have shown that a strong sense of belief in law and order, and an expectation this belief is shared by their peers, is required for compliance with fishing rules by fishing boat captains. Systemic and organized illegal fishing creates an open access regime for fisheries where compliance with domestic and international law is de-incentivized. However, compliance is a fundamental characteristic of trading inside supply chains. Large seafood importers in the United States are accountable to retailer policies that specify proof of legality as a product attribute and are additionally vulnerable to allegations of handling stolen goods.

2.7.1 Outcomes from publishing the estimates

The results were published in the journal Marine Policy online as an open access article in April 2014. The paper was the Social Selection in Science magazine the week it was published, and was noted in the journal Nature in a news item entitled 'Illegal fishing hooks online attention'. The article scored in the 99th percentile for all articles read in Marine Policy, all articles of similar age, and all articles tracked overall by Altmetric. The article was the topic of a lead story in the weekly Health and Science section of the Washington Post by columnist Darryl Fears and this was republished in several US newspapers including the Boston Globe. It was the subject of weekly online news columns by National Geographic and Environment 360. The download count for the article was 17,000 within ten months. At six months after publication it has been cited 22 times.

Prior to publication, the anonymous reviewers of the article for Marine Policy contributed detailed comments that said, in summary, "It is important to remember that the overwhelming driving force in the fishing industry is the demand for fish", from people in the most developed economies for fish resources from the least developed economies. "It is ironic that the vast and necessary effort in the science and application of fisheries management exists to a large degree separate from the situation described in this paper,

which is thus a welcome bridge between the two 'halves' of the fishing industry - the catching side on the one hand, and the 'land' side on the other." The comment went on to say that "the paper is clearly structured and well written, underpinned with a full exposition of the methodology and results, again underpinned with a vast range of sources detailed in the Supplementary material. The importance of this paper can hardly be over-emphasized. Although restricted to the US case study, it systematically sets out the full scope of the IU fish trade, and is a major contribution to the field."

On June 17, 2014 the White House released a Presidential Memorandum entitled "Establishing a Comprehensive Framework to Combat Illegal, Unreported and Unregulated Fishing and Seafood Fraud". Among other actions the Memorandum established a Presidential Task Force co-chaired by the Departments of State and Commerce and made up of a broad range of other federal agencies[5]. The Task Force is directed to report to the President within six months with "recommendations for the implementation of a comprehensive framework for integrated programs to combat IUU fishing and seafood fraud that emphasizes areas of greatest need (NOAA 2014). Following the announcement public submissions on the issue were invited at Regulations.gov and among the submissions the article was cited seven times. An action plan and new federal program to introduce traceability for seafood imports was announced on March 16, 2015 and made national news. A story in the Washington Post by Darryl Fears, entitled 'Federal Officials Plan to Track Every Fish and Crustacean Shipped to US Ports', ran on March 16[6] and concluded with a link to this author's 2014 article on illegal fishing in Marine Policy.

The research results were also noted in the seafood media. "Retailers should reject claims about IUU entering US based on wild allegations" was the headline story run by SeafoodNews.com the day the article was published online and remained the news site's most-read story for several weeks, according to editor John Sackton.

[5] Announcement at http://www.nmfs.noaa.gov/ia/iuu/taskforce.html
[6] http://www.washingtonpost.com/national/health-science/sea-hunt-officials-plan-to-track-seafood-bait-to-plate-to-end-fraud/2015/03/14/0ab191d8-c7fe-11e4-aa1a-86135599fb0f_story.html

Following publication of the article online, the authors heard from researchers in Russia, China, Indonesia and Chile that the estimates were very similar to their own in-country estimates of illegal and unreported fishing for the same seafood product types. The researchers corroborated the magnitude of the problem, although the researcher in Chile said some estimates for Chile should be higher.

2.8 Screening seafood supply chains for forced and trafficked labour

In Fall 2012 a proposal was developed for a new private sector measure to help the seafood industry to clean up supply chains from risks for forced and trafficked labour. The Sustainability Incubator, a Honolulu-based company owned by this author, was invited to submit the proposal to the US charitable foundation Humanity United for consideration for grant funding. The proposal was approved and a project to build the "Labour Safe Screen" began in October 2013. The Labour Safe Screen is a risk audit for seafood companies to use to investigate working conditions and to build accountability in supply chains with the goal of making labour safe even in high-risk zones. It provides information to locate extreme labour risks, based on the UN indicators for human trafficking, and offers recommendations to help to verify that working conditions are legal and workers have the ID they need to escape vulnerability to trafficking.

Thai companies and police currently face few to no consequences for trafficking Burmese labour (BBC 2014, Reuters 2013, Environmental Justice Foundation 2013, ILO 2013, IUU Risk Intelligence 2012). Typically Burmese migrants are tribal people from several language groups who seek cash work and enter Thailand with a broker promising a job (ILO 2013). In the city of Samut Sakhon alone 300-400,000 migrants work in processing. Ninety percent are Burmese and half lack legitimate ID documentation (LPN 2013). Inside Thailand, Burmese are disenfranchised and easily exploited as an open access resource with men and boys held captive and re-sold by several brokers through to a final sale to a fishing boat captain who may keep them working at sea as an unpaid captive for years to repay the 'debt' (BBC, 2014; Environmental Justice Foundation, 2013; Bangkok Post, 2013; Daily Mail UK, 2013: Democratic Voice of Burma News, 2013; Undercurrent News, 2013 and 2012a-c;

National Public Radio, 2012). Forced labour from Cambodians and Laotians is also prevalent suggesting the magnitude of trafficked crew in the Thai fleet is even higher. However true slavery conditions for Cambodian workers may be declining due to growing social support systems to combat trafficking in Cambodian communities (Becky Palmstrom, personal communication, November 2012). Journalists and labour experts at international agencies (UNIAP, UN Lift, ILO) report that gaining access to trafficked Burmese in Thailand through regulatory channels is extraordinarily difficult.

A wide array of seafood products common to supermarket shelves worldwide are made from the many species processed by Thai factories. In the beginning phase of the project 40 interviews were conducted with seafood and anti-trafficking experts. Based on the interview results it would appear that the highest risks for trafficking are found where seafood deals and trading are done 'off-book' at-sea and at points of trans-shipment at sea, ports, as well as in primary and secondary processing when supplies change hands and amalgamated and transformed in production. There is little to no transparency for seafood importers into the zone of production at the front-end of supply chains between fishing grounds and tertiary processing at export-facing facilities. Export-facing facilities are often large and owned by publicly traded companies and operating with working conditions that may be audited in a conventional manner with spotchecks by a third party auditor. Vessels at sea by contrast, and primary processing facilities around ports, tend to be owned privately by family companies (FAO 2013) where working conditions are more difficult to audit. Traceability of seafood can be very low where enormous volumes of seafood are produced in small and medium sized family-owned companies, like in Thailand's seafood sector. Where trading is non-transparent, it is not possible for importers in Canada or the USA to verify that the companies they buy seafood from are providing working conditions free of forced and trafficked labour.

As of 2013 no labour auditing protocol, including Social Accountability 8000, reached backward to the highest risk zones for forced and trafficked labour in seafood work like primary processing and trans-shipping at sea. This meant seafood importers could not substantiate a claim of zero tolerance to human trafficking. This measure sought to fill a gap in the market to make it possible to trace and verify the provenance of imported products in

terms of the working conditions across seafood supply chains. There was a gap in industry awareness of trafficking in seafood and how to manage product risks. There was an opportunity to incorporate risk assessment and verification practices into the existing tools seafood companies use to show due diligence in procuring supplies. There was a gap in reliably ensuring the supply chain is buying from vessel-owning and processing companies that are aware of the risks and working to reduce them. There was an opportunity to leverage suppliers and networks to support further work in traceability to enable more seafood buyers to identify trade flows of suspect products.

The Labour Safe Screen project began in late September 2013. It is supported by a multivariate design based on understanding the working conditions in seafood supply chains both at sea and onshore. The supply chains of fourteen major Thai seafood export products were researched intensively in the development phase of the Labour Safe Screen project and an algorithm for risk scoring at sea was developed and tested. The Nexus Institute, a trafficking think-tank based in Bangkok, and the Labour Rights Promotion Network, a Thai organization serving abused migrant and child workers in the Thai seafood industry, became project partners. Thai Union Frozen and Tesco UK were engaged as prospective users of the screen and to test its components. The information needed to assess risk for each product includes product details (including batch code and delivery notes), immediate supplier details, an introduction and permission to contact the supplier for information, and source and processing points for all supplies for the product. An online questionnaire was published in April 2014 as a user portal to the screen. The data submitted by companies is proprietary and is anonymized before analysis.

The Labour Rights Promotion Network provides on-the-ground surveillance for the Labor Safe Screen in Thailand and also contributes research findings. A quantitative research project sponsored by the Labour Safe Screen under this author's oversight led to new research and 104 interviews with fishing boat workers in Thailand. The interviews were conducted by experts at the Labour Rights Promotion Network with oversight by the Nexus Institute (and not by this author, although results are co-owned) and were completed in August 2014. The findings may be the first that use the workers' perspective to pinpoint the

working conditions that signal forced and trafficked labour in the Thai seafood sector. Key findings include:

1. There is no skill training on boats for workers to learn how to operate the fishing gears.
2. No information on living condition on the boat is provided for the workers at recruitment.
3. There are no medical equipment and personnel to treat any person if they are injured from work.
4. There is no contract between business owners and boat captains / chiefs / workers.
5. There is no standard payment or wages for the workers on the boats
6. The workers on the fishing boats do not have any insurance plans, e.g. health, life or accident.
7. Eighty percent of workers on the fishing boats are undocumented migrants while twenty percent of workers may have travel documents but most of them do not have work permit.

The workers interviewed revealed that their labour is brokered to fishing vessels by labour chiefs who receive a lump sum paid by the business owners and do not pay wages directly to the workers at their discretion. The chiefs have ownership of the workers and manipulate them which results in exploitation and human trafficking (LPN 2014).

The general principle behind the Labour Safe Screen is to plug loopholes for undocumented fish. It is designed to help seafood importers to get the information they need to show accountability for the products they sell. To do so it is first important to understand how trade works and how products flow from Thai vessels to Thai factories and ports for export. General trade flows are understood but direct engagement with Thai exporters will help the project to fully trace products back to vessels. This function could grow to be very important to the market because the scale of the issue appears to be very large to the point of possibly reversing the usual burden of proof. Concepts like fail-safe catch verification, batching, and refusal of mixed shipments are considered in the design of the audit and for the questionnaire there is use of the concept of one-up/one-down traceability. Guiding principles are inclusivity - the extent to which the scheme is designed to provide documentation for all fish products, impermeability - the extent to which the scheme is

designed to exclude fish products caught by slave labour on fishing vessels, and verifiability - the extent to which the scheme may be audited objectively and independently by parties other than those directly responsible for handling products and for filling out and validating any accompanying documentation.

The outcome expected is a risk screen for comparing import products that will estimate the risk of forced and trafficked labour for products at the export level. It will offer a sightline on extreme risk for illegal and inhumane working conditions all the way back to the raw material source. While ultimately a full traceability and verification tool will be required, the Labour Safe Screen project will incrementally build specific components – building progressively towards a full system. This will help to build experience and trust amongst the various actors, including providing avenues for progressive demonstration of the effectiveness of various components and building a broader base of engagement with stakeholders.

2.8.1 Outcomes from the Labour Safe Screen

In June 2014 the Guardian newspaper in the United Kingdom published a story, entitled "Revealed: Asian slave labour producing prawns for supermarkets in UK, US" (Guardian 2014). The same month the US State Department announced that Thailand was demoted to its bottom tier for human trafficking due in part to the unchecked abuse of migrant workers in Thai seafood and especially in the fishing fleet (US State Department 2014). In response the military government in Thailand made an announcement in July 2014 of the National Commission for Peace and Order – NCPO to allow employers, particularly in fishing industry, to register their workers in any of the 22 coastal provinces, the number of migrant registrations is increasing. There are some attempts to issue contract for workers on the boat in Samut Sakhon from the beginning of June 2014 (LPN 2014).

On April 3, 2014 this author received an email from the Sustainability Director for Thai Union Frozen Products PCL, the largest exporter of Thai seafood. It said, "It is my pleasure to be able to contribute to the Labour Safe Screen project. Thai Union Group is working

towards increasing transparency and traceability in our supply chain. We would thus expect the Labour Safe Screen project could be valuable when implemented in conjunction with other supply chain initiatives". Thai Union Frozen was part of a network that grew around the Labour Safe Screen 2012-2014 to bridge seafood sustainability and human trafficking research and advocacy. The network includes regional experts at the United Nations interagency program on human trafficking in Bangkok, the International Labour Office in Bangkok, the Labour Rights Promotion Network in Samut Sakhon, the Nexus Institute in Bangkok, Human Rights Watch in Bangkok, Project Isere in Bangkok, the Mekong Club in Hong Kong, international vessel owning company Pacific Andes, Morrisons UK, Tesco UK, Seafish UK, Safeway, Costco, Nestle Purina, UN Lift in Yangon, US State Department, as well as journalists for BBC, Associated Press, National Public Radio, and NGOs Greenpeace Southeast Asia, Liberty Asia, FishWise and FishChoice. The Labour Screen is promoted to the industry by Seafish UK, FishWise, FishChoice and the Sustainable Fisheries Partnership and will be featured in an upcoming edition of the Stanford Social Innovation Review.
In response to market demand, in Fall 2014 a concept for publishing risk scores for seafood sources worldwide was developed in association with Humanity United with Morrisons (UK), Seafish (UK), the Global Aquaculture Alliance, Pacific Andes, and FishChoice.

At time of writing the senior seafood buyer for the UK grocer Morrisons asked about incorporating the Labour Safe Screen in their seafood procurement program as well as into new fishery improvement projects in Thailand, which would mean generating information for the Sustainable Fisheries Partnership and World Wildlife Fund to use to help Thai seafood companies to make improvements.

2.9 Effects from seven sustainable seafood measures

To avoid the 'bluewashing' phenomenon, sustainable seafood campaigns must be goal-oriented and communicate whether or not goals were met (Jacquet 2009). There is a need to assemble hard evidence with which to test the effects that voluntary sustainable seafood measures really have on the market and on sustainability for fish populations (Ward and

Phillips, 2008). The research goal was to ask what kinds of effects have resulted from voluntary industry measures for sustainable seafood?

The cases show organizations trying to solve problems and to advance their positions across a wide array of issues and parts of production. The effects are summarized in the following table. New knowledge was sought on effects, performance, and corporate strategy in private sector measures for sustainability (Wahl and Bull 2013). Effects were defined by the metrics of success specified by each measure. New contributions to corporate strategy from the measures were sought in the form of new partnerships and processes for information exchange facilitating a license to operate, as described in theory on corporate sustainability (Vurro et al 2010) and corporate-NGO partnerships (Cashore, Auld and Newsom 2013).

Table 2.1: Summary of effects from seven measures for sustainable seafood

Sustainable Seafood Measure	Effects	Performance & Strategy
Metrics for Sustainable Shrimp Sustainable shrimp metrics were developed and published in a scoring grid for assessing the sustainability of tropical shrimp fisheries worldwide. Ten major shrimp fisheries were scored using the grid and also relative to the Marine Stewardship Council standard for sustainable fisheries. The results were shared with conservation NGOs and seafood industry executives. Metric for success: Number of MSC certified tropical wild shrimp fisheries Context: In 2008 conservation organizations were advising consumers to avoid tropical shrimp and farmed shrimp production was expanding rapidly.	1. Highly respected fisheries scientists were engaged in a worldwide conversation about best practices in multi-species trawl fisheries. 2. The Suriname Seabob is MSC certified in 2012. 3. Australia's Northern Prawn Fishery is certified in 2013 with the highest scores of any fishery certified to date. 4. Fishery improvement projects start for wild shrimp in the US Gulf of Mexico. 5. Fishery improvement projects start for wild shrimp in the Mexico Gulf of California. 6. US and Mexico shrimp fisheries entered the MSC program. 7. Publication of sustainable shrimp metrics is rejected by the journal Fish and Fisheries due to a disagreement by reviewers over the relevance of the Marine Stewardship Council standard to best practices in fisheries.	Participating scientists said it was valuable to focus on best practices to try to move a sector of fisheries toward a target. They liked the focus on reducing severe environmental impacts especially to non-shrimp species caught in trawl gear. SFP's investment in sustainable shrimp showed the difficulty of getting shrimp fisheries into the Marine Stewardship Council program or even evaluated fairly by NGO ratings. Fishery improvement projects for wild shrimp in the US Gulf of Mexico for fisheries in Louisiana, Texas and Florida and backed by Publix and Golden Eagle with SFP set a goal to reduce the incidental capture of sea turtles. Fishery improvement projects for wild shrimp in the Mexico Gulf of California shrimp fisheries and backed by Walmart with SFP set a goal to reduce the amount of illegal fishing in the region.

Sustainable Seafood Measure	Effects	Performance & Strategy
Reducing illegal fishing on Mediterranean bluefin tuna Mitsubishi Corporation was asked by SFP to consider hosting an intra-industry warranty program to plug loopholes for the export of unverified tuna catches from the Mediterranean. Metric of success: (1) Catches reduced to levels capable of rebuilding stocks in 10 years with a 90% certainty; (2) 65% of bluefin tuna exports are covered by an industry-led catch verification program. Context: Mitsubishi Corporation is the buyer of 50-65% of Mediterranean bluefin supplies. In 2009 the Prince of Monaco proposed listing bluefin tuna on the CITES Appendix I to ban the international trade and end Japanese imports.	1. Mitsubishi's tuna procurement and CSR teams looked at a warranty concept to eliminate illegal fishing from bluefin supply chains at their headquarters in Tokyo. They were also briefed on loopholes in current verification programs and on specific ways Mitsubishi could support reductions to the fishing catch to meet scientists' recommendations for recovery of bluefin stocks. 2. In July 2010 Mitsubishi Corporation announced a new position to reduce purchasing of Mediterranean bluefin tuna to amounts commensurate with the catch levels advised by scientists for recovery of the stocks. 3. Mitsubishi stated its support for catch verification to reduce overfishing in 2010 and 2013. 4. ICCAT declared that under-reporting has ended and increased the total allowable catch in 2014.	A CITES listing on Appendix 1 did not pass in 2010. The Mitsubishi tuna team challenged SFP to return with a proposal that suits the business environment in Japan. They work strategically with the Japanese government and cannot be seen to lead an intra-industry initiative with their competitors, however would join if such an initiative were led by an independent organization. Instead SFP transferred the information to World Wildlife Fund-Japan. Mitsubishi Corporation subsequently invited World Wildlife Fund-Japan to participate on their environmental board. If under-reporting has been curtailed, as ICCAT claims in 2014, then the proportion of export supply with a catch verified by ICCAT exceeds 70%.
Industry support for Canada's Wild Salmon Policy? All MSC certifications for BC salmon were conditional to 80+ corrective actions. Most concerned the implementing of Canada's Wild Salmon Policy. BC salmon buyers showed support for policy implementation to satisfy MSC conditions through a fishery improvement project. Metrics for success: 14 of 37 certified fisheries were not in good shape at the time of certification. However, the status of the 39 Pacific salmon fisheries in the MSC program is published on msc.org and the information is used by NGOs to motivate improvements. Context: Salmon was certified despite very low returns to BC's rivers 2007-2009.	1. In 2010 Sobeys Canada advised BC salmon suppliers to participate in a fishery improvement project. 2. US grocer-retailer Meijer sent a letter asking Canada's Prime Minister to implement the Wild Salmon Policy as a matter of Canada's reputation as a reliable source of sustainable seafood. 3. In 2011 Sobeys Canada produced a video series on BC wild salmon calling for implementation of Canada's Wild Salmon Policy. 4. In 2012 BC seafood companies Albion Fisheries and Pasco Fisheries expressed interest and started initial planning for a public campaign to show their support for Canada's Wild Salmon Policy. 5. Participants from industry ended the project when DFO announced half of sockeye populations need recovery (Grant et al in 2012).	In 2010 Canada's Wild Salmon Policy had not been implemented. Curiously, it was not funded or scheduled for implementation by the Department of Fisheries and Oceans, even though the DFO had written the action plans to support the MSC certificates. This did not change 2010-2013 despite efforts by the project to promote its importance. Benchmarking of BC sockeye salmon populations in 2012 showed that stock recovery is needed at a large scale for 50% of stocks. If implemented, the Wild Salmon Policy would require significant long-term reductions in salmon fishing. Strategically, this news turned the advantages of implementing the Wild Salmon Policy turned to disadvantages. The Executive Director of the MSC client group advised BC salmon buyers in a group email to avoid drawing attention to the Wild Salmon Policy.

Sustainable Seafood Measure

Responsible tuna measures by Hawaii's longline fleet

The Hawaii pelagic longline fishery sought to show their leadership in responsible tuna fishing in the Pacific.

Metrics for success: Bycatch to catch ratios to show declining impacts to sea turtles impacts

Context: Alongside local efforts to gain recognition for responsible fishing, Hawaii seafood needed to meet the sustainability criteria in global buying policies for Sam's Club as the fishery was rated red by the Seafood Watch program of the Monterey Bay Aquarium.

Effects

1. The Hawaii Seafood Council was formed in 2011 to promote the sustainability and health benefits of Hawaii seafood.
2. The fisheries were assessed twice against the FAO Code of Conduct for Responsible Fisheries and scored highly.
3. An article describing the reduction in turtle interactions in the Hawaii longline fisheries was published in Marine Policy in 2010; and cited 8 times.
4. The fisheries were assessed against the Marine Stewardship Council standard in 2009, 2010, 2013 and 2014 and scored in the passing range.
5. A 'Fishery Improvement Project' section was added to the Hawaii Seafood Council website in Fall 2012 and updated in Fall 2014 to help local vendors meet Sam's Club's buying requirements.
The Sustainable Fisheries Partnership deemed the information to be 'not credible' in 2012 leading to conflict and confusion for the vendor. This was resolved in 2014 by engaging senior scientists in the assessments.
6. The fishery was rated red by the Seafood Watch program in 2007, 2009, and 2015, and as a good alternative in 2012.

Performance & Strategy

The performance of the fishery reducing the incidental capture and mortality of sharks, turtles, seabirds and marine mammals is communicated widely in scientific literature (numerous articles by Beverly, Chapman, and Gilman).
The Western and Central Pacific Fisheries Commission adopted several new conservation and management measures 2008-2012 based on the fishery's improvements.

The methodology used to assess Hawaii's fisheries against the FAO Code of Conduct for Responsible Fisheries was adopted by the Alaska Seafood Marketing Institute to launch a global seafood eco-label in 2011. The new programs challenged the Marine Stewardship Council program and Alaska salmon fisheries dropped out of the MSC program.

In 2012 the red rating for the fishery by the Seafood Watch program changed to yellow, coinciding with an announcement by Whole Foods to no longer sell any products rated red. The rating became red again in 2015.

Different perspectives on seafood sustainability were bridged in 2014 when the Hawaii Seafood Council published the materials demanded by NGOs to support their claim of responsible tuna fishing.

Improving fishing impacts on marine food webs

In 2012 the UK retailer ASDA commissioned a series on ecosystem based fisheries management in order to influence fisheries to shift in fisheries toward ecosystem-based management

Metrics of success: Number of fisheries that consider food webs in harvest planning

Context: Fishing impacts to marine food webs are largely unmanaged worldwide.

1. Several leading scientists participated in the research and peer review for the report. The scientists recommended more precautionary fisheries management that factors in ecosystem level effects.
2. ASDA published the series as recommendations for its supply chains to support.

Performance of fisheries to reduce fishing impacts to marine food webs was poor at the time of the review. Few fisheries had food web programming or policy in place despite the availability of scientific evidence on fishing impacts.

ASDA's strategy was to promote ecosystem fisheries management to help to redefine expectations for sustainable seafood around the conservation of ecosystem level targets. ASDA influences their vendors and producers who may influence fisheries managers, policy makers and NGOs and may inspire updated goals for sustainable seafood.

Sustainable Seafood Measure	Effects	Performance & Strategy
Estimating illegal fishing in US seafood imports Research 2012/13 sponsored by the World Wildlife Fund policy branch in Washington DC calculated estimates of the proportion of US seafood imports linked to illegal fishing. Metrics for success: Risk scores for illegal fishing by export countries; Percentage of seafood imports linked to illegal fishing Context: Unlike the European Union the United States lacks an import ban on illegally fished seafood. WWF is seeking new US legislation.	1. A methodology for estimating illegal and unreported fishing at the country level, published by David Agnew et al (2009), was revised for seafood products by this author; including a risk scoring method. 2. Quantitative and case study research and risk assessment over an 8 month period produced estimates of illegal fishing for the top 30 imports in 2011, being the top 3 products from the top 10 exporting countries to the US. Seafood researchers at World Wildlife Fund country offices worldwide reviewed the results. 3. Results were published in Marine Policy in April 2014. 4. The article was cited widely, e.g. in the Washington Post. 5. The article was cited 6 times in submissions to the Presidential Task Force on IUU Fishing and Seafood Fraud. 6. The article was downloaded 17,000 times by early 2015. 7. The article was cited in 2015 in a Washington Post article announcing a new federal traceability program for seafood imports, arising from the Presidential Task Force.	The results showed a lack of performance keeping illegally fished seafood out of the USA. Prior to publication the review within the World Wildlife Network generated controversy, according to the research sponsors, especially in countries where high levels of illegal fishing are associated with seafood exports like Russia, China and Indonesia. The Marine Policy article reached a wider audience of scientists, industry and policy makers. Research sponsors at the World Wildlife Fund used the research results in 2014/5 to lobby the US government for new legislation to ban seafood imports linked to illegal fishing.
Cleaning up seafood supply chains from human trafficking Risk assessment methods for screening working conditions in seafood supply chains were developed. Recommendations are given to reduce extreme risks of forced and trafficked labour. Humanity United provided the funds to develop the Labour Safe Screen. Metrics for success: High scores are reduced to protect producers. Context: Seafood companies and NGOs lack tools for due diligence.	1. The results include an at-sea calculator (algorithm) for risk of forced and trafficked labour, an online questionnaire for seafood companies to enter data, a research partnership with Thai organizations the Labour Rights Promotion Network and Nexus Institute, supply chain diagrams for fourteen major Thai seafood export products, and 104 interviews with workers on Thai fishing boats (mostly Burmese). 2. The US State Department downgraded Thailand's status to the bottom tier of its watch list for human trafficking in 2014. 3. The Guardian UK broke a story in June 2014 and triggered a large reaction in the global industry and other media (NPR, BBC, Bloomberg, Reuters, AP).	The lack of performance of seafood importers on the issue of forced and trafficked labour in their supply chains came to light with the attention to the Guardian story on slave labour in prawn production. A network of anti-trafficking experts and seafood industry executives in Thailand, Myanmar, Australia, Canada, the UK and the US came together to support the Labour Safe Screen.

These effects were considered against thirty indicators for the system wide assessment of the sustainability of seafood production (Micheli et al 2014; summarized in Table 1). The measures that most protect and improve ecosystem health, as one of the 30 indicators, are the sustainable shrimp metrics and best practices for conserving marine food web in fisheries. The sustainable shrimp metrics showed the most effect meeting thirteen indicators: management plan, harvest control, defined boundaries and access rights, presence of marine protected areas, compliance, native biodiversity, habitat integrity, food web integrity, resilience, stock abundance, interaction with endangered species, connectivity, and bycatch. The measure for minimizing fishing impacts to marine food webs linked scientific findings across the two disciplines of fisheries and marine ecosystem science. It met 16 of 30 indicators of system wide sustainability in seafood production namely leadership, governance structure and function, management plan, harvest control, user involvement mechanisms, presence of marine protected areas, compliance, diversification, native biodiversity, habitat integrity, food web integrity, resilience, stock abundance, interaction with endangered species, connectivity, and bycatch.

The industry-led measures for Mediterranean bluefin, British Columbia wild salmon and Hawaii tuna were essentially self-reported statements of responsible practice in response to overfishing controversies, with a goal to position the organization as a good actor in the market relative to the controversy by communicating a stance for protecting ecosystem health from fishing impacts. The measures on their own did not protect or improve ecosystem health but did address 12 of 30 indicators of system wide sustainability in seafood production namely leadership, enforcement of regulation, incentives, management plan, harvest control, user involvement mechanisms, defined boundaries and access rights, compliance, traceability, diversification, stock abundance, and bycatch.

The illegal fishing estimates showed there was a problem in the US market with 10-70% of imports attributable to illegal fishing (Pramod et al 2014). The measure produced a methodology for seafood product-level estimates where previously only country-level estimates had been published (Agnew et al 2009). The more granular results gave readers an association for the problem. The measure was intended by its sponsor the World Wildlife Fund to influence the US government and the results informed the US Presidential Task Force on Illegal, Unreported and Unregulated Fishing in 2014. The results met 22 of 30 indicators of system wide sustainability in seafood production namely leadership, legislation, enforcement of regulations, governance structure and function, incentives, harvest control, user involvement mechanisms, defined boundaries and access rights, equity, free labour, compliance, socioeconomic development, fair wages and benefits, occupational health and safety, fair conditions of employment, traceability, diversification, resilience, stock abundance, interaction with endangered species, connectivity, and bycatch.

The Labour Safe Screen measure for assessment of risk for forced and trafficked labour in seafood supply chains improves human dimensions of ecosystem health by linking worker voices directly to corporate decision makers. It presented a diagnostic tool to the market for an extreme issue that was an open secret in the seafood industry before 2014. The issue became very important after June 2014 after a story linked grocery store shrimp from Thailand to slavery (The Guardian 2014). The diagnostic tool addresses complete supply chains for fourteen Thai seafood products including fishing and trans-shipping at sea, ports, and all levels of processing before export. The results met 18 of 30 indicators of system wide sustainability in seafood production namely leadership, legislation, enforcement of regulation, incentives, user involvement mechanisms, defined boundaries and access rights, equity, free labour, compliance, socioeconomic development, education, fair wages and benefits, occupational health and safety, fair conditions of employment, traceability, diversification, resilience, and connectivity.

Together the measures had effects that spanned the breadth of system wide sustainability in seafood production with 28 of 30 indicators met overall. They did not contribute to indicators for water quality or use of chemicals, drugs or pesticides.

2.10 Evaluation results for seven sustainable seafood measures

The real world impacts arising from the seven measures are difficult to assess owing to the short time period and to the integration of effects with other measures for sustainable seafood taken in the same period by the same organizations.

Table 2.2 Evaluation Results

Did a measure result in:	Shrimp metrics	Bluefin catch controls	Bigeye bycatch controls	Salmon productivity	Conserving marine food webs	IUU fishing estimates	Screening for forced labour
Reduced overfishing?	Yes	Yes	Yes	Yes	No	No	No
Access to resources made more secure for business?	Yes	Yes	Yes	Yes	No	No	No
Compliance with scientific advice?	Yes	Yes	Yew	No	Yes	Yes	Yes
Self regulation by users?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Positive recognition in the market?	Yes	Negative recognition	Yes	Yes	No	Negative recognition	Negative recognition
Addressed NGO concerns?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
New and objective info to determine where change is needed?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Less risk of illegal fishing or forced labour?	No	Yes	No	No	No	Yes	Yes
Better oversight by authorities or independent parties?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
More accountability in seafood business for the impacts of sourcing?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The significance of the evaluation results and their relevance to sustainability theory is discussed in chapter four. Before that discussion, the next chapter presents an in-depth look at the metrics products from the measures. Six of seven measures produced new metrics that may be helpful to future voluntary measures for sustainable seafood.

3. Metrics for sustainable seafood in an era of overfishing

New metrics for progress toward sustainability resulted from six of the seven measures (the marine food webs research produced a benchmark but not metrics). The metrics were developed in context of ongoing debates over scientific and standards-based definitions of seafood sustainability. A debate over definitions occurred within the private sector as well for example between the Monterey Bay Aquarium, Sustainable Fisheries Partnership and the Hawaii Seafood Council over whose criteria are more credible.

As described in chapter one, metrics for sustainable seafood need to communicate compliance. Compliance is one of the most valuable attributes of a sustainability claim in a market (Wahl and Bull 2013). In a business context metrics need to communicate how a company is delivering outputs to people, how it is reducing business risks, and how it is building its competitive advantage in markets (GIIN 2013). Theoretically, in today's market a company can make their seafood product eligible for many retailers to buy if they can show progress improving fisheries. A seafood product is sustainable when it is shown to be compliant with the sustainability definitions of seafood retailers or where the product is sanctioned by conservation NGOs. As a result, any seafood company seeking credit from a measure for sustainable seafood will need to show progress—ideally against retailer and NGO criteria for maximum return. Metrics offer the most value to businesses when they can be used to show progress against published criteria and are measured by an independent agent like a third party auditor or a second party consultant (Cashore et al 2012; Vurro et al 2008). For example, Walmart states on their website that 90% of their supplies are in the MSC program or are from improving fisheries (Walmart 2014). Seafood vendors must show this standing for the fishery origins of the seafood they wish to sell to Walmart. A comparable product without the standing is ineligible for purchase.

Not surprisingly, the metrics from six of the measures were designed to show progress against a baseline. All derive from measures with a similar developmental process that started with problem definition around the available scientific evidence followed by breaking down complex overfishing issues into manageable parts to serve a business imperative for a seafood company or NGO. Each represents an attempt to integrate diverse perspectives on

sustainable seafood, including diverse viewpoints on scientific and standards methodologies. This combining has significance for sustainability theory and is discussed in chapter four.

Three approaches can be seen in the metrics, taken as a group, to solve overfishing as a business problem. The first is a tool kit approach for improving fisheries incrementally. The idea is to shift more production towards a sustainability target like a benchmark derived from a review of best practices in wild shrimp, wild salmon, or tuna fisheries worldwide. The second is a promotional approach for incentivizing sustainability as a value that organizations can add to production to gain a competitive advantage. The third is a verification approach for defining a problem at a point in time as a baseline to work up against, or in order to check the validity of a claim. Some metrics serve many approaches.

3.1 Tool kit metrics

Two of the measures took a pressing problem with no current solution and broke them down into testable factors and recommendations. The sustainable shrimp metrics and the Labour Safe Screen were developed at a time when the problem of concern was only very broadly defined. Although severe negative impacts were attributed to seafood, from trawl impacts to the sea floor and from forced and trafficked labour in Thailand, the problems had not yet been parameterized. Both measures developed parameter sets that could be tested empirically. This was the first step toward solving the problems with what might be called a tool kit approach to metrics. According to the FAO (2008) the sustainable shrimp metrics combined the biological metrics conventionally used in fisheries, like the rate of fishing mortality on shrimp from trawling, with indicators for ecosystem health that address the fishing impacts that most threaten sustainability. The metrics were set into a framework with scoring thresholds. The framework of the Marine Stewardship Council standard was used to give the metrics a value against a known standard.

This author designed 'tool kit metrics' in the study period to offer criteria in a recognizable manner to motivate investment in improvements toward a higher standard of care defined by a benchmark of best practices in a sector.

3.1.1 Sustainable shrimp metrics

Standard metrics are difficult to produce because management premises differ widely across fisheries and species around the globe. Wild shrimp status is related to indirect fishing attributes like the rate of removal of predators by trawls and to fluxes in environmental parameters like temperature and oxygen content of seawater. When efforts to reduce bycatch are successful and predation increases, target shrimp stocks may decrease, and paradoxically this may occur when the bycatch-to-catch ratio is reduced, because fishers are using mandatory bycatch reduction devices. These factors combine in complicated ways, for example wild shrimp stocks in the Gulf of Mexico may decrease over time due to increasing hypoxia coupled with reductions to juvenile red snapper bycatch from new rules for using the shrimp trawls (Nance 2006). Further, most wild shrimp is harvested in developing countries. A tool kit approach to sustainability metrics was a way to be accountable to the modalities and nuances across fisheries, including data limitations in developing countries.

The initial research included a wide survey to identify the fishing controls employed in ten major wild shrimp fisheries in warm water regions worldwide (Tables 3.1, 3.2 and 3.3). The survey involved a detailed review of the ten fisheries for the fishing rules, controls, and monitoring protocols that they employ to manage commercial fishing for wild shrimp.

Table 3.1: Catch controls in ten tropical shrimp fishing regions

	US Oregon	US South Atlantic	US Gulf of Mexico	Southern Australia	Western Australia	Indonesia	Northern Australia	Torres Strait	Mexico Gulf of California	Thailand
Limited entry	√	√	√	√	√	√	√	√	√	
Logbooks	√	√	√	√	√	√	√	√	√	
Gear restrictions	√	√	√	√	√		√	√	√	
Boat size restrictions				√	√			√		
Real time catch monitoring				√	√		√	√		
Standardized surveys	√	√	√	√	√		√	√		
Catch & effort data are centralized	√	√		√	√		√	√	√	
Catch limits/season				√	√		√			√
Effort cap			√				√	√		
Monitor prawn size	√						√	√	√	√
Undersize controls				√			√			
Permanent spatial closures or limits		√			√	√	√		√	
Closure: overfishing		√	√	√				√		
Closure: low biomass					√			√		
Closure: Inshore/sea grass closures				√	√		√		√	√
Closure: day/night				√	√		√			
Closure: seasonal	√	√	√	√	√	√	√	√	√	
Closure: environment		√			√		√			
Closure: reproductive	√		√	√	√		√	√	√	
VMS	√	√		√	√	√	√	√	√	

Record mortality all landed catch				√	√			√		
MCS	√	√		√	√		√	√	√	√

Table 3.2: Controls to reduce environmental impacts in ten tropical shrimp fishing regions

	US Oregon	US South Atlantic	US Gulf of Mexico	Southern Australia	Western Australia	Indonesia	Northern Australia	Torres Strait	Mexico Gulf of California	Thailand
Bycatch Management Plan	√	√	√	√	√		√	√		
Monitor protected species interactions	√	√		√	√		√			
Seabed monitoring							√	√		
Cap on discards										
Controls on bycatch sop	√		√		√		√	√		
Closures: bycatch spp		√	√	√	√		√	√	√	
TEDs compulsory	N/A	√	√	√	√	√	√	√	√	√
NMFS TED program	N/A	√	√	√	√		√	√	√	
BRDs compulsory	√	√	√	√	√		√	√		
Observers		√		√	√		√	√		
Fishery EIA		√	√	√	√		√	√		
Ecosystem monitoring				√	√		√	√		
Endangered spp rules	√	√	√	√	√		√	√	√	
Stakeholder participation	√	√	√	√	√	√	√		√	√

Table 3.3: Overfishing stock status in ten tropical shrimp fishing regions

Reported by fishery as:	Healthy	Fully Fished	Overfishing is occurring	Overfished	Overfished & Overfishing
US Oregon	Pink shrimp				
US South Atlantic	Brown, White, Pink & Rock shrimp				
US Gulf of Mexico	Brown, White, Pink & Rock shrimp				
Southern Australia		Western king prawn			
Western Australia		Western king prawn, Brown tiger prawn, Banana prawn, Endeavour prawn			
Indonesia					Endeavor prawn, Banana prawn, Tiger prawn, Rainbow prawn
Northern Australia	Grooved tiger prawn Brown tiger prawn Endeavour prawn	Banana prawn			
Torres Strait	Brown tiger prawn, Blue endeavor prawn (2007 actual)	Brown tiger prawn, Blue endeavor prawn (if full effort allocation were utilized)			
Mexico Gulf of California		Brown shrimp		Blue shrimp, White shrimp	
Thailand					Black tiger prawn & Penaeus spp

The survey results showed that it was typical but by no means universal for fisheries to set bycatch limits. Fewer fisheries made bycatch reduction devices compulsory however this was still common practice. Some fisheries were actively mitigating bycatch by enforcing limits on impacts to habitat and protected and endangered species. A few fisheries set catch

limits that were intentionally calculated to protect juvenile finfish and other at-risk sizes, age classes or species and this level of care constituted best practice in the results.
The findings helped with the development of an overall profile of best practice and a set of parameters for comparing fishery outcomes, like stock status and bycatch reduction. Bycatch reduction was clearly the top priority worldwide so a scale metric was added to compare a fishery's progress to best practice (Figure 3.1). Fisheries' priorities were structured into a checklist for sustainability structured around the problem areas identified by the FAO in 2008, being discards, impacts to juvenile food fish and to the sea bottom (Table 3.4).

Figure 3.1 Progress versus performance in tropical shrimp fisheries

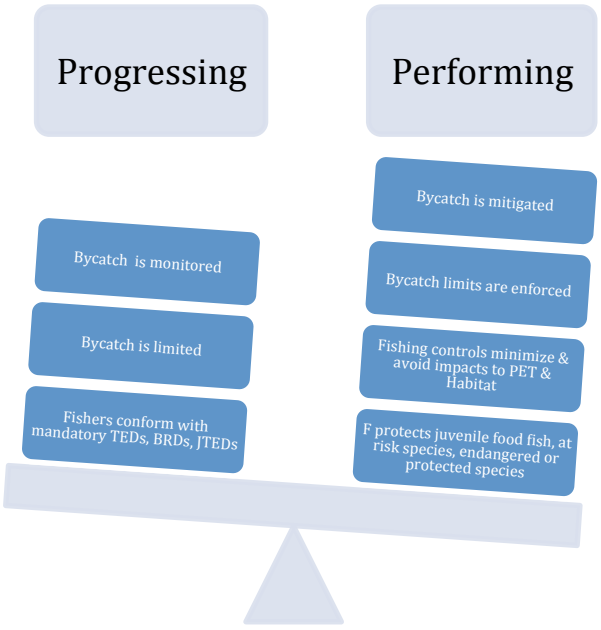


Table 3.4: Sustainability survey for tropical shrimp trawl fisheries

Sustainability Questions	**Indicators of Current Performance**
1. Is the management strategy precautionary?	*Target* 1. There a clear set of management strategies in which: a) a precautionary biological limit reference point is defined with a clear action (overfished) (B_{lim}, $B_{20\%}$ or an equivalent proxy) b) a precautionary overfishing fishing mortality reference point is defined (for a stock below the biological target reference) with clear actions (overfishing) ($F_{lim} \leq F_{msy}$) green should be Fcur<Fmsy, red should be Flim>Fmsy c) a biological target reference point is defined and is precautionary (i.e. Btrp≥Bmsy) d) stock status is regularly assessed through a stock assessment or indicator, e) a sound estimate is available of the potential productivity of the fished stock(s) and proportion that can be harvested, and if not, management strategies are in place that compensate for this higher level of risk[7], f) a management tool is in place e.g. an effort cap, TAE or TACs g) a clearly defined monitoring program (preferably through an independent monitoring program) of size, catch, effort and biomass status (either spawning, recruitment or both) is established h) All sources of fishing mortality on the stock are considered and monitored e.g. recreational, subsistence. 2. The fishery is managed to minimize capture of juvenile shrimp/small prawns through the use of a limit reference point and/or through spatial/temporal closures. *Bycatch* 1. There is a clear bycatch plan that mandates: a) the use of TEDs and BRDs as a minimum, b) an observer program, c) a validated monitoring program that monitors bycatch composition (key species, PETs, at risk species) d) an action plan to avoid TEPs, reduce bycatch and remove impacts on at risk species e) there is a formal BRD innovation program *Benthic impact* 1. The benthic impacts are known and not shown to place benthic species at risk, or a process is in place to mitigate that risk. a). There are defined indicators of benthic impact or some proxy or evidence that present management strategies greatly reduce this impact. b). The spatial extent of the fishery monitored with e.g. VMS? c. There are benthic impact mitigation systems or harvest strategies in place. *Ecosystem* 1. There are programs or info sources in place to assess the changes of the key species or predators e.g. non target species monitoring program or risk assessment. 2. There are ecosystem models developed to assess potential ecosystem impacts on key species.

Sustainability Questions	**Indicators of Current Performance**
2. Do managers follow scientific advice?	*Target* 1. Managers set catch or effort levels in accordance with scientific advice e.g. a) $TAC_{set} \leq TAC_{advised}$ or $TAE_{set} \leq TAE_{advised}$? b) observer or monitoring programs are implemented at scale recommended by scientists, c) recommend spatial and temporal closures as identified by scientists d) an enforcement plan is implemented 2. Managers monitor and enforce their management plan e.g. a) catch or effort monitoring, b) observer programs, c) at sea or port inspections d) vessel at sea monitoring e.g. VMS *Bycatch* Managers legislate or resource in accordance with scientific advice e.g. a) bycatch observer or bycatch monitoring programs are implemented at scale recommended by scientists, b) recommended spatial and temporal closures as identified by scientists are implemented, c) a bycatch enforcement plan is implemented especially targeting effective use of TEDs and BRDs. *Ecosystem* 1) Managers legislate or resource in accordance with scientific advice e.g. implement habitat closures or protection mechanisms as recommended by scientists.
3. Do fishers comply with managers' decisions?	1. Fishers have a code of conduct or co-management rules that includes management of at-sea rubbish and responsible fishing practices. *Target* 1. Fishers catch at levels in accordance with management advice e.g. a) $C_{actual} \leq TAC_{set}$ or $E_{actual} \leq TAE_{set}$ b) Effort or gear caps or restrictions are adhered to *Bycatch* 1. Fishers conform with TED, BRD, JTED restrictions and keep this gear performing 2. Fishers can not avoid spatial and/or temporal closures *Benthic* 1. Fishers do not trawl on sensitive ground (e.g. coral reefs by changing their gear to "clean" new space)

Sustainability Questions	**Indicators of Current Performance**
4. Is the resource healthy or species not at risk?	*Target* *i. The stock is healthy* 1. The stock is at or above the biological target reference point i.e. $B_{cur} \geq B_{trp}$ OR *ii. The species is NOT OVERFISHED AND on a recovery pathway* 1. The stock is not overfished i.e. Bcur $\geq B_{lrp}$ and 2. Overfishing is not occurring i.e. $F_{cur} \leq F_{lrp}$, *Bycatch* 1. A formal risk assessment or similar approach shows that less than 1% of the species caught are a risk or bycatch targets are formally in place, or mitigation processes are in place for at risk species 2. Observer coverage is 10% or an independent monitoring program combined with an at sea compliance program is in place. *Benthic* 1. Seabed is monitored (through simulation and remote data such as VMS or directly) for the environmental impact or relationships between fish down and recovery given an amount of effort per area per year is known mostly at species level
5. Will the fish stock be healthy in the future?	*Target* 1. If overfishing is occurring, clear management action(s) are in place to reduce overfishing 2. If the fishery is below the biological reference point (ie. $B_{cur} < B_{trp}$), a clear recovery plan is in place and being implemented (i.e. $F_{cur+1} < F_{trp}$) *Bycatch* 1. Current F does not threaten juvenile food fish, at risk species, endangered or protected species *Benthic* 1. If species are at risk, a management strategy and monitoring program is in place to address species at risk and PETs.

The intent of the survey was to offer a tool for self-assessment that would be recognizable and useful to shrimp fishery managers worldwide. The checklist was peer reviewed by Doctors Reg Watson, Steven Eayrs and James Nance. A scoring grid was produced from the research results (Table 3.5). The scoring grid aligned the metrics for sustainable shrimp with the 60%, 80% and 100% score posts in the Marine Stewardship Council (MSC) standard.

Table 3.5: Sustainable shrimp scoring grid for tropical shrimp trawl fisheries

Assessment Questions	Evidence, Indicator & Score	Reference Indicators in the MSC Scoring Tree
Minimum threshold for assessing sustainability: Is the shrimp stock not overfished? AND Is there evidence of bycatch reduction and monitoring?	No – Fishery cannot claim sustainability at this time; assessment cannot proceed. Yes – Score 60% and proceed to assess the fishery against the pass marks (80% score posts) and best practices (100% score posts). For fisheries that score between 80 and 100 on this grid, proceeding to assess the fishery against Grid 1 can assess the gap to 100.	MSC Bycatch Information/Monitoring (2.2.3) 60-Info on main bycatch spp available 80-Qual. & some quant. info available 100-accurate & verifiable info available
80% Indicator (i) Is the management strategy precautionary?	PASS threshold where fishery shows measurable progress: Target - Overfishing Status: If a fishing mortality reference point is defined: $F_{lim} \leq F_{msy}$ (when the stock levels are at or above Bmsy, Fmsy will be the default level for Flim) - Stock Target: If a biological target reference point is defined: Btrp <Bmsy - Biomass conservation: If a biological limit reference point is defined: B_{lim}, $B_{20\%}$ or equivalent proxy - Juvenile/Small Prawn Catch: If the fishery is managed with limit reference points and/or spatial/temporal closures Bycatch - Monitoring: If Bycatch Monitoring is formalized, assess evidence of each of: a) bycatch management plan, b) systematic bycatch monitoring, c) fishery ecological assessment, d) environmental impact statement is current	MSC Reference Points (1.1.2) 80 score- Target reference point maintains stock at level of Bmsy or surrogate and for low trophic level species takes account stock's ecological role

Questions	Evidence, Indicator & Score	Reference Indicators in MSC Scoring
80% Indicator (ii) Do managers follow scientific advice?	PASS threshold where fishery shows measurable progress: Target - Catch & Effort Limits: If catch & effort limits are set in agreement with scientific advice Bycatch - Limits: If bycatch is limited with: a) mandatory TEDs, b) mandatory/widespread use of BRDs and JTEDs	MSC Harvest control rules & tools (1.2.2) 80-Well defined HCR in place that take account uncertainty and evidenced to be effective at reducing overexploitation MSC Bycatch Outcome Status (2.2.1) 80-Main bycatch species highly likely to within biologically based limits or have mitigation measures for recovery
80% Indicator: (iii) Do fishers comply with managers' decisions?	PASS threshold where fishery shows measurable progress: Target - Caps & Restrictions: If catch, effort & gear caps or restrictions are in place Bycatch - Fishers' Compliance: If fishers conform with TED, BRD, JTED, and other bycatch-reducing trawl modifications and restrictions	MSC Harvest control rules & tools (1.2.2) 80-Well defined HCR in place that take account uncertainty and evidenced to be effective at reducing overexploitation MSC Compliance & enforcement (3.2.3) 80- A monitoring, control and surveillance system has been implemented; Sanctions to deal with non-compliance exist; Some evidence exists to demonstrate fishers comply with the management system; no evidence of systematic non-compliance
80% Indicator: (iv) Is the resource healthy and species not at risk?	PASS threshold where fishery shows measurable progress: Target - Overfished Status: If stock is not overfished Bcur < B_{lrp}, Bcur = B_{lrp} and Bcur > B_{lrp}) - Overfishing: If overfishing is not occurring $F_{cur} < F_{lrp}$, $F_{cur} = F_{lrp}$, and $F_{cur} \leq F_{lrp}$ - Biomass Status: If stock is above the biological target reference point $B_{cur} < B_{trp}$, $B_{cur} = B_{trp}$ and $B_{cur} \geq B_{trp}$ Bycatch, Benthic & Ecosystem - Species at Risk: If evidence is available of action on species risks: a) as identified in fishery bycatch, b) catch restrictions placed on known species-at-risk c) from biological opinion or other formal investigations are made into suspected species risks	MSC Stock Status (1.1.1) 80-Highly likely that stock above point recruitment impaired; fluctuating near reference point MSC Bycatch Outcome Status (2.2.1) 80-Main bycatch species highly likely to within biologically based limits or have mitigation measures for recovery MSC Bycatch Information/Monitoring (2.2.3) 80-Qual.& some quant. info available on main bycatch species affected by fishery & sufficient to estimate outcome status with respect to biologically based limits; adequate to support a partial strategy to manage main bycatch species Protected, Endangered and Threatened (PET) Species Management Strategy (2.3.2) 80-Strategy in place for managing fishery's impact on PET species including measures to minimize mortality and designed to achieve national or international requirements for PET protection to high likelihood (objective basis for confidence + evidence strategy is being implemented successfully)

Questions	Evidence, Indicator & Score	Reference Indicators in MSC Scoring
80% Indicator: (v) Will the fish stock be healthy in the future?	PASS threshold where fishery shows measurable progress: Target through Ecosystem - Fishery-dependent Monitoring: If fishery performance and environmental impacts are monitored - Fishery-independent Monitoring: If monitoring is active for stock abundance, biodiversity and habitat - Long-term Planning: If explicit objectives for ecosystem-based management are defined for this fishery	MSC Retained Species Information/Monitoring 2.1.3 80-Qual. & some quant. info available and sufficient to estimate outcome status with respect to biologically based limits and supporting a partial strategy to manage main species MSC Bycatch Information/Monitoring (2.2.3) 80-Qual.& some quant. info available on main bycatch species affected by fishery & sufficient to estimate outcome status with respect to biologically based limits; adequate to support a partial strategy to manage main bycatch species MSC Fishery Specific Objectives (3.2.1) 80-Short and long term objectives consistent with MSC principles 1 & 2 are explicit in fishery management plan
100% Indicator: (i) Is the management strategy precautionary?	BEST PRACTICE performance: **Bycatch** - Reduction Planning: If each of the following is in place in the fishery: a) the use of TEDs and BRDs as a minimum, b) an observer program, c) a validated monitoring program that monitors bycatch composition (key species, PETs, at risk species) d) an action plan to avoid PETs, reduce bycatch and remove impacts on at risk species e) a formal BRD innovation program **Benthic**- Mitigation of Benthic Impact: If benthic impacts known and avoided or mitigated by the fishery and indicators of benthic impact are defined **Ecosystem-** Mitigation of Ecosystem Impact: If each of the following is in place: a) ecosystem impacts are documented for the fishery, b) indicators of ecosystem impact are defined, c) programs or information sources are in place to assess changes of key species or predators, d) ecosystem modeling finds potential impacts on key species - Spatial Impact: If the fishery's spatial impacts are known	MSC Bycatch Management Strategy (2.2.2) 100-Strategy in place to manage & minimize bycatch and is based on fishery-level information with clear evidence of successful implementation, of intended changes occurring and with high confidence as supported by testing MSCBycatch Information/monitoring (2.2.3) 100-Accurate & verifiable info available on amount of all bycatch and consequences for affected populations, and sufficient to quantitatively estimate outcome status re. biologically based limits with high degree certainty, also to support comprehensive strategy to manage bycatch and evaluate whether strategy achieving its objectives. Monitoring sufficiently detailed to assess ongoing mortalities to all bycatch species. MSC Ecosystem Outcome Status (2.5.1) 100-Evidence fishery is highly unlikely to disrupt key elements underlying ecosystem structure & function to point of serious or irreversible harm MSC Habitat Outcome Status (2.4.1) 100-There is evidence the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm

Questions	Evidence, Indicator & Score	Reference Indicators in MSC Scoring
100% Indicator: (ii) Do managers follow scientific advice?	BEST PRACTICE performance: Target - Stock Enforcement: If there is evidence of enforcement of precautionary management of the target stock with: a) catch monitoring, b) effort monitoring, c) observer programs, d) at sea or port inspections e) vessel at sea monitoring e.g. VMS Bycatch - Enforcement: If there is evidence of enforcement of precautionary management of the bycatch with: a) bycatch observer or monitoring programs at scale recommended by scientists b) spatial and temporal or habitat closures identified by scientists, c) targeted and innovative use of TEDs and BRDs as shown effective by research	MSC Harvest Strategy (1.2.1) 100-The harvest strategy is responsive to the state of the stock and is designed to achieve the objectives of the target and limit reference points. Its performance has been fully evaluated and evidence shows objectives are being achieved including clear ability to maintain stocks at target levels. Strategy is periodically reviewed and improved as necessary. MSC Compliance & Enforcement (3.2.3) 100- comprehensive monitoring, control and surveillance system has been implemented.
100% Indicator: (iii) Do fishers comply with managers' decisions?	BEST PRACTICE performance: Bycatch, Benthic & Ecosystem - Sensitive Habitat and Protected, Endangered or Threatened Species: If fishing controls require fishers to avoid or minimize interactions causing adverse environmental impacts.	MSC PET Species Outcome Status (2.3.1) High degree certainty that effects of confidence that there are no significant detrimental effects (direct or indirect) of the fishery on PET species MSC Compliance & Enforcement (3.2.3) 100- A comprehensive monitoring, control and surveillance system has been implemented.
100% Indicator: (iv) Is the resource healthy or species not at risk?	BEST PRACTICE performance: Target - Monitoring Stock- If abundance trends with environmental conditions - Monitoring Catch Trends: If an observer program is active on trawl vessels Bycatch, Benthic, Ecosystem - Monitoring Trends in Incidental Impact: If impact monitoring is active for: a) sea-bed, b) discards, c) bycatch mortality	MSC Retained Species Outcome Status (2.1.1) 100- There is a high degree of certainty that main retained species are within biologically based limits. MSC Bycatch Outcome Status (2.2.1) 100-There is a high degree of certainty that bycatch species are within biologically based limits. MSC Ecosystem Outcome Status (2.5.1) 100-Evidence fishery is highly unlikely to disrupt key elements underlying ecosystem structure & function to point of serious or irreversible harm MSC Habitat Outcome Status (2.4.1) 100-There is evidence the fishery is highly unlikely to reduce habitat structure and function to a point of irreversible harm

Questions	Evidence, Indicator & Score	Reference Indicators in MSC Scoring
100% Indicator: (v) Will the fish stock be healthy in the future?	BEST PRACTICE performance: Target - Recovery Efforts: If stock rebuilding efforts are toward $F_{cur+1} < F_{trp}$ Bycatch - Non-Target Species Risks: If current catch limit protects juvenile food fish, at risk species, endangered or protected species	MSC Retained Species Outcome Status (2.1.1.) 100- There is a high degree of certainty that main retained species are within biologically based limits. MSC Bycatch Outcome Status (2.2.1) 100-There is a high degree of certainty that bycatch species are within biologically based limits.

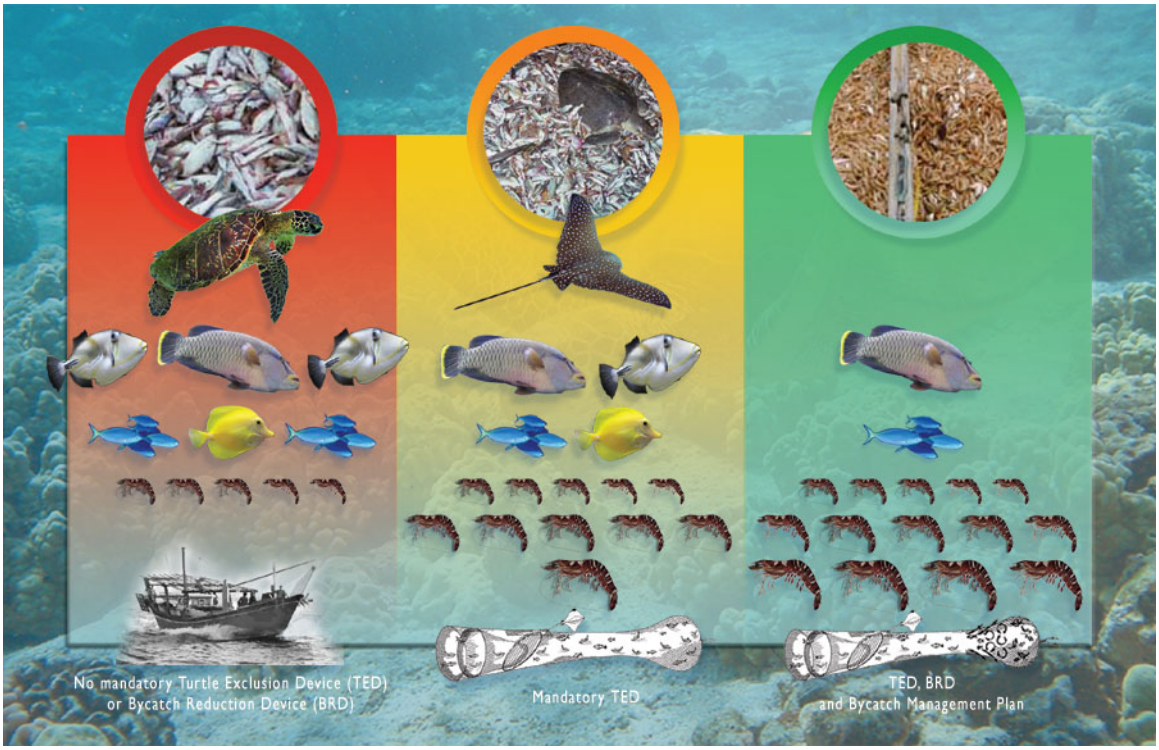
The scoring grid's purpose is to offer a tool to organizations trying to take a stepwise approach to improving a fishery to meet the MSC standard over time. A fishery can be assessed with the scoring grid to see gaps to passing scores. Closing gaps is a strategy to bring a fishery closer to certification. As described in chapter one, this strategy is accepted by many as a legitimate pathway to seafood sustainability, with over forty major seafood retailers and suppliers worldwide having a specification in their buying policies to buy seafood from 'improving fisheries'. The ten fisheries in the survey were scored to produce a picture of 'sustainable shrimp' for the private sector in 2008 (Table 3.6).

Table 3.6: Sustainability indicators in ten tropical shrimp trawl fisheries

Score post and indicators	US Oregon	US South Atlantic	US Gulf of Mexico	Southern Australia	Western Australia	Indonesia	Northern Australia	Torres Strait	Mexico Gulf of California	Thailand
60% -not overfished+ overfishing? -bycatch reduction?	√ √	√ √	√ √	√ √	√ √	X √	√ √	√ √	√ √	X X
i. 80% - target - bycatch	X √	X √	X √	√ √	√ √	X X	√ √	√ √	X √	X X
ii. 80% - target - bycatch	√ √	√ √	√ √	√ √	√ √	X √	√ √	√ √	X √	X √
iii. 80% - target - bycatch	√ √	X √	√ √	√ √	√ √	X X	√ √?	√ √	X √?	X √?
iv. 80% - target - bycatch, benthic, ecosystem	√ √	√ X	√ √	√ √	√ √	X X	√ √	√ √	X X	X X
v. 80% - target	√	√	√	√	√	X	√	√	X	X
i. 100% - bycatch - benthic - ecosystem	X √ X	X X X	X X X	√ √ √	√ √ √	X X X	√ √ √	X X √	X X X	X X X
ii. 100% - target - bycatch	√ √	√ X	X X	√ √	√ √	X X	√ √	√ √	X √	X X
iii. 100% - bycatch, benthic & ecosystem	√	√	√	√	√	√	√	X	√	X
iv. 100% - target - bycatch, benthic & ecosystem	√ √ (without seabed)	√ X	X X	√ √ (without seabed)	√ √ (without seabed)	X X	√ √	√ √	X X	X X
v. 100% - target - bycatch	X X	X X	X √	√ √	√ √	X X	√ √	√ X	√ X	X X

A graphic can communicate the attributes of a sustainable shrimp harvest to a broad audience (Figure 3.2).

Figure 3.2 A sustainable harvest of wild shrimp



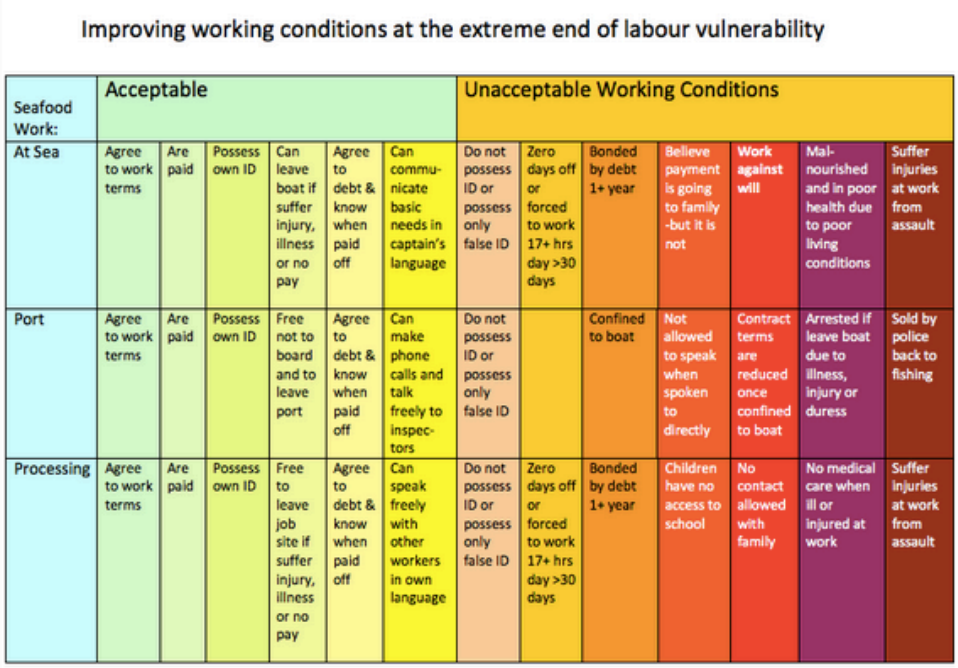
3.1.2 Labour Safe Screen metrics

The Labour Safe Screen produces risk scores for forced and trafficked labour in seafood production. It is a diagnostic tool comprised of an algorithm and online questionnaire. The results provide a risk reading for a particular seafood product. A group of products or a geographic area can be screened to produce a measure of the problem for seafood supplies and source areas of interest to the user. The user may be a seafood company, NGO, or a government agency. This author is the founder of the Labour Safe Screen. The intent was to share risk scores and recommendations with the seafood industry to use to eliminate forced and trafficked labour in seafood supply chains. The Labour Safe Screen can also be used to confirm where risks are low. The results help seafood importers to screen import products for high business risks and the results help them to talk to their suppliers about the

problem and what to do. For any product of interest the risks of forced and trafficked labour are screened along the entire chain of custody from fishing vessels, trans-shipping at sea, and ports through primary, secondary and tertiary processing to export to US or UK markets.

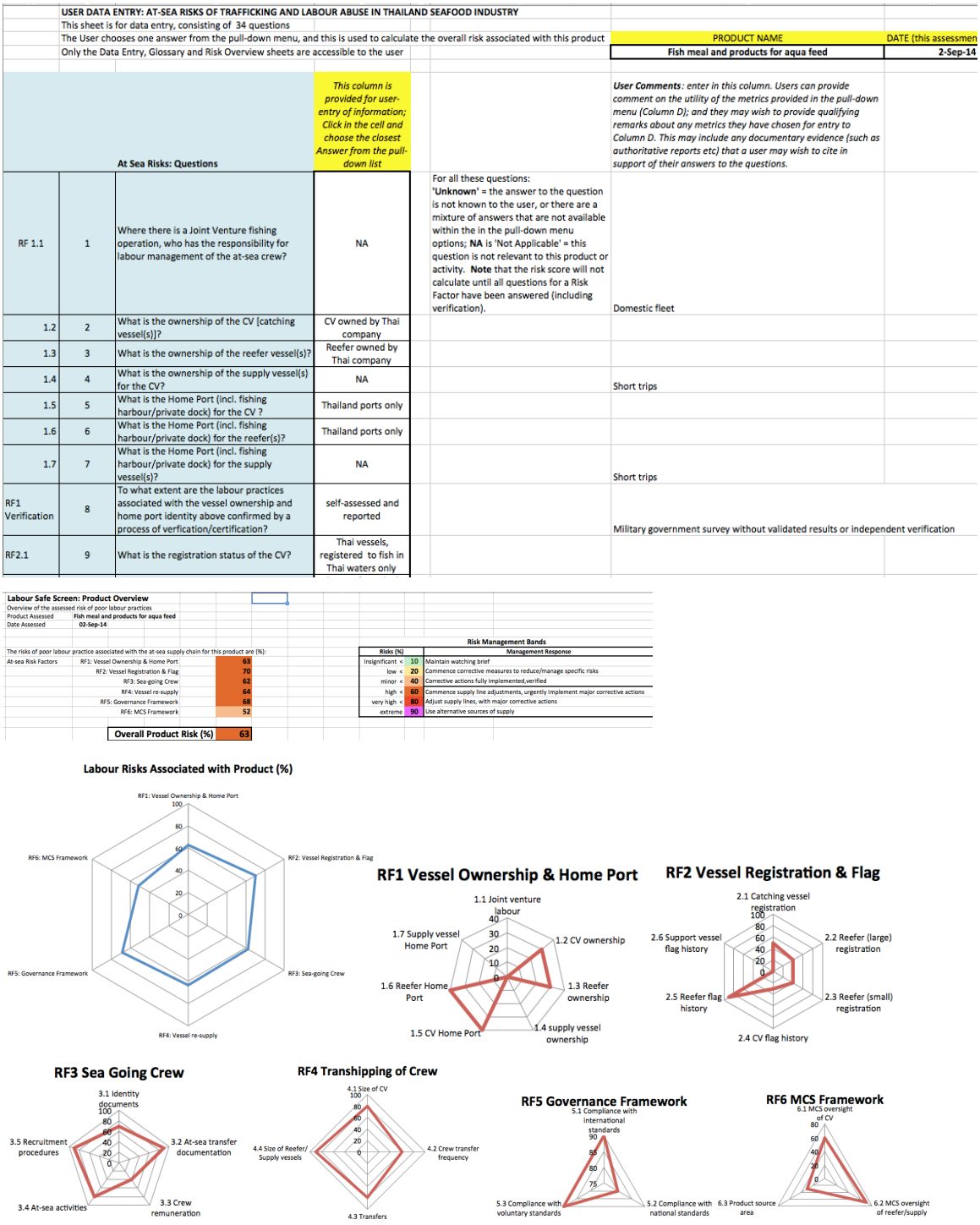
Before the algorithm was developed it was necessary to define the terms and units of the forced and trafficked labour problem in seafood. Seafood harvesting is hard work. Many people hear 'slavery' associated with fishing and mistakenly think that means long hours in rough conditions at sea. The first metric in support of the Labour Safe Screen was a classification of seafood working conditions against the UN Indicators for Human Trafficking (UN 2011). The classification helps to define and separate working conditions meeting the characteristics of high risk for forced and trafficked labour in seafood supply chains. Whenever labour is provided freely and voluntarily by a worker then the working conditions do not meet the test of forced and trafficked labour in this classification. Indentured work is an unacceptable working condition universally, however because it is widespread and not illegal in many fishing contexts it does not on its own meet the definition of forced and trafficked labour in the Labour Safe Screen. The working conditions are defined as forced or trafficked when an indentured worker does not possess their personal identification because the employer has confiscated it or provided a false one, lacks a contract or specific knowledge of how and when their debt will be satisfied, or when they do not have freedom to communicate or are constrained in the workplace for undue periods (Figure 3.3).

Figure 3.3 UN indicators of human trafficking adjusted to seafood



Behind the Labour Safe Screen is an algorithm with six risk factors. Each risk factor has a set of parameters with a weight attached such that a score can be assigned for each parameter. The scores are weighted according to the reliability of the information provided. A verification weighting of 50% is applied to each score, meaning each score is halved unless supporting evidence is available and has been verified. There is no penalty in scoring if some information is missing however this limits the accuracy of the results. The individual scores can be aggregated together to produce a risk factor score. Each risk factor represents a node in the supply chain. If high risks are found, they are pinpointed at that node in the seafood supply chain (Figure 3.4).

Figure 3.4 Labour Safe Screen Algorithm and Scores



		USER DATA ENTRY: AT-SEA RISKS OF TRAFFICKING AND LABOUR ABUSE IN THAILAND SEAFOOD INDUSTRY				
		This sheet is for data entry, consisting of 34 questions				
		The User chooses one answer from the pull-down menu, and this is used to calculate the overall risk associated with this product			PRODUCT NAME	DATE (this assessmen
		Only the Data Entry, Glossary and Risk Overview sheets are accessible to the user			Fish meal and products for aqua feed	2-Sep-14
		At Sea Risks: Questions	*This column is provided for user-entry of information; Click in the cell and choose the closest Answer from the pull-down list*		***User Comments**: enter in this column. Users can provide comment on the utility of the metrics provided in the pull-down menu (Column D); and they may wish to provide qualifying remarks about any metrics they have chosen for entry to Column D. This may include any documentary evidence (such as authoritative reports etc) that a user may wish to cite in support of their answers to the questions.*	
RF 1.1	1	Where there is a Joint Venture fishing operation, who has the responsibility for labour management of the at-sea crew?	NA	For all these questions: **'Unknown'** = the answer to the question is not known to the user, or there are a mixture of answers that are not available within the in the pull-down menu options; **NA** is 'Not Applicable' = this question is not relevant to this product or activity. **Note** that the risk score will not calculate until all questions for a Risk Factor have been answered (including verification).		
1.2	2	What is the ownership of the CV [catching vessel(s)]?	CV owned by Thai company		Domestic fleet	
1.3	3	What is the ownership of the reefer vessel(s)?	Reefer owned by Thai company			
1.4	4	What is the ownership of the supply vessel(s) for the CV?	NA		Short trips	
1.5	5	What is the Home Port (incl. fishing harbour/private dock) for the CV ?	Thailand ports only			
1.6	6	What is the Home Port (incl. fishing harbour/private dock) for the reefer(s)?	Thailand ports only			
1.7	7	What is the Home Port (incl. fishing harbour/private dock) for the supply vessel(s)?	NA		Short trips	
RF1 Verification	8	To what extent are the labour practices associated with the vessel ownership and home port identity above confirmed by a process of verfication/certification?	self-assessed and reported		Military government survey without validated results or independent verification	
RF2.1	9	What is the registration status of the CV?	Thai vessels, registered to fish in Thai waters only			

Labour Safe Screen: Product Overview

Overview of the assessed risk of poor labour practices

Product Assessed	Fish meal and products for aqua feed
Date Assessed	02-Sep-14

The risks of poor labour practice associated with the at-sea supply chain for this product are (%):

At-sea Risk Factors	
RF1: Vessel Ownership & Home Port	63
RF2: Vessel Registration & Flag	70
RF3: Sea-going Crew	62
RF4: Vessel re-supply	64
RF5: Governance Framework	68
RF6: MCS Framework	52
Overall Product Risk (%)	**63**

Risk Management Bands

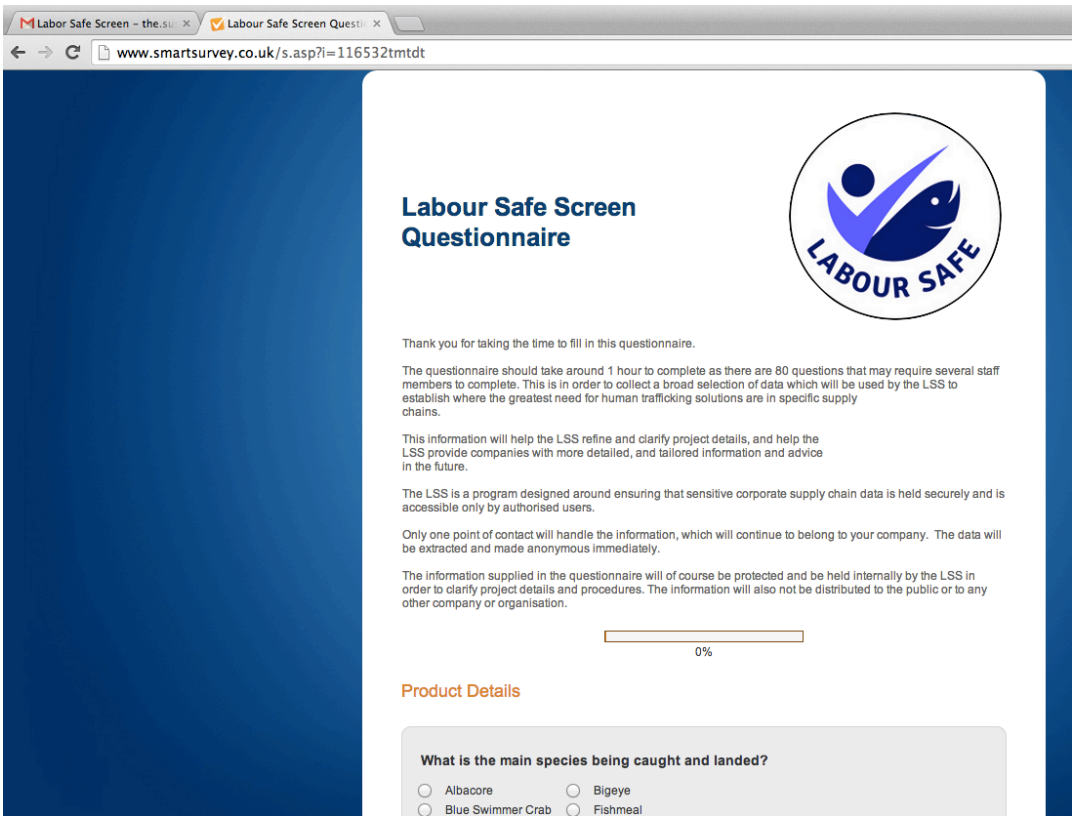
Risks (%)		Management Response
Insignificant <	10	Maintain watching brief
low <	20	Commence corrective measures to reduce/manage specific risks
minor <	40	Corrective actions fully implemented,verified
high <	60	Commence supply line adjustments, urgently implement major corrective actions
very high <	80	Adjust supply lines, with major corrective actions
extreme	90	Use alternative sources of supply

If the user is a seafood importer and they use the risk scores and recommendations to engage their key suppliers in corrective actions, then they may re-run the screen periodically

to test for progress. In this way the risk scores function as 'tool box metrics' that may be helpful to the user to show due diligence on the issue.

The Labour Safe Screen algorithm was designed to be flexible and scalable to user needs. At time of writing, risk scores and recommendations are available for fourteen major Thai seafood export products. If a broad picture of risks is wanted, general risk results can be generated for the products of interest to the user based on available published evidence. However, if the user needs accurate results because they seek to make major sourcing decisions or changes in their own supply chain, they can contribute additional information about supply origins to the screen through an online questionnaire (Figure 3.5). The additional information is combined with the available evidence to produce a more granular picture of risk that is specific to the users' seafood products.

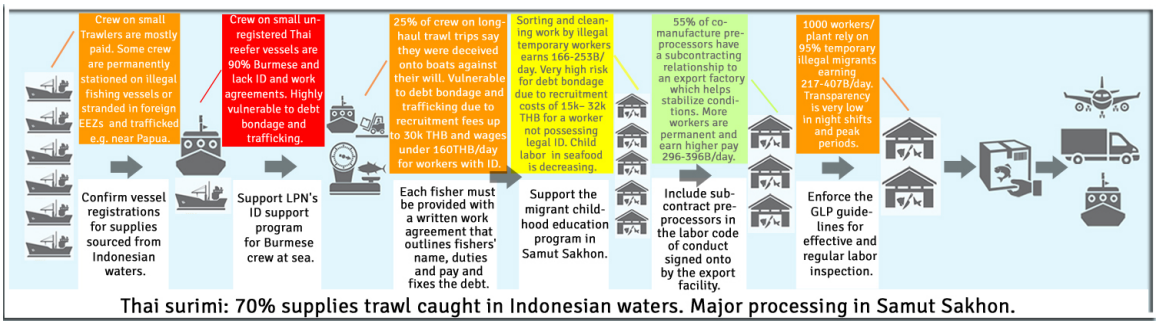
Figure 3.5: Online Labour Safe Screen questionnaire



If any high risks are identified, recommendations for corrective actions are provided to the user. The recommendations were written by this author and come from research into the flow of seafood through the risk hot spot together with advice from anti-trafficking organizations like the International Labour Organization of the United Nations and anti-trafficking experts at the Nexus Institute and Labour Rights Promotion Network. They provide peer review of findings and recommendations.

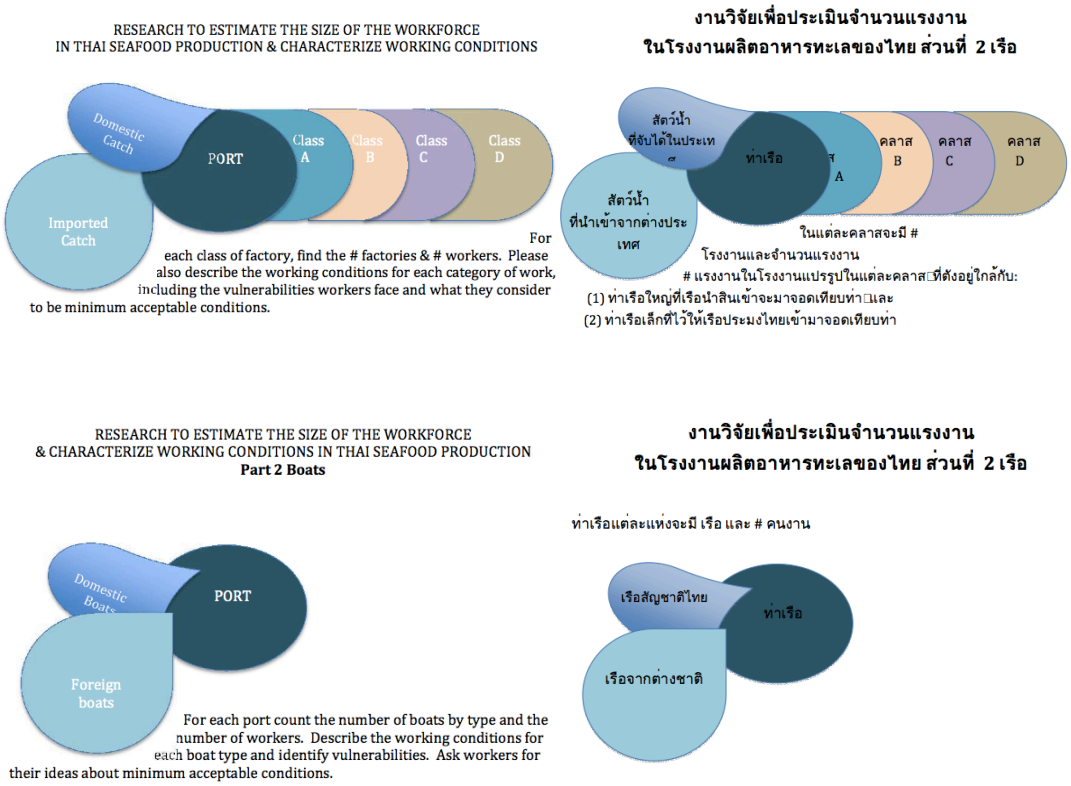
The Labour Safe Screen presents a graphic of a supply chain to communicate the results. Any hotspots found for high risks of forced and trafficked labour anywhere in the supply chain are shown on the graphic in red at the relevant node in the chain, for example for trans-shipping at sea or at the port. This is a visual metric that is meant to communicate results to a non-technical audience. For example, the risks of forced and trafficked labour for surimi are shown along the supply chain for Thai surimi (Figure 3.6).

Figure 3.6 Risks for forced and trafficked labour in Thai surimi exports



During the pilot phase of the Labour Safe Screen it became clear that the highest risk places in Thai seafood supply chains were long distance trawl and purse seine trips, places of supply transfers at sea, and primary processing around ports. A new port-based methodology was added to the Labour Safe Screen to track the flow of workers. For each port, the fishing boats were classified by the gear type, product type, and category of work. This also provided a new framework for qualitative data. 104 workers were interviewed in the process of counting workers in and out of Thai ports in Summer 2014.

Figure 3.7 Counting workers in and out of Thai ports



Although tested in Thailand, all Labour Safe Screen metrics can be used worldwide.

High-risk scores are presented together with recommendations for what the company can do to solve the problem. In most cases the advice is to improve oversight at the affected node in the supply chain. The user is advised to have their suppliers provide missing information to document the transfers of seafood through the node and to reveal who is in charge of working conditions at that place in the supply chain. In this way the Labour Safe Screen offers the user information and guidance to hold their suppliers accountable for working conditions across the entire supply chain. This level of accountability was not available to retailers and importers in the US and UK seafood before the Labour Safe Screen. No other program seeking to eliminate forced and trafficked labour from seafood production engages the full supply chain or the seafood businesses at the front-end of supply chains at sea and in developing countries in a solution. The 'tool kit metrics' built into the screen can be inserted into existing standards, traceability and seafood sourcing programs.

3.2 Verification metrics

Two measures addressed ongoing controversies about overfishing associations for so-called sustainable seafood. 'Verification metrics' were developed by this author to break the problems down into verifiable factors at a point in time. For British Columbia salmon the problem was divided opinion over implementation of Canada's Wild Salmon Policy and whether Marine Stewardship Council certification for wild salmon fisheries would motivate or demotivate the implementation of major management changes. For another controversy, the problem was whether the United States had become a destination market for illegally fished seafood after the European Union banned imports of seafood linked to illegal, unreported and unregulated (IUU) fishing in 2010.

When it became clear that Canada's Wild Salmon Policy was unlikely to be implemented within the first five-year term of Marine Stewardship Council (MSC) certification for BC sockeye, 2010-15, this author completed a rapid appraisal of the status of all stocks of wild salmon in the MSC program. Most Pacific wild salmon was in the MSC program at that time. The status of BC sockeye at the time of certification raised doubts about the status of other salmon populations in the program. The purpose of the rapid appraisal was to check to see if each population was healthy now and/or likely to become healthy in the future. This author performed the appraisal using information from MSC certification reports in 2012/13.

An article in the journal Nature in 2013 drew the attention of the US seafood industry to the problem of unknowingly importing seafood that was fished illegally. The article documented under-reporting of large catches of fish from West Africa via China to the US (Pala 2013). It raised questions about the amount of seafood imported to the USA that might derive from illegal fishing (Greenpeace 2013; World Wildlife Fund 2013). High proportions of US seafood imports were suspected to have origins in illegal fishing but nobody had yet done the analysis. The World Wildlife Fund hired this author with Dr. Pramod Ganapathiraju to estimate the proportion of US seafood imports linked to illegal and unreported fishing worldwide.

3.2.1 Status of Pacific salmon stocks

The appraisal utilized assessment results from the certification reports published on the Marine Stewardship Council website (MSC 2013c-d; MSC 2012; MSC 2011; MSC 2010a-b). The scope of the appraisal includes all salmon units in the Marine Stewardship Council and all certification reports published as of January 2013. While there is no single approach for appraising the status of salmon fisheries, in the appraisal 'healthy now' meant a fishery is meeting its escapement goals. An escapement is the number of fish allowed to escape a fishery to spawn thus to sustain the population. 'Healthy in the future' meant a good track record in the fishery for meeting escapement goals and adjusting the catch when needed.

Table 3.7: Rapid appraisal of stock status for MSC wild salmon

Fishery units with passing scores on healthy status	Fishery units with failing scores on healthy status	Fishery units with passing scores on healthy status likely in the future	Fishery units with failing scores or other clear indications that healthy status may be unlikely in the future
Pink salmon – Alaska, Cook Inlet		Pink salmon – Alaska, Cook Inlet	
Pink salmon – Alaska, Southeast Alaska		Pink salmon – Alaska, Southeast Alaska	
Pink salmon – Alaska, West Alaska			Pink salmon – Alaska, West Alaska
	Pink salmon – Alaska, Prince William Sound		Pink salmon – Alaska, Prince William Sound
	Pink salmon – Alaska, Norton Sound	Pink salmon – Alaska, Norton Sound	
	Sockeye salmon – Alaska, Cook Inlet	Sockeye salmon – Alaska, Cook Inlet	
Sockeye salmon – Alaska, Bristol Bay		Sockeye salmon – Alaska, Bristol Bay	
Sockeye salmon – Alaska, Prince William Sound			Sockeye salmon – Alaska, Prince William Sound
Sockeye salmon – Alaska, Copper/Bering			Sockeye salmon – Alaska, Copper/Bering
Sockeye salmon – Alaska, West Alaska		Sockeye salmon – Alaska, West Alaska	

Fishery units with passing scores on healthy status	Fishery units with failing scores on healthy status	Fishery units with passing scores on healthy status likely in the future	Fishery units with failing scores or other clear indications that healthy status may be unlikely in the future
	Sockeye salmon – Alaska, Southeast Alaska		Sockeye salmon – Alaska, Southeast Alaska
Chum salmon – Alaska, Bristol Bay		Chum salmon – Alaska, Bristol Bay	
Chum salmon – Alaska, Arctic/Yukon/Kuskokwim		Chum salmon – Alaska, Arctic/Yukon/Kuskokwim	
Chum salmon – Alaska, Cook Inlet		Chum salmon – Alaska, Cook Inlet	
Chum salmon – Alaska, West Alaska		Chum salmon – Alaska, West Alaska	
	Chum salmon – Alaska, Prince William Sound		Chum salmon – Alaska, Prince William Sound
	Chum salmon – Alaska, Southeast Alaska		Chum salmon – Alaska, Southeast Alaska
	Chum salmon – Alaska, Prince William Sound		Chum salmon – Alaska, Prince William Sound
	Chinook salmon – Arctic/Yukon/Kuskokwim	Chinook salmon – Arctic/Yukon/Kuskokwim	
	Chinook salmon – Alaska, Cook Inlet	Chinook salmon – Alaska, Cook Inlet	
Chinook salmon – Alaska, Bristol Bay		Chinook salmon – Alaska, Bristol Bay	
Chinook salmon – Alaska, Southeast Alaska Non-troll		Chinook salmon – Alaska, Southeast Alaska Non-troll	
Chinook salmon – Alaska, Copper/Bering		Chinook salmon – Alaska, Copper/Bering	
Pink salmon – Russia, Sakhalin, Iturup Island			Pink salmon – Russia, Sakhalin, Iturup Island
Pink salmon – Russia, Northeast Sakhalin		Pink salmon – Russia, Northeast Sakhalin	
Sockeye salmon – Russia, Ozernaya River		Sockeye salmon – Russia, Ozernaya River	
Chum salmon – Russia, Sakhalin, Iturup Island			Chum salmon – Russia, Sakhalin, Iturup Island
Fishery units with	Fishery units with	Fishery units with	Fishery units with

passing scores on healthy status	failing scores on healthy status	passing scores on healthy status likely in the future	failing scores or other clear indications that healthy status may be unlikely in the future
Pink salmon – British Columbia, Fraser River		Pink salmon – British Columbia, Fraser River	
	Pink salmon – British Columbia, North and Central Coast	Pink salmon – British Columbia, North & Central Coast	
	Pink salmon – British Columbia, Inner South Coast	Pink salmon – British Columbia, Inner South Coast	
Sockeye salmon – British Columbia, Skeena River			Sockeye salmon – British Columbia, Skeena River
Sockeye salmon – British Columbia, Nass River		Sockeye salmon – British Columbia, Nass River	
Sockeye salmon – British Columbia, Barkley Sound			Sockeye salmon – British Columbia, Barkley Sound
	Sockeye salmon – British Columbia, Fraser River		
	Chum salmon – British Columbia North and Central Coast (still in assessment 1/2013)		Chum salmon – British Columbia North and Central Coast (still in assessment 1/2013)
	Chum salmon – British Columbia Westcoast Vancouver Island		Chum salmon – British Columbia Westcoast Vancouver Island
	Chum salmon – British Columbia Inner South Coast		Chum salmon – British Columbia Inner South Coast
Chum salmon – British Columbia Fraser River		Chum salmon – British Columbia Fraser River	
Pink salmon – Russia, Iturup Island, Sakhalin		Pink salmon – Russia, Iturup Island, Sakhalin	
	Chum salmon – Japan, Kitami Hokkaido Fall (still in assessment 1/2013)		Chum salmon – Japan, Kitami Hokkaido Fall (still in assessment 1/2013)

Based on the evidence in MSC certification reports, the count of Pacific salmon fisheries found to be 'healthy now' was twenty-one of thirty-seven (57%). The count of fisheries likely to be healthy in the future was also twenty-one of thirty-seven (57%). This metric was intended to serve as a truth-in-advertising style check on the MSC's logo claim that fisheries in the program have been 'certified sustainable'.

3.2.2 Status of US seafood imports linked to illegal fishing

The provenance of thirty leading seafood products imported to the USA in 2011 was researched in detail to establish the species, fishery sources, trading characteristics in the export country, provenance measures and enforcement in the export country, trade flows to U.S. retailers, and IUU impacts. Information for each product served as a base for tracing trade flows from export countries to destinations in the USA and for scoring each product/country combination for risks of illegal and unreported fishing (Figure 3.8).

Nine parameters provided a basis for estimating risks for illegal and unreported fishing were estimated for the top three seafood products imported to the USA from each of the top ten exporting countries. A maximum score of 36 indicates the highest level of risk on nine parameters, each scored on a 1 to 4 scale. The parameters are (1) product sourcing from multiple jurisdictions, (2) transshipping at sea and ports, (3) country-level traceability and certification requirements for seafood imports and exports, (4) enforcement in the exporting country, (5) size and profile of import companies, (6) import trend in 2011, (7) level of organization among producers or in the supply chain around fixing fishery-level problems, (8) biological impacts of illegal fishing in the export country, and (9) economic impacts of illegal fishing in the export country. Impacts were measured for the product/country combinations and their export supply chains only, and do not include spillover impacts for other markets, fishery jurisdictions, communities and ecosystems.

Table 3.8 Risk scores for 30 leading seafood imports to the USA in 2011

Product/Country Combination	**IUU Risk Score (n/36)**	**Product/Country Combination**	**IUU Risk Score (n/36)**	**Product/Country Combination**	**IUU Risk Score (n/36)**
THAILAND Tuna	33	PHILIPPINES Tuna	25	VIETNAM Tuna	19
INDIA Octopus	33	THAILAND Squid	24	ECUADOR Shrimp	18
PHILIPPINES Octopus	32	MEXICO Snapper	24	ECUADOR Tuna	17
INDONESIA Tuna	32	PHILIPPINES Crab	24	ECUADOR Mahi mahi	17
INDIA Squid	30	VIETNAM Crab	23	CHILE Swordfish	16
INDIA Crab	30	MEXICO Tuna	22	CANADA Herring	15
THAILAND Crab	29	CHINA Russia Pollock	21	CHILE Toothfish	14
INDONESIA Snapper	28	CHINA Squid	21	CANADA Lobster	11
INDONESIA Crab	25	MEXICO Shrimp	20	CANADA Crab	11
CHINA Salmon	25	CHILE Pacific Hake	19	VIETNAM Crab	10

In general higher scores indicate higher risks from mixed sources, less-developed regulatory regimes for seafood in exporting countries and low exposure of U.S. buyers. Information was collected in late 2012 and in some instances adjustments were necessary to exclude current information that would lower or raise a 2013 score. For example for Russian pollock processed in China the 2011 score for IUU risk is 21 whereas in 2013 the score would be 16, reflecting an improved regulatory regime, a drop in import trend to the U.S., and increases in both buyer exposure and producer-level and supply chain organization around the IUU fishing risks for Russian pollock. Although not a top product, Russian king crab imports to the USA were also scored for 2011 due to increasing concern of the product's associations to illegal fishing. The IUU risk score for Russian king crab is 22.

The risk scores provided a new level of insight on supply chains to the analysis and contributed to estimates of the proportions of illegally fished and unreported seafood that come into the USA comingled with legal supplies in imports (Table 3.7). The main finding is

that on average 20-32% of seafood imported to the US appears to have origins in illegal and unreported fishing. Products that appear in the market to be fully traceable back to fishing vessels, like canned tuna from Thailand with origin information encoded on every can, continues to be produced with mixed-in content from untraceable sources. Importing seafood with origins in illegal and unreported fishing contravenes the US Lacey Act.

Table 3.9: Estimated Illegal and Unreported catches for the top 30 seafood products exported in the year 2011, by volume for the top 10 countries

Country	**IUU Catches range (National Average est.%)**	**IUU catches range average est.% (for top 3 products exported to USA in 2011**	**Product**	**Catch exported to USA in 2011 (in tonnes)**	**IUU Catches Weighted average estimated %: for top 3 products exported to USA by each country (in tonnes)**	
					Lower Limit	**Upper Limit**
China	30-150	40-78	Pollock	71,752	28,413	55,894
			Salmon	39,926	15,561	30,611
			Squids	38,786	15,359	30,214
Thailand	60-150	23-39	Tuna	128,381	29,014	50,235
			Squids	4252	960	1666
			Crabs	4000	904	1568
Indonesia	43-82	23-41	Tuna	19,443	4549	7893
			Crabs	8913	2085	3618
			Snapper	759	177	308
Ecuador	56-111	10-16	Tuna	21,510	2215	3377
			Shrimps	7358	757	1155
			Mahi Mahi	5382	554	844
Canada	16-41	3-7	Lobsters	42,652	1236	2772
			Crabs	39,964	1158	2597
			Herring	11,488	333	746

Country	IUU Catches range (National Average est.%)	IUU catches range average est.% (for top 3 products exported to USA in 2011	Product	Catch exported to USA in 2011 (in tonnes)	IUU Catches Weighted average estimated %: for top 3 products exported to USA by each country (in tonnes)	
					Lower Limit	Upper Limit
Vietnam	30-50	11-19	Tuna	24,513	2574	4657
			Crabs	2977	312	565
			Clams	2311	242	439
Philippines	50-103	24-39	Tuna	30,931	7547	12,186
			Octopus	5552	1354	2187
			Crabs	2915	711	1148
India	70-125	25-40	Squids	5506	1365	2191
			Crabs	1599	396	636
			Octopus	1679	416	668
Mexico	51-92	18-30	Shrimps	10,423	1876	3085
			Snappers	3529	635	1044
			Tuna	4213	758	1247
Chile	7-37	15-34	Toothfish	3727	570	1256
			Squids	819	125	276
			Hake	66	10	22
Total		**22-41%**		**544,716**	**122,166**	**225,195**

The 'verification metrics' developed for wild salmon and illegal fishing produced an empirical reading of the status of a problem of concern at a point in time. This type of metric can be repeated periodically to check on the extent of the problem at a later date. Verification is a key part of tracking products across global supply chains by tracking the sources and their status at a point of time (Cashore and Stone 2014). Legality verification for example has been taken up by Indonesia (as a producer), China (as a manufacturer) and the United States (as a consumer) in order to curb illegal activity to promote environmental and social stewardship in the forest sector (Cashore and Stone 2014). Instead of imposing

wide ranging "gold standard" certification systems, verification is a way to enforce a claim (Cashore and Stone 2014).

3.3 Promotional metrics

Promotional metrics are meant to produce a competitive advantage for the user. They were developed in some measures to help show the host to be a responsible resource user or community member. 'Promotional metrics' represent the measurements made to show a company's due diligence efforts in the community. They were meant to communicate leadership and performance in a defensible way. This type of metric was a natural grouping even though 'promotions' is not a word used by any of the communities and was not found by this author in the theoretical literature. Promotional did not mean making a false claim, but rather the voluntary showing of proof to defend a claim. The tuna metrics for example were promotional. The Hawaii Seafood Council sponsored the preparation of an article for the journal Marine Policy to show that the ratios of sea turtle bycatch to fishing catch for Hawaii tuna were less than for other tunas. This communicated proof that Hawaii tuna is more responsible than other Pacific tunas. For Mediterranean bluefin tuna, Mitsubishi Corporation advocated for radical catch reduction and published metrics for stock recovery in its public statement as the world's largest buyer of Mediterranean bluefin tuna. The tuna metrics were more precautionary than those recommended by scientists for the fishery and this communicated proof that Mitsubishi Corporation is a responsible resource user. They were developed in 2009-2010 before any tuna fisheries were certified by the MSC program. This author contributed scientific definitions to the development of both sets of tuna metrics while emphasizing that overfishing is occurring on most tuna stocks worldwide (Kirby et al 2014; Worm et al 2006). Since 2008 this author has observed a cascade of shifting fishing effort from bigger to smaller sizes of tuna worldwide.

What made these metrics promotional was they sought to demonstrate leadership and performance in a climate of claims by NGOs that *all* industrial tuna fishing is unsustainable (Greenpeace 2014; Pew 2014). The promotional metrics were industry-led and they

communicated that *some* products in the market were produced by responsible resource users.

3.3.1 Recovering Mediterranean bluefin tuna

For Mediterranean bluefin tuna the metric was the recovery rate for the stock. In 2010 Mitsubishi Corporation, as the buyer of 65% of the catch, set a lower and more precautionary catch limit than the target set by the management institution the International Commission for Conservation of Atlantic Tunas (ICCAT). It did so by reducing its purchase of bluefin tuna caught in 2010 to a level that is more than proportional to the reduction in catch to the total allowable catch from 2009 to 2010 (Mitsubishi Corporation 2010). "Sound scientifically-based management is of the highest priority. To the extent we believe there is a need above and beyond ICCAT agreed upon actions to protect the long-term sustainability of the bluefin tuna population, we will take those measures voluntarily and unilaterally" (Mitsubishi Corporation 2010).

At the time of the CITES controversy, the total accountable catches for 2009, 2010, and 2011 were set by ICCAT at 22,000 t, 19,950 t, and 18,500 t respectively. In Spring 2010 Mitsubishi Corporation advised the Sustainable Fisheries Partnership that it supported a moratorium (no catch) followed by catches reductions to recover the stock with a probability of 90% in ten years. The government of Japan called for a moratorium (no catch) at the meeting of ICCAT's scientific committee in 2010 (ICCAT 2010). It did not pass. However, after the CITES initiative failed, catches were reduced to The 2011, 2012, and 2013 TACs were set at 12,900 t for 2011, 12,900 t for 2012, and 13,500 t for 2013 (ICCAT 2014). In 2014 ICCAT set a catch of 13,400 t/year for a probability of 60% that the stock will recover in fifteen years (ICCAT 2013). The catch level complies with scientific advice but at a probability threshold of 60% this recovery plan has a low chance of succeeding.

In 2010 Mitsubishi Corporation communicated its position that a 10-year stock recovery with 90% probability was needed. This stance was more robust, more probable, and more scientific than the stance taken by the management institution. This was a promotional

metric and set a position for Mitsubishi Corporation that was above the controversy and aligned with the advice published by Greenpeace, the World Wildlife Fund and the Sustainable Fisheries Partnership.

3.3.2 Best in class metrics for Hawaii tuna

The Hawaii Seafood Council published a number of promotional metrics to show the responsibility and leadership of the Hawaii longline fleet in the study period. These included the low ratio of the fleet's bycatch of sea turtles to tuna catch or swordfish catch presented together with the high ratios of other Pacific longline fleets, the fishery's high rate of compliance with the UN Code of Conduct for Responsible Fisheries (2008 and repeated in 2010), and assessment results showing that the fishery nearly meets the Marine Stewardship Council standard for sustainable seafood (2009 and repeated in 2010, 2013 and 2014). The metrics meant to communicate the good standing of the Hawaii pelagic longline fisheries against global standards for seafood sustainability as well as the fleet's leadership and performance as responsible stewards of Pacific tuna and swordfish.

The summary scores for Hawaii longline fisheries for performance against the UN Code of Conduct for Responsible Fisheries were:

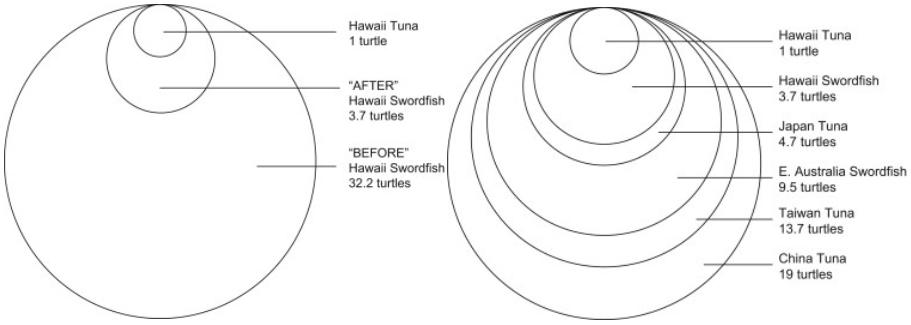
- 96% (109.5 of 114 points) for Article 7 (Fishery Management)
- 93% (70 of 75 points) for Article 8 (Fishing Operations)
- 83% (17.5 of 21 points) for Article 10 (Integration with Coastal Zone Management)
- 95% (38 of 40 points) for Article 11 (Post-harvest Practices and Trade)
- 92% (30.5 of 33 points) for Article 12 (Fisheries Research)

The cumulative score was 94% (265.5 of 283 points) (PacMar Inc, 2008).

Higher relative performance of the Hawaii pelagic longline fisheries compared to other longline fisheries was demonstrated with a bycatch to fish catch (B/C) ratio. The ratio was developed as a metric to differentiate Hawaii tuna and swordfish based on relative sea turtle impacts. The idea was to calculate the B/C for comparable seafood products as a basis for comparing the number of sea turtle interactions per weight of catch. For Hawaii, B/C ratios

were compared before (1994-1999) and after (2004) management measures were implemented in the swordfish fishery to reduce sea turtle interactions. International comparisons were also made with the major non-US longline fisheries operating in the western and central Pacific Ocean (Figure 3.9).

Figure 3.8 Sea turtle bycatch to catch ratios in Pacific longline fisheries, per 190,000 kg catch



The larger the area of the circle the more sea turtle interactions are associated with every kilogram of fish from that fishery. The rate of sea turtle bycatch depends on how longline gear is configured, where and when gear is set in relation to the habitat, distribution and abundance of turtles, and behavior of turtle species. Sea turtles are air breathers and inhabit the upper layers of the ocean, especially the upper 50 m ("turtle layer") (Beverly and Chapman, 2007). When longline gear is set relatively shallow in the water column to target swordfish, most hooks are deployed within the turtle layer where there is a higher likelihood of interactions with sea turtles. When gear is set deeper to target bigeye tuna, there are fewer interactions with sea turtles (OFP, 2001). Sea turtle bycatch, which is estimated as a number of fishery interactions, are not equivalent to mortalities. They range from non-lethal entanglement with no injury to hooking events with immediate or possible delayed mortality. The impact of a turtle interaction varies considerably depending on the species, their conditions after capture, its life stage and the status of its population, but no distinction or weighting could be made in the present study. Ideally this distinction should be made because an incidental capture and mortality of an adult from a severely depleted population,

such as eastern Pacific leatherbacks, would be more significant than the mortality of a juvenile from a healthier population, such as Atlantic leatherbacks. These results were published in an article introducing the B/C metric in Marine Policy (Kaneko, Bartram and Nakamura 2010).

The status of the Hawaii longline pelagic fisheries against the Marine Stewardship Council standard is the third promotional metric communicated by the Hawaii Seafood Council in order to distinguish Hawaii seafood from its competitors. In 2009, 2010, 2013 and 2014 the Hawaii Seafood Council sponsored a preliminary assessment. The results show that gaps to passing scores were filled in that period (Figure 3.10).

Figure 3.9: Status of Hawaii pelagic longline fisheries against the MSC standard, 2009-14

Principle	Component	PI number	Performance Indicator	2009 Score	2014 Score
1	Outcome	1.1.1	Stock status	Bigeye "around 80 ", Swordfish >80, page 55	Bigeye WCPO 60-80 and EPO 80, Swordfish 80
		1.1.2	Reference points	60-80, page 56	80
		1.1.3	Stock rebuilding	N/A	N/A
	Management	1.2.1	Harvest Strategy	60-80, page 57	80
		1.2.2	Harvest control rules and tools	"around 80", page 57	80
		1.2.3	Information and monitoring	80, page 58	80
		1.2.4	Assessment of stock status	>80, page 58	80-100
2	Retained species	2.1.1	Outcome	80, looked only at yellowfin, page 59	80 for yellowfin, striped and blue marlin
		2.1.2	Management	60-80 page 60	80
		2.1.3	Information	60-80, page 60	80
	Bycatch species	2.2.1	Outcome	60-80 (certifier missed info), page 61	80
		2.2.2	Management	60, page 60	80
		2.2.3	Information	60-80, page 60	80
	ETP species	2.3.1	Outcome	80, page 61	80
		2.3.2	Management	80-100, page 61	80-100
		2.3.3	Information	80-100, page 61	80-100
	Habitats	2.4.1	Outcome	100, page 62	100
		2.4.2	Management	80-100, page 62	80-100
		2.4.3	Information	>80, page 62	80
	Ecosystem	2.5.1	Outcome	60-80, page 63	60-80
		2.5.2	Management	60-80, page 63	80
		2.5.3	Information	80, page 63	80
3	Governance and Policy	3.1.1	Legal and customary framework	>80, page 64	80-100
		3.1.2	Consultation, roles and responsibilities	80, page 65	80-100p
		3.1.3	Long term objectives	80 approaching 100, page 65	80-100
		3.1.4	Incentives for sustainable fishing	60, page 65	80
	Fishery specific management system	3.2.1	Fishery specific objectives	80, page 66	100
		3.2.2	Decision making processes	80, page 66	80
		3.2.3	Compliance and enforcement	80-100, page 67	80-100
		3.2.4	Research plan	60-80, page 67	80
		3.2.5	Management performance evaluation	60-80, page 67	80

3.4 Interdisciplinary metrics for sustainable seafood

The seven cases confronted and expanded the notion of sustainable seafood. They set new and higher targets for sustainability in seafood production. They helped people to communicate a change, or the need for a change, to improve fishing impacts for people and the environment. The metrics were interdisciplinary, often linking science and standards approaches, and they were designed to speak to multiple groups of people in business, conservation advocacy, and scholarship. The metrics expanded sustainability definitions to be more inclusive of new sectors like wild shrimp, wild salmon and tuna as well as for more kinds of fisheries, like multi-species fisheries, and more kinds of impacts, like safe labour in seafood work. They combined different types of metrics in new ways and mixed the biological metrics used conventionally in fishery science with the metrics for improvement that are used in standards and certification. Indicator and scoring type metrics were combined with risk assessment. The intent of combining methods and perspectives was to test methods for sustainable seafood in a way that mimics what the seafood industry already does to maintain quality assurance of food safety across global supply chains, for example with the Hazard Analysis and Critical Control Points (HACCP) program.

It is important to consider the limits to metrics that bring bias to their results. Being interdisciplinary, metrics for sustainable seafood are prone to selection issues including the selection of testable parameters and selection of parameters to tilt results toward desired outcomes like more progress against a target versus less. The research challenges with establishing targets, parameterizing them, and integrating diverse perspectives reflect the problem-solving orientation of the measures. One of the important findings was that metrics for sustainable seafood are inherently paradoxical. For example a low bycatch ratio for shrimp from trawl fisheries does not necessarily mean a low environmental impact because impact needs to be considered in the context of the number of vessels relative to the area. If the bycatch-to-prawn ratio is low but there are a 1000 vessels fishing then the total bycatch is still high. However if 1000 boats work in a small area then the environmental impact is even higher. It is this dilemma that led Australia to invest in ecological risk assessments for fisheries governance. Different approaches have been tried and those by Fletcher (2002, 2005) include social and economic risks. The Commonwealth "Ecosystem

Risk Assessment" by Smith et al (2007) and Zhou and Griffiths (2008) are holistic and integrate ssocial, environmental and economic risks together.

It is too soon to know if the seven measures presented in this thesis will produce positive and lasting environmental and social effects. They contribute new and integrated approaches and methods for sustainable seafood that may assist in future design and should be tested and improved by future scholars.

Standard metrics of sustainability for fisheries are difficult to produce because management premises differ widely across fisheries and species around the globe (Gulbrandsen 2009). This thesis has presented cases where private sector organizations are trying to solve social and environmental problems while also advancing their positions as leaders in the seafood market. This is true for seafood companies and NGOs alike. In all cases, benchmarks for sustainability were drawn from science and standards combined and defined experimentally around best practices and conservation priorities. This led to some alignment on metrics by seafood companies, NGOs and even governments across issues and seafood sectors, for example around the estimates of US seafood imports linked to illegal fishing. From a scientific perspective, iterative experimentation with fishing rules and fishing policy can be an exercise in integrated and adaptive management that may contribute to sustainable governance of oceans (Costanza et al. 1998). From a standards perspective, fisheries improvements may have value beyond the immediate consequences of a measure by drawing investment to sustainability in the private sector.

4. Discussion: In an era of overfishing, the effects of voluntary measures for sustainable seafood can be challenging to identify

Concerns about changes in the natural world and the loss of important properties like biodiversity have given rise to questions about the industrial use of natural resources and its impacts, for example to oceans from overfishing. Twenty-eight years after the concept of global sustainability was introduced in a 1987 report, 'Our Common Future' (UN 1987) the report of the first World Oceans Assessment reports that overfishing is a major stressor to oceans with worldwide implications for sustainability (World Oceans Assessment 2015).

Scientific skepticism over seafood sustainability in an era of overfishing has led scholarly attention to frame voluntary measures in the private sector as 'blue wash'. The measures are disconnected from the public sector and do not put more fish in the water because too many fisheries are overfished (Pitcher and Cheung 2013) and understudied (Costello et al 2013), including some Marine Stewardship Council certified fisheries (Proess and Froese 2013; Jacquet 2010). Yet, the MSC has resulted in an increasing number of well-managed fisheries worldwide. The number of fisheries meeting the MSC standard is rising, with 231 certified in 2014 and 88 more under assessment; up from 179 certified fisheries in 2012 and 48 in 2009 (MSC 2015). Scholars of sustainability standards have shown that positive and unanticipated effects are being produced as an increasing number fisheries are assessed against a global benchmark (Cashore et al 2012) including widespread adoption of science based reference points for catch limits (Gulbrandsen 2009). Compliance with sustainability standards is driving regulatory changes in the private sector (Wahl and Bull 2013). Efforts by public sector fishery managers are certainly more likely to protect fish in the sea from overfishing, but it is conservation NGOs that are holding seafood companies accountable to the sustainability policies of major North American and European retailers, and in a number of ways as this thesis has described. In the study period, the integrity of sustainability claims for seafood in the market was protected by corporate-NGO partnerships that also provided the institutional arrangements needed to support them.

4.1 Effects from sustainable seafood? Evaluation results

Evaluation results indicate that all seven voluntary measures for sustainable seafood produced attributes of sustainability that scholars have said are necessary conditions for the improved stewardship of common pool natural resources. For example, all seven of the measures evaluated in this thesis led to new forms of self-regulation by users where industry self regulation is needed to help control the input variables causing overfishing (Waters 1991). Compliance increases with self-regulation (Osterblom 2011). All seven measures produced new empirical information to help determine where change is needed in production to improve social and environmental impacts of concern. This information is needed to solve conflicts and reduce risks where they occur in seafood supply chains (US Department of State 2014b, Cashore et al 2012).

What kinds of effects have resulted from voluntary measures for sustainable seafood? The measures were evaluated with ten questions drawn from sustainability scholarship:

1. *Did any of the seven measures reduce overfishing?* Four measures for shrimp, tuna and salmon contributed to new catch limits and controls to reduce overfishing in ways that satisfy fishery science conventions for sustained yields advocated by one group of scientists (Branch et al 2014, Beddington et al 2007, Hilborn 2007, Hampton et al 2005) but not another (Pitcher and Cheung 2013, Pikitch 2013, Essington 2012, Pauly 2008).

2. *Did any measure make access to resources more secure for business and resource users?* Overfishing is inevitable when fisheries are managed on the premise that commercial behavior can be constrained to meet biological goals without secure access to the resource (Berkes 2006). Secure access is a critical attribute of successful common property resource management (Cinner et al 2013, Ostrom 2009). Resource economist Gary Libecap has argued that all environmental and natural resource problems due to overexploitation of public goods arise from incompletely defined and enforced property rights (Libecap 2009). In the four measures for shrimp, tuna and salmon the industry organizations carefully defined their stake in the resource and demonstrated responsible use and leadership in a public manner as a business investment in securing the harvest for future access.

3. *Did any measure increase compliance with scientific advice?* All seven measures were developed from scientific advice and six of seven succeeded in increasing compliance with scientific advice (not BC salmon). Seafood is not sustainable when fishers fail to comply with fishing rules and fishery managers fail to comply with scientific advice (Beddington 2007). When the responsibilities of resource users relative to use rights are clear it strengthens the license to operate (Libecap 2009).

4. *Did any measure yield new forms of self-regulation for resource users?* Markets need to generate the self-interest that arises from attachment to place (Ostrom 2009, Olson 2000). All of the measures required the organizations to undertake independent analyses of social and environmental impacts from fishing. All of the measures developed metrics for impact, promotions and verification for self-tracking and self-report to prospective seafood buyers and philanthropic donors.

5. *Did the measures receive positive recognition in the market?* Three of the measures resulted in negative recognition in the market. Mitsubishi Corporation was portrayed as the villain in the movie "End of the Line", about overfishing bluefin tuna and it did not gain positive recognition outside of Japan for its efforts to limit buying or to support a catch moratorium. The measures looking into high risks for illegal fishing and for forced labour and human trafficking resulted in negative recognition in the market by the end of the study period when the issues had become significant in the public discourse around sustainable seafood due to media and US Department of State reporting on corruption in Thailand. These issues were also perceived as negative in the market even for companies taking positive steps like Costco, which subsequently faced a class action suit alleging its seafood buyers knew the prawns from Thailand were produced with slave labour (The Guardian 2015). Four of the measures received positive recognition in the market. It is important for establishing credibility and value in the sustainability claim and for improving the organization's reputation as a trusted trader or legitimate authority on sustainability (Costello et al 2013, Cinner et al 2013, Bostrom and Hallstrom 2013, Hallstrom and Bostrom 2010, Vurro et al 2010, Grafton, Nelson and Turris 2005).

6. *Did the measures address NGO concerns?* All of the measures addressed NGO concerns except the outcomes were not always recognized. Legitimacy is earned through collaboration when all parties gain what they expect (Cashore, Auld and Newsom 2004), which can be rare. Measures led independently of NGOs can achieve a fragile authority at best (Hallstrom and Bostrom 2010). By blending moral and corporate authority corporate-NGO partnerships can produce a license to operate that opens new markets and draws new investment (Hallstrom and Bostrom 2013).

7. *Did any measure produce new empirical information to determine where change is needed in seafood production to improve impacts?* The measures responded to 28 of 30 indicators of system wide sustainability in seafood production (Micheli et al 2014). All of the measures included assessments that produced new empirical information on where fishing impacts occur and need more care to conserve multiple species (shrimp metrics), a depleted stock (Mediterranean bluefin tuna), charismatic species liks sea turtles (bycatch controls in the Hawaii longline fisheries), salmon productivity and marine food webs, and to pinpoint where risks are highest for illegal fishing and forced labour in seafood production. The measures also produced new empirical information that helps scholars to better understand effective strategies and performance in voluntary regulation (Wahl and Bull 2013).

8. *Did measures reduce risks of illegal fishing or forced labour in seafood supply chains?* Mitsubishi Corporation reduced its risks of purchasing Mediterranean bluefin tuna with origins in illegal fishing first by stopping purchasing in 2010 and second by then requiring 'fish with paperwork'. Estimates for illegal fishing content in 30 top US seafood imports helped to enumerate the risks for retailers and the US government to aid procurement and programming decisions for seafood imports. Even the most severe illegal practices can occur in certified fisheries when the issue is out of scope of the standard (Luisa CDeBaca, US Ambassador to Combat Human Trafficking, 2014).

9. *Did the measures contribute to better oversight by authorities and independent third parties?* The growing visibility of misconduct in boundary-less industries is driving innovation in supply chain management (Vurro et al 2014). According to Nobel laureate Oliver Williamson, in resource industries the transaction is the basic unit of analysis. Governance over

transactions is the vehicle to infuse order, mitigate conflict and realize mutual gains, although this may take many years of "scaling up from toy models to real world phenomenon and progressing from informal to pre-formal to semi-formal to fully formal" (Williamson 2009). All seven measures contributed to better oversight by authorities and independent third parties. The measure for BC salmon improved oversight by authorities (Department of Fisheries and Oceans) and third parties around the MSC status of the fisheries. Although a public stand on promoting the implementation of Canada's Wild Salmon Policy was withdrawn by the industry in 2012, BC salmon companies took the decision together. As companies within a sector begin to form long-term relationships adding oversight to production becomes worthwhile (Vurro 2009).

10. *Did any of the measures increase accountability in seafood business for the impacts of sourcing?* When buyers and sells share a uniform standard for purchasing seafood it can lower perceived risks and increase legitimacy and reliability for the product and its vendors (Perrini and Vurro 2010). Paying attention to the environmental and social impacts of sourcing can help companies to innovate, test new technology in advance, and foresee dynamics of change (Kanter 1999). All seven measures produced benchmarks for the industry for uniform sourcing criteria. The benchmarks were taken up in MSC assessments and retailers' sourcing policies.

4.2 Sustainability metrics

Where is the evidence that voluntary measures are improving the social and environmental impacts of seafood production? Are the proportions of supply inputs that are compliant with sustainability benchmarks increasing? Sustainability metrics are important features of measures for communicating progress (Costello et al 2013, Cinner et al 2013, Wahl and Bull 2013, Grafton, Nelson and Turris 2005) and compliance of actors across supply chains is the defining feature (Wahl and Bull 2013). Three types of metrics were exhibited in the seven measures in this thesis, for promotions, verification, and impacts measurement. The metrics were developed to report positively on the effects of the measures. What do they measure?

A product can look like it was produced more reliably than others when its sellers advertise it with sustainability metrics. Promotional metrics communicate values that help to sell seafood competitively. Yet, other types of sustainability metrics communicate additional values, for example by helping to confirm product origins, that production met reference points and other scientific benchmarks for sustainability, or simply that a product is covered by a measure to distinguish it from those that are not. Sustainability metrics can also help to prove that the sustainability claim is making a difference so the effects of the measure can be recognized in the market.

4.2.1 Measuring value

In a twist on the word 'charitable', billions of dollars worth of seafood is sold today with endorsements by global charities including the World Wildlife Fund, the Sustainable Fisheries Partnership, and the Marine Stewardship Council. Sustainability claims have value when they are endorsed by authoritative organizations in the private sector and reported in recognizable units and terms. Claims that are self-reported by seafood producers, for example for Hawaii tuna by the Hawaii Seafood Council and Mediterranean tuna by Mitsubishi Corporation, can come across as less valuable in the market compared to metrics that are independently verified to comply with a global standard, for example through MSC certification. Sustainability measures taken in the private sector are intended to produce new value for seafood products. Any information that helps a seafood retailer to meet its procurement policy is valuable, for example ASDA's advice to minimize fishing impacts to marine food webs.

Adding sustainability to a transaction, as Oliver Williamson has advised (2009), increases the expectations from buyer to seller and may add to cost. The seller has to find an ongoing way to produce the value in order to recover the costs of voluntary measures. The costs of a measure have either to be paid by a company or NGO (with donor funds) or both. Measures like the Labour Safe Screen can offer help to seafood companies to reduce reputational risks by showing due diligence but do not produce positive new value for seafood and may not be able to raise enough revenues to cover the costs. When scientists

advised that BC sockeye salmon populations need low harvest levels for the long-term (Grant et al 2012) and severe catch reductions, the balance of costs to benefits changed and the industry dropped the voluntary measure for BC salmon immediately.

4.2.2 Distance to benchmarks and reference points

Effective management requires an understanding of how the fishing system is performing relative to reference points that define overfishing (Costello et al 2013; Hilborn 2013; Beddington et al 2007). Benchmarks for sustainability were set in all seven measures. They were defined experimentally around best practices and conservation priorities. They provide a target to measure seafood production against to see gaps for improvement.

The first type of benchmark was the Marine Stewardship Council standard and stepwise approaches for fisheries to improve to move closer to the standard (Walmart 2013; CASS 2013; WWF 2013). Forty-one commitments to procure seafood from fishery improvement projects were counted on seafood company websites in 2014. Each one of these commitments is backed up by a set of criteria for fishery improvement projects that is published on the website for the Conservation Alliance for Seafood Solutions representing seventeen seafood conservation NGOs in North America (CASS 2014). When a supplier can show a retailer that an increasing proportion of their products meet their buying policy and the criteria then they have a competitive advantage over other companies who cannot.

The second type of benchmark was clear reference points for sustainability in fishery sectors not yet represented in the MSC program, as they were for wild shrimp, wild salmon and tuna early in the study period. Often there are significant costs for early adopters, for example ASDA is the only major retailer known to this author that invested in promoting an ecosystem approach to fisheries. The Sustainable Fisheries Partnership bore the costs of developing sustainable shrimp metrics. Most of the measures developed a reference standard and methodology. The Labour Safe Screen, the research report on minimizing fishing impacts to marine food webs, and the illegal fishing estimates gave retailers new ways to test that the products they sell meet their corporate values.

4.2.3 Measuring impact

Seafood companies are not in the business of generating impacts but contribute to impacts in the course of production. For every product a company makes there are social and environmental impacts. A negative impact that becomes a business risk may hurt operations and profits over time. Showing positive impacts on the other hand can help a company to build a better reputation and reliable trading relationships. Altogether, in the study period more seafood from diverse fisheries entered the scope of sustainable seafood. Seafood from unregulated and overfished fisheries is no longer excluded. Generally, the measures taken by NGOs help seafood producers to meet retailers' buying policies. The goal appears to establish more fisheries managed in stronger partnerships with seafood companies. The criteria for fishery improvement projects published by the Conservation Alliance for Seafood Solutions (CASS 2012) became very influential in the study period for testing the sustainability claims of seafood vendors (Walmart 2011, 2014; Sam's Club 2014, Fishing News International 2015).

For a seafood company, signing on to a partnership with an NGO may contribute more license-to-operate in a geographic area or sector where the NGO has influence (Cashore, Auld and Newsom 2013; Vurro et al 2010). However, the research results indicate that a company is more likely to take on a voluntary measure with an NGO partner to handle positive but not negative impacts from seafood production. For example Mitsubishi Corporation did not ultimately join the NGO Sustainable Fisheries Partnership in its pursuit of a voluntary measure, which would have required the company to build a coalition with its competitors. Instead, Mitsubishi Corporation acted unilaterally to revise its procurement policy for Mediterranean bluefin tuna around the same ideas. In contrast, the UK retailer ASDA hired the Sustainable Fisheries Partnership to complete an analysis of best practices for reducing fishing impacts on marine food webs as part of a research series in support of 'ecosystem improvement projects' (ASDA 2012; SFP 2012). Sam's Club and McDonalds also partner with the Sustainable Fisheries Partnership and follow their advice on sustainable sourcing and supplier surveillance. This builds trust and a mutual license to operate in the sustainable seafood arena. It leads to increased sales for companies and strengthens the

NGO brand. The conservation NGOs that do the work can own the impacts and show them to donors to earn more investment.

4.3 Institutional arrangements for sustainable seafood

In the 2008 to 2014 study period, experimentation with different measures for sustainable seafood led to a clustering of ideas in the North American market. The Monterey Bay and New England aquariums added sustainability ratings to their programming and the World Wildlife Fund and Sustainable Fisheries Partnership added stepwise approaches to the MSC standard to their programming and all with subtly different criteria. Seafood companies like Kroger and Safeway backed up sustainability claims with the name of an NGO partner and a statement of compliance with NGO programming. Other organizations like the Alaska Seafood Marketing Institute took measures independently and claimed to be compliant with scientific best practices and sustainability standards. Mainly, the claims helped to sell more seafood.

Dismissed in some scholarly circles as 'blue wash' it is important to look at which sales approaches have worked best and why. A sustainability claim that can help sell fish in the market has business value. Unilateral claims did not appear to help sell more fish in the measures led by Mitsubishi Corporation in 2010 and by the Hawaii Seafood Council 2009-14 By contrast, retailers like Sam's Club preferentially purchased seafood with a sustainability claim validated by its NGO partner, the Sustainable Fisheries Partnership. Validation of the claim by an NGO partner appeared to make the difference between a purchase and no purchase, and this is consistent with the seafood policy published by Walmart (Walmart 2012). The research findings support the notion that companies and NGOs co-created a license to operate in areas they could not access or fully exploit on their own (Cashore, Auld and Newsom 2004). Sustainable Fisheries Partnership was responsible for measures to bring wild salmon, wild shrimp, and tuna fisheries closer to meeting the Marine Stewardship Council standard. The World Wildlife Fund exposed the extent of illegal fishing in US seafood imports. Sam's Club and the Hawaii Seafood Council examined the standing of Hawaiian tuna in several comprehensive ways. Mitsubishi Corporation made a statement to

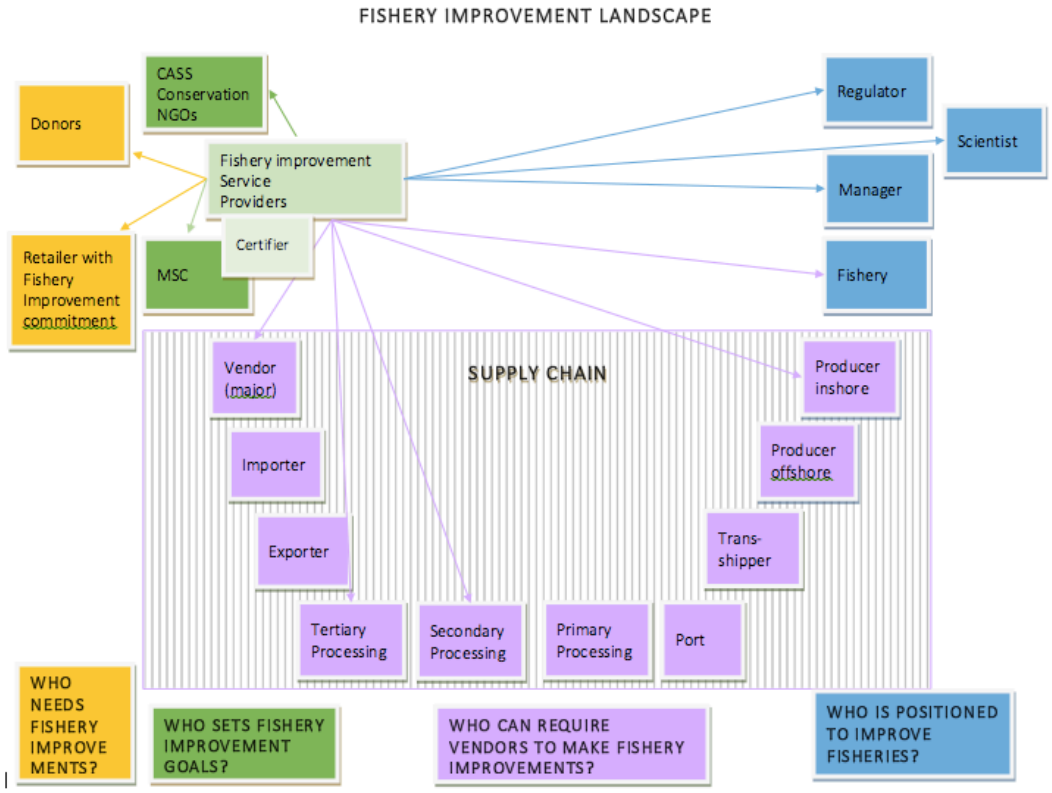
promote the recovery of Mediterranean tuna stocks. Walmart invested in improvements to wild shrimp fisheries by preferentially sourcing shrimp from certified and improving fisheries. ASDA promoted the need for seafood production to change to minimize fishing impacts to marine food webs. Humanity United invested in the development of a diagnostic tool for the seafood industry to help to eliminate forced and trafficked labour.

Positive outcomes like trust were seen across different alliances of companies and NGOs striving for the same goals. For example, Safeway and Whole Foods partnered respectively with FishWise and the Monterey Bay Aquarium in the study period and created a significant market pull for the seafood rated 'best choice' by the aquarium's Seafood Watch program. The World Wildlife Fund has a partnership with the retailer Kroger and operates fishery improvement projects to help its partner buy seafood only from fisheries destined for MSC certification (WWF 2013). These positive feedback loops help sell fish and contribute new proprietary value to seafood companies from the NGO brand. An undeniable race for competitive advantage was observed among conservation NGOs in the study period.

Authority to question the credibility of a sustainability claim emerged as a key market driver of voluntary measures for sustainable seafood in the later part of the study period. Bostrom and Hallstrom (2013) have helped to explain the tensions in market settings where non-state authorities set the rules. The Marine Stewardship Council (MSC) evolved over the study period, for example, from a partnership between Unilever and the World Wildlife Fund into a multi-stakeholder standards body with global authority as the rules-setter for seafood. The MSC program provides a common platform for voluntary regulatory arrangements but as a non-state organization lacks enforcement capacities like those vested in sovereign states (Bostrom and Hallstrom 2013). Organizations like the Marine Stewardship Council and the Conservation Alliance for Seafood Solutions are in a sense self-elected and rely on horizontal relationships for their legitimacy and to gain broad support (Bostrom and Hallstrom 2013). Over the study period supporters around voluntary measures for sustainable seafood have grown to include seafood retailers, NGOs, donors, and some major importers. In the first half of the study period the measures were designed to meet the goals of retailers, donors and conservation NGOs (Figure 4.1). Exporters and producers in developing countries were not much engaged initially. This began to change in 2012/13. Over the study period

the disconnection between the needs of organizations at either end of long and complex supply chains likely constrained the effects of voluntary measures for sustainable seafood.

Figure 4.1: Landscape for voluntary measures for sustainable seafood



5. Conclusion

Where is the evidence that voluntary measures for sustainable seafood are improving the social and environmental impacts of seafood production? What kinds of effects have resulted? For the seven measures presented in this thesis, the evaluation results show effects that meet some conditions for stewardship defined in sustainability scholarship. Although it is too early to tell if things are getting better, the research found effects that include more self-regulation, better oversight, compliance with scientific benchmarks, efforts to address NGO concerns, more accountability to the impacts of sourcing, access to resources made more secure, and even some reductions in risks of overfishing, illegal fishing and forced labour.

This small group of measures is not representative of all measures for sustainable seafood. These were short time-bound initiatives designed to support the sustainable seafood claims of the host organizations. They were taken in the frontier spaces of voluntary industry measures beyond eco-labels. Causality, accountability for impacts, and competing versus common goals were raised as questions early in this research. Scholarly literature attributing large-scale sustainability impacts to standards and certification systems is rare and moreover, rigorously designed studies do not always find the impacts expected (Cashore et al 2012). Causality between the effects of the seven measures and the ongoing real world impacts of seafood production is unknown. This finding of 'unknown' is significant. Impacts are multi-factoral and cannot easily be linked back to specific activities. This finding is consistent with the conclusion from a large-scale impacts assessment of sustainability measures, led by Ben Cashore and an interdisciplinary team that included food corporations and donors (Cashore et al 2012), which found reasonable evidence to suggest significant though not universal positive changes. Their conclusion was that systems affect the practices and performance of producers, leading to impacts beyond the farm or enterprise level. These broader impacts affect other stakeholders, either by influencing the uptake of certain practices or by affecting the broader economy or society. These direct effects, in turn, affect the attitudes and behaviors of stakeholders, consumers, and businesses, which influence how they engage with producers (Cashore et al 2012). This author agrees and adds that accountability for the impacts of sourcing was found to be a major driver of outcomes.

Any organization that makes a claim of sustainability for a product in the market also makes themselves accountable to the impacts of production. Some sustainability scholars have said market claims of sustainable seafood are 'blue wash' for false claims (see Jacquet and Pauly 2010 and Jacquet 2009). However, the findings of this research suggest that sustainability claims were drivers of investment in measures that set a new bar to raise supplies to meet. In a market, a sustainability claim is an expression of self-interest. It may indicate the attachments to place that resource economists have said are needed in the market for stewardship to occur (Ostrom 2009, Olson 2009). The logic of collective action in resource industries for achieving economic benefits from stewardship is described in economic theory. In his Nobel address Oliver Williamson emphasized that measures that increase the governance around a transaction may infuse order, mitigate conflict and produce mutual gain (Williamson 2009). Accountability to the impacts of seafood sourcing occurred, according to the results of this research, where organizations needed to comply with the sourcing requirements of their corporate partner or customer.

Compliance with retailers' sustainable seafood policies was a major market benefit and driver of participation in the study period. Compliance is the defining feature of private regulation for sustainability, according to a major review by Wahl and Bull (2013). By the end of the study period most seafood retailers in North America had procurement policies that require the seller to prove the seafood origins come from improving fisheries (David and Lucille Packard Foundation 2014). Many more fisheries are MSC certified and nearly a hundred more fisheries are covered by improvement projects such that today thousands of seafood products meet the sourcing policies of major retailers in North America and Europe, endorsed by an NGO partner. Today virtually all seafood types are covered by NGO strategies promoting 'best choices' (Seafood Watch 2010) and to 'fix the worst first' (Sobeys 2010). As a result, for a seafood company with an NGO partner it is inexpensive to make a sustainability claim. Thanks to uniformity in retailers' policies for sustainable seafood around improving fisheries, widespread compliance by seafood sellers with NGO programming is possibly the most significant development in the study period. It has added a very interesting institutional arrangement to the market. Economic theory predicts that sustainability is more likely to occur when the costs of defining and enforcing a claim are lower than the expected benefits (Cheung 1970). If required to do nothing but sign on, a

seafood selling company could exploit NGO programming and claim to sell "sustainable" products without necessarily making any changes in production. Costs of making a false claim would increase with enforcement, but protectionism can also be expected to continue through corporate-NGO partnerships. Thinking more broadly about systems-level changes, the benefits outweigh the threat. By bringing together different kinds of people with diverse perspectives on seafood production together to think about ending overfishing, voluntary measures (whether NGO- or industry led) incubate positive unanticipated effects.

The seven measures produced more alignment between NGOs and seafood companies. Alignment is a necessary pre-condition for compliance in voluntary regulatory schemes. There was a general alignment of NGO and corporate interests around verifiable sustainability claims at the end of the study period. There was also more competition between NGOs and between seafood companies. At the end of the study period, the market landscape was cleaved in different pieces around dominant conservation NGOs, and each piece appearing to operate with a slightly different version of sustainable seafood. Competition across organizations caused clusters to form. In a market context, all organizations have a stake in the credibility of all claims. A key observation from the research is that the organizations hosting voluntary measures need to support their own claims and their partners' claims. They must also question or throw doubt on the claims made by competitors. Although not evaluated directly, becoming a stronger competitor is one of the most interesting unanticipated effects from the seven voluntary industry measures for sustainable seafood. Competition is a market driver that could be giving form to seafood sustainability as a property right. Overfishing is inevitable when property rights are incompletely defined and unenforced to the degree that opportunistic traders may exploit the grey areas for profit (Libecap 2009). Future scholars of sustainability should look into common versus competing goals. Is one better than the other, or are both needed to drive changes in production for better social and environmental impacts? Has the sustainable seafood movement generated the broad compliance needed to truly harness the power of the private sector for sustainable seafood? In a competitive market landscape, where sustainability is branded by competing NGOs, is that the right goal? Future researchers of sustainability in commodity industries would do well to consider that the systems behind stewardship might exist in a fluid state due to the dynamic nature of trade.

At the end of the study period most seafood is still sold as a commodity and low prices drive sales. Illegal fishing and forced and trafficked labour worldwide keep prices down. Sustainable seafood will continue to gain in value in the private sector only if new measures produce business value and real world evidence that things are getting better. In the market very little to no premium is added to help consumers to distinguish sustainable from unsustainable production (Roheim 2011, Smith et al 2010). In this setting, voluntary measures need to be tactical and benefits-driven to get off the ground and results-oriented to persevere. Some attributes for success are suggested by the research findings and this author's twenty-year career with voluntary measures for sustainable seafood. New metrics are needed for a more finely resolved and granular measurement of impacts. At least three types of metrics are needed to promote a voluntary measure, verify its sustainability claim in the market, and measure progress and effects. Scientific and standards assessment methodologies need to be integrated and tested and the results published in scholarly journals to increase credibility, accuracy and effectiveness. Tools more robust than checklists and web searches are needed because the problems are complex and nuanced: there are real world local implications for any shift in production. More inclusive approaches are needed to activate supply chains. Diverse voices and ideas not only tools and metrics are needed to test the validity of claims and to promote accountability for the impacts of sourcing. Suppliers need support and encouragement to volunteer information that is accurate and actionable. This will improve the voluntary take-up of sustainability programming. Verification will produce higher levels of trust, health and safety. Durable solutions are likely to be complex and nuanced as well. It will be difficult to raise funds to build voluntary measures from the inside out.

The interdisciplinary nature of seafood sustainability, the knowledge gaps in sustainability theory, especially around local perspectives, and the 'wicked problem' nature of sustainable seafood in an era of global overfishing must be acknowledged, while also noting that diversity, gaps, and complexity are a source of innovation. This author advocates for a balance between scientific, standards and economic perspectives in sustainability scholarship and for a sharper distinction between what businesses can do and cannot do in future research and design. Research and practice should be tactical and benefits-driven. Future

investigations looking for evidence of social and environmental impact from voluntary measures should look for the link between corporate decision makers and the voices of the people affected most by the issue. Future sustainability scholars should link their analyses to the real world conditions of seafood production and its consequences for oceans and producers. Taking note of the positive local effects of measures and not only global deficiencies can generate good will and trust, even inspire innovation and compliance.

There is a clear value proposition for sustainable seafood in an era of overfishing. Based on the evidence in this thesis, voluntary measures for sustainability were fairly easy to motivate when they added new value to a seafood product. Positive effects were produced from measures that combined on-the-ground intelligence, primary research and market know-how with global indices and data. The next stage of sustainable seafood should expand beyond first world problems and concepts and tap into fresh thinking by engaging regional scientists and local NGOs with the knowledge needed to understand the problem at the node of production where it occurs. In the short-term, philanthropic donors should look into the implications and impacts of corporate-NGO partnerships for sustainable seafood to see the effects and limits to the approach. In the study period, NGOs were successful at "getting companies to yes" when it came to signing on new partners, and sharing NGO brand power, but less successful at motivating financial investment from companies to improve the conditions of production that could have significant positive effects. The next wave of opportunities demands new ways of thinking when it comes to voluntary regulatory measures for controlled versus uncontrolled supply chains. Compliance auditing for sustainability in commodities production can be strengthened with combined scientific, social learning and economic approaches. Ethical sourcing will be easier to achieve with data and cost sharing and with a provision of voluntary opportunities for all sellers, buyers and producers to gain from optimized supply chain communications and management.

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