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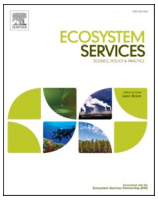

Evaluating the role of market-based instruments in protecting marine ecosystem services in wild-caught fisheries

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ABSTRACT

Over the last few decades there has been increasing concern about the sustainability of wild-caught fisheries. Ecosystem-based fisheries management and the use of market-based instruments represent promising approaches to promote sustainable fisheries. However, little is known about the extent to which market-based instruments align with the principles of ecosystem-based management. In this paper, we evaluate seven market-based instruments applied to wild-caught fisheries against an adapted version of the Millennium Ecosystem Assessment typology to measure how well they address marine ecosystem services. Our results indicate that market-based instruments used in wild-caught fisheries do not explicitly address all marine ecosystem services in the text of their standards. While almost all address provisioning services, they generally do not address regulating, cultural, or supporting services. The explicit incorporation of ecosystem services into market-based instruments may offer an opportunity to better support the goals of ecosystem-based fisheries management and improve the sustainability of wild-caught fisheries. The historical focus on stock management, the breadth in the missions of implementing organizations, and the barriers to evaluating ecosystem services are likely contributors to the slow uptake of ecosystem service-oriented requirements.

1. Introduction

The dramatic growth of global fishing activity has raised concern about the sustainability of fisheries (Pauly, 2013). As a result, significant investments have been made in both governance reform and market-based approaches to promote sustainable fisheries (Kittinger et al. 2021). Governance efforts have been dominated by community-based fisheries management, the establishment of marine reserves, and national level policy (Cudney-Bueno and Basurto, 2009; Battista et al., 2018). Though these efforts have led to the recovery of stocks and ecosystems in certain regions, many stocks remain vulnerable (Worm et al., 2009). National and sub-national level governance alone is insufficient for ensuring the sustainability of fisheries that extend beyond national jurisdiction and into multiple exclusive economic zones or international waters (Kalfagianni and Pattberg, 2013). Multi-national governance, such as the Coral Triangle Initiative and the EU Landing Obligation, can help address the mismatch between ecological and political boundaries. Additionally, governance initiatives often lack consistent enforcement and fail to link to the seafood market (Christie et al. 2016; Onofri and Maynou, 2020; Kittinger et al. 2021). Despite the importance of governance reform for sustainable fisheries, overexploitation and mismanagement persist, supporting the need for alternative approaches, such as incentive-based instruments (Di Leva, 2002).

Market-based instruments (MBIs) have emerged as a promising tool in wild-caught fisheries to address the areas where traditional governance has been less successful, such as global fisheries and global fishery markets (Allison, 2001; Di Leva, 2002; Ward, 2008). MBIs are intended to encourage sustainable behavior through market signals rather than explicit directives (TEEB, 2009; Pirard, 2012). MBIs also offer a flexible, adaptive, and cost-effective approach that garner support from the private sector (EU Commission, 2007; Stavins and Whitehead, 2008; Gómez-Baggethun and Muradian, 2015). Despite the promise of market-based approaches, little is known about the effectiveness of MBIs in achieving sustainability outcomes (Kaiser and Edwards-Jones, 2006; Jacquet and Pauly, 2007; Ward, 2008). In this paper, we evaluate the

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performance of seven MBIs for wild-caught fisheries in addressing ecosystem services provided by marine ecosystems.

Over the last few decades, the importance of an ecosystem approach to fisheries management has become widely recognized. Ecosystem-based fisheries management (EBFM) emerged as a response to the shortcomings of single- and multi-species management, applying a holistic, ecosystem approach (Larkin, 1996; Link, 2002; Pikitch et al., 2004). The Fisheries and Agriculture Organization of the United Nations (FAO) recommends the integration of ecosystem-level thinking into MBIs for fisheries (FAO, 2003), and some instruments contain ecosystem-level requirements (e.g., Marine Stewardship Council (MSC), Principle 2). However, the small body of literature evaluating how well MBIs for wild-caught fisheries protect ecosystem health and align with principles of EBFM are conflicting (Ward, 2008; Kirby et al., 2014; Selden et al., 2016).

Kirby et al. (2014) evaluated the International Seafood Sustainability Foundation (ISSF), the Marine Stewardship Council (MSC), and Friend of the Sea (FOS) and determined that their written standards align with international governance and support an ecosystem approach. Ward (2008) took their analysis one step further, evaluating how the MSC requirements were interpreted and implemented by third party reviewers. They found that due to ambiguous performance indicators for ecosystem health (Principle 2) reviews of fisheries were inconsistent among evaluators. They determined this would hinder the MSC's ability to make significant contributions to marine biodiversity conservation. Selden et al. (2016) evaluated the effectiveness of certification by analyzing ecosystem-level outcomes for certified and non-certified fisheries. They found that MSC-certified fisheries only performed better than non-certified stock in some metrics of ecosystem-based sustainability and were indistinguishable in others. Together, these studies suggest that requirements for ecosystem health are still not well defined and, therefore, ecosystem health is only minimally addressed by the leading MBIs for wild-caught fisheries.

The ecosystem services framework is well-suited for evaluating how well the requirements of MBIs align with the shift towards an ecosystem approach. Ecosystem services represent the benefits human populations derive from ecosystem functions (Costanza et al., 1997) and include provisioning, regulating, cultural, and supporting services. Many aspects of ecosystem health are closely aligned with availability of these services, including maintaining ecosystem diversity, species diversity, genetic variability, and trophic level balance (Gislason et al., 2000). The value of the services provided by fisheries' complex coupled human and natural systems will rely directly on the health of the ecosystem (Millennium Ecosystem Assessment, 2005). In fact, the influential report from The Economics of Ecosystems & Biodiversity initiative (TEEB, 2009) cites MBIs as important tools for ensuring the protection of biodiversity and ecosystem services.

In this paper, we evaluate the extent to which seven MBIs for wild-caught fisheries address ecosystem health and align with the principles of an ecosystem-approach by evaluating the text of their standards. These MBIs include the five most impactful global certification and ratings systems, responsible for reviewing over 99% of certified and rated wild-caught fish take globally: MSC, FOS, Seafood Watch (SFW), Naturland, and Fair Trade (Potts et al., 2017; Certification & Ratings Collaboration (CRC), 2019). Certifications and ratings systems have emerged as popular market-based mechanisms for wild-caught fisheries to provide transparency and assurance about sustainability (Deaton, 2004). A certification is, "the provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements" (ISO 10015:2019, 2019). Ratings systems are non-voluntary evaluations designed to provide information on the full spectrum of product quality (CRC, 2019) and are often partnered with consumer-facing buying guides (Ward and Phillips, 2009). Today, nearly 30% of global wild production is certified, rated, or in a fisheries improvement project (Potts et al., 2017), indicating that the level of investment in these MBIs as a solution to unsustainable fishing practices is significant. For comparison, we also evaluate one local certification for fisheries, Alaska Responsible Fisheries Management (RFM), and one global instrument that is not specific to fisheries (i.e., external to the fishing sector), the International Finance Corporation (IFC) standards for sustainable development.

2. Methods

To evaluate the extent to which existing market-based mechanisms directly address ecosystem services provided by marine ecosystems, we began with the ecosystem services typology defined by the Millennium Ecosystem Assessment (MA) (2005). We tailored this typology using two marine-specific typologies that together encompass marine ecosystem services that may be impacted by fishery activity (Beaumont et al., 2007; Böhnke-Henrichs et al., 2013; See Appendix 1, Table A1).

We evaluated seven MBIs, including four global certifications, one global ratings system, one local certification, and one financing organization. MSC and FOS are the two largest certifiers of wild-caught fisheries, having certified 10.0% and 10.1% of global wild catch, respectively (Potts et al., 2017). Naturland was listed as the third largest certifier of global wild catch in 2015 (Potts et al., 2017). Since 2015, Fair Trade has emerged as a fourth key player in the certification of wild-caught fisheries, and as of 2019 it has certified nine fisheries producing a total of 5,000 metric tons from five countries (CRC, 2019). The Monterey Bay Aquarium Seafood Watch Program (SFW) is the largest ratings program of wild-caught seafood. As of 2019, SFW, also a member of the Seafood Certification and Ratings Collaboration, rated 9% of global wild catch production, with an additional 10% currently under assessment. Though they rate seafood produced globally, their focus is on seafood sold in North American markets (Monterey Bay Aquarium, 2011; CRC, 2019).

To offer comparisons to these global, fishery-specific (FS) MBIs, we included one local, seafood-specific certification program and one global, non-seafood specific MBI in our evaluation. The Alaska RFM Certification Program was the first local certification for wild-caught fisheries recognized by the Global Sustainable Seafood Initiative (GSSI) in 2016, both of which were developed with FAO principles. IFC, a member of the World Bank Group, is the largest global development institution focused exclusively on the private sector in developing countries and has had Performance Standards on Environmental and Social Sustainability for over two decades.

We developed an assessment framework to evaluate the MBIs (Table 1). To receive a rating of "completely addressed", the MBI's standards required language that directly addressed the impacts of: (1) stock removal on the stock's ability to provide the specified service, (2) stock removal on the ecosystem's capacity to provide this service, and (3) fishing practices on the ecosystem's ability to provide this service. A service was rated as "partially addressed" if at least one of the three requirements was explicitly addressed. A service was "absent" (i.e. not addressed) from an MBI if none of the three requirements were explicitly addressed.

We systematically coded all seven MBI standards using latent content analysis. This coding was done by two of the authors to ensure consistency and transparency. For each instrument, the most up-to-date version of the standard was used to identify if protection of a service was "completely addressed", "partially addressed", or "absent". The coders read each standard document in its entirety, including every requirement, indicator, guidance, and footnote (documents ranged from 15 to 528 pages) (Alaska Seafood Marketing Institute, 2018; Fair Trade, 2017; Friends of the Sea, 2017; International Finance Corporation, 2012; Marine Stewardship Council, 2014; Monterey Bay Aquarium, 2016; Naturland, 2018). Computer searches within the documents for relevant keywords were also used. After independently coding all MBIs, we calculated interrater reliability between the two coders. The linear weighted Cohen's kappa for the two coders was 0.66 (For individual reviews see Appendix 1, Table A2). There were no discrepancies

Table 1
The requirements used to evaluate if an instrument received a rating of complete, partial, or absent for each service. If all three requirements for a given service were achieved, then the instrument received a rating of complete. If any of the requirements were addressed, the instrument received a rating of partial.

Services	Requirements
Provisioning	1. Ensure population is harvested in a way that maintains target species for *provisioning*. 2. Ensure target species is harvested in a way that maintains ecosystem *provisioning*. 3. Address the impacts of fishing practices on *provisioning* services. Applied to all provisioning services evaluated
Regulating	1. Address the loss of *regulating* services provided by the target species due to harvesting of the stock. 2. Address the loss of *regulating* services provided by the ecosystem due to harvesting of the stock. 3. Consider the impacts of fishing practices on *regulating* services. Applied to all regulating services evaluated
Cultural	1. Address the loss of *cultural* services provided by the target species due to harvesting of the stock. 2. Address the loss of *cultural* services provided by the ecosystem due to harvesting of the stock. 3. Consider the impacts of fishing practices on *cultural* services. Applied to all ten cultural services evaluated
Supporting	1. Address the loss of *supporting* services provided by the target species due to harvesting of the stock. 2. Address the loss of *supporting* services provided by the ecosystem due to harvesting of the stock. 3. Consider the impacts of fishing practices on *supporting* services. Applied to the two supporting services evaluated.

between the two coders for FOS and only one disagreement between coders for both MSC and SFW. Discrepancies for FairTrade (6), Naturland (5), and Alaska RFM (6) were moderate in number, while the two coders had the most discrepancies coding IFC (15). These mismatches only occurred when discerning between "partial" versus "complete", or "partial" versus "absent". The final evaluations for the seven incentives were agreed upon by the two original coders with facilitation from a third author.

3. Results

The seven MBIs evaluated in this review vary in structure, mission, and scope (Table 2). IFC is the only MBI reviewed that is not FS and instead has a broad mission to reduce global poverty. MSC, FOS, Fair Trade, Naturland, and SFW are all global in reach and FS. Unlike the others, SFW is not a certification but a ratings system designed to inform consumers, making it the only non-voluntary MBI reviewed. Its mission, like MSC and FOS, is primarily environmental, whereas the primary missions of Fair Trade, Naturland, and IFC are human-oriented. Fair Trade works to ensure sustainable development and community empowerment, while Naturland focuses specifically on organic products. The Alaska RFM certification is the only local incentive reviewed and is also seafood-specific, making it the narrowest in scope. Its mission is to improve the Alaska seafood industry with sustainability being an identified component of this larger mission.

IFC is unique in its treatment of ecosystem services, with every service at least partially addressed, and 13 out of 22 completely addressed by IFC's performance standards (Table 3). We found variation in how well the global certifications address ecosystem services, ranging from 3 (FOS) to 13 (Fair Trade) of the 22 services being at least partially addressed. All global certifications fully address food provisioning. Fair Trade and MSC also fully address primary production. SFW, the global ratings system, addresses four services, with three of these rated complete. Alaska RFM, the local certification program, addresses 10 services, with only two of these rated complete. Overall, only 16 of the 22

Table 2
A description of the structure of each instrument assessed, its mission, and its scope.

Marine Stewardship Council Certification: MSC is an independent non-profit organization with a voluntary certification program. Certification is given at the fishery level. Certified fisheries can sell products with the MSC label. Assessments are conducted by accredited independent certifiers. Certification is paid for by the fishery to the certifier. To maintain certification requires annual audits and reassessment within 5 years.

Mission: MSC's mission is to use our ecolabel and fishery certification program to contribute to the health of the world's oceans by recognizing and rewarding sustainable fishing practices, influencing the choices people make when buying seafood and working with our partners to transform the seafood market to a sustainable basis.

Scope: Global; 14.2% of global fish take is certified, 5.7% by MSC (Marine Stewardship, 2020; Potts et al., 2017)

Fair Trade USA Certification: Fair Trade Certified is the global brand of Fair Trade USA. Fair Trade USA is an independent non-profit organization with a voluntary certification program. Certification is given at the fishery level. Third party assessment bodies perform audits and make certification recommendations, which are approved by Fair Trade USA. A certified fishery can sell products using the Fair Trade Certified™ seal with premium pricing. Funds raised through premium pricing go to fisher groups to fund community development projects.

Mission: Fair Trade USA® enables sustainable development and community empowerment by cultivating a more equitable global trade model that benefits farmers, workers, fishermen, consumers, industry, and the earth. We achieve our mission by certifying and promoting fair trade products

Scope: Global; 9 seafood companies (Fair Trade)

Friend of the Sea: Friend of the Sea (FOS) is currently a project of the World Sustainability Organization, an international trademark registered with humanitarian and environmental conservation missions. It offers a voluntary certification program. Certification is completed at the fishery level. The audit is completed by an accredited, third-party certification body. Once a fishery is certified, products can be sold with the FOS label.

Mission: Friend of the Sea's mission is to protect the oceans for future generations, promoting certified sustainable seafood and Omega3 from sustainable fishing and sustainable aquaculture.

Scope: Global; 14.2% of global fish take is certified, 6.2% by FOS (Friends of the Sea, 2020; Potts et al., 2017)

Naturland: Naturland is an independent non-profit and an international association for organic agriculture. The focus of certification for Naturland's Sustainable Capture Fishery standards is on small-scale fisheries that set an example of best practices. Voluntary certification is completed at the fisheries level, typically for single species. Naturland representatives complete an on-sight pre-evaluation of the fishery. Assessments are conducted by accredited independent certifiers. The Naturland Certification Committee makes the final decision on approval and completes annual reviews. Once a fishery is certified, seafood from this fishery can be sold with the Naturland label.

Mission: Naturland develops and propagates organic agriculture at local, national and global levels. We join force to campaign for the production, processing and marketing of high quality, healthy and enjoyable foodstuffs and organic products. In pursuing these aims, we strive to remain in harmony with nature, in recognition of the responsibility we bear towards succeeding generations.

Scope: Global; 6 certified fisheries (Naturland, 2020)

Alaska Seafood Marketing Institute's Responsible Fisheries Management (RFM) Certification: The Alaska Seafood Marketing Institute (ASMI) is a public–private partnership between Alaska and the Alaska seafood industry. ASMI's Alaska Responsible Fisheries Management certification is voluntary. It allows certified fisheries to sell products with an ecolabel. Assessment and certification are done by ISO 17,065 Accredited Certification Bodies. They are responsible for ensuring the competence and consistency of assessments. Two independent experts review their assessment. There is also a 30-day public comment period. An independent certification committee makes the final decision. Once certified, the fishery must undergo annual assessments and re-certification after five years.

Mission: The Alaska Seafood Marketing Institute is a marketing organization with the mission of increasing the economic value of the Alaska seafood resource through: increasing the positive awareness of the Alaska Seafood brand; Collaborative marketing programs that align with ASMI and industry marketing efforts for maximum impact within the food industry; championing the sustainability of Alaska's seafood harvests resulting from existing Alaska fisheries management imperatives; Proactive marketing planning to address short

(*continued on next page*)

Table 2 (*continued*)

and long-term goals while remaining flexible and responsive to a changing environment and economy; Quality assurance, technical industry analysis, education, advocacy and research; Prudent, efficient fiscal management.

Scope: Alaska specific; 8 certified species (Alaska Seafood Marketing, 2020)

Monterey Bay Aquarium Seafood Watch program: The Seafood Watch (SFW) program, run by Monterey Bay Aquarium, is a rating system that provides consumers with information on the sustainability of seafood by assessing the ecological impacts of fisheries on marine and freshwater ecosystems up to the dock. These non-voluntary assessments give fisheries a sustainability rating of best choices, good alternatives, or avoid. Assessments are done by internal SFW staff or trained contracted analysts. Assessments are reviewed by multiple SFW staff members to ensure the standard is applied consistently. They do not evaluate fisheries on non-ecological or post-harvest impacts.

Mission: The Monterey Bay Aquarium Seafood Watch program helps consumers and businesses choose seafood that's fished or farmed in ways that support a healthy ocean, now and for future generations. Our recommendations indicate which seafood items are Best Choices or Good Alternatives, and which ones you should avoid.

Scope: Cover 80–85% of seafood (sourced globally) on the US and Canadian markets (Monterey Bay Aquarium Seafood, 2020)

International Finance Corporation: IFC is a member of the World Bank Group and the largest global development institution focused exclusively on the private sector in developing countries. In the case of its direct investments (including finance provided through financial intermediaries), IFC requires its clients to apply the Performance Standards to manage environmental and social risks and impacts. IFC ensures standards are met by including them in the initial credit review process. This is completed by IFC staff. The client must continue to meet the Performance Standards throughout the life of an investment by IFC.

Mission: IFC's mission is to fight poverty with passion and professionalism, for lasting results.

Scope: Global; SolTuna Ltd. received first funding for new wild-caught fishery in 15 years (International Finance Corporation, 2020)

services provided by marine ecosystems were rated complete for at least one MBI. Six do not receive a rating of complete in any MBI evaluated (Appendix 1, Table A3 provides examples of complete coverage for each service where available).

3.1. Provisioning services

Provisioning services that are applicable to wild-caught fisheries include food, genetic resources, pharmaceuticals, and ornamental goods. Based on our evaluation, every FS MBI completely addresses food provisioning in their written requirements, while IFC only partially addresses it (Table 3). FOS is the only instrument where genetic resources are absent. Genetic resources are fully addressed in SFW, Alaska RFM, and IFC. Biochemical and pharmaceutical/ornamental provisioning services are absent from all FS MBIs and are only partially addressed in IFC.

3.2. Regulating services

Regulating services that are applicable to wild-caught fisheries include climate regulation, water regulation, erosion regulation, water purification, disease regulation, and pest regulation. Overwhelmingly, regulating services are not directly addressed in MBIs. None of the MBIs completely address water purification, but five MBIs partially address this service. Climate regulation and erosion regulation are both completely addressed by IFC but are only partially addressed by three and two FS MBIs, respectively. Both water regulation and pest regulation are completely addressed by IFC and partially addressed by one FS MBI-Fair Trade and SFW, respectively. Finally, disease regulation is the least addressed service with IFC being the only MBI to partially address it.

3.3. Cultural services

The cultural services that are applicable to wild-caught fisheries include cultural diversity, spiritual and religious values, knowledge systems, educational values, inspiration, aesthetic values, social relations, sense of place, cultural heritage values, and recreation and ecotourism. Cultural services are poorly addressed by the MBIs. Knowledge systems are the best addressed cultural service with IFC receiving a rating of complete and four FS MBIs partially addressing it. Cultural diversity, cultural heritage, and social relations are completely addressed by IFC and partially addressed by Alaska RFM, Fair Trade, and Naturland. Sense of place and spiritual and religious values are completely addressed by IFC and partially addressed by Naturland and

Table 3
Final evaluation for each instrument based on individual assessments followed by a discussion with a third reviewer when the first coders' evaluations differed. **Indicates partial protection in certifications specific to salmon and bivalve fisheries.

Service	Fair Trade	FOS	MSC	Naturland	SFW	Alaska RFM	IFC
Provisioning							
food	complete	complete	complete	complete	complete	complete	partial
genetic resources	partial	absent	partial	partial	complete	complete	complete
biochemical	absent	absent	absent	absent	absent	Absent	partial
ornamental	absent	absent	absent	absent	absent	Absent	partial
Regulating							
climate regulation	absent	partial	absent	partial	absent	Partial	complete
water regulation	partial	absent	absent	absent	absent	Absent	complete
erosion regulation	partial	absent	partial	absent	absent	Absent	complete
water purification	partial	partial	absent**	partial	absent	Partial	partial
disease regulation	absent	absent	absent**	absent	absent	absent	partial
pest regulation	absent	absent	absent**	absent	partial	absent	complete
Cultural							
cultural diversity	partial	absent	absent	partial	absent	partial	complete
spiritual/religious	partial	absent	absent	partial	absent	absent	complete
knowledge systems	partial	absent	partial	partial	absent	partial	complete
educational values	absent	absent	absent	absent	absent	absent	partial
inspiration	absent	absent	absent	absent	absent	absent	complete
aesthetic values	absent	absent	absent	absent	absent	absent	complete
social relations	partial	absent	absent	partial	absent	partial	complete
sense of place	partial	absent	absent	partial	absent	absent	complete
cultural heritage	partial	absent	absent	partial	absent	partial	complete
recreation/ecotourism	absent	absent	absent	absent	absent	partial	partial
Supporting							
primary production	complete	absent	complete	absent	complete	partial	partial
nutrient cycling	partial	absent	partial	absent	absent	absent	partial

Fair Trade. Recreational and tourism values are partially addressed by IFC and Alaska RFM. Inspiration, aesthetic, and educational values are only addressed by IFC, with the inspiration and aesthetic values being completely addressed and educational values only partially addressed.

3.4. Supporting services

The supporting services that are applicable to wild-caught fisheries include primary production and nutrient cycling. Five of the seven MBIs at least partially address primary production, with Fair Trade, MSC, and SFW completely addressing it and Alaska RFM and IFC partially addressing it. Only Fair Trade, MSC, and IFC partially address nutrient cycling.

4. Discussion

Our analyses suggest that market-based instruments do not comprehensively address the ecosystem services associated with fisheries and their ecosystems with the explicit language in the standards. The ecosystem services addressed by the instruments evaluated vary, aligning with the differences in their mission and scope. Of the FS instruments, the three with missions on both human welfare and ecosystem health—Fair Trade, Naturland, and Alaska RFM—provide the greatest coverage of ecosystem services, performing beyond the others most notably in their acknowledgement of regulating and cultural services. Alaska RFM provides more specific language regarding ecosystem services of interest for the region, such as climate regulation and cultural services important to local and indigenous communities. Instruments with environment-focused missions all fully address food provisioning, but their consideration of regulating and cultural services is lacking. IFC stood out as the only instrument that explicitly links conservation, sustainability, and ecosystem services, naming every category of ecosystem services—provisioning, regulating, cultural, and supporting—in the introduction of Performance Standard 6 (IFC, 2012). This is not surprising given IFC's mission of sustainable development, which is deeply aligned with the principles of an ecosystem services approach (Sachs and Reid, 2006; Wood et al., 2018).

4.1. Coverage of provisioning services

Every FS MBI fully addresses food provisioning and mentions bycatch and secondary species. Though the specificity and extent of coverage vary between instruments, this service, unsurprisingly, stands out as the best addressed service in every FS MBI. Stock-focused management has historically been fundamental to fisheries management practices and is deeply integrated into these MBIs (Selden et al., 2016).

Partial acknowledgement of genetic resources in FS MBIs was primarily to maintain the diversity of life history traits in the stock species. This aligns with the value placed on genetic diversity in EBFM (Gislason et al., 2000). However, failure to mention genetic diversity of the stock more broadly, or genetic resources of non-harvest species, suggests indicators addressing genetic diversity are written to support the food provisioning values of the stock more than to protect the value of genetic resources more broadly. This is an area of concern because even in well-studied species relatively little is known about genetic diversity in subpopulations, including those of bycatch and other fishing-impacted species, yet these features are likely of evolutionary importance and may have value for potential future human use (MA, 2005).

The lack of attention to ornamental and biochemical/pharmaceutical services in FS MBIs may not be surprising since the instruments we reviewed have historically focused on stock-specific outcomes (Selden et al., 2016); however, the marine aquarium trade is a multi-million dollar industry, with coral reef species being of particular importance (Wabnitz et al., 2003). The stocks provisioned for these services may receive indirect protection from maximum sustainable yield requirements for food stocks or ecosystem-oriented indicators for secondary species, but secondary species provisioned for ornamental or biochemical services may demand different populations sizes and structures than those estimated for ecosystem health.

The IFC at least partially addresses all provisioning services but fails to completely address food provisioning. This is because it is written to be applied to any industry. As a result, their standards provide less specificity on how to fully address food provisioning services than the FS MBIs.

4.2. Coverage of regulating services

Acknowledgement of regulating services in the FS MBIs is limited and inconsistent. While some of the threats fisheries pose to regulating services are recognized, it seems the industry has not reached a consensus on which services are most likely to be impacted or how they should be addressed. When MBI partially address regulating services are partially addressed, they do not mention the services by name. For example, restrictions on pollution from vessels protect water quality, reducing impacts to water purification services. Yet this connection is not explicitly made, presumably because such impacts are considered adequately dealt with under international and national shipping controls.

This presents two issues. First, the FS MBIs fail to directly address many regulating services that have been identified as vulnerable to wild-caught fisheries. For instance, pest regulation is a major concern in marine ecosystems. Invasive species have been widely recognized as a significant threat to marine ecosystems with only 16% of marine ecoregions having no reported invasions (Molnar et al., 2008). Fishing activities have been identified as a major source of bioinvaders (Carlton, 2001), yet only one FS MBI partially addressed pest regulation services. Disease regulation may also be impacted by fishing activities. Processing activities have been linked with eutrophication that can cause harmful algal blooms (MA, 2005). These blooms can release toxins causing health impacts in aquatic species and humans (Berdalet et al., 2016). Additionally, structural changes in communities may reduce ecosystem resilience to both pests and disease (Smith et al., 2011).

Second, most requirements that address regulating services consider a process by which fishing activities may impact the service. This approach may fail to protect regulating services from impacts which are more poorly understood. Bans on dynamite fishing and bottom trawling were developed due, in part, to the understanding that these practices reduce ecosystem capacity for water and erosion regulation (MA, 2005; Beck et al., 2018). Similarly, requirements for vessel pollution aim to reduce the impacts of fishing on water purification services. Yet, these services may be impacted in other ways that existing standards would not address.

Not only does IFC address every regulating service, but the standards also mention "regulating services," by name. This aligns with their mission of sustainable development, as regulating services have been recognized as perhaps the most important services provided by ecosystems (MA, 2005). IFC standards differ from the requirements addressing regulating services in the FS MBIs. Instead of addressing a process by which regulating services are impacted, IFC standards call for the direct evaluation and protection of the service itself. This is likely because IFC's standards must apply to a breadth of industries which affect regulating services differently.

4.3. Coverage of cultural services

The level of acknowledgement of cultural services in FS MBIs seems mission-dependent. It is likely MSC, FOS, and SFW would not consider the protection of cultural services to be within their purview, as their missions focus on environmental health. In fact, SFW explicitly states that their assessments "do not consider non-ecological impacts such as social issues, [and] human health…" (Seafood Watch Research, 2018). Still, there is growing recognition that marine ecosystems and wild-

caught fisheries are enormously important for cultural life and that wild-caught fisheries impact cultural services (Urquhart et al., 2013). Fair Trade, Naturland, and Alaska RFM—all of which prioritize human well-being in their missions—are designed to address more cultural services. All three partially address cultural diversity, knowledge systems, social relations, and cultural heritage values. This is consistent with concerns about the pressures globalized fisheries place on local communities (Kittinger et al., 2013). However, they focus on stakeholder engagement but do not include outcome-oriented metrics ensuring the values of these services are not lost. For example, they may require that local knowledge is used to inform fishing practices but do not ensure that the fishery or fishing practices do not reduce the value of knowledge systems over time.

Alaska RFM is the only FS MBI to address ecotourism or recreation. This aligns with the Alaska Seafood Marketing Institute's (the parent organization for Alaska RFM) commitment to local economic growth, considering the importance of ecotourism for Alaska's economy. However, it is surprising ecotourism is not mentioned in other FS MBIs. Researchers have identified many instances where wild-caught fisheries have impacted the ability of marine ecosystems to provide tourism and recreation values, including SCUBA diving (MA, 2005) and recreational fishing (Cesar et al., 2003).

IFC standards are more protective than the FS MBIs, not only in the extent of coverage of cultural services but also the depth of their coverage for each service. IFC makes explicit mention to cultural services, listing many by name, and uses outcome-oriented standards. For example, IFC standards require cultural services be valued, preserved when possible, and ensure reprimands when these services are affected. IFC's superiority in protecting cultural services is unsurprising since a fundamental value of sustainable development is improving human welfare and social well-being (UN General Assembly, 2015).

4.4. Coverage of supporting services

Supporting services are the services necessary for providing all other services. The importance of primary production for the health of marine fisheries is well accepted (Pauly and Christensen, 1995), and half of the FS MBIs completely addressed primary production, though they did not measure direct outcomes for primary producers. Instead, primary production was most often indirectly addressed through trophic cascades and ecosystem health more broadly. Acknowledgement of nutrient cycling was much less common than acknowledgement of primary production. This is likely because the impacts fisheries may have on nutrient cycling are less understood. Still, there is evidence that fishing may affect nutrient cycling services provided, both by reef fish in nutrient poor environments (Allgeier et al., 2014) and by migrating species (MA, 2005), such as Pacific salmon (Ben-David et al., 1998; Helfield & Naiman, 2001). Importantly, when FS MBIs do address supporting services, it is based on the importance of these services to support the health of the target species, not to support marine ecosystems more broadly. This allows for the possibility that even if supporting services are sufficiently maintained to support a healthy stock, other ecosystem processes are still being negatively affected.

IFC partially addresses both supporting services, but like food provisioning, its addressal of supporting services was less complete than many of the FS MBIs (i.e., MSC, Alaska RFM, and Fair Trade). Again, this is likely due to the broad scope of IFC and the depth of scientific understanding that informs the FS MBIs.

4.5. Opportunities for integrating protection of ecosystem services into MBI standards

The Millennium Ecosystem Assessment (2005) identifies fishing as one the major forces impacting structure, function, and biodiversity of the oceans today and notes that increased provisioning of fish has had significant negative impacts on the ability of coastal and marine ecosystems to provide other ecosystem services. Previous research indicates that existing ecosystem-level indicators in MBIs may not adequately protect all aspects of ecosystem health and sustainability (Ward, 2008; Selden et al., 2016). Resource management that addresses the impacts of resource provisioning on all linked ecosystems and human well-being is more effective for achieving sustainability and conservation goals than sectoral or single-species management (Kay & Alder, 2017). Incorporating indicators that directly address ecosystem services into MBIs would provide a way to better integrate environmental health and human well-being into standards.

Directly addressing ecosystem services could also ensure MBIs better align with principles of EBFM. The FAO Technical Guidelines for Responsible Fisheries identifies MBIs, and certifications specifically, as important complements to governance for implementing the ecosystem-approach. The incorporation of ecosystem-focused indicators suggests there is some effort to integrate the principles of EBFM into existing MBIs (FAO, 2003). However, the fifth key principle of EBFM states that governance should ensure both human and ecosystem well-being and equity (FAO, 2003). Existing standards, from the evidence reviewed here, do not seem to encompass this principle. By design, integration of ecosystem services would link ecosystem and human well-being.

Most of the FS MBIs address cultural services by requiring stakeholder engagement. This reflects the recognition that consideration of social issues is critical for fisheries management. However, it is well known that engagement of stakeholders does not ensure their voices and needs are incorporated meaningfully into decision-making (Cornwall, 2008). The effective integration of cultural services would not only require that stakeholders' voices be heard but that the values they gain from the environment be protected from the effects of fishing activities. This is an inherently more equitable approach, as it does not position the value of these ecosystems to the fishers above other community users, broadens the view of potential stakeholders, and ensures their voices are not only heard but their needs are protected.

The careful integration of ecosystem services into outcome-oriented indicators could also provide an opportunity to enhance our understanding of the relationship between ecosystem services and wild-caught fisheries, better protect vulnerable communities, and ensure all MBIs meet a research-based standard. When services are addressed, standards often focus on well-defined links between fisheries and services. It is likely, however, that many impacts of fishing practices on ecosystem services are still poorly understood. Ecosystem service-based indicators could create an opportunity for monitoring to help better understand the dynamic relationship between fish provisioning and other services.

Finally, though these instruments vary based on their missions, it is unlikely that a fishery will be evaluated by multiple MBIs. Certainly, most fisheries will not work to receive multiple broad-scale certifications, due to their costliness, time intensiveness, and the limited benefit having multiple certifications may have in the eyes of consumers. Still, certifications continue to be the easiest way for downstream buyers like fish product manufacturers, retailers, and consumers to purchase products that have sustainability attributes. If researchers identify a minimum level of protection needed, then each certification could use its own language and style to integrate ecosystem services into their standards, while indicating to consumers that they provide sufficient protection to ecosystem services. Development and oversight of a set of minimum standards might be best managed by a global accreditation system specifically addressing this problem for ocean ecosystems and drawing on the IFC design and experiences.

4.6. Challenges to integrating ecosystem services into MBI standards

There are many challenges associated with integrating ecosystem services into MBIs used in wild-caught fisheries, first and foremost, being the development of well-defined, measurable indicators. Every FS MBI fully addresses food provisioning based on our evaluation; however, they did not all provide the same level of detail and guidance on how it

should be evaluated. It is possible that stock health could be adequately assessed during the review process without specificity in evaluation indicators. However, this puts the responsibility on third party evaluators and leaves room for inadequate and inconsistent evaluations. The lack of specificity in MSC Principles 2 and 3 makes evaluation of ecosystem health difficult (Gutiérrez et al., 2012), and produces inconsistent evaluations of ecosystem health in certified fisheries (Ward, 2008). Therefore, it is likely that even if MBI standards address an ecosystem service, if the indicators are not well-defined or easily interpreted and evaluated by third party reviewers, then protection of these services will not be achieved.

Developing clear indicators to protect regulating, cultural, and supporting services may prove even more challenging. Though many studies have identified relationships between wild-caught fisheries and ecosystem services, the effects of fisheries on marine ecosystem services are understudied. This makes it difficult to incorporate the same level of specificity and guidance into indicators for these services as is seen for food provisioning. Standards could focus on monitoring change in the value of the service, but many of the marine services impacted by fisheries are also affected by other anthropogenic stressors in these systems, such as coastal development and pollution (MA, 2005). This may make it difficult to isolate the changes caused by fisheries. Again, this places the responsibility of ecosystem service valuation onto third party evaluators, who may not have experience evaluating ecosystem services.

There may also be institutional challenges to incorporating ecosystem services into MBIs for wild-caught fisheries. The process of evaluation for these instruments is already long and costly, making it difficult for many fisheries to participate. Adding additional requirements may increase the complexity of the evaluation process. Additionally, the MBIs reviewed in this paper were developed by organizations with different missions, and their standards reflect that. It may be difficult to convince organizations to incorporate ecosystem service-based requirements if they consider certain services as outside of the purview of their organization.

4.7. Additional considerations

It is possible that though written indicators do not explicitly address ecosystem services, there is indirect protection of these services through existing indicators and evaluation methods. For instance, indicators protecting food provisioning may maintain populations at a high enough level to protect biopharmaceutical and ornamental provisioning.

However, there are three possible shortcomings of indirect protection. First, without direct mention of these services, there is no signal to fisheries, third-party evaluators, community stakeholders, or consumers that the protection of these services are critical to the sustainability of marine fisheries. Second, poorly defined indicators for ecosystem health in MBIs creates highly variable evaluations of ecosystem health on the ground (Ward, 2008). This level of inconsistency cannot ensure marine ecosystem health globally. Finally, indicators may currently protect services from well-studied impacts, while failing to protect them from others. Without explicitly monitoring for changes to ecosystem services, these changes may go unnoticed. This suggests that though it is important to evaluate how well ecosystem services are already being indirectly protected, there is still value in integrating ecosystem services into standards.

Alternatively, it is also possible that even when MBIs fully address ecosystem services, they may fail to adequately protect them. Stock-focused management is fundamental to sustainable fisheries, and although fisheries science has established clear guidelines for ensuring sustainable harvesting, which have been deeply integrated into the criteria of these MBIs (Selden et al., 2016), evidence indicates that global catches of wild stocks have still been in decline for decades (except in the case a small number of large and intensively managed fisheries; Zeller and Pauly, 2019). This continued decline may be due to poorly developed criteria for evaluation or inconsistent auditing practices. Therefore, an important next step would be to evaluate ecosystem services in certified, rated, and other fisheries to identify how well these services are protected by on the ground implementation.

5. Conclusion

Existing MBIs operating in the fisheries space do not directly protect ecosystem services in their written standards. Though they may provide protection to ecosystem services indirectly through existing indicators or on the ground evaluations, incorporating ecosystem services into standards could provide a clear and auditable framework by which to evaluate ecosystem-level impacts of fisheries. Such an approach would also signal the importance of these services to the wild-caught fishery community, facilitate the alignment of MBIs with the principles of EBFM, increase our understanding of the relationship between fisheries and ecosystem services, and could ultimately help standardize MBIs, while allowing them to maintain their unique missions. We anticipate that there will be challenges to integrating indicators that address ecosystem services into MBIs. Thus, ecosystem services-based standards could not replace existing, stock-focused and social standards. Still, MBIs have emerged as a popular solution to complement the goals of EBFM. We therefore consider that the explicit protection of ecosystem services offers a promising and novel approach to integrating ecosystem health into market-based instruments to achieve sustainable fisheries management.

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Appendix A. Su6pplementary data

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References

Alaska Seafood Marketing Institute. 2020. https://www.alaskaseafood.org. Accessed: Feb 21, 2020.

Alaska Seafood Marketing Institute (2018). Alaska Responsible Fisheries Management Certification Program. Version 2.0. https://uploads.alaskaseafood.org/2019/10/AK-RFM-V2.0-GuidanceFINAL-May-2018-New-Seal-Oct2019.pdf.

Allgeier, J.E., Layman, C.A., Mumby, P.J., Rosemond, A.D., 2014. Consistent nutrient storage and supply mediated by diverse fish communities in coral reef ecosystems. Global Change Biology 20 (8), 2459–2472. https://doi.org/10.1111/gcb.12566.

Allison, E.H., 2001. Big laws, small catches: global ocean governance and the fisheries crisis. Journal of International Development 13 (7), 933–950. https://doi.org/10.1002/jid.834.

Battista, W., Kelly, R.P., Erickson, A., Fujita, R., 2018. Fisheries governance affecting conservation outcomes in the United States and European Union. Coastal Management 46 (5), 388–452. https://doi.org/10.1080/08920753.2018.1498711.

Beck, M.W., Losada, I.J., Menéndez, P., Reguero, B.G., Díaz-Simal, P., Fernández, F., 2018. The global flood protection savings provided by coral reefs. Nature Communications 9 (1), 1–9. https://doi.org/10.1038/s41467-018-04568-z.

Ben-David, M., Bowyer, R.T., Duffy, L.K., Roby, D.D., Schell, D.M., 1998. Social behavior and ecosystem processes: river otter latrines and nutrient dynamics of terrestrial vegetation. Ecology 79 (7), 2567–2571. https://doi.org/10.1890/0012-9658(1998)079[2567:SBAEPR]2.0.CO;2.

Beaumont, N.J., Austen, M.C., Atkins, J.P., Burdon, D., Degraer, S., Dentinho, T.P., Derous, S., Holm, P., Horton, T., van Ierland, E., Marboe, A.H., Starkey, D.J., Townsend, M., Zarzycki, T., 2007. Identification, definition and quantification of goods and services provided by marine biodiversity: implications for the ecosystem approach. Marine Pollution Bulletin 54 (3), 253–265. https://doi.org/10.1016/j.marpolbul.2006.12.003.

Berdalet, E., Fleming, L.E., Gowen, R., Davidson, K., Hess, P., Backer, L.C., Moore, S.K., Hoagland, P., Enevoldsen, H., 2016. Marine harmful algal blooms, human health and wellbeing: challenges and opportunities in the 21st century. Journal of the Marine Biological Association of the United Kingdom 96 (1), 61–91. https://doi.org/10.1017/S0025315415001733.

Böhnke-Henrichs, A., Baulcomb, C., Koss, R., Hussain, S.S., de Groot, R.S., 2013. Typology and indicators of ecosystem services for marine spatial planning and management. Journal of Environmental Management 130, 135–145. https://doi.org/10.1016/j.jenvman.2013.08.027.

Carlton, J. T. (2001). Introduced Species in U.S. Coastal Waters: Environmental impacts and management priorities. Prepared for the Pew Oceans Commissions, Arlington, VA. http://agris.fao.org/agris-search/search.do?recordID=US201300072733.

Certification and Ratings Collaboration. (2019). Sustainable Seafood: A Global Benchmark. https://certificationandratings.org/wp-content/uploads/2019/11/Sustainable-Seafood-A-Global_Benchmark.pdf.

Cesar, H., Burke, L., and Pet-Soede, L. (2003). The economics of worldwide coral reef degradation. Cesar environmental economics consulting (CEEC). http://agris.fao.org/agris-search/search.do?recordID=GB2013202743.

Christie, P., Pietri, D.M., Stevenson, T.C., Pollnac, R., Knight, M., White, A.T., 2016. Improving human and environmental conditions through the Coral Triangle Initiative: progress and challenges. Current Opinion in Environmental Sustainability 19, 169–181. https://doi.org/10.1016/j.cosust.2016.03.002.

Cornwall, A., 2008. Unpacking 'Participation': models, meanings and practices. Community Development Journal 43 (3), 269–283. https://doi.org/10.1093/cdj/bsn010.

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature 387 (6630), 253–260. https://doi.org/10.1038/387253a0.

Cudney-Bueno, R., Basurto, X., 2009. Lack of cross-scale linkages reduces robustness of community-based fisheries management. PloS one 4 (7). https://doi.org/10.1371/journal.pone.0006253.

Deaton, B.J., 2004. A theoretical framework for examining the role of third-party certifiers. Food control 15 (8), 615–619. https://doi.org/10.1016/j.foodcont.2003.09.007.

Di Leva, C. E. (2002). The conservation of nature and natural resources through legal and market-based instruments. Rev. Eur. Comp. & Int'l Envtl. L., 11, 84. https://doi/pdf/10.1111/1467-9388.00305.

EU Commission. (2007). Green paper on market-based instruments for environment and related policy purposes. Commission of the European Communities. https://ec.europa.eu/taxation_customs/sites/default/files/resources/documents/common/whats_new/com%282007%29140_en.pdf.

FairTrade USA. 2020. https://www.fairtradecertified.org. Accessed: Feb 21, 2020.

Fair Trade USA. (2017). Capture Fisheries Standard. Oakland, CA. https://www.fairtradecertified.org/sites/default/files/filemanager/documents/CFS/FTUSA_STD_CFS_EN_1.1.0.pdf.

FAO (2003). Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 2. Rome, IT. fao.org/3/a-i2708e.pdf.

Friends of the Sea. 2020. https://friendofthesea.org/. Accessed: Feb 21, 2020.

Friends of the Sea (2017). Friend of the SFOS - Wild Sustainable Fishing Requirements. Milan, Italy. http://www.friendofthesea.org/public/catalogo/FOS%20Wild%20standard%20V3.1_en.pdf.

Gislason, H., Sinclair, M., Sainsbury, K., O'boyle, R., 2000. Symposium overview: incorporating ecosystem objectives within fisheries management. ICES Journal of Marine Science 57 (3), 468–475. https://doi.org/10.1006/jmsc.2000.0741.

Gómez-Baggethun, E., Muradian, R., 2015. In markets we trust? Setting the boundaries of market-based instruments in ecosystem services governance. Ecological Economics 117, 217–224. https://doi.org/10.1016/j.ecolecon.2015.03.016.

Gutiérrez, N.L., Valencia, S.R., Branch, T.A., Agnew, D.J., Baum, J.K., Bianchi, P.L., Cornejo-Donoso, J., Costello, C., Defeo, O., Essington, T.E., Hilborn, R., Hoggarth, D. D., Larsen, A.E., Ninnes, C., Sainsbury, K., Selden, R.L., Sistla, S., Smith, A.D.M., Stern-Pirlot, A., Teck, S.J., Thorson, J.T., Williams, N.E., Peck, M., 2012. Eco-label conveys reliable information on fish stock health to seafood consumers. PloS one 7 (8), e43765. https://doi.org/10.1371/journal.pone.0043765.

Helfield, J.M., Naiman, R.J., 2001. Effects of salmon-derived nitrogen on riparian forest growth and implications for stream productivity. Ecology 82 (9), 2403–2409. https://doi.org/10.2307/2679924.

International Finance Corporation. 2020. https://www.ifc.org. Accessed: Feb 21, 2020.

International Finance Corporation (2012). Performance Standards on Environmental and Social Sustainability.https://www.ifc.org/wps/wcm/connect/24e6bfc3-5de3-444d-be9b-226188c95454/PS_English_2012_Full-Document.pdf?MOD=AJPERES&CVID=jkV-X6h.

ISO 10015:2019 (2019). Quality management - Guidelines for competence management and people development. https://www.iso.org/standard/69459.html.

Jacquet, J. L., and Pauly, D. (2007). The rise of seafood awareness campaigns in an era of collapsing fisheries. Marine Policy, 31(3), 308-313. https://doi:10.1016/j.marpol.2006.09.003.

Kaiser, M. J., and Edwards-Jones, G. (2006). The role of ecolabeling in fisheries management and conservation. Conservation Biology, 20(2), 392-398. https://doi:10.1111/j.1523-1739.2006.00319.x.

Kalfagianni, A., Pattberg, P., 2013. Fishing in muddy waters: Exploring the conditions for effective governance of fisheries and aquaculture. Marine Policy 38, 124–132. https://doi.org/10.1016/j.marpol.2012.05.028.

Kay, R., Alder, J., 2017. Coastal planning and management. CRC Press.

Kirby, D.S., Visser, C., Hanich, Q., 2014. Assessment of eco-labelling schemes for Pacific tuna fisheries. Marine Policy 43, 132–142.

Kittinger, J.N., Finkbeiner, E.M., Ban, N.C., Broad, K., Carr, M.H., Cinner, J.E., Gelcich, S., Cornwell, M., Koehn, Z., Basurto, X., Fujita, R., Caldwell, M., Crowder, L., 2013. Emerging frontiers in social-ecological systems research for sustainability of small-scale fisheries. Current Opinion in Environmental Sustainability 5 (3–4), 352–357. https://doi.org/10.1016/j.cosust.2013.06.008.

Kittinger, J.N., Bernard, M., Finkbeiner, E., Murphy, E., Obregon, P., Klinger, D.H., Schoon, M.L., Dooley, K.J., Gerber, L.R., 2021. Applying a jurisdictional approach to support sustainable seafood. Conservation Science and Practice 3 (5). https://doi.org/10.1111/csp2.v3.510.1111/csp2.386.

Larkin, P.A., 1996. Concepts and issues in marine ecosystem management. Reviews in Fish Biology and Fisheries 6 (2), 139–164. https://doi.org/10.1007/BF00182341.

Link, J. S. (2002). What does ecosystem-based fisheries management mean. Fisheries, 27 (4), 18-21. https://www.researchgate.net/profile/Jason_Link/publication/269576198_What_does_ecosystem-based_fisheries_management_mean/links/5499b4310cf21eb3df60dc7d.pdf.

Marine Stewardship Council. 2020. https://www.msc.org/home. Accessed: Feb 21, 2020.

Marine Stewardship Council (2014). MSC Fisheries Certification Requirements and Guidance. London, UK. https://www.msc.org/docs/default-source/default-document-library/for-business/program-documents/fisheries-program-documents/msc_fisheries_certification_requirements_and_guidance_v2-0.pdf.

Millennium Ecosystem Assessment (2005). Ecosystems and Human Well-being: Biodiversity Synthesis. World Resources Institute, Washington, DC. https://www.millenniumassessment.org/documents/document.354.aspx.pdf.

Monterey Bay Aquarium (2011). Turning the Tide: The State of Seafood. Monterey, CA. USA. https://www.seafoodwatch.org/-/m/c4de19eac4f24657a23f12e17b392b2c.pdf.

Molnar, J.L., Gamboa, R.L., Revenga, C., Spalding, M.D., 2008. Assessing the global threat of invasive species to marine biodiversity. Frontiers in Ecology and the Environment 6 (9), 485–492. https://doi.org/10.1890/070064.

Monterey Bay Aquarium Seafood Watch. 2020 seafoodwatch.org. Accessed: Feb 21, 2020.

Monterey Bay Aquarium (2016). Seafood Watch® Standard for Fisheries. Version F3.2. https://www.montereybayaquarium.org/-/m/56BBC009FD0E40B1BA2AE3066B21FE0E.pdf.

Naturland (2018). Naturland Standards for Sustainable Capture Fishery. Gräfelfing, Germany. https://www.naturland.de/images/UK/Naturland/Naturland_Standards/Other_Standards/Naturland-Standards_Sustainable-CaptureFishery.pdf.

Naturland 2020. https://www.naturland.de/en. Accessed: Feb 21, 2020.

Onofri, L., Maynou, F., 2020. Unwanted catches, quota systems and the EU Landing Obligation: An economic and econometric analysis. Ocean & Coastal Management 189, 105159. https://doi.org/10.1016/j.ocecoaman.2020.105159.

Pauly, D. (2013). Beyond duplicity and ignorance in global fisheries. WIT Transactions on State-of-the-art in Science and Engineering, 64. https://hdl.handle.net/10.3989/scimar.2009.73n2215.

Pauly, D., Christensen, V., 1995. Primary production required to sustain global fisheries. Nature 374 (6519), 255–257. https://doi.org/10.1038/374255a0.

Pikitch, E.K., Santora, C., Babcock, E.A., Bakun, A., Bonfil, R., Conover, D.O., Dayton, P., Doukakis, P., Fluharty, D., Heneman, B., Houde, E.D., 2004. Ecosystem-based fishery management. Science 305 (5682), 346–347. https://doi.org/10.1126/science.1098222.

Pirard, R., 2012. Market-based instruments for biodiversity and ecosystem services: A lexicon. Environmental Science & Policy 19, 59–68. https://doi.org/10.1016/j.envsci.2012.02.001.

Potts, J., Lynch, M., Wilkings, A., Huppé, G., Cunningham, M., and Voora, V. (2017). The state of sustainability initiatives review 2014: Standards and the green economy. International Institute for Sustainable Development and London and the International Institute for Environment and Development. https://www.iisd.org/sites/default/files/publications/ssi-blue-economy-2016.pdf.

Sachs, J. D., and Reid, W. V. (2006). Investments toward sustainable development. Science, 312(5776), 1002-1002. https://doi.org/10.1126/science.1124822.

Seafood Watch Research. (2018). Developing Seafood Watch Recommendations. https://www.seafoodwatch.org/-/m/sfw/pdf/criteria/mba-seafoodwatch-recommendation-process.pdf?la=en.

Selden, R. L., Valencia, S. R., Larsen, A. E., Cornejo-Donoso, J., and Wasserman, A. A. (2016). Evaluating seafood eco-labeling as a mechanism to reduce collateral impacts of fisheries in an ecosystem-based fisheries management context. Marine Policy, 64, 102-115. https://doi:10.1016/j.marpol.2015.11.010.

Smith, P., Ashmore, M., Black, H., Burgess, P., Evans, C., Hails, R., Potts, S.G., Quine, T., and Thomson, A. and Breeze, T. (2011). Regulating services. Ecosystem Services. 535-596. http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=XPPBQJuWlzk%3D&tabid=82.

Stavins, R., Whitehead, B., 2008. Market-Based Environmental Policies 7, 105–117.

The Economics of Ecosystems & Biodiversity, 2009. The Economics of Ecosystems and Biodiversity for National and International Policy Makers – Summary: Responding to the Value of Nature. http://www.teebweb.org/media/2009/11/National-Executive-Summary_-English.pdf.

UN General Assembly. (2015). Transforming our world: the 2030 Agenda for Sustainable Development. A/RES/70/1. https://www.refworld.org/docid/57b6e3e44.html.

Urquhart, J., Acott, T., Zhao, M., 2013. Introduction: social and cultural impacts of marine fisheries. Marine Policy 37, 1–2. https://doi.org/10.1016/j.marpol.2012.04.007.

Wabnitz, C., Taylor, M., Green, E., and Razak, T. (2003). From Ocean to Aquarium; The global trade in marine ornamental species. UNEP-WCMC, Cambridge, UK.

Ward, T.J., 2008. Barriers to biodiversity conservation in marine fishery certification. Fish and Fisheries 9 (2), 169–177. https://doi.org/10.1111/j.1467-2979.2008.00277.x.

Ward, T., Phillips, B. (Eds.), 2009. Seafood ecolabelling: principles and practice. John Wiley & Sons.

Wood, S.L., Jones, S.K., Johnson, J.A., Brauman, K.A., Chaplin-Kramer, R., Fremier, A., Girvetz, E., Gordon, L.J., Kappel, C.V., Mandle, L., Mulligan, M., O'Farrell, P., Smith, W.K., Willemen, L., Zhang, W., DeClerck, F.A., 2018. Distilling the role of ecosystem services in the Sustainable Development Goals. Ecosystem services 29, 70–82. https://doi.org/10.1016/j.ecoser.2017.10.010.

Worm, B., Hilborn, R., Baum, J.K., Branch, T.A., Collie, J.S., Costello, C., Fogart, M.J., Fulton, E.A., Hutchings, J.A., Jennings, S., Jensen, O.P., Lotze, H.K., Mace, P.M., McClanahan, T.R., Minto, C., Palumbi, S.R., Parma, A.M., Ricard, D., Rosenberg, A. A., Watson, R., Zeller, D., 2009. Rebuilding global fisheries. science 325 (5940), 578–585. https://doi.org/10.1126/science.1173146.

Zeller, D., Pauly, D., 2019. Back to the future for fisheries, where will we choose to go? Global Sustainability 2.