Chapter 11. Capture Fisheries

Writing team: Fábio Hazin, Enrique Marschoff (Co-Lead member),
Beatrice Padovani Ferreira (Co-Lead member), Jake Rice (Co-Lead member),
Andrew Rosenberg (Co-Lead member)

1. Present status and trends of commercially exploited fish and shellfish stocks

Production of fish from capture fisheries (Figure 1) and aquaculture for human consumption and industrial purposes has grown at the rate of 3.2 per cent for the past half century from about 20 to nearly 160 million mt by 2012 (FAO 2014).

Table 1. Marine capture fisheries production per country. From SOFIA (FAO, 2014).

[illegible]							
4 275 115	5 332 862	5 420 247	27.8	1.7	2	Indonesia	Asia
4 912 627	5 131 087	5 107 559	4.0	0.5	3	United States of America	America
[illegible]							
5	Russian Federation	Asia/Europe	3 090 798	4 005 737	4 068 850	31.6	
11 584	21.9	3.9	6	Japan	Asia	4 626 904	3 741 222
02 405	15.1	4.7	7	India	Asia	2 954 796	3 250 099
[illegible]							
1 649 061	1 737 870	1 660 165	0.7	-4.5	13	Republic of Korea	Asia
[illegible]							
16.7	1.0	16	Mexico	Americas	1 257 699	1 452 970	1 467 790
27.0	27.3	17	Iceland	Europe	1 986 314	1 138 274	1 449 452
[illegible]							
Share 18 major countries (percentage)							

In 20112012, the top ten species (by tonnage) in marine global landings were Peruvian anchoveta, Alaska pollock, skipjack tuna, various sardine species, Atlantic herring, chub mackerel, scads, yellowfin tuna, Japanese anchovy and largehead hairtail. In 2012, 20 species had landings over a half a million tons and this represented 38 per cent of the total global marine capture production Man3a1whea/P <</MC0.23 0 Td0[mr Tw 0 Td [(0r)4( )-10

1.1 Regional Status

Significant growth in marine capture fisheries has occurred in the eastern Indian Ocean, the eastern central Atlantic and the northwest, western central and eastern central Pacific over the last decade, but landings in many other regions have declined. Thus, even though overall landings have been quite stable, the global pattern is continuing to adjust to changing conditions and regional development of fishing capacity (Table 2).

Table 2. Fishing areas and captures (from SOFIA, FAO, 2014)

[redacted]

[illegible]						61	Pacific, Northwest
n Central	10 831 434	11 014 145	12 078 487	11.5	4.0	71	Pacific, Wester
n Central	1 769 177	1 923 433	1 940 202	9.7	0.9	77	Pacific, Eastern
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	81	Pacific, Southw
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
18, 48, 58, 88	Arctic and Antarctic areas	[illegible]	[illegible]	[illegible]			
World total		79 578 873	82 583 935	79 705 910			

An estimated 3.7 million fishing vessels operate in marine waters globally, 68 per cent of these operate from Asia and 16 per cent from Africa. Seventy per cent are mofrThu-27.840 Tc 0 Tw 0

2. Present status of small-scale artisanal or subsistence fishing

The FAO defines small-scale, artisanal fisheries as those that are household based, use relatively small amounts of capital and remain close to shore. Their catch is primarily for local consump

3. Impacts of capture fisheries on marine ecosystems

The effects of exploitation of marine wildlife were first perceived as a direct impact primarily on the exploited populations themselves. These concerns were recognized in the 19^{th} and early 20^{th} centuries (e.g., Michelet, 1875; Garstang, 1900; Charcot, 1911) and began to receive policy attention at the Stockholm Fisheries Conference of 1899 (Rozwadowski, 2002). In 1925, an attempt to globally manage “marine industries” and their impact on the ecosystems was presented before the League of Nations (Suarez, 1927), but little action was taken. Only following WWII, with rapid increases in fishing technology, was substantial overfishing in both the Atlantic and Pacific Oceans (Gulland and Carroz, 1968) acknowledged. Establishment in 1946 of FAO, with a section for fisheries, provided an initial forum for global discussions of the need for regulation of fisheries.

Capture fisheries affect marine ecosystems through a number of different mechanisms. These have been summarized many times, for example by Jennings and Kaiser (1998) who categorized effects as:

(i) The effects of fishing on predator-prey relationships, which can lead to shifts in with ecosystem considerations being added to target species management primarily in the past two to three decades.

If the exploited fish stock can compensate through increased productivity because the remaining individuals grow faster and produce more larvae, with the increase in productivity extracted by the fishery, then fishing can be sustained. However, if the rate of exploitation is faster than the stock can compensate for by increasing growth and reproduction, then the removals will not be sustained and the stock will decline. At the level of the target species, sustainable exploitation rates will result in the total population biomass being reduced roughly by half, compared to unexploited conditions.

The ability of a given population of fish to compensate for increased mortality due to fishing depends in large part on the biological characteristics of the population such as growth and maturation rates, natural mortality rates and lifespan, spawning patterns and reproduction dynamics. In general, slow growing long-lived species can compensate for and th

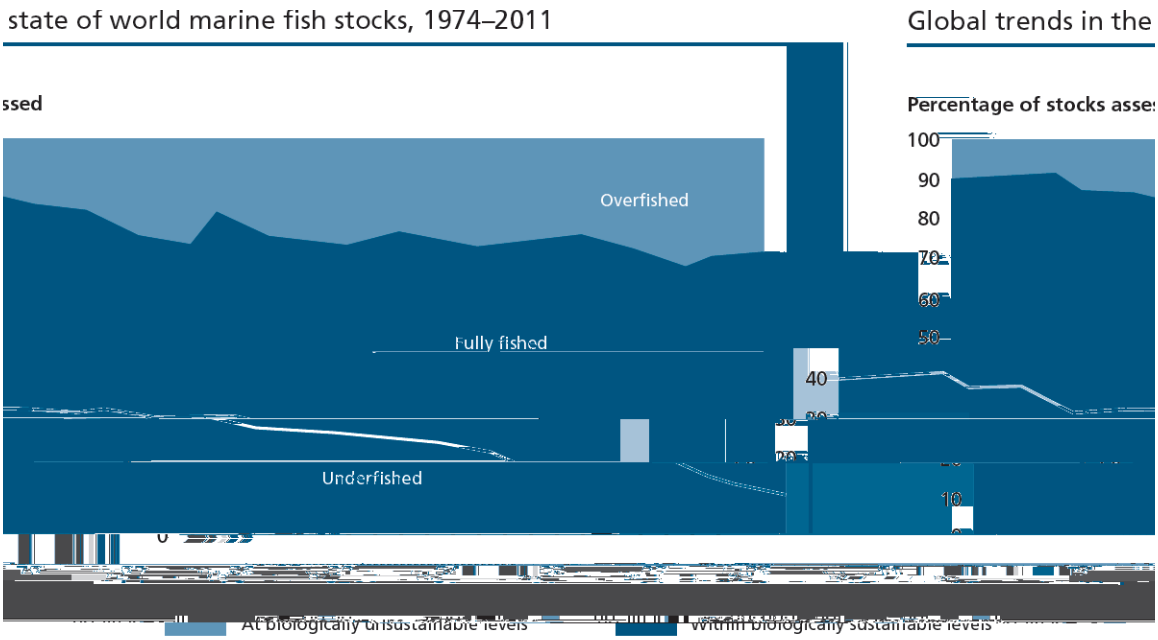

state of world marine fish stocks, 1974–2011
Global trends in the
ssed
Percentage of stocks asse
Overfished
Fully fished
Underfished
100
90
80
40
10
0
At biologically unsustainable levels
Within biologically sustainable levels

Figure 2. S

3.3 Ecosystem effects of fishing — food webs

Marine food webs are complex and exploiting commercially important species can have a wide range of effects that propagate through the food web. These include a cascading effect along trophic levels, affecting the whole food web (Casini et al., 2008; Sieben et al., 2011). The removal of top predators may result in changes in the abundance and composition of lower trophic levels. These changes might even reach other and apparently unrelated fisheries, as has been documented, for example, for sharks and scallops (Myers et al., 2007) and sea otters, kelp, and sea urchins (Szpak et al., 2013). Because of these complexities in both population and community responses to exploitation, it is now widely argued that target harvesting rates should be less than MSY. No consensus exists on how much less, but as information about harvest amounts and stock biology is more uncertain, it is agreed that exploitation should be reduced correspondingly (FAO, 1995).

The controversial concept of "balanced harvesting" refers to a strategy that considers the sustainability of the harvest at the level of the entire food web (see, for example, Bundy, A., et al. 2005; Garcia et al., 2011; FAO 2014). Rather than harvesting a relatively small number of species at their single-species MSYs, balanced harvesting suggests there are benefits to be gained by exploiting all parts of the marine ecosystem in direct proportion to their respective productivities. It is argued that balanced harvesting gives the highest possible yield for any level of perturbation of the food web. On the other hand, the economics of the fishery may be adversely affected by requiring the harvest of larger amounts of low-value but highly productive stocks.

3.4 Other ecosystem effects of fishing — by-catches

Fisheries do not catch the target species alone. All species caught or damaged that are not the target are known as by-catch; these include, inter alia, marine mammals, seabirds, fish, kelp, sharks, mollusks, etc. Part of the by-catch might be used, consumed or processed (incidental catch) but a significant amount is simply discarded (discards) at sea. Global discard levels are estimated to have declined since the early 1990s, but at 7.3 million tons are still high (Kelleher, 2005).

Fisheries differ greatly in their discard rates, with shrimp trawls producing by far the greatest discard ratios relative to landed catches of target species (Table 2).

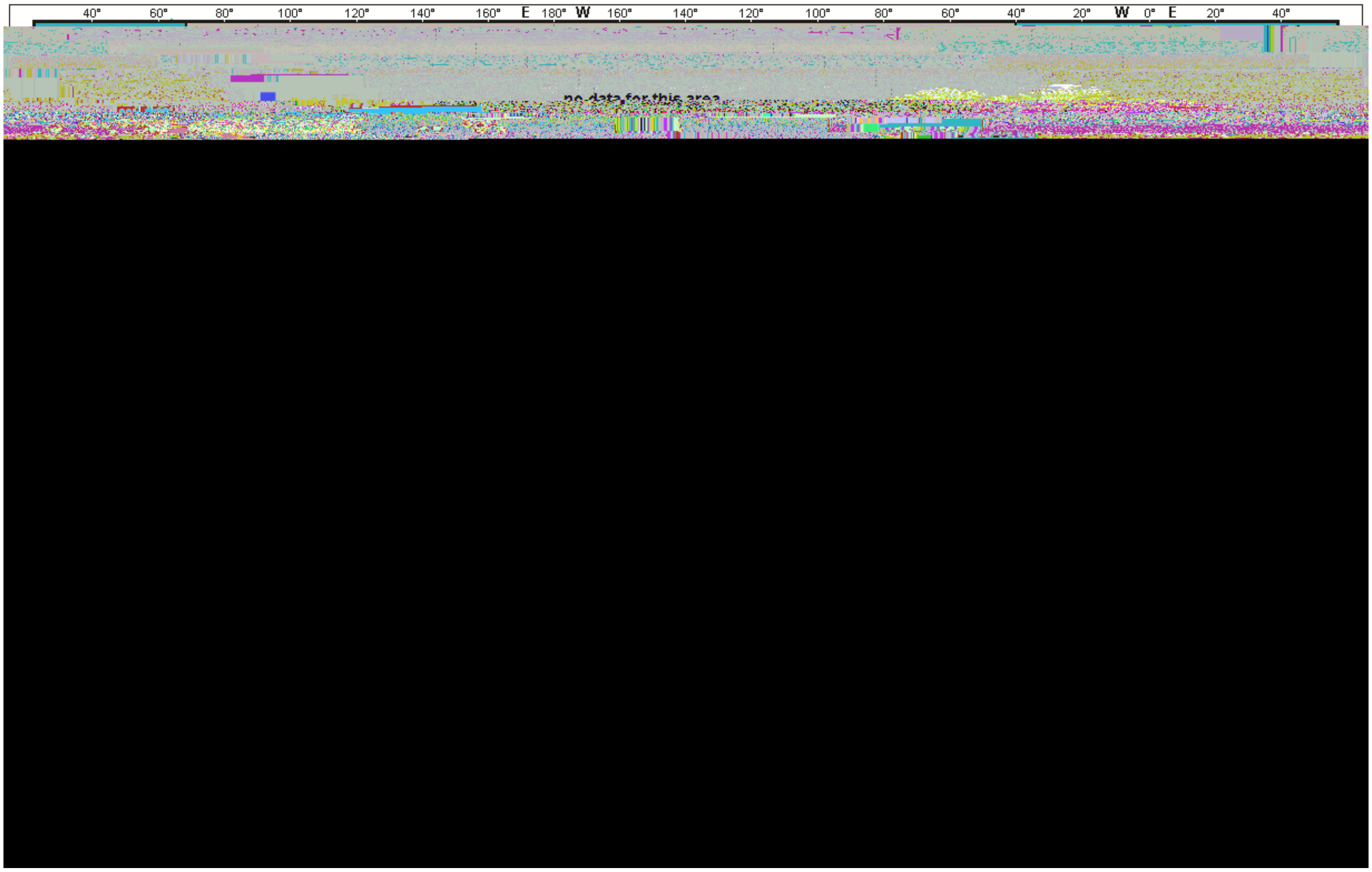
Table 3. Discards of fish in major fisheries by gear type. From Kelleher, 2005.

[redacted]

[illegible]					
60 432	1 601	0.1	0–1	Squid jig	9
[illegible]					

Very few time series have been found that document trends in by-catch levels for marine fisheries in general, or even for particular fisheries or species groups over longer periods. Although both Alverson et al. (1994) and Kelleher (2005) provide global estimates of discards

It documents the very great differences among fishe



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 3. Distribution of discards by FAO statistical areas (numbers in bold are FAO statistical areas, catches in tons). * Note: the high discard rate in FAO Area 81 is a data artefact. Source: Kelleher, 2005.

At the global level, calls for action on by-catch and discards have been raised at the United Nations General Assembly, including in UNGA resolutions on sustainable fisheries and at the Committee on Fisheries. In response, FAO developed International Guidelines on Bycatch Management and Reduction of Discards, these were accepted in 2011 (FAO, 2011).

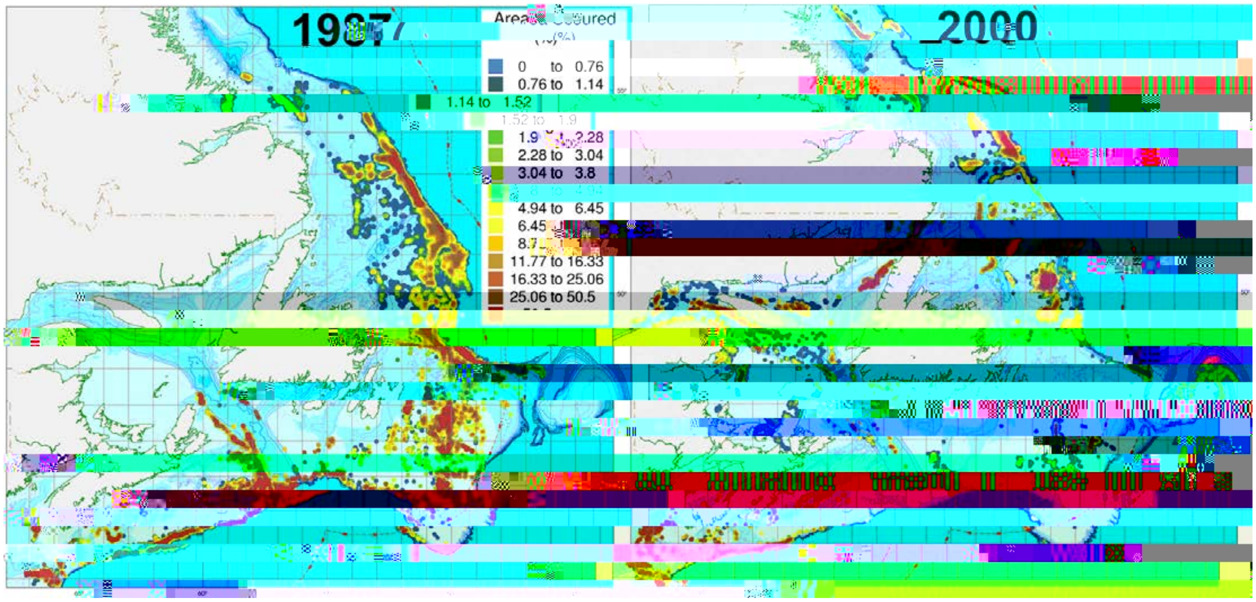
3.5 Ecosystem effects of fishing –

A very large literature exists on habitat impacts of fishing gear; experts disagree on both the magnitude of the issue and the effectiveness of management measures and policies to address the impacts. In the late 2000s, several expert reviews were conducted by FAO and the Convention on Biological Diversity in cooperation with UNEP. These reports (FAO, 2007; 2009) provide a recent summary of the types of impacts that various types of fishing gear can have on the seafloor. Most conclusions are straightforward:

- All types of gear that contact the bottom may alter habitat features, with impacts larger as the gear becomes heavier.
- Mobile bottom-contacting gear generally has a larger area of impact on the seabed than static gear, and consequently the impacts may be correspondingly larger.
- The nature of the impact depends on the features of the habitat. Structurally complex and fragile habitats are most vulnerable to impacts, with biogenic features, such as corals and glass sponges, easily damaged and sometimes requiring centuries to recover. On the other hand, impacts of trawls on soft substrates, like mud and sand, may not be detectable after even a few days.
- The nature of the impacts also depends on the natural disturbance regime, with high-energy (strong current and/or wave action) habitats often showing little incremental impacts of fishing gear, whereas areas of very low natural disturbance may be more severely affected by fishing gears.
- Impacts of fishing gears can occur at all scales of fishery operations; some of the most destructive practices, such as drive netting, dynamite and poisons, although uncommon, are used only in very small-scale fisheries (Kaiser 2001).

All gear might be lost or discarded at sea, in particular pieces of netting. These give rise to what is known as “ghost fishing”, that is fishing gear continuing to capture and kill marine animals even after it is lost by fishermen. Assessment of their impacts at either a global or local level is difficult, but the limited number of studies available on its incidence and prevalence indicate that ghost fishing can be a significant problem (Laist et al., 1999; Bilkovic et al. 2012).

Quantitative trend information on habitat impacts is generally not available. Many reports provide maps of how the geographical extent and intensity of bottom-contacting fishing gear have changed over time (e.g. Figure 4 from Gilkinson et al. 2006; Greenstreet et al. 2006). These maps show large changes in the patterns of the pressure, and accompanying graphs show the percentage of area fished over a series of years. However, these are individual studies, and broad-scale monitoring of benthic communities is not available. Insights from individual studies need to be considered along with information on the substrate types in the areas being fished to know how increases in effort may be increasing benthic impacts. Furthermore, the recovery potential of the benthic biota has been studied in some specific geographies and circumstances but broadly applicable patterns are not yet clear (e.g., Steele et e.py h(a)40 Td [(e)



The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 4. Distribution of trawling effort in Atlantic Canadian waters in 1987 and 2000, based on data of bottom-trawl activity adjusted to total effort for <150 t. From Gilkinson et al., 2006.

Even without quantitative data on trends in benthic communities, however, marine areas closed to fishing have increased. Views differ on what level of protection is actually given to areas that are labelled as closed to fishing, but the trend in increasing area protection is not challenged (c.f. CBD, 2012; Spalding et al., 2013). Moreover, the size of the areas being closed to fishing that are not already affected by historical fishing

Processing methods might significantly reduce the lead and cadmium contents of fish (Ganjavi et al. 2010) and presumably those of other contaminants, whose concentrations generally increase with size (age) of fish (Storelli et al., 2010)

Some species of fish might be toxic (venomous) on their own, such as species of the genus Siganus and Plotosus in Singapore, which are being culled to reduce their presence on beaches (Kwik, 2012) and Takifugu rubripes (fugu), whose properties are relatively well known, such that it is processed accordingly (Yongxiang et al., 2011). However, in extreme situations, human consumption of the remains of fugu processing resulted in severe episodes (Saiful Islam et al., 2011).

Fish, mussels, shrimp and other invertebrates might become toxic through their consumption of harmful algae, whose blooms increased due to climate change, pollution, the spreading of dead (hypoxic/anoxic) zones, and other causes.

Harmful algal blooms are often colloquially known as red tides. These blooms are most common in coastal marine ecosystems but also the open ocean might be affected and are caused by blooms of microscopic algae (including cyanobacteria). Toxins produced by these organisms are accumulated by filtrators that become toxic for species at higher trophic levels, including man. Climate change and eutrophication are considered as part of a com

5. Illegal, unreported and unregulated (IUU) fishing

The FAO International Plan of Action for IUU fishing (FAO 2001) defines IUU fishing as:

- Illegal fishing refers to activities conducted by national or foreign vessels in waters under the jurisdiction of a State, without the permission of that State, or in contravention of its laws and regulations; conducted by vessels flying the flag of States that are parties to a relevant regional fisheries management organization but operate in contravention of the conservation and management measures adopted by that organization and by which the States are bound, or relevant provisions of the applicable international law; or in violation of national laws or international obligations, including those undertaken by cooperating States to a relevant regional fisheries management organization;

- Unreported fishing refers to fishing activities which have not been reported, or have been misreported, to the relevant national authority, in contravention of national laws and regulations; or undertaken in the area of competence of a relevant regional fisheries management organization which have not been reported or have been misreported, in contravention of the reporting procedures of that organization;

- Unregulated fishing refers to fishing activities in the area of application of a relevant regional fisheries management organization that are conducted by vessels without nationality, or by those flying the flag of a State not party to that organization, or by a fishing entity, in a manner that is not consistent with or contravenes the conservation and management measures of that organization; or in areas or for fish stocks in relation to which there are no applicable conservation or management measures and where such fishing activities are conducted in a manner inconsistent with State responsibilities for the conservation of living marine resources under international law.

Notwithstanding the definitions above, certain forms of unregulated fishing may not always be in violation of applicable international law, and may not require the application of measures envisaged under the International Plan of Action (IPOA). FAO considers IUU fishing to be a major global threat to sustainable management of fisheries and to stable socio-economic conditions for many small-scale fishing communities. This illegal fishing not only undermines responsible fisheries management, but also typically raises concerns about working conditions and safety. Illegal fis6Td [(f)-6(i)-2(s6(i)4(s)5(5)-4(0.1)3(t)(m)]

these effects on the resources will be “mild” or “severe” will require prudent fisheries management that is precautionary enough to be prepared to assist fishers, their communities and, in general, stakeholders in adapting to the social and economic consequences of climate change (Grafton, 2009).

Small-scale, artisanal fisheries are likely to be more vulnerable to the impacts of climate change and increasing uncertainty than large-scale fisheries (Roessig et al. 2004). While small-scale fisheries may be able to economically harvest a changing mix of species, varying distribution patterns and productivity of stocks may have severe consequences for subsistence fishing. Further, the value of small-scale fisheries as providers not only of food, but also of livelihoods and for poverty alleviation will be compromised by direct competition with large-scale operations with access to global markets (Alder and Sumaila, 2004).

The data clearly indicate that the amount of fish that can be extracted from historically exploited wild stocks is unlikely to increase substantially. Some increase is possible through the rebuilding of depleted stocks, a central goal of fisheries management. Current trends diverge between well-assessed regions showing stabilization of fish biomass and other regions continuing to decline (Worm and Branch, 2012).

In Europe, North America and Oceania, major commercially exploited fish stocks are currently stable, with the prospect that reduced exploitation rates should achieve rebuilding of the biomass in the long term. In the rest of the world,

References

Alder, J., and Sumaila, U.R. (2004). Western Africa: A Fish Basket of Europe Past and Present. The Journal of Environment Development, June, 13 (2): 156-178.

Allison, E.H., Horemans, B. (2006). Putting the principles of the Sustainable Livelihoods Approach into fisheries development policy and practice. Marine Policy, 30: 757-766.

Alverson, D.L., Freeberg, M.H.,

Jennings, S., and Kaiser, M. (1998). The effects of fishing on marine ecosystems. Advances in Marine Biology 34: 201-352.

Jennings, S., Reynolds, J.D., and Mills, S.C. (1998). Life history correlates of responses to

Saiful Islam, M., Luby, S.P., Rahman, M., Parveen, S., Homaira, N., Begum, N.H., Dawlat Khan, A.K.M., Sultana, R., Akhter, S., and Gurley, E.S. (2011). Social Ecological Analysis of an Outbreak of Pufferfish Egg Poisoning in a Coastal Area of Bangladesh. American Journal of Tropical Medicine and Hygiene 85 (3) 498-503.

Satyanarayana S.D.V., Pavan Kumar, A., Amit, S., Dattatreya, A., Aditya, G. (2012). Potential Impacts of Food and it's Processing on Global Sustainable Health. Journal of Food Processing & Technology 143:

Sieben, K., Rippen, A.D., and Eriksson, B.K. (2011). Cascading effects from predator removal depend on resource availability in a benthic food web. Marine Biology 158: 391-400.

Spalding, M.D., Meliane, I., Milam, A., Fitzgerald, C., and Hale, L.Z. (2013) Protecting Marine Spaces: global targets and changing approaches, Ocean Yearbook 27: 213-248.

Steele, M.A., Malone, J.C., Findlay, A.M., Carr, M. and Forrester, G. (2002). A simple method for estimating larval supply in reef fishes and a preliminary test of population limitation by larval delivery in the kelp bass Paralabrax clathratus. Marine Ecology Progress Series 235: 195–203.

Storelli, M.M, Barone, G., Cuttone, G., Giungato, D. (2010). Occurrence of toxic metals (Hg, Cd and Pb) in fresh and canned tuna: public health implications. Food and Chemical Toxicology (48), 11: 3167–3170.

Suarez, J.L. (1927). Rapport au Conseil de la Société des Nations. Exploitation des Richesses de la Mer. Publications de la Société des Nations V. Questions Juridiques V.1. 120-125.

Szpak, P., & Orchard, T.J., Salomon, A.k., and Gröcke, D.R. (2013). Regional ecological variability and impact of the maritime fur trade on nearshore ecosystems in southern Haida Gwaii (British Columbia, Canada): evidence from stable isotope analysis of rockfish (Sebastes spp.) bone collagen. Archaeol Anthropol Sci DOI 10.1007/s12520-013-0122-y.

Townsend, H.M., Link, J.S., Osgood, K.E., Gedamke, T., Watters, G.M., Polovina, J.J., Levin, P.S., Cyr, N., and Aydin, K.Y. (eds) (2008). Report of the National Ecosystem Modeling Workshop (NEMoW). NOAA Technical Memorandum NMFS-F/SPO-87.

UNEP/CBD/FAO (2011). Report of Joint Expert Meeting on Addressing Biodiversity Concerns in Sustainable Fisheries. https://www.cbd.int/doc/meetings/mar/jem-bcsf-01/official/jem-bcsf-01-sbstta-16-inf-13-en.pdf

Worm, B., Hilborn, R., Baum, J.K., Branch, T.A., Collie, J.S., Costello, C., Fogarty, 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: 578-584.

Yamada, A.; Bemrah, N.,