South Asia and Indian Ocean Island catch updates to 2018*

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Abstract
The initial marine catch reconstructions for South Asian and Indian Ocean Island entities were completed independently for the years 1950 to 2010. These reconstructions were further updated to 2018 as documented in this contribution for the Andaman and Nicobar Islands (India), Bangladesh, the Chagos Archipelago (British Indian Ocean Territory), the Indian mainland, the Maldives, Pakistan and Sri Lanka. We conservatively accounted for the reported and unreported fisheries catches in these waters using data as reported by each country to the Food and Agriculture Organization (FAO) as the reported date baseline, and data and information reported by government or secondary data sources for unreported catches. Descriptions of the methods used to reconstruct catches in each Exclusive Economic Zone (EEZ) are presented in EEZ-specific sections.

Introduction
The original marine catch reconstructions for South Asian and Indian Ocean Island entities, including the Andaman and Nicobar Islands (India), Bangladesh, the Chagos Archipelago (British Indian Ocean Territory), mainland India, the Maldives, Pakistan and Sri Lanka were completed independently by a variety of authors. These reconstructions have been independently updated to 2016 (Maldives, Pakistan), 2017 (Andaman & Nicobar Islands, Bangladesh, Chagos Archipelago, Sri Lanka) or 2018 (India mainland) and descriptions of the methods used are presented in country-specific sections below. Catches of the industrial large pelagic fisheries were addressed separately in a global study by Coulter et al. (2020).

Materials and Methods
Andaman and Nicobar Islands (India)
The reconstruction of the marine fisheries catches within the Andaman and Nicobar Islands EEZ (part of India) were originally completed to 2010 by Hornby et al. (2015, 2016). Here, they are updated to 2017, then carried forward to 2018. Reported landings were updated using national data for 2011-2016 that are of higher taxonomic resolution than FAO data and national total landings data for 2017 (Anon. 2018, 2019). The taxonomic disaggregation for 2016 was used to disaggregate the total reported landings for 2017.

Artisanal fisheries
The reported landings data were assumed to be entirely from the artisanal sector and were applied to the corresponding existing taxonomic groups. Because the amount of reported tunas increased substantially, tuna landings were assumed to be fully reported since 2011. Longtail tuna, *Thunnus tonggol*, were assumed to account for 6.2% of total mainland India longtail tuna landings, skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*) and big eye tuna (*Thunnus obesus*) were assumed to be as reported in Anon. (2019b). The unreported coastal tuna bycatch to target species ratio was maintained at 62.2% from 2010. Catches of

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groupers (Serranidae) remained unaccounted for in reported data. Malabar grouper (Epinephelus malabaricus) appeared to account for 21.6% of the total grouper catch and 4.3% of the total annual marine landings (Kiruba-Sankar et al. 2013). Therefore, we assumed that groupers accounted for 5% of the artisanal reported catch in 1950 and 20% from 2010 to 2017.

Mollusc landings were updated with new information. Anchor points from Roy et al. (2004) were utilized with linear interpolation between anchor point years: 152 tonnes in 1933, 505 tonnes in 1975, 500 tonnes in 1983, 124.6 tonnes in 1984 and 1985, 3.2 tonnes in 1995, 2.9 tonnes in 1996, 7.3 tonnes in 1997, 0.1 tonnes in 1998, 1.7 tonnes in 1999. Fishing for mollusces was banned in 2001; however, poaching persisted (MOEF 2011; Kiruba-Sankar et al. 2019), and thus we continued to interpolate catches. The next available anchor points were the annual number of poachers apprehended with a mollusc catch from 2008 to 2018 (MOEF 2011; Kiruba-Sankar et al. 2019). Because poachers were found with a maximum of 40 mollusc shells, it was assumed that each poacher collected at least 10% of this amount on average, or 4 molluscs per poacher (Abraham 2018). The number of total poached mollusc shells was multiplied by the average wet weight from Long et al. (1993).

Tourist consumption was updated using new tourist arrival numbers and a tourist fish consumption rate of 5.6 kg of fish consumed per tourist, per average stay, as per Hornby et al. (2015). All tourist consumption was considered to be unreported artisanal catches following Hornby et al. (2015). The previous taxonomic breakdown for tourist consumption was maintained. Discards for the artisanal fishery were maintained at 0.5% of total artisanal landings. Taxonomic breakdowns for each individual fishery were maintained.

**Subsistence fisheries**
Subsistence fisheries catches were updated from 2009 to 2017 for i) indigenous subsistence, ii) take-home catch from commercial fisheries, iii) and ‘other’. Each subsistence fishery was individually updated as follows: i) indigenous subsistence utilizing indigenous population data (Anon. 2011) and a constant per capita consumption (56 kg·person⁻¹·year⁻¹); ii) take-home catch and iii) ‘other’ were updated with the existing decline in per capita consumption from 2008 of 41 kg·person⁻¹·year⁻¹ and 21 kg·person⁻¹·year⁻¹, respectively. Take-home catch was calculated using the consumption rates and updated census information on fishery household numbers. ‘Other’ subsistence catch was calculated using the non-indigenous, non-fisher population (Anon. 2011) and the consumption rates. The overall taxonomic breakdown for the subsistence fishery was maintained.

**Transition from 2017 to 2018**
The catch reconstructed to 2017 was carried forward to 2018 using the semi-automated procedure outlined in Noël (2020), based on national data. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update that will also consider information in Advani (2020).

**Marine biodiversity protection**
India has agreed to protect the biological diversity of the Andaman and Nicobar Islands (a Union Territory) through the international Convention on Biological Diversity (Aichi), the United Nations Convention on the Law of the Sea, the Ramsar Convention on Wetlands of International Importance, the International Coral Reef Initiative and the World Heritage Convention. These islands are also part of the international network of UNESCO Man and the Biosphere and signatories to regional treaties and agreements, such as the Regional Seas Convention (Marine Conservation Institute 2020).

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84 https://www.businesstoday.in/current/economy-politics/foreign-tourists-can-now-fly-directly-to-the-andamans/story/305582.html
In the Andaman and Nicobar Islands, there are 105 MPAs that occupy 1,570 km² (ENVIS 2016), which is small relative to the islands’ EEZ, i.e. 659,590 km² (Hornby et al. 2016). Most of these MPAs were established in the 1970s as ‘Sanctuaries’ (approx. 91.5%) or ‘National Parks’ (approx. 8.5%) (ENVIS 2011). “Human health, social security, and livelihoods in the A & N Islands with their substantial number of artisanal villages are closely linked to the sea through food security, shoreline protection, business, medicine, and tourism. Therefore, their management is critical mainly because of demand for the same resources by different stakeholders. There is a need to regulate the resources judicially among the various stakeholders in such a way that it should help in protection and conservation of the natural resources. […] Coastal ecosystem management needs to consider the fragile nature of these island ecosystems, incorporating the local area condition and the interests of the people” (Jha et al. 2019).

Some of the threats to the islands are development activities, terrigenous runoff and overfishing. “Fishing in Andaman and Nicobar waters is regulated by the Union territory of Andaman and Nicobar [(ANI)] as per the fishing regulations. Shells and sea cucumbers are some of the important target species for poachers in ANI waters. Currently, the surveillance of EEZ of ANI is done by Coast Guard, Marine Police, Forest department, Fishermen watch groups and a coordination committee” (Kiruba-Sankar et al. 2019).

“Along with the massive new influx of tourists, often to a relatively small area, issues have arisen of pollution, waste disposal, and fresh water requirement, all putting local infrastructure and habitats under enormous pressure” (Jha et al. 2019). In a study focused on investigating plastic debris in beach sediments of this Archipelago, the major plastic variety was irregular shaped polyethylene and polypropylene debris. “The plastic litter was contributed from tourist, shipping activities and improper handling of solid wastes. […] The plastic litters disposed in the marine environment could be carried away by currents, which then circulate around the island and finally reach the coastal areas of the Andaman and Nicobar Archipelago” (Krishnakumar et al. 2020).

**Bangladesh**

The initial reconstruction of Bangladesh’s marine fisheries catches were completed for 1950-2010 by Ullah et al. (2014, 2016), and is updated to 2017 here. New data reported by the FAO (2019) became available to 2017 and were accepted as the reported baseline.

**Commercial fisheries**

National data from the Bangladesh Bureau of Statistics (Hossain et al. 2018) were utilized for the artisanal and industrial sectoral breakdown for reported catch categories ‘Marine crustaceans nei’ (shrimps), Hilsa shad and ‘Marine fishes nei’. The artisanal and industrial sector breakdown for all other reported taxa not specified in the national data were carried forward from Ullah et al. (2014, 2016). The Bangladesh Bureau of Statistics Year Books of 2016 and 2017 (Anon. 2017; Hossain et al. 2018) indicated an almost 50% increase in the number of vessels but only a 6% increase in reported catch. Therefore, increasing catch is likely due to a massive increase in effort rather than reporting, suggesting a strong decline in catch rates, or CPUE, which is a sign of declining stocks. In the absence of new information, we maintained the artisanal unreported catch as 17.5% of reported landings. The ratio of shrimp trawl discards to industrial landings of ‘Miscellaneous marine crustaceans’ (1:6.6) was carried forward to 2017. The ratio of finfish trawl discards to the remaining industrial landings (1:0.2) was also carried forward to 2017.
Subsistence fishing
The trend of rising income and alternative sources of fish from aquaculture and inland fisheries (Hossain et al. 2018) influenced a declining subsistence catch that was noted by Ullah et al. (2014), and which has continued. Subsistence catch was updated by maintaining the coastal population per province from the Bangladesh Bureau of Statistics (Hossain et al. 2018) available for some years, as well as maintaining the existing decline in consumption using updated population data from the World Bank (2018). Taxon and gear breakdowns were maintained from Ullah et al. (2014).

Transition from 2017 to 2018
The catch reconstructed to 2017 was carried forward to 2018 using the semi-automated procedure outlined in Noël (2020), based on FAO data. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

Marine biodiversity protection
Bangladesh has agreed to protect biological diversity through the international Convention on Biological Diversity (Aichi) and the Ramsar Convention on Wetlands of International Importance (Marine Conservation Institute 2020).

Bangladesh has 12 MPAs and two marine managed areas. The implemented MPAs occupy 4,254 km², which is about 5% of the EEZ of 84,846 km² (Hornby et al. 2016).

The MPAs of Sundarban East, West and South are wildlife sanctuaries, designated in 1996 with a total no-take area of 1,396 km², i.e., (33% of the total MPAs’ extent (Marine Conservation Institute 2020). “The Sundarbans are classified as moist subtropical forest, comprised of a mosaic succession of four types of tidal forest communities: low mangrove forest, tree mangrove forest, saltwater Heritiera forest, and freshwater Heritiera forest (UNEP/WCMC 2008). The Sundarbans are important for globally endangered species, including the Ganges and Irrawaddy dolphins, estuarine crocodiles, and the critically endangered endemic river terrapin” (Claudino-Sales 2019).

“The country declared its first marine protected area, namely, the Swatch-of-No-Ground Marine Protected Area, for conservation of some species of dolphins, porpoises, whales and sharks. However, this declaration has not been supported with an effective and robust legal, policy and institutional framework. [...] Following the declaration of the MPA, the necessary legal and institutional arrangements for prohibition of illegal fishing, prevention of marine pollution from ships, restrictions on shipping and other activities are expected from the relevant government agencies for conservation of the protected species in the SoNG-MPA. However, significant initiatives regarding these are yet to be seen. [...] Forest Department also seriously lacks the capacity to deal with technical issues related to management of MPA” (Karim and Uddin 2019).

The Forest Department is the management authority of all Bengali MPAs, including the MPAs of Sundarban East, West and South. The protection of this unique ecosystems might also be affected by the lack of enforcement from the Forest Department, as well as the lack of interagency and stakeholders’ cooperation (Karim and Uddin 2019).

Chagos Archipelago (British Indian Ocean Territory)
The reconstruction of domestic marine fisheries catches in the British Indian Ocean Territory (BIOT), otherwise known as Chagos Archipelago, was completed by Zeller and Pauly (2014, 2016) for 1950-2010 and updated to 2017 using updated reported data from the FAO (2019). Since the earlier work, there were
retroactive changes to the reported data, amended here to match the 2017 FAO data baseline. Changes to ‘Tuna-like fishes nei’ were reflected in the unreported Scombridae catches.

**Recreational fishing**

Since 1972, all domestic catches in the Chagos Archipelago have been deemed recreational by military and contract staff on Diego Garcia. The population of Diego Garcia has remained around 3000 residents since 2014, and the recreational catch rate was maintained at 24.1 kg-person$^{-1}$-year$^{-1}$ since 2010. The taxonomic breakdown was also maintained. The UK declared the BIOT EEZ a commercial no-take Marine Protected Area (MPA) in 2010, thereby banning all commercial fishing but permitting recreational fishing to continue. Therefore, the ban does not affect domestic fishing.

**Foreign fisheries**

Since 2010, foreign fishing in the BIOT EEZ has been banned, but it is likely that illegal fishing occurs, notably by vessels with home ports in Tamil Nadu, India (Tickler et al. 2019) and in Sri Lanka (Martin et al. 2013).

**Transition from 2017 to 2018**

The catch reconstructed to 2017 was carried forward to 2018 using the semi-automated procedure outlined in Noël (2020), based on FAO data. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

**Marine biodiversity protection**

Within Chagos’ territory, marine biological diversity is protected through the international Convention on Biological Diversity (Aichi) (Marine Conservation Institute 2020).

Chagos has one MPA, which was implemented as a commercial no-take area in 2010 (Marine Conservation Institute 2020) occupying 100% of its EEZ of 638,555 km$^2$ (Zeller and Pauly 2016). Since then (2010), this MPA is the largest officially declared no-take area in the world.

“The creation of the no-take MPA, which banned all fishing, was opposed by several interests. Some of the objections, predictably, came from the fisheries industry. More came from arguments that its creation was little more than a cynical political exercise designed to exclude Chagossian inhabitants who had been removed in the 1970s, some of whom sought to return. Arguments were made that the fisheries were so well regulated already that a no-fishing policy was unnecessary, and even, absurdly, that it would do more harm than good, both to Chagos and other fish stocks” (Sheppard and Sheppard 2019).

“On the islands, there has been a noticeable recovery in the populations of green and hawksbill turtles, and a spectacular recovery of the large coconut crab. The latter, very easily collected and exterminated in most of its oceanic range, was absent on several islands in the 1970s and with mainly small adults only on the rest; today, most islands have very substantial numbers of large coconut crabs (an average of 30 adults per hectare in Diego Garcia). Genetics of this species has shown significant recruitment from the Seychelles and Africa, so that this Archipelago is now one of the world’s largest reservoirs of this species (Sheppard 2016)” (Sheppard and Sheppard 2019).

Other studies, also have highlighted the regional and global importance of this archipelago for different species of turtles, finding that 56% of the coastline provided suitable nesting habitat. (*Current estimates of___

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6,300 hawksbill and 20,500 green turtle clutches laid annually in Chagos represent an increase of 225–525% for hawksbill and 465–930% increase for green turtles since the 1996 surveys [...]” (Mortimer et al. 2020). This is a surprising recovery, considering that there is only one multipurpose patrol vessel, which has been previously estimated to detect just 10% of illegal fishing activity (Price et al. 2010).

**India (mainland)**

A reconstruction of India’s mainland marine fisheries catches was first completed to 2000 by Bhathal (2005) and updated to 2010 by Hornby et al. (2015), see also Bhathal et al. (2016). India’s Mainland marine fisheries catches were fully re-estimated for 1950-2018 by Ansell (2020), as summarized here, to address distinct data source problems associated with unreliable subsistence catch data sources used in Hornby et al. (2015). India’s Central Marine Fisheries Research Institute (CMFRI) data were used as the reported data baseline. Catches from inboard engine or mechanised vessels were treated as industrial, and outboard engine or unmotorized vessels were considered artisanal. A 1% discard rate was applied to industrial catches by trawlers, driven by increased retention of previously unwanted bycatch for reduction to fishmeal. Subsistence catches were assumed to be the take-home catch (5%) of artisanal fishers. These subsistence estimates are likely conservative estimates, and need investigation in future years.

Catches from the Lakshadweep Islands of the west coast of India were assumed to be missing from the formal CMFRI data due to its restrictive mandate and were estimated based on various reports by the CMFRI and the Lakshadweep regional government. Estuarine catch was assumed to be missing from CMFRI data because such catches are treated by Indian authorities as originating from inland fisheries. Thus, 90% of the marine taxa reported to be caught in estuaries was included as 95% artisanal and 5% subsistence. Since India is known to fish outside of its EEZ, 2.5% of India’s catches in the Eastern Indian Ocean were assumed to be caught in Bangladeshi waters. A few taxa commonly caught in Sri Lankan waters from 1974 to 2018 were assumed to be caught by Indian fisheries in Sri Lankan waters. Industrially caught large pelagic taxa were excluded and addressed separately in Coulter et al. (2020).

**Marine biodiversity protection**

India (mainland) has agreed to protect biological diversity through the international Convention on Biological Diversity (Aichi), the United Nations Convention on the Law of the Sea, the Ramsar Convention on Wetlands of International Importance, the International Coral Reef Initiative and the World Heritage Convention. It is also part of the international network of UNESCO Man and the Biosphere and is a signatory to regional treaties and agreements such as the Regional Seas Convention (Marine Conservation Institute 2020).

There are 25 MPAs that occupy 8,232 km² (ENVIS 2016), which is about 0.05% of an EEZ covering 1,629,607 km² (Bhathal et al. 2016). Most of them were established between the 1960s and the 1990s, and 80% were labelled as ‘Sanctuaries’, 16% as ‘National Parks’ and 4% as ‘Community Reserves’.

“Varied anthropogenic activities that are a cause for concern over and above natural disturbances include runoff and sedimentation from development activities (projects); eutrophication from sewage and agriculture; the physical impact of maritime activities; dredging, collecting, and destructive fishing practices; pollution from industrial sources, golf courses, and oil refineries; and the synergistic impacts of anthropogenic disturbances. The amount of sediments and chemicals the runoff carries to the sea has profound effects on the fertilization of eggs of marine species. Likewise, the quality of runoff water can affect the metamorphosis of the larvae of many species. Oil pollution induces mortality, decreases fecundity and fails recruitment. India has three megacities as well as many small, medium, and major ports and industries around the 8,000 km coast. The enactment of the Water Pollution Act in 1974 and the Environment Protection Act in 1986 has
helped in regulating the disposal of waste from industries. These measures have resulted in the reduction of pollution loads of the coastal waters, to a certain extent. Major industries such as fertilizer, petrochemical, agrochemical, and chemicals are mainly located along the coasts” (Raghunathan et al. 2019).

In a study that assessed the intensity and impact of marine debris in the Gulf of Mannar (GoM) identified that “[l]ive corals were found to be the commoner substrates for marine debris in GoM than dead corals and algae. [...] Apart from causing direct mechanical damage to the corals, the marine debris also paves the way for diseases or facilitates the invasion of space competitors. [...] A system involving fishermen, researchers and conservation authorities should be developed to inform about ghost gears and to remove them without damaging the corals. Proper recycling of the removed debris without damaging the environment should be developed. [...] More importantly, reduction of fishing pressure in the reef areas is a critical prerequisite to reduce the amount of abandoned fishing gears in Gulf of Mannar” (Patterson Edward et al. 2020).

Reducing fishing pressure is key to reduce debris (Patterson Edward et al. 2020) and improve protection, but fishers choose to continue using conventional fishing practices and even destructive gears such as dynamite. This is mainly due to their low income, illiteracy, and general lack of awareness of the damage they cause to ecosystems by utilizing unsustainable fishing practices (Magesh and Krishnakumar 2019). Within this area, the Marine National Park of the Gulf of Mannar, designated in 1986 with 393 km² and 193 km² of no-take area (Marine Conservation Institute 2020), and the Gulf of Mannar Biosphere Reserve, of 10,500 km² (Singh 2003), have suffered ethnic and military conflict resulting in the militarization of conservation, which includes the integration of conservation, security and counterinsurgency through violent and armed strategies. “[In these trans-boundary marine environments,] marine protected areas allow the state to achieve its security outcomes even as it fails to meet its conservation goals due to non-local drivers of declines in species populations. [This is an example of] how conservation measures are used to meet security objectives in marine environments. These strategies have violent outcomes for artisanal fishing communities who are disproportionately affected” (Muralidharan and Rai 2020).

**Maldives**

The marine fisheries catches of the Maldives were reconstructed for 1950 to 2010 by Hemmings et al. (2014, 2016), and were updated to 2016 before being carried forward to 2018. Since the data reported by the FAO (2018) and the national data from Maldives (2017) match closely, the FAO data were maintained as the reported baseline as per the original reconstruction by Hemmings et al. (2014).

**Export fisheries**

In 2010, the Maldives introduced a ban on shark fishing (Sinan et al. 2011). Following this ban, reported catches of sharks declined until a catch of 0 tonnes was reported by the FAO in 2016. The breakdown of the types of shark fishing (oceanic, reef, or traditional) and corresponding taxon breakdowns from 2010 were maintained to 2016. Sea cucumber was still considered an export by the Statistics of Maldives in 2017 (Maldives 2017). However, since 2011 no fisheries catches were reported due to production by aquaculture (Ahmed et al. 2018).

**Tuna fisheries**

A new species breakdown was created due to increased disaggregation in FAO reported data in recent years. Albacore (Thunnus alalunga), black marlin (Istiompax indica), blue marlin (Makaira nigricans), ‘Marlins, sailfish, etc. nei’, striped marlin (Kajikia audax), and swordfish (Xiphias gladius) were assumed to be caught entirely by the industrial sector, along with 80% of bigeye (Thunnus obesus), kawakawa (Euthynnus affinis), skipjack (Katsuwonus pelamis) and yellowfin tunas (Thunnus albacares). These industrially caught large
pelagic species were excluded here and addressed separately by Coulter et al. (2020). The remainder of the reported tunas were assumed to be for local consumption and were considered caught by the small-scale sectors. Estimates of unreported tuna catches followed the method of Hemmings et al. (2014, 2016) and were updated using the export statistics and product conversion factors. The ratio between reported tuna landings and live bait from pole and line fishing taken from Hemmings et al. (2014, 2016) was used to update catches to 2016.

**Consumption-based fisheries**

Two types of general fish consumption were estimated for the Maldives, i) tourist (sourced from artisanal sector) and ii) local (subsistence). Tourist consumption was updated with ‘bed nights’ from the Maldives (2017) census and multiplied by the existing declining tourist consumption rate as per Hemmings et al. (2014). For local subsistence consumption, the downward consumption trend was maintained and multiplied by new census population data (Maldives 2017). The grouper fishery was updated as per original reconstruction methods using the conversion factor of the grouper amount to updated reef fish exports (Maldives 2017). Taxa and gear breakdowns were maintained throughout the update.

**Transition from 2016 to 2018**

The catch reconstructed to 2016 was carried forward to 2018 using the semi-automated procedure outlined in Noël (2020), based on FAO data. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

**Marine biodiversity protection**

The Maldives have agreed to protect biological diversity through the international agreements of the Convention on Biological Diversity (Aichi), the United Nations Convention on the Law of the Sea, International Coral Reef Initiative and the World Heritage Convention. The Maldives is a signatory to regional treaties and agreements such as the Regional Seas Convention. It is also part of the international network of UNESCO Man and the Biosphere with the Reserve of Baa Atoll, designated in 2011 with 30 km$^2$ of marine area (Marine Conservation Institute 2020).

The Maldives have 42 MPAs and two marine managed areas. The implemented MPAs occupy 472 km$^2$ (Marine Conservation Institute 2020), which is little considering that the EEZ covers 916,000 km$^2$ (Hemmings et al. 2016). “The 2008 Constitution of the Maldives [art 22] includes a ‘fundamental duty of the state to protect and preserve the biodiversity, resources and beauty of the country for the benefit of present and future generations’ as well as ensuring every citizen has the right to a safe environment. This provides a foundation for strengthening environmental regulation, nonetheless it is clear that environmental, fisheries and tourism laws existed before this inclusion. [...] The General Fisheries Regulations ban the use of dynamite, poison and guns, as well as more specific activities: collecting sea cucumber and lobster with scuba gear, nets to catch mackerel and small reef fish, as well as trawling in some areas. It is this provision that was initially used to prohibit shark fishing in the territorial sea” (Techera and Cannell-Lunn 2019).

The shark fishing prohibition is related to ecotourism, which emphasizes shark watching. “[The] increasing abundance of sharks can raise demand for dive trips significantly [15%] and generate economic gains for both dive and local tourism industries [US$58 million annually]. The presence of illegal fishing, or if dive operators do not engage in conservation actions against illegal fishing, can result in a substantial reduction in the demand for dive trips [56%] and economic losses not only to the dive industry [US$24 million annually to the dive tourism industry], but also to the broader local tourism market” (Zimmerhackel et al. 2018).
Similarly, and because of economic and ecological benefits, there has been a movement to protect wave breaks, which are important for surfing tourism. However, the Maldives are still not on par with New Zealand, for example, where the government includes surf breaks in their marine planning. In contrast, the Maldives government has placed concrete ‘tetrapods’ for coastal protection around several islands, and thus destroyed the surf break of Male Point (Scheske et al. 2019). Coral reefs, a part of providing vital ecosystem services, are also a major tourist attraction, generating income for the country. However, the lack of wastewater treatment and proper landfills and the lack of legislation for emerging contaminants are jeopardizing these ecosystems. As a result, the health and livelihoods of the Maldivian people and the economy of the Maldives are also at risk (Rizzi et al. 2020).

**Pakistan**

The reconstruction of Pakistan’s marine fisheries catches was completed for 1950-2010 by Hornby et al. (2014, 2016) and is here updated to 2016 with a subsequent carry-forward to 2018. New data reported by the FAO were available to 2016 and were accepted as the reported baseline. There was a retroactive disaggregation of ‘Swordfish’ from ‘Tuna-like fishes nei’ from 2006 to 2010 in the FAO data that was adopted in this update to reflect the modified FAO data. The sector and gear breakdown for ‘Swordfish’ was maintained from Hornby et al. (2014), and the 90% of the large pelagic catch determined to be industrial was addressed separately by Coulter et al. (2020).

**Non-commercial fisheries**

Despite a slightly declining consumption rate, subsistence catches have risen rapidly since the 2000s. The subsistence catch was retroactively updated by interpolating between the anchor point in 1999 (Hornby et al. 2014) and a new anchor point in 2015 (FAO 2019). Updated population data (World Bank 2018) were multiplied by the annual 1.9 kg per capita consumption rate to estimate total fish consumption. According to FAO (2019), the marine component was only 56%; therefore, total fish consumption was multiplied by 56% to derive the marine fish consumption component. The gradual decline in recreational fishing was maintained in this update. Both subsistence and recreational fisheries were considered entirely unreported and the taxa and gear breakdown from Hornby et al. (2014) were maintained in this update.

**Commercial fisheries**

Reported tuna catches (kawakawa, longtail tuna, skipjack tuna, yellowfin tuna and swordfish) were considered to 10% being caught by artisanal fisheries; ‘Marlins, sailfishes, etc. nei’ were considered to 40% being caught by artisanal fisheries. The industrial portion of these taxa was addressed separately by Coulter et al. (2020). The rest of the reported taxa were split into artisanal and industrial and gear type following Hornby et al. (2014). Unreported landings for artisanal and industrial catches were carried forward using the ratio of unreported landings to reported landings from Hornby et al. (2014). Discards were carried forward using the ratio of total industrial shrimp trawl landings to discards from Hornby et al. (2014). As no new information was available, foreign fishing by Taiwan was carried forward at 128 tonnes per year.

**Transition from 2016 to 2018**

The catch reconstructed to 2016 was carried forward to 2018 using the semi-automated procedure outlined in Noël (2020), based on FAO data. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.
Marine biodiversity protection
Pakistan has agreed to protect biological diversity through the international Convention on Biological Diversity (Aichi) and the Ramsar Convention on Wetlands of International Importance (Marine Conservation Institute 2020).

Pakistan has two MPAs and eight marine managed areas. The implemented MPAs occupy 1,707 km² (UNEP-WCMC and IUCN 2020), which is less than 0.1% of the EEZ of 222,255 km² (Hornby et al. 2016). Astola Island, designated in 2017, is the first MPA in Pakistan (IUCN 2017). “Astola Island is under the ownership of Balochistan Revenue Department and is guarded by Pakistan Coast Guards and Pakistan Navy. The Balochistan Fisheries Department is responsible for management of fisheries within 12 nautical miles from the coastline [and] the Maritime Security Agency (MSA) is responsible for the enforcement of fisheries regulation” (MFF Pakistan 2018).

The principal responsibilities of the Fisheries Department are issuing and renewal of fishing licenses, preventing illegal fishing and providing support to stranded vessels and fishermen in case of emergency. However, its field staff are not equipped to deal with trawlers operating illegally. Illegal trawling fleets are large, armed with guns, and often fire at Fisheries Department patrol boat (MFF Pakistan 2018).

Even though maritime tourism is an industry that is still not well-developed in Pakistan, notably due to the absence of basic amenities (Shahzad 2020), some impacts of tourism and local fishing in Astola island are already visible. For example, kitchen waste, other solid waste and various beach activities on sandy beaches are making it difficult for female turtles to dig nests and lay their eggs (MFF Pakistan 2018).

Sri Lanka
A reconstruction of Sri Lanka’s marine fisheries catches was completed for 1950-2008 by O’Meara et al. (2011) which was updated to 2010 by O’Meara et al. (2016). Here, we document how this was updated to 2017, then carried forward to 2018.

Increasing reported catches
From 2009 to 2014, a substantial increase in FAO reported landings was observed. The increase in landings from 2009 to 2014 were assumed to be due, in part, to an increase in fishing effort, as many vessels were donated to Sri Lanka after the 2004 tsunami (Anon. 2015; Nadanasabesan 2015). Additionally, it was thought that a portion of the 2009-2014 increase in reported landings was due to improvements in reporting of catches, in which catches from subsistence fisheries are now included in reported catch. This assumption was based on the trends for estimated catch by sector in the original reconstruction, which suggest that parts of the newly increased catches may be due to improved data collection or estimation of subsistence activities.

Offshore industrial fisheries
The Ministry of Fisheries and Aquatic Resources (MFAR) estimated total reported landings caught in offshore waters for 2009-2017 (Anon. 2015). Taxa caught offshore in previous years were assumed to be caught by industrial fisheries operating both offshore and in coastal waters for 2009-2010, and entirely offshore for 2011-2017. Total offshore landings estimated by the MFAR were greater than the FAO landings data for taxa reportedly caught offshore during 2011-2014. Thus, the remaining MFAR offshore landings were taxonomically assigned to “Marine fishes not elsewhere included”.

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Coastal industrial fisheries

Total landings from coastal industrial fisheries for 2009-2010 were estimated by summing the coastal portion of reported landings of taxa caught by industrial fisheries both offshore and in coastal waters and the reported landings of marine crustaceans and other coastal taxa determined to be caught industrially. Reported landings by coastal industrial fisheries were unlikely to continue to increase at the rapid rate seen in 2009-2010. The total estimated coastal industrial landings in 2010 were held constant for 2011-2017 due to a lack of updated information on these fisheries. Once all coastal industrial taxa were accounted for, the remaining industrial coastal landings were assigned to the taxon “Marine fishes not elsewhere included”. Discards, all considered unreported (Zeller et al. 2018), from shrimp fisheries for 1980-2014 were retroactively changed and updated to 2017 using a new secondary anchor point source for 2015 based on Jones et al. (2018). Jones et al. (2018) found shrimp fishers discard 0.62 kg of non-target species for every 1 kg of shrimp they catch, which was more conservative than the rate used in O’Meara et al. (2011).

Artisanal fisheries

The total number of non-mechanized traditional crafts and non-mechanized beach seine crafts from Anon. (2015) were multiplied by an average CPUE for each gear-type to estimate the 2009-2017 reported landings by artisanal fisheries. Reported landings by beach seines in Sri Lanka were reported to be 54,410 tonnes in 2004 (FAO 2011). Using the total number of beach seines in 2004 (Anon. 2015), an annual CPUE of 51.72 tonnes per beach seine was determined. Similarly, the 2004 CPUE for non-mechanized traditional crafts was estimated to be 4.17 tonnes per craft, per year based on the remaining (non-beach seine) artisanal catch in 2004 divided by the number of traditional crafts obtained from Anon. (2015). The CPUE for each gear was assumed to remain constant for 2009-2017 and was used to calculate artisanal gear-specific landings. Total artisanal landings were disaggregated into taxa based on the FAO breakdown of coastal taxa determined to be caught by artisanal fisheries.

Subsistence fisheries

Total subsistence catches were assumed to remain constant for 2008-2017 based on O’Meara et al. (2011, 2016). The reported landings remaining after accounting for industrial and artisanal reported landings were assumed caught by subsistence fisheries. These subsistence catches were assumed to have the same taxonomic composition as the reported artisanal landings. Unreported subsistence catches were determined to be the difference between total subsistence and reported subsistence catches. The 2008 taxonomic breakdown for unreported subsistence catches was maintained for 2009-2017.

IUU fisheries

While Illegal, Unreported and Unregulated (IUU) fisheries catches by Sri Lanka in other EEZs were not estimated in the original reconstruction by O’Meara et al. (2011, 2016) or in this update, IUU fishing continues to pose a problem for fisheries management in Sri Lanka. From January 2015 to April 2016, the European Union (EU) banned exports from Sri Lankan fisheries as a result of Sri Lanka’s continued IUU fishing activities, despite previous warnings and an EU yellow card status issued in 2012 (Nadanasabesan 2015; Ramakrishnan 2016). To have the ban lifted, Sri Lanka prepared a national plan to combat IUU fishing, and introduced several rules and regulations to align with international regulations (Ramakrishnan 2016). Sri Lanka became a party to The Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (Anon. 2016). Under this agreement, Sri Lanka will take measures to support the conservation and management measures adopted by other countries and organizations and to improve multi-level cooperation to ensure its effective implementation (FAO 2016).
Despite Sri Lanka’s ban of mechanized bottom trawling in its waters in 2015, an estimated 150 Indian fishers were arrested for illegally trawling in Sri Lankan waters between January and September 2016 (Srinivasan 2016), and illegal Indian fishing in Sri Lankan waters has been known to occur for a long time (Ansell 2020). Nadanasabesan (2015) described 2000 Indian trawlers fishing three or more days per week in Sri Lanka’s EEZ in 2015. Conflicts between Indian trawlers in Sri Lanka and local Sri Lankan fishers have occurred since the end of Sri Lanka’s civil war, and have added to the pressure of destructive fishing methods such as dynamite fishing and illegal net usage (Bavinck 2015; Nadanasabesan 2015). IUU fishing by Sri Lankan vessels in the waters of other countries, such as the British Indian Ocean Territory (Chagos Archipelago) no-take MPA, also contributes to concerns about the lack of fisheries control in and by Sri Lanka (Graham et al. 2010).

**Transition from 2017 to 2018**
The catch reconstructed to 2017 was carried forward to 2018 using the semi-automated procedure outlined in Noël (2020), based on FAO data. Semi-automated reconstructed catch data will later be replaced by a more detailed, research-intensive update.

**Marine biodiversity protection**
Sri Lanka has agreed to protect its marine biological diversity through the international Convention on Biological Diversity (Aichi), and the Ramsar Convention on Wetlands of International Importance; it is also part of the international network of UNESCO Man and the Biosphere (Marine Conservation Institute 2020).

Sri Lanka has 12 MPAs and five marine managed areas. The implemented MPAs occupy 334 km², which is very small vis-a-vis an entire EEZ of 531,000 km² (O’Meara et al. 2016). “The first true MPA in Sri Lanka was declared in 1961 at Hikkaduwa in the form of a fisheries protected area under the Fisheries Ordinance to halt indiscriminate fishing. [...] The major legislation used in declaring protected areas is the Fauna and Flora Protection Ordinance (FFPO) of 1993, which is administered by the Department of Wildlife Conservation (DWC). National parks provide the highest level of protection and do not allow any form of resource extraction. They also require regulation of access for non-extractive uses, although this is currently not carried out within marine national parks. Sanctuaries allow open access for non-extractive uses, and limited subsistence-based resource extraction under permit. [...] Most Sri Lankan MPAs have been declared without adequate consideration of suitable management options or their practicality” (Perera and de Vos 2007).

“Sri Lankan and South Indian fishermen have been using the Palk Bay and Gulf of Mannar waters for a long period. Nevertheless, after signing the maritime agreements in 1974 and 1976, Indian fishermen encroaching Sri Lankan waters with the usage of bottom trawlers (banned in Sri Lanka) has been a serious issue (which worsened since the cessation of the ethnic conflict in 2009). However, in the Fisheries Act (Regulations of Foreign Fishing Boats) it is not indicated what type of fishing gear, methods and harmful material are prohibited (with or without any permits), while there is no specific penalty system for usage of banned fishing gear, materials and methods. Hence there is a requirement to reform the existing laws with proper law enforcement and regular monitoring of illegal fishing” (Kularatne 2020).

Tourism is growing in Sri Lanka, along with other threats to marine ecosystems. However, community-based tourism could be used as an instrument for coastal natural resources conservation and be a very important tool to sustain the cooperation of low-income fishermen involved in turtle conservation (Rathnayake 2016).

**Results and Discussion**
The results of the reconstruction updates presented above for South Asia and Indian Ocean Islands are summarized in Figure 1 and are also available on the website of the Sea Around Us (www.seaaroundus.org).
Figure 1. Catches in the South Asia and Indian Ocean Island region examined here for 1950-2018, by A) EEZ; and B) fishing sector. Andaman and Nicobar Islands (India), Bangladesh, Chagos Archipelago (British Indian Ocean Territory), India (mainland), Maldives, Pakistan and Sri Lanka EEZs; and B) fishing sector. The overlaid dashed line represents the reported catch as indicated by the FAO. Industrially caught large pelagic species catches are excluded, and are addressed by Coulter et al. (2020).

Not considering the industrial large pelagic fisheries catches that are excluded here (but see Coulter et al. 2020), catches in the Indian mainland dominate the region examined in this chapter (Figure 1A). Overall, while industrial fisheries dominate total catches, a substantial portion of catches are derived from small-scale commercial (i.e., artisanal) and non-commercial fisheries (Figure 1B). Much of the small-scale non-commercial fisheries catches are unreported, and recreational fisheries in the area are minimal.

Acknowledgements
Funding for the work presented here was provided by the Minderoo Foundation, by the Marisla, Oak, and David and Lucille Packard Foundations, and by the Bloomberg Philanthropies through Rare.

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Bangladesh


Chagos Archipelago (U.K)


India (Mainland)


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**Maldives**


Pakistan

Sri Lanka


