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Report

Current and Future Sustainability of Island Coral Reef Fisheries

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Summary

Overexploitation is one of the principal threats to coral reef diversity, structure, function, and resilience [1, 2]. Although it is generally held that coral reef fisheries are unsustainable [3–5], little is known of the overall scale of exploitation or which reefs are overfished [6]. Here, on the basis of ecological footprints and a review of exploitation status [7, 8], we report widespread unsustainability of island coral reef fisheries. Over half (55%) of the 49 island countries considered are exploiting their coral reef fisheries in an unsustainable way. We estimate that total landings of coral reef fisheries are currently 64% higher than can be sustained. Consequently, the area of coral reef appropriated by fisheries exceeds the available effective area by ~75,000 km^2, or 3.7 times the area of Australia's Great Barrier Reef, and an extra 196,000 km^2 of coral reef may be required by 2050 to support the anticipated growth in human populations. The large overall imbalance between current and sustainable catches implies that management methods to reduce social and economic dependence on reef fisheries are essential to prevent the collapse of coral reef ecosystems while sustaining the well-being of burgeoning coastal populations.

Results

Overall, 55% of coral reef fisheries in 49 island countries are unsustainable—according to either their ecological footprint or their exploitation status (Figure 1 and 2). One-third (17 of 49) of the islands have unsustainable ecological footprints (>1), assuming a maximum sustainable yield of 5 mt · km^{-2} · yr^{-1} (Figure 2). The proportion of islands with unsustainable footprints ranges from 18% to 71% under optimistic and pessimistic sustainable-yield scenarios, respectively. Nearly half (23 of 49) are categorized as overexploited or collapsed (Figure 2). Most under- or fully exploited islands (23 of 26) also had sustainable ecological footprints of <1, suggesting that both measures of sustainability are consistent (Figure 2). These 49 island nations landed 964, 154 mt · yr^{-1} of coral-reef-associated fishes, crustaceans, and molluscs, which is 375,154 mt · yr^{-1} or 64% greater than the estimated sustainable yield (see Table S5 in the Supplemental Data available online). The combined global coral-reef-fisheries footprint across the study islands is 1.64. This implies that the Earth would require an additional 75,031 km^2 of coral reef area with the same productivity and resilience as the studied reefs to ensure that current catches are sustainable—an area that is equivalent to 3.7 Great Barrier Reefs.

Human population size and coral reef area were significant predictors of ecological-footprint size and explained 49% of the variation ($F_{2,45} = 21.8$, $p < 0.001$, $n = 49$; Figure 3). This is consistent with empirical island-scale field studies that have shown that the number of islanders per unit of coral reef is a good predictor of both fishing effort and the direct and indirect effects of fishing [9–11]. The close correlation between coral-reef-fisheries footprints and human population density allowed a forecast, using island-specific human population projections, of future footprints to 2050. The combined coral reef footprint across all islands is projected to increase by ~160% between now and 2050 under the UN Population Division's growth scenarios. The overall coral reef area appropriated by 2050 is projected to be 313,271 km^2. This is equivalent to a deficit of 196,041 km^2 of coral reef (Table 1). This estimate of future fisheries landings and sustainability could also be influenced by the potential abandonment of atolls as a result of projected sea-level rise (lowering fishing pressures) and bleaching-induced coral mortality (lowering reef productivity).

Discussion

We reveal a high overall level of unsustainability in island coral reef fisheries worldwide. However, there is considerable variation among islands, and many coral reef fisheries, particularly in the Pacific Ocean, appear sustainable. There are five reasons why we should not be complacent about the status of these island fisheries and why we may have overestimated sustainability. First, coral reef catches may be greater than estimated because a large proportion of reef landings go unreported as a result of difficulties in recording catch from diverse multispecies fisheries in remote places [6, 12]. Overall underreporting of landings is almost unknown, but in American Samoa reconstructed coral-reef-fisheries catches were 17-fold greater than reported in official FAO statistics [13]. Second, the overall ecological footprint is underestimated by approximately 10% because

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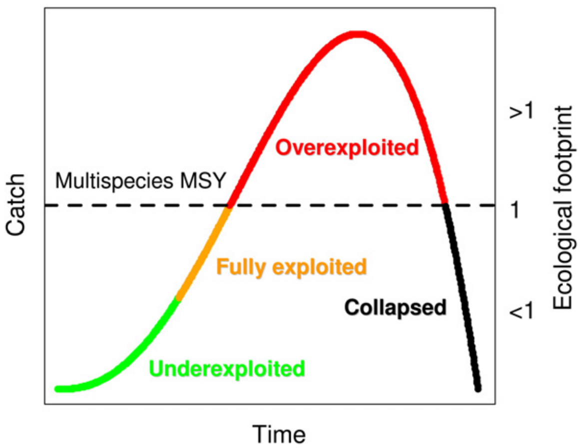

Figure 1. The Development of a Fishery and Its Ecological Footprint through Time

If regulation is ineffective, overexploitation and collapse will occur. The dashed line shows the multispecies maximum sustainable yield (MSY), which will be the sum of the sustainable yields of the component species. Species in the multispecies community respond differently to fishing as a consequence of their life histories, and thus multispecies MSY will vary with exploitation and community composition. The development and demise of a fishery can be categorized into four phases: underexploited (catch < MSY, ecological footprint < 1), fully exploited (catch ≈ MSY, footprint < 1), overexploited (catch > MSY, footprint > 1), and collapsed (catch < MSY, footprint < 1).

we conservatively included nine islands with collapsed fisheries, yet apparently sustainable footprints. Third, a proportion of FAO landings (marine fish "not elsewhere identified") which may have been coral reef derived were excluded from the analysis (see Supplemental Data). Fourth, our analysis did not incorporate the impacts of the trade in ornamental, aquarium, and live-food fishes [8]. Finally, estimates of sustainable yields assumed that fisheries productivity has not been affected by ongoing coral reef degradation and loss [14]. This is unlikely because the removal of top predators and herbivores by fishing can have detrimental cascading effects on coral reef structure and function, effects that may also reduce fisheries productivity [11, 15, 16]. Climate change is expected to have substantial impacts on reef health and productivity [17, 18], and future work could consider the interaction of overexploitation with bleaching- and disease-induced coral loss. The effects of lower-than-expected sustainable yields and underestimated catches suggest that our footprints are conservative

Our estimate of the proportion of islands that are unsustainably exploited is consistent with findings of a qualitative indicator-based assessment that found 36% of the world's reefs at risk from overexploitation [19]. The trade in live reef fish alone is highly unsustainable, with ecological footprints of 2.5 and 6 in the Indo-Pacific Ocean and South East Asia, respectively [8]. These continental live-reef-fish-fishery footprints are considerably greater than the island footprints reported here (average island footprint = 1.42), commensurate with the greater population densities and diversity of impacts affecting continental coastlines.

Coral reef fisheries account for a small fraction (2%–5%) of global fisheries catches [20]. However, the global importance of these fisheries lies not in the absolute magnitude of the catch, but in terms of their contribution to the protein and income needs of the poorest people in the developing world [6, 21]. Millions of people and thousands of communities are dependent on coral reef fisheries [22]. Unchecked, the high levels of current and projected overexploitation can only lead to long-term social and economic hardship for islanders, and forgone development opportunities [3]. The size of the reef-fishery footprint indicates the scale of the management challenge to ensure sustainable use. Given high

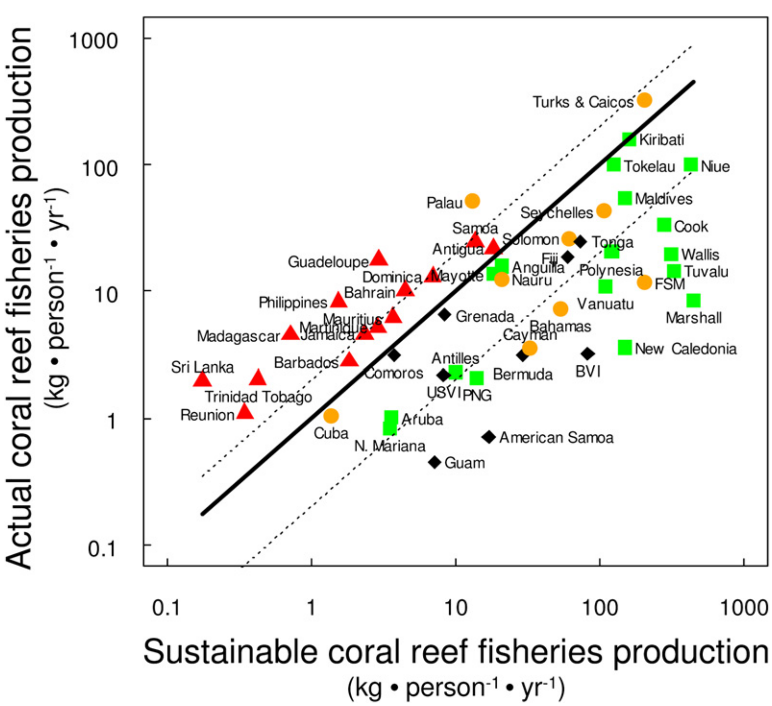

Figure 2. Globally, Over Half of the Island Coral Reef Fisheries Considered Are Unsustainable

The bold line represents an ecological footprint of 1 (where resource consumption balances sustainable reef production, assuming a sustainable yield of 5 mt $\cdot$ km^{-2} $\cdot$ yr^{-1}). Islands above and to the left of the bold line have unsustainable footprints. Island reef fisheries status is represented by four symbols—green squares, underexploited; orange circles, fully exploited; red triangles, overexploited; and black diamonds, collapsed—with the colors following Figure 1. Thin dashed lines represent ecological footprints of 1 under the optimistic (upper line, 10 mt $\cdot$ km^{-2} $\cdot$ yr^{-1}) and pessimistic (lower line, 1 mt $\cdot$ km^{-2} $\cdot$ yr^{-1}) MSY scenarios.

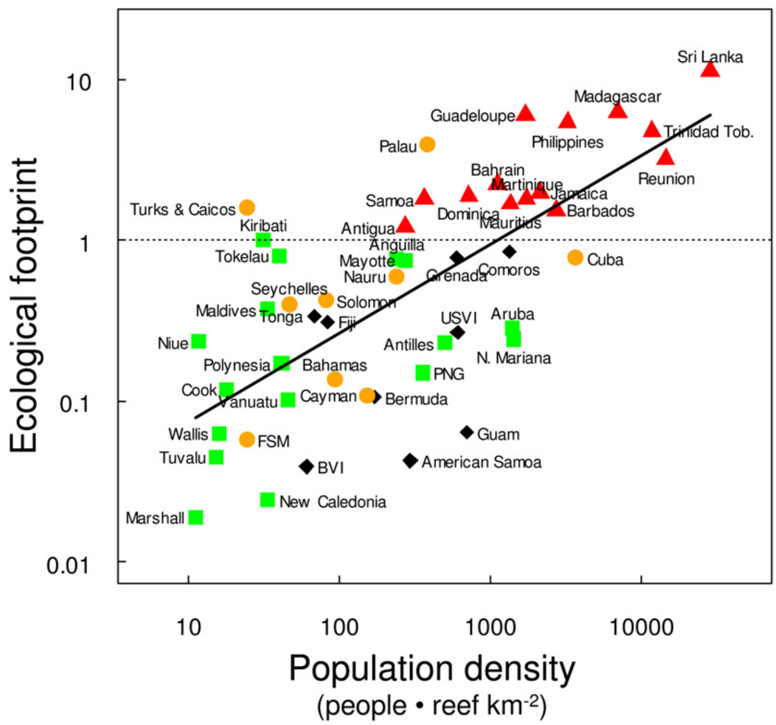

Figure 3. Densely Populated Islands Have Unsustainable Coral-Reef-Fisheries Footprints

There is a positive relationship between human population density per unit area of island coral reef and ecological footprint size. The line represents the least-squares regression model [$\log_{10}$ ecological footprint = 0.53 · ($\log_{10}$ persons · coral reef km^{-2}) − 1.59]. The dashed line represents an ecological footprint of 1 for an MSY of 5 mt · km^{-2} · yr^{-1}. Island reef fisheries status is represented by four symbols—green squares, underexploited; orange circles, fully exploited; red triangles, overexploited; and black diamonds, collapsed.

levels of dependency on reef fisheries, the catch reductions needed to move overexploited and collapsed fisheries toward sustainability are unlikely to be achieved without identifying and supporting alternative livelihoods for many of the people currently dependent on reef fisheries [23]. Thus, the move toward ecological sustainability, whether driven by rights-based management, marine protected areas, or other tools, will only be achieved if reliance on current total catches can be reduced—an essential action but one that lies largely outside the control of conventional fisheries management [6]. At the island scale, comparison of sustainable and unsustainable fisheries could provide further insight into the social, economic, and ecological factors that favor sustainability. This insight, coupled with a more detailed understanding the compounding effects of climate change, disease, pollution, and acidification, would help support more effective management, but only if the issues surrounding socioeconomic dependency are also addressed.

Experimental Procedures

Selection of Countries and Territories

We considered only noncontinental coral reef island countries and territories because we had more confidence that we could attribute their fisheries landings to source ecosystems than for continental nations and islands (e.g., Australia). This study encompasses 41% of the global coral reef area and almost one million metric tons (mt) of landings, representing 23%–69% of global coral-reef-fisheries landings (assuming a total global annual landing of 1.4–4.2 million metric tons) [5].

Calculation of Ecological Footprints

Ecological footprints represent the effective reef area appropriated by fishers to provide ecosystem products and services. The ecological footprint of coral reef fisheries was calculated for each island as the ratio of resource consumption (i.e., reef-derived landings) to sustainable reef-fisheries production [8, 24]. Resource consumption was calculated from fisheries landings statistics reported to the Food and Agriculture Organization (FAO) FISHSTAT database. Positive ecological footprints (>1) represent unsustainable exploitation. We report footprints as the total coral reef area appropriated by the current levels of fisheries exploitation. Landings were disaggregated to species level, where possible; then, reef-derived consumed fish, molluscs, and crustaceans were extracted for each island for each year. The rules used to assign FAO landings statistics to taxonomic categories and ecosystems and an evaluation of the robustness of conclusion to different categorizations are detailed in the Supplemental Data. Mean consumed coral-reef-fishery landings were calculated for each island from 1997 to 2001 and expressed as kg · $person^{-1}$ · yr^{-1}. Sustainable reef-fisheries production was derived by multiplying the coral reef area of each island country [25] by an estimated maximum sustainable yield for seafood derived only from coral reefs [8]. Coral-reef-fishery yields range from 0.2 to 40 mt · km^{-2} · yr^{-1} with a median yield of ∼3 mt · km^{-2} · yr^{-1}

Table 1. Future Ecological Footprints and Effective Coral Reef Area Appropriated for Island Coral Reef Fisheries

Year	Predicted Reef Landings (mt · yr^{-1})	Unsustainable Reef Landings (mt · yr^{-1})	Ecological Footprint	Reef Area Appropriated (km^2)	Reef-Area Deficit (km^2)
2015	1,173,796	584,977	2.0	234,356	117,126
2025	1,324,827	738,677	2.3	264,560	147,330
2050	1,568,404	982,254	2.7	313,271	196,041

Unsustainable reef landings are derived by subtracting the sustainable component (∼589,000 mt · yr^{-1}) from the predicted reef landings, assuming a coral reef maximum-sustainable-yield value of 5 mt · km^{-2} · yr^{-1}.

(n = 79) [12, 21, 26]. The higher yields come from small shallow areas of actively growing coral reef, and the lower yields are associated with coralline shelf areas including sand, rock, and other substrata [21, 27]. We used an average sustained yield of ~5 mt · km^{-2} · yr^{-1}, which is more realistic for this broader definition of coral reef habitat, but we also consider pessimistic (1 mt · km^{-2} · yr^{-1}) and optimistic (10 mt · km^{-2} · yr^{-1}) scenarios [8, 12, 27] (Table S5). We assume a single maximum sustained yield; however, this value is likely to vary locally depending on a range of factors—for example, island size, reef area, species richness, and the mean trophic level of catch [28].

The Exploitation Status of Coral Reef Island Fisheries

We searched primary and secondary literature and global and regional fisheries databases, and we questioned local scientists and fisheries officers for estimates of the status of the inshore coral reef fisheries of each island. We categorized these status estimates into four stages of fisheries development: (a) underexploited, (b) fully exploited, (c) overexploited, and (d) collapsed [29]. Where there were signs only of local overexploitation, these islands were scored conservatively as under- or fully exploited. Countries were scored as overexploited only when there was evidence for widespread depletion of target species to levels of abundance that were inconsistent with obtaining high and sustainable catches. Countries with a footprint of <1 and overexploited status were scored as collapsed (see Supplemental Data for full details).

Correlates of Coral Reef Fisheries Footprints

Eleven dependent variables were considered on the basis that each might have some direct or indirect effect on coral reef productivity, and therefore on the sustainability of coral reef fisheries (Table S6). The minimum adequate model was sought via information-theoretic model selection with Akaike's information criterion (AIC). The two most significant predictor variables were total human population size (t = 6.2, $p < 0.0001$) and total coral reef area ($t = -4.9$, $p < 0.0001$). We collapsed both variables to give the number of people per square kilometer of coral reef ($people^{-1}$ · coral reef km^{-2}). The calculation of the future island coral reef footprints is detailed in the Supplemental Data.

Supplemental Data

Supplemental Data include Experimental Procedures, one figure, and six tables and are available with this article online at http://www.current-biology.com/cgi/content/full/17/7/655/DC1/.

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Supplemental Data

Current and Future Sustainability of Island Coral Reef Fisheries

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Supplemental Experimental Procedures

Categorization of Fisheries Landings Statistics

Island countries and territories were selected with these criteria: presence of coral reefs, as defined in [S1]; presence of coral reef fisheries; and availability of fishery landings and human population statistics for 1997–2001.

We calculated average landings of fish, crustaceans, and molluscs for each island over the span of 1997 to 2001 from the Food and Agriculture Organization of the United Nations (FAO) FISHSTAT website database (http://www.fao.org/). FAO landings statistics were categorized according to the most likely source ecosystem (coral reef, demersal, ocean, freshwater, and estuarine), taxon (elasmobranch fishes, teleost fishes, molluscs, crustaceans, and echinoderms), and human use (consumed or destined for the aquarium trade) (Table S1). Only coral-reef-associated species, i.e., those living predominantly on or near coral reef ecosystems and deriving energy from coral reefs and associated habitats for a major proportion of their lifespan, were considered. We followed the definitions and categorizations of ecosystem, taxonomy, and human use provided in FishBase and CephBase [S2, S3]. We used the primary literature to categorize landings of molluscs and crustaceans [S4–S6].

FAO statistics report family-level landings for many important fish groups but some species within these families are not coral reef associated. We assumed that the majority of species within these families are coral reef associated and explored the sensitivity of the footprints to the exclusion of these families. Twenty-four family-level categories made up half (52% or 499,028 metric tons [mt]) of the total coral-reef-derived fish landings considered here. The most important groups were scads nei (nei = not elsewhere included) (26.8%), carangids nei (4.8%), ponyfishes (=slipmouths) nei (6.7%), and threadfin breams nei (3%). All other groups each made up a relatively small proportion (<3%) of total reef-derived landings (Table S2).

The conclusions drawn from ecological-footprint analysis were robust to the removal of these four landings categories. The most affected counties are the Philippines and Sri Lanka. Removing all four families reduced the Philippines coral-reef-fisheries footprint from 5.4 to 2.5. Sri Lanka has a large continental shelf area and a potentially large non-reef-derived catch of carangids nei; however, removing this family lowered the footprint slightly, from 11.25 to 8.64. Removing all four groups reduced the overall average ecological footprint of each country from 1.42 to 1.28, and exclusion of both the Philippines and the four most important families reduced the overall average footprint of each country to 1.25.

Categorization of Marine Fishes Not Elsewhere Included, or "mfnei"

Island coral reef countries typically have two main fisheries: (1) a large pelagic tuna fishery, and (2) an inshore subsistence or artisanal fishery largely for coral-reef-dependent species [S6–S9]. The tuna are usually destined for export markets; by contrast, the coral reef fisheries tend to provide important livelihoods, earnings, and a protein source for islanders [S6, S9, S10]. Tuna fisheries are generally of higher national importance because they generate considerable trade revenues, and, accordingly, catch statistics for tuna fisheries are well reported and usually disaggregated to species level [S11]. In contrast, catch statistics for the inshore coral-reef-dependent sector tend to be less accurate and poorly disaggregated [S12, S13]. For many countries considered here, the FAO landings attributed as derived from coral reef habitat were much lower than expected, and much of the non-pelagic fishery landings are reported by FAO as marine fish nei. To assess the scale of this problem, we compared marine fish nei landings to the fish landings and total landings. Marine fish nei made up between 0.35% and 100% of total landings of each country, with the exception of Aruba, which did not report any landings in this category (Table S3).

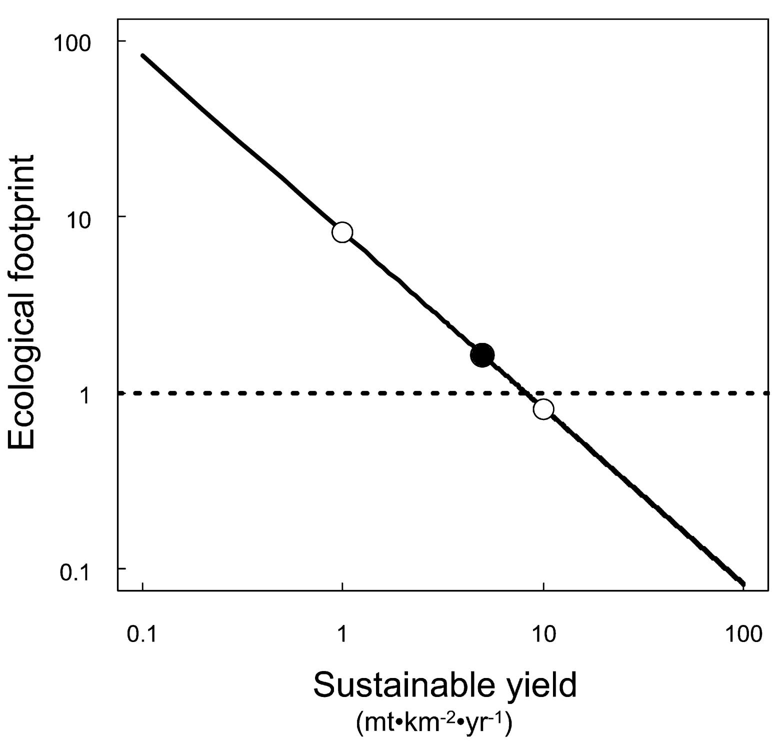

Figure S1. The Sensitivity of Coral Reef Fisheries Footprints to a Range of MSYs

Typical yield estimates of coral reef fisheries range from 0.2 to 40 mt · km^{-2} · yr^{-1}, with MSY estimates lying closer to 1–15 mt · km^{-2} · yr^{-1}. The ecological footprint reported here is represented by the filled circle (MSY = 5 mt · km^{-2} · yr^{-1}) and is flanked by open circles representing the ecological footprint for MSYs of 1 and 10 mt · km^{-2} · yr^{-1}. The dashed line represents the sustainability horizon where the ecological footprint is 1.

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Table S1. The Categorization of FAO Landings by Ecosystem, Taxon, and Human Use

FAO Landings Category	Ecosystem	Taxonomy	Human Use
Abalones nei	dm	mo	c
Albacore	o	f	c
Alfonsinos nei	dm	f	c
American eel	fw	f	c
Anadara clams nei	r	mo	c
Anchovies, etc. nei	o	f	c
Angelfishes nei	dm	f	t
Aquatic invertebrates nei	r	inv	c
Ark clams nei	r	mo	t
Atlantic bluefin tuna	o	f	c
Atlantic bonito	o	f	c
Atlantic moonfish	e	f	c
Atlantic sailfish	o	f	c
Atlantic seabob	o	f	c
Atlantic thread herring	r	f	c
Atlantic white marlin	o	f	c
Banana prawn	dm	cr	c
Barracudas	r	f	c
Barramundi	e	f	c
Batfishes	r	f	c
Bigeye scad	r	f	c
Bigeye tuna	o	f	c
Black marlin	o	f	c
Black stone crab	dm	cr	c
Blackfin tuna	o	f	c
Blacklip abalone	r	mo	c
Blacktip shark	r	e	c
Blue crab	e	cr	c
Blue marlin	o	f	c
Blue swimming crab	e	cr	c
Blue tilapia	fw	f	c
Bluestripe herring	r	f	c
Boxfishes nei	r	f	c
Brazilian sardinella	o	f	c
Broad-striped anchovy	o	f	c
Butterfishes, pomfrets nei	o	f	c
Carangids nei	r	f	c
Cardinalfishes, etc. nei	r	f	t
Caribbean spiny lobster	r	cr	c
Cephalopods nei	o	mo	c
Cero	r	f	c
Chacunda gizzard shad	e	f	c
Chub mackerel	o	f	c
Cichlids nei	fw	f	c
Clams, etc. nei	r	mo	c
Clupeoids nei	o	f	c
Cobia	r	f	c
Common dolphinfish	r	f	c
Common squids nei	o	mo	c
Conger eels, etc. nei	dm	f	c
Croakers, drums nei	r	f	c
Cusk-eels, brotulas nei	dm	f	c
Cuttlefish, bobtail squids nei	r	mo	c
Cyprinids nei	fw	f	c
Demersal percomorphs nei	dm	f	c
Diadromous clupeoids nei	o	f	c
Dogtooth tuna	o	f	c
Echinoderms	r	ec	c
Emperors (=scavengers) nei	r	f	c
Endeavour shrimp	o	cr	c
False trevally	o	f	c
Filefishes, leatherjackets nei	r	f	t
Flatfishes nei	dm	f	c
Flyingfishes nei	o	f	c
Freshwater crustaceans nei	fw	cr	c
Freshwater fishes nei	fw	f	c
Freshwater gobies nei	fw	f	c
Freshwater molluscs nei	fw	f	c
Freshwater prawns, shrimps	fw	cr	c

Table S1. *Continued*

FAO Landings Category	Ecosystem	Taxonomy	Human Use
Frigate and bullet tunas	o	f	c
Fusiliers	r	f	c
Gastropods nei	r	mo	c
Giant river prawn	fw	cr	c
Giant tiger prawn	dm	cr	c
Glassfishes	fw	f	c
Goatfishes	r	f	c
Goatfishes, red mullets nei	r	f	c
Gobies nei	r	f	c
Green mussel	fw	mo	c
Green seaweeds	r	p	c
Green turtle	r	r	c
Groupers nei	r	f	c
Groupers, seabasses nei	r	f	c
Grunts, sweetlips nei	r	f	c
Gudgeons, sleepers nei	fw	f	c
Hairtails, scabbardfishes nei	dm	f	c
Halfbeaks nei	r	f	c
Hawksbill turtle	r	r	c
Indian mackerel	o	f	c
Indian mackerels nei	o	f	c
Indian pellona	fw	f	c
Indo-Pacific king mackerel	o	f	c
Indo-Pacific sailfish	o	f	c
Indo-Pacific swamp crab	m	cr	c
Indo-Pacific tarpon	e	f	c
Jacks, crevalles nei	r	f	c
Japanese eel	fw	f	c
Jellyfishes	o	f	c
Kawakawa	dm	f	c
King mackerel	o	f	c
Lane snapper	r	f	c
Large-eye breams	r	f	c
Little tunny (=Atl. black skipj)	o	f	c
Lizardfishes nei	r	f	c
Loggerhead turtle	r	r	c
Longbill spearfish	o	f	c
Longtail tuna	o	f	c
Mackerels nei	o	f	c
Mangrove cupped oyster	m	mo	c
Marine crabs nei	e	cr	c
Marine crustaceans nei	dm	cr	c
Marine fishes nei	o	f	c
Marine molluscs nei	dm	mo	c
Marine shells nei	r	mo	t
Marine turtles nei	r	r	t
Marlins, sailfishes, etc. nei	o	f	c
Milkfish	r	f	c
Mojarras (=silver-biddies) nei	r	f	c
Moonfish	r	f	c
Mozambique tilapia	fw	f	c
Mullets nei	e	f	c
Narrow-barred Spanish mackerel	o	f	c
Nassau grouper	r	f	c
Natantian decapods nei	dm	cr	c
Needlefishes nei	r	f	c
Needlefishes, etc. nei	r	f	c
Nile tilapia	fw	f	t
Northern pink shrimp	dm	cr	c
Oceanian crayfishes nei	fw	cr	c
Octopuses, etc. nei	r	mo	c
Opah	o	f	c
Parrotfishes nei	r	f	c
Patagonian toothfish	dm	f	c
Pearl oyster shells nei	r	mo	t
Penaeus shrimps nei	dm	cr	c
Percoids nei	o	f	c
Philippine catfish	r	f	c
Pomfrets, ocean breams nei	o	f	c
Ponyfishes (=slipmouths)	r	f	c

Table S1. *Continued*

FAO Landings Category	Ecosystem	Taxonomy	Human Use
Porgies	r	f	c
Porgies, seabreams nei	r	f	c
Portunus swimcrabs nei	e	cr	c
Queenfishes	r	f	c
Rainbow runner	r	f	c
Rainbow sardine	r	f	c
Rays, stingrays, mantas nei	r	e	c
Red grouper	r	f	c
Red hind	r	f	c
Red seaweeds	r	p	c
River and lake turtles nei	fw	r	c
River eels nei	fw	f	c
River prawns nei	fw	cr	c
Round sardinella	o	f	c
Ruffs, barrelfishes nei	o	f	c
Sardinellas nei	o	f	c
Scads nei	r	f	c
Scaled sardines	o	f	c
Scallops nei	dm	mo	c
Scats	r	f	c
Sea catfishes nei	e	f	c
Sea chubs nei	r	f	c
Sea cucumbers nei	r	ec	t
Sea urchins nei	r	ec	c
Seerfishes nei	o	f	c
Sergestid shrimps nei	dm	cr	c
Serra Spanish mackerel	o	f	c
Sharks, rays, skates, etc. nei	o	e	c
Short mackerel	o	f	c
Short neck clams nei	dm	mo	c
Shortbill spearfish	o	f	c
Shortfin mako	o	e	c
Silky shark	o	e	c
Sillago-whitings	dm	f	c
Silversides (=sand smelts) nei	fw	f	c
Silver-stripe round herring	o	f	c
Skipjack tuna	o	f	c
Slipper cupped oyster	m	mo	c
Slipper lobsters nei	dm	cr	c
Snappers nei	r	f	c
Snappers, jobfishes nei	r	f	c
Snooks (=robalos) nei	r	f	c
Southern bluefin tuna	o	f	c
Southern red snapper	dm	f	c
Spinefeet (=rabbitfishes) nei	r	f	c
Sponges	r	s	t
Spotted sicklefish	r	f	c
Squillids nei	o	cr	c
Squirrelfishes nei	r	f	c
Stolephorus anchovies	o	f	c
Streaked seerfish	o	f	c
Striped marlin	o	f	c
Striped snakehead	fw	f	c
Stromboid conchs nei	r	mo	t
Surgeonfishes nei	r	f	c
Swordfish	o	f	c
Threadfin breams nei	r	f	c
Threadfins, tasselfishes nei	r	f	c
Tilapias nei	fw	f	c
Torpedo scad	r	f	c
Torpedo-shaped catfishes nei	fw	f	c
Triggerfishes, durgons nei	r	f	c
Trochus shells	r	mo	c
Tropical spiny lobsters nei	r	cr	c
Tuna-like fishes nei	o	f	c
Unicorn cod	o	f	c
Various squids nei	o	mo	c
Wahoo	o	f	c
Wolf-herrings nei	r	f	c
Wrasses, hogfishes, etc. nei	r	f	c

Table S1. *Continued*

FAO Landings Category	Ecosystem	Taxonomy	Human Use
Yellowfin tuna	o	f	c
Yellowtail snapper	r	f	c

Key to ecosystems: r = reef associated, dm = demersal marine, o = oceanadromous, fw = freshwater, and e = estuarine. Key to taxa: f = fish, mo = mollusc, cr = crustacean, ec = echinoderm, and e = elasmobranch. Key to human use: c = consumed and t = traded.

Table S2. Landings of FAO Family-Level Categories that Include Coral-Reef- and Non-Coral-Reef-Associated Species

FAO Category	Average Landings (metric tons, 1997–2001)	Proportion of Total Reef Landings (%)	Countries Reporting under this Category
Scads nei	258,594	26.8	Grenada, Guam, N. Marianas, Philippines
Ponyfishes (=slipmouths) nei	64,350	6.7	Philippines
Carangids nei	46,746	4.8	American Samoa, Antigua and Barbuda, Bahamas, Bahrain, Barbados, Bermuda, Comoros, Grenada, Guam, Mauritius, N. Marianas, Palau, Philippines, Reunion, Seychelles, Sri Lanka
Threadfin breams nei	29,243	3.0	Philippines
Snappers, jobfishes nei	21,105	2.2	American Samoa, Antigua and Barbuda, Aruba, Barbados, Bermuda, Cuba, French Polynesia, Grenada, Guam, Kiribati, Mauritius, N. Marianas, Palau, Philippines, Seychelles, U.S. Virgin Islands
Groupers, seabasses nei	13,646	1.4	Antigua and Barbuda, Grenada, Mauritius, Philippines, Réunion, Seychelles
Barracuda nei	11,410	1.2	American Samoa, Antigua and Barbuda, Bahrain, Fiji, Grenada, Guam, Kiribati, Palau, Philippines, Seychelles
Emperors (=scavengers) nei	10,614	1.1	American Samoa, Bahrain, Fiji, Guam, Kiribati, Mauritius, N. Marianas, Palau, Seychelles
Needlefishes nei	10,345	1.1	Philippines
Gobies nei	7,814	0.8	Philippines
Lizardfishes nei	6,591	0.7	Philippines
Queenfishes	3,954	0.4	Bahrain, Philippines
Jacks, crevalles nei	3,909	0.4	British Virgin Islands, Cook Islands, Cuba, Fiji, Kiribati, Trinidad and Tobago
Snappers nei	2,938	0.3	Bahamas, Bahrain, British Virgin Islands, Cook Islands, Fiji, New Caledonia, Reunion, Seychelles
Threadfins, tasselfishes nei	2,743	0.3	Philippines, Reunion
Groupers nei	2,312	0.2	American Samoa, Aruba, Bahamas, Bahrain, Bermuda, British Virgin Islands, Cook Islands, Cuba, Fiji, Guam, N. Marianas, Palau, U.S. Virgin Islands
Grunts, sweetlips nei	1,598	0.2	Antigua, Bahamas, Bahrain, Cuba, Grenada
Porgies, seabreams nei	591	0.1	Antigua and Barbuda, Bahrain, Cuba
Porgies	301	0.0	Cuba
Parrotfishes nei	129	0.0	American Samoa, Antigua and Barbuda, Bahrain, Grenada, Guam, N. Marianas, Palau
Ponyfishes (=slipmouths)	79	0.0	Fiji
Boxfishes nei	14	0.0	Antigua and Barbuda, British Virgin Islands
Needlefishes, etc nei	1	0.0	Grenada
Snooks (=robolos) nei	1	0.0	Grenada
Total landings of composite families	499,028		
Total reef-derived landings	964,154		

Landings of each group as a proportion of total coral reef landings and the countries reporting under each category.

Table S3. The FAO Landings Category, "Marine Fish nei," or mfnei, Expressed as Proportion of Total Landings and Fish-Only Landings, and the Rational for Allocating mfnei Landings as Reef-Derived or Otherwise

	Marine Fish nei			
Country	Total Landings (%)	Fish Landings (%)	Allocation and Rationale	References
American Samoa	0.35	0.35	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S18–S20]
Anguilla	72	99.7	No reported pelagic or reef-derived landings, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8, S21]
Antigua and Barbuda	53	79	Increased taxonomic resolution of landings statistics from 2001 onward support categorization of mfnei as reef-derived	[S8]
Bahamas	1	9	No pelagic landings reported, and reef-derived taxa appear to be well reported; mfnei categorized as demersal	—
Bahrain	8.9	14.3	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8]
Barbados	2	2	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8, S22]
Bermuda	21	24	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S23]
British Virgin Islands	42	49	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S24]
Cayman Islands	30	30	Good taxonomic resolution of pelagic landings, few reef taxa reported and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S25]
Comoros Islands	10	10	Good taxonomic resolution of pelagic landings, few reef taxa reported and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8]
Cook Islands	47	63	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	([S6], p. 412)
Cuba	34	49	Good taxonomic resolution of landings, mfnei categorized as demersal	[S8, S26]
Dominica	80	80	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8]
Fiji	3	4	Good taxonomic resolution of landings, mfnei categorized as demersal	[S8, S27]
French Polynesia	36	36	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S6, S28, S29]
Grenada	12	12	Good taxonomic resolution of landings, mfnei categorized as demersal	[S8]
Guadeloupe	65	70	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S30]
Guam	27	28	Good taxonomic resolution of landings, mfnei categorized as demersal	[S31]
Jamaica	38	93	Good taxonomic resolution of pelagic landings, few reef taxa reported (mainly conch), and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S32]
Kiribati	10	11	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8]
Madagascar	56	63	Good taxonomic resolution of pelagic landings, almost no reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S33]
Maldives	12	12	Good taxonomic resolution of pelagic landings, almost no reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S34]
Marshall Islands	5	5	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8, S20]
Martinique	25	28	Good taxonomic resolution of pelagic landings, few reef taxa reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S35]

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Table S3. *Continued*

Country	Marine Fish nei		Allocation and Rationale	References
	Total Landings (%)	Fish Landings (%)		
Mauritius	4	4	Good taxonomic resolution of landings, mfnei categorized as demersal	—
Mayotte	31	31	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8]
Federal States of Micronesia	13	13	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8, S20]
Nauru	99	99	Reef-derived fishes reported to make up no more than 10% of total landings; 10% mfnei categorized as reef-derived	[S6]
Netherlands Antilles	51	52	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S36, S37]
New Caledonia	17	19	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S6, S20]
Niue	99	99	Reef-derived fishes reported to make up half of total landings; 50% mfnei categorized as reef-derived	[S6, S14, S20]
Northern Mariana Islands	34	35	Good taxonomic resolution of landings; mfnei categorized as demersal. This is likely to be very conservative	[S6, S20]
Palau	29	29	Good taxonomic resolution of pelagic landings, few reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8, S38]
Papua New Guinea	13	13	Good taxonomic resolution of pelagic landings, few reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S6, S8, S39]
Philippines	1	1	Good taxonomic resolution of landings; mfnei categorized as demersal	—
Réunion	13	13	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8]
Samoa	37	40	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8, S20, S40]
Seychelles	0.7	0.7	Good taxonomic resolution of landings, mfnei categorized as demersal	—
Solomon Islands	26	26	Good taxonomic resolution of pelagic landings, few reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S6, S41, S42]
Sri Lanka	11	11.1	Good taxonomic resolution of pelagic landings, few reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S30, S43–S45]
Tokelau	99.8	99.8	Evidence only for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S46]
Tonga	65.2	68.7	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S47]
Trinidad and Tobago	23.5	25.6	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8] and Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad and Tobago.
Turks and Caicos Islands	3	99	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S48]
Tuvalu	32	32	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S6, S8]
U.S. Virgin Islands	62	72	Good taxonomic resolution of pelagic landings, few reef fishes reported, and evidence for artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S49, S50]

Table S3. *Continued*

Country	Marine Fish nei		Allocation and Rationale	References
	Total Landings (%)	Fish Landings (%)		
Vanuatu	4	5	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S8]
Wallis and Futuna	90	99	Good taxonomic resolution of pelagic landings, no reef fishes reported, and evidence for large artisanal and/or subsistence reef fisheries; mfnei categorized as reef-derived	[S20, S51]

Table S4. The Exploitation Status of Island Coral Reef Fisheries

Country	Status of Coral Fisheries	Reference
American Samoa	Overexploited. Catches of inshore fish and shellfish have declined in American Samoa for many years.	[S19, S30]
Anguilla	Underexploited. Earlier work considered these reef fisheries to be lightly exploited.	[S35]
Antigua and Barbuda	Overexploited. Declines in average fish size and catch, in addition to algal overgrowth on some reefs, suggest that the shallow reef fishery is overexploited around Antigua, less so around Barbuda. Reef fish populations have declined significantly in recent years, as indicated by a decrease in the size of landed fish and algal proliferation.	[S8, S30]
Aruba	Underexploited. Earlier work considered these reef fisheries to be lightly exploited.	[S35]
Bahamas	Under or fully exploited. Inshore fisheries show a stable catch trend.	
Bahrain	Overexploited. Fisheries overexploited with dramatic declines in landings of preferred species and shifts to targeting secondary species. Total landings and the number of fishing boats have increased steadily over the last 20 years. Much of the increase in landings has been from increased landings of secondary species. For some preferred species, such as orange-spotted grouper and shrimp, landings have declined significantly. Production from Bahrain's fisheries has not kept pace with increasing population, and imports have grown more slowly than demand (rising from 1448 metric tons [mt] in 1990 to 3573 mt in 2001). As a result of these factors, per capita supply has halved since 1985, from 27.2 kg per capita (1985) to 13.4 kg per capita (2001).	[S8]
Barbados	Overexploited. Inshore fisheries have exhibited declining catch per unit effort (by 73%) since the mid-1960s.	[S22]
Bermuda	Overexploited. Sequential depletion of reef fauna (serranids depleted by 1970s); fishery moved to target deeper-water species and pelagic species. Fisheries in Bermuda have been under some form of control for nearly 400 years, yet these restrictions seem to have had only limited success in protecting the resources. Adjusted fisheries catches for Bermudian waters have shown a decline from the 1970s and 1985 peaks in landings. However, more recent years show an increase in landings, mainly driven by increasing landings of pelagics.	[S23]
British Virgin Islands	Overexploited. All commercially important species overfished, but regarded as moderately exploited compared to Jamaica.	[S30, S52, S53]
Cayman Islands	Under- or fully exploited. There have been sharp declines in grouper abundance at spawning aggregations, leading to a ban on their exploitation in 2003. The local fishery is largely artisanal and mostly recreational subsistence. Local commercial fishers are artisanal; further expansion is discouraged because of the small physical size of stocks.	[S25]
Comoros	Overexploited. The coastal fringe is overexploited because of the narrow shelf width and the limited operating range of the artisanal craft.	[S20]
Cook Islands	Underexploited. In the outer islands, where subsistence fishing prevails, fish catches often exceed demand, and simple preservation techniques such as salting and drying are regularly employed to prevent waste of surplus catches. On Rarotonga, and to a lesser extent on Aitutaki, where the cash economy is better developed and where tourism is concentrated, demand for fresh fish and seafood often exceeds supply. Coastal reef and lagoon species offer less potential for economic development, especially in the northern islands because of their remoteness, fragility, and importance as a source of subsistence nutrition." Therefore, overall likely to be sustainable.	[S8, S20]
Cuba	Fully or overexploited. Overall, Cuban reported catches peaked at 76,000 mt in 1987, and have been declining since, to just under 55,000 mt by 1999. The majority of fisheries resources in Cuban waters are considered fully or overexploited.	[S26]
Dominica	Overexploited. The limited continental shelf that exists around Dominica influences the availability of marine resources, which is also affected by other stresses including pollution, overfishing of certain species, and coral reef destruction (man-made or through natural disasters). The queen conch (*Strombus gigas*) has undergone a considerable decline in numbers over the years and is not really a targeted species. Habitat degradation due to pollution and other land-based activities, as well as overfishing, has contributed to this decline. There are no data available on landings, and there is a need to rebuild stocks to exploitable levels.	[S8, S37]
Fiji	Overexploited. Marine resources overexploited in all but least inhabited islands.	[S20, S54–S58]
French Polynesia	Underexploited. Underexploited reef resources, except depletion of stocks has occurred only in populated areas of some Society Islands	[S28]
Grenada	Overexploited. Inshore catches declined by 62% from 1062 mt to 400 mt between 1987 and 2001.	[S8, S59]
Guadeloupe	Overexploited. Fish stocks are overexploited and large fish (groupers, snappers, and parrotfish) are relatively rare. Demand is almost double capture production.	[S30]
Guam	Overexploited. Fish populations have declined for the past fifteen years.	[S30]
Jamaica	Overexploited. Overexploitation of major reef fish taxa followed by mass urchin mortality has contributed to a phase shift in ecosystem structure and reduced resilience.	[S37, S60]
Kiribati	Underexploited. Local overexploitation, overall likely to be sustainable. In the less-populated centers, supplies from subsistence and small artisanal fishing activities are normally sufficient to meet demand. In the urban areas, particularly Tarawa, shortfalls in supply may occur.	[S8, S46]

Table S4. *Continued*

Country	Status of Coral Fisheries	Reference
Madagascar	Overexploited. Fishing effort has increased 5-fold in the last 20 years, but limited knowledge of effect on fish stocks. The Ministry of Fisheries estimates most resources are under- or optimally exploited. Overexploitation near urban population centers. In contrast to the fisheries department, nearly all traditional fishers report declining catches.	[S30, S33, S61, S62]
Maldives	Underexploited. Reef fish are the main source of dietary protein in poor-weather months, and reef fisheries suffer from increasing demand from tourist and export markets, particularly for wrasse, lobster, and grouper. Stocks locally overexploited near population centers. Grouper catches may be greater than MSY. Generally, FAO suggests reef fish and demersal species also can sustain considerable increases in exploitation.	[S8, S34]
Marshall Islands	Underexploited. No evidence for overexploitation reported.	[S8, S46]
Martinique	Overexploited. "The shallow waters of Martinique are widely overfished and some species are disappearing" [S35]. Yields of reef fish are high but do not meet demand; there have been declines in lobster, queen conch, and snappers.	[S35, S63]
Mauritius	Overexploited. "Exploitation of traditional resources has reached a high level, and no further increase in yield can be expected" [S8]. The fishing effort in the traditional sector needs to be substantially reduced to ensure sustainability of the resources. "There has been a 50% decline in fish catch from reef areas in thirty years and a 6-fold increase in fishing effort" [S61].	[S8, S61, S64]
Mayotte	Underexploited. No evidence for overexploitation reported.	[S65]
Federal States of Micronesia	Under- or fully exploited. Sustainable levels of fishing prevail in the outer islands, but the local market for fresh fish continues to operate in urban centers; however, reductions in government employment because of reduced overseas support has meant somewhat less consumption in several locations.	[S8]
Nauru	Under- or fully exploited. Little detail known but many people have increased their fishing activity, especially in inshore areas, and declines in abundance of popular fish and invertebrates have been noted.	[S8]
Netherlands Antilles	Underexploited. Local overexploitation of reef fishes, including declining size of snappers and decline in grouper catches at Saba Bank, but very lightly fished at Bonaire.	[S36, S37]
New Caledonia	Underexploited. Very little exploitation of reef fisheries but may be some local overexploitation near Noumea.	[S66–S68]
Niue	Underexploited.	[S8, S14]
Northern Mariana Islands	Underexploited. No evidence for overexploitation.	[S8, S30, S46]
Palau	Under- or fully exploited. Most fishermen report recent declines in catches and depletion and loss of some spawning aggregations.	[S8, S30, S38, S46, S69]
Papua New Guinea	Underexploited. Coastal finfish in rural or remote areas of PNG are considered to be underexploited. Although the reef-fishery resources are underutilized on a national scale, localized overfishing has occurred where there has been access to cash markets.	[S8, S46, S70]
Philippines	Overexploited. Reef-fishery resources are heavily overexploited. A major fishing ground, Lingayen Gulf, reached its maximum sustainable yield (MSY) more than 20 years ago. The fishery now has four times the optimum effort for the available fish stocks. Catch rates in the Gulf are only one-fifth of what they were 15 years ago, compelling fishers to invest more time and money in dwindling catches.	[S71, S72]
Réunion	Overexploited. Fish aggregation devices (FADs) have been introduced to reduce pressure on reef fish stocks, and decreases in reef fish stocks are clearly apparent. Decrease in the abundance and diversity of fish on all reef flats has occurred.	[S30, S73]
Samoa	Overexploited. Heavy exploitation of coastal waters coupled with the deleterious effects of destructive fishing methods, coastal development, and occasional severe cyclones have led to important declines in inshore fishery productivity in many areas around Samoa.	[S8, S40, S58]
Seychelles	Fully or overexploited. "Although further research and fishing trials may reveal new or unexploited resources, in general the opportunity for a large increase in the landings of demersal fish is moderate" [S8]. Signs of local overexploitation and declines of biomass and diversity of target species.	[S8, S74–S76]
Solomon Islands	Fully or overexploited. Deep-bottom fish and reef fish are moderately exploited in some areas and underexploited in others.	[S8, S41, S46]
Sri Lanka	Overexploited. Evidence for overexploitation and use of destructive fishing techniques.	[S43, S44, S77]
Tokelau	Underexploited. Turtles rare and overexploited, severe depletion of giant clams (*Tridacna* spp.), but no evidence of depletion of other resources.	[S46]
Tonga	Overexploited. Up to the early 1960s, domestic demand was almost wholly met through catches from the country's reefs and lagoons. Subsequently, however, increases in population and fishing effort and the growth of the cash economy have led to overfishing in many inshore areas. Some traditionally important fish, especially mullet, have been reduced to a small fraction of their earlier abundance, and inshore invertebrates such as beche-de-mer, lobsters, and giant clams have undergone severe declines, some quite recently. These problems are found throughout Tonga, but are most acute close to population centers or in easily accessible fishing areas.	[S8, S58]
Trinidad and Tobago	Overexploited. The inshore artisanal fisheries resources are considered to be very heavily fished, to the point of being overexploited.	[S8]
Turks and Caicos	Fully exploited. Queen conch and spiny lobster make up most of catches, and both are exploited within MSY.	[S78–S80]

(*Continued on next page*)

Table S4. *Continued*

Country	Status of Coral Fisheries	Reference
Tuvalu	Underexploited. No clear evidence of overexploitation.	[S8]
U.S. Virgin Islands	Overexploited. Throughout the islands, chronic stresses like overfishing (commercial, hand-line, trap fishing, spear fishing, net, long-line, trolling, driftnet) may do the most damage. Overfishing has markedly reduced resources, including those within Virgin Islands National Park (VINP) and Buck Island Reef National Monument (BUIS). Reports from 20 years ago suggested that fishing was already changing the reef fish populations, even before developments on land caused extensive loss of habitat as well coral diseases, hurricanes, and other stresses. Fisheries are close to collapse, and even areas within the boundaries of "marine protected areas" are deteriorating.	[S49, S50]
Vanuatu	Underexploited. Traditional management practices have been used in the past to conserve fishery stocks, but with advances in fishing techniques and equipment, and increasing pressure for financial reward from fishing, customary fishing practices have declined in some areas. The resulting pressure on inshore resources and numerous examples of localized resource depletion has heightened awareness of the need for better management of inshore fishing activities.	[S8, S46]
Wallis and Futuna	Underexploited. Fishing is an important activity, although largely still operating at a subsistence level. However, there have been records of blast fishing.	[S1]

Fisheries status was categorized as underexploited, fully exploited, overexploited, and collapsed, representing exploitation levels corresponding to under, at, or over, a food-production maximum sustainable yield (Figure 1).

Table S5. Ecological Footprints of Island Coral Reef Risheries

MSY ($mt \cdot km^{-2} \cdot yr^{-1}$)	Reef Area (km^2)	Actual Coral Reef Landings ($mt \cdot yr^{-1}$)	Sustainable Landings ($mt \cdot yr^{-1}$)	Ecological Footprint	Reef Area Appropriated (km^2)	Reef-Area Deficit (−) or Surplus (+) (km^2)
1	117,800	964,154	117,800	8.2	964,154	−846,354
5	117,800	964,154	589,000	1.6	192,831	−75,031
10	117,800	964,154	1,178,000	0.8	96,415	+21,385

Footprints were calculated with the assumption of a sustainable yield of 5 $mt \cdot km^{-2} \cdot yr^{-1}$, with pessimistic (1 $mt \cdot km^{-2} \cdot yr^{-1}$) and optimistic (10 $mt \cdot km^{-2} \cdot yr^{-1}$) yields shown for comparison. Sustainable landings were calculated as reef area × MSY. The overall ecological footprint was calculated as the ratio of summed reef landings to summed sustainable landings. The total appropriated reef areas were calculated as the overall ecological footprint × total reef area. Reef-area surplus and deficits were calculated as the appropriated reef area − actual reef area.

Table S6. Independent Variables Used to Explain the Variation in Ecological-Footprint Size, the Transformations Used to Normalize Variables, the Time Span, and the Data Source

Variable	Transformation Used	Timespan	Reference
Human population density	$\log_{10}$	2000	[S81]
Coral reef area (km^2)	$\log_{10}$	2001	[S1]
Continental shelf area (km^2)	$\log_{10}$	n/a	[S81]
Coral reef health	arcsine square root	1998	[S82]
Mangrove forest area (km^2)	$\log_{10}$	1997	[S83]
Oceanic primary production	$\log_{10}$	1997	[S81, S84, S85]
Maximum elevation (m)	$\log_{10}$	n/a	[S86]
Average precipitation (mm)	$\log_{10}$	2001	[S87]
Latitude (degrees)	arcsine square root	n/a	[S86]
Fish species richness	$\log_{10}$	2001	[S1, S81]
Coral species richness	arcsine square root	2001	[S1, S81]

FAO landings are disaggregated into coral reef fishes for only nine island states and territories: Bahamas, Cuba, Fiji, Grenada, Guam, Mauritius, Northern Marinas Islands, Philippines, and Seychelles. For these countries and territories, we conservatively assumed that marine fish nei did not include reef-derived fishes (Table S3). For the remaining countries, we assumed that marine fish nei landings represented the "missing" coral reef fish landings (Table S3) if the following three conditions were met:

- the country had well-disaggregated landings of pelagic taxa,
- with few readily identifiable coral-reef-associated fish landings, and
- yet was reported elsewhere as having coral-reef-based fisheries.

These rules allowed marine fish nei to be allocated for all apart from two countries: Nauru and Niue. Nauru and Niue reported landings only of tuna and marine fish nei. Both countries have relatively small coastal shelves, and the artisanal fisheries target mainly pelagic fishes other than tuna. Coral reef fishes were estimated to make up 50% and 10% of marine fish nei for Niue and Nauru, respectively [S6, S14].

Categorizing the Exploitation Status of Coral Reef Island Fisheries

We recognize that collapsed status can result from either a genuine collapse in fishery production or substantial underreporting of official landings statistics. However, we note that substantial underreporting has gone hand-in-hand with a genuine collapse in fishery catches in American Samoa [S15]. We present the reported exploitation status of each island and the information sources in Table S4.

Both ecological footprints and exploitation status represent the average status across all reefs within a country for a short time period (1997–2001), and therefore these measures do not provide insight into the within-country variation in reef catches. The within-country heterogeneity (or otherwise) of exploitation will have considerable implications for the resilience and recovery of these reefs.

How Big Is the Great Barrier Reef?

The area of the Great Barrier Reef is 341,300 square kilometers. Of this, 223,977 square kilometers is continental shelf, and the remainder is ocean. The total reef area is 20,055 square kilometers, which comprises 2,904 individual reefs, and this is the value used here [S16].

Projections of the Future Island Coral Reef Footprints

Potential future coral reef footprints were calculated with future scenarios of human population size to derive projections of fisheries landings. We used human population size to project future landings ($R^2 = 0.59$, $F_{1,46} = 69.3$, $p < 0.0001$) by using the future human population scenarios from the United Nations Population Division's medium-variant predictions of future population size for 2015, 2025, and 2050 [S17]. Population projections were available for all countries apart from Mayotte. Future footprint sizes were calculated with the projected landings and assuming no change in coral reef area and maximum-sustainable-yield value (5 mt · km^{-2} · yr^{-1}). These are highly conservative assumptions, and therefore our predictions are also conservative, subject to the caveat that future demand for coral reef fish is similar to that at present.

Additional Figures and Tables

The sensitivity of the measured ecological footprint to sustainable yield assumptions is explored in Figure S1. The details and status categorizations of the exploitation status of each island coral reef fishery are presented in Table S4. Details of the calculation of the ecological footprint for three levels of maximum sustained yield are presented in Table S5. Details of the abiotic and biotic variables used in the general linear modeling (GLM) analysis to explain the variation in ecological footprint size are presented in Table S6. Mangrove area and shelf area covaried significantly; therefore, we used residual mangrove area from a linear regression of shelf area (independent variable) versus mangrove area (dependent variable) as an explanatory variable.

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