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January 2025

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The Nature Conservancy

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**(Grant #TNC_GA_BSU_032023, Project ID P121796)**

**Suggested citation:** Venturelli, P., Hrabowski, J., Muehler, A., Schaeffer, W., Willbanks, P., Boyd, R., Longley-Wood, K., & Spalding, M. (2025). Investigating Patterns in the Distribution of Coastal and Marine Recreational Fishing Worldwide. Ball State University and The Nature Conservancy

## Contents

# Executive summary



Recreational fishing, or fishing for pleasure, is widespread all around the world, where it provides numerous social and economic benefits, including health and well-being, employment and income.

Despite its importance, recreational fishing has been poorly quantified. Beyond localized studies **there is little information on fisher numbers, catch sizes, species or the intensity of fishing from place to place**. Without such detail, it is challenging to make the case for appropriate management. Without management, recreational fishing may struggle to remain sustainable, or may suffer from competition with other fisheries, or from other impacts such as pollution. Conversely, **appropriate management of recreational fisheries can lead to enhanced catches, greater engagement and longer-term benefits across societies, while also generating benefits for conservation**.

The current work explores marine recreational fishing (MRF), looking at possible approaches to rectify this information shortfall. Focusing primarily on user-generated content from a single recreational fisher app, Fishbrain, it explores marine and coastal recreational fishing around the world. These findings are enhanced with an additional literature review of fisher numbers and economic values from multiple sources.

**Over a million distinct catch records were assessed, covering over 2100 marine and coastal fish species.**

**These were caught by 250,000 fishers.**

**Catches were recorded across 184 countries**, although the focus was on 39 countries deemed to have data at sufficient resolution for further investigation. These 39 countries covered over 98% of users and 99% of catches in the dataset. They included the USA, Canada, Australia and multiple European nations where MRF is of particular importance, as well as a number of smaller nations such as the Bahamas and Costa Rica where MRF is an important economic sector.

Maps were prepared at different resolutions based on data richness, highlighting fishing intensity at the national level (normalized by country totals). All **39 countries were mapped at 20km resolution, with 14 of these mapped at 10km and 7 of these also mapped at 2km resolution**. While lower resolutions only show general patterns, the higher resolution maps show clear patterns of use intensity, for example showing the particular importance around population and tourism centers. Such information can greatly support planning and management.

A subset of 44 pelagic game fish species (billfishes, Spanish mackerel and tunas) was given further attention. These species are highly sought-after, driving a small but high-value segment of MRF. Maps of these **high value pelagic game fish catches highlight the increasing proportion of such fish in catches with distance from shore, and show key hotspots, mostly in warmer waters**.

Utilizing information on the origin of fishers, we show the variation in national versus international fishing effort. **International fishers make up an increasing proportion of fishers in lower-income countries**, and also make up a higher proportion of the pelagic game fish catches.

Diverse sources identified total marine recreational fisher numbers for 32 countries, including many larger countries where MRF is popular. These represent 23 million fishers in total, and these **marine recreational fishers account for about 2% of the total population of those countries with available data**. Participation rates were highest in developed countries, notably New Zealand, Norway and Iceland, and were much lower in poorer countries.

Comparable economic expenditure data (confined to studies that take a holistic definition including travel, accommodation and other expenses) was found for 24 countries. The **combined values for these 24 countries are some US$79 billion per year**, a number strongly driven by the USA. As a contribution to GDP such numbers vary considerably, but are highest for the Bahamas and Puerto Rico, but also high for a mix of wealthy countries such as New Zealand and the USA, and for less wealthy countries including Costa Rica, Cape Verde and Namibia.

# Introduction

Recreational fishing in coastal and offshore waters (marine recreational fishing, MRF) is a globally distributed, high value recreational activity, generating multiple benefits including health and wellbeing, the direct provision of jobs and income, and ancillary benefits in travel and accommodation, and even conservation benefits where such fisheries lead to more focused management (Hyder et al. 2020). Despite such apparent values, the quantification and mapping of MRF values remains rare, and these benefits can be overlooked in wider processes of natural resources management (Scheufele and Pascoe 2022). This work explores new methods for the quantification and valuation of MRF, with a strong focus on user-generated content (UGC) from recreational fishers and key market suppliers. Although preliminary in nature, it also highlights initial values for selected countries, whilst illustrating approaches that might be further developed in the generation of more reliable and detailed future efforts either at large scale or for local or national studies.

Recreational fishing is defined as fishing of aquatic animals (mainly fish) that do not constitute the individual's primary resource to meet basic nutritional needs, and are not generally sold or otherwise traded on export, domestic, or black markets (FAO 2012). Recreational fishers often outnumber commercial fishers severalfold, especially in developed countries. Arlinghaus et al. (2019) estimated that there were some 220 million recreational fishers globally: five times more than commercial fishers. In Australia, one in five people go fishing for recreation at least annually (Moore et al. 2023). Such numbers underpin a deep societal value, as well as potentially very large economic values and cascades that have often been overlooked in planning (Arlinghaus et al. 2019).

The contribution of recreational fishing to total catches, by contrast, remains small, at least at the global scale. MRF catch was estimated at 900,000 tonnes in 2014, with statistics dominated by Asia, North America, and Europe (Freire et al. 2020). At around 1% of total marine catch that year, a key message from this statistic may be that recreational fisheries values need to be measured in terms other than tonnage.

Value can be measured in many ways, including monetary values and community welfare metrics, such as the provision of jobs. Australia's recreational fisheries have been estimated to contribute AUS$11 billion annually to the national economy and support 100,000 jobs (Moore et al. 2023). In Southeast Florida, recreational fishing on coral reefs (not including offshore or pelagic game fishing) was estimated to be generating 3,787 jobs and an annual economic output of $384 million (Wallmo et al. 2021).

The importance of recreational fishing clearly varies considerably between countries, and although national fishers dominate statistics in more developed countries, the role of international tourists becomes increasingly important in many poorer countries (Freire et al. 2020), especially in coastal and marine settings (Bower et al. 2020). In all cases across this spectrum from domestic to international dominance, however, recreational fishing can make a clear contribution to local economies and livelihoods (Barnett et al. 2016).

It is important to note that, although recreational fishing can represent high values for relatively low catches, it can still have negative impacts (Lewin et al. 2019). Governance of recreational fishing is often weak or non-existent (Potts et al. 2020). Even when rules are in place, some recreational fishers routinely break them (Bergseth et al. 2017). Recreational fishing can also drive or maintain stock declines, especially if it is less regulated than commercial fisheries (e.g., Blamey and Bolton 2018). The removal of larger predators can have cascade effects, as was noted in US Atlantic coastal saltmarshes when high recreational fishing of predators led to a profusion of crabs, increasing herbivory and driving the collapse of some marsh areas (Altieri et al. 2012). It has also been pointed out that, because recreational fishing is not profit-dependent, the self-regulation that might appear with declining stocks and reductions in catch-per-unit-effort may not affect such fisheries, which have been described as self-subsidizing (Kleiven et al. 2020).

Understanding the value and impact of recreational fishing can play a critical role in wider natural resource management. Like all fisheries, recreational fisheries depend on healthy fish stocks, and in some cases on critical habitats. Unsustainable practices could have far-reaching impacts on ecosystems, and on the social and economic benefits that come from such fishing. Understanding value, and human dependence on such value, by contrast, can support planning, and enable recreational fishing to be appropriately managed alongside other marine activities, which may be compatible with such fishing. Maps showing the spatial distribution of recreational fishing can provide a critical layer in coastal and marine spatial planning (Spalding et al. 2023).

In the absence of direct reporting of catches or expenditure, or on the spatial distribution of recreational fishing, there may still be opportunities to quantify and map such values through indirect means. Early work by The Nature Conservancy (TNC) showed the potential for utilizing UGC to understanding patterns of nature-dependent activities in tourism and recreation, including fishing, in-water activities on coral reefs, and bird watching (Spalding et al. 2017, Spalding and Parrett 2019, Spalding et al. 2023). Fisheries-specific examples that use text and data mining approaches are abundant. These include studies of recreational fishing of seabass in Wales (Monkman et al. 2018), dentex and bluefish in the Mediterranean (Sbragaglia et al. 2020, Eryaşar and Saygu 2022), popular species in the Eastern Caribbean (Spalding et al. 2023), flounder and sharks in the United States (Shiffman et al. 2017, Hall et al. 2022), threatened species in the Southern Atlantic Ocean (Martinazzo et al. 2022), near-shore species in Hawaiian Islands (Grabowski et al. 2023) – as well as global assessments of drone fishing (Winkler et al. 2022), COVID-19 pandemics on fishing (Britton et al. 2023), and fishing interest (Wilde and Pope 2013, but see Ficetola 2013, McCallum and Bury 2014). Similarly, studies have mined data from portable fish finders to understand recreational fishing effort and behavior (Fricke et al. 2020, Dainys et al. 2022, Audzijonyte et al. 2023).

Venturelli et al. (2017) proposed the use of fisher smartphone apps as a source of recreational fisheries data, and Skov et al. (2021) found that fisheries experts from 20, mostly European, countries supported using such app data to describe spatiotemporal variation in recreational fishing effort. Studies of this nature have been carried out in Canada (Papenfuss et al. 2015, Johnston et al. 2022), Denmark (Gundelund and Skov 2021, Gundelund et al. 2021 and 2023), the United Kingdom (Hook et al. 2022), and the United States (Jiorle et al. 2016, DePiper et al. 2023). They show that app data can generate reliable estimates of effort, especially at relatively coarse scales (e.g., annually or regionally). Other relevant applications of app data include catch and harvest rates (Liu et al. 2017, Gundelund et al. 2020, 2021 and 2023, Gundelund and Skov 2021, Johnston et al. 2022, Hook et al. 2022, Skov et al. 2022), and the species composition of the catch (Gundelund et al. 2021, Skov et al. 2022).

In this study, we examined the utility of “big data” from global datasets and UGC to explore the feasibility of mapping MRF, and of further exploring such value in monetary or other terms. Our starting point was data from the recreational fishing app, Fishbrain, given its popularity and proven potential in understanding spatial fishing patterns in the United States and Canada (Martin 2017, Weir et al. 2022, McDonald et al. in press). We complemented these data with data from additional sources, namely FishBase (a global database of biological information about almost 35,000 fish species; Froese and Pauly 2024), the Sea Around Us Project (Freire et al. 2020), and two literature searches. Given the preliminary nature of the work and the limitations of some of the data, we focused our attention on a subset of countries for which data availability was high, and TNC had ongoing or potential conservation interests. We present these findings, alongside proposals for future research and the application of such approaches to develop consistent methodologies at global to local scales.

# Methods

Here we describe how we processed and mapped catch records of marine and brackish species (henceforth marine species) from the Fishbrain app, and obtained supporting information, in particular targeting countries that TNC considered to be a high priority (Figure 1). Briefly, we extracted catches of marine species that occurred within the coastal area of any country or territory (henceforth country), and then mapped these data for a subset of countries that were relatively well-represented in the Fishbrain dataset and appeared to have high marine recreational fishing participation rates. In parallel with this effort, we conducted online searches to obtained information on the numbers of marine recreational fishers and the economic impacts of marine recreational fishing for any of these countries.

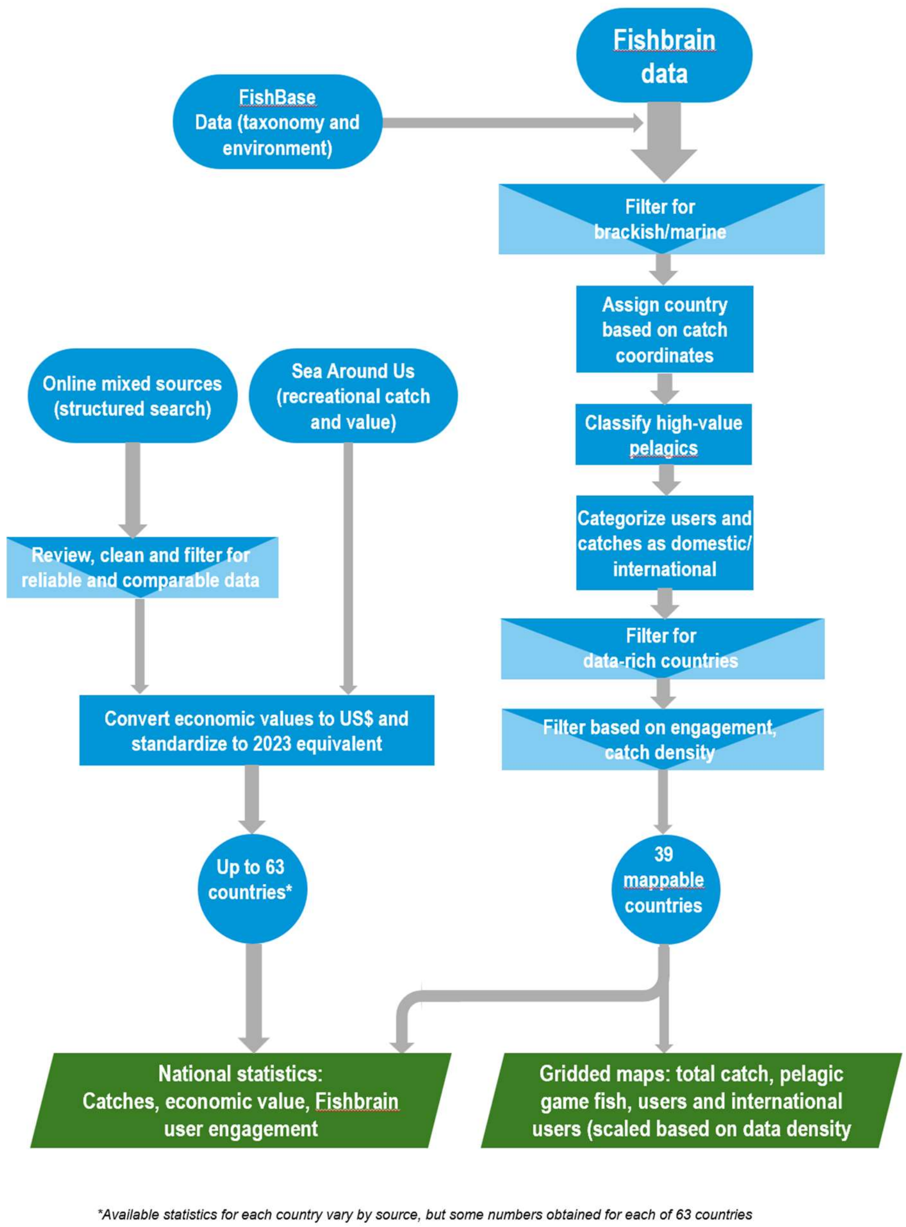


**Figure 1:** Flow diagram showing our process for mapping marine catches reported through Fishbrain, and obtaining supporting information.

## 1. App-based catch data

We obtained over 11 years (December 2011 to April 2023) of anonymized global, recreational fishing data via a data sharing agreement with the popular Fishbrain app. The app is free, and available in English, Spanish, Portuguese, French, Japanese, and Swedish. Fishers use the app to record and share the photos and attributes of the fish that they catch (Figure 2). We used four catch attributes for this study – date, time, location, and species – plus two fisher attributes that were associated with each catch – a unique, but anonymized, fisher ID, and the country of residence that each fisher indicated when registering for the app.

The app obtains catch date, time and location automatically from the photo. If photo data are not available, the user can add them manually. Fishers enter the common name of their catch, often by choosing from a ranked list that the app generated via a proprietary image recognition algorithm that is applied to the catch photo. The app then pulls the corresponding scientific name from a proprietary reference list. Only scientific names were shared with us for this study.

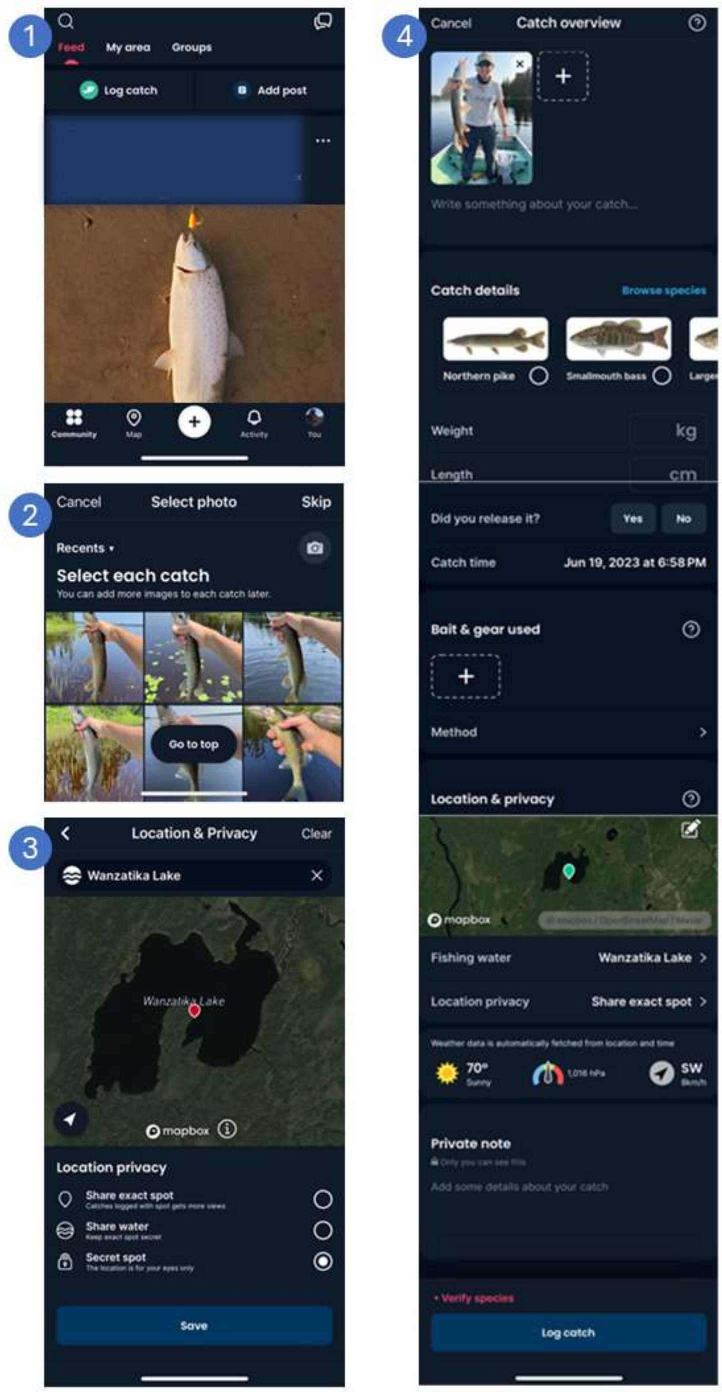


**Figure 2:** User flow diagram for logging a catch via the Fishbrain smartphone application. 1) Users start a new catch via the home screen "Log catch" button, (information related to the featured catch is obscured in this image) 2) select their catch photo, 3) review location information (pin and waterbody name) and associated level of privacy, and 4) enter optional data about the catch (species, size, whether it was released, etc.). Locations and time stamps can be populated automatically or manually. (Screenshots are from one of the authors' (PV) Fishbrain accounts, with permission.)

## Species selection

We used the ‘rfishbase’ package (Boettiger et al. 2012) in R version 4.3.0 (R Core Team 2023) to extract the following information about each species from FishBase (www.fishbase.org): common name, Family, Order, and environment (freshwater, brackish, or marine). If a species was categorized as either strictly marine or marine and brackish, then we also obtained its primary habitat association via the DemersPelag variable (bathydemersal, bathypelagic, benthopelagic, demersal, pelagic, pelagic-neritic, pelagic-oceanic, or reef-associated).

One key interest was to explore the data on high-value offshore rod and line recreational fishing. Although multiple species may be caught offshore, a subset of species is almost exclusively caught by boat-based, game-fishing ventures. These target fish are typically highly active, physically large species that provide a “fight” when hooked. To avoid overlap with other offshore fishing methods, we created a subcategory of pelagic game fishes that are primarily targeted by such fishing approaches. Our list included 44 species from the Fishbrain database (Table S1): billfishes (Families Istiophoridae and Xiphiidae), Spanish mackerel (Tribe Scomberomorini) and tunas (Tribe Thunnini) in the Family Scombridae, and Dolphinfish or Mahi-mahi (*Coryphaena hippurus*) in the Family Coryphaenidae. We excluded two tribes within the Family Scombridae – smaller mackerels (Tribe Scombrini) and bonitos (Tribe Sardini) – because they are often caught by other methods and/or in the nearshore, and are not primary targets for offshore, pelagic game fishing.

## Country assignment

We used a multi-step process to assign each catch of a marine species to a country. We first developed a coastal and marine extent layer for every country by using the National Oceanic and Atmospheric Administration’s coastal shapefile (Wessel & Smith, 1996) to define all coastlines. We created a buffer 2 km inland from coastlines to account for coastline complexity (e.g., estuaries and lagoons) and incorrect catch locations (e.g., because of geolocation errors or fishers logging marine catches from shore without location tracking). We joined this inland buffer to an offshore buffer that extended 200 nautical miles (370 km) out to the edge of each country’s Exclusive Economic Zone (EEZ) using the GADM database of Global Administrative Areas (GADM, 2020). All catches of marine species within this coastal and marine extent were assigned to the correct country. For the few cases in which a catch was associated with two countries due to overlapping buffer areas, we assigned the catch to the nearest country. Finally, we used the assigned country of the catch and the self-reported country of origin of the fisher to categorize each catch as either domestic (national) or international.

We summarized catch data by both country and species. Summary metrics for each country included total fishers and catches, and fishers and catches by fisher origin (domestic or international). Country-specific catch data were for all species as well as pelagic game fishes. Similarly, for each species, we summarized total catches, catches by fisher origin, the number of countries in which each species was caught, regardless of origin, and the number of countries in which each species was caught by fisher origin.

## Country selection

In seeking to use recorded catches as a proxy for overall recreational fishing effort, we needed to have some assurances that the Fishbrain data were representative. Although the filtered dataset included >250,000 marine and coastal fishers registered in 184 countries, there was considerable geographic variability in reporting. Over three-quarters of both user and marine catch records were from the United States, and only ~50 other countries had >200 records of marine catches.

We chose to focus our attention for subsequent data gathering on countries that were relatively well-represented in the Fishbrain dataset, and to further select countries in places or regions in which TNC had an active field program or other interest. Relatively data-rich countries were first filtered by a simple threshold that excluded countries with <50 users or <90 catches. The only exception was Barbados (40 users and 79 catches), which is a small country (440 $km^2$, population 282,000) in which TNC is actively working.

We generated two additional variables to further inform decisions regarding the removal of countries that were unlikely to be well represented: catch density (catches per 100 km of coastline length) and the degree of engagement in recreational fishing represented in the Fishbrain data (users per million of 2020 population; The World Bank 2023). The latter was intended as an indication of likely reporting reliability. Countries with extensive coastlines might risk being removed based on catch density, but allowance was made where countries have extensive remote or sparsely populated coastlines (Table 1). Degree of engagement is most useful for countries in which the catch records are largely determined by national users, and we used this variable when looking at countries in which >50% of users were national.

## Mapping fishing intensity

Catch locations from Fishbrain were intended to be used as indicative locations of fishing activity, with higher densities of catches indicating likely locations of higher use by recreational fishing more generally. We gridded this catch information following prior approaches involving UGC data for tourism mapping (e.g., Wood et al, 2013) to reduce dimensionality and improve visual representation and computational efficiency. Given that the number of catch reports varied among countries, we used a tiered and nested grid system to facilitate among-country comparisons. We used 20, 10, and 2 km grids for countries that had 20-70, 71-300, and >300 catches per 100 km of coastline, respectively. Thirty-nine “mappable” countries had sufficient information for this mapping at least at the 20km resolution (Table 1). All countries that were mapped at higher resolutions were also mapped at lower resolutions. This allowed for the presentation of a “global” consistent map for all countries at the lowest resolution.

***Table 1.*** *Thirty-nine countries mapped at different resolutions based on total catches and users, catches per 100 km of coastline, and users per million people. Notes on selection criteria and exceptions are footnoted, and TNC priority countries are highlighted with an asterisk *. Higher resolution countries were also mapped at lower resolutions to facilitate comparisons among countries.*

| **High resolution (2 km grid)** | **Medium resolution (10 km grid)** | **Low resolution (20 km grid)** |
|---|---|---|
| Countries with >190 catches per 100 km of coastline, >100 users, and >220 catches. | Countries with >30 catches per 100 km of coastline | Selected countries only. Most have >10 catches per 100 km of coastline. |
| Aruba | Bahamas[b,]* | Brazil[c,]* |
| Australia* | Barbados* | Canada[d,]* |
| Bermuda[a] | Belize* | Denmark |
| Puerto Rico* | British Virgin Islands | Dominican Republic* |
| Singapore[a] | The Cayman Islands | Finland |
| U.S. Virgin Islands* | Costa Rica* | France |
| United States* | Guam* | Honduras |
| | Ireland | Jamaica* |
| | Mauritius* | Maldives* |
| | Mexico* | Netherlands |
| | Sweden | New Zealand* |
| | Turks & Caicos Islands | Norway |
| | UK | Panama* |
| | United Arab Emirates | Portugal |
| | | South Africa[c,]* |
| | | Spain |
| | | St. Lucia* |
| | | Trinidad & Tobago |

*TNC priority country

[a] Except for Singapore, each of the high resolution countries has >265 users per million inhabitants and >850 catches per million inhabitants. Singapore had 48 users and 172 catches per million, but with a highly urbanized population it was felt that such a low proportion was to be expected. Bermuda has only 124 catches per 100 km of coastline, but was included out of interest.

[b]Bahamas in the medium resolution countries, with 18 catches per 100 km because it has extensive coastlines with very low population and presumably little to no recreational fishing on these coasts.

[c]Catches in South Africa (70/100 km) were included in this group despite slightly higher scores because reporting appears to be inconsistent, and because the records suggest a high proportion of recording is by national users (>90%), but these make up a very small part of the overall population (13 per million).

[d]Canada and Finland were included despite lower scores as both have complex (and therefore long) coastlines, and both have high proportional representation of fishing in the total population (Finland = 53 users per million, Canada at 143). In particular, Canada has extensive and largely unfished coastlines, notably along its Arctic shores.

### Spatial gridding

We applied at least one grid to the EEZ of each country depending on the assigned resolution of the country: 2x2 km grids for high-resolution countries, 10x10 km grids for high-and medium-resolution countries, and 20x20 grids for high-, medium-, and low-resolution countries. Each grid initially contained the following information from the filtered Fishbrain dataset: total catches, total catches by international users, total catches of pelagic game fishes, and the number of unique international users. We summarized each of these metrics via a standardized, within-country decile-score to facilitate visual comparisons among countries. Scores were from 1-10, with 1 representing the bottom 10% of values for a country, 2 representing the next 10%, etc. The only exceptions were countries that had <10 unique values for a metric (i.e., fewer unique values than classes). In these cases, the number of classes was equal to the number of unique values. For example, Aruba had only 8 distinct values for pelagic catches (0, 1, 2, 3, 4, 5, 16, and 74), so its scale only ranged from 1-8. Finally, we joined all country-specific grids of the same resolution into a single grid at that resolution. The result was three global grids: one at each of high-, medium-, and low-resolution. We also mapped percent pelagic catch and percent unique international users by cell.

## 2. Supporting information

We sought country-specific information on the numbers of marine recreational fishers and the economic impacts of marine recreational fishing to gauge the overall importance of recreational fishing in different countries, and provide further context to the data and maps that were derived from the Fishbrain data. In addition to targeting the 39 countries for which we could map Fishbrain data (Table 1), we sought information for 60 “priority” countries in which TNC is actively involved or has an interest. The original list included Comoros, but it did not have any catch data. Nineteen of the priority countries were already on the mapped list, so our final list included 80 countries (20 mapped only, 41 priority-only, and 19 both). Table S2 includes summary information for those countries where the data met our minimum criteria.

### Number of marine recreational fishers

We used the Google search engine from May to August 2023 to conduct a structured, online search for any sources (government, NGO, industry, academic) that indicated the number of coastal and marine recreational fishers by country. Our search term was a single question with all combinations of specific keywords: How many (Marine OR Saltwater) (Recreational OR Sport OR Game) (Anglers OR Fishers OR Fishermen) are there in [country of interest]? We conducted a secondary search by applying forward and backward reference chaining to all sources that we found. If neither approach was successful, then we requested this information from at least one appropriate governmental or non-governmental organization via email. We recorded the number of coastal and marine recreational fishers in a country, the source, the year that the data were obtained in the original source, and any explanatory notes and definitions. We also recorded the total number of freshwater and/or total recreational fishers if this information was available.

### Expenditures by marine recreational fishers

We conducted a parallel Google search with reference chaining and emailing to identify estimates of annual coastal and marine recreational fishing expenditures by country. Our search term was (Marine OR Saltwater) AND Recreational$^{2}$ AND Fishing AND Economic$^{3}$ AND [country of interest]$^{1}$, where superscripts identify the order in which quotations were added to each search term when a search was unsuccessful. For example, if *Saltwater AND Recreational AND Fishing AND Economic AND Italy* did not generate a source, then we tried *Saltwater AND Recreational AND Fishing AND Economic AND “Italy”* followed by *Saltwater AND “Recreational” AND Fishing AND Economic AND “Italy”*. We recorded annual coastal and marine recreational fishing expenditures by country, the source, the year that the data were obtained in the original source, and any explanatory notes and definitions. We facilitated comparisons among countries by converting all expenditures to United States Dollars (USD) via www.exchangerates.org.uk and the average exchange rate for the year that the data were collected, and then converting all USD to USD in October 2023 via the U.S. Bureau of Labor Statistics' online Consumer Price Index calculator (data.bls.gov/cgi-bin/cpicalc.pl).

We developed a regression model to estimate expenditures for the TNC priority countries for which we could not obtain data. Candidate variables included all users and catches, international users and catches, domestic users and catches (all from Fishbrain), the number of marine recreational fishers, and the annual landed tonnage and value of the reconstructed marine recreational catch (mean of 2017-2019; www.seaaroundus.org). We intended to apply Akaike information criterion (AIC) to select among all possible models based on all available variables and data, but changed our approach after an initial exploration of the data revealed that i) many of our predictor variables were correlated with each other but not expenditures, and ii) the global dataset (range $280 thousand to $59 billion) was biasing models close to the origin where we need to make predictions. Therefore, we constrained our model to a smaller subset of variables, and data from countries with annual expenses <$200 million.

# Results

## 1. App-based catch data

Our final dataset comprised 1,007,069 marine catches that were logged in 184 countries from December 2011 to April 2023; another 31 countries had no catches, but users from these countries logged a small number of catches (223) in other countries. These catches were made by some 260,000 users, of whom 19,000 logged international catches (outside their country of registration). Summary numbers are presented in Table 2 and Table S1.

The 39, relatively data-rich countries that we mapped represented 99% of all catches and 98% of all users. Maps of these data showed high spatial variability at both global and local scales. For example, a global map of normalized catches showed that recreational fishing extends quite far offshore in the southeastern United States, and that for a number of countries (Brazil, Australia, New Zealand, South Africa) fishing intensity appears to correlate well with population density. A variant on this is for countries with a greater dependence on tourism, fishing intensity appears to correlate with tourism activities (e.g. Mexico, Costa Rica, Dominican Republic) (Figure 3). These tourism-driven patterns are also seen at finer resolutions, for example in Figure 4b, where onshore catches in the Mexican Caribbean move to offshore atolls and barrier islands in Belize. Similarly, high-resolution mapping (2-km grid) around Puerto Rico showed that most catches were relatively close to shore (Figure 5) – likely in association with populations centers and launch locations (Figure 5). See Figures S1-S11 for more regional maps of normalized catch at the 20-km resolution.

***Table 2.*** *Fishbrain catch and user data associated with marine species for the top-20 countries by catch. International users were those who reported a catch in a country that was different from their home country according to their app registration information, and international catches were catches in a country that were reported by international users. Pelagic game fishes are defined in the Species selection section of the Methods. The last row is totals and percentages for all 215 countries and territories in the dataset, rounded to 2 significant figures. See* Table S1 *for further information. All top-20 countries met our mapping criteria except for Japan (only 6 catches per 100 km of shoreline and 4 users per million people).*

| | Unique users | | | Catches | | | |
|---|---|---|---|---|---|---|---|
| **Country or territory** | **All** | **International** | **Percent international** | **All** | **International** | **Total pelagic** | **Percent pelagic** |
| United States | Very high | High | <1% | Very high | High | Very high | <1% |
| Australia | High | High | 1-10% | High | High | High | 1-10% |
| UK | Medium | Medium | 1-10% | Medium | Medium | Medium | 1-10% |
| Norway | Medium | High | 30-40% | Medium | High | Medium | 10-20% |
| Mexico | Medium | Very high | 80-90% | Medium | Very high | High | 70-80% |
| Canada | Medium | Medium | 10-20% | Medium | Medium | Medium | 1-10% |
| Sweden | Medium | Low | 1-10% | Medium | Low | Medium | 1-10% |
| Brazil | Medium | Very low | 1-10% | Low | Very low | Low | 1-10% |
| New Zealand | Low | Low | 10-20% | Low | Low | Low | 10-20% |
| Denmark | Low | Low | 10-20% | Low | Low | Low | 10-20% |
| Ireland | Low | Low | 20-30% | Low | Very low | Low | 10-20% |
| Spain | Low | Low | 30-40% | Low | Medium | Low | 30-40% |

| | Unique users | | | Catches | | | |
|---|---|---|---|---|---|---|---|
| **Country or territory** | **All** | **International** | **Percent international** | **All** | **International** | **Total pelagic** | **Percent pelagic** |
| Puerto Rico | Low | Medium | 70-80% | Low | Medium | Low | 50-60% |
| South Africa | Low | Very low | 10-20% | Low | Very low | Low | 10-20% |
| Costa Rica | Low | Medium | 10-20% | Very low | Medium | Medium | 70-80% |
| Bahamas | Low | High | 90-100% | Very low | Medium | Very low | 90-100% |
| Japan | Very low | Very low | 30-40% | Very low | Low | Very low | 20-30% |
| United Arab Emirates | Very low | Very low | 20-30% | Very low | Very low | Very low | 10-20% |
| Portugal | Very low | Very low | 20-30% | Very low | Very low | Very low | 10-20% |
| France | Very low | Very low | 20-30% | Very low | Very low | Very low | 10-20% |
| **TOTAL** (all countries) | **260,000** | **19,000** | **7%** | **1,000,000** | **40,000** | **42,000** | **4%** |

*Numbers in the colored cells represent a summary of the proportion of the global total falling to each country.*

*For all users and catches these broadly correspond to the following classes: Very high, >70% of global total; High, >10%; Medium, >0.8%; Low, >0.25%; and Very low, >0.1%*

*For all international users and catches: Very high, >15% of global total; High, >5%; Medium, >2%; Low, >1%; and Very low, >0.3%*

*For pelagic catches: Very high, >65% of global total; High, >8%; Medium, >0.5%; Low, >0.1%; and Very low, >0.005%*

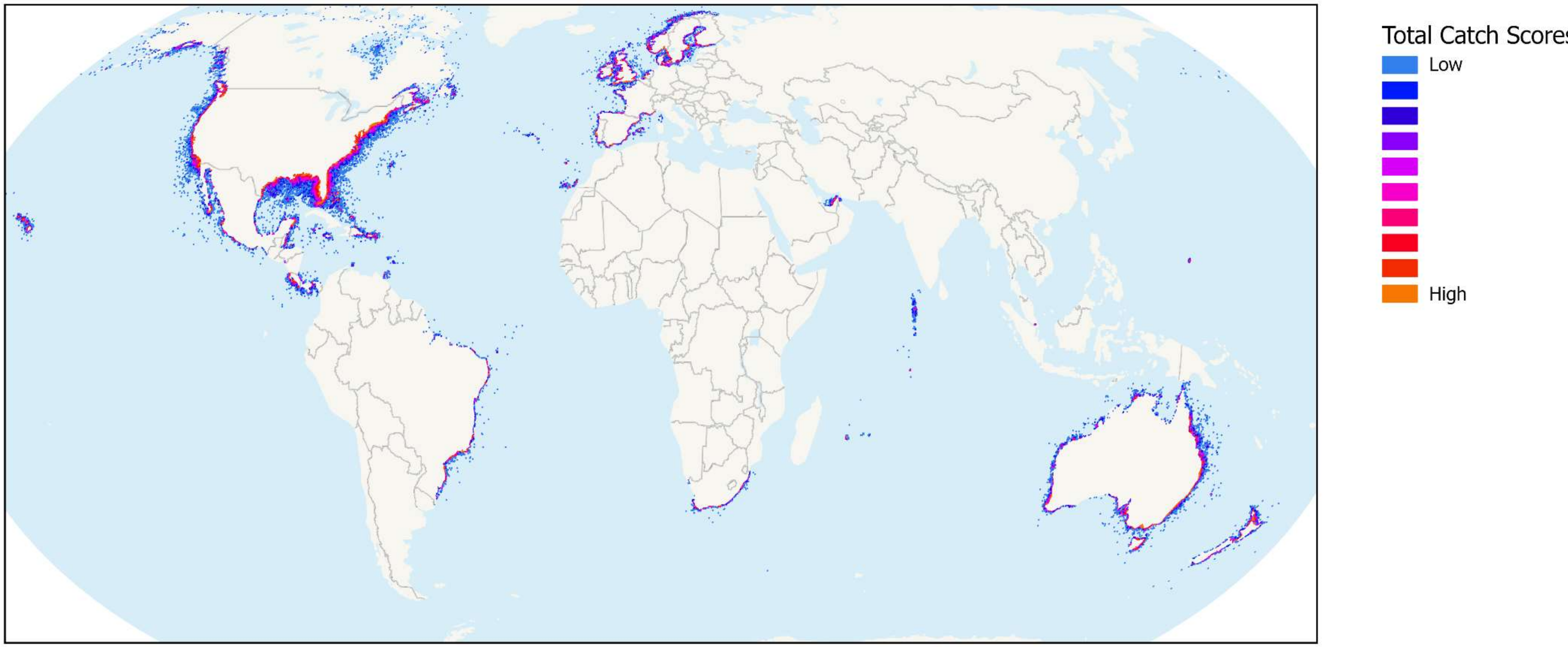


***Figure 3.*** *The global distribution and relative intensity of marine recreational catches among the 39 countries and territories that were relatively well-represented in the Fishbrain dataset and appeared to have high marine recreational fishing participation rates (Table 1). Data were mapped using a 20 km grid and colour-coded using a within-country decile score to facilitate among-country comparisons. Regional maps are available as Supplementary Material (Figures S1-S11).*

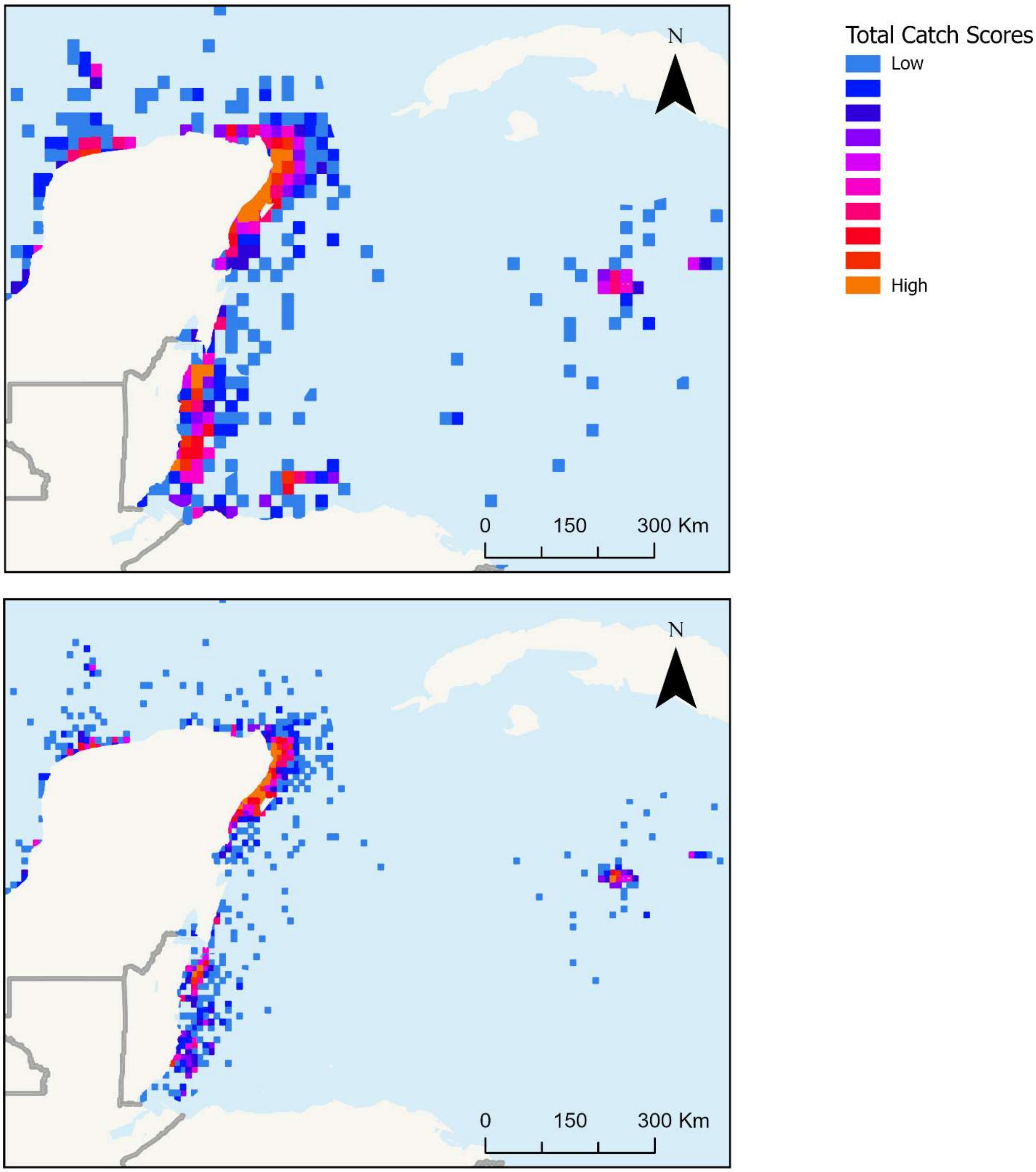


***Figure 4.*** *The distribution and relative intensity of marine recreational catches around the Yucatan Peninsula (Belize, Honduras, and Mexico) and The Cayman Islands at (A) 20- and (B) 10-km resolutions. Each cell was colour-coded using a within-country decile score to highlight relative differences and facilitate among-country comparisons. Catches that were associated with Honduras were not mapped onto the 10-km grid because catch rates, catch densitis, and participation rates were deemed to be too low to show reliable spatial patterns at this resolution.*

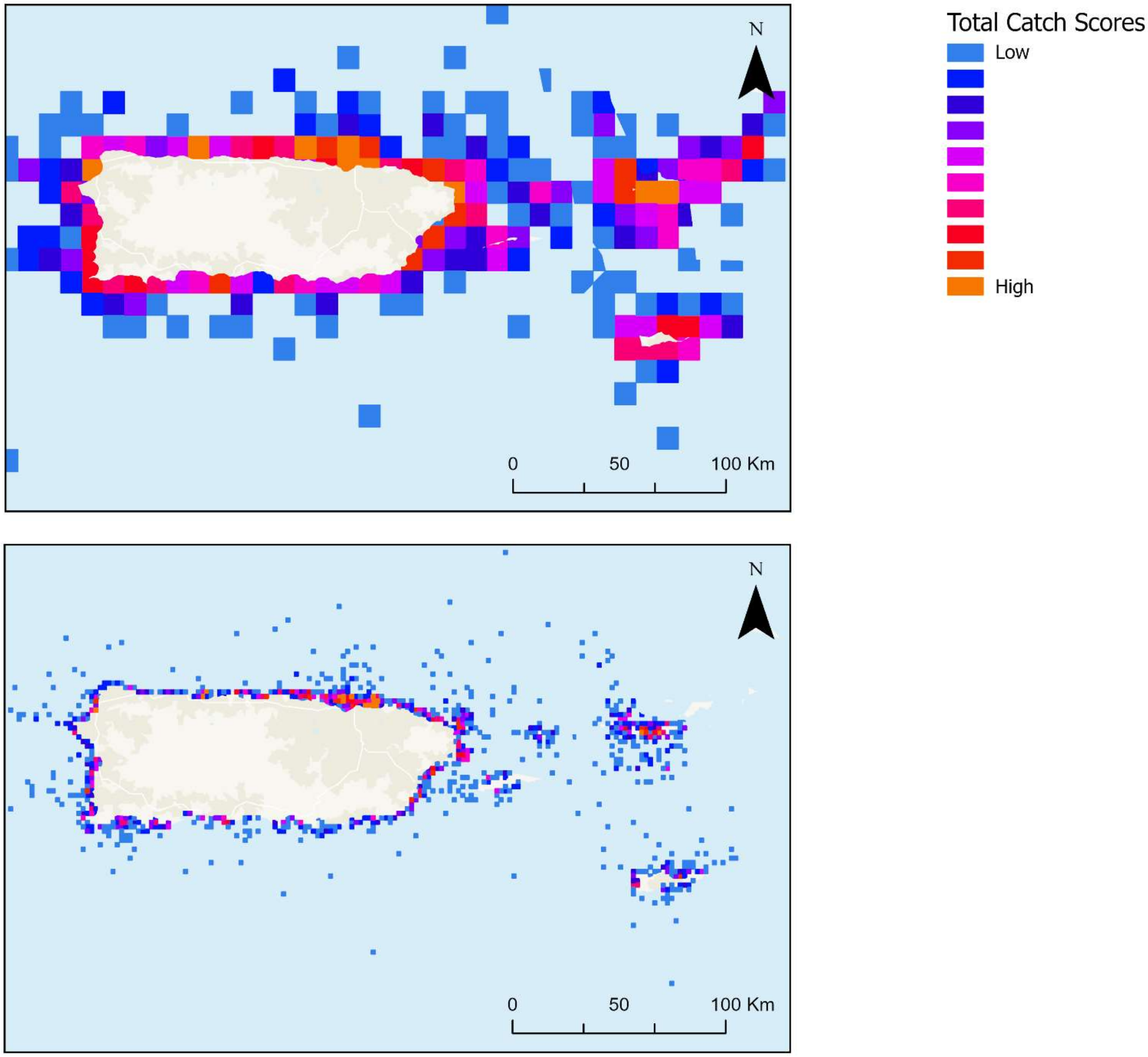


***Figure 5.*** *The distribution and relative intensity of marine recreational catches around Puerto Rico, the British and U.S. Virgin Islands at (A) 10- and (B) 2-km resolutions. Each cell was colour-coded using a within-country decile score to highlight relative differences and facilitate among-country comparisons. Catches that were associated with the British U.S. Virgin Islands were not mapped onto the 2-km grid because catch rates, catch densities, and participation rates were deemed to be too low to show reliable spatial patterns at this resolution.*

The proportion of international users and catches by international users was highly variable among countries (Figure 6). For example, catches by international users among countries with at least 200 catches and 100 users ranged from 1% in the United States to 99% in the US Virgin Islands (Table 3). The 10 lowest rates of international catches tended to be associated with large, sub-tropical or temperate countries. Conversely, the 10 highest rates of international catches were associated with small, tropical or sub-tropical countries. Countries in both groups tended to be high- or upper-middle income. The only exceptions were Madagascar and Mozambique, two low-income countries in the high international catch group.

***Table 3.*** *The top-10 and bottom-10 countries and territories by percent of marine-recreational catches that were reported by international users. Only countries with at least 200 catches and 100 users were considered (n = 48). Economic status was based on World Bank gross national income thresholds for 2023.*

| | **Users** | | **Catches** | | **Country information** | |
|---|---|---|---|---|---|---|
| **Country or territory** | **Total** | **Percent inter-national** | **Total** | **Percent inter-national** | **Economic status** | **Climate zone(s)** |
| U.S. Virgin Islands | 251-500 | 98 | 501-1000 | 99 | High | Tropical |
| Turks & Caicos Islands | <250 | 99 | 251-500 | 99 | High | Tropical |
| Belize | 251-500 | 96 | 501-1000 | 98 | Upper-middle | Tropical |
| Bahamas | 1001-2000 | 95 | 1001-2000 | 94 | High | Sub-tropical |
| Aruba | <250 | 94 | 251-500 | 94 | High | Tropical |
| Bermuda | <250 | 92 | <250 | 90 | High | Sub-tropical |
| Cuba | <250 | 90 | 251-500 | 89 | Upper-middle | Tropical |
| Dominican Republic | 251-500 | 93 | 501-1000 | 87 | Upper-middle | Tropical |
| Cayman Islands | <250 | 90 | <250 | 87 | High | Tropical |
| Fiji | <250 | 93 | <250 | 80 | Upper-middle | Tropical |
| | | | | | | |
| Singapore | 251-500 | 14 | 501-1000 | 12 | High | Tropical |
| Finland | 251-500 | 13 | 251-500 | 11 | High | Temperate/Frigid |
| Canada | 2001-5000 | 17 | 5001-10,000 | 10 | High | Temperate |
| Argentina | <250 | 9 | 251-500 | 7 | Upper-middle | Temperate |
| UK | 5001-10,000 | 9 | 10,001-50,000 | 5 | High | Temperate |
| Sweden | 2001-5000 | 7 | 5001-10,000 | 5 | High | Temperate |
| South Africa | 501-1000 | 11 | 2001-5000 | 5 | Upper-middle | Sub-tropical |
| Brazil | 2001-5000 | 5 | 5001-10,000 | 4 | Upper-middle | Tropical |
| Australia | 10,001-50,000 | 4 | 100,001-250,000 | 3 | High | Tropical to Temperate |
| United States | >100,000 | 1 | >750,000 | 1 | High | Temperate/Sub-Tropical |

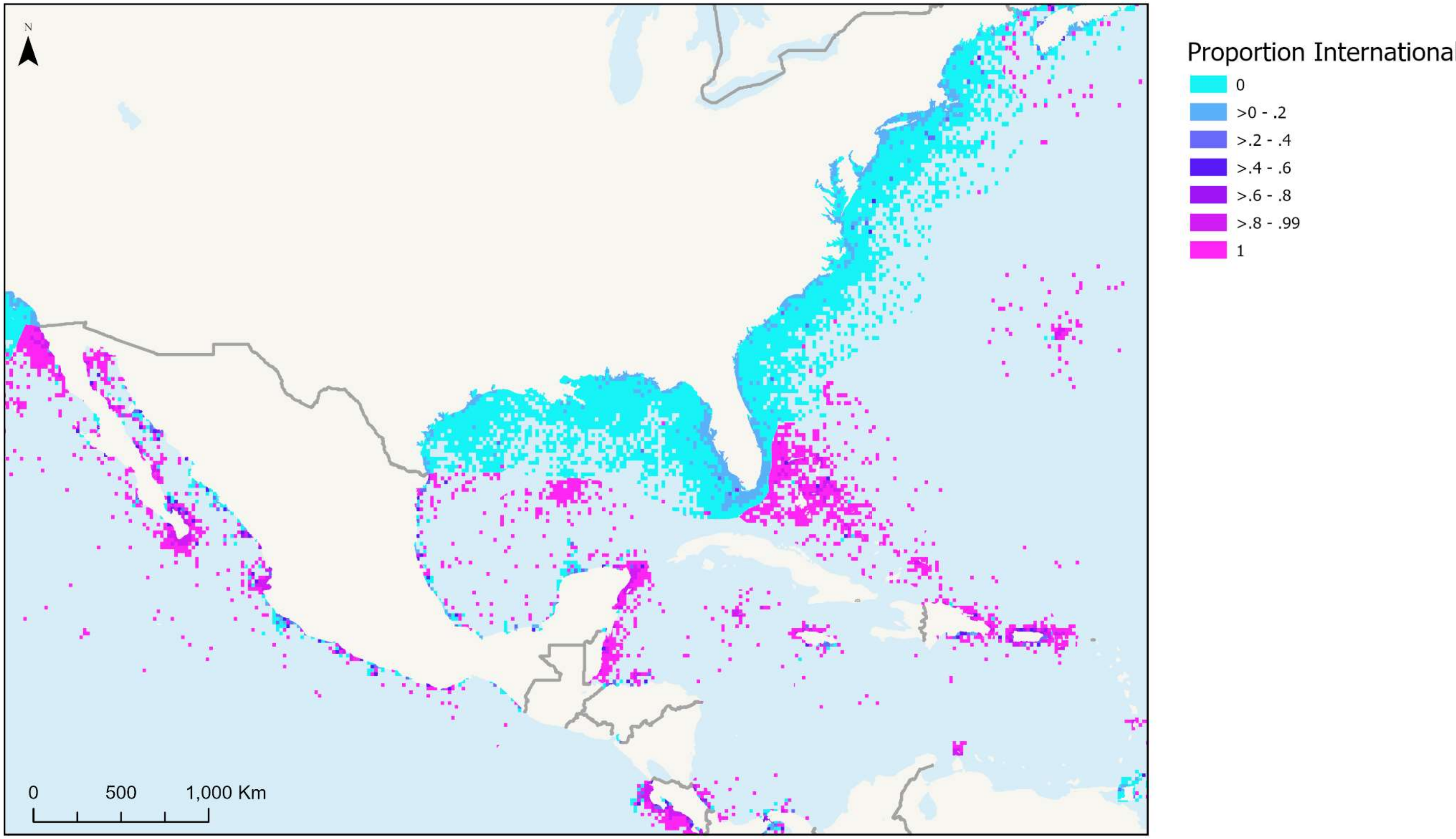


***Figure 6.*** *Percent international catches at the 20-km resolution for the middle Americas. The map clearly shows the considerable dominance of international fishers in some countries (e.g. the Bahamas, 94% across all catches), and their absence from others (United States 1%), with Mexico (76%) showing a mixed picture depending on the coastal region.*

The final Fishbrain dataset contained over one million catch records for 2,114 marine and brackish fish species. Given that over three-quarters of catches were from the United States, the most reported species tended to be popular U.S. sportfishes (notably drums (Sciaenidae) and temperate basses (Moronidae) which make up over 20% of all catches). Other highly reported species include common Australian targets such as flatheads, and seabreams (about 6% of all catches).

Half of the catches were of demersal species that are typically caught on or near the bottom in <50 m of water. Another 30% were reef-associated species. Pelagic (i.e., open-water) species made up ~10% of the catch. This included 42,600 catches of high-value pelagic game fishes as described above (40% of the pelagic catch, 4% of the total catch). The offshore nature of the pelagic game fish fishery is evident in Figure 7. Interestingly, 17% of pelagic game fish catches were reported by international users; a high value considering that international users were responsible for only 4% of catches in the global dataset. Catches of pelagic game fish among tropical countries made up 35-55% of the catch in countries like Aruba, Costa Rica, Dominican Republic, Guatemala, Mexico, and Mozambique (mean 87% international users), but only 1-10% of the catch in countries like Brazil, Cuba, Indonesia, Philippines, Puerto Rico, and Singapore (mean 45% international users). Belize was a clear outlier with only 7% high-value pelagics despite 96% international users.

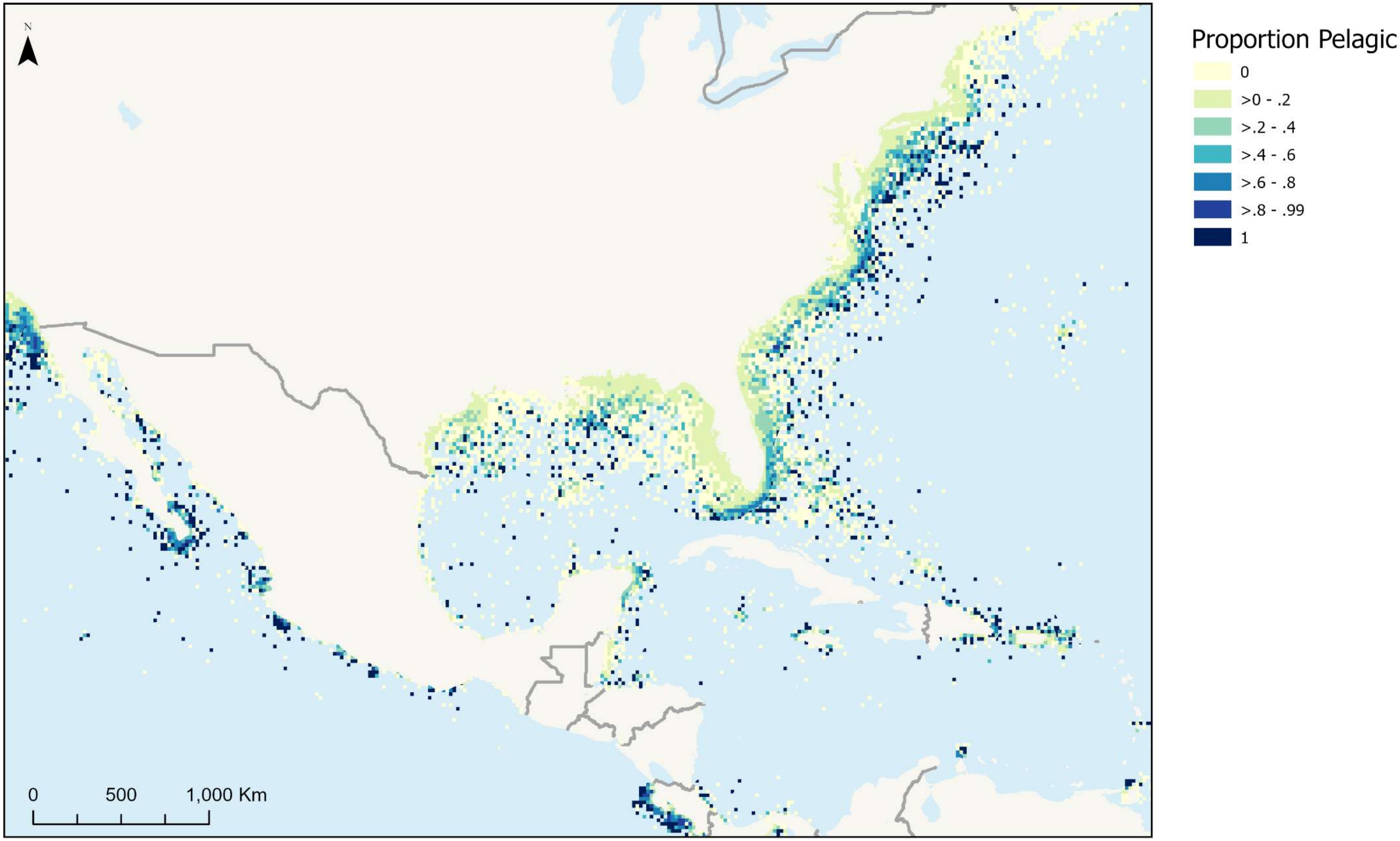


***Figure 7.*** *The proportion of pelagic game fish catches at the 20-km resolution for the middle Americas.*

## 2. Supporting information

The availability of supporting information was low for fisher and expenditure data (obtained from the literature), but high for landings data (obtained from the Sea Around Us project). After removing unreliable data (due to age or unclear metrics), MRF expenditure data was found for 24 countries, while fisher numbers were found for 32 countries.

For expenditure, numbers were only reported if they were considered to broadly follow the approach of Southwick, et al. (2016), with a broad definition to include travel, accommodation, food, gifts/souvenirs, entertainment, clothing, fishing tackle, guide fees, vehicle purchases, rentals and maintenance, donations, and personal items. Numbers from the highest-ranking countries are included in Table 5, below with all findings provided in Table S2). Hyder et al. (2018) accounted for approximately half of all data; the rest were extracted from primary and secondary sources that we found through online searches and reference chaining (i.e., snowballing). We found no additional information through email.

The highest numbers of marine recreational fishers were recorded from USA (13.8 million), but with large numbers across Europe and in New Zealand (704,000), South Africa (548,000) and Brazil (435,000). In general, numbers were low or very low for lower-income countries, as these numbers refer to resident rather than tourist fishers. Participation per capita was lowest in Angola (36 fishers per million inhabitants), Ghana (117), and Cape Verde (126), and highest in New Zealand (137,482), Norway (238,871) and Iceland (281,065).

Annual MRF expenditures for those countries with comparable estimates, expressed in October 2023 USD, ranged from $3.15 million (Angola) to $1.25 billion (Puerto Rico) to $59 billion for the USA. Of course larger countries tend to dominate such statistics, but it is notable that the contribution of such expenditure to the overall economy follows a different pattern, with expenditures in the Bahamas reaching over 5% of GDP and almost 1% for Puerto Rico. Although of considerable interest and value, such numbers should be treated with some caution as they represent a combination of data from diverse sources.

***Table 5.*** *Annual MRF expenditures and fisher numbers for the most important countries (either with expenditure of more than $600 million or more than 600,000 recreational fishers). Expenditure numbers are expressed in millions of 2023 USD. These values are also expressed as a proportion of 2023 GDP PPP and 2020 population (World Bank statistics). See Table S2 for data from all countries as well as source information.*

| Country | Annual fishing expenses (millions 2023 USD) | Fishing expenses as proportion of GDP | Total marine recreational fishers | Marine fishers per million of population |
|---|---|---|---|---|
| Bahamas | $693.79 | 5.247% | | |
| Brazil | $661.60 | 0.016% | 435,000 | 2,085 |
| Canada | $11,443.29 | 0.510% | | |
| Costa Rica | $613.46 | 0.457% | | |
| France | | | 1,319,000 | 19,512 |
| Greece | | | 730,514 | 68,281 |
| Italy | $378.48 | 0.012% | 800,000 | 13,459 |
| New Zealand | $871.11 | 0.342% | 704,473 | 138,398 |
| Norway | | | 1,285,000 | 238,871 |
| Puerto Rico | $1,254.27 | 0.910% | 126,674 | 38,602 |
| UK | $2,909.44 | 0.078% | 1,150,000 | 17,143 |
| USA | $59,125.99 | 0.237% | 13,800,000 | 41,626 |

Landings data from The Sea Around Us project were gathered for 37 countries. Mean annual recreational landings were lowest in lower income small island states such as St Kitts and Nevis, Grenada and The Maldives (1-1.5 tonnes, valued between $4-5,500), and highest in the USA, Australia, and China with the former estimated at 243,000 tonnes and an estimated value of $779 million.

We were unable to develop a reliable model for predicting annual expenditures. Expenditures were strongly correlated with marine fisher numbers ($r$ = 0.97, Figure 8), but our sample size was low (only 5 countries <$200 million) and the corresponding regression model could only be used to predict expenditures ($29.5 ± 25.5 million 95% PI) from fisher numbers in Mozambique (6000). Expenditures were also correlated with catches by national users ($r$ = 0.82) and the number of national users ($r$ = 0.74). However, the number of national users and catches by national users were themselves strongly correlated ($r$ = 0.95). The best model using these variables was a univariate linear model (expenditures ~ catches by national users), but 95% predictions intervals were too wide to be of practical use. For example, the model predicted that expenditures in Guam (35 catches by national users) were in the interval $-23.9 ± 71.4 million. We do not report either equation here because we discourage using them to make country-specific predictions.

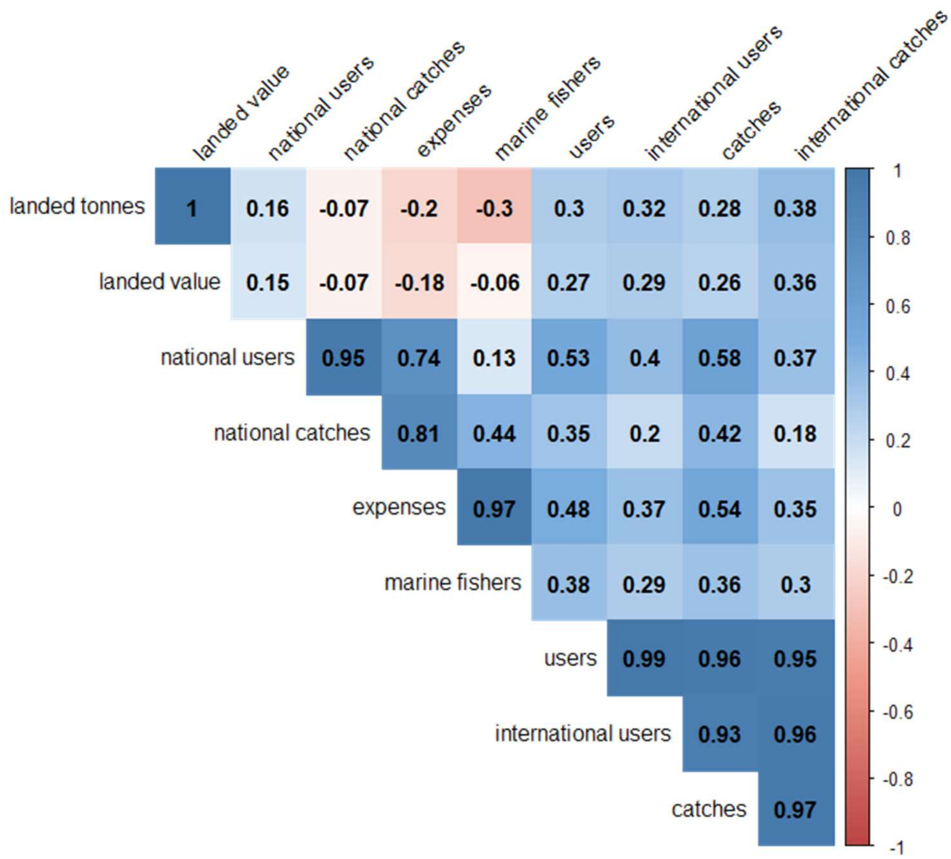


***Figure 8.*** *Pearson correlation matrix for 10 variables associated with Fishbrain, Sea Around Us, and two literature searches for 17 TNC priority countries for which annual marine fishing expenditures was <$200 million (see Methods for details). Some sample sizes were <17 due to data gaps in some variables.*

We observed strong correlations among other variables (Figure 8), but these correlations were expected. Many of the Fishbrain variables were strongly correlated (e.g., $r$ = 0.99 between users and international users), as were both Sea Around Us variables ($r$ = 0.99).

## Discussion

Marine recreational fisheries around the world are regionally and locally important. Aside from obvious social and cultural benefits, they can provide notable economic and health benefits, and may contribute to research and monitoring, education and even conservation (Hyder et al. 2020). Despite this importance, formal records of marine recreational fishing are rare, and few countries, if any, have a detailed understanding of this value, or its spatial distribution. This is a significant issue. In the increasingly crowded space of coastal and nearshore waters, it is important to understand the needs and requirements of all activities, in order to avoid conflicts and to maximize synergies and social and economic benefits.

Our work provides the first, albeit exploratory, attempt to map the distribution of recreational fishing intensity around the world using a mixed array of sources. We use a million, individual, unsolicited catch records drawn from the smartphone-based fishing app, Fishbrain, to show that, for some regions and countries, there is already a rich information base from which maps can be drawn. Data from the USA dominate the totals, but we have also developed maps, at varying resolutions, for Australia, New Zealand, and several countries in northern and western Europe, Central America, the Caribbean and elsewhere.

Our independent search for fisher numbers and expenditure, although limited in its findings, shows the considerable importance of fishing in many countries, with fishers making up 13% of the population in New Zealand and generating expenditure reaching almost 4% of GDP in the Bahamas.

### Interpretation

Maps at the lowest (20 km) resolution show the broad distribution of recreational fishing intensity across 39 countries. These maps only show the most general patterns of fishing intensity, but may still be of use for larger countries in pointing to general areas where fishing may be more focused.

Data were considered sufficiently detailed to map 21 of these countries at medium resolution (10 km). At this resolution, it is possible to make more specific observations about the distribution of recreational fishing. The strong nearshore focus is not surprising, but it is also possible to see locations of more intense fishing, often linked to urban or tourism centres, while gaps may also be seen where recreational fishing is apparently rare.

The finest (2 km) resolution was considered only applicable for seven countries: the USA and Australia, plus five relatively small island states (Aruba, Bermuda, Puerto Rico, Singapore, and the U.S. Virgin Islands). These maps may be suitable for utilization in more direct marine planning and governance purposes, enabling governments and private sectors players, as well as a wider public, to assess the varying spatial importance of recreational fishing and giving them the potential to ensure sustainable management and to avoid conflicts with other sectors.

The role of domestic versus international fishers showed a clear pattern, with international fishers predominating in many of the lower income countries, and in countries where coastal tourism is a major economic driver. By contrast, most catches in wealthier, often higher latitude, countries are dominated by domestic fishers. Mexico presents a more nuanced picture, but even here the division between domestic and international fishers shows clear geographic segregation at more local levels, with international fishers dominating close to the Pacific US border and around the tourist centres of southern Baha, and eastern Yucatan. Such maps may simply corroborate expected patterns, which demonstrates clear value in being able to separate domestic from international recreational fishing. International arrivals can generate important income and foreign exchange for many countries, and may not always be included in national surveys of recreational fishing.

Similarly, domestic fishers are an important constituency which, in many developed nations, make up a significant proportion of the general public.

The analyses of pelagic game fish catches provides an initial exploration into the utility of the species specificity that is contained within the Fishbrain dataset. Our map (see Figure 7) clearly shows the offshore nature of these species, particularly in areas where there is a wide continental shelf such as around the eastern seaboard of the USA. As target species for boat-based rod-and-line fishing, these species are of considerable economic significance. Their predominance in the overall catches for three countries in particular (Bahamas, Costa Rica and Mexico) is a clear signal to the importance, and the likely very high value, of offshore fishing charters for these countries, all of which have a strong reliance on tourism for their national economies.

The challenges of locating national estimates of total fishers and total expenditure are considerable, however the values located help to underpin the wider value of recreational fishing. Across the 32 countries for which we found fisher data, the total estimate is 23 million individual fishers (out of a total population of 1.2 billion people), which represents about 2% of all people in these countries. The combined values, at $79.7 billion are a critical contribution to local and national economies. As a proportion of GDP the numbers are highly variable, but it is notable that after the Bahamas and Puerto Rico, the highest contributions come from a mix of lower countries, including Costa Rica, Cape Verde and Namibia, but also wealthy nations including New Zealand, the USA and Canada.

While the national economic and fisher numbers are derived from different sources, and different years (with economic values extrapolated to 2023 values) they help to highlight the overall importance of MRF across a broad geographic and socio-econonmic range of countries. They also show that, while the FishBrain data may represent a useful sample of fishers in some countries, it may be less representative for others.

User-generated content is typically vulnerable to error and bias, and while we were able to control for certain issues, weaknesses remain. The apparently strong national variability in use of Fishbrain between countries prevents any quantitative comparison of catch levels between countries. To counter this, normalising catch numbers in each country by catch totals for that country it was possible to generate broadly comparable maps showing the relative intensity of MRF. Fishbrain is a multi-lingual platform and there are in fact many records from France, Brazil, Sweden, and several Spanish-speaking nations. Even so, there appears to be a bias towards English-speaking nations. National bias in Fishbrain utilization may also have ramifications for international records, for example reflecting higher international catch records in countries frequented by US visitors compared to countries more popular with non-English speaking travellers.

Fishbrain provides a rich source of taxonomic resolution, however errors of species identification are likely to occur and so the only species-specific component we explored was that of easily recognizable pelagic game-fish. We were also aware that, in using individual catch records as evidence of catch intensity there will be some under-reporting, as many users catch more fish than they report, often with a bias toward reporting higher interest catches (large individuals or preferred species).

Given the global scale and the relatively low resolution of our work, we also did not attempt to quantify spatial error in detail. A review of the habitat preferences of particular species showed that broad locational data were typically accurate. Our spatial filter buffered inland to ensure that we included marine and brackish water species that may have otherwise been excluded either by mis-recording of catch location or by inaccuracies in the base-line map and definition of coastal waters. Likewise, the exclusion of freshwater species removes false positives from our records. Nevertheless, it would be helpful in future work to develop a better understanding of spatial accuracy, particularly if there is interest in using the data at resolutions higher than 2 km.

Our attempts to draw out associated information on fisher numbers and economic value showed that such data exist for many countries. Considerably more investment is needed to both assess existing data and generate new information. In particular, we encourage the development of a standard approach to estimating recreational fishing expenditures that relies on direct measures or correlates that are readily available for most countries (see next subsection). The particularly high value and importance of recreational fishing expenditure in many countries has broad connotations. While overall numbers for value were missing for some countries, it was noteworthy that sectors within the fishery (such as offshore billfish and fly fishing) have been the subject of distinct studies (e.g. Smith et al, 2023). This may provide an opportunity to focus future models towards different sectors in recreational fishing, and ultimately develop spatial layers for identifying high-value locations.

## Future work

The current work provides a range of data, both mapped and numerical, that should already be of use for particular countries and territories to assess the distribution and value of MRF. It also provides an important starting point in considering how MRF data might be further utilized, or enhanced, by additional datasets or analyses. To this end we have already begun to investigate other sources of information and approaches.

Remote sensing and Automatic Identification Systems. Groups such as Global Fishing Watch have been tracking commercial fishing for a number of years, and improvements in both data inputs and analytical tools is such that it is possible to track smaller and smaller vessels, and to greatly refine models to understand the activity of such vessels, which may help to filter recreational fishing vessels (see, for example, Paolo et al. 2024).

A number of platforms are now available to look at companies and boat charters that offer MRF. Spatial data associate with these will tend to focus on points of departure. They may also enable further refinements in terms of understanding catch, fishing methods, and pricing.

Fish tagging programs. A number tagging programs have been established in collaboration with recreational fishers in countries around the world (mostly, but not entirely, higher income countries). Most of these have biases in geographic selectivity (even within country) or species selectivity, however they can be data rich, and could yield valuable local data for specific components of recreational fishing.

Other user-generated content. The very rapid advances with AI could well enable much wider data harvest from third parties, using text and image recognition.

A further direction towards this general mapping might come from predictive mapping. Such mapping is already widely used in commercial fisheries, and is also starting to be built into recreational fisher apps. Predictions could be driven by a combination of best fishing locations (marine habitats, bathymetric or other features, FADs, reserve boundaries), opportunities to reach them (distance from accessible shore, boat launch points, reasonable boating distance from nearest port or launching point), and negative drivers such as conflicting marine usage (no-take areas, dive sites, fish farms, shipping lanes, sensitive infrastructure, polluted waters).

The potential to explore sub-categories of fishing could be important both for understanding value, and for access, licensing and stock management, including interactions with commercial fisheries. It is already possible to use Fishbrain data to identify some aspects of pelagic game fishing, and future targets might include fly-fishing, catch and release fisheries (e.g. flats fisheries in the Caribbean), as well as single species targets.

In their work in the Eastern Caribbean, Spalding et al. (2023) found that global data sources were insufficient, on their own, for mapping recreational fisheries at scales likely to be of use for planning, at least for small island nations. However, they also showed that the potential utility of these maps could be greatly enhanced by combining data from multiple sources that included local knowledge.

The current work delivers mapped data, but equally points to a way forwards in which this critical activity can be put on the map and effectively valued. In so doing, it should be possible to greatly enhance management for the long-term sustainability, indeed enhancement, of recreational fishing world-wide.

### Data availability

All of the Fishbrain data was obtained by a data sharing agreement and data requests need to be directed to Fishbrain. The summary data shown in this report can be explored, but not downloaded, on the Mapping Ocean Wealth platform: [www.maps.oceanwealth.org](www.maps.oceanwealth.org)

## Acknowledgments

We thank Fishbrain for their support, data-sharing, and for advice on its use. We also thank C. Skov and K. Hyder for feedback during the development of this report. Photographs are all courtesy of Mark Spalding

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## Supplementary figures

**Figure S1:** South Africa and Mauritius.

**Figure S2:** Mauritius, the Chagos Archipelago and the Maldives.

**Figure S3:** mainland Australia.

**Figure S4:** South-East Australia and New Zealand.

**Figure S5:** northern Europe.

**Figure S6:** South-West Europe.

**Figure S7:** Pacific coast of the United States and Canada.

**Figure S8:** the eastern seaboard of the United States and Canada.

**Figure S9:** Mexico, Central America, and the Gulf Coast of the United States.

**Figure S10:** the Caribbean and the Gulf of Mexico.

**Figure S11:** Brazil.

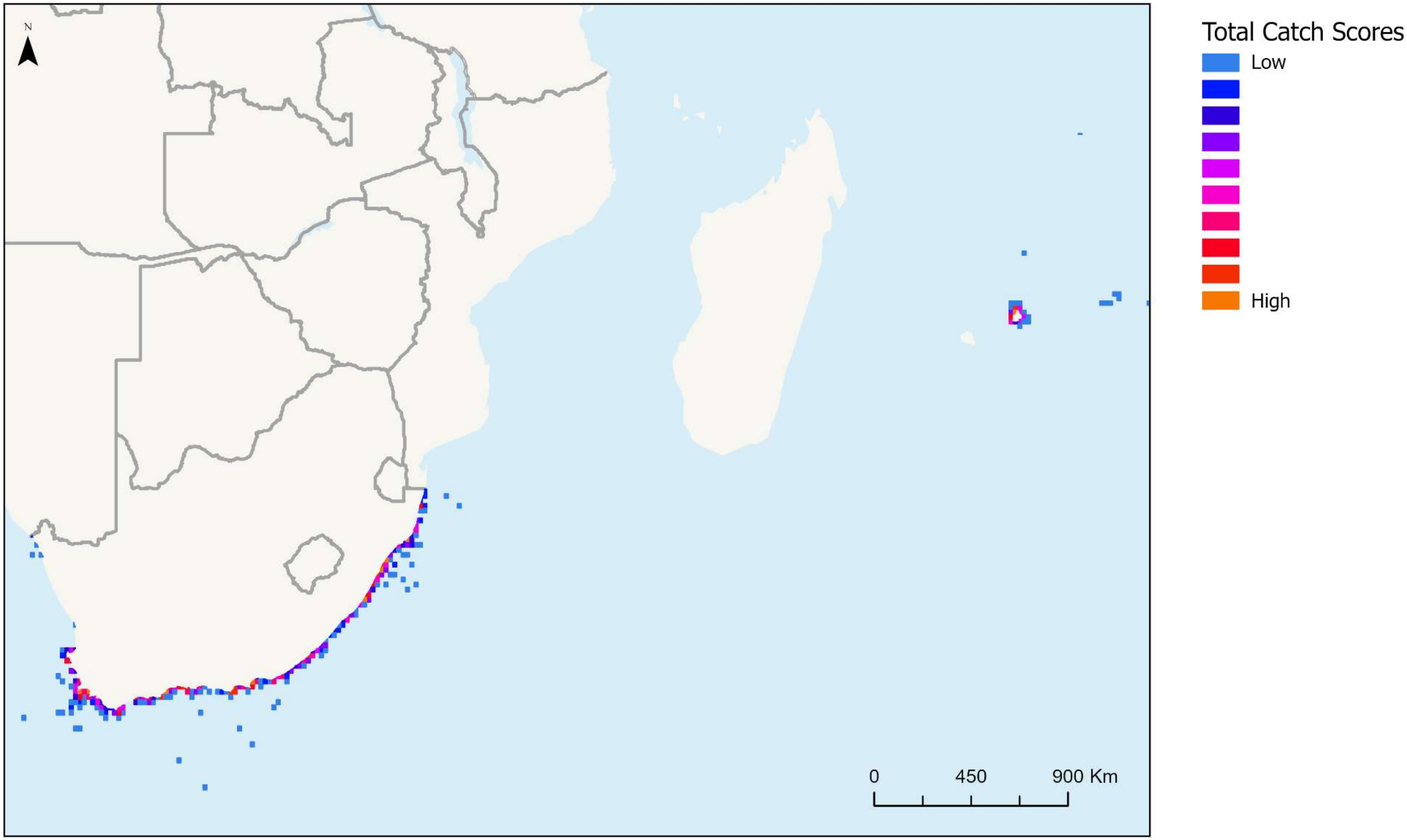


**Figure S1.** The relative intensity of marine recreational catches reported along the coast of South Africa and Mauritius via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

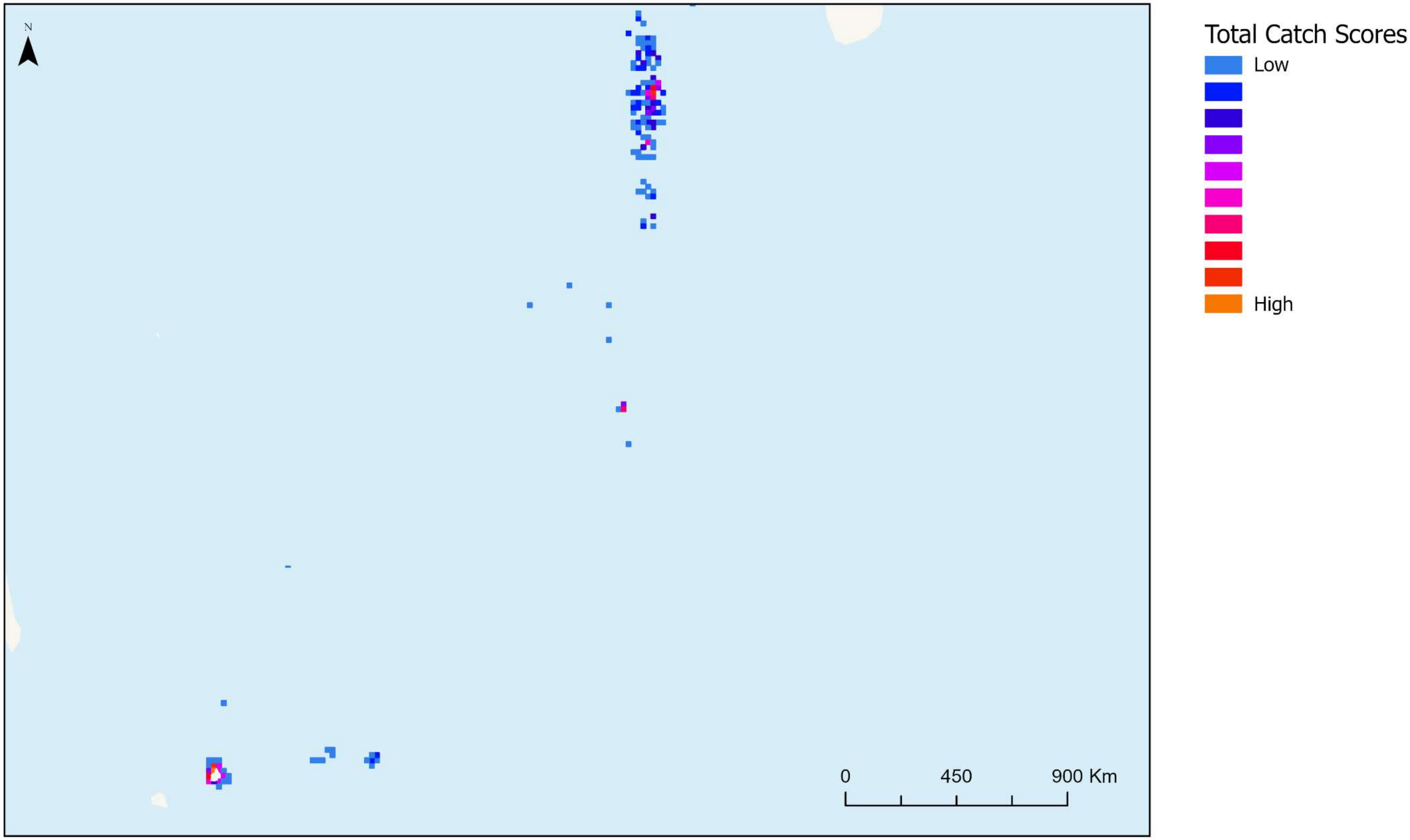


**Figure S2.** The relative intensity of marine recreational catches reported along the coast of Mauritius, the Chagos Archipelago and the Maldives via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

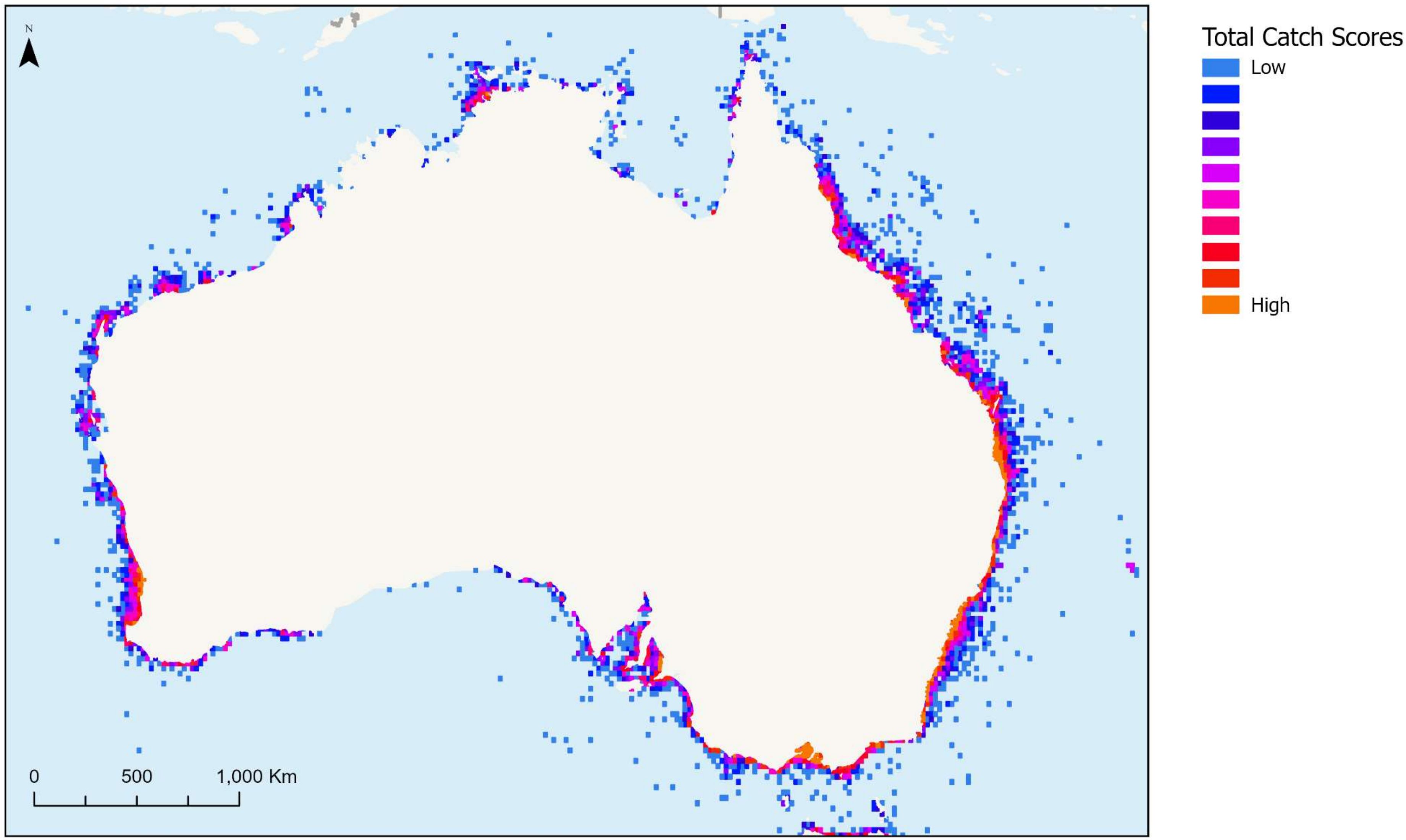


**Figure S3.** The relative intensity of marine recreational catches reported along the coast of mainland Australia via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

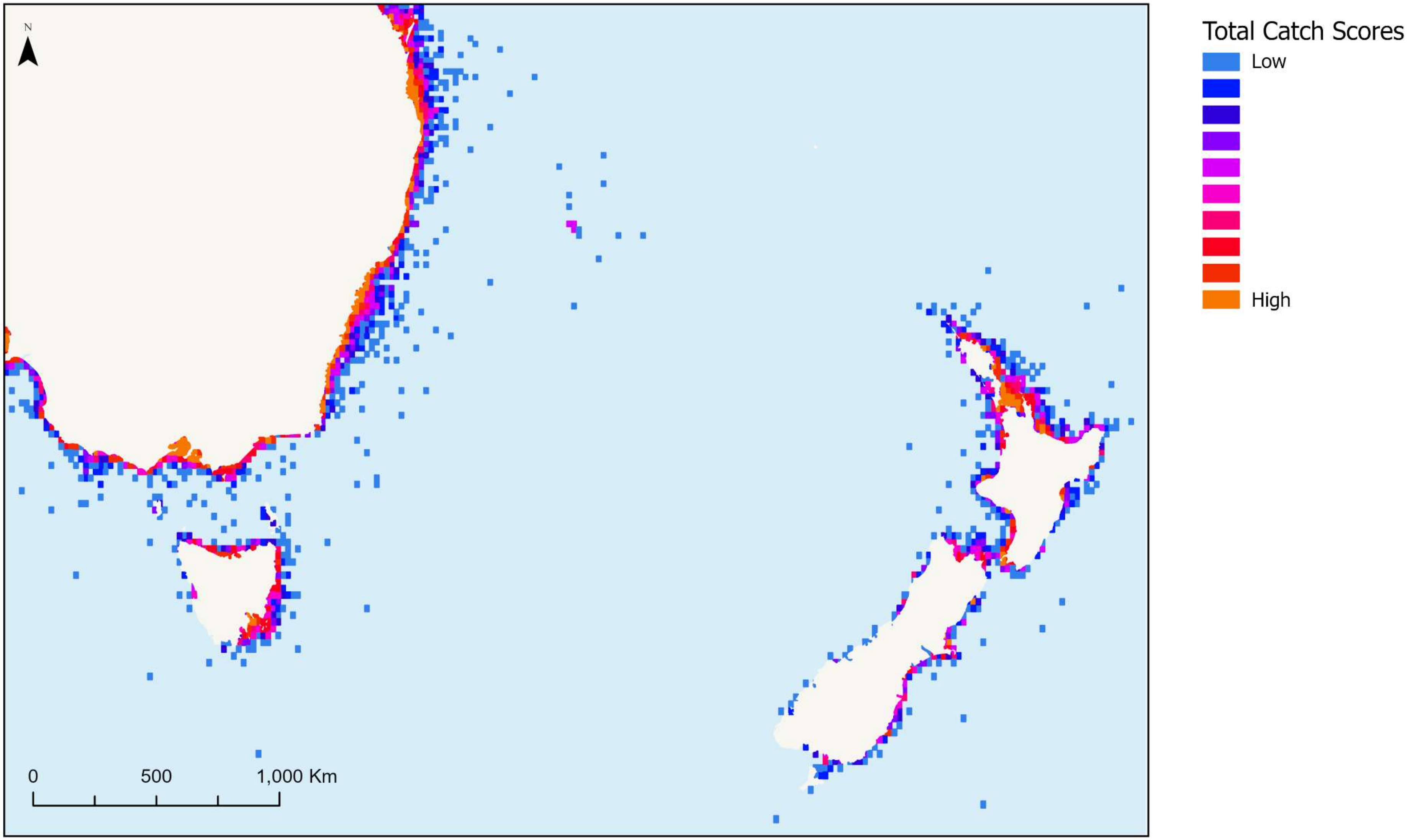


**Figure S4.** The relative intensity of marine recreational catches reported along the coast of South-East Australia and New Zealand via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

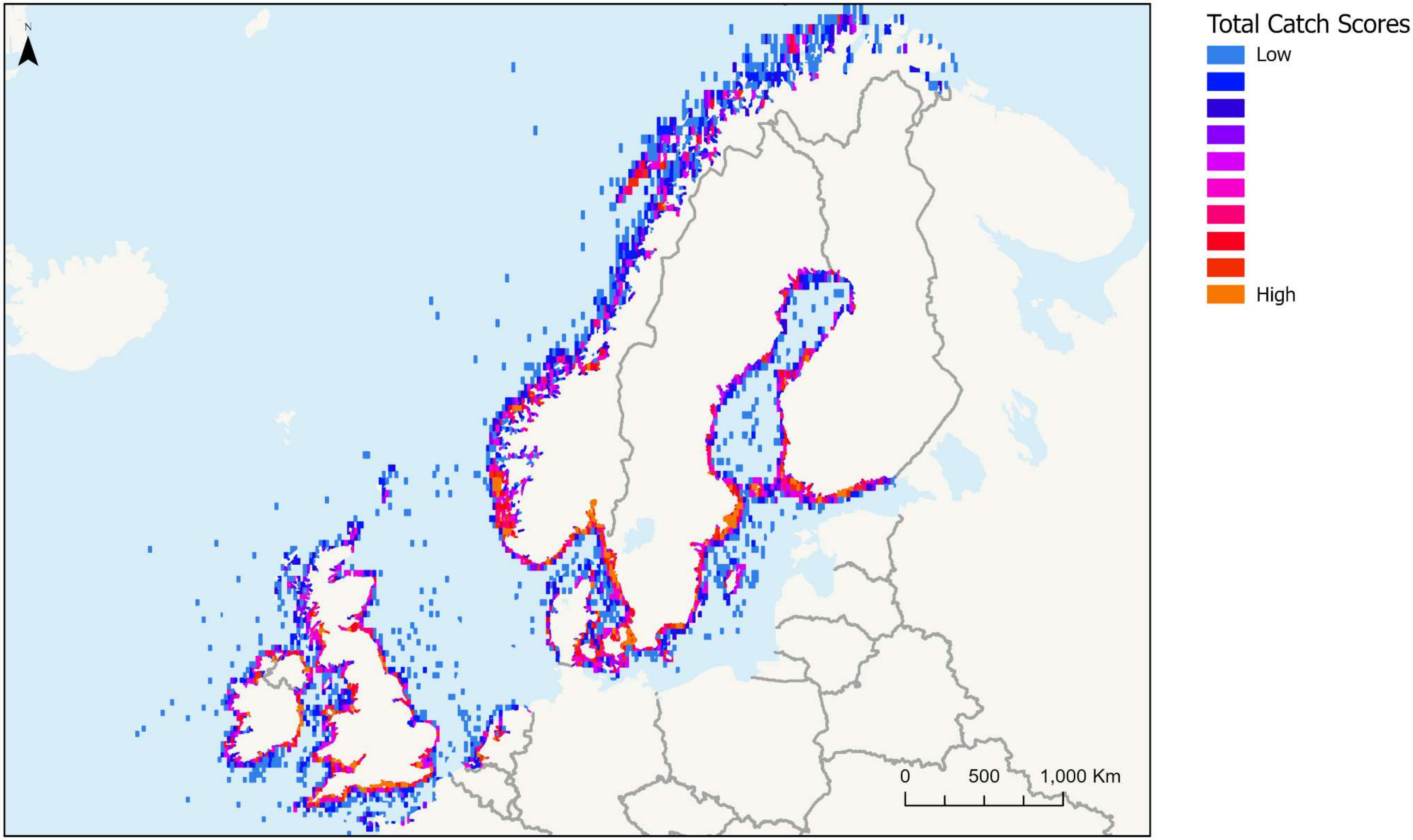


**Figure S5.** The relative intensity of marine recreational catches reported along the coast of northern Europe via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

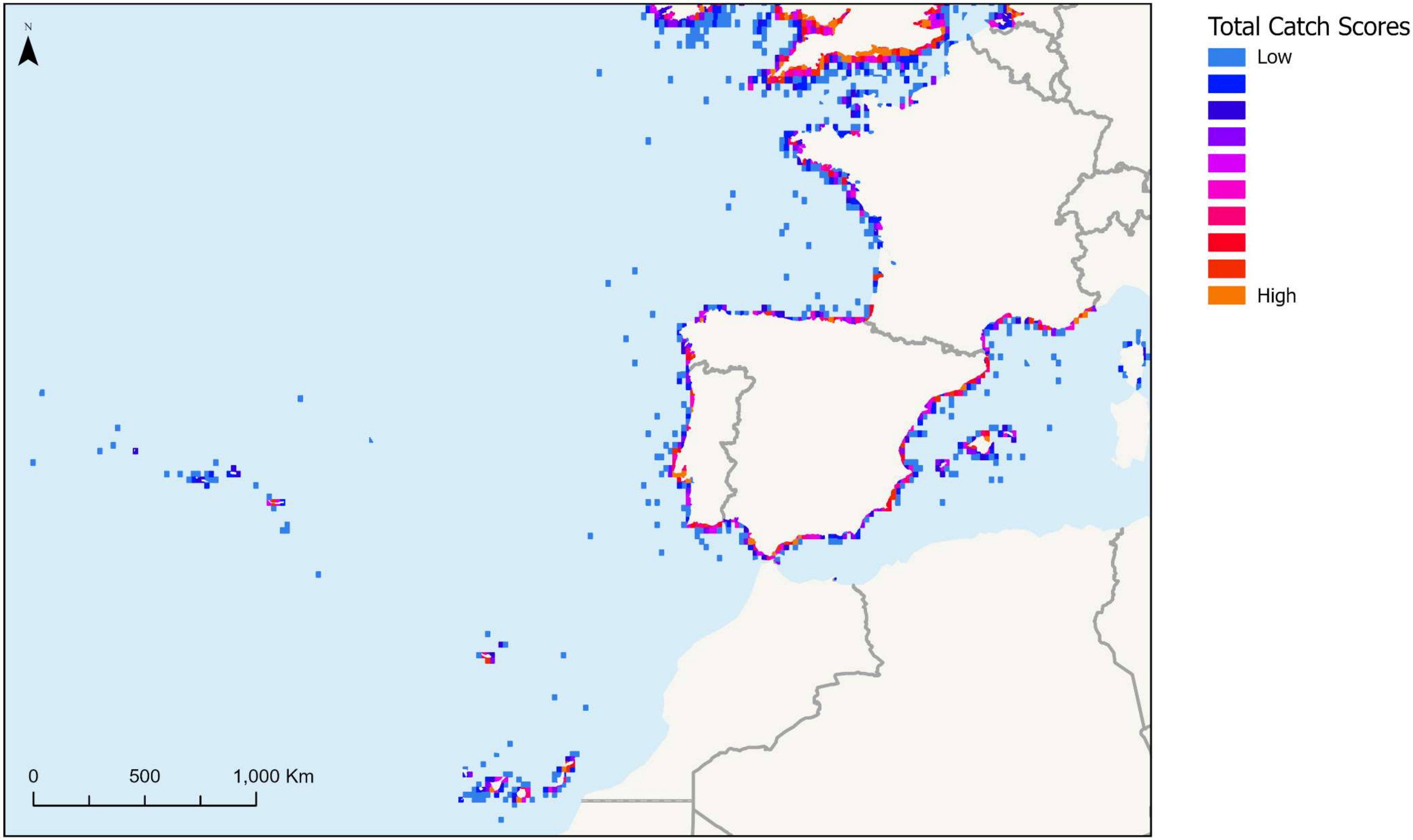


**Figure S6.** The relative intensity of marine recreational catches reported along the coast of South-West Europe via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

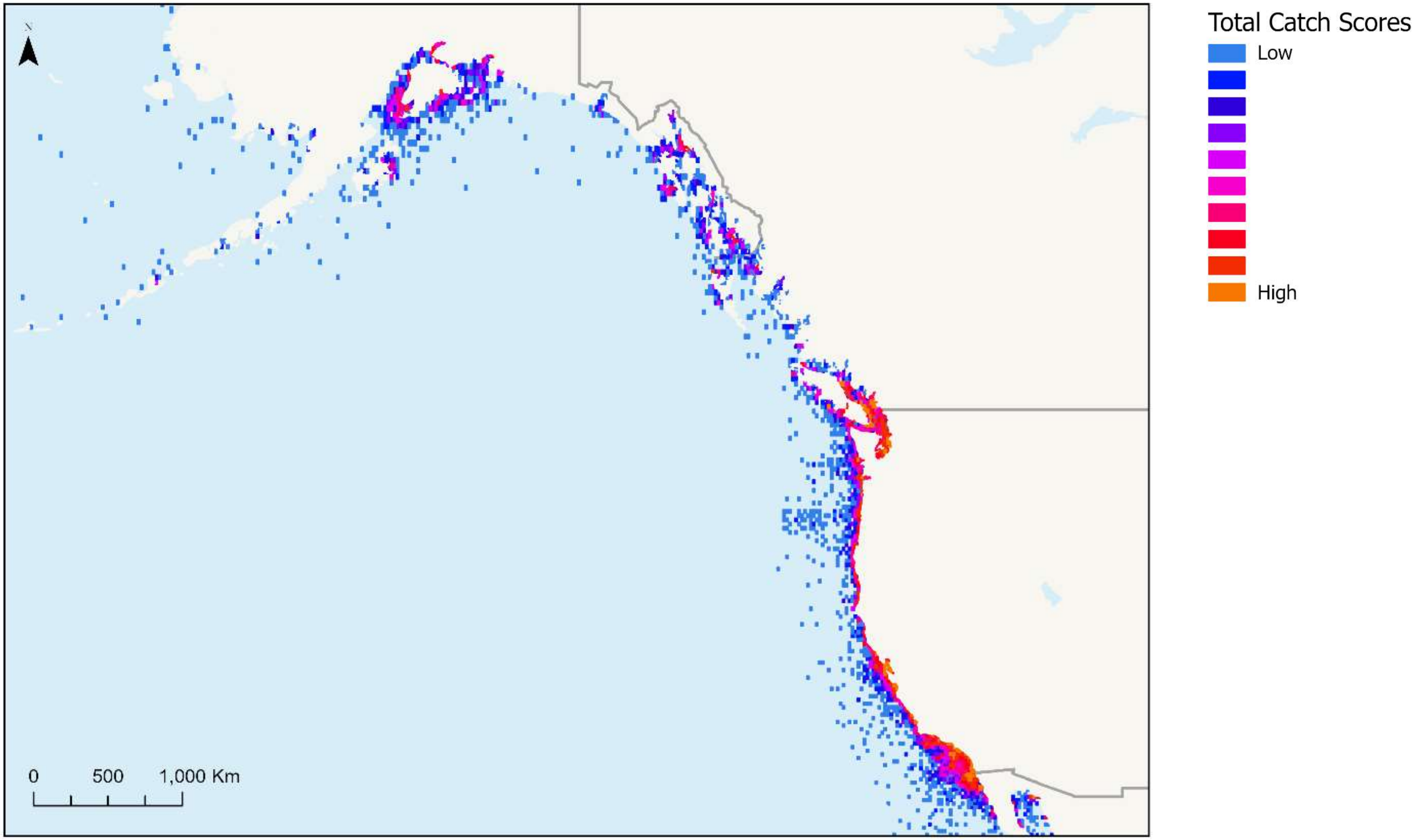


**Figure S7.** The relative intensity of marine recreational catches reported along the Pacific coast of the United States and Canada via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

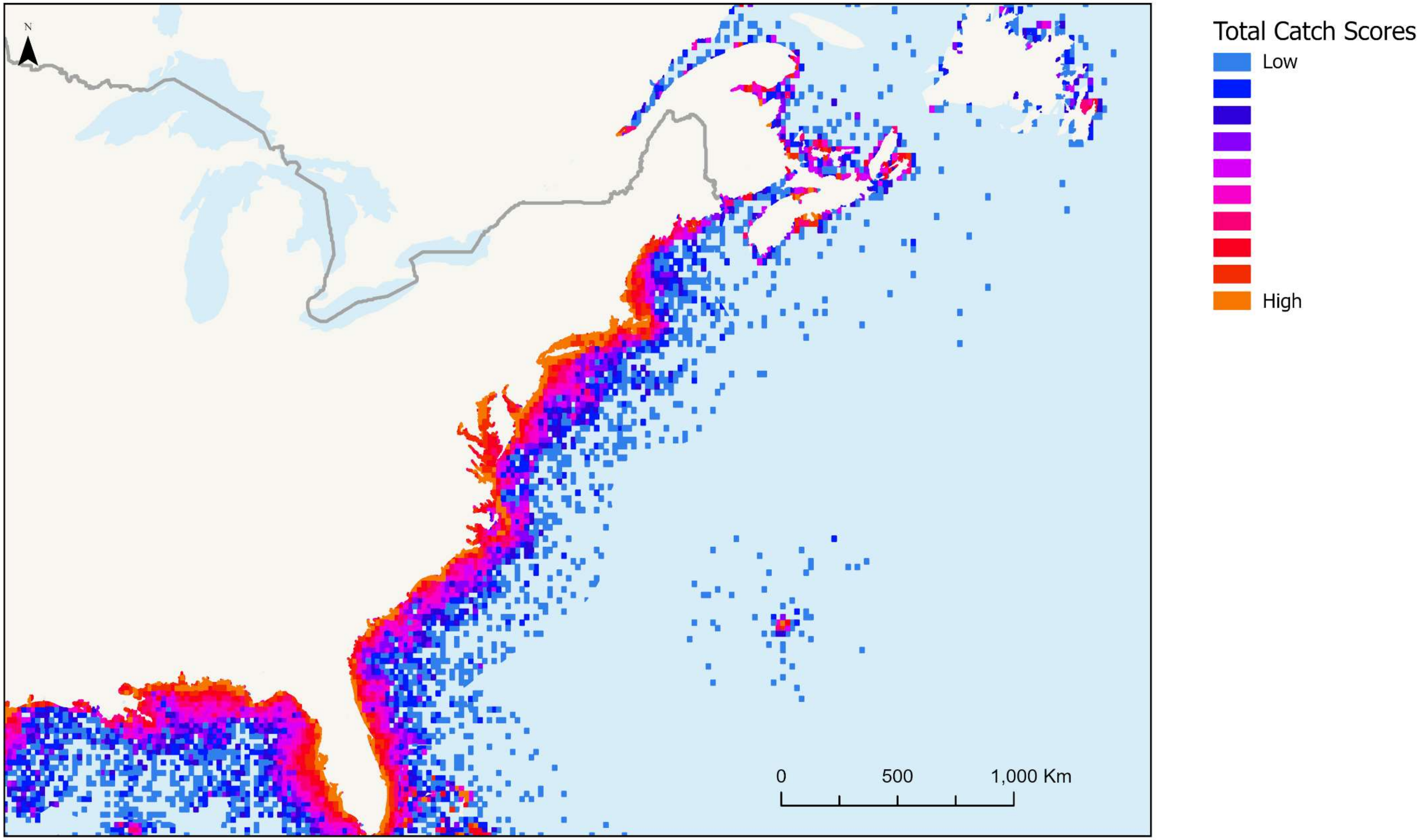


**Figure S8.** The relative intensity of marine recreational catches reported along the coast of the eastern seaboard of the United States and Canada via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

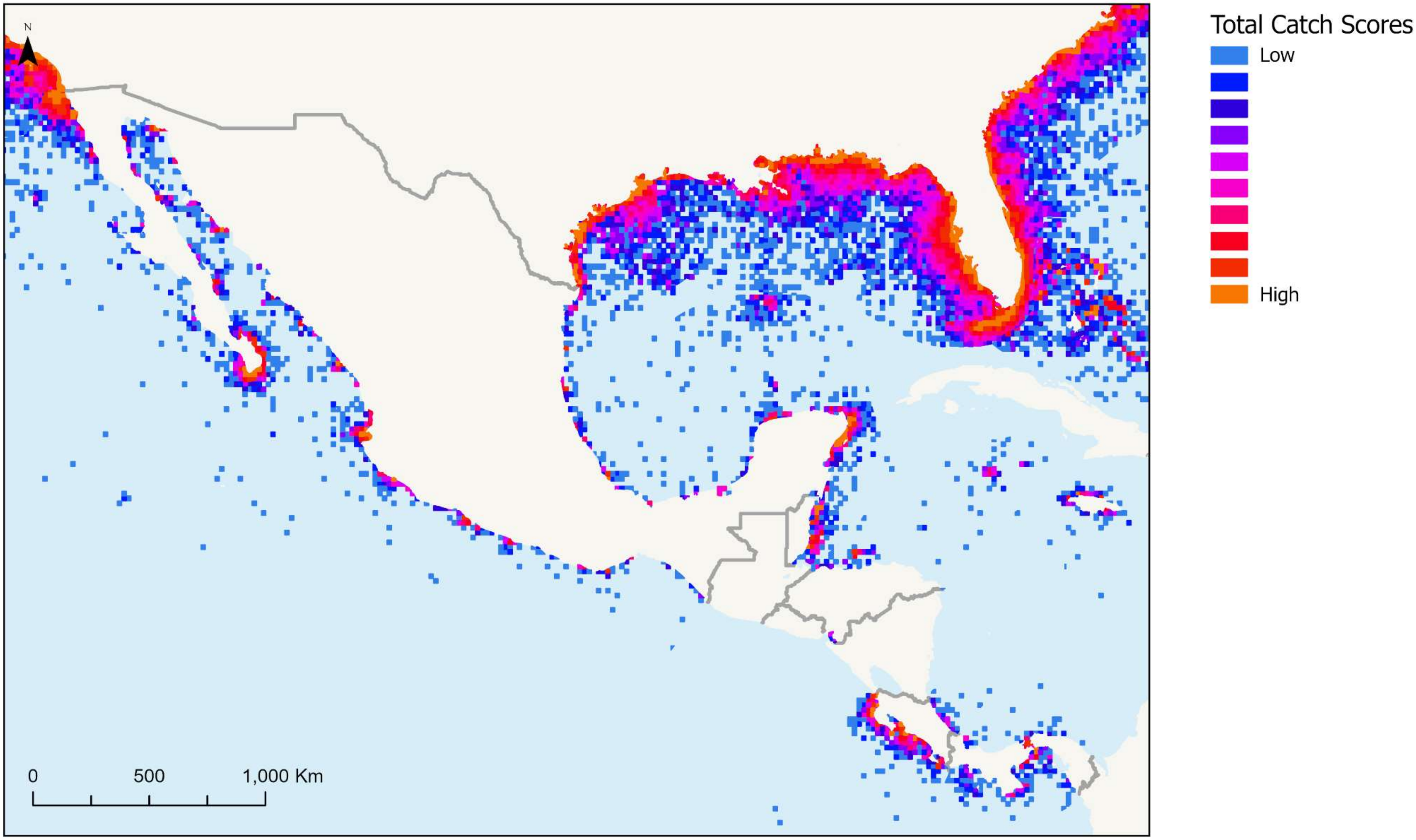


**Figure S9.** The relative intensity of marine recreational catches reported along the coast of Mexico, Central America, and the Gulf Coast of the United States via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

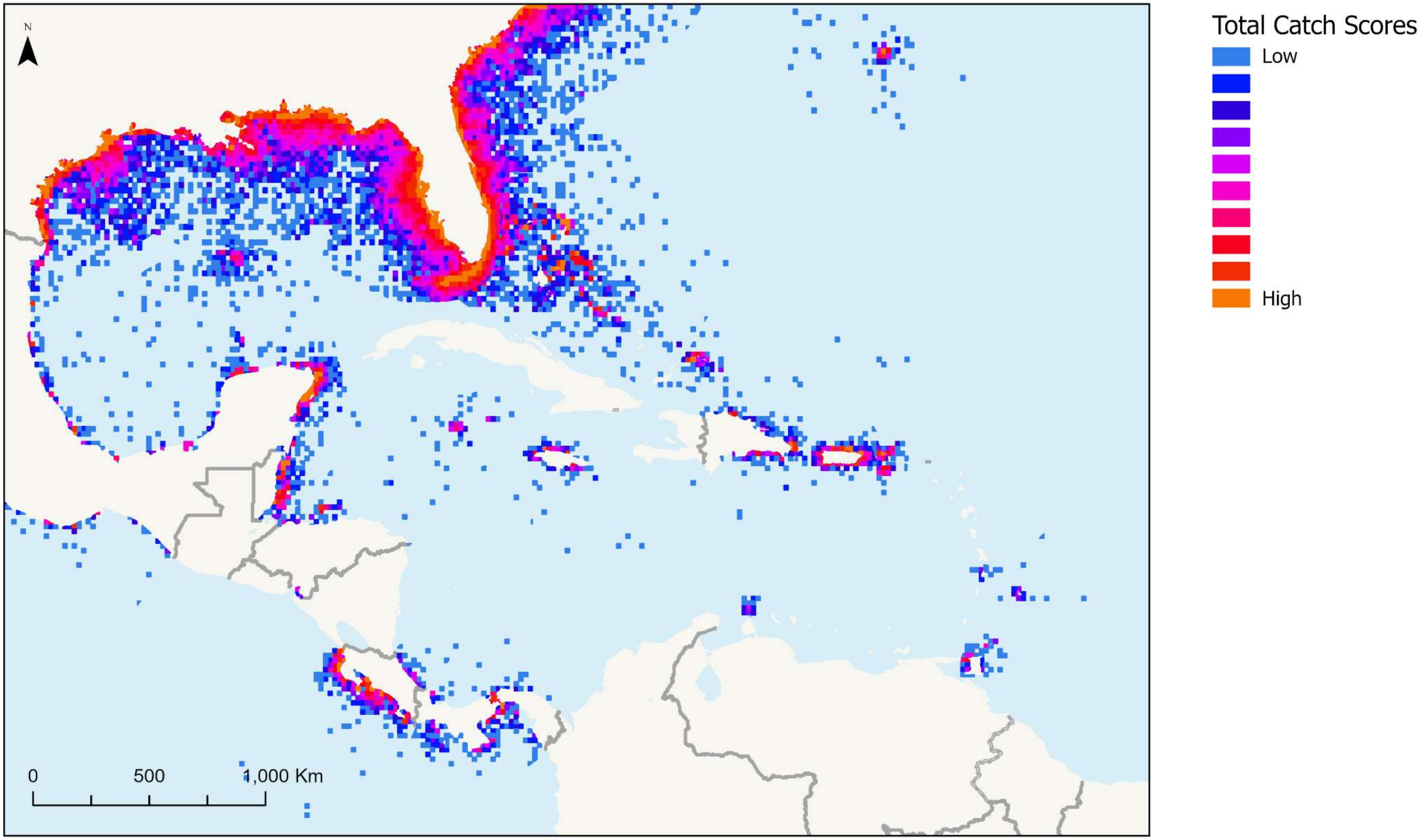


**Figure S10.** The relative intensity of marine recreational catches reported along the coast of the Caribbean and the Gulf of Mexico via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

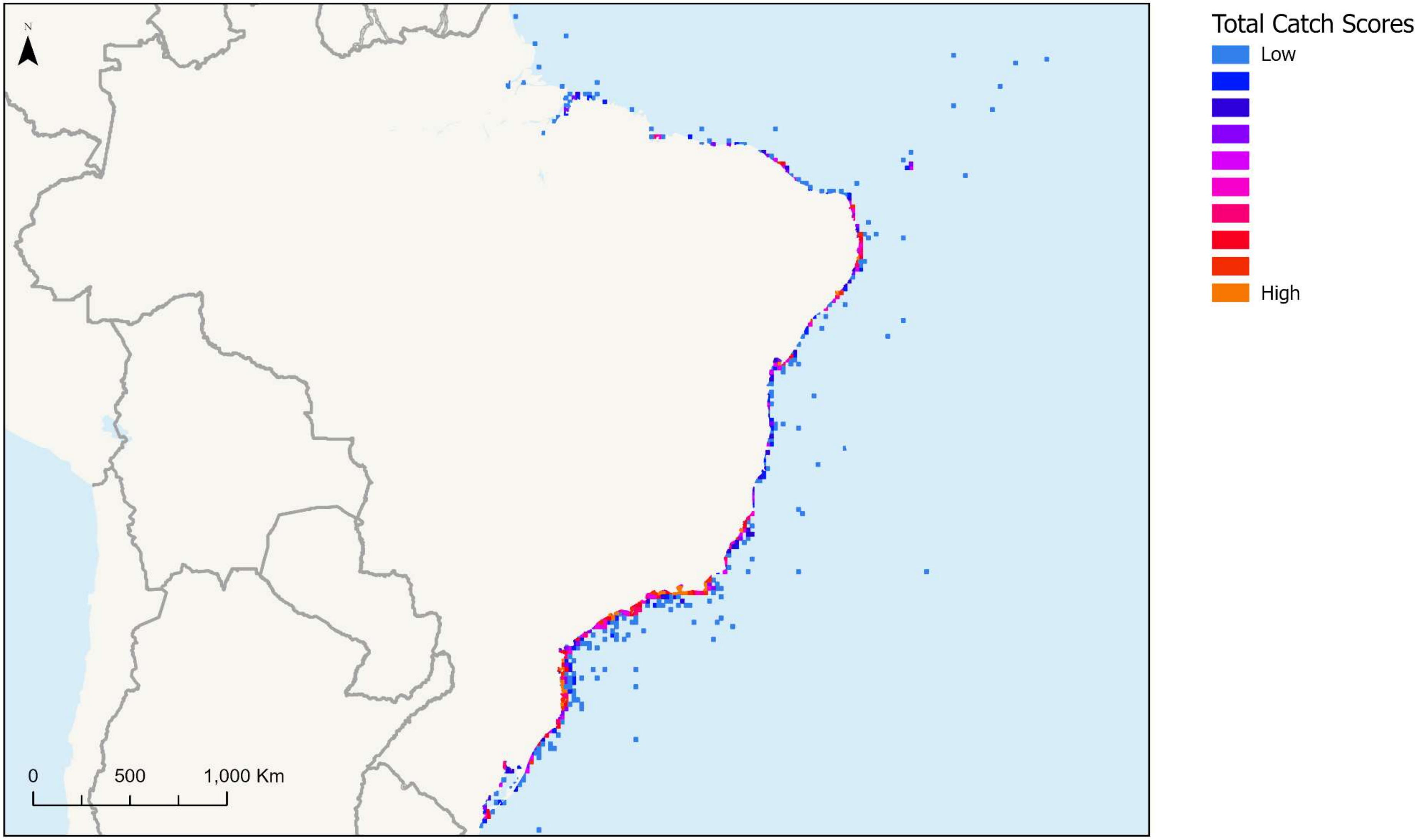


**Figure S11.** The relative intensity of marine recreational catches reported along the coast of Brazil via the Fishbrain app. Grids are 20 km a side, and were color-coded according to a within-country decile system to facilitate among-country comparisons.

## Supplementary tables

***Table S1.*** Summary data from Fishbrain. Data have been grouped into size classes using the following:

| Score | Proportion of all users | Proportion of all catches | Catches per million of population | Proportion of catch pelagic |
|---|---|---|---|---|
| 1 | >70% | >70% | >4000 | >50 |
| 2 | >10% | >10% | >1000 | >30 |
| 3 | >0.8% | >0.8% | >500 | >10 |
| 4 | >0.25% | >0.25% | >100 | >5 |
| 5 | 0-0.25% | 0-0.25% | 1-100 | 0-5% |

| **Country** | **All users (proportion of global)** | **International users (proportion of national)** | **Catches (proportion of global)** | **Catches per million of population** | **Proportion of catches pelagic** |
|---|---|---|---|---|---|
| Aruba | 5 | >90% | 5 | 1 | 2 |
| Australia | 2 | <10% | 2 | 1 | 5 |
| Bahamas | 4 | >90% | 5 | 1 | 3 |
| Barbados | 5 | 70-90% | 5 | 4 | 2 |
| Belize | 5 | >90% | 5 | 2 | 4 |
| Bermuda | 5 | >90% | 5 | 2 | 3 |
| Brazil | 3 | <10% | 4 | 5 | 5 |
| British Virgin Islands | 5 | >90% | 5 | 2 | 2 |
| Canada | 3 | 10-30% | 3 | 4 | 5 |
| Cayman Islands | 5 | >90% | 5 | 2 | 3 |
| Costa Rica | 4 | 70-90% | 5 | 4 | 2 |
| Denmark | 4 | 10-30% | 4 | 3 | 5 |
| Dominican Republic | 5 | >90% | 5 | 5 | 2 |
| Finland | 5 | 10-30% | 5 | 5 | 5 |
| France | 5 | 10-30% | 5 | 5 | 5 |
| Guam | 5 | 70-90% | 5 | 2 | 2 |
| Honduras | 5 | 70-90% | 5 | 5 | 2 |
| Ireland | 4 | 10-30% | 4 | 3 | 5 |
| Jamaica | 5 | 70-90% | 5 | 4 | 3 |
| Maldives | 5 | 30-70% | 5 | 3 | 3 |

| | | | | | |
|---|---|---|---|---|---|
| Mauritius | 5 | 30-70% | 5 | 4 | 2 |
| Mexico | 3 | 70-90% | 3 | 5 | 2 |
| Netherlands | 5 | 30-70% | 5 | 5 | 5 |
| New Zealand | 4 | 10-30% | 4 | 3 | 5 |
| Norway | 3 | 30-70% | 3 | 2 | 5 |
| Panama | 5 | 30-70% | 5 | 4 | 3 |
| Portugal | 5 | 10-30% | 5 | 4 | 4 |
| Puerto Rico | 4 | 70-90% | 4 | 3 | 4 |
| Singapore | 5 | 10-30% | 5 | 4 | 5 |
| South Africa | 4 | 10-30% | 4 | 5 | 4 |
| Spain | 4 | 30-70% | 4 | 5 | 4 |
| St. Lucia | 5 | >90% | 5 | 3 | 3 |
| Sweden | 3 | <10% | 3 | 3 | 5 |
| Trinidad & Tobago | 5 | 10-30% | 5 | 4 | 3 |
| Turks & Caicos Islands | 5 | >90% | 5 | 1 | 3 |
| U.S. Virgin Islands | 5 | >90% | 5 | 1 | 3 |
| UK | 3 | <10% | 3 | 4 | 5 |
| United Arab Emirates | 5 | 10-30% | 5 | 4 | 3 |
| USA | 1 | <10% | 1 | 2 | 5 |

**Table S2:** Data from recreational fishing expenditure and fisher numbers research. GDP is gross domestic product converted to international dollars (constant 2023 international $) using purchasing power parity rates. Population totals by country used in the final column are based on 2020 population numbers: fisher numbers are from varying years and so the combination of these numbers can only be a broad guide to the proportion of fishers in a country. Both economic and population information are drawn from the World Bank DataBank.

| Country | Annual fishing expenses (millions 2023 USD) | Source | Fishing expenses as proportion of GDP | Total marine recreational fishers | Source | Marine fishers per million of population |
|---|---|---|---|---|---|---|
| Angola | $3.15 | Belhabib et al. (2016) | 0.001% | 1,208 | Belhabib et al. (2016) | 36 |
| Bahamas | $693.79 | Southwick et al. (2016) | 5.247% | | | |
| Belgium | $48.22 | Hyder et al. (2018) | 0.006% | 24,000 | Hyder et al. (2018) | 2,080 |
| Brazil | $661.60 | Freire & Sumaila (2019) | 0.016% | 435,000 | Freire & Sumaila (2019) | 2,085 |
| Canada | $11,443.29 | Brownscombe et al. (2014) | 0.510% | | | |
| Cape Verde | $18.54 | Belhabib et al. (2016) | 0.382% | 4,786 | Belhabib et al. (2016) | 126 |
| Costa Rica | $613.46 | Chacon et al (2010) | 0.457% | | | |
| Cyprus | | | | 23,500 | Michailidis et al (2020) | 18,046 |
| Denmark | $336.10 | Hyder et al. (2018) | 0.078% | 386,000 | Hyder et al. (2018) | 66,193 |
| Estonia | $7.31 | Hyder et al. (2018) | 0.013% | 20,000 | Hyder et al. (2018) | 15,043 |
| Finland | | | | 300,000 | Hyder et al. (2018) | 54,254 |
| France | | | | 1,319,000 | Hyder et al. (2018) | 19,512 |
| Gambia | | | | 3,890 | Belhabib et al. (2016) | 1,546 |
| Germany | $172.43 | Hyder et al. (2018) | 0.003% | 174,000 | Hyder et al. (2018) | 2,092 |
| Ghana | $28.03 | Belhabib et al. (2016) | 0.012% | 3,724 | Belhabib et al. (2016) | 117 |
| Greece | | | | 730,514 | Papadopoulos et al. (2019) | 68,281 |
| Iceland | | | | 103,000 | Hyder et al. (2018) | 281,065 |
| Ireland | $185.58 | Hyder et al. (2018) | 0.030% | 77,000 | Hyder et al. (2018) | 15,445 |
| Italy | $378.48 | Hyder et al. (2018) | 0.012% | 800,000 | Hyder et al. (2018) | 13,459 |
| Kiribati | $3.60 | Campbell & Hanich (2014) | 0.850% | | | |
| Latvia | | | | 41,000 | Hyder et al. (2018) | 21,574 |
| Madagascar | | | 0.000% | 100,000 | Le Manacha et al. (2011) | 3,454 |
| Morocco | | | | 5,180 | Belhabib et al. (2016) | 142 |
| Mozambique | | | 0.000% | 6,000 | Kadagi et. al. (2021) | 195 |
| Namibia | $69.21 | Belhabib et al. (2016) | 0.231% | 15,461 | Belhabib et al. (2016) | 5,666 |
| Netherlands | $208.97 | Hyder et al. (2018) | 0.016% | 504,000 | Hyder et al. (2018) | 28,897 |
| New Zealand | $871.11 | Southwick et. al. (2018) | 0.342% | 704,473 | Southwick et. al. (2018) | 138,398 |
| Norway | | | | 1,285,000 | Hyder et al. (2018) | 238,871 |
| Panama | $135.52 | Southwick et al. (2013) | 0.085% | | | |
| Portugal | $203.12 | Hyder et al. (2018) | 0.046% | 175,000 | Hyder et al. (2018) | 16,995 |
| Puerto Rico | $1,254.27 | Gentner Consulting Group (2010) | 0.910% | 126,674 | NOAA Marine Recreational Information Program | 38,602 |
| Senegal | | | | 9,405 | Belhabib et al. (2016) | 560 |
| South Africa | | | | 547,799 | Potts et. al. (2022) | 9,045 |
| Spain | | | | 298,000 | Hyder et al. (2018) | 6,291 |
| Sri Lanka | $2.17 | Wimalasena et al (2019) | 0.001% | | | |
| Sweden | $328.79 | Hyder et al. (2018) | 0.049% | 566,000 | Hyder et al. (2018) | 54,668 |
| UK | $2,909.44 | Hyder et al. (2018) | 0.078% | 1,150,000 | Hyder et al. (2018) | 17,143 |
| USA | $59,125.99 | National Marine Fisheries Service (2021) | 0.237% | 13,800,000 | www.statista.com | 41,626 |

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