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Contrasting Global Game Fish and Non-Game Fish Species

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ABSTRACT: *We compared biological and ecological traits between global game fish and non-game fish species using an analysis with randomly chosen fish species from each group and an analysis where species were matched by body length. We used data from the International Game Fish Association (IGFA), FishBase, and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Game fish species were defined as being present in the IGFA world record list. The random comparison revealed that on average game fish were significantly larger (155.0 ± 121.5 versus 34.1± 59.5 cm), occupied shallower minimum depths (19.4 ± 58.8 versus 130.0± 359.0 m), had a broader latitudinal range (51°.2 ± 29.4°versus 31.1°± 25.9°), and significantly higher trophic levels (4.1 ± 0.1 versus 3.4± 0.1 trophic units) than non-game fish species. The length-matched analysis similarly identified that game fish species occupied higher trophic levels than non-game fish(3.9 ± 0.4 versus 3.6± 0.6 trophic units), but latitudinal range and depth associations did not differ between groups. Both the random and length-matched analyses revealed that game fish were more commonly found in freshwater than non-game fish. Both*

Comparación global entre especies reservadas y no reservadas a la pesca recreativa

RESUMEN: Se realizó una comparación global de los atributos biológicos y ecológicos entre especies de peces reservadas a la pesca recreativa y aquellas que no lo están, mediante una selección al azar de especies de cada grupo y mediante un análisis en el que las especies se sorteaban de acuerdo a su talla. Se utilizaron datos provenientes de la Asociación Internacional de Pesca Deportiva (AIPD), FishBase y de la Lista Roja de la Unión Internacional para la Conservación de la Naturaleza (UICN). El selección de especies reservadas y no reservadas a la pesca recreativa se realizó considerando aquellas que estaban presentes en el registro mundial de la AIPD y aquellas que no se encontraron bajo el nombre de "pesca recreativa" en FishBase. La comparación al azar entre los dos grupos mostró que, en promedio, las especies de pesca recreativa fueron significativamente más grandes (155.0 ± 121.5 versus 34.1 ± 59.5 cm), ocuparon profundidades mínimas más someras (19.4 ± 58.8 versus 130.0 ± 359.0 m), presentaron una distribución latitudinal más amplia (51.2 ± 29.4 versus 31.1 ± 25.9) y pertenecieron a niveles tróficos significativamente más altos (4.1 ± 0.1 versus 3.4 ± 0.1 unidades) que aquellas especies no reservadas a la pesca recreativa. En el sorteo por similitud de tallas se evidenció algo parecido, siendo las especies de pesca recreativa las que ocuparon niveles tróficos mayores (3.9 ± 0.4 versus 3.6 ± 0.6 unidades), pero los rangos latitudinales y de profundidad no difirieron entre los grupos. Tanto el sorteo al azar como el de similitud de tallas mostraron que los peces dulceacuícolas eran las especies más comúnmente encontradas en la pesca recreativa en comparación que las del otro grupo. Los análisis, así mismo, indicaron que las especies de la pesca recreativa eran especies más migratorias y que ambos grupos diferían en cuanto a distribución geográfica. El sorteo al azar mostró que las especies de la pesca recreativa eran, con mucha mayor frecuencia, también objeto de la pesca comercial, menos resilientes y más amenazadas que las que no son de pesca recreativa. Si bien se debe tener cuidado al sintetizar información proveniente de bases globales de datos, en el presente estudio se identifican diferencias importantes entre especies reservadas y no reservadas a la pesca recreativa, lo cual es relevante para las iniciativas de conservación y manejo.

analyses found that game fish species were more migratory and that both groups differed in their geographical distributions. The random comparison revealed that game fish were significantly more targeted by commercial fisheries, less resilient, and more threatened relative to non-game fish. Caution must be exercised when synthesizing data from broad data sources, yet this study identifies important differences between game fish and non-game fish species, which are relevant to management and conservation initiatives.

Introduction

Worldwide, recreational and game fisheries have become popular and economically important industries. Recreational fishing participation rates vary widely among countries but are estimated to be about 10.6% worldwide (Arlinghaus and Cooke 2008), generating billions of dollars of direct and indirect revenue (Cowx 2002). In the United States alone, recreational fishing generated over $35 billion in gross revenues in 2001 (U.S. Fish and Wildlife Service 2001). In terms of biomass, game fish have been estimated to represent up to 12% of the global fish catch (Cooke and Cowx 2004) and in some fisheries can represent up to 90% of the annual harvest (National Research Council 2006). Despite the economic importance and scope of this industry, only recently have researchers and managers begun to assess the scale and consequences of the recreational fisheries sector and are now recognizing the importance of incorporating this information into assessments of the conservation status of fish populations (Post et al. 2002; Coleman et al. 2004; Arlinghaus and Cooke 2005; Lewin et al. 2006).

Little is known about the biological traits that differentiate game fish from non-game fish species, particularly at a global scale.

Fisheries management and conservation efforts require a basic understanding of the general biology, population dynamics, and harvesting regimes of vulnerable species. At a global scale, many fisheries are data limited (Vasconcellos and Cochrane 2005;Mora et al. 2009), and the global recreational fisheries sector has been hampered by poor data collection on participation and harvest rates (Cooke and Cowx 2004, 2006), posing challenges for fisheries management and conservation. As a consequence, little is known about the biological traits that differentiate game fish from non-game fish species, particularly at a global scale. We used the best available data from three publicly available databases to test the hypothesis that game fish species have unique biological features that distinguish them from non-game fish at a broad, global scale. We conducted two sets of comparisons that contrast a suite of biological and ecological traits between game fish and non-game fish species. We also discuss the limitations of the datasets and approach used here, recognizing that at present they represent the best available data to conduct such analyses.

Materials and Methods

Random and Length-Matched Analyses

We contrasted several characteristics of game fish and non-game fish species using three publicly available databases: the International Game Fish Association (IGFA) World Record List (IGFA2006b), FishBase (Froese and Pauly 2008), and the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (IUCN 2008). The IGFA World Record List was used to assemble an initial list of species that were known to be targeted at a global scale (see Appendix). The game fish species included here are not meant to be an all-inclusive list of all possible game fish species but instead represent species that are commonly targeted for world record catches worldwide. FishBase was used to randomly select non-game fish species for comparisons, which were selected for inclusion based on a randomly generated number system. The random selection process involved generating a list of all species in FishBase and importing this list into a spreadsheet program. Each entry was assigned to a randomly generated number. The list was randomized and the top-ordered non-game species were selected to compare to the species identified on the IGFA list. For inclusion, non-game fish were required to contain data in at least 75% of the categories being examined to facilitate statistical comparisons between game fish and non-game fish. Though this resulted in our comparison not being truly random, it was necessary to ensure that non-game fish species included sufficient data to be used for statistical comparisons. This method also ensured that non-game fish were not artificially biased toward data-deficient species. Species were considered non-game fish as long as they were not included on the IGFA list and not listed as "game fish" in FishBase.

The random comparison derived from data from FishBase revealed that, on average, game fish were significantly larger than non-game fish species. Body length may differentially affect a number of the traits examined in this study, so to avoid missing key comparisons that may either be driven or masked by body length, we present both the random analysis and the length-matched comparison. The length-matched comparison was conducted by first randomly selecting game fish species from FishBase (using the methods described above for the random comparison) and then sorting fish by recorded total length and populating a list of game fish and non-game fish that did not differ statistically in size (determined by t-test). This procedure resulted in a database of equal numbers of game fish and non-game fish species that did not differ in body length. In the length-matched comparison, only fish species for which reliable total length data (i.e., cited from a peer-reviewed source) were included, resulting in a smaller subset of species (i.e., smaller sample size) used in the length-matched comparison relative to those in the random comparison. In total, there were

328 species from the IGFA listed as game fish in our random analysis and 225 game fish species from the IGFA list for the length-matched analysis. In each analysis, an equal number of randomly selected non-game fish species was included for comparisons with game fish species. Maximum length represents the maximum published total length data that were available for a species in FishBase. For approximately 20 species, total lengths were not available, so standard lengths or fork lengths were used to approximate total lengths.

International Game Fish Association World Record List

The IGFA World Record List is a database that maintains records for global marine and freshwater fish species (the regulations for these different classifications are described in detail in IGFA 2006a, 2006b).The IGFA states that species captured by rod, reel, line, and hook are eligible to be added to the list, provided that the capture meets IGFA regulations. The IGFA stipulates that fish must be captured by the laws and regulations that govern a particular species in a particular region, must be regularly recreationally angled with a rod and reel in the general area of capture, and cannot be captured in hatchery or sanctuary waters. In this article, we define a game fish as a species that fits the criteria to be eligible for inclusion on the IGFA World Record List. New records for species of conservation concern are not added to the IGFA World Record List, but standing records for species of conservation concern remain on the list (Jason Schratwieser, personal communication). Although headquartered in the United States, IGFA membership is open to persons of all nationalities. Nonetheless, it is possible that the species in the IGFA list tend to be focused in developed nations (particularly North America) or destination fisheries in developing countries (e.g., bonefish [*Albula* spp., Albulidae] in the Seychelle Islands). The IGFA lists fish by species; however, some entries are grouped by family or genus due to identification problems with morphologically similar congeners that are difficult to identify. For this study, we expanded these groups to the species level (i.e., we examined each applicable species within the genus and included species-specific data from FishBase for each) to obtain species-specific data from FishBase, rather than generalizing to the genera level: dorado (*Salminus* spp., Characidae), snakehead (*Channa* spp., Channidae), sorubim (*Pseudoplatystoma* spp., Pimelodidae), bonefish, Pacific bonito (*Sarda* spp., Scombridae), ladyfish (*Elops* spp., Elopidae), hammerhead shark (*Sphyrna* spp., Sphyrnidae), mako shark (*Isurus* spp., Lamnidae), thresher shark (*Alopias* spp.,Alopiidae), snook (*Centropomus* spp., Centropomidae), sturgeon (Acipenseridae family), and ground shark (Carcharinidae family).To ensure that non-game fish species were not erroneously included in analyses, we excluded species that had overlapping genera with the aforementioned expanded families.

FishBase

FishBase is a comprehensive database that contains data on approximately 31,800 global fish species. For species in each analysis, we used FishBase to assemble the database of biological, ecological, and life history characteristics. Data obtained from FishBase included the following continuous variables: maximum length, trophic level, latitude range, maximum water depth (i.e., the deepest water depth that has been recorded for each species), and minimum water depth (i.e., the shallowest water depth that has been recorded for each species). Data obtained from FishBase included the following categorical variables: general habitat (freshwater, marine), habitat (demersal, reef-associated, benthopelagic, pelagic, bathypelagic, bathydemersal), migratory status (nonmigratory, migratory; i.e., amphidromous, oceanodromous, anadromous, catadromous, potamodromous), climate (tropical, subtropical, temperate, boreal, polar, deepwater), hemisphere, level of commercial fishing (no commercial fishery/of no interest or grouped together as subsistence, minor, commercial, highly commercial), and resilience (minimum population doubling time; high [<15 months], medium [1.4–4.4 years], low [4.5–14 years], very low [>14 years]). Trophic-level data were obtained as a calculated value from FishBase where both diet composition and food item trophic levels are taken into account. The trophic levels of a given group of fish (individuals, population, species) is estimated as trophic level = 1 + mean trophic level of the food items, where the mean is weighted by the contribution of the different food items (Froese and Pauly 2008).

International Union for Conservation of Nature Red List

The IUCN Red List of Threatened Species across the globe is a database of global species of conservation concern across the globe. Species that had been assessed by IUCN were categorized conservatively as either not threatened (i.e., IUCN categories for data deficient, least concern, and near threatened) or threatened (i.e., IUCN categories for vulnerable, endangered, and critically endangered).

Statistical Analyses

Normality was assessed visually using a normal quantile plot. Heteroscedasticity was assessed using Levene's test. Pearson's chi-square tests for independence were used to determine whether there were statistically significant differences between game fish and non-game fish species for each of the categorical variables (e.g., to test whether game fish species are more likely to occur in marine or freshwater habitat).Welch's analyses of variance were used to assess differences between game fish and non-game fish species for each of the continuous variables. A nonparametric approach was necessary because transformations failed to solve violations of the assumption of normality. A Bonferroni correction was performed at the 0.05 significance level to account for multiple comparisons based on the 13 statistical tests performed in each of the random and length-

matched comparisons (Zar 1996) and resulted in a corrected significance level of a = 0.004. Unless noted otherwise, all reported values are means plus or minus one standard deviation (SD). For both length-matched and random comparisons, statistical analyses were conducted using JMP 7.0 (SAS Institute Inc., Cary, North Carolina).

Results

The random comparison revealed that relative to non-game fish, game fish species were significantly larger, occupied shallower minimum depths, had a broader latitudinal range, and occupied significantly higher trophic levels (Figure 1). The length-matched analysis similarly identified that game fish species occupied higher mean trophic levels than non-game fish, but latitudinal range and depth associations did not differ between groups (Table 1).

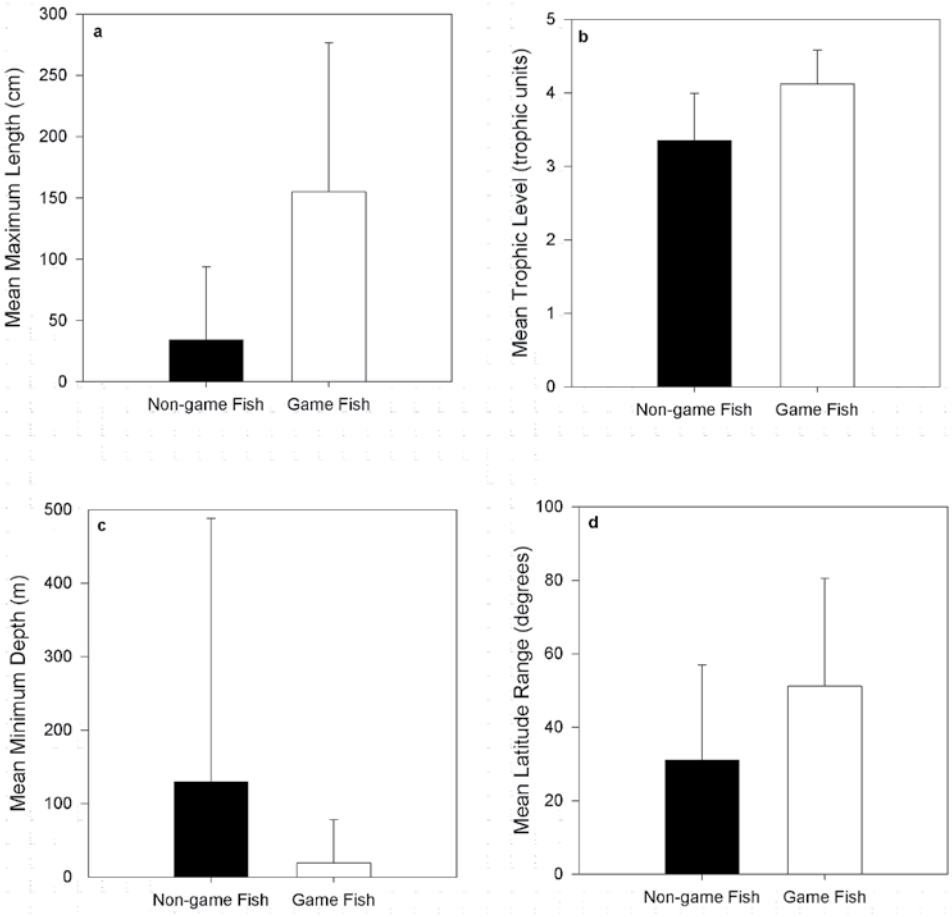

Figure 1. Results of the random comparison that contrasts the continuous variables that characterize game fishand non-game fish species:(a) maximum length, (b) trophic level, (c) minimum depth, and (d) latitude range.Table 1 shows statistical results.

Game fish species associated more often with freshwater habitats (39.9% for the random comparison and 51.7% for the length-matched comparison) than non-game fish species (19.7% for the random comparison and 19.9% for the length-matched comparison; Table 2, Figures 2a and 3a). In both analyses, game fish and non-game fish tended to differ in their habitat associations (Table 2). Demersal habitat associations were most common for both non-game fish and game fish species in each analysis. Game fish were more frequently associated with benthopelagic and pelagic habitats relative to non-game fish, but non-game fish were unique to both bathydemersal and bathypelagic habitats (Figures 2b and 3b). In both analyses, climate association varied significantly between groups (Table 2). Game fish were most commonly associated with tropical, subtropical, and temperate regions. Non-game fish were found primarily in tropical regions, as well as in deepwater, subtropical, temperate, and boreal/polar regions (Figures 2c and 3c). In the random analysis, game fish had larger latitudinal ranges than non-game fish (Table 1), but this was not apparent in the length-matched analysis (Table 1). In both analyses, relative to non-game fish, game fish species were more likely to be migratory (Table 2, Figures 2d and 3d). Game fish occurred primarily in the northern hemisphere (39.9% in the random comparison and 52.3% in the length-matched comparison) or both hemispheres (56.6% in the random comparison and 44.6% in the length-matched comparison), whereas non-game fish were distributed between both hemispheres (43.5% in the random comparison and 61.6% in the length-matched comparison; Table 2, Figures 2f and 3e).

The random comparison revealed that game fish (92.1%) are significantly more targeted by commercial fisheries than non-game fish (50.9%) and are less resilient (61.1%) compared to non-game fish (15.1%; Table 2, Figure 2e). However, in our length-matched analysis we did not find significant differences between groups for commercial fishing pressure or resilience (Table 2). The random analysis revealed that game fishare more threatened than non-game fish based on the 2008 IUCN Red List, whereas the length-matched analysis did not reveal significant differences between groups. In the random analysis, 11.9% of non-game fish species and 24.4% of game fish species were evaluated by IUCN compared to 18.2% of non-game fish species and 19.1% of game fish species in the length-matched analysis (Table 3). IUCN 2008 Red List status (i.e., species categorized as vulnerable, endangered, or critically endangered)

TABLE 1. Comparison of characteristics between game fish and non-game fish for continuous variables.

Characteristic	Group	Random comparison						Length-matched comparison					
		n	Mean	SD	*F*	*df*	*P*	*n*	Mean	SD	*F*	*df*	P
Maximum body length (cm)	Game fish	313	155.0	121.5	636.5	1	<0.001	225	108.3	77.3	2.1	1	0.051
	Non-game fish							225	93.4	90.2			
Minimum depth (m)	Game fish	116	19.4	58.8	14.3	1	<0.001	135	26.1	70.2	5.9	1	0.015
	Non-game fish	178	130.0	359.0				180	83.1	264.9			
Maximum depth (m)	Game Fish	116	287.9	788.8	1.2	1	0.3000	132	245.7	894.9	4.9	1	0.027
	Non-game fish	178	438.9	721.2				179	448.0	707.7			
Latitudinal range (°)	Game fish	265	51.2	29.4	68.0	1	<0.001	185	40.7	24.8	0.6	1	0.454
	Non-game fish	206	31.1	25.9				172	42.7	26.5			
Trophic level (trophic units)	Game fish	184	4.1	0.1	61.8	1	<0.001	189	3.9	0.4	39.4	1	<0.001
	Non-game fish	49	3.4	0.1				177	3.6	0.6			

TABLE 2. Comparison of characteristics between game fish and non-game fish for categorical variables.

Characteristic	Group	Random comparison				Length-matched comparison			
		n	$\chi 2$	*df*	*P*	*n*	$\chi 2$	*df*	*P*
General habitat	Game fish	328	31.7	1	<0.001	225	43.2	1	<0.001
	Non-game fish	328				225			
Habitat	Game fish	322	149.8	5	<0.001	225	62.3	5	<0.001
	Non-game fish	328				225			
Climate	Game Fish	319	133.4	4	<0.001	223	44.5	4	<0.001
	Non-game fish	326				225			
Hemisphere	Game fish	265	54.3	2	<0.001	185	44.1	2	<0.001
	Non-game fish	210				189			
Migratory status	Game fish	165	91.9	5	<0.001	108	87.1	5	<0.001
	Non-game fish	79				146			
Resilience	Game fish	309	141.0	3	<0.001	215	0.3	3	0.963
	Non-game fish	303				215			
Commercial fisheries	Game fish	290	141.0	1	<0.001	208	0.1	1	0.888
	Non-game fish	208				200			
IUCN threatened status	Game fish	328	10.89	1	<0.001	225	1.7	1	0.193
	Non-game fish	328				225			

differed significantly between groups in the random comparison (8.2% of game fish, 3.4% of non-game fish) but did not differ significantly in the length-matched comparison (8.4% of game fish, 5.3% of non-game fish; Table 2). To put these values into context, of the approximately 31,800 total species described in FishBase, 3,481 (~11.0%) fish species have been evaluated by IUCN and 1,275 (~4.0%) species are listed as threatened on the IUCN Red List 2008.

Discussion

Many of the traits that were significantly different between game fish and non-game fish were consistent with differences in geographic associations, including general habitat (i.e., marine versus freshwater), aquatic habitat (e.g., demersal, pelagic), climate, and hemisphere. Game fish are less common in bathypelagic or bathydemersal regions. In the marine environment, these results may reflect the limitations of fishing gear

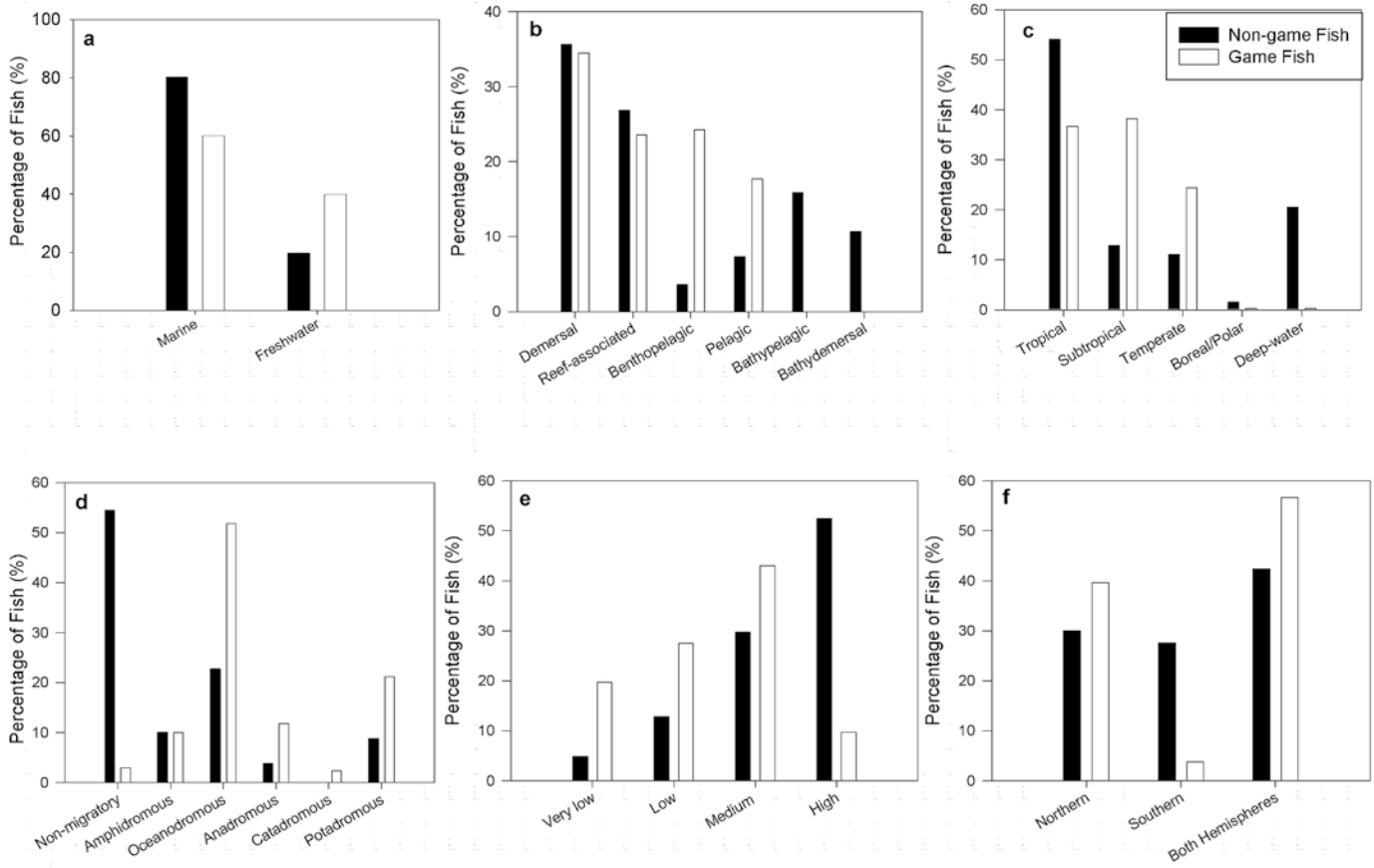

Figure 2. Results of the random comparison that contrasts the categorical variables that characterizegame fishand non-game fish species:(a) general habitat, (b) habitat, (c) climate, (d) migratory status, (e) resilience, and (f) hemisphere.Table 2 shows statistical results.

to exploit deeper water and open seas. Recreational fisheries tend to target areas that are accessible by standard recreational fishing gear, including near shore, shallow regions, estuaries, reefs, mangroves, and embayments in marine habitats (Coleman et al. 2004; Cooke and Cowx 2004) and most freshwater habitats (Arlinghaus et al. 2002; Arlinghaus and Cooke 2005). Game fish that occupy marine pelagic and benthopelagic habitats are frequently targeted only when they are in aggregations due to behavioral (e.g., migratory) or habitat-mediated means (Coleman et al. 2004). In contrast, bathydemersal and bathypelagic species tend to occupy deep regions (i.e., greater than 1km deep) and thus may avoid fishing pressure. However, the development of new deepwater recreational fishing technology (Roberts 2002) suggests that fish at depths may become increasingly targeted and has already been identified as a major conservation concern for marine commercially targeted fish stocks (Morato et al. 2006).

The differences between game fish and non-game fish in terms of climate, as well as latitude range in the random comparison, may reflect human population distribution (e.g., anglers tend to fish close to home; Post et al. 2002).This finding could be related to the fact that the majority of data for recreational fisheries participation are from developed countries in North America and Europe,and there is unequal reporting on participation from other countries (Arlinghaus et al. 2002; Cooke and Cowx 2006). Unfortunately, there are few data on recreational fishing participation rates or harvest in developing countries because the distinction between recreational and subsistence fishing is often not possible (Aas 2002), landings are often unmonitored and unreported, and there is a lack of wealth and funding (European Inland Fisheries Advisory Commission 2008). However, the extent of recreational fishing in developing countries may be relatively large, due to high human population and subsequent fishing pressure (Allan et al. 2005). If latitude range is taken as a measure of general tolerance, then larger ranges should make these species more tolerant to changing environmental conditions (Malakoff 1997), and it has been hypothesized that this would make species less susceptible to imperilment from fishing pressure (Froese and Torres 1999).However, field studies and models of the relationship between latitude range and vulnerability have found limited evidence that this occurs in marine systems (Dulvy and Reynolds 2002).The latitude ranges measured here may be influenced by migratory status. For example, of the 50 game fish with the largest latitude ranges, 37 are considered "highly migratory species" by Annex I of the 1982 Law of the Sea Convention (United Nations 1982). The larger latitudinal ranges

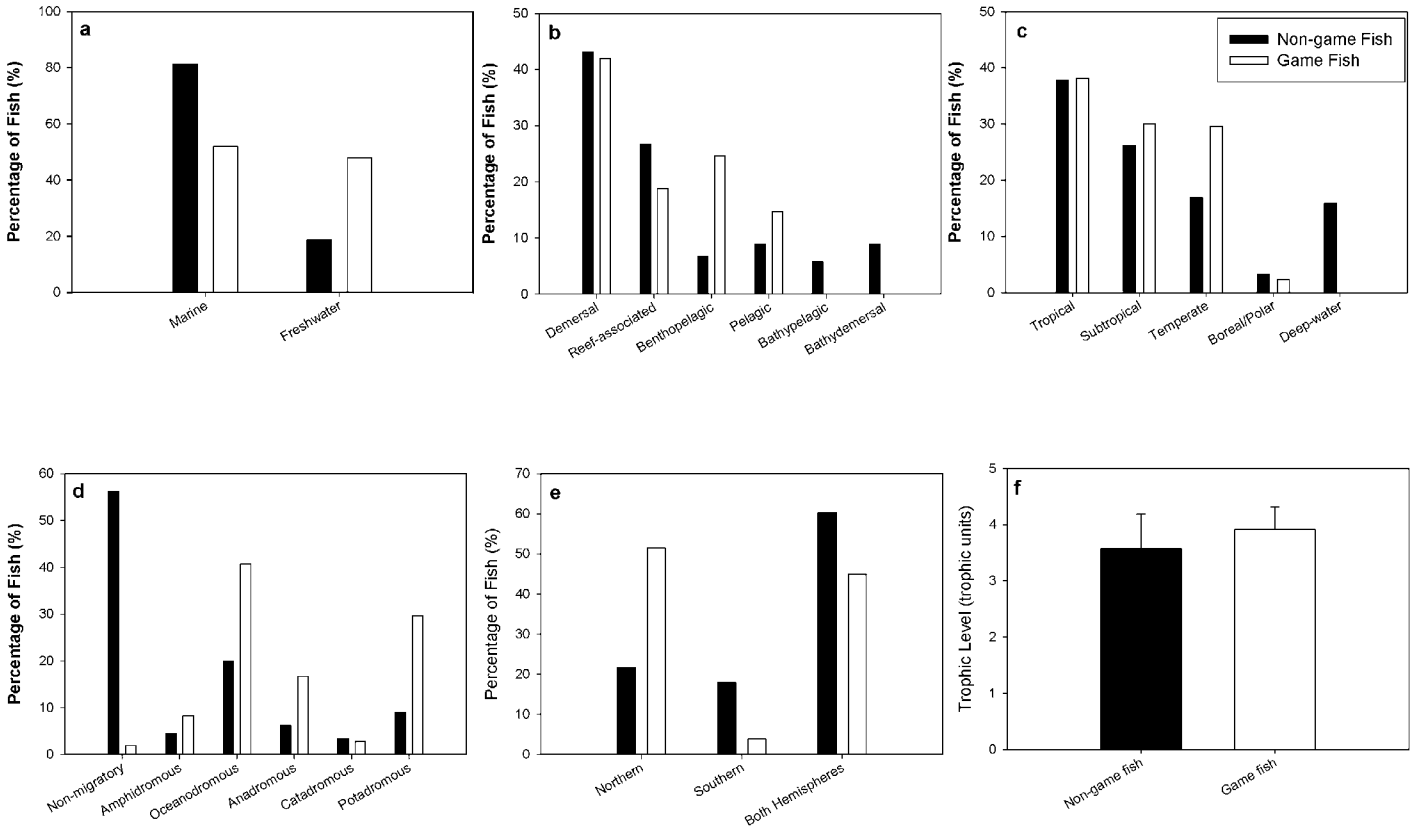

Figure 3. Results of the length-matched comparison that contrasts the characteristics of game fish and non-game fish species:(a) general habitat, (b) habitat, (c) climate, (d) migratory status, and (e) hemisphere.Tables 1 and 2 show statistical results.

TABLE 3. A summary of the number of game fish and non-game fish species that have been evaluated under the IUCN Red List 2008.Categories include data deficient (DD), least concern (LC), low risk/near threatened (LRNT), near threatened (NT), vulnerable (VU), endangered (EN), and critically endangered (CR).Percentages reflect the number of species in a particular IUCN category in relation to the total number of species examined in each analysis (n = 328 in random comparison, n = 225 in length-matched comparison).

IUCN Category	Random comparison		Length-matched comparison	
	Non-game fish *n* (% of overall)	Game fish *n* (% of overall)	Non-game fish *n* (% of overall)	Game fish *n* (% of overall)
DD	8 (2.4)	10 (3.1)	7 (3.1)	7 (3.1)
LC	14 (4.3)	20 (6.1)	12 (5.3)	15 (6.7)
LRNT	4 (1.2)	7 (2.1)	2 (0.8)	7 (3.1)
NT	2 (0.6)	16 (4.8)	1 (0.4)	2 (0.8)
VU	6 (1.8)	17 (5.2)	5 (2.2)	7 (3.1)
EN	4 (1.2)	4 (1.2)	9 (4.0)	3 (1.3)
CR	1 (0.3)	6 (1.8)	5 (2.2)	2 (0.8)
Total	39 (11.9)	80 (24.4)	41 (18.2)	43 (19.1)

of the game fish examined in this study are also linked to the introductions of popular game fish species outside of their endemic range (Cambray 2003). Of the 50 game fish species with the largest latitude ranges, 9 species have ranges that can be attributed to distribution rather than migrations. Of these, several species (e.g., rainbow trout [*Oncorhynchus mykiss*, Salmonidae], brown trout [*Salmo trutta*], brook trout [*Salvelinus fontinalis*, Salmonidae], lake trout [*Salvelinus namaycush*, Salmonidae]) are widely introduced game fish species, and rainbow trout is globally considered one of the most highly invasive species (Invasive Species Specialist Group 2004).

Though migration has often been linked to conservation concerns by both environmental factors and fisheries pressure (Jonsson et al. 1999; McDowall 1999), the link between migration status and recreational fishing has rarely been considered. We found that game fish were more likely to be migratory than non-game fish. Fish migrations tend to be cyclical and predictable in both timing and location and, accordingly, migratory species can be exploited at key locations throughout the migration (e.g., dense aggregations of diadromous migrants passing through river mouths; Froese and Torres 1999; McDowall 1999). Highly migratory species, particularly those that cross political boundaries, can be slow to recover from exploitation due to political disagreements between the governments that have access to the fish (Caddy and Agnew 2004).

The random analysis revealed that game fish are larger than non-game fish species. Large fish tend to be targeted by anglers (Wilde and Pope 2004), and the IGFA list of record weights reflects this tendency, as there is a minimum size restriction for record submission (IGFA 2006a), and only the largest landed individual of each species is included (IGFA2006b). Our body length-matched analysis found that game fish and non-game fish were equally targeted by commercial fisheries at relatively high proportions, providing evidence for the links between body size, competing fisheries interests, and the potential for conservation risk (Olden et al. 2007). The random analysis revealed that game fish also had lower resilience and were more likely to be imperilled; however, this may be an artefact of game fish tending to be better studied and understood relative to non-game fish. Though the length-matched analysis did not find differences between game fish and non-game fish in terms of resilience or Red List status, the relatively large-bodied species in this comparison may be at a higher risk of conservation concern, yet these contrasts did not differ between groups, as might be expected. For instance, large body size can be correlated with life history characteristics that lead to imperilment, such as longer lifespan, slow growth, late age at maturity, high trophic level, as well as low natural adult mortality and relatively low annual recruitment to the adult stock (Garrod and Knights 1979; Reynolds et al. 2001; Dulvy and Reynolds 2002; Hutchings 2002; Morato et al. 2006).Further, lifespan is also closely related to age at first breeding (Roff 1988; Beverton 1992; Winemiller and Rose 1992), with long-lived species having delayed maturity (Norse and Crowder 2005). Large body size and late maturity, two traits common among species at high trophic levels, have been shown to be the best predictors of vulnerability when fish are faced with fishing pressure (Reynolds et al. 2005; Olden et al. 2007). For example, several imperilled species in the family Carcharhinidae (e.g., borneo shark [*Carcharhinus borneensis*], daggernose shark [*Isogomphodonoxyrhynchus*], Ganges shark [*Glyphis gangeticus*], smooth tooth blacktip shark [*Carcharhinus leiodon*], and speartooth shark [*Glyphis glyphis*]) tended to have large body sizes (70–720 cm), very low resilience, and high trophic status.

The intensive commercial harvest of fishes has been implicated in the widespread declines of fish populations worldwide (Christensen et al. 2003; Dulvy et al. 2003; Pauly et al. 2003; Worm et al. 2006). Recent evidence has shown that many parallels exist between recreationally and commercially targeted species (Post et al. 2002; Coleman et al. 2004; Cooke and Cowx 2004, 2006). The random analysis showed that game fish are more likely to be targeted by commercial fisheries than non-game fish. Though the length-matched analysis did not show differences between groups, it revealed that large species of both game fish and non-game fish were targeted by commercial fisheries. Together, commercial and recreational exploitation may contribute to the many interactive environmental and other anthropogenic factors that lead to conservation concerns (Rose 2005). For example, the composition of catches generated by sport and commercial fishing has been shown to be similar for blue shark (*Prionace glauca*, Carcharhinidae) populations in Atlantic Canada (Campana et al. 2006). As a result, Campana et al. (2006) found it necessary to combine the catches from recreational and commercial fisheries to obtain an accurate estimation of the impacts of fishing pressure on blue shark populations.

The random analysis revealed that 27 game fish species are considered threatened by IUCN, based solely on the species that fall in the categories of vulnerable, endangered, and critically endangered, which provides additional rationale for enhancing efforts on the study of game fish species at a global scale. Population declines of marine fishes and the inability to recover from severe commercial fishing pressure have been associated with characteristics such as large body size, slow growth rates, late age at maturity, and a long lifespan (Reynolds et al. 2001; Dulvy and Reynolds 2002; Hutchings 2002; Morato et al. 2006). Although less research has been conducted in freshwater systems, similar trends are apparent (Post et al. 2002; Allan et al. 2005; Jelks et al. 2008). Since this trend did not emerge in the length-matched comparison, clearly body size has a greater influence on conservation concern than game fish status alone.

One of the greatest challenges of conducting a global assessment contrasting game fish and non-game fish species is finding complete, quality data sets. Here, we chose FishBase because of its global scope;its use of cited, peer-reviewed data; and the fact that its data are widely used in the literature (e.g., Dulvy and Reynolds 2002; Foster and Vincent 2004).The non-game fish species included in this study were often data deficient, resulting in a not truly random selection of non-game fish because we had to rely on criteria of species having at least 75% of the required data categories in FishBase to be included in analyses. However, because many of the species contrasted in this study are data deficient, we contend that this study represents the best possible approach to contrasting game fish and non-game fish species. Until more complete data are available on these species, however, our results should be interpreted cautiously. The IUCN Red List is one of the most high-profile and trusted data sources of its kind because its classifications are based on expert input and long-term data sources. Our categorization of IUCN ranks as either threatened or not threatened is somewhat conservative: there may be species that fall into the data deficient category that may indeed be considered threatened once sufficient data are available for these species to be evaluated. As such, our classification may underrepresent the conservation concern status of both game fish and non-game fish species. Game fish may be more likely to be listed by IUCN, because more research tends to be conducted on these species relative to non-game fish, which may be more poorly understood. However, these issues cannot be resolved until more data can be obtained to further improve IUCN categorizations. The IGFA World Record List represents one of the few citable documents that takes a global approach to listing fish species that are targeted for world record catches by rod and reel. However, we recognize that the species contained in the IGFA list (see Appendix) may be biased toward North American species and may not include all possible game fish species, instead focusing on the species that are most commonly targeted by anglers.

Understanding the fundamental differences between game fish and non-game fish species, particularly in a conservation context, may become increasingly relevant as anglers begin to target species in remote locations, for which little is known about their biology and that have previously received negligible recreational fishing pressure. For example, destination tourism fisheries are being developed in many regions of the world, particularly in inland waters (Allan et al. 2005), with the promise of income for local economies even though the risks of such fisheries are largely unknown (e.g., taimen [*Hucho taimen*, Salmonidae] fisheries in Mongolia;Vander Zanden et al. 2007). Similarly, as efforts to expand aquatic protected areas increase, there is uncertainty regarding whether catch-and-release fisheries or limited harvest recreational fisheries are compatible with no-take or other types of protected areas (Cooke et al. 2006). This study characterizes fundamental differences between game fish and non-game fish characteristics at a broad scale using the best available data. These results show that there are fundamental gaps in knowledge that must be addressed to clarify these relationships. Though this study is a necessary first step, future research must focus on specific empirical comparisons between these groups to develop broad strategies for the conservation and management of game fishes at a global scale.

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From the Archives

"To Germany, beyond question, belongs the honor of discovering and carrying into practical usefulness, the art of fish culture. Upon the estate of Jacobi as has been seen, it was carried on as a branch of agriculture for nearly eighty years – from 1741-1825 – though it was nearly one hundred years before public opinion was ripe for a general acceptance of its usefulness. Recognition of fish culture was finally brought about by the zealous advocacy of men of science in France, Scotland, Bohemia and Switzerland. During the interim it appears to be certain that at no time was the practice of fish culture from a practical standpoint entirely abandoned by citizens of Germany.

Prof. G. Brown Goode, Transactions of the Tenth American Fish Cultural Association, 1881

Appendix. A list of game fish species included in this study (IGFA 2006b).

Common Name	Scientific Name	Family
Albacore	*Thunnus alalunga*	Scombridae
Alligator gar	*Lepisosteus spatula*	Lepisosteidae
Almaco jack	*Seriola rivoliana*	Carangidae
Amazon pellona	*Pellona castelneana*	Latidae
American shad	*Alosa sapidissima*	Channidae
Amur snakehead	*Channa argus warpachowskii*	Channidae
Arawana	*Osteoglossum bicirrhosum*	Osteoglossidae
Arctic char	*Salvelinus alpinus*	Salmonidae
Arctic grayling	*Thymallus arcticus*	Salmonidae
Armed snook	*Centropomus armatus*	Centropomidae
Assamese snakehead	*Channa stewartii*	Channidae
Atlantic bigeye tuna	*Thunnus obesus (Atlantic)*	Scombridae
Atlantic bonito	*Sarda sarda*	Scombridae
Atlantic cod	*Gadus morhua*	Gadidae
Atlantic halibut	*Hippoglossus hippoglossus*	Pleuronectidae
Atlantic sailfish	*Istiophorus platypterus (Atlantic)*	Istiophoridae
Atlantic salmon	*Salmo salar*	Salmonidae
Atlantic salmon (landlocked)	*Salmo salar (landlocked)*	Salmonidae
Atlantic sharpnose shark	*Rhizoprionodonterraenovae*	Carcharhinidae
Atlantic spadefish	*Chaetodipterus faber*	Ephippidae
Atlantic spearfish	*Tetrapturus belone*	Istiophoridae
Australian bass	*Macquaria colonorum*	Percichthyidae
Australian blacktip shark	*Carcharhinustilstoni*	Carcharhinidae
Australian bonito	*Sarda australis*	Scombridae
Australian sharpnose shark	*Rhizoprionodontaylori*	Carcharhinidae
Barca snakehead	*Channa barca*	Channidae
Barramundi	*Lates calcarifer*	Latidae
Barred sorubim	*Pseudoplatystoma fasciatum*	Pimelodidae
Barred sorubim	*Pseudoplatystoma fasciatum reticulatum*	Pimelodidae
Bigeye thresher	*Alopias superciliosus*	Alopiidae
Bigeye trevally	*Caranx sexfasciatus*	Carangidae
Bigmouth buffalo	*Ictiobus cyprinellus*	Catostomidae
Bignose shark	*Carcharhinusaltimus*	Carcharhinidae
Black bullhead	*Ameiurus melas*	Ictaluridae
Black crappie	*Pomoxis nigromaculatus*	Centrarchidae
Black drum	*Pogonias cromis*	Sciaenidae
Black marlin	*Makaira indica*	Istiophoridae
Black sea bass	*Centropristis striata*	Serranidae
Black skipjack	*Euthynnus lineatus*	Scombridae
Black snakehead	*Channa melasoma*	Channidae
Black snook	*Centropomus nigrescens*	Centropomidae
Black/blue rockfish	*Sebastes melanops/mystinus*	Sebastidae
Blackfin seabass	*Lateolabrax latus*	Lateolabracidae
Blackfin snook	*Centropomus medius*	Centropomidae
Blackfin tuna	*Thunnus atlanticus*	Scombridae
Blacknose shark	*Carcharhinusacronotus*	Carcharhinidae
Blackspot shark	*Carcharhinussealei*	Carcharhinidae
Blackstriped peacock	*Cichla intermedia*	Cichlidae
Blacktip reef shark	*Carcharhinusmelanopterus*	Carcharhinidae
Blacktip shark	*Carcharhinuslimbatus*	Carcharhinidae
Blue catfish	*Ictalurus furcatus*	Ictaluridae
Blue marlin (Atlantic)	*Makaira nigricans (Atlantic)*	Istiophoridae
Blue marlin (Pacific)	*Makaira nigricans (Pacific)*	Istiophoridae
Blue shark	*Prionace glauca*	Carcharhinidae
Bluefin trevally	*Caranx melampygus*	Carangidae
Bluefin tuna	*Thunnus thynnus*	Scombridae
Bluefish	*Pomatomus saltatrix*	Pomatomidae
Bluegill	*Lepomis macrochirus*	Centrarchidae
Bonefish	*Albula vulpes*	Albulidae
Bonito, Atlantic	*Sarda sarda*	Scombridae
Bonnethead	*Sphyrna tiburo*	Sphyrnidae
Borna snakehead	*Channa amphibia*	Channidae
Borneo shark	*Carcharhinusborneensis*	Carcharhinidae
Bowfin	*Amia calva*	Amiidae
Brazilian sharpnose shark	*Rhizoprionodonlalandii*	Carcharhinidae
Broadfin shark	*Lamiopsistemminckii*	Carcharhinidae
Brook trout	*Salvelinus fontinalis*	Salmonidae
Brown bullhead	*Ameiurus nebulosus*	Ictaluridae
Brown trout	*Salmo trutta*	Salmonidae
Bull shark	*Carcharhinusleucas*	Carcharhinidae
Bull trout	*Salvelinus confluentus*	Salmonidae
Burbot	*Lota lota*	Lotidae
Burmese snakehead	*Channa harcourtbutleri*	Channidae
Butterfly peacock	*Cichla ocellaris*	Cichlidae
California corbina	*Menticirrhus undulatus*	Sciaenidae
California halibut	*Paralichthys californicus*	Paralichthyidae
California yellowtail	*Seriola lalandi dorsalis*	Carangidae
Caribbean reef shark	*Carcharhinusperezii*	Carcharhinidae
Caribbean sharpnose shark	*Rhizoprionodonporosus*	Carcharhinidae
Centropomus rubens	*Centropomus rubens*	Kuhliidae
Cero mackerel	*Scomberomorus regalis*	Scombridae
Chain pickerel	*Esox niger*	Esocidae

Common Name	Scientific Name	Family
Channa africana	*Channa africana*	Channidae
Channa bankanensis	*Channa bankanensis*	Channidae
Channa baramensis	*Channa baramensis*	Channidae
Channa burmanica	*Channa burmanica*	Channidae
Channa cyanospilos	*Channa cyanospilos*	Channidae
Channa diplogramma	*Channa diplogramma*	Channidae
Channa diplogramme	*Channa diplogramme*	Channidae
Channa insignis	*Channa insignis*	Channidae
Channa lucia	*Channa lucia*	Channidae
Channa maculata	*Channa maculata*	Channidae
Channa melanoptera	*Channa melanoptera*	Channidae
Channa nox	*Channa nox*	Channidae
Channel catfish	*Ictalurus punctatus*	Ictaluridae
Chinook salmon	*Oncorhynchus tshawytscha*	Salmonidae
Chum salmon	*Oncorhynchus keta*	Salmonidae
Cobia	*Rachycentron canadum*	Rachycentridae
Coho salmon	*Oncorhynchus kisutch*	Salmonidae
Commerson's glassy	*Centropomus ambassis*	Ambassidae
Common carp	*Cyprinus carpio*	Cyprinidae
Common snooke	*Centropomus undecimalis*	Centropomidae
Conger	*Conger conger*	Congridae
Copper shark	*Carcharhinusbrachyurus*	Carcharhinidae
Creek whaler	*Carcharhinusfitzroyensis*	Carcharhinidae
Crevalle jack	*Caranx hippos*	Carangidae
Cubera snapper	*Lutjanus cyanopterus*	Lutjanidae
Cutthroat trout	*Oncorhynchus clarki*	Salmonidae
Daggernose shark	*Isogomphodonoxyrhynchus*	Carcharhinidae
Dentex	*Dentex dentex*	Sparidae
Dogtooth tuna	*Gymnosarda unicolor*	Scombridae
Dolly Varden	*Salvelinus malma*	Salmonidae
Dolphinfish	*Coryphaena hippurus*	Coryphaenidae
Doublespotted queenfish	*Scomberoides lysan*	Carangidae
Dusky shark	*Carcharhinusobscurus*	Carcharhinidae
Dwarf snakehead	*Channa gachua*	Channidae
Eastern Pacific bonito	*Sarda chilensis chilensis*	Scombridae
Emperor snakehead	*Channa marulioides*	Channidae
European bass	*Dicentrarchus labrax*	Moronidae
European grayling	*Thymallus thymallus*	Salmonidae
European pollack	*Pollachius pollachius*	Gadidae
European seabass	*Centropomus lupus*	Moronidae
Fat snook	*Centropomus parallelus*	Centropomidae
Finetooth shark	*Carcharhinusisodon*	Carcharhinidae
Flathead catfish	*Pylodictis olivaris*	Ictaluridae
Florida gar	*Lepisosteus platyrhincus*	Lepisosteidae
Freshwater drum	*Aplodinotus grunniens*	Lepisosteidae
Gag grouper	*Mycteroperca microlepis*	Serranidae
Galapagos shark	*Carcharhinusgalapagensis*	Carcharhinidae
Ganges shark	*Glyphisgangeticus*	Carcharhinidae
Giant sea bass	*Stereolepis gigas*	Polyprionidae
Giant snakehead	*Channa micropeltes*	Channidae
Giant tigerfish	*Hydrocynus goliath*	Alestiidae
Giant trahira	*Hoplias macrophthalmus*	Erythrinidae
Giant trevally	*Caranx ignobilis*	Carangidae
Golden trout	*Oncorhynchus aguabonita*	Salmonidae
Goliath grouper	*Epinephelus itajara*	Serranidae
Graceful shark	*Carcharhinusamblyrhynchoides*	Carcharhinidae
Grass carp	*Ctenopharyngodon idellus*	Cyprinidae
Great barracuda	*Sphyraena barracuda*	Sphyraenidae
Great hammerhead	*Sphyrna mokarran*	Sphyrnidae
Great snakehead	*Channa marulius*	Channidae
Greater amberjack	*Seriola dumerili*	Carangidae
Green sunfish	*Lepomis cyanellus*	Centrarchidae
Grey reef shark	*Carcharhinusamblyrhynchos*	Carcharhinidae
Grey sharpnose shark	*Rhizoprionodonoligolinx*	Carcharhinidae
Guianan snook	*Centropomus mexicanus*	Centropomidae
Guinean barracuda	*Sphyraena afra*	Sphyraenidae
Hardnose shark	*Carcharhinusmacloti*	Carcharhinidae
Horse-eye jack	*Caranx latus*	Carangidae
Huchen	*Hucho hucho*	Salmonidae
Inconnu	*Stenodus leucichthys*	Salmonidae
Irrawaddy river shark	*Glyphissiamensis*	Carcharhinidae
Japanese parrotperch	*Oplegnathus fasciatus*	Oplegnathidae
Japanese seabass	*Lateolabrax japonicus*	Lateolabracidae
Kahawai	*Arripis trutta*	Arripidae
Kawakawa	*Euthynnus affinis*	Scombridae
Kelp bass	*Paralabrax clathratus*	Serranidae
King mackerel	*Scomberomorus cavalla*	Scombridae
Kokanee	*Oncorhynchus nerka*	Esocidae
Lake trout	*Salvelinus namaycush*	Salmonidae
Lake whitefish	*Coregonus clupeaformis*	Salmonidae
Largemouth bass	*Micropterus salmoides*	Centrarchidae

Common Name	Scientific Name	Family
Large-toothed cardinalfish	*Centropomus macrodon*	Apogonidae
Leerfish (Garrick)	*Lichia amia*	Carangidae
Lemon shark	*Negaprionbrevirostris*	Carcharhinidae
Lingcod	*Ophiodon elongatus*	Hexagrammidae
Little tunny	*Euthynnus alletteratus*	Scombridae
Longbill spearfish	*Tetrapturus pfluegeri*	Istiophoridae
Longfin mako	*Isurus paucus*	Lamnidae
Longfin mako	*Isurus alatus*	Lamnidae
Longjaw bonefish	*Albula forsteri*	Albulidae
Longnose gar	*Lepisosteus osseus*	Lepisosteidae
Longtail tuna	*Thunnus tonggol*	Scombridae
Madai	*Pagrus major*	Sparidae
Meagre	*Argyrosomus regius*	Sciaenidae
Mexican snook	*Centropomus poeyi*	Centropomidae
Milk shark	*Rhizoprionodonacutus*	Carcharhinidae
Mullet snapper	*Lutjanus aratus*	Lutjanidae
Muskellunge	*Esox masquinongy*	Esocidae
Mutton snapper	*Lutjanus analis*	Lutjanidae
Narrowbarred mackerel	*Scomberomorus commerson*	Scombridae
Nembwe	*Serranochromis robustus*	Cichlidae
Nervous shark	*Carcharhinuscautus*	Carcharhinidae
Night shark	*Carcharhinussignatus*	Carcharhinidae
Nile perch	*Centropomus niloticus*	Latidae
Nile perch	*Lates niloticus*	Moronidae
Northern pike	*Esox lucius*	Characidae
Oceanic whitetip shark	*Carcharhinuslongimanus*	Carcharhinidae
Ocellated snakehead	*Channa pleurophthalma*	Channidae
Orange-spotted snakehead	*Channa aurantimaculata*	Channidae
Oscar	*Astronotus ocellatus*	CyNodontidae
Pacific bigeye tuna	*Thunnus obesus (Pacific)*	Scombridae
Pacific bonito	*Sarda chiliensis lineolata*	Scombridae
Pacific cod	*Gadus macrocephalus*	Gadidae
Pacific crevalle Jack	*Caranx caninus*	Carangidae
Pacific cubera snapper	*Lutjanus novemfasciatus*	Lutjanidae
Pacific halibut	*Hippoglossus stenolepis*	Pleuronectidae
Pacific sailfish	*Istiophorus platypterus (Pacific)*	Istiophoridae
Pacific sharpnose shark	*Rhizoprionodonlongurio*	Carcharhinidae
Pacific sierra mackerel	*Scomberomorus sierra*	Scombridae
Panaw snakehead	*Channa panaw*	Channidae
Papuan black snapper	*Lutjanus goldiei*	Pimelodidae
Payara	*Hydrolicus scomberoides*	Cichlidae
Pelagic thresher	*Alopias pelagicus*	Alopiidae
Permit	*Trachinotus falcatus*	Carangidae
Pigeye shark	*Carcharhinusamboinensis*	Carcharhinidae
Pink salmon	*Oncorhynchus gorbuscha*	Salmonidae
Plain bonito	*Orcynopsis unicolor*	Scombridae
Pollock	*Pollachius virens*	Gadidae
PompaNo, African	*Alectis ciliaris*	Carangidae
Pondicherry shark	*Carcharhinushemiodon*	Carcharhinidae
Porbeagle shark	*Lamna nasus*	Lamnidae
Rainbow runner	*Elagatis bipinnulata*	Carangidae
Rainbow snakehead	*Channa bleheri*	Channidae
Rainbow trout	*Oncorhynchus mykiss*	Salmonidae
Red drum	*Sciaenops ocellatus*	Sciaenidae
Red grouper	*Epinephelus morio*	Serranidae
Red piranha	*Serrasalmus natterati*	Catostomidae
Red snapper	*Lutjanus campechanus*	Lutjanidae
Redbreast sunfish	*Lepomis auritus*	Centrarchidae
Redear sunfish	*Lepomis microlophus*	Salmonidae
Redtail catfish	*Phractocephalus hemioliopterus*	Pimelodidae
Rock bass	*Ambloplites rupestris*	Centrarchidae
Rock flagtail	*Centropomus rupestris*	Kuhliidae
Roosterfish	*Nematistius pectoralis*	Nematistiidae
Roundjaw bonefish	*Albula glossodonta*	Albulidae
Sandbar shark	*Carcharhinusplumbeus*	Carcharhinidae
Sauger	*Stizostedion canadense*	Clupeidae
Scalloped bonnethead	*Sphyrna corona*	Sphyrnidae
Scalloped hammerhead	*Sphyrna lewini*	Sphyrnidae
Scoophead	*Sphyrna media*	Sphyrnidae
Sharpjaw bonefish	*Albula neoguinaica*	Albulidae
Sharptooth catfish	*Clarias gariepinus*	Clariidae
Shoal bass	*Micropterus coosae*	Centrarchidae
Shortbill spearfish	*Tetrapturus angustirostris*	Istiophoridae
Shortened redhorse	*Moxostoma macrolepidotum*	Catostomidae
Shortfin mako	*Isurus oxyrinchus*	Lamnidae
Shortnose gar	*Lepisosteus platostomus*	Lepisosteidae
Sicklefin lemon shark	*Negaprionacutidens*	Carcharhinidae
Silky shark	*Carcharhinusfalciformis*	Carcharhinidae
Silver redhorse	*Moxostoma anisurum*	Salmonidae
Silvertip shark	*Carcharhinusalbimarginatus*	Carcharhinidae
Skipjack tuna	*Katsuwonus pelamis*	Scombridae
Sliteye sharkead	*Loxodonmacrorhinus*	Carcharhinidae

Common Name	Scientific Name	Family
Small snakehead	*Channa asiatica*	Channidae
Small snakehead	*Channa formosana*	Channidae
Small snakehead	*Channa ocellata*	Channidae
Smalleye hammerhead	*Sphyrna tudes*	Sphyrnidae
Smallmouth bass	*Micropterus dolomieu*	Centrarchidae
Smallmouth buffalo	*Ictiobus bubalus*	Catostomidae
Smalltail shark	*Carcharhinusporosus*	Carcharhinidae
Smooth hammerhead	*Sphyrna zygaena*	Sphyrnidae
Smoothtooth blacktip	*Carcharhinusleiodon*	Carcharhinidae
Snakehead	*Channa argus*	Channidae
Snakehead	*Channa obscura*	Channidae
Snakehead murrel	*Channa striata*	Channidae
Sockeye salmon	*Oncorhynchus nerka (landlocked)*	Percidae
Southern bluefin tuna	*Thunnus maccoyi*	Scombridae
Southern yellowtail	*Seriola lalandi lalandi*	Carangidae
Spadenose shark	*Scoliodonlaticaudus*	Carcharhinidae
Spanish mackerel	*Scomberomorus maculatus*	Scombridae
Speartooth shark	*Glyphisglyphis*	Carcharhinidae
Speckled peacock	*Cichla temensis*	Pristigasteridae
Spinner shark	*Carcharhinusbrevipinna*	Carcharhinidae
Spottail shark	*Carcharhinussorrah*	Carcharhinidae
Spotted bass	*Micropterus punctulatus*	Centrarchidae
Spotted gar	*Lepisosteus oculatus*	Salmonidae
Spotted parrotperch	*Oplegnathus punctatus*	Oplegnathidae
Spotted seatrout	*Cynoscion nebulosus*	Sciaenidae
Spotted snakehead	*Channa punctata*	Channidae
Spotted sorubim	*Pseudoplatystoma corruscans*	Pimelodidae
Squirefish snapper	*Pagrus auratus*	Sparidae
Striped bass	*Morone saxatilis*	Moronidae
Striped bass (landlocked)	*Morone saxatilis (landlocked)*	Moronidae
Striped bonito	*Sarda orientalis*	Scombridae
Striped marlin	*Tetrapturus audax*	Istiophoridae
Summer flounder	*Paralichthys dentatus*	Paralichthyidae
Swordfish	*Xiphias gladius*	Xiphiidae
Swordspine snook	*Centropomus ensiferus*	Centropomidae
Taimen	*Hucho taimen*	Characidae
Talang queenfish	*Scomberoides commersonnianus*	Carangidae
Tambaqui	*Colossoma macropomum*	Cyprinidae
Tarpon	*Megalops atlanticus*	Megalopidae
Tarpon snook	*Centropomus pectinatus*	Centropomidae
Tautog	*Tautoga onitis*	Labridae
Tench	*Tinca tinca*	Alestiidae
Thintail thresher	*Alopias vulpinus*	Alopiidae
Threadfin bonefish	*Albula nemoptera*	Albulidae
Threadfin, king	*Polydactylus macrochir*	Polynemidae
Tiger cardinal	*Centropomus arabicus*	Apogonidae
Tiger shark	*Galeocerdo cuvier*	Carcharhinidae
Tiger sorubim	*Pseudoplatystoma tigrinum*	Pimelodidae
Tigerfish	*Hydrocynus vittatus*	Alestiidae
Tope shark	*Galeorhinus galeus*	Triakidae
Tripletail	*Lobotes surinamensis*	Lobotidae
Union snook	*Centropomus unionensis*	Centropomidae
Wahoo	*Acanthocybium solandri*	Scombridae
Walking snakehead	*Channa orientalis*	Channidae
Walleye	*Stizostedion vitreum*	Percidae
Warmouth	*Lepomis gulosus*	Centrarchidae
Weakfish	*Cynoscion regalis*	Sciaenidae
Wels	*Silurus glanis*	Siluridae
White bass	*Morone chrysops*	Moronidae
White catfish	*Ameiurus catus*	Ictaluridae
White crappie	*Pomoxis annularis*	Centrarchidae
White marlin	*Tetrapturus albidus*	Istiophoridae
White perch	*Morone americana*	Percidae
White seabass	*Atractoscion nobilis*	Sciaenidae
White shark	*Carcharodon carcharias*	Lamnidae
White snook	*Centropomus viridis*	Centropomidae
Whitecheek shark	*Carcharhinusdussumieri*	Carcharhinidae
Whitefin hammerhead	*Sphyrna couardi*	Sphyrnidae
Whitefish, mountain	*Prosopium williamsoni*	Salmonidae
Whitefish, round	*Prosopium cylindraceum*	Salmonidae
Whitenose shark	*Nasolamiavelox*	Carcharhinidae
Whitetip reef shark	*Triaenodonobesus*	Carcharhinidae
Winghead shark	*Eusphyra blochii*	Sphyrnidae
Yawa	*Albula argentea*	Albulidae
Yellow bass	*Morone mississippiensis*	Moronidae
Yellow bullhead	*Ameiurus natalis*	Ictaluridae
Yellow perch	*Perca flavescens*	Esocidae
Yelloweye rockfish	*Sebastes ruberrimus*	Sebastidae
Yellowfin snook	*Centropomus robalito*	Centropomidae
Yellowfin tuna	*Thunnus albacares*	Scombridae
Yellowtail snapper	*Ocyurus crysurus*	Lutjanidae
Zander	*Stizostedion lucioperca*	Percidae