click for previous page

The Caribbean Plate, which occupies a central position in relation to the others, provides a useful reference point for understanding their interactions and relative motions. There are two fundamentally different kinds of models for its formation and evolution. Models based on the hypothesis of in situ origin (e.g., Weyl, 1973; Meyerhoff and Meyerhoff, 1972; Donnelly, 1989) suggest that the anomalously thick crust that gives the plate its identity is the result of a flood basalt event that occurred between the two American continents as they separated in the early Mesozoic, between 200 and 165 Ma. In general, these models involve movement of South America and Africa (which were a single unit at that time) to the east-south-east with respect to North America. The movements of separation between the American continents are hypothesized to have ended at about 120 to 130 Ma as Africa separated from South America, reducing the rate of movement of the latter continent and initiating the opening of the South Atlantic Ocean (Donnelly, 1989), a feature that is therefore younger than the Intra-Americas Sea.

Alternative models are based on the hypothesis that the Caribbean Plate originated in the Pacific. These models propose that the thick flood basalts were created to the west of the North and South American Plates, perhaps genetically related to the Galapagos hotspot according to some models, and that the Caribbean Plate has been transported subsequently to its present position between the two continents (e.g., Malfait and Dinkelman, 1972; Pindell, 1994). Using paleomagnetic data from ODP Sites 998 to 1001, Acton et al. (2000) estimated that the Caribbean plate was 5 to 15^{o} south of its current position at about 80 Ma, placing it directly over the equator in the late Cretaceous. The inferred displacement implies an over-all rate of progression of 18 km/my. These results are compatible with models that have the Caribbean plate originating more than 1 000 km from its current position relative to North and South America.

The northern and southern boundaries of the Caribbean plate are best described as plate boundary zones or broad belts in which boundaries are not well defined and the effects of plate interaction are difficult to specify. A special problem occurs on the northern boundary where Cuban terranes in the Antillean arc collided with the North American plate and became fused to it in latest Paleocene or early Eocene. Subsequently, transform movement has taken place near the Cayman Trench, south of the Cuban platform.

Historical Biogeography

The science of biogeography was revolutionized in the 1960s in light of the formalization of plate tectonics and the general acceptance by biologists of a mobilist view of the earth's crust. The recognition that whole biotas could be transported in unison with mobile terranes led to entirely new models and methodologies for the explanation of the distributions of organisms. As a result, descriptive biogeography based on ad hoc delineation of biotic units (e.g., biogeographic realms, regions or provinces), was generally succeeded by historical biogeography based on phylogenetic inference and the objective search for areas of endemism. In an independent but nearly simultaneous development, MacArthur and Wilson (1963, 1967) developed the theory of island biogeography which seeks explanations about the composition of island biotas that are independent of phylogeny and that are of interest on much shorter time scales. Both of these two trajectories in biogeography - historical and ecological - were developed to a substantial degree on the basis of cases from the Caribbean region, probably because of its complex geographic subdivision and because its geographic units contain the high diversity of organisms necessary to resolve multiple events and, possibly, multiple processes that underlie them. A review of the relationship between the two approaches as applied to the Caribbean is provided by Pregill and Crother (1999).

A change of emphasis also occurred **within** the field of historical biogeography. Prior to the acceptance of plate tectonics, it was taken for granted that it was mobile organisms that dispersed relative to a stable physical geography. Discussion was heavily based on terrestrial organisms, and debate centred on the relative roles of two hypothesized means of dispersal among islands and continents, i.e., whether particular examples were best explained by dispersal of terrestrial species over expanses of water or by means of land bridges. Once it was recognized that units of lithosphere are themselves moving, the debate shifted to the relative contribution of dispersal or vicariance (subdivision of biotas due to geographic isolating events) as mechanisms in determining the distributions of organisms. Vicariant events in the marine realm include geotectonic events that alter topography as well as changes in circulation or the distribution and characteristics of water masses.

Patterns of Diversity

Generalized patterns of distribution among the species treated in these volumes were sought by combining the range maps of individual species. The species maps contributed by authors were digitized using ESRI ArcInfo and compared in a system of cells, 0.5^{o} on each side. Cells have an area of 2 539 to 3 078 km^{2} at the northern and southern boundaries of the WCA respectively (35 to 5^{o}N). The difference (17%) was deemed negligible because much greater variance in the area of aquatic habitat within cells is created by intersection with the region's many small islands and its extensive coastline. Cells were considered to be occupied by a species range if the range entered any part of the cell.

The composite distribution of all 1 172 species mapped in these volumes (Fig. 10) shows that the area of highest species richness is located in waters surrounding southern Florida, the eastern Bahamas, and northern Cuba. Secondary centres of diversity are located (in descending order of richness) on the continental shelves of northern South America, Central America, and in the northern Gulf of Mexico. These patterns of richness are apparently robust as they are repeated in the composite distributions for fishes (Fig. 11) and invertebrates (Fig. 12) taken separately. The distributions of tetrapods are quite general, and are not shown separately.

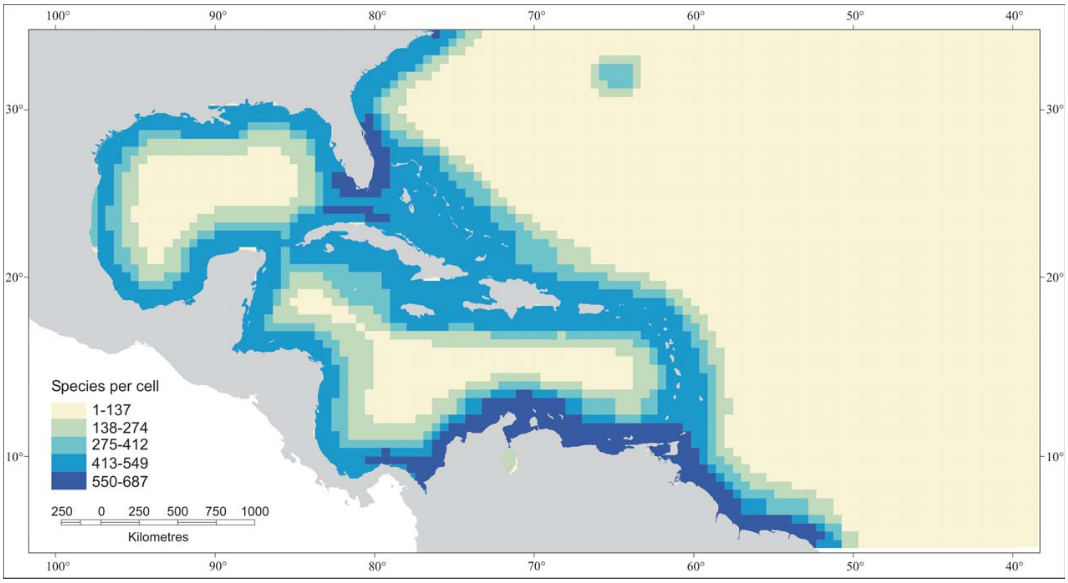

Fig. 10 Composite distributions of 1 172 species of invertebrates, fishes, and tetrapods based on maps in this guide

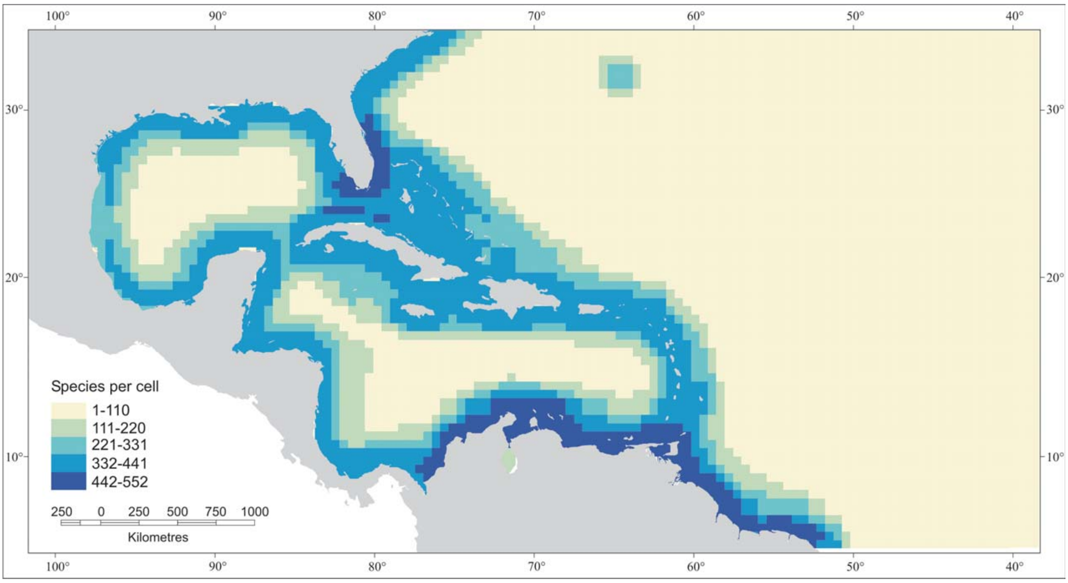

Fig. 11 Composite distributions of 987 fish species based on maps in this guide

Although a comprehensive analysis of patterns of richness across the whole Atlantic Ocean has never been undertaken, the tropical and subtropical waters of the wider Caribbean region are generally regarded as having the highest species richness. For comparison, the FAO guide to Mediterranean marine fisheries resources covers 156 species (Fischer, 1973) and that for the tropical waters along the coast of Africa covers 681species (Fischer et al., 1981) compared to 1 172 in this guide. Given that the Strait of Florida has by far the highest richness in the WCA, it is likely to rank as the most species-rich area within the Atlantic Basin.

Areas of Endemism

A search for areas of endemism was based on fishes which are represented by a much larger sample size than are the other taxa. In order to identify concentrations of endemic fishes, maps were examined in order to identify range polygons that are contained wholly within the WCA. Some of the polygons so identified are disjunct parts of the ranges of species that occur outside the WCA. For example, several morays have disjunct populations in the Caribbean and Ascension Island. Such cases were eliminated by comparison to range statements in the species accounts in these volumes or in the published literature. A total of 227 fish species or 23% were found to be endemic to the WCA. Based on the ranges in the species accounts (which reflect maximum extent of occurrence), these restricted-range species occupy areas from approximately 8 616 to 333 152 km^2 (3 to 116 cells). Given that three of the borders of the WCA are formed by arbitrary lines through aquatic habitat rather than by physical limits to distributions, these limits may intersect the ranges of restricted-range species. Because transboundary species are not counted as endemics, these additional restricted-range species are not included in our considerations of range size (that is, we are dealing with a minimum estimate).

The combined distributions of the 75 smallest endemic fish ranges are shown in Fig. 13. Areas of endemism occur in roughly the same places that show high species richness. That is, the greatest concentration of endemic fishes occurs in the northern WCA (centred on the Strait of Florida), followed in order by the northern coast of South America, the Caribbean coast of Central America and the northern Gulf of Mexico.

The high degree of endemism in the region contradicts the general view that marine species have large distributions. In fact, marine species show a range in the size of their distributions just as do terrestrial organisms, and this includes numerous micro-endemics in our region. The maps in these volumes show fine-grained patterns of micro-endemism in various groups including 11 species of toadfishes (Batrachoididae), and 11 species of silversides (Atherinopsidae). It should be noted that the sample of species covered in this guide is probably biased against the notion of fine-grained endemism, as many groups expected to show high endemism (e.g., gobies) have not yet been treated.

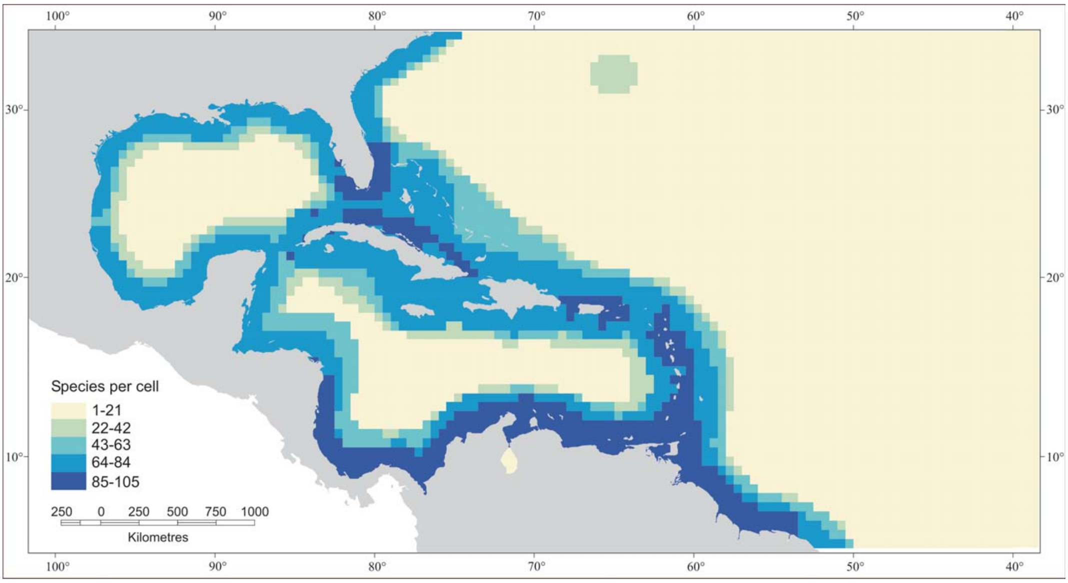

Fig. 12 Composite distributions of 144 invertebrate species based on maps in this guide

Prominence of Shelf Fishes

The two primary areas of endemism in the WCA, the Strait of Florida and the coastal waters of Venezuela and Colombia, have quite different species composition and they could be viewed as separate hotspots for marine biodiversity. The differences may reflect the fact that these areas represent distinct continental faunas that were separated by the Inter-American Seaway during most of the history of the Caribbean Basin.

A striking aspect of species distribution in the WCA is the degree to which species richness is dominated by the fauna along the coasts of the continents (Figs 11,12). There are 212 species or 21% of fishes associated with the continental shelves. These species are absent from island platforms that are separated from the continents by wide expanses of water deeper than 140 m and that therefore remained separate from the continental shelves even during low sea stands of the Pleistocene.

The fishes that are restricted to the continental shelves can be considered to comprise 4 components. Ten shelf species span the WCA from north to south and therefore provide no resolution of biogeographic events inside the WCA. Eighty-six species are WCA endemics that are restricted to small parts of the continental shelves. Forty-nine shelf species have distributions entering the WCA from the eastern coast of North America and extending to varying degrees along the Central American shelf or farther south (Fig. 14). On the southern side of the WCA, 67 species have ranges extending into the WCA to some degree (Fig. 15). These patterns suggest that the emergence of the Central American Isthmus may have been associated with a marine faunal exchange similar to the “great American biotic interchange” that is well documented in the terrestrial biotas (Stehli and Webb, 1985), but that has not been noted as an aspect of marine biogeography. The elevation of ridges in the position of present Central America, (see Paleoceanography, above), would have established a continuous continental shelf between the Americas for the first time in early to mid-Miocene, based on barriers to deep and intermediate circulation inferred to have arisen at that time. The relatively low levels of endemism and species diversity on the Central American shelf may reflect, in part, its relatively recent connection to the older faunas of the North and South American continental shelves.

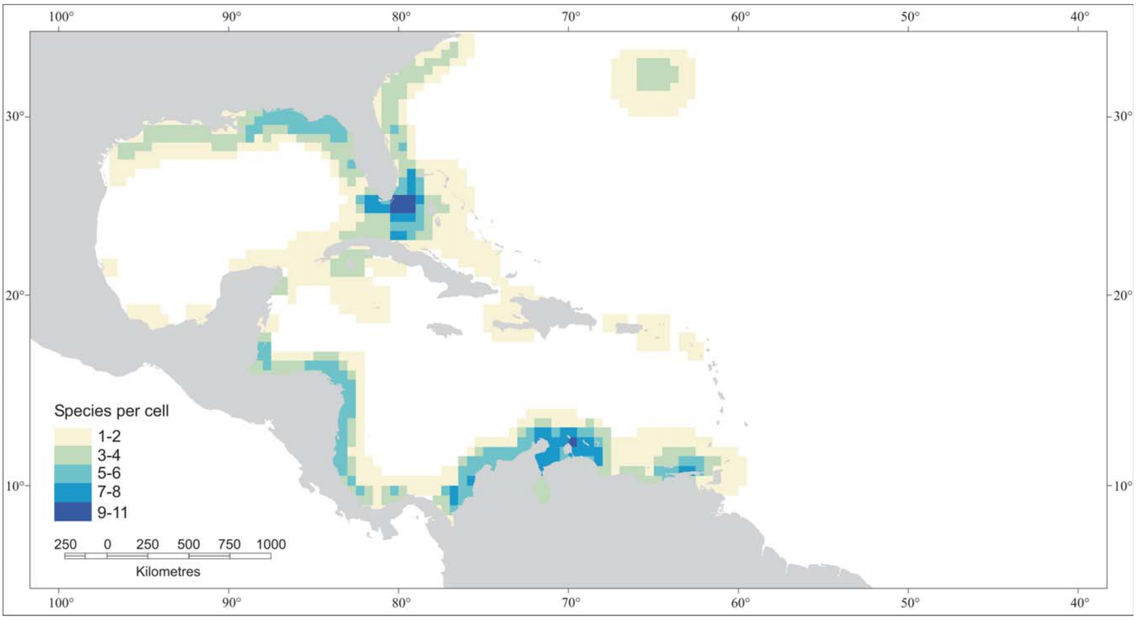

Fig. 13 Composite distributions of 75 endemic species of fishes with the smallest range sizes (3 to 116 cells)

Vicariance Due to Climate Change

In several cases, the present distributions of inshore species appear to conserve information about climate change. Over most of its length, the modern coastline of the Western Atlantic Ocean runs from north to south so that species in most sections of the continental shelves might readily adjust their latitudinal positions in response to changing climate. An exception occurs in the Gulf of Mexico which forms a large-scale cul-de-sac that is open to the south, but closed at its northern end. This circumstance is associated with one of the more conspicuous and well known patterns in the distribution of Western Central Atlantic species.

Many species that occur in the northern Gulf of Mexico also occur at higher latitudes along the eastern coast of North America, but they are not present in southern Florida. This disjunction

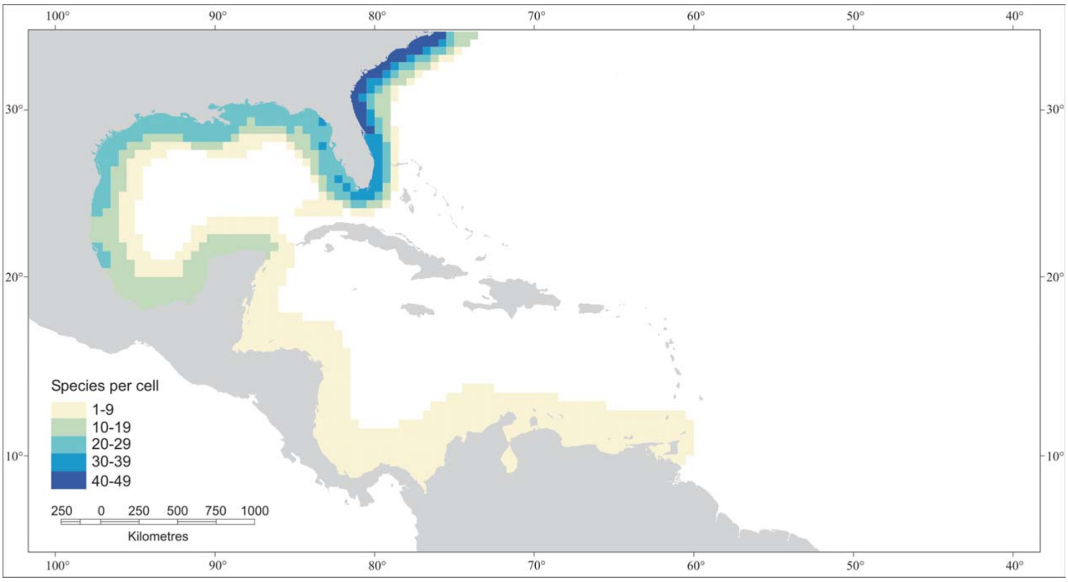

Fig. 14 Composite distributions of 49 shelf fishes entering the WCA from North America

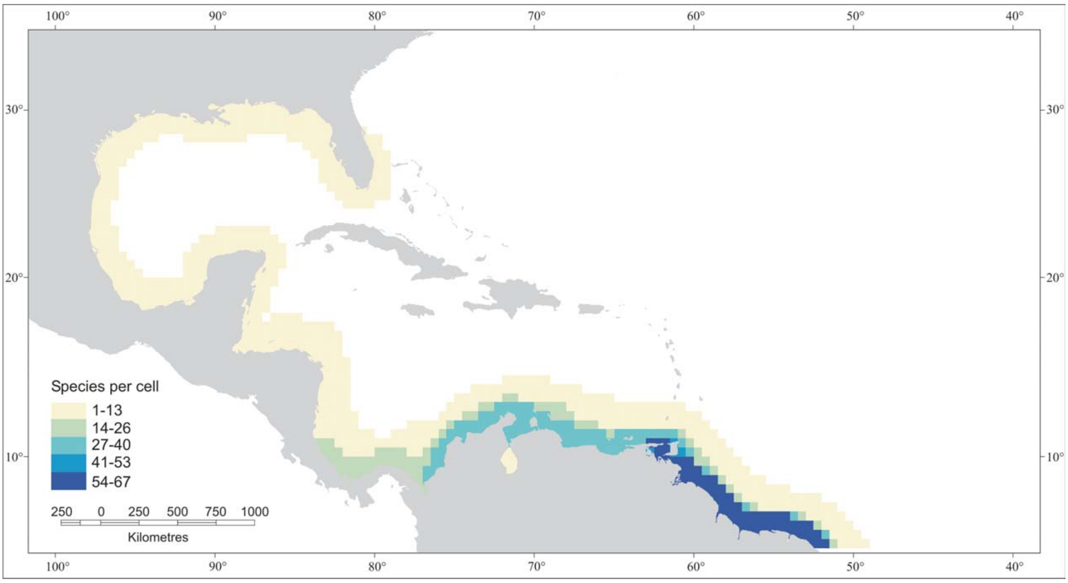

Fig. 15 Composite distributions of 67 shelf fishes entering the WCA from South America

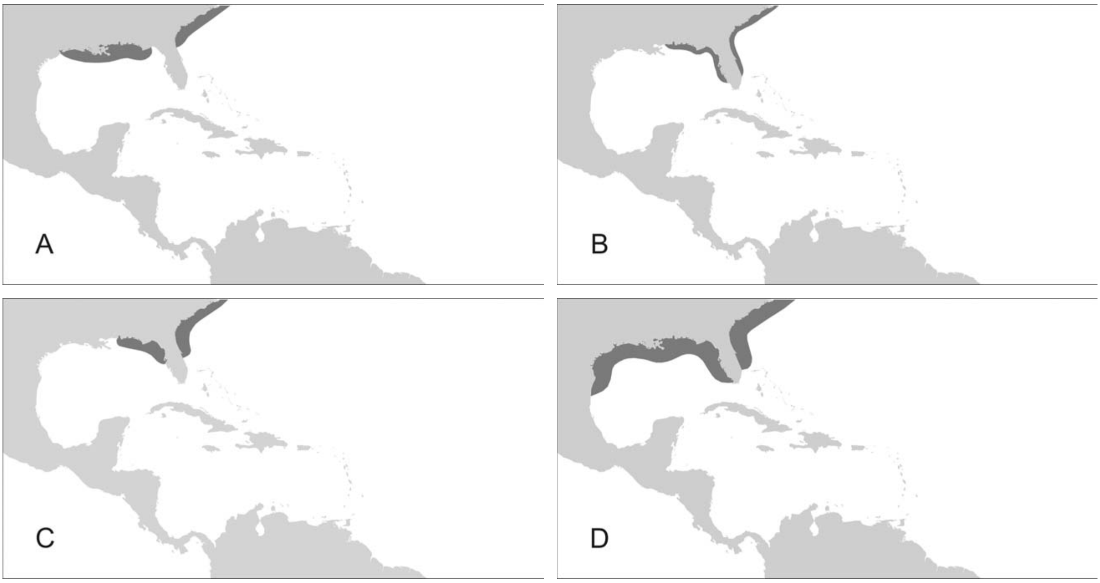

Fig. 16 Composite map of disjunct distributions of inshore fishes in four families: A) *Morone saxatilis*, Moronidae, B) *Etropus cyclosquamus*, Paralichthyidae, C) *Larimus fasciatus*, Sciaenidae, and D) *Centropristis striatus*, Serranidae

recurs in the distributions of several families of fishes (Fig. 16) and in the distributions of tunicates (Van Name, 1954), molluscs (Rehder, 1954), nemertean worms (Coe, 1951, 1954), and other groups of invertebrates (Hedgpeth, 1953; Frey, 1965). The recurrence of a common feature in the distributions of taxa with diverse ecologies implies a common historical cause. In this case, the most general explanation is that the distributions of midlatitude species on the east coast of North America were displaced southward and around the southern tip of Florida during periods of lowered sea temperatures contemporaneous with the glacial ages (Frey, 1965). With the rise of sea temperatures during inter-glacials, the southern distributional limits of midlatitude species were displaced northward on both sides of the Florida Peninsula, resulting in disjunctions in the ranges of inshore species. Such climate-induced vicariance is likely associated with differentiation of populations on opposite sides of Florida (e.g., the shads *Alosa alabamae* on the Gulf coast and *Alosa sapidissima* on the Atlantic coast north of central Florida; Rivas, 1954), therefore contributing to endemism in the northern Gulf of Mexico.

Fisheries

The fisheries of the WCA are the most diverse of all FAO fishing areas in the Atlantic. This is in terms of both numbers of species and numbers of countries that exploit these resources. The management of this diversity is complicated by the geographical complexity of the region, with a patchwork of numerous islands with varied local current systems (Appledoorn et. al, 1987) and a continental shelf that is traversed by several major rivers. This results in what is presumably a very complex stock structure. This apparently contributes to the fact that very little is known of the actual status of individual stocks in the WCA. Cochrane (2001) reported that of the 57 stocks falling under the jurisdiction of the United States Gulf of Mexico Fisheries Management Council, the status of 46 (81%) was unknown or undefined. This situation is worse for those 179 stocks falling under the jurisdiction of the United States Caribbean Fisheries Management Council (CFMC) wherein the status of 175 (98%) is unknown or undefined. Cochrane (2001) suggests that fisheries assessment status elsewhere in the WCA is likely to be similar to or worse than that of the CFMC.

One thing that is fairly certain about the status of fisheries in the WCA is that the overall fisheries resources of the area appear to be at or to have exceeded their maximum level of exploitation. Catches steadily increased until a peak in 1984 of 2.2 million t, followed by a decline and leveling off at around 1.8 million t of total annual catches (Fig. 17). This general trend is consistent among all major resource groups.

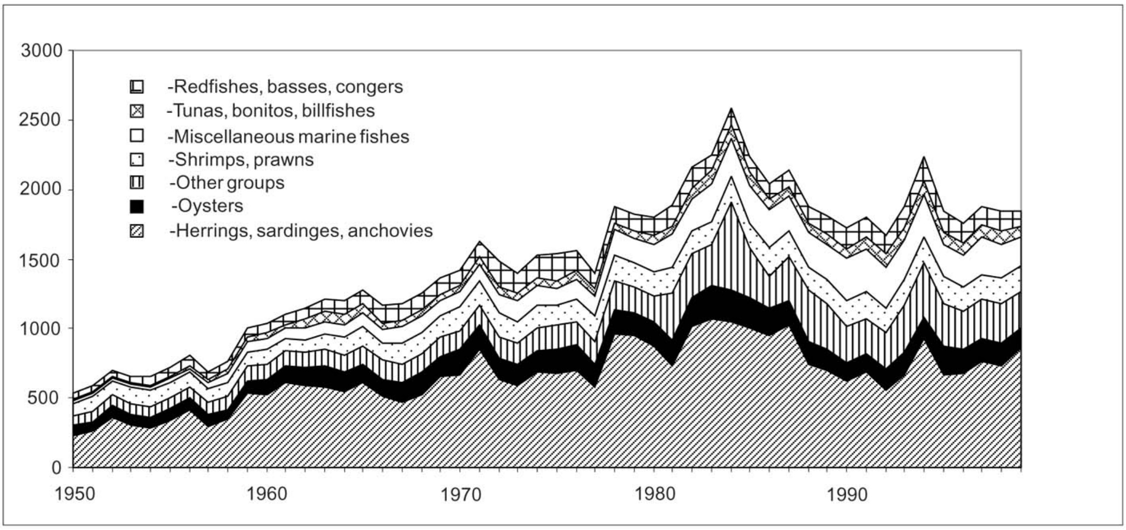

Fig. 17. Landings according to FAO Fisheries statistics from 1950 to 1999

The major fishing regions of the area can be roughly classified as Gulf of Mexico, northern coast of South America, islands of the Antilles, and Caribbean Central America. The Gulf of Mexico is the most productive in the area with landings from both Mexico and the USA coming mostly from these Gulf fisheries (Table 1). These two countries reported the first and third highest average annual landings in the area with the USA contributing between about 772 and 1 022 thousand t per year between 1996 and 2000 and Mexico between about 275 and 321 thousand t per year between 1996 and 2000. Prominent catches in the Gulf of Mexico are related to its extensive continental shelf area (Table 2). The northern coast of South America is the second most productive in the area with Venezuela contributing the second highest average annual landings. This ranged between about 272 and 391 thousand t per year between 1996 and 2000. Guyana also figured prominently with landings ranging between about 48 and 53 thousand t for the same period. Colombia, Suriname, and French Guiana also contributed substantially to South American catches in the area and ranged between about 3 and 27 thousand t per year between 1996 and 2000. In the Antilles, catches from Cuba, the Dominican Republic, and Jamaica dominated with between 49 and 59, 9 and 13, and 6 and 12 thousand t annually for the same period, respectively. From the Caribbean Central America, Nicaragua and Honduras annually contributed between about 10 and 15 and 2 and 7 thousand t, respectively, between 1996 and 2000.

A number of extralimital countries also report landings from Area 31 (Table 3). These include mostly large pelagics such as tunas and billfishes but sharks also make up a minor part of the catch. Taiwan Province of China and Japan report the bulk of foreign landings with annual ranges between 4 and 6 and 1 and 4 thousand t, respectively, from 1996 to 2000. Unlike nearly all of the countries bordering Area 31, these extralimital fishers are steadily increasing their landings.

FAO currently lists 1 255 taxonomic statistical units in its Yearbook of Fishery Statistics (FAO, 2002). This includes fresh-water species and units typically not added to totals such as corals and sponges. In the WCA, area landings were reported for 187 marine and brackish-water taxonomic statistical units (excluding 4 units not typically included in totals) for the period between 1996 and 2000. The most important 75 of these taxonomic units include a wide taxonomic range from molluscs to bony fish (Table 4). The top 10 taxonomic unit landings were dominated by the Gulf Menhaden, *Brevoortia patronus*, which accounted for between 29 and 39% of the total reported landings for the area between 1996 and 2000. This species is restricted to the Gulf of Mexico, caught mostly by purse seines and gill nets, and used mostly for extraction of fish oil and for fish meal. The American cupped oyster, *Crassostrea virginica* had the second highest landings in 2000 and ranged between about 85 and 223 thousand t from 1996 to 2000. The catch-all group bony fishes or Osteichthyes, however, more consistently ranked second in total landings and ranged between about 188 and 263 thousand t from 1996 to 2000. The fact that a large percentage of species are being reported as simply unidentified bony fish underscores the need for improved species identification. Biological management of fisheries requires species-specific population parameters. These aggregrate statistical units will hopefully dissemble over time as species identification becomes more practical using this guide.

Country	1996	1997	1998	1999	2000
Anguilla	200	250	250	250	250
Antigua and Barbuda	1 209	1 437	1 415	1 361	1 481
Aruba	150	205	182	175	163
Bahamas	9 866	10 439	10 124	10 473	10 500
Barbados	3 512	2 809	3 644	3 250	3 100
Belize	977	1 045	911	1 185	886
Bermuda	465	461	465	452	286
British Virgin Islands	506	105	116	115	43
Cayman Islands	110	125	125	125	125
Colombia	23 888	6 235	26 825	3 040	15 196
Costa Rica	437	420	364	666	1 050
Cuba	48 799	58 896	53 386	51 533	51 500
Dominica	1 030	1 079	1 212	1 200	1 150
Dominican Republic	12 606	13 468	9 076	7 804	10 842
French Guiana	7 377	6 602	6 709	6 271	5 237
Grenada	1 574	1 548	1 852	1 802	1 696
Guadeloupe	9 570	10 480	9 084	9 114	10 100
Guatemala	390	285	328	292	366
Guyana	47 783	53 373	52 215	53 241	48 018
Haiti	4 745	4 801	4 759	4 500	4 500
Honduras	2 691	6 560	2 332	1 865	7 093
Jamaica	12 054	7 748	6 110	8 058	5 226
Martinique	3 500	5 500	5 500	6 000	6 314
Mexico	294 231	320 829	302 157	285 833	274 532
Montserrat	38	45	46	50	50
Netherlands Antilles	1 000	950	950	950	950
Nicaragua	9 685	9 451	12 011	13 127	14 838
Panama	0	0	0	20	714
Puerto Rico	2 701	3 187	3 006	3 020	4 154
Saint Kitts and Nevis	352	216	407	348	257
Saint Lucia	1 274	1 311	1 314	1 718	1 759
Saint Vincent/Grenadines	889	947	1 283	1 031	7 294
Suriname	12 850	13 800	15 995	16 000	16 000
Trinidad and Tobago	9 205	11 088	9 027	8 728	9 661
Turks and Caicos Is.	1 297	1 250	1318	1 300	1 300
United States of America	771 970	867 630	822 594	943 641	1 021 580
US Virgin Islands	400	350	300	263	300
Venezuela	378 795	362 474	390 785	304 680	271 515
Total	1 678 126	1 787 399	1 758 177	1 753 481	1 810 026

Table 1. Landings in metric tonnes (t) of all countries bordering FAO Fishing Area 31 from 1996 to 2000 (FAO, 2002)

Location	Area (`000 km^2)
US east coast	**110**
Gulf of Mexico	**600**
Yucatán - Eastern Venezuela	**250**
Guyana, Suriname, French Guiana	**200**
Islands and offshore banks	**380**
Total	**1 540**

Table 2. Locality and area of the major coastal shelf zones in the Western Central Atlantic (Stevenson 1981)

Country	1996	1997	1998	1999	2000
Japan	**1 454**	**1 262**	**1 605**	**4 133**	**3 415**
Korea, Republic of	**626**	**143**	**621**	**1 789**	**3 327**
Philippines	**0**	**0**	**28**	**549**	**376**
Spain	**906**	**3 145**	**2 090**	**1 998**	**2 224**
Taiwan Province of China	**4 516**	**3 669**	**2 430**	**5 663**	**6 039**
Total	**7 502**	**8 219**	**6 774**	**14 132**	**15 381**

Table 3. FAO Fishing area 31 landings in metric tonnes (t) of countries not bordering Area 31 from 1996 to 2000 (FAO, 2002)

Invertebrates or ‘shellfish’ contributed prominently to total landings in the area (Table 4). The most important crustaceans included *Farfantepenaeus aztecus* (northern brown shrimp), *Litopenaeus setiferus* (northern white shrimp), *Callinectes sapidus* (blue crab), *Penaeus* spp. (unidentified penaeid shrimps), *Panulirus argus* (Caribbean spiny lobster), and *Xiphopenaeus kroyeri* (Atlantic seabob). Each contributed between around 17 and 63 thousand t yearly between 1996 and 2000. Of these shrimps, found primarily in the northern part of the area, none are not considered to be over fished, except for the Atlantic seabob, whose status is unknown (Cochrane, 2001). The spiny lobster stocks in the CFMC area are not considered to be overfished but elsewhere they are mostly fully or over exploited. In addition to *Crassostrea virginica*, other molluscs contributed substantially with landings between 1996 and 2000 for *Arca* spp between about 34 and 47 thousand t, *Octopus vulgaris* (an aggregate species) between about 17 and 29 thousand t, and *Strombus* spp. (conch species) between about 11 and 17 thousand t. Within the area of the CFMC, the most important conch species, the pink or queen conch (*Strombus gigas*) is considered to be over exploited while elsewhere in the WCA status estimates ranged from lightly to over exploited (Cochrane, 2001).

The most important finfish group in terms of landings came from pelagic resources captured primarily from purse seines, gill nets, and longlines. This included small pelagics in the family Clupeidae (Table 5), with *Brevoortia patronus* (Gulf menhaden), *Sardinella aurita* (round sardinella), and *Brevoortia tyrannus* (Atlantic menhaden) contributing the bulk of the 664 to 860 t landings for this family between 1995 and 1999 (Table 4). Cochrane (2001) reports that these menhaden species are currently overfished but that the round sardinella, fished mostly in Venezuela, may be under to fully exploited. Another group of small pelagics, the flyingfishes (Exocoetidae), are locally important in some of the

Statistical taxonomic unit (common name)	1996	1997	1998	1999	2000
Brevoortia patronus (Gulf menhaden)	491 612	597 565	497 461	694 242	591 434
Crassostrea virginica (American cupped oyster)	108 971	95 608	101 957	85 150	222 866
Osteichthyes (bony fishes)	230 812	263 826	232 790	196 376	188 613
Sardinella aurita (round sardinella)	155 426	143 116	190 895	128 048	75 571
Penaeus aztecus (northern brown shrimp)	54 703	44 459	50 722	60 527	62 713
Penaeus setiferus (northern white shrimp)	27 461	31 928	39 799	44 014	52 280
Callinectes sapidus (blue crab)	48 222	58 859	59 162	44 846	50 237
Penaeus spp (penaeid shrimps)	50 122	53 816	50 679	40 810	48 203
Arca spp (ark clams)	33 888	42 117	30 880	41 145	47 209
Panulirus argus (Caribbean spiny lobster)	29 650	29 226	27 216	30 905	35 204
Xiphopenaeus kroyeri (Atlantic seabob)	17 310	21 464	16 603	18 648	24 764
Thunnus albacares (yellowfin tuna)	24 775	26 131	27 172	24 413	24 426
Brevoortia tyrannus (Atlantic menhaden)	24 169	0	27 779	18 815	23 812
Octopus vulgaris (common octopus)	28 608	17 809	16 565	19 120	22 562
Epinephelus spp (groupers)	20 170	19 352	18 855	16 757	21 980
Ariidae (sea catfishes)	22 150	14 885	16 385	16 442	20 306
Strombus spp (conches)	11 389	16 025	12 688	14 390	16 857
Opisthonema oglinum (Atlantic thread herring)	5 634	15 191	14 592	17 066	14 802
Mugilidae (mullets)	11 315	16 618	15 846	10 628	14 779
Lutjanidae (snappers)	12 317	13 457	15 444	10 017	14 450
Cynoscion spp (weakfishes)	14 011	10 577	13 551	6 394	12 799
Mugil cephalus (flathead grey mullet)	16 721	13 593	10 583	10 023	10 657
Haemulidae (grunts)	13 881	18 081	15 565	11 338	10 006
Caranx spp (jacks)	12 030	12 833	12 376	9 517	9 917
Thunnus alalunga (albacore)	3 706	2 958	1 400	5 500	9 623
Scomberomorus cavalla (king mackerel)	9 639	12 769	8 021	9 559	8 980
Elasmobranchii (sharks and rays)	11 499	12 371	10 059	11 176	8 822
Penaeus duorarum (northern pink shrimp)	4 757	10 761	12 452	3 806	8 513
Scomberomorus maculatus (look in Scombridae)	11 183	8 720	8 625	9 050	6 999
Rajiformes (skates and rays)	7 591	8 852	9 885	8 021	6 584
Carcharhinidae (requiem sharks)	12 145	9 785	8 588	6 254	6 451
Cynoscion nebulosus (spotted weakfish)	3 610	3 797	6 786	6 742	6 367
Scomberomorus brasiliensis (look in Scombridae)	5 389	5 940	5 782	4 158	5 537
Mercenaria mercenaria (northern quahog)	0	0	0	0	5 506
Scombroidei (tuna-like fishes)	16 756	2 221	24 915	2 824	5 272
Centropomus undecimalis (common snook)	5 132	4 867	5 012	5 119	5 034
Portunus spp (swimming crabs)	1	289	224	4 042	4 995
Lutjanus campechanus (northern red snapper)	6 346	6 264	5 166	5 412	4 841
Katsuwonus pelamis (skipjack tuna)	4 853	5 576	5 863	4 186	4 483

Table 4. The landings in metric tonnes (t) of the 40 most important statistical taxonomic units from FAO Fishing Area 31 from 1996 to 2000 (FAO, 2002). All aggregate taxa (other than species) are not elsewhere included

Scientific (common) name	1995	1996	1997	1998	1999
Clupeidae (herrings)	**663875**	**678662**	**758166**	**732544**	**859791**
Osteichthyes (bony fish)	**232888**	**231195**	**266901**	**236218**	**205135**
Scombridae (tunas)	**77580**	**76573**	**80446**	**75517**	**76326**
Mugilidae (mullets)	**37659**	**31895**	**32044**	**29628**	**23789**
Lutjanidae (snappers)	**25401**	**26583**	**28152**	**29120**	**23049**
Sciaenidae (croakers)	**34747**	**27038**	**24147**	**32468**	**20688**
Carangidae (jacks)	**20880**	**20949**	**22844**	**23405**	**19365**
Serranidae (groupers)	**26982**	**21417**	**21057**	**20384**	**18037**
Ariidae (sea catfishes)	**26630**	**22150**	**14885**	**16385**	**16442**
Haemulidae (grunts)	**14261**	**13881**	**18081**	**15565**	**11335**
Elasmobranchii (sharks and rays)	**12494**	**10728**	**10495**	**9941**	**8815**
Centropomidae (snooks)	**7089**	**6576**	**6036**	**6093**	**8257**
Rajiformes (rays)	**7710**	**7591**	**8852**	**9886**	**8021**
Perciformes (perciforms)	**8085**	**8305**	**9326**	**8129**	**7216**
Carcharhinidae (requiem sharks)	**12215**	**12149**	**9795**	**8623**	**6278**
Gerreidae (mojarras)	**9698**	**9756**	**5911**	**5487**	**4091**
Coryphaenidae (dolphinfishes)	**3849**	**3549**	**4300**	**3586**	**4064**
Trichiuridae (cutlassfishes)	**4965**	**4632**	**5060**	**5413**	**4043**
Scombroidei (tuna-like fishes)	**2108**	**17919**	**3163**	**26287**	**3384**
Xiphiidae (sword fish)	**3371**	**1703**	**2611**	**2872**	**3231**
Sparidae (porgies)	**3607**	**2838**	**3748**	**2670**	**2545**
Exocoetidae (flyingfishes)	**1843**	**2148**	**1623**	**2835**	**2165**
Sphyraenidae (barracudas)	**1742**	**1596**	**2130**	**2072**	**1907**
Stromateidae (butterfishes)	**2695**	**2685**	**648**	**1821**	**1664**
Engraulidae (anchovies)	**1605**	**1472**	**904**	**1897**	**1621**
Istiophoridae (billfishes)	**1199**	**1242**	**1057**	**1268**	**1305**
Paralichthyidae (sand flounders)	**1926**	**2192**	**1059**	**1333**	**1020**
Pomatomidae (bluefish)	**1458**	**758**	**1147**	**899**	**756**
Rachycentridae (cobia)	**499**	**392**	**757**	**717**	**630**
Pleuronectiformes (flatfishes)	**770**	**335**	**487**	**558**	**594**
Balistidae (triggerfishes)	**1457**	**810**	**551**	**717**	**496**
Branchiostegidae (tilefishes)	**611**	**114**	**425**	**374**	**406**
Squalidae (dogfish sharks)	**26**	**138**	**310**	**334**	**222**
Scaridae (parrotfishes)	**156**	**99**	**100**	**118**	**99**
Hemiramphidae (halfbeaks)	**529**	**399**	**295**	**443**	**92**
Mullidae (goatfishes)	**380**	**276**	**180**	**170**	**91**
Belonidae (needlefishes)	**159**	**66**	**33**	**67**	**65**
Cynoglossidae (tonguefishes)	**0**	**0**	**0**	**0**	**59**
Labridae (wrasses)	**821**	**529**	**1456**	**52**	**52**
Gempylidae (snake mackerels)	**0**	**0**	**0**	**61**	**44**
Holocentridae (squirrelfishes)	**85**	**80**	**41**	**67**	**27**
Lophiidae (anglerfishes)	**0**	**0**	**25**	**12**	**19**
Megalopidae (tarpons)	**283**	**167**	**43**	**53**	**16**
Elopidae (tenpounders)	**30**	**143**	**745**	**979**	**15**
Ophidiidae (cusk eels)	**198**	**118**	**97**	**42**	**14**
Acanthuridae (surgeonfishes)	**5**	**11**	**4**	**9**	**7**
Moronidae (temperate basses)	**7**	**9**	**12**	**14**	**4**
Triakidae (houndsharks)	**46**	**253**	**27**	**45**	**3**
Anguillidae (fresh-water eels)	**43**	**35**	**19**	**9**	**2**
Gadiformes (gadiform fishes)	**0**	**0**	**4**	**2**	**1**
Ostraciidae (boxfishes)	**0**	**0**	**1**	**1**	**1**
Gadidae (cods)	**0**	**0**	**0**	**0**	**1**
Lamnidae (mackerel sharks)	**0**	**0**	**1**	**1**	**0**
Berycidae (alfonsinos)	**278**	**22**	**0**	**0**	**0**

Table 5. The landings in metric tonnes (t) of statistical taxonomic units aggregated to family, order, or class from FAO Fishing Area 31 from 1996 to 2000 (FAO, 2001)

small island countries although they contribute only about 2 to 3 thousand t annually to overall landings. The family Scombridae (tunas) also contributed substantially to landings of pelagic resources with between about 76 and 80 thousand t annually between 1995 and 1999. A large part of this catch came from the yellowfin tuna, *Thunnus albacares*, which, along with other large pelagics such as the skipjack tuna (*Katsuwonus pelamis*) and the albacore (*Thunnus alalunga*) is considered to be fully or over exploited in the area (Cochrane, 2001).

Six bottom-associated, or groundfish, families of finfishes contributed an annual average of around 20 thousand t or more in recently reported landings (Table 5). Between 1995 and 1999 yearly landings for these families ranged between about 15 and 38 thousand t. This included mullets (Mugilidae) which are bottom feeders caught mostly with gill nets, snappers (Lutjandiae), jacks (Carangidae), and groupers (Serranidae) which are mostly hard substrate associated and caught with hook-and-line, and croakers (Sciaenidae) and sea catfishes (Ariidae) which are caught mostly with trawls over soft substrates. The majority of the most important groundfish species are known to be over fished (Cochrane, 2001). This includes the red snapper (*Lutjanus campechanus*), red grouper (*Epinephelus morio*), Nassau grouper (*Epinephelus striatus*), goliath grouper (*Epinephelus itajara*), red drum (*Sciaenops ocellata*), and vermilion snapper (*Rhomboplites aurorubens*). The status of the majority of the lesser important reef fishes is unknown.

Elasmobranchs (sharks and rays) have also figured prominently in landings of the area. The aggregate landings of unidentified elasmobranchs, requiem sharks identified only to family level (Carcharhinidae), and rays and skates (Rajiformes) ranged between about 22 and 32 thousand t annually between 1995 and 2000 (Fig. 17). Landings of this aggregate increased dramatically over the last half of last century with less than 5 thousand t in 1950 and peaking at 37 thousand t in 1994. In recent years there has been a steady decline in catches (Fig. 17), raising concerns that this resource may be over exploited. Elasmobranchs are slow-growing, slowly maturing species with low fecundity and therefore particularly vulnerable to over fishing.

The diversity of species and countries in the WCA, and the unknown status of most of the stocks being fished, results in a challenging fisheries management environment. The FAO's Western Central Atlantic Fishery Commission (WECAFC) has a number of working and advisory groups to help improve assessment and management of some of the most important resources. For example, the WECAFC Scientific Advisory Group drew attention to the need for more detailed collection of information on shark catches to the lowest appropriate taxonomic level (Cochrane, 2001). It is generally recommended that steps should be taken to improve the information base for key species, indicator stocks, and important communities. This new edition of the WCA species identification guide is intended to aid in this endeavor.

Map Data Sources

The projection for WCA maps is Cylindrical Equal-Area, central meridian 74^{o}W, standard parallel 22^{o}N. Country and continent borders are from Environmental Systems Research Institute (ESRI), "ESRI Data and Maps CD" data set, 1999. Plate boundaries are based on the data set in ESRI ArcAtlas: Our World. Fishing area boundaries were provided by FAO. Bathymetric data are from Digital Relief of the Surface of the Earth (ETOPO5), NOAA, National Geophysical Data Center, Boulder, Colorado, 1988. Drilling site locations were obtained from the Ocean Drilling Program on-line database, http://www-odp.tamu.edu/sitemap/sitemap.html (August 2002). ISO country codes in Fig. 4 correspond to countries as follows: AI, Anguilla; AG, Antigua and Barbuda; AN, Netherlands Antilles; AW, Aruba ; BB, Barbados; BM, Bermuda; BR, Brazil; BS, Bahamas; BZ, Belize; CO, Colombia; CR, Costa Rica; CU, Cuba; DM, Dominica; DO, Dominican Republic; GD, Grenada; GF, French Guiana; GP, Guadeloupe; GT, Guatemala; GY, Guyana; HN, Honduras; HT, Haiti; JM, Jamaica; LC, St. Lucia; KN, St. Kitts and Nevis; KY, Cayman Islands; MQ, Martinique; MS, Montserrat; MX, Mexico; NI, Nicaragua; PA, Panama; PR, Puerto Rico; SR, Suriname; TC, Turks and Caicos Islands; TT, Trinidad and Tobago; US, United States; VC, St. Vincent and the Grenadines; VE, Venezuela; VI, U.S. Virgin Islands; VG, British Virgin Islands.

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