Ciguatera in the Eastern Caribbean

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ABSTRACT—Ciguatera fish poisoning plays an important role in Caribbean marine resource development. Many independent eastern Caribbean island nations rely heavily on marine protein. Current demand in these areas for seafood approaches 775,000 t, a figure greatly in excess of the 200,000 t potential yield, as well as current landings which are near 87,000 t.

Annual incidence of ciguatera fish poisoning may reach nine per thousand residents in Caribbean communities like St. Thomas, U.S. Virgin Islands. These high rates affect public health, fishery development, and liability aspects of island life. Distribution of ciguatera in the Caribbean indicates that it is found most frequently north of Martinique. Three areas of "high risk," as well as "high risk" species, are identified. In St. Thomas nearly 50 percent of the 84 species in the catch and 56 percent of the total landings by weight bear some risk of intoxication if eaten.

Introduction

Ciguateric fish poisoning is a disease of circumtropical distribution which has apparently been a feature of human use of Caribbean marine resources since pre-Columbian times (Price, 1966). Resource use patterns by the Carib and Arawak Indians who inhabited the eastern Caribbean would indicate that they, too, must have encountered ciguateric problems (Price, 1966).

Presently, many of the Lesser Antillean islands have ended or are ending their colonial ties and have assumed the economic responsibilities of independent nationhood. Many of these new Caribbean island nations are among the most densely populated areas in the world, with several (most notably Barbados) among the top ten in world population density. As part of their continuing political and economic evolution, emphasis is being placed upon economic development of the limited resources available.

Fish have traditionally been a primary source of protein for island residents, a fact which has resulted in a high demand for them and heightened the impact of ciguatera within the communities. Fisheries development is a frequent and important strategy for the region since primary production of marine protein both enhances the local diet and eliminates the need to import expensive substitutes, which may exacerbate serious balance-of-payment deficits that normally characterize small-island economies.

There are two features of fishery resources in the eastern Caribbean which override the best intentioned plans for development. The first of these is the inability of the resources to support the additional levels of exploitation implied by most projected development schemes. Many island platforms are simply too small to support additional exploitation, and development must concentrate upon optimization of resource utilization and distribution. Evidence to this effect is presented subsequently.

The second feature limiting Caribbean fishery development is tropical fish poisoning, which affects and limits every serious or responsible attempt to develop fisheries in areas where ciguatera occurs. Ciguatera problems may range from the unquantifiable loss of productivity of poisoned workers to lack of product export and public health problems stemming from insufficient protein in the diet.

Tacket[1] estimated that the annual incidence of fish poisonings reported to the emergency room in St. Thomas, V.I., was around 4.2 cases per thousand population. In a household survey, she reported a level of 7.3 per thousand, indicating that 43 percent of the cases are not reported to the emergency room. McMillan et al. (1980) found in their household survey that only 45 percent of those poisoned reported to the emergency room. They also found that 22 percent of all households surveyed experienced at least one poisoning in 5 years. Taylor (cited by Tacket, footnote 1) reported that this figure was as high as 31 percent in homes where fish was eaten. In this regard, St. Thomas is probably typical of other islands where ciguatera is a normal risk associated with the consumption of marine protein.

Ciguatera poisoning is not only frequent but dangerous: Scheuer[2] has reported that ciguatoxin is possibly the fifth most toxic chemical compound

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[1]Tacket, C. 1981. Studies of epidemiological and clinical aspects of ciguatera. Presentation at Ciguatera Conference, San Juan, Puerto Rico, unpubl.

[2]Scheuer, P. 1981. Chemistry of ciguatoxin. Presentation at Ciguatera Conference, San Juan, Puerto Rico, unpubl.

known. The minimum lethal dose in mice is 45×10^{-8}g/kg.

Since most fishery development attempts involve capitalization of centralized marketing mechanisms, liability associated with the sale of ciguatoxic fish also becomes an issue. In the Virgin Islands, fish has traditionally been marketed by the fishermen themselves, and resolution of the liability question has been accomplished through personal interaction. As marketing has evolved through the establishment of cooperatives and fish markets, resolution of liability conflicts associated with fish poisoning has been through the courts. Currently, fish markets in the Virgin Islands carry expensive product liability insurance which requires the posting of warnings that "purchase of local fish may be hazardous to the customer's health." All of these costs are, of course, passed on to the consumer. Several St. Thomas markets no longer sell local fish and import all fish products sold, except for a very narrow range of species caught from specific "safe" locales by fishermen who have developed reputations for product reliability.

Ciguatera impacts can also be felt in the tourist industry. The diversity and novelty of local fishes frequently attract tourists. Many hotels, however, refuse to risk preparing locally caught fish since poison victims may sue for damages or, at best, make bad publicity.

Although these impacts are difficult to assess, we attempt to do so here. To relate them to the utilization of eastern Caribbean fishery resources, this discussion will deal with the region's demand for and ability to produce marine protein. We also analyze the incidence and risk of fish poisoning in the Virgin Islands, which is more or less typical in species composition to many of the small islands in the eastern Caribbean. Finally, we present some of the characteristics common to ciguatoxic fish which are used by the knowledgeable fish buyer to reduce the risk associated with consumption of locally caught fish. Eastern Caribbean seafood consumers have acquired a considerable body of local knowledge which they employ in order to avoid intoxication.

Table 1.—Caribbean island fisheries background data.

Island/nation	Land area[1] (km^2)	Shelf area[2] (km^2)	Population	Number of tourists[4]	Fish landings[5] (t)	
Bahamas	13,935	195,000	210,000	118,596	2,800	(Nassau only)
Hispanicla						
Dominican Republic	48,734	1,350	5,275,410	301,178	6,435	
Haiti	27,750	N/A	4,832,504	139,964	2,500	
Jamaica	11,430	3,250	2,137,300	395,382	10,100	
Cuba	114,524	40,000	9,533,000	N/A	165,000	
Bermuda	54	518	60,000	N/A	468	(shellfish only)
Turks and Caicos	430	1,200	7,615	12,005	1,050	
Puerto Rico	8,897	3,990	3,187,600	1,698,481	1,819	
U.S. Virgin Islands	449	1,972	95,000	1,200,000	1,272	
British Virgin Islands	202	4,579	12,574	120,054	692	
Anguilla	120	[3]4,493	8,615	7,422	760	
St. Martin	34	[3]4,493	25,598	221,544	1,000	
St. Barthelemy	N/A	[3]4,493	5,000	N/A	N/A	
Saba	13	4,198	1,018	N/A	[6]40	
St. Christopher-Nevis	261	[3]882	47,481	32,437	27	
St. Eustatius	261	[3]882	1,342	N/A	40	
Antigua-Barbuda	441	2,533	78,000	86,627	800	
Montserrat	98	140	14,160	15,537	126	
Guadeloupe	1,760	1,884	324,530	118,078	4,990	
Dominica	751	470	70,302	13,651	500	
Martinique	1,100	1,273	324,832	158,375	2,167	
St. Lucia	616	545	109,928	90,070	2,200	
Barbados	430	320	251,272	369,924	1,579	
St. Vincent and Grenadines	389	1,300	101,000	38,448	379	
Grenada	344	2,000	111,184	29,389	900	
Aruba	193	206	159,067	188,831	[6]700	
Curacao	444	96	63,049	68,457	[6]850	
Bonaire	288	82	9,034	22,746	[6]100	
Trinidad and Tobago	5,218	20,400	1,162,000	194,898	4,322	
Cayman Islands	259	250	11,000	120,263	N/A	

[1]Europa Publications (1980).
[2]Manar (1974).
[3]Shared jurisdiction, boundaries undeclared.
[4]Caribbean Tourism Research and Development Centre, 1981 (1980 figure).
[5]FAO Fish. Rep. 278, supplement.
[6]G. van Buurt, Netherlands Antilles Department of Agriculture and Fisheries. Pers. commun., 1982.

Eastern Caribbean Fisheries

The 31 island nations of the Antilles chain are located on 29 different island platforms. In addition, outlying submerged banks contribute an additional area for a total of around 300,000 km^2 of fishable shelf. Although some island nations (most notably Barbados) have succeeded in harvesting significant quantities of pelagic species, most of the fish harvest depends on the island platform for its production.

Fishery officials have estimated that the sustainable yield in the Caribbean is 0.64 t/km^2 (CFMC[3]). Using this figure, fish production of the submerged platforms can then be calculated by multiplying the shelf area times the production constant. The assumption is made that sustainable yield levels cannot be exceeded without long-term reduction of the resource's ability to replenish itself. In fact, however, some eastern Caribbean fisheries resources are harvested in excess of sustainable yield. Long-term implications of this strategy are presently unknown. The results presented in Table 1 indicate that the total potential annual fish production which may be expected in the Caribbean islands is slightly under 200,000 t.

In Table 2 we have estimated the demand for marine protein as determined from population estimates and per capita seafood consumption figures from the literature. Total annual demand for seafood consumed in the Antilles is near 775,000 t, over three

[3]CFMC. 1981. Fishery management plan for shallow water reef fishes. Unpubl. rep., 47 p., on file with the Caribbean Fishery Management Council.

Table 2.—Demand for marine protein in the Caribbean Islands.

Island/nation	Resident consumption rate[1] (kg/person/year)	Resident fish consumption[2] (t/year)	Tourist fish consumption[3] (t/year)	Total demand (t/year)
Bahamas		5,446	235	5,681
Hispaniola				
Dominican Republic		136,808	598	137,406
Haiti		125,323	274	125,597
Jamaica	[4]30.1	145,458	773	146,231
Cuba		247,222		247,222
Bermuda		1,556		1,556
Turks and Caicos		197	23	220
Puerto Rico	[5]8.2	26,138	3,323	29,461
U.S. Virgin Islands	[5]16.4	1,558	2,347	3,905
British Virgin Islands	[6]34.1	429	235	664
Anguilla	[7]23.6	203	15	218
St. Martin		664	433	1,097
St. Barthelemy		130		130
Saba		26		26
St. Christopher-Nevis		1,230	63	1,293
St. Eustatius		37		37
Antigua-Barbuda	[8]25.9	2,020	169	2,189
Montserrat		367	30	397
Guadeloupe		8,411	231	8,642
Dominica	[9]41.4		27	27
Martinique		8,424	310	8,734
St. Lucia	[4]26.0	2,851	176	3,027
Barbados	[10]26.0	6,515	723	1,238
St. Vincent and Grenadines	[4]27.7	2,797	75	2,872
Grenada		2,883	57	2,940
Aruba		4,125	369	4,494
Curacao		1,635	134	1,769
Bonaire		234	44	278
Trinidad and Tobago		30,134	981	31,115
Cayman Islands		205	235	440

[1]Rate assumed at 25.9 kg/person/year unless otherwise noted.
[2]Computed by multiplying the population by consumption rate.
[3]Computed based on 7-day average stay and 46.3 kg/tourist/year consumption rate.
[4]Cole (1976).
[5]CFMC (text footnote 3).
[6]CDB. 1980. Appraisal report on fisheries development—British Virgin Islands, 43 p. On file at Caribbean Development Bank, Bridgetown, Barbados.
[7]D. A. Olsen and J. C. Ogden. 1981. Management planning for Anguilla's fishing industry. Eastern Caribbean Natural Areas Program, Christiansted, St. Croix, 43 p. Unpubl. rep.
[8]CDB. 1979. Appraisal report on fisheries development—Antigua, 46 p. On file at Caribbean Development Bank, Bridgetown, Barbados.
[9]J. Wylie. 1977-78. Pers. commun.
[10]Adams (1980).

Table 3.—Comparison between island shelf potential yield, fish landings, and demand for marine protein in the Caribbean.

Island/nation	Fish landings (t)	Potential yield[1] (t)	Demand (t)
Bahamas	[2]2,800	124,800	5,681
Hispaniola			
Dominican Republic	6,435	864	137,406
Haiti	2,500		125,231
Jamaica	7,227	2,080	146,231
Cuba	43,186	25,600	247,222
Bermuda	[3]468	331	1,556
Turks and Caicos	1,050	768	220
Puerto Rico	1,819	2,553	29,461
U.S. Virgin Islands	1,272	1,262	3,905
British Virgin Islands	692	2,930	664
Anguilla	760	2,875	218
St. Martin	1,000	2,875	1,097
St. Barthelemy	N/A	2,875	130
Saba	[4]40	2,686	26
St. Christopher-Nevis	27	564	1,293
St. Eustatius	40	564	37
Antigua-Barbuda	800	1,621	2,189
Montserrat	126	90	397
Guadeloupe	4,990	1,205	8,642
Dominica	500	301	27
Martinique	2,167	814	8,734
St. Lucia	2,200	349	3,027
Barbados	1,579	205	7,238
St. Vincent and Grenadines	379	832	2,872
Grenada	900	1,280	2,940
Aruba	[4]700	132	4,494
Curacao	[4]850	61	1,769
Bonaire	[4]100	52	278
Trinidad and Tobago	4,322	13,056	31,115
Cayman Islands	N/A	160	440
	88,947	193,785	774,540

[1]Available yield = shelf area × 0.64 t/km² (CFMC, text footnote 3).
[2]Nassau only.
[3]Shellfish only.
[4]G. van Buurt, Netherlands Antilles Department of Agriculture and Fisheries, 1982. Pers. commun.

times the sustainable yield. This demand figure is compared in Table 3 to the actual landings and the sustainable yield available for harvest.

Table 3 demonstrates several facts. First, few of the islands are currently supplying their own demand for seafood. Second, although current landings constitute less than 50 percent of the yield, most of that underexploited area is on the Bahama Bank. If the Bahama Bank is deleted from consideration, current landings of 87,000 t exceed the 66,000 t sustainable yield figure for the region. Thus, although local areas of potential expansion may exist, any increase in landings must come from expansion into currently unexploited resources.

Occurrence of Ciguatera in the Caribbean

Surveys of Halstead (1970), more recently by Bagnis[4], and our own surveys have supported statements that ciguatera is more prevalent in the islands north of Martinique. Areas of ciguatera risk in the eastern Caribbean are shown in Figure 1. Three primary centers of the toxin are shown. The first occurs in the area of Redondo between Antigua and Montserrat and was responsible for a significant outbreak of poisonings in Antigua in 1980. The second area occurs between the eastern edge of the Saba Bank and along the southern edge of the Anguilla Bank. Fish from this area are almost certainly responsible for the intoxication of nearly 70 persons in St. Croix in early 1981 (Lewis et al., 1981). The final center of toxicity occurs along the narrow shelf south of Norman and Peter Islands in the British Virgin Islands.

Figure 1 also shows that large areas of the southern Virgin Islands shelf, the Anguilla Bank, the Antigua-Barbuda Bank, and some of the other islands consistently produce toxic fish. The remaining shelf area is generally free of toxic fish, with some exceptions. This figure demonstrates the universality of

[4]Bagnis, R. 1978. Report of the Mission to the Antilles and Easter Island August 15 - September 25, 1978. Institute of Medical Research, Papeete, Tahiti, 58 p., unpubl.

risk assumed by seafood consumers in the Caribbean.

Historically, one "solution" to avoid poisoning has been to consume fish from only low-risk areas. Traditionally, fish buyers knew (or learned) which fishermen fished in these areas and altered their buying patterns accordingly. However, with the advent of more aggressive marketing practices, this familiarity is no longer feasible. Additionally, fish market owners frequently find that local fishermen are not sufficiently reliable in their supply and have begun to import fish from other areas. As our previous analysis has shown, surplus production is available only from the Anguilla Shelf, the Antigua-Barbuda Bank, and the Saba-Nevis area. As is shown in Figure 1, ciguatera is present on these shelves.

Another factor which has resulted in an increase in the presence of toxic fish in the market has been the relatively recent increase in "distant seas" fishing by Puerto Rican and St. Croix fishermen who fish throughout the northeast Caribbean. Until the mid-1970's, seafood consumers in these islands were generally certain that they were purchasing fish caught on their own island platform. Since that time, considerable investment has resulted in a fleet of Puerto Rican fishing boats which fish throughout much of the Caribbean. St. Croix fishermen, limited by the relatively small island shelf, have also begun to fish the Saba Bank. As a result, both islands have begun to receive fish landed from distant areas where fishermen may be unfamiliar with the incidence of toxicity.

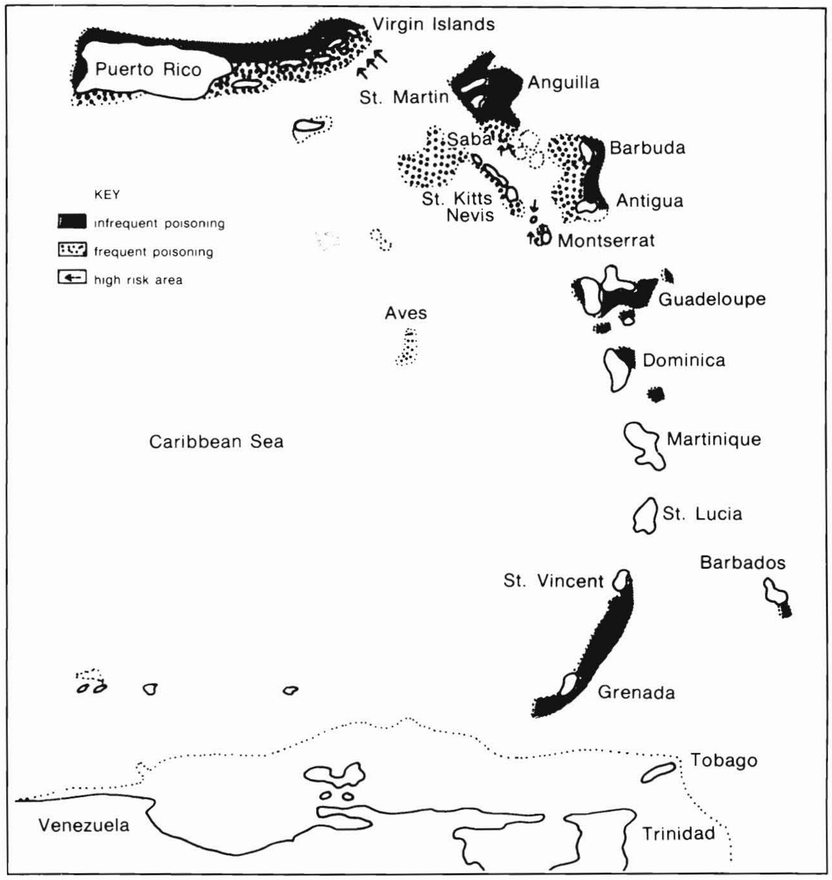

Figure 1.—Areas of ciguateric fish poisoning in the eastern Caribbean.

Which Fish Are Poisonous?

Several generalities can be used to summarize the body of information on which fishes tend to poison in the Caribbean. These are:

1) Toxic fish are generally associated with the island shelf benthic food chain. Pelagic fishes like dolphin and tuna are rarely, if ever, implicated in ciguatera intoxications (Randall, 1958).

2) Fishes in one local area may have a high level of toxicity, but the same species nearby may be relatively free of ciguatoxin. As an example, the south coast of St. Thomas is highly suspect, while the north coast is considered to be safe, as is St. Croix 40 miles to the south.

3) An area previously free of fish poisoning may suddenly give rise to an outbreak of toxic fish, then eventually return to a safe condition. Although documented only in the Pacific (Banner, 1967), circumstantial evidence for a similar phenomenon in the Caribbean is known to the authors.

4) Toxic fish are generally high in the food chain and are generally fish-eating predators. In the Caribbean where all species of fish are eaten, plant-eating, plankton-eating, and coral-eating fish tend not to be toxic.

5) A greater risk of intoxication is incurred when eating large individuals of any species than when eating small individuals of the same species.

These generalities are consistent with the body of knowledge accumulating on *Gambierdiscus toxicus*, the assumed ciguatoxin biogenitor (Bagnis et al., 1980). Following is an ecological model which explains the epidemiology of ciguatera.

Gambierdiscus toxicus is found abundantly as an epiphyte on the sessile algae such as *Dictyota, Turbinaria, Acanthophora*, and *Spyridia* making up the mixed community present on dead coral and other hard substrates in shallow water. As herbivorous species graze on the algae, they ingest the dinoflagellates and the toxin enters the food web. Depending on position in the food web, most members of the coral reef community are exposed to some of the toxin. Since the toxin is extremely stable, and is accumulated throughout the life of the fish, it leads to higher concentrations in larger and older individuals, with more toxin present in the liver than in muscle tissue. As expected, species high in the food chain are more likely to carry large amounts of toxin. Individual food preference and availability can greatly alter these generalities: A large carnivorous fish may contain no significant toxin (Randall, 1958), while a small omnivore may produce a clinical case of poisoning. Certain species, because of diet preferences, may pose a high risk of toxicity, while closely allied species do not. Some examples from Division of Fish and Wildlife research will serve to demonstrate the above:

1) Greater amberjack, *Seriola dumerili*, is a highly suspect species; yet, a 23-pound individual from an area with a high incidence of ciguatoxic fishes proved nontoxic in a mongoose bioassay of its liver and subsequent human consumption.

2) Mutton snapper, *Lutjanus analis*, and dog snapper, *L. jocu*, commonly have overlapping home ranges, yet the former is considered to be toxin free, while the latter is commonly responsible for ciguatera intoxication.

3) The gastropod *Cittarium pica* is a prized and regularly consumed item of seafood considered to be free of ciguatoxin; yet, one of the authors contracted a suite of neurological symptoms characteristic of ciguatera after several consecutive meals of *C. pica* collected near the previously mentioned Norman Island center of ciguatoxin. (*C. pica* grazes primarily on shallow sessile algae.)

We believe that ecological conditions may support a continuous population of dinoflagellates, resulting in an area with a high level of ciguatoxic fishes. A transient supply of nutrients or suitable substrate might result in a bloom of *G. toxicus*, which creates a pulse of toxin into the food chain. As this toxin reaches the carnivorous fish consumed by humans, a short-term epidemic of ciguatera could occur in a previously safe area (Banner, 1967).

The final point to be made involves the generally accepted idea that specific knowledge of which fishes are most often toxic will allow consumers to reduce risk of poisoning. In the Virgin Islands, many fish importers, through careful selection of species and sources, are convinced that they are eliminating risk. Although most fish consumers in the Caribbean are aware of the more common fish which poison (great barracuda, *Sphyraena barracuda*; greater amberjack, etc.), many are unaware of the widespread distribution of ciguatoxin throughout the food chain. Although they may certainly be successful in reducing risks, the lack of a definitive test for toxins precludes risk elimination.

To demonstrate the wide distribution of ciguatoxin, we have presented in Table 4 a list of the fish landings in St. Thomas and indicated high-risk species, frequent poisoners, infrequent poisoners, and generally safe species. This list is derived largely from interviews and information acquired from Virgin Islands fishermen. In St. Thomas, high-risk species are generally not landed and are underrepresented on this list. Table 4 shows the complexity of the choice facing consumers between species desirable for eating and those safe for consumption, as they choose from among the 85 species which appear in this list. The summary results indicate that only 44 percent of the landings by poundage and 50 percent of the species can be considered to be effectively without risk. It should also be noted that many of these "safe" species are among the less desirable. A considerable ability to identify species is required to select safely among those more highly prized, such as the snappers and groupers.

Summary

The following observations would appear to characterize the fishery impact of ciguatera in the eastern Caribbean. First, fish is an important staple of the eastern Caribbean diet. Demand for it far outstrips both current catch levels and the potential of the resources to supply it. Consequently, any action or phenomenon which reduces the amount of harvestable marine protein may nutritionally affect the populations of less developed nations and economically exacerbate undesirable balance-of-payments problems when substitute sources are imported.

Secondly, ciguatera reduces the exportability of fish from the few areas which could conceivably export surplus available yield in exchange for foreign currency. The amount of this reduction has been estimated at between 2 and 15 percent of the available yield. In St. Thomas, as much as 64 percent of the poundage landed bears some risk of intoxication.

It follows, then, that improvement of the situation will require one of two events. The first, only remotely possible, would be the development of techniques to limit or predict an introduction of the toxin into the marine system. The second would be the development of a universally applicable field test to determine whether or not any given fish is toxic. In this way ciguatoxic fish poisoning may be substantially reduced as a major circumtropical health problem.

Acknowledgments

We would like to acknowledge the unpublished information we gathered at the National Marine Fisheries Service workshop on ciguatera held in San Juan, Puerto Rico, in 1981.

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Table 4.—Composition of Virgin Islands commercial fish catch in percent of pounds landed.

Family Genus, species, and common name	Rank risk[1]	Percent of landings[2]
Dasyatidae		
Dasyatis americana, southern stingray	4	
Orectolobidae		
Ginglymostoma cirratum, nurse shark	4	
Belonidae		
Tylosurus crocodilus, houndfish	3	0.45
Holocentridae		
Squirrelfishes		4.84
Holocentrus adscensionis, squirrelfish	3	
H. coruscus, reef squirrelfish	3	
H. rufus, longspine squirrelfish	3	
Serranidae		
Sea basses and grouper		0.60
Epinephelus adscensionis, rock hind	2	2.31
E. afer, mutton hamlet	4	0.60
E. cruentatus, graysby	3	
E. fulvus, coney	4	2.37
E. guttatus, red hind	3	8.71
E. morio, red grouper	2	0.84
E. striatus, Nassau grouper	4	2.25
Mycteroperca venenosa, yellowfin grouper	2	0.58
Hypoplectrus unicolor, butter (black) hamlet	4	0.60
Carangidae		
Seriola dumerili, greater amberjack	1	
Caranx crysos, blue runner	3	
C. latus, horse-eye jack	1	0.37
C. lugubris, black jack	1	
C. ruber, bar jack	1	0.75
Scombridae		
Scomberomorus cavalla, kingfish	2	2.34
Euthynnus alletteratus, little) tunny)	3	3.43
Sarda sarda, Atlantic bonito)		
Lutjanidae		
Apsilus dentatus, black snapper	3	0.07
Lutjanus analis, mutton snapper	4	0.13
L. apodus, schoolmaster	2	0.28
L. buccanella, blackfin snapper	2	0.81
L. campechanus, red snapper	3	
L. griseus, gray snapper	3	0.76
L. jocu, dog snapper	1	0.45
L. mahogoni, mahogany snapper	2	
L. synagris, lane snapper	4	0.03
Ocyurus chrysurus, yellowtail snapper	4	2.89
Pristipomoides aquilonaris, wenchman	4	1.92
Muraenidae		
Gymnothorax funebris, green moray	2	
G. moringa, spotted moray	2	
Haemulidae		
Grunts (unidentified)		6.61
Anisotremus surinamensis, black margate	3	
A. virginicus, porkfish	3	
Haemulon album, margate	3	1.06
H. aurolineatum, tomtate	3	
H. bonariense, black grunt	3	
H. flavolineatum, French grunt	3	0.07
H. melanurum, cottonwick	3	0.04
H. plumieri, white grunt	3	0.35
H. sciurus, bluestriped grunt	3	0.05
Sparidae		
Porgies (unidentified)		3.48
Calamus calamus, saucereye porgy	3	0.15
C. penna, sheepshead porgy	4	
C. pennatula, pluma	4	
Mullidae		
Mulloidichthys martinicus, yellow goatfish	4	0.25
Pseudupeneus maculatus, spotted goatfish	4	0.74
Chaetodontidae		
Chaetodon capistratus, foureye butterflyfish	4	
C. sedentarius, reef butterfly fish	4	
C. striatus, banded butterflyfish	4	
Pomacanthidae		
Holacanthus ciliaris, queen angelfish	4	0.20
H. Isabelita, blue angelfish	4	0.07
H. tricolor, rock beauty	4	0.20
Pomacanthus arcuatus, gray angelfish	4	3.03
P. paru, French angelfish	4	0.53
Scaridae		
Scarus coeruleus, blue parrotfish	4	1.84
S. croicensis, striped parrotfish	4	0.12
S. taeniopterus, princess parrotfish	4	0.09
S. vetula, queen parrotfish	4	0.10
Sparisoma aurofrenatum, redband parrotfish	4	0.19
S. chrysopterum, redtail parrotfish	4	1.47
S. radians, bucktooth parrotfish	4	
S. rubripinne, redfin parrotfish	4	
S. viride, stoplight parrotfish	4	3.99
Labridae		
Bodianus rufus, Spanish hogfish	2	0.12
Halichoeres radiatus, puddingwife	4	
Lachnolaimus maximus, hogfish	3	1.06
Acanthuridae		
Acanthurus bahianus, ocean surgeon	4	0.12
A. chirurgus, doctorfish	4	3.73
A. coeruleus, blue tang	4	0.02
Sphyraenidae		
Sphyraena barracuda, great barracuda	1	
Scorpaenidae		
Scorpaena plumieri, spotted scorpionfish	2	
Bothidae, left-eye flounders	4	
Balistidae		
Aluterus scriptus, scrawled filefish	4	
Balistes vetula, queen triggerfish	2	29.68
Cantherhines pullus, orangespotted filefish	4	
Monacanthus ciliatus, fringed filefish	4	0.40
Ostraciidae		
Lactophrys bicaudalis, spotted trunkfish	3	0.08
L. polygonia, honeycomb cowfish	3	0.16
L. quadricornis, scrawled cowfish	3	0.27
L. triqueter, smooth trunkfish	3	0.21
Diodontidae		
Diodon holocanthus, balloonfish	3	
D. hystrix, porcupinefish	3	
Sciaenidae		
Equetus lanceolatus, jackknife-fish	4	
E. punctatus, spotted drum	4	
Ephippidae		
Chaetodipterus faber, Atlantic spadefish	4	
Pomacentridae		
Abudefduf saxatilus, sergeant major	4	

[1]Rank risk:	*% of landings (1b)*	*% of species*
1 High risk of poisoning	0.37%	3.5%
2. Frequent poisoners	33.05	10.5
3. Infrequent poisoners	21.88	36.5
4. Seldom poison	44.70	49.5
	100.00%	100.0%

[2]No figure = less than 0.01 percent.

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