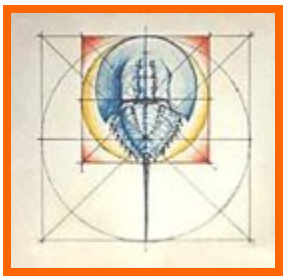

LEGORE
ENVIRONMENTAL ASSOCIATES, INC.

BAIT FISHERIES SERVING THE MARINE RECREATIONAL FISHERIES OF PUERTO RICO

by
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PROLOGUE

The author is grateful for the assistance and participation of several individuals, each making valuable contributions to the efforts described in this document. The program was initiated in coordination with Dr. Craig Lilyestrom of the Puerto Rico Department of Natural and Environmental Resources (DNER), who has consistently supported the successful completion of this effort. He also reviewed a draft of this report prior to its finalization. Representatives of the commercial guided marine recreational fisher and bait fisher communities were very supportive, although some components of the non-commercial recreational community were more reticent. Mr. Jorge Casillas, a graduate student at the University of Puerto Rico, Mr. Eloy Martinez, an aspiring graduate student recently accepted at the University of South Florida, and Ms. Maria Camacho-Rodríguez of the DNER were of great help with certain logistic arrangements and in conducting certain interviews. Messrs. Mark Hardin and Frank Hearne provided helpful assistance and advice, and Christopher LeGore assisted with photographic production. Finally, Mr. Jose M. Berríos served as Contract Manager for DNER, as ably assisted by Ms. Aitza Pabón. All of these contributions were essential to the successful conduct of this effort, and all are appreciated.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

List of Figures (Continued) . . . . . .

List of Figures (Continued) . . . . . .

1.0 INTRODUCTION

1.1 STUDY BACKGROUND

Puerto Rico supports a large and growing marine recreational fishery. Only a single recreational fisheries characterization effort was made in the 1980s (Berrios *et al.* 1989), but a more substantial effort, the Marine Recreational Fisheries Statistics Survey (MRFSS), was initiated in the year 2000 (MRFSS 2000). The number of recreational fishing trips recorded by MRFSS increased from 1,226,144 in 2000 to 1,401,024 in 2001 – a 14.3% increase in one year (NMFS 2004). The results reflected a total of 222,128 documented anglers in 2001 who fished from shore 64% of the time and from private boats 36% of the time, as compared to only 81,000 resident marine anglers in the late 1980s (Schmied 1989). Although the NMFS figures include approximately 30,000 non-resident anglers, leaving 192,128 as residents, while Schmied's figures include only residents, these figures nevertheless reflect a growth in numbers of resident marine anglers of 137% from 1989 to 2001. In 2002, a total of 196,820 residential anglers were documented (Cortés and Irrizary 2003), representing a further increase of 2.4% over the previous year. Clearly, these figures reflect a diverse and growing marine recreational fishery.

The numbers of big game fishing tournaments are also increasing. Schmied (*op cit.*) reported only 20 tournaments in the 1980s, while 36 tournaments were reported in 1992 (Pérez *et al*. 1992), an 80% increase in just a few years. A decade later, 47 fishing tournaments were reported to have occurred in 2002 (Rodriguez and Rodriguez 2003). This number dropped to 28 in 2006, primarily because commercial fishers decided against sponsoring their tournaments, citing the effects of new fishing regulations as the reason (Rodriguez-Ferrer and Rodriguez-Ferrer 2007). Targets of the 2002 and 2006 tournaments are indicated in Table 1.1-1.

In addition to the species targeted by these tournaments, numerous other species are touted by tourism interests, including **White Marlin** (Grand Illusion 2007; Puerto Rico Angling 2007), **Bluefin and other Tuna** (Puerto Rico Angling 2007), **Sharks** (Light Tackle Paradise 2007), Ladyfish (Quick Silver 2007; Tight Loop Charters 2007), **Bonefish** (Light Tackle Paradise 2007; Tight Loop Charters 2007), **Jack Crevalle** (Light Tackle Adventure 2007; Light Tackle Paradise 2007; Puerto Rico Tarpon 2007; Quick Silver 2007; Tight Loop Charters 2007), **Grouper** (Puerto Rico Angling 2007); **False Albacore** (Light Tackle Paradise 2007), **Barracuda** (Light Tackle Adventure 2007; Light Tackle Paradise 2007; Puerto Rico Tarpon 2007; Quick Silver 2007), **Snapper** (Light Tackle Adventure 2007; Puerto Rico Angling 2007; Tight Loop Charters 2007), and **Permit** (Light Tackle Paradise 2007; Puerto Rico Tarpon 2007; Tight Loop Charters 2007).

García (2002) reported that there are 27 nautical facilities on the island, with 23 of these recognized as "marine facilities" with ten or more slips each, and 57,464 registered boats.

These figures include only constructed and permitted facilities, but do not include informal boat launching areas used in many areas of Puerto Rico.

Table 1.1-1
Recreational Fishing Tournaments in 2002 and 2006

Target	Scientific Name	Number of Tournaments	
		2002	2006
Dolphin	*Coryphaena hippurus*	9	6
Blue Marlin	*Makaira nigricans*	18	13
Wahoo	*Acanthocybium solandri*	3	2
Mackerel	Scombridae fam.	1	
Sailfish	*Istiophorus platypterus*	2	2
Tarpon & Snook	*Megalops atlanticus* & *Centropomus* spp.	2	
Dolphin and Wahoo	*Coryphaena hippurus* & *Acanthocybium solandri*	1	1
"Light Tackle"	N/A	5	3
"Trolling"	N/A	3	
"Shore Fishing"	N/A	3	

Despite the size, growth, and diversity of Puerto Rico's marine recreational fisheries, little to nothing is documented concerning the types of bait used in these fisheries, their sources, methods of capture, stock assessments, bycatch, or environmental and population impacts of the bait fisheries supporting these recreational fisheries. Larsen (2004) refers to several baits such as flying fish, squid, Allison Skipjacks, Spanish Mackerel up to 5 pounds, ballyhoo, and bonefish. He considers the latter to be an excellent marlin bait. Pinfish, mullet, crabs, shrimp and squid are reportedly used in the tarpon fishery (Light Tackle Adventure 2004). Little detail is provided by these sources, however, concerning amounts of baits captured or used, or the methods and locations for their capture. Similar fisheries in South Florida utilize wild captured Ballyhoo (*Hemiramphus brasiliensis*), Balao (*H. balao*), flying fishes (*Exocoetidae*) and halfbeaks (*Hemiramphidae*) other than ballyhoo and balao (McBride and Styer 2002), but little documented capture of these species in Puerto Rico has been noted. It is important to overcome this "paucity of adequate research" to create "a better understanding and adequate management of island fisheries" (Beets and LaPlace 1991).

The study reported here is intended to gather information characterizing the bait fisheries supporting marine recreational fisheries in Puerto Rico as an important step toward determining the nature of these fisheries and the degree to which active management will be helpful for sustaining these resources.

Figure 1.1-1. Cast-netting for bait in Puerto Rico

1.2 STUDY OBJECTIVES

The objectives of this program were to collect, document, and report biological and social data characterizing the marine recreational bait fisheries in Puerto Rico, including the participants; species and numbers captured and utilized by the recreational fisheries; capture methods, habitats and locations; and biology of the exploited species in support of developing effective management policies, strategies and tactics.

This program was designed to fulfill several objectives:

1. Identification of the baits predominantly used in each of the marine recreational fisheries of Puerto Rico, including whether they are used alive or dead, fresh or preserved, captured locally or imported, how they are rigged or otherwise utilized, and the amounts and sizes used in typical fishing events.
2. Development of authoritative taxonomic identification of the bait species captured in local waters.
3. Collection and documentation of known basic information on the biology and ecology of the locally captured bait species, including their size at maturity, habitat associations, life cycles and reproductive strategies, and evaluation of potential impacts on population sustainability imposed by the identified bait fisheries.
4. Identification of recreational bait fishers as to whether they are the recreational fishermen themselves, commercial fishermen serving the recreational fishery, or part-time or opportunistic participants, with comparisons of these potential components.
5. Characterization of the equipment and methods used to capture the bait species, including net characteristics and dimensions; influence of times of day, lunar cycles, and seasons if any; seasonality of demand; hook sizes; lures; baits for the baitfish; attractors; etc., with photographic documentation of equipment and fishing procedures.
6. Identification of bait capture locations and habitat types, correlated with NOAA benthic habitat maps (NOAA 2002).
7. Characterization of the potential for bait fishery practices to impact essential fish habitat, e.g. trap or trawl fishing if practiced (Anon 2000).
8. Determination of which species are imported from off-island, with estimation to the extent possible of volumes and values imported.
9. Discussion of political and management issues that bait fishers believe may be important.
10. Identification of potential or critical bait fishery management gaps with recommendations for future actions

2.0 SURVEY METHODS

2.1 MOBILIZATION

An organizational meeting was held on July 18, 2006, shortly after final execution of contract documents. The meeting was held in the Marine Resources Division of the Department of Natural and Environmental Resources (DNER), and was attended by project personnel, Dr. Craig Lilyestrom, and Ms. Zulena Cortés Rodriguez. The purpose of this meeting was to review program objectives and plans, and to convey information from DNER relevant to the program, including contact recommendations concerning individuals actively engaged in marine recreational fisheries in Puerto Rico. Basic information was inventoried, including lists of fishing guides, bait and tackle shops, and marinas serving recreational fisheries.

Additional background information was gathered in a meeting with Dr. Edgardo Ojeda of the Sea Grant office in Mayagüez to discuss the nature of recreational fisheries in Puerto Rico and to secure advice concerning approaches and contact. A telephone conference was also held with Mr. Michael Nemeth of the University of Puerto Rico, to discuss a related effort titled "Fisheries extension enhancement effort for the baitfish, Octopus (*Octopus vulgaris, Octopus briareus*), Batwing Coral Crab (*Carpilius corallinus*), and Spotted Spiny Lobster (*Panulirus guttatus*) fisheries in Puerto Rico.

2.2 SITE VISITS AND INTERVIEWS

Site visits and interviews were conducted with several different kinds of stakeholders, including owners and operators of bait and tackle shops, fishing guides, recreational fishers, pescadería operators, and bait fishers. Efforts to engage sport fishing associations in interview sessions were unsuccessful. Interviews were conducted on all coasts of the island. Not all attempts to contact recommended individuals were successful. In a few cases, telephone calls went unanswered, and in at least two instances the charter company had gone out of business. Some others were not interested in being interviewed for this program. Most contacts were agreeably enthusiastic in their responses, however.

Figure 2.2-1. Pescadería in Puerto Fajardo

Pescaderías were visited along the north coast in Isabella Arecibo, Vega Baja, Piñones, Rio Grande, and on the east and south coasts in Fajardo, Humacao, Manaubo, Arroyo, Punta Pozuelo, Juana Díaz, La Guancha, Ponce, La Parguera, and Puerto Real (Cabo Rojo). With the exception of the Ponce area (Ponce, Juana Díaz and La Guancha), pescaderías were searched for , but not found along the entire coast between La Parguera and Playa Santa Isabel;

Figure 2.2-2. Pochy Rosario, light tackle guide based in Boquerón

the locations searched to no avail included Playa de Guayanilla, Manzanillo (Rt. 508), Galicias (Rt. 572), Capitanejo, Pastillo, Playa Cortada (Rt. 537), and Playa Santa Isabel (Rt. 538). Similarly, none were found along the southwest coast on the coastal Route 102 from Puerto Real northward to San Jose, just south of Mayagüez.

Professional fishing guides were interviewed in the San Juan, Fajardo, Yabucoa, La Parguera, Boqueron and Rincón areas. A list of contacts is provided in Appendix A. Fishers and hangers-on were interviewed in each of these areas as opportunities permitted.

The objectives of all interviews were to characterize the bait fisheries supporting marine recreational fisheries in Puerto Rico, including the species used, their sources, capture methods and locations, and how they are used. Question lists were prepared prior to the interviews to serve as guidance for the interviewer, but questionnaires were not submitted to interviewees for them to complete. Responses were recorded by the interviewer in all cases. Preparations were made to discuss the subject areas indicated below.

Figure 2.2-3. Omar Orraca, light tackle guide based in Congrejos Yacht Club near San Juan

2.2.1 Questions for Bait Sellers and Bait Fishers

1. What kinds of natural baits do you sell?

2. May we have specimens [only if needed – not from all]?

3. What target species are each of these baits used for?

4. Who are your best customers, fishing guides or individual recreational fishers? Can you estimate the proportion of your sales to each?

5. If you purchase the baits, where and from whom do you buy them? Is this a local fisher who captures the baits for sale to you? If so, are they live or dead? If dead, are they fresh or frozen when you buy them? Do you know where he gathers the baits or the methods he uses? Can you provide contact information, i.e. names, addresses, telephone numbers, e-mail addresses – or even introductions? What size(s) of baits or bait packages do you handle/sell?

6. How often do you purchase the bait(s) and in what quantities? Do you sell it all, or is there left-over waste? Are unsold live and fresh baits frozen for later sale?

7. Do you import any of the baits you sell? If so, which baits and in what quantities and frequencies?

8. At what price range does each bait sell? Is there seasonal fluctuation?

9. Is there any seasonality associated with the availability of the baits you sell?

10. Do you sell any pre-rigged terminal tackle? What kinds and what target species are they used for? Which baits are used with each kind?

11. Are you aware of any baits commonly captured by (rather then purchased) recreational fisherman? If so, what are they and what target species are they used for?

12. Would you like to tell us about any issues affecting the recreational or bait fisheries that concern you and that you would appreciate being brought to the attention of resource managers like DNER?

2.2.2 Questions for Recreational Fishers and Fishing Guides

1. What fish species do you target when you go fishing?

2. What natural bait(s) do you use for each target species or target species group?

3. Are they dead or alive when you use them? If dead, fresh or frozen? What sizes do you use?

4. May we have a specimen [only if needed – not from all]?

5. How do you rig these baits for use [specific hook sizes, weight sizes, rig appearance, etc. to degree possible]? How do you fish them? Are you willing to demonstrate your rigging or fishing methods to us? May we take pictures?

6. Where do you get the baits – purchase or capture?

7. If you purchase the baits, where and from whom do you buy them? Is this a store or a local fisher who captures the baits to sell to recreational fishers or to bait shops? Can you provide contact information, i.e. names, addresses, telephone numbers, e-mail addresses – or even introductions?

8. How often do you purchase the bait(s) and in what quantities? How much of the bait is purchased for a typical day of fishing? How many days per year do you fish with this bait?

9. If you capture your own baits, where do you get them and in what kind(s) of habitat(s)? Would you be willing to show us on a map? What method(s) and equipment do you use to capture them? Do you capture them on the same day as you go fishing, or the day before? Would you be willing to demonstrate to us how you capture the bait? Can we take pictures?

10. Is there seasonality in the availability or abundance of these baits? Is it better to gather them at particular times of the day or night? Have you noted any migration patterns of these baits?

11. How often do you capture these baits and in what quantities?

12. Do you feel your bait choices are limited? If so, what baits would you like to have available that are not now commonly available to you?

13. Can you suggest other people or organizations we should be speaking with?

14. Would you like to tell us about any issues affecting the recreational or bait fisheries that concern you and that you would appreciate being brought to the attention of resource managers like DNER?

2.3 SPECIES LITERATURE REVIEWS

After the primary bait species were identified, literature searches were conducted to capture taxonomic, natural history, and life cycle information relevant to the evaluation of the bait fisheries supporting recreational fisheries in Puerto Rico.

Figure 2.3-1. The Villa Pesquera in Ponce serves primarily commercial fishers

3.0 FINDINGS

This discussion is divided into three parts. The first (Section 3.1) is a discussion of the various recreational fishery types and the baits used in them. The second section (3.2) discusses the biology and taxonomy of the primary bait species, and the third section (3.3) concerns the rigs and terminal tackle used to fish the baits.

3.1 FISHERIES AND BAITS

It was found during this program, that the use of many kinds of natural bait is opportunistic, and that small fish and invertebrates of almost any species are from time to time used as bait. This includes even small specimens of game or food species. To be comprehensive, this discussion would have to consider virtually every fish swimming in Puerto Rican waters, which would not be useful. The focus of this discussion, therefore, is on those species purposefully targeted and commonly used as natural baits in the recreational fisheries of Puerto Rico.

There are several different kinds of marine recreational fisheries in Puerto Rico, each involving its own kinds of rigs and baits. For purposes of this report they are divided into several categories which are discussed separately in the following sections. These categories are:

- Casual Shore Fishers
- Nearshore Recreational Fishers
    - Guided
    - Individual
- Offshore and Billfish Recreational Fishers

The difference between "nearshore" and "offshore" as used here is not intended to denote distance from land or to conform with scientific or technical terminology. Rather, as used here, it refers to the type of fishing, with nearshore referring to fishing in more shallow environments than offshore fishing. In some areas, "offshore" fishing in this sense can occur very near shore, such as along the north coast of Puerto Rico where depth drops quickly.

3.1.1 Types of Recreational Fisheries and Baits

3.1.1.1 *Casual Shore Fishers*

Casual shore fishers are considered those fishing from shore or shoreline structures such as piers and jetties, without the use of a boat. While some of the fishers in this category may take their fishing quite seriously rendering the term "casual" inoperative, and may be restricted from boat ownership for only economic reasons, this category is nevertheless useful for

describing most fishers in this category. The category does not include activities that do not employ natural baits, such as cast-net fishers, octopus fishers, or divers.

Figure 3.1-1. Shore Fisher

These fishers target any fish within casting range, which may include snappers, grunts, jacks, or other opportunistic targets. Equipment generally consists of a hand line on a Yo-Yo or a fishing rod capable of casting, and terminal tackle usually consists of a weight and one or two hooks.

Bait for these fishers generally consists of meat that is most readily available to them and simplest to transport and maintain. By far, the most common bait observed among these fishers was frozen squid purchased from a local pescaderia or super market. Less frequently observed baits included any fish – bait fish or otherwise -- obtained from a nearby fisher. Species of the bait makes little difference, as it is generally used as cut bait; convenience, ready availability and cost seem to dictate bait choices. Shrimp were seen being used only once, as they do not compete well with the convenience, availability, low cost, and hardiness of frozen squid.

Figure 3.1-2. Cut penaeid shrimp used by a shore fisher

3.1.1.2 *Nearshore Recreational Fishers – Guided*

Availability of a boat creates many more fishing opportunities, but the nearshore guides are somewhat specialized concerning their target species. The three species targeted by nearshore fishing guides are the Tarpon or Sábalo (*Megalops atlantica*), Snook or Róbalo (*Centropomus undecimalis*), and Mangrove Snapper or Pargo Prieto (*Lutjanus griseus*). Other species are advertised as available to customers of these guides, but for the most part they appear to be incidental catches while fishing for the three primary targets, with their value being mainly for advertising. These species include Jack Crevalle or Jurel (*Caranx hippos*), False Albacore or Albacora (or Vaca and Bonito) (*Euthynnus alleteratus*), Barracuda or Picúa (*Sphyraena barracuda*), and Permit or Pámpano (*Trachinotus falcatus*). Bonefish or Macaco (or Conejo and Ratón) (*Albula vulpes*) are also targeted, but this is primarily a fly fishery that does not employ natural baits.

Figure 3.1-3. Belly-hooked Scaled Sardine

The techniques for targeting Tarpon and Snook are similar, and usually consist of free-lining a live bait fish with nothing on the line so the baits may swim naturally and appear as wounded live prey. On occasion, a float may be added to keep the bait from swimming downward into bottom habitat,

such as coral reef structure. The baits may be hooked through the nostrils, through both lips, through the upper lip, through the back, or through the belly, depending on strategy. For example, a belly-hooked sardine tends to swim downward, which is favorable for targeting downward-looking species, such as Snook and Snappers. The Tarpon is an upward looking fish, however, so a nose hooked sardine is better when targeting them.

Figure 3.1-4. Nose-Hooked Scaled Sardine

In addition to wild populations of Tarpon there are several populations of Tarpon that become somewhat "tame," due to being fed by humans. This commonly occurs around restaurants and docks and piers used by local commercial fishers who throw unwanted bycatch into the water on a regular basis. Tarpon learn this behavior and frequent these areas, becoming accustomed to these easy handouts. Because these Tarpon rely less on hunting live prey, they become accustomed to eating dead fish and fish parts, and fishers targeting them do well by imitating their accustomed food, i.e. dead rather than live bait. One guide frequently inserts a small piece of Styrofoam through a small belly incision to make his dead bait float more like the waste fish being thrown away. Dead bait may also be fished under a float, especially if the fisher wishes to cast farther to avoid approaching too near his target.

Figure 3.1-5. Free-lined dead surgeon fish with Styrofoam inserted into its belly to simulate discarded commercial bycatch

In some cases, sardines are torn apart and used as chum, or as bait for ["tame"] Tarpon and Mangrove Snappers along mangrove shorelines.

The species used as bait in these fisheries are varied, reflecting local availability, and use of some species varies seasonally. Clupeids are the most varied and the most frequently used, including several herring-like and anchovy species. These most commonly include Threadfin Herring or Arenque (*Opistonema oglinum*), the Scaled Sardine or Cascarúa (*Harengula jaguana*), the Redear Herring or Machuelo (*Harengula humeralis*), and several anchovies.

Figure 3.1-6. Anchoa "Culebra"

The taxonomy of anchovies is difficult and complex, and was beyond the resources of this program. Difficulties occurred trying to ship preserved samples from Puerto Rico to the USA for laboratory inspection because of Homeland Security prohibition of shipping liquids at the time. An anchovy identified by a guide in western Puerto Rico as

Anchoa culebra, is not a valid species name, and its identity is uncertain. At least three anchovy species were observed being used for bait in the San Juan area also, but their taxonomy was not undertaken.

Figure 3.1-7. Yellowfin Mojarra

Another group of highly valued baits in the eastern Tarpon fishery are the mojarras, including the Yellowfin Mojarra or Muniama (*Gerres cinereus*), the Striped Mojarra or Espuelua (*Eugerres plumerei*), and to a slightly lesser extent the Rhomboid Mojarra or Mojarreta (*Diapterus rhombeus*). All are readily captured in the mangrove shorelines and mangrove channels – such as the Canal Suárez in San Juan -- using cast-nets or small hooks and cut bait.

A highly prized bait on the west coast for larger Tarpon is the White Grunt or Boquicolorado (or Cachicata) (*Haemulon plumierii*), because the distress sounds it makes as a bait effectively attracts targeted Tarpon. Another grunt, Burro Grunt or Viejo (*Pomadasys crocro*) is also used when available, as is the Sea Bream or Chopa (*Archosargus rhomboldalis*). Crabs are also occasionally used on the west coast, but are infrequently available. White mullet or Jarea (or Lisa Blanca) (*Mugil curema*) and small Jack Crevalle or Jurel (*Caranx hippos*) are rarely used.

Figure 3.1-8. Striped Mojarra

Figure 3.1-9. White Grunt

Figure 3.1-10. Callinectes bocourti

Figure 3.1-11. Burro Grunt

Figure 3.1-12. Sea bream

3.1.1.3 *Nearshore Recreational Fishers – Individual*

For the most part, individual recreational nearshore fishers in Puerto Rico seem less satisfied than tourists by the Tarpon fishery, and more interested in edible fishes, so their targets are somewhat different. Several of them are pelagic fishes including King Mackerel (Carite – *Scomberomorous cavalla*), Cero Mackerel (Sierra Alasana – *Scomberomorous regalis*), Jack Crevalle (Jurel – *Caranx hippos*), Snook (Róbalo – *Centropomus undecimalis*), and Cobia (Bacalao – *Rachycentron canadum*). These species are generally targeted using artificial or natural baits, and live baits, which are used with basically the same methods discussed above, in Subsection 3.1.1.2. The use of live baits is also restricted to boats equipped with live wells or other live bait holding equipment. Fishers in this category also frequently troll artificial and natural baits as discussed below in Subsection 3.1.1.4, especially when small tunas are encountered, such as Albacore (Albacora – *Thunnus alalunga*) and False Albacore or Little Tunny (Vaca or Bonito – *Euthynnus alletteratus*), although these species may also be caught using free-lined and slow-trolled live baits.

Figure 3.1-13. Dorsal-hooking an anchovy

Several ground and habitat-oriented fishes are also targeted by this group, including Greater Amberjack (Medregal – *Seriola dumerili*), Hogfish (Capitán – *Lachnolaimus maximus*), several Snapper species (Chillo, Manchego, Pargo Amarillo y Colorado, Sama – *Lutjanus* spp.), Yellowtail Snapper (Colirrubia – *Ocyurus chrysurus*), Grunts (*Haemulon* spp.), and Groupers (*Epinephelus* spp.). Fishers in this category use both live and dead natural baits, as their equipment allows.

Figure 3.1-14. Arecibo fishing supply store

Virtually every fisher and pescadería worker interviewed responded that the baits they use most frequently are Squid (Calamar) and "sardines." With very few exceptions, the squid referred to was imported frozen product available in supermarkets or stocked by pescaderías. In a few cases, fishers indicated that they sometimes capture local squid under lights at night using dip nets. The squid are generally not targeted, but are opportunistically captured when fishing from boats for snapper or other species. This is apparently a widespread practice, as it was reported by fishers in Punta Pozuelo in the southeast part of the island, as well as

in Isabella in the northwest. All responses indicated that squid captured by these means were for personal use and not for resale.

The term "sardine" was somewhat problematic in that, in practice, it is a generic term referring to different clupeid species in different areas and at different times, and specimens were frequently unavailable during the interviews. Pictures were used to solicit species identifications, but because of species similarities, these identifications were not always regarded as reliable. Nevertheless, it was clear that in most cases, fishers were referring to one or more of three species: the scaled sardine (*Harengula jaguana*), the Redear Herring (*H. humeralis*), and the False Herring (*H. clupeola*). A fourth species sometimes encountered was the Threadfin Herring (*Opistonema oglinum*). In at least one area (Isabela), the term also loosely included "Bocúa," itself a loose term potentially including multiple species of anchovy.

Throughout the surveys, the use of live bait primarily entailed the use of these "sardines." All were captured either by the recreational fishers themselves or by friends and acquaintances, as there is no industry on the island to transport live bait. These species are convenient because they are plentiful, occur in large and visible schools, and swim near the surface where they are vulnerable to cast-nets.

Figure 3.1-15. Arroyo Pescadería

A single angler in Vega Baja indicated that he catches Bigeye Scad (Chicharro – *Selar crumenophthalmus*) with a cast net to use as bait for King Mackerel, Wahoo and Tunas.

Figure 3.1-16. Frozen sardines offered for sale

The list of dead baits includes this same group of clupeids, and may sometimes be purchased frozen from local pescaderías, as may frozen ballyhoo, and imported squid. Two different species are interchangeably referred to as "ballyhoo:" Balajú (*Hemiramphus brasiliensis*) and Balao (*H. balao*). Small bags of frozen Scaled Sardines (Cascarúa – *Harengula jaguana*) were seen in several pescaderías, but not all.

Figure 3.1-17. Maunabo Pescadería

Pescaderías were visited along the north coast from Isabella to Fajardo and the entire east and south coasts from Fajardo to Boqueron. In every interview the primary baits referred to by fishers and pescaderia staff consisted of locally caught sardines or purchased frozen squid or ballyhoo. In the southeastern area of Punta Pozuelo, fishers referred to the "Boqueta," which

was identified as a local name for the Scaled Sardine, and another type of sardine called "Casco," which we were unable to identify without samples.

It was learned in Fajardo that chum is sometimes made using the Dwarf Herring (Mijúa – *Jenkinsia lamprotaenia*) by macerating them with coarse sand. The mixture is then lowered to depth in a paper bag, which soon gives way and allows the chum to gradually escape.

Other species are frequently used as cut bait when available, including White Mullet (Jarea or Lisa Blanca – *Mugil curema*), the Lisa or Lisa Macho Mullet (*M. liza*), and Bonefish (Macaco or Ratón – *Albula vulpes*). In Arecibo, interviewers were informed that Albacore captured by the fishers themselves are commonly used as cut bait on the north coast of the island.

3.1.1.4 *Offshore and Billfish Recreational Fishers*

Figure 3.1-18. Offshore fishing boats

This group consists primarily of the troll fishery for larger pelagic game fishes including Blue Marlin (Aguja Azul – *Makaira nigricans*)), White Marlin (Aguja Blanca – *Tetrapturus albidus*), Sailfish (Pez Vela – *Istiophorus platypterus*), Swordfish (Pez Espada – *Xiphias gladius*), Dolphin (Dorado – *Coryphaena hippurus*), Wahoo (Peto – *Acanthocybium solandri*), Yellowfin Tuna (Atún Aleta Amarilla – *Thunnus albacares*) and Bluefin Tuna (Atún Aleta Azul – *Thunnus thynnus*).

Several billfish fishers indicated that they seldom use natural baits, but rely almost entirely on artificial baits, which may be trolled at higher speeds and are more durable, allowing coverage of more water (e.g. M. Benitez, M. Aldaña, J. Alfonso *pers. comm.*.). Some also maintain that using artificial baits results in a higher survival rate of released fish. Many troll natural baits, however. The most convenient and by far most widely used

Figure 3.1-19. Pepi Alfonso, offshore guide based in Rincón

natural bait is Ballyhoo, which may be readily purchased frozen. While some fishers use other bait species when they are available, the supply of other species is intermittent and undependable compared to the ballyhoo supply. When the baits are available, however, bill fishers will troll White Mullet, Bonefish, Cero and Spanish Mackerel, small (≈ 14-16 inches long) King Mackerel, and small (≈ 10-12 inches long) Albacore. Most boats routinely use the more convenient ballyhoo, however, and a typical marlin boat uses 10-20 ballyhoo per full day of fishing, depending on strike activity.

Boats trolling for non-billfish species such as Dorado and Wahoo almost universally use ballyhoo rigs of various kinds and cut bait. A typical boat trolls four lines, and 3-4 of them are usually baited with ballyhoo, while 0-1 may fish with only artificial bait. Trolled cut baits usually consist of strip baits cut from Skipjack Tuna or other white-bellied fish.

When schools of target species such as Dorado, Tuna, or King Mackerel are encountered, other available baits may be used, such as "sardines." Boats equipped with live wells sometimes use free-lined or slow-trolled live bait in these circumstances.

3.1.2 Sources of the Baits

With few exceptions, most natural baits used in the marine recreational fisheries of Puerto Rico are either captured by the fishers themselves or provided by local part-time fishers. Imported frozen squid is an exception, as are ballyhoo and other species captured by ballyhoo fishers. The latter fishery is described below in Subsection 3.1.3.

Figure 3.1-20. Super Mercado Cancel in Guanica

In most cases, local bait fishers sell both directly to other local fishers and to local pescaderías, who in turn sell the baits to local fishers. A typical local system was described in Guanica, where perhaps 10-15 local fishers supply locally caught white mullet and sardines to the Super Mercado Cancel. When the pescadería's needs are satisfied, fishers take their excess catch to other local fishers they know will buy them (M. Cancel, *pers. comm.*.). None of these 10-15 bait fishers make their living selling bait, and most only fish for bait 2-3 times per week, when they need bait for their own fishing needs. Within this system of local supply, today's seller of bait may well become tomorrow's buyer of bait. Indeed, in some cases baits are freely exchanged or bartered. This represents a very informal but effective local network that is emulated in fishing towns throughout Puerto Rico.

Figure 3.1-21. Pescadería in Juana Diaz

Some pescaderías do not sell bait at all; the Pescadería El Indio in Juana Díaz, and the El Ancha Cafetería y Pescadería in Isabella, are examples. Others serve commercial fishers only, such as the Pescadería Rio Grande and the Pescadería Maternillo in Puerto Real, and were therefore outside the purview of this program. Those who do sell bait to recreational fishers almost always stock imported frozen squid and frozen ballyhoo caught in Puerto Rico. In many cases, these are the only baits sold. In other cases, freezers contain an eclectic collection of mullet, mackerel, and other baitfish purchased from local fishers when and if they are caught. Because baits are generally supplied by local sources, fishers use whatever is conveniently available and most affordable, and many species may be used interchangeably as cut bait, so most such bait species are not specifically related to target fishes. In only one pescaderia (La Guancha, Ponce) was sale of an imported frozen bait fish reported as "Pescadilla" (Whiting). A "fisherman associate" lounging outside the shop mentioned this bait (F. Vendrell, *pers. comm.*.), but the shop was closed, so a specimen was not seen.

Figure 3.1-22. Bait cast netter

Most bait fish in these fisheries are captured using cast nets with a stretch mesh of 0.5-0.75 inch. Mullets and clupeid baits, including sardines and anchovies, are commonly captured along beaches, in and around submerged grass habitat, and along mangrove shorelines, while mojarras are generally captured in or near mangrove habitats. Cast nets are seldom if ever used directly above coral structures, as severe damage to the nets would result.

Gill nets are also used to capture some bait species, including mullets and bonefish. These nets generally have a stretch mesh of 2 – 2.5 inches. For bonefish, they are reported to be deployed on sand bottom close to reefs. For mullet they may be deployed in shallow grass habitat or along shorelines. In the latter case, they are sometimes deployed parallel to the shore with an exaggerated "J" hook in the end of the deployment, said to deflect and concentrate mullet in a circular-swimming pattern. There are apparently some differences in habitat among species, as it was reported in Punta Pozuelo that the Lisa Mullet is captured only in the local bay, while the White Mullet is captured both within and outside the bay. All deployments were reported to occur only in daylight hours.

Figure 3.1-23. Sardine Fisher at Humacao Pier

One fisher in the southwest area of the island reported that he uses a 12 ft deep floating gill net with a 2.5 inch stretch mesh to capture small albacore, which he sells for bait. This was an isolated report, but it is possible the method may be used elsewhere. Albacore are also caught using fishing jigs, with or without cut bait on them.

Bonefish are also sometimes captured with hook and line. Mullet is reportedly used as cut bait for bonefish in the Loiza grassbeds, for example. This method was also reported in the La Parguera area, and is almost certainly used in other areas as well.

There is no industry for making live-bait available for purchase in Puerto Rico, with the exception of small, very local informal opportunities. Most live bait is captured by fishers themselves and carried in their live wells, although they also purchase small numbers of live fish from local fishers at the site of capture if such opportunities present themselves. In some cases, informal relationships have developed over time, with some of the cast-netters saving a few baits in submerged containers for the fishers whose needs are anticipated. This relationship between fishing guides and local fishers was observed in the San Juan area in particular.

Figure 3.1-24. A Mojarra sale

While many species are known to be used as baitfish (e.g. Kimmel 1991), most are baits of opportunity. There are a few species most commonly used in the recreational fisheries, and many others that are readily used, but only if they are opportunistically and conveniently available.

3.1.3 The Ballyhoo (Balajú) Fishery

The most organized bait fishery in Puerto Rico is the Ballyhoo fishery. It consists of a small number of full-time bait fishers whose income is at least 90% dependent on the capture and sale of Ballyhoo (Balajú – *Hemiramphus brasiliensis*) and Balao (Balao – *H. balao*), two

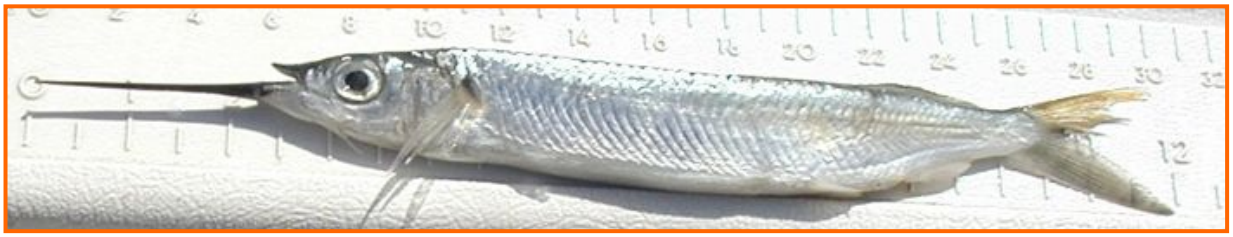


Figure 3.1-25. Ballyhoo. Note length measurements in inches and centimeters

species of the halfbeak family, Hemiramphidae, and a somewhat larger number of smaller scale fishers who participate seasonally or on a very limited effort basis. These two species are seldom differentiated in this fishery, and discussions below refer to "Ballyhoo," but concern both species interchangeably.

There are only four major Ballyhoo fishers in Puerto Rico who provide bait throughout the island, indicated here by their commonly known names in the fishery. Full names and contact

information are available in the List of Contacts provided in Appendix A. "Toño" is located in La Parguera, "Wiso" in Humacao, "Junior" in El Combate, and "Neco" in Guanica. All four were visited and interviewed.

In addition, several Ballyhoo fishers who serve small local communities were mentioned in interviews, only one of whom was found and interviewed. These include "Weso" in Punta Pozuelo, "Johnny" in La Playa Salinas, "Tavin" in the Fajardo – Las Croabas area, "Omar" in Fajardo, and another whose family name is "Laboy," but whose given name the interviewee could not remember, in the Arroyo area. A final local fisher who was found and interviewed was Mr. Jaime Maldonado in Puerto Real (Fajardo).

Figure 3.1-26. Jaime Maldonado, Ballyhoo Fisher

Mr. Maldonado was the single Ballyhoo fisher interviewed who uses a beach seine. His 1,200 ft seine has a stretch mesh of 1 inch, and one-half of the net is 6 ft deep while the remainder is 16 ft deep. Mr. Maldonado formerly fished about 2 times per week, capturing an estimated average of 100 pounds of Ballyhoo per day, which he sold primarily to military personnel stationed at Roosevelt Roads. This installation recently closed, however, and his business has dropped off drastically. In the week prior to our visit, Mr. Maldonado sold only 5 pounds of Ballyhoo.

Finally, there are apparently some recreational fishers or fishing guides who fish for Ballyhoo during the peak marlin season and sell them to fishing guides and fishers known to them. These are apparently small scale, seasonal cash transactions, and none of these fishers were identified by name.

3.1.3.1 *Ballyhoo Fishing and Handling Methods*

H. brasiliensis and *H. balao* are nearshore surface-swimming species that form dense schools, often in association with each other. Fishing for them is non-random, therefore, being a sight-fishing venture requiring that the fisher understands and can see what he is looking for. Although they are nearshore species, they can be somewhat far-ranging following their food sources and preferred water temperature in the neighborhood of 26°C (Burgess *et al.* Undated). Smaller scale fishers commonly use cast nets with a stretch mesh of ≤1 inch. Larger scale fishers, however, use floating gill nets with stretch mesh of 1-1½ inch. Depths of the nets between the float and weight lines, and the lengths of nets used vary among the fishers. Two methods of deploying the gill nets were described during interviews. It is unfortunate that we were unable to make arrangements to observe actual Ballyhoo fishing to photo-document fishing methods.

Method #1: After the school of Ballyhoo is located, the gill net is deployed in a single line, with a slightly concave set facing toward the school. The fishing boat is then driven to the opposite side of the Ballyhoo school and then back and forth around the school gradually

driving the fish toward the gill net. After the fish are impinged on the net, they are harvested by retrieving the net from one end onto the boat, removing Ballyhoo as the net is retrieved.

Method #2: This method requires two boats and is similar to the "circle gill netting" method used in California to capture jack and bay smelt (*Atherinopsis californiensis* and *Atherinops affinis*) and sometimes for the mackerel, *Pneumatophorus diego* (Rounsefell and Everhart 1965). After the school of Ballyhoo is located, one end of the gill net is retained in the primary fishing boat, while the free end is carried by a smaller boat around the Ballyhoo school and back to the primary boat, thereby encircling the fish. The net is then retrieved while maintaining the circle and constricting the school, and fish are removed from the net as it is retrieved.

Upon capture, each individual ballyhoo is gently squeezed from belly toward the anus to force intestinal content out, and then each fish is rinsed. This process is rigorously followed as the quality of bait degrades rather quickly if the fish are not stripped in this manner. From this point, slight differences in fish handling procedures occur among the fishers, which are described below in Subsection 3.1.3.2.

3.1.3.2 *The Major Ballyhoo Fishers*

The four major Ballyhoo fishers comprise easily the bulk of this fishery, and the operations of each differ somewhat.

"Wiso:" Although it is difficult to be certain, Wiso may be the largest Ballyhoo supplier on the island, with customers located from Yabucoa northward on the east coast, and along the entire north coast to at least Arecibo. Customers come to his pescadería in Humacao to purchase their baits; he does not deliver. He himself fishes for Ballyhoo exclusively in "the area" of Vieques, and he purchases Scaled Sardines from a local cast netter for packaging and resale in his store. Most are sold frozen, but he also sells some unfrozen fresh baits when demand coincides with fishing trips.

Figure 3.1-27. Wiso's pescadería

Wiso currently uses monofilament gill nets of 1 inch and 1½ inch stretch mesh. One of the nets currently in use is 8 ft deep from float to weight line and the other is 14 ft deep. Both are 1,200 ft long. Wiso maintains that the 14 ft net catches more fish, because more find their way under the 8 ft net.

Wiso indicated that he sells about 1,000 pounds of Ballyhoo per week during the winter-month Dorado and Wahoo seasons, but that sales fall off drastically in the summer months. He attributes this to increasing use of artificial baits among Marlin fishers.

Figure 3.1-28. Bagged frozen Ballyhoo

He also stated that fishing for Ballyhoo is better in the cooler months, which differs a bit from what other fishers indicated. We were not able to clarify whether there are actually more Ballyhoo in winter months or if fishing is better because he can more readily sell his catch during winter months. Clearly if the catch is difficult to sell in the warmer months, fishing effort will also drop off, making estimates of Ballyhoo presence difficult to quantify.

Unlike most other Ballyhoo fisher, Wiso does not put his catch on ice. Rather, after stripping and rinsing the fish he places them in a container of clean seawater, which he keeps shaded at all times. When he returns to dock, he then bags them for fresh and frozen sale.

"Toño:" Toño works with his two sons, Tonito and Edgardo, from his residence in La Parguera. His customers are widespread, ranging from the La Parguera area to Rincón. They come to him to purchase bait, with some buying small amounts and others purchasing larger supplies. One fishing guide, for example, drives from Rincón to La Parguera fairly frequently, to purchase approximately 200 pounds of frozen Ballyhoo per trip (J Alfonso, *pers. comm.*.). The Ballyhoo are normally packaged in 4 pound bags, so this amounts to a purchase of about 50 bags, with 1-3 bags being used each full fishing day, depending upon the kind of fishing and level of success.

Toño uses monofilament gill nets with a stretch mesh of 1 inch. He has been using one 750 ft long and 6 ft deep, but recently took delivery of a new net, 2,000 ft long and 9 ft deep. With the smaller net, he typically collects 800-1,000 pounds per fishing trip, and he goes fishing whenever his frozen Ballyhoo supply dwindles. He indicated that he averages about three fishing trips per month, although the frequency varies throughout the year depending on recreational fishing seasons. Dorado and Wahoo seasons are his busiest.

Figure 3.1-29. Toño, Ballyhoo Fisher showing his new gill net

Unlike Wiso, after stripping fecal material and rinsing the fish, Toño places them on ice in coolers. Toño's method differs from others, however, in that a small amount of baking soda is added to his rinse water, which he believes preserves the fish's shiny coloration. At dock, he then bags the ballyhoo in plastic, forces air from the bag by submerging it to somewhat vacuum seal them, and freezes them for sale. Some of Toño's customers request fresh unfrozen Ballyhoo, and for them he will make special trips to get 200 or so pounds, depending on the customer's request. These fish are treated exactly the same as the others, except they are not frozen prior to purchase.

In response to questions about seasonality, Toño indicated that Ballyhoo run closer to shore during winter months, when Dorado are in season. They are therefore easier to get to, but seem to occur in lower concentrations than in summer months.

Figure 3.1-30. Albacore captured for bait. For scale, the report binder is 11 inches long.

Toño's business consists >90% of Ballyhoo sales, but he does capture and sell a small amount of other baits. He indicated, for example, that Machuelo (Redear Herring) are frequently mixed in with Ballyhoo and captured with them. When targeting "sardines," however, they use cast nets with ½ inch stretch mesh. On occasion they will specifically target 10-12 inch long Albacore for Marlin bait using a 12 ft deep, 2½ inch stretch mesh gill net. They also sometimes catch Bonefish for Marlin bait. These are caught with gill net sets and hook and line fishing in areas of sandy bottom near coral reefs. Finally, they occasionally catch halfbeaks (Pico Fósforo – *Hyporhamphus unifasciatus*), which are related to Ballyhoo and Balao, and can also be used as bait. They do not bother targeting halfbeaks, however, as they are smaller and require a smaller gill net stretch mesh of ½ inch, which they do not have.

Interestingly, mention was made of preliminary discussions of potential for exporting Ballyhoo to Guatemala and Venezuela, where retail Ballyhoo prices are much higher than in Puerto Rico.

"Junior:" Junior operates from his home in the El Combate area. Bait fishing is his primary business, but he also fishes for food species. Of the bait business, he estimates that 90% is for Ballyhoo, while about 10% is for White Mullet.

Figure 3.1-31. Junior, Ballyhoo Fisher, with Jorge Casillas, Interviewer

For Ballyhoo, Junior uses a 6 ft deep, 20 brazas (fathoms) or 1,200 ft long gill net with a stretch mesh of 1½ inch. He typically fishes 3-4 times per week, and even 5 times, weather permitting. He catches <1 – 500 pounds per day, with a typical year-around average of 100-200 pounds. Junior fishes far more widely than any other bait fisher encountered, with his fishing grounds extending from La Parguera northward to Mayagüez, and out to about 8 miles from land. He does not encounter seasonal issues in his catch as reported by other fishers, because he fishes so widely. The fish are there, he reported, but you sometimes have to go far and wide to find them, which he does.

Upon capture, the fish are stripped of fecal material and washed in clean sea water, but without any additives such as baking soda, and held on ice to shore. They are then packaged at 4 pounds per plastic bag, which is then submerged in water to drive out air, and then sealed and frozen. He is willing to sell fresh Ballyhoo to customers requesting them, but most of his catch is sold frozen.

Junior's customers are from throughout Puerto Rico, from as far away as San Juan. He sells the Ballyhoo for $1.50-2.00 per pound. The lower price is for bulk buyers and the upper is for the drive-up angler wanting only small amount of bait. His regular price for consistent customers seems to be $1.75 per pound, or $7.00 per bag.

He also indicated that he has sold larger amounts to boats from Venezuela and the Dominican Republic, who purchase ≥1,000 pounds at a time at his normal prices. It is worth it to the buyers because of the high value of the product in their home countries. For example, it is said that Ballyhoo sell for $2.00-3.00 per fish in Venezuela. One pound of Ballyhoo contains 4-5 fish, so a $7.00 bag purchased in Puerto Rico can – if these figures are accurate – be sold in Venezuela for about $36.00-54.00, a substantial markup if accurate.

To catch White Mullet, or Jarea, Junior uses a gill net with a stretch mesh of 2½ inches. It is not clear, however, where or how this net is employed.

"Neco:" Of the four "major" Ballyhoo fishers, Neco's is the smallest scale operation. He fishes exclusively about one mile out from Guanica Bay, catching 90-100 pounds of Ballyhoo per trip, and fishing only 1-2 times per week. He uses a 4 ft deep monofilament gill net with a stretch mesh of 1½ inch.

The economics of this operation are difficult. For each trip, he must purchase 12 bags of ice at $1.50 each, or $18.00. A tank of gas and motor oil costs $18.50. His direct expenses are therefore $36.50 per trip. A good day will produce 100 pounds of Ballyhoo, which he sells at $1.25 per pound, or $125.00. This yields a gross profit of $88.50 for a good day. Two days prior to our interview, he caught only a single Ballyhoo in an entire day.

Figure 3.1-32. Neco, Ballyhoo Fisher

Neco fishes from a 19 ft Yola, and his normal fishing day is from about 8:00 a.m. to 4:00 p.m. In good months, however, he sometimes fishes at night, because the fish seem to be more concentrated, but night fishing success does not appear to be influenced by moon phases.

Neco reported that October to February is slow for him, because the water cools and Ballyhoo are not so easy to catch. Because Neco fishes exclusively within one mile from land, this may coincide with Toño's comment that in cooler months fish are nearer shore but not so plentiful.

Figure 3.1-33. Neco's yola

Neco handles his catch the same as does Junior, i.e. fecal stripping, seawater rinse, then storage on ice.

3.2 BAIT SPECIES BIOLOGY

Virtually any small fish available to a recreational fisher in Puerto Rico may find itself used as bait, but some are more commonly used and targeted for capture and use than others. Several are merely opportunistic, i.e. if they are available, they will be utilized, but fishers tend to concentrate on a much smaller number of bait species for the great preponderance of fishing effort and time. A total of 23 species is discussed here, but the discussions are divided between the more commonly used, or "Major Species," and others that are used from time to time. The discussions concerning the major species are more extensively researched than those for the other species in the following subsection 3.2.2. Note that this division between major and other species is artificially based upon results of interviews conducted during this program. It is entirely possible that species included in the "other" category may be considered "major species" in some local areas or seasonally, but the division presented here reflects findings of this program.

3.2.1 Major Species

3.2.1.1 *Scaled Herring*

***Harengula jaguana* (Poey, 1865)**

Spanish Names:
The Scaled Herring is known in Puerto Rico primarily as the **Cascarúa**[13] or Sardina Escamúa[13] (USGS 2000), but also simply as Sardina[13] (Erdman 1987) and in some areas as Boqueta[13] or Blanquilla[13] (Fishers *pers. comm.*). Reported Spanish language names for this species include Conchúa[14] (Kotlyar 1984), Sardina[5,14] (Kotlyar 1984, Silva 1994), Sardina Escamudina[4] (Claro 1994), Sardineta jaguana[11,14] (Sánchez 1997, FAO-FIDI 2006), and Sardinita Vivita Escamuda[10] (Nelson *et al.* 2004)

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Names:
Fish Base 2007) presents the English common name of *H. jaguana* as Scaled Herring, but the accepted English language name for this species in Puerto Rico appears to be Scaled Sardine (Erdman 1987). Scaled Sardine is also the English language name preferred by the American Fisheries Society (Nelson *et al.* 2004), although Pilchard is also sometimes used in the USA (Zaneveld 1983), and Pierce *et al.* (2001) refer to it as the Scaled Herring in Florida. English language names used for this species in other countries include Guiana Harring[7,9+Guyana] (Zaneveld 1983), Herring[Guyana] (Zaneveld 1983), Scaled Herring[UK] (FAO-FIDI 2006),

Figure 3.2-1. Scaled Sardine (Rome Peebles 2007)

and Scaled Sardine[1,2,4,10] (Böhlke and Chaplin 1993, Greenfield and Thomerson 1997, Claro and Parenti 2001, Nelson *et al.* 2004).

Taxonomy:

Class:	Actinopterygii (ray-finned fishes)
Order:	Clupeiformes (herrings)
Family:	Clupeidae (herrings, scads, sardines, menhaden)
Genus:	*Harengula*
Species:	*jaguana*

The first reference to this species misidentified it as H*arengula humeralis* Valenciennes, 1847 (Whitehead 1985) and a few subsequent papers misidentified *H. jaguana* as *H. humeralis* (e.g. Kotlyar 1984, Claro 1994), but the accepted scientific name for the Scaled Herring is *Harengula jaguana* Poey, 1865 (Poey 1865). Several other names have been rejected as junior synonyms, including *Harengula pensacolae* Goode & Bean, 1879 (Goode and Beans 1879), *Harengula majorina* Storey, 1938 (Storey 1938), and *Hyrtlinus altiforma* Fowler, 1958 (Fowler 1958).

Caribbean Distribution:
H. jaguana is a Southwest and West Central Atlantic species that is native to Puerto Rico (Evermann and Marsh 1902, Anon. 1999, 2003, Whitehead 1985, Kimmel 1991), as well as to most of the Caribbean, including Anguilla, Antigua & Barbuda, Aruba, Barbados, Belize, Bermuda, British Virgin Islands, Cayman Islands, Colombia, Costa Rica, Curaçao, Dominica, Dominican Republic, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Martinique, México, Montserrat, Netherlands Antilles, Nicaragua, Panamá, St. Lucia, St. Kitts & Nevis, St. Vincent & The Grenadines, Trinidad & Tobago, Turks & Caicos, U.S. Virgin Islands, United States, Venezuela (Whitehead 1985), Bahamas Böhlke and Chaplin 1993), Cuba (Claro and Parenti 2001), and Jamaica (Alleng 1997).

Biology:
H. jaguana is a gregarious species inhabiting the neritic environment and commonly schools around mangrove shorelines, *Thalassia* beds, and surf zones (Modde 1980, Modde and Ross 1981, 1983, Ruple 1984, Peters and Nelson 1987), the latter habitat being important during juvenile development as nursery areas (Modde 1980, Ruple 1984).

The Scaled Herring is apparently a very fast-growing short-lived fish, living little more than a year (Pierce *et al.* 2001). Ages up to 3 years were reported by Martinez and Houde (1975) based on their studies of scale circuli. Similarly, Hubold and Mazzetti (1982) calculated a 3-year life span for this species based upon modal length age groups defined as 40 mm TL (Age 1), 105 mm TL (Age 2) and 140 mm TL (Age 3). Pierce *et al*. (2001) were able, however, to count fish age on a daily basis using their approaches, and determined that the 40 mm Age 1 fish of Hubold and Mazzetti probably were actually only 30-40 days old, and that the other modal values resulted from spawning peaks within the same year, which fits with the estimated growth rate of Scaled Herring at about 0.5 mm per day.

The numbers of spawning events and spawning seasons in this species are not clear from the literature. The spawning period in Cuba has been reported as October – December (García-Cagide *et al.* 1994), and as February – August in Florida (Martinez and Houde 1975, Whitehead 1985). Others have noted one to two peak spawning events in April or September, or in both months (Gunther 1945, Springer and Woodburn 1960, Low 1973, Modde 1980, Modde and Ross 1980). Pierce *et al.* (2001) report that spawning in the Tampa Bay region is nearly continuous throughout the year, with the potential for fish spawned early in the year growing to become mature spawners themselves in the fall of the same year.

Fish Base (2007) report a minimum population doubling time for this species of 1.4 – 4.4 years, but this is based on the estimated maximum age of 3 years. Clearly, if conclusions presented by Pierce *et al.* (2001) are correct, this estimate is overstated, and the minimum population doubling time for the Scaled Herring is more likely to be <15 months.

H. jaguana are at least partially nocturnal feeders (Modde and Ross 1983, Sogard *et al.* 1989). They feed primarily on zooplankton, especially Crustacea (Odum and Heald 1972, Carr and Adams 1973, Sierra *et al.* 1994, Motta *et al.* 1995), but also on small finfish, benthic Crustacea, worms, mollusks, sponges, tunicates, phytoplankton and other plants (Vega-Cendejas *et al.* 1994, Motta *et al.* 1995).

Morphology:
H. jaguana is a moderately small, strongly compressed, fusiform normal, deep bodied silver herring. Unlike *H. humeralis*, it has no dark pigment at the tips of the anterior dorsal fin rays, and it has no red or orange spot behind the upper end of the gill (Fish Base 2007). The toothplates on the tongue and floor of the mouth are also very broad as compared to *H. humeralis* (Whitehead 1985). *H. jaguana* has no dorsal or anal fin spines, the dorsal fin has 13-21 soft rays and the anal fin has 12-23 soft rays. Scales are firmer than in *H. humeralis* and not so easily shed (Smith 1997). The belly has a deep, lower profile, more curved than the flattened upper profile (Robins and Ray 1986).

Morphometric measurements as a percentage of Fish Total Length are: Standard Length – 80.8%, Fork Length – 85.1%, Pre-anal Length – 62.3%, Pre-dorsal Length – 34.7%, Pre-pelvic Length – 39.4%, Pre-pectoral Length – 18.1%, Body Depth – 28.5%, Head Length – 19.7%, Eye Diameter – 39.5% of Head Length, Pre-orbital Length – 28.9% of Head Length.

The maximum reported total length for *H. jaguana* is 21.2 cm (Cervigón *et al.* 1992). Length-weight parameters *a* and *b* have been variously estimates at $a = 0.0100 – 0.0134$, and $b = 3.150 – 3.280$ (Suárez-Caabro *et al.* 1961, Hubold and Mazzetti 1982, Claro and García-Arteaga 1994). The median values computed on Fish Base (2007) were used to construct the following length-weight curve.

$$\text{Weight} = a(L^b) = 0.0106\ (L^{3.2500})$$

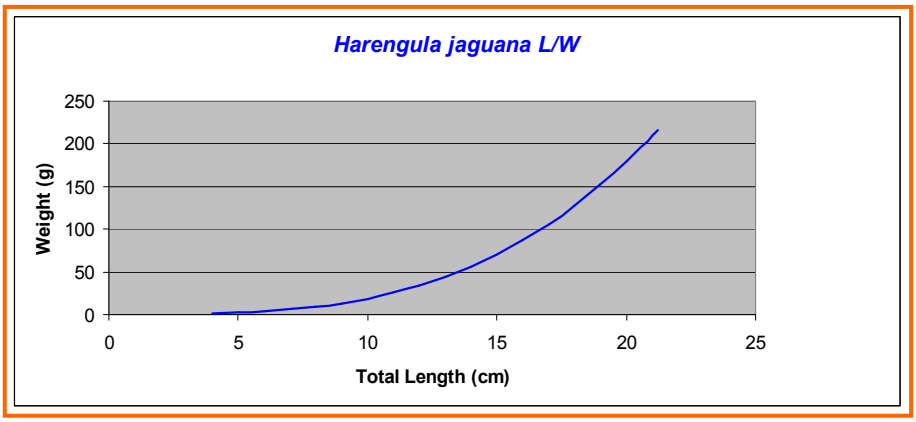
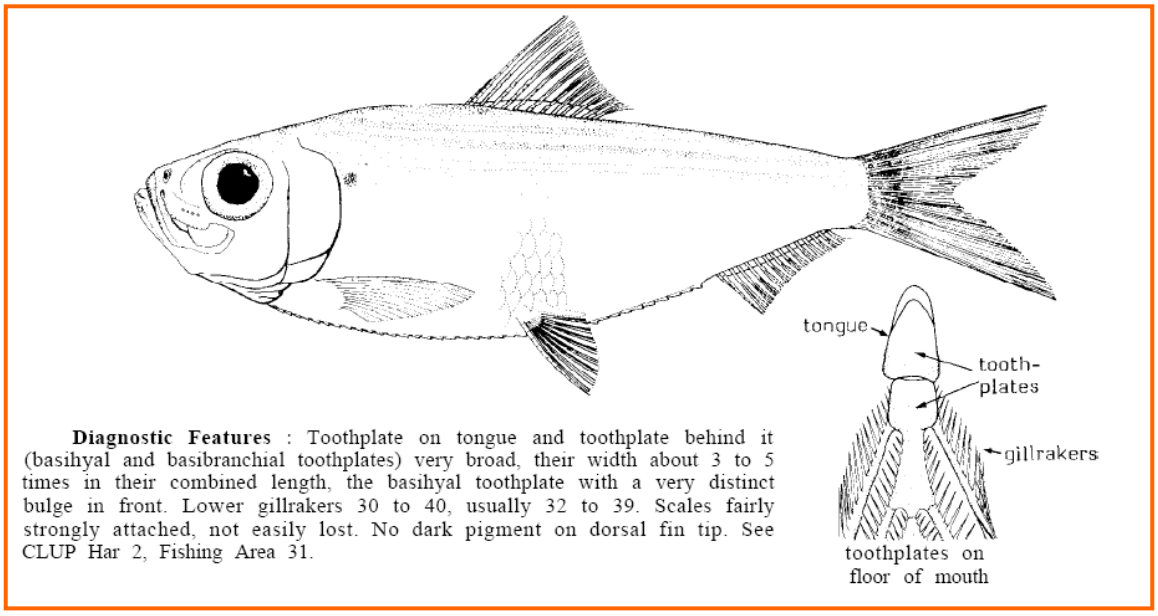


Figure 3.2-2. Length-Weight Curve for Scaled Herring



Diagnostic Features : Toothplate on tongue and toothplate behind it (basihyal and basibranchial toothplates) very broad, their width about 3 to 5 times in their combined length, the basihyal toothplate with a very distinct bulge in front. Lower gillrakers 30 to 40, usually 32 to 39. Scales fairly strongly attached, not easily lost. No dark pigment on dorsal fin tip. See CLUP Har 2, Fishing Area 31.

Figure 3.2-3. Scaled Herring Diagnostics from Whitehead (1985)

3.2.1.2 *Redear Herring*

***Harengula humeralis* (Cuvier, 1829)**

Spanish Names:
Harengula humeralis is known in Puerto Rico primarily as the **Machuelo**[13] (Erdman 1987), and occasionally as Sardina de Ley[13] or Pincers[13] (Fishers *pers. comm...*). Reported Spanish language names for this species include Conchúa Pelona[14] (Kotlyar 1984), Manzanillera[14,17] (Kotlyar 1984, Nahím and Cervigón 2003), Sardina[5,14] (Kotlyar 1984, Silva 1994), Sardina de Ley[4,14] (Kotlyar 1984, Claro 1994), Sardineta Manzanilla[11] (Sánchez 1997), Sardineta Manzanillera[14] (FAO-FIDI 2006), and Sardinita de Ley[10] ((Nelson *et al.* 2004).

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Names:
Fish Base (2007) presents the English common name of *H. Harengula* as Redear Herring, but the accepted English language names for this species in Puerto Rico appear to be Redear Sardine or Yellow Bill (Erdman 1987). Redear Herring appears in print in FAO-FISDI 2006, but other names appear to be more prevalent, such as Loose Scaled Sardine (Zaneveld 1983), Pilchard (Butsch 1939, Zaneveld 1983), Pincers (Zaneveld 1983), Redear Sardine (Crossman 1972, Claro and Parenti 2001, Nelson *et al.* 2004), Red-Ear Sardine (Zaneveld 1983, Böhlke and Chaplin 1993), Red-Ear Pilchard (Zaneveld 1983), Sardientje (Zaneveld 1983), Sardine (Zaneveld 1983), Sprat (Zaneveld 1983, Kotlyar 1984), Whitebill (Zaneveld 1983, Kotlyar 1984), and Yellowbill Sprat (Ogden *et al,* 1975.

Taxonomy:

Class:	Actinopterygii (ray-finned fishes)
Order:	Clupeiformes (herrings)
Family:	Clupeidae (herrings, shads, sardines, menhadens)
Genus:	*Harengula*
Species:	*humeralis*

The first recorded name for the Redear Herring was *Clupea humeralis* Cuvier, 1829, which was abandoned for the now accepted scientific name, *Harengula humeralis* Cuvier, 1829 (Cuvier 1829). Several other names have been rejected as junior synonyms, including *Harengula maculosa* Valenciennes, 1847 (Cuvier and Valenciennes 1847*a*), *Alosa apicalis* Müller & Troschel, 1848 (Schomburgh 1848), *Harengula sardine* Poey, 1860 ((Poey 1858-61), and *Harengula callolepis* Goode, 1879 (Goode and Bean 1879).

Caribbean Distribution:
H. Harengula is a Southwest and West Central Atlantic species that is native to Puerto Rico (Evermann and Marsh 1902, Bane 1964, Saunders 1966*a*, 1966*b*, Randall 1967, 1996,

Almodóvar and Pagan 1971, Austin 1971, Cooper 1974, Whitehead 1985, Kimmel 1985, 1991, Dyer *et al.* 1985) and to most of the Caribbean Region, including Anguilla, Antigua & Barbuda, Aruba, Barbados, Belize, Bermuda, British Virgin Islands, Cayman Islands, Colombia, Costa Rica, Curaçao, Dominica, Dominican Republic, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Martinique, México, Montserrat, Netherlands Antilles, Nicaragua, Panamá, St. Lucia, St. Kitts & Nevis, St. Vincent & The Grenadines, Trinidad & Tobago, Turks & Caicos, United States, Venezuela (Whitehead 1985), Bahamas (Böhlke and Chaplin 1993), Cuba (Claro and Parenti 2001), Jamaica (Alleng 1997), and the U.S. Virgin Islands (Ogden *et al.* 1975).

Biology:
H. humeralis is a gregarious species inhabiting the neritic environment and commonly schools around mangrove shorelines and *Thalassia* beds. They are reported to spawn ten months per year in Cuba, from November through August, and they have a mean fecundity of about 2,000 oocytes/gram of fish (García-Cagide *et al.* 1994). Their larvae have a watery, mucoid dilution of the muscles which renders them very transparent and makes them float (Lagler et al 1962). Ciguatera poisoning has been reported in *H. Harengula* (Dammann 1969, Halstead 1970, Cervigón *et al.* 1992), and in clupeids in general (Lagler *et al.* 1962).

They reach first maturity at an age of about 0.8 year at a length of 10-11 cm (García-Cagide 1988, García-Cagide *et al.* 1994). They have an estimated mean life span of approximately 2.7 years (Fish Base 2007), but are highly resilient, with a minimum population doubling time of <15 months.

Redear Herrings feed primarily on zooplankton including invertebrates (mysids, copepods), fish eggs and larvae (Sierra *et al.* 1994), but they also feed on later stages of small finfish, benthic crustaceans (amphipods, copepods, isopods, ostracods, shrimps, prawns), polychaetes, mollusks, and even benthic algae and weeds (Randal 1967,Sierra *et al.* 1994, Ortaz *et al.* 1996).

Morphology:
H. humeralis is a moderately small, strongly compressed, fusiform normal, deep bodied silver herring with brownish to olive shadings on the back. Tips of the anterior dorsal fin rays are always dark, and in life, a reddish or orange spot occurs behind the upper end of the gill (Smith 1997). This species has no dorsal or anal fin spines; the dorsal fin has 13-21 soft rays, and the anal fin has 12-23 soft rays; gill rakers on lower limb 27-31; tooth plate on tongue and tooth plate behind it are very narrow (Whitehead 1985). Scales are thin, loosely attached and easily shed (Smith 1997). The body is slender, with evenly curved upper and lower profiles (Robins and Ray 1986).

Morphometric measurements as a percentage of Fish Total Length are: Standard Length – 83.2%, Fork Length – 86.7%, Pre-anal Length – 61.9%, Pre-dorsal Length – 36.4%, Pre-pelvis length – 40.3%, Pre-pectoral Length – 20.1%, Body Depth – 27.3%, Head Length – 22.5%, Eye Diameter – 35.8% of Head Length, Pre-orbital Length – 30.6% of Head Length (Fish Base 2007).

The maximum reported total length for *H. humeralis* is 22.0 cm (Claro 1994). Length-weight parameters *a* and *b* have been variously estimated at *a* = 0.0107 – 0.0135, and *b* = 3.100 – 3.190 (García-Arteaga 1993, Claro and García-Arteaga 1994, García-Arteaga *et al.* 1997). The median values computed on Fish Base (2007) were used to construct the following length-weight curve.

$$\text{Weight} = a(L^b) = 0.0107\ (L^{3.1900})$$

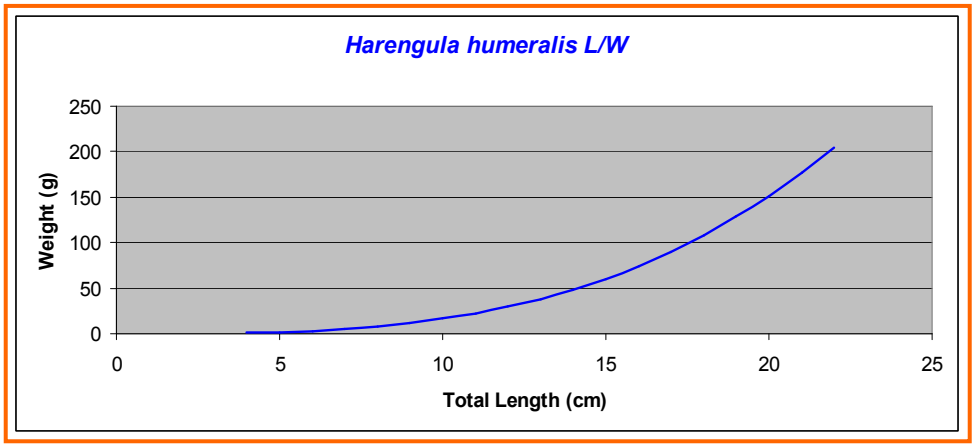


Figure 3.2-4. Length-Weight Curve for Redear Herring

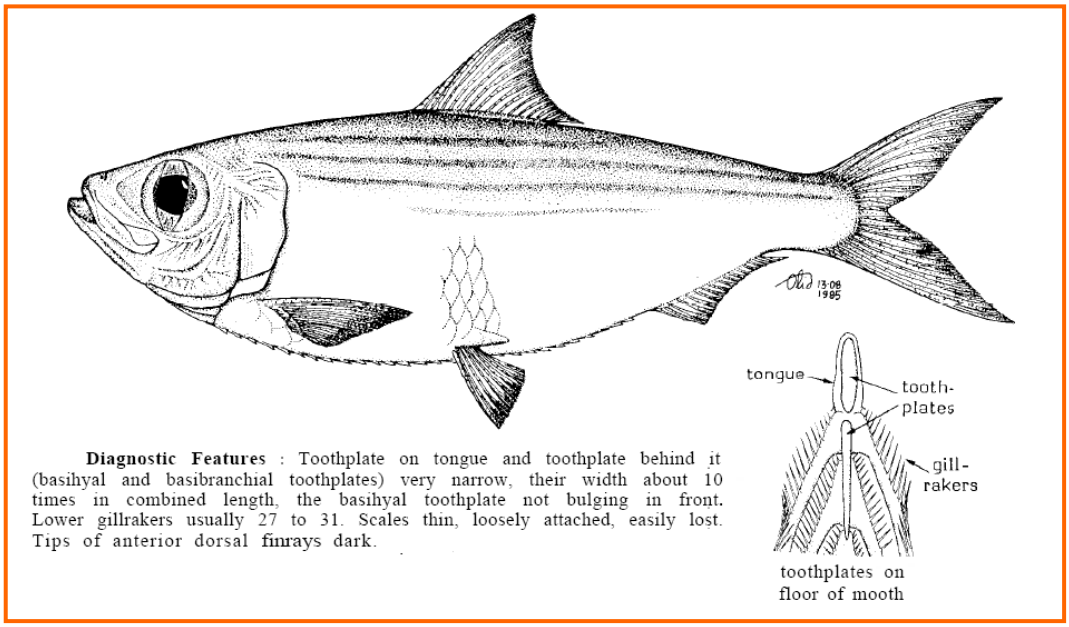


Figure 3.2-5. Redear Herring Diagnostics from Whitehead (1985)

3.2.1.3 *Threadfin Herring*

***Opisthonema oglinum* (Lesueur 1818)**

Spanish Common Names:
The Threadfin Herring, *Opisthonema oglinum*, is primarily known in Puerto Rico as the **Arenque**[13], but also as the Arenca[13] (USGS 2000), Sardina de Altura[13] in the San Juan area, and Sardina de Lacha[13] in Arecibo (Erdman 1987). It has also been referred to as Machuelo[13] in Puerto Rico (Zanefeld 1983), but this name is usually reserved for the Redear Herring, *Harengula humeralis*. Machuelo[4,5,14,17] (Kotlyar 1984, Silva 1994, Nahím and Cervigón 2003. Other Spanish language names reported in the literature include Machuelo Atlántico in Uruguay (Nion *et al.* 2002), Muchuelo de Hebra[11] (Sánchez 1997), Sardina Vivita de Hebra[14] (Whitehead 1985), and Machuelo Hebra Atlántico[14] (FAO-FIDI 2006).

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Common Names:
O. oglinum is most commonly referred to as the Threadfin Herring, although it is frequently called simply the Thread Herring (Butsch 1939, Zaneveld 1983, Randall 1996) or the Atlantic Thread Herring (Zaneveld 1983, Böhlke and Chaplin 1993, Greenfield and Thomerson 1997, Claro and Parenti 2001, Nion *et al.* 2002, Nelson *et al.* 2004, FAO-FIDI 2006). Other common English names founding the literature include Sprat in Barbados and Cuba (Zaneveld 1983), the Hairy Back in the United Kingdom (Kotlyar 1984), the Harryback in Surinam (Zaneveld 19843) and Bermuda Herring (Zaneveld 1983).

Taxonomy:

Class:	Actinopterygii
Order:	Clupeiformes
Family:	Clupeidae
Genus:	*Opisthonema*
Species:	*oglinum*

The original scientific name of the Threadfin Herring was *Megalops oglina*, but this was abandoned in favor of *Opisthonema oglinum* (Lesueur 1818). Misspellings that have appeared in the literature are *Ophisthonema oglinum, Opisthonema oglinum,* and *Ophistonema oglinum* (Lesueur *op cit.*). Several more recent names have been dismissed as junior synonyms, including *Megalops notata* (Lesueur 1818), *Chatoessus signifer* (DeKay 1842), *Alausa striata* (Cuvier and

Figure 3.2-6. Threadfin Herring (Rome Peebles 2007)

Valenciennes 1847), *Meletta thrissa* (Cuvier and Valenciennes 1847), *Chatoessus eumorphus* (Gosse 1851), and *Opisthonema captivai* (Rivas 1872). The latter may be a Colombian subspecies, *O. oglinum captivai.*

Caribbean Distribution:
O. oglinum is native to Puerto Rico (Evermann and Marsh 1902, Fowler 1911, 1928, Siddiqi and Cable 1960, Bane 1964, Ramsey 1967, Randall 1967, 1996, Eger 1968, Austin 1971, Martin and Patus 1973, Parrish and Zimmerman 1977, Corujo-Flores 1980, Parrish 1982, Kimmel 1985, 1991, Whitehead 1985, Dennis *et al.* 1991, Burger *et al.* 1992, Bunkley-Williams *et al.* 1996) and to mot of the Caribbean Region, including Anguilla, Antigua & Barbuda, Aruba, Barbados, Belize, Virgin Islands, Cayman Islands, Colombia, Costa Rica, Curaçao, Dominica, Dominican Republic, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Martinique, México, Montserrat, Netherlands Antilles, Nicaragua, Panamá, Saint Lucia, St. Kitts & Nevis, St. Vincent & the Grenadines, Trinidad & Tobago, Turks & Caicos, Venezuela, and the USA (Whitehead 1985). It is also native to the Bahamas (Böhlke and Chaplin 1993), Cuba (Claro and Parenti 2001), and Jamaica (Aleng 1997).

Biology:
O. oglinum is a small tropical to temperate clupeid species occurring primarily between latitudes of 41º N and 37º S, in harbors, estuaries and shallow coastal areas (Lieske and Myers 1994). They commonly form dense schools in the upper 3m of the water column, and while they primarily feed by filtering copepods from the water column, they are reported to also utilize other zooplankton such as planktonic invertebrates (Randall 1967, Carr and Adams 1973, Finucane and Vaught 1986), shrimps and prawns (Sierra *et al.* 1994), small finfish (Whitehead 1985), benthos including copepods, crabs, worms, sponges and tunicates (Randall 1967,Whitehead 1985, Sierra *et al. op cit.*) and detritus (Carr and Adams 1973, Bowman *et al.* 2000).

Prest (1971) reported that *O. oglinum* spawns in nearshore shelf waters to depths of about 100 ft during March-July, while Bigelow *et al.* (1963) report spawning in May-June. Whitehead (1985) reports that the threadfin possibly spawns March-July in offshore waters of Venezuela. The species scatters its eggs in open water and on substratum, and does not guard its eggs.

O. oglinum matures at 4.7-5.7 inches Fork Length at age 1 or 2 (Berkeley and Houde 1984). The species reaches maturity very early in life, with mean sizes of 5.6 inch at age 1, 5.7 at age 2, and 5.8 at age 3 in the Gulf of Mexico (Reintjes 1979). Houde *et al.* (1983) reported specimens from the Gulf of Mexico with mean length of 4.3 inch (108.2 mm) at year 1 and 6.0 inch (152.4 mm) at year 2. Fuss *et al.* (1969) reported a year 1 mean length of 5.8 inch (146 mm) along the west coast of Florida. Specimens collected off North Caroline were somewhat larger, with the year 1 mean being 6.1 inch (155 mm) and Year 2 being 6.8 inch (172 mm) (Smith 1994). Smith (1994) reported two fish at ages 7 and 8, while Arce and Sanchez (1991) reported specimens to 8 years of age.

Morphology:
The maximum total length for *O. oglinum* has been reported to be 38 cm (15.0 inch) (Claro and García-Arteaga 1994).

O. oglinum is a small clupeid, with a compressed fusiform body and terminal mouth. An elongated filamentous last dorsal fin ray differentiates this species from all other western clupeids except *Dorosoma* spp., which has an inferior rather than terminal mouth. *O. oglinum* has no dorsal or anal fin spines; the dorsal fin has 19-21 soft rays, and the anal fin has 23-24 soft rays. The threadfin is similar in general aspect to *Harengula* spp., but differentiated by the elongated dorsal ray and small-toothed hypomaxilla in the upper jaw (Whitehead 1985). The body has a silver color with a bluish or greenish back, a dark spot above the opercle and a larger dark spot behind the opercle, frequently with a row of dark spots trailing to the posterior. Lower body profile is deeply curved, and the head is pointed (Robins and Ray 1986).

Morphometric measurements as a percentage of Fish Total Length are: Standard Length – 79.7%, Fork Length – 89.4%, Pre-anal Length – 60.1%, Pre-dorsal Length – 34.4%, Pre-pelvic Length – 40.1%, Pre-pectoral Length – 18.8%, Body Depth – 25.8%, Head Length – 19.0%, Eye Diameter – 27.4% of Head Length, and Pre-orbital Length – 30.1% of Head Length (Fish Base 2007).

Length-weight parameters *a* and *b* have been variously estimated at $a = 0.0034 – 0.0336$ and $b = 2.69 – 3.53$ (Bezerra 1968, Etchevers 1975, Reintjes 1979, Valdés and Sotolongo 1983, Berkeley and Houde 1984, García-Arteaga *et al.* 1997, García *et al.* 1998, Feltrim and Schwingel 2005). The median values computed on Fish Base (2007) were used to construct the following length-weight curve:

$$\text{Weight} = a\,(L^{b}) = 0.0174\,(L^{2.9800})$$

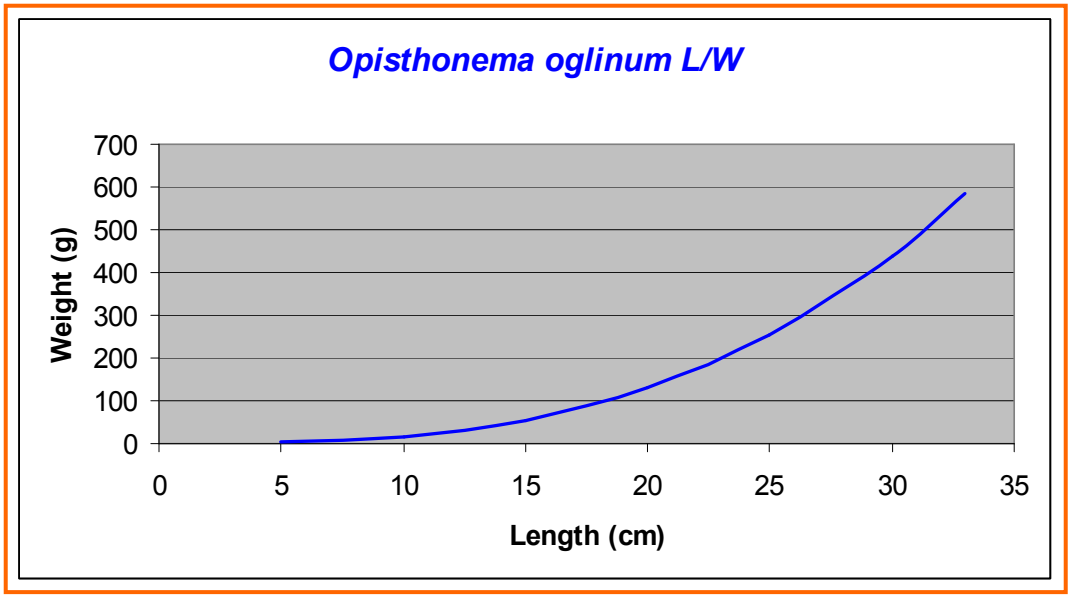
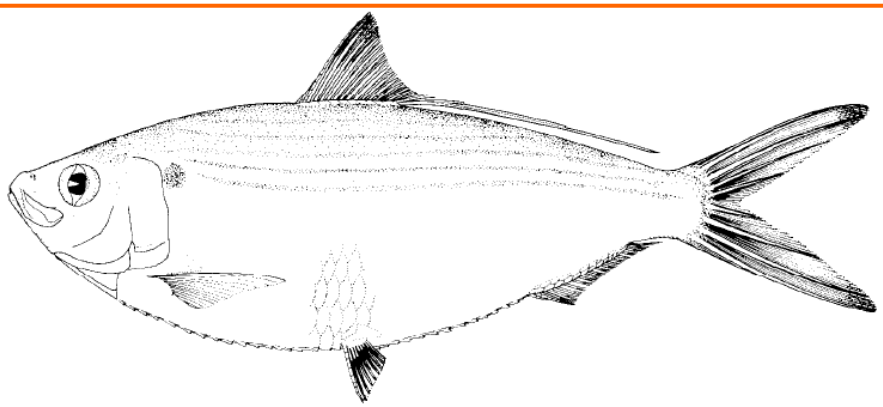


Figure 3.2-7. Length-Weight Curve for Threadfin Herring



Diagnostic Features : The filamentous last dorsal finray distinguishes it from all other western Atlantic clupeoids except Dorosoma, which has an inferior mouth. Otherwise, superficially resembles species of Sardinella (but i 8 pelvic finrays in western Atlantic species, cf. i 7 in Opisthonema) and Harengula (but small toothed hypomaxilla in upper jaw). Lower gillrakers increasing initially with size of fish, but stable at 28 to 46 after 8 cm standard length.

Figure 3.2-8. Threadfin Herring Diagnostics from Whitehead (1985)

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3.2.1.4 *Ballyhoo*

***Hemiramphus brasiliensis* (Linnaeus 1758)**

Spanish Common Names:
Hemiramphus brasiliensis is almost universally known in Puerto Rico as the **Balajú**[13] (Zaneveld 1983, Erdman 1987), Escribano (USGS 2000), or by its English names, Ballyhoo or Halfbeak (Zaneveld *op cit.*). It is also known as Agujeta[14] (Kotlyar 1984), Agujeta Brasileña[10,14] (Crespo *et al.* 2001, Nelson *et al.* 2004, FAO-FIDI 2006), Agujeta del Brasil[14] (Cervigón *et al.* 1992), Balajú[4,13,14] (Zaneveld 1983, Kotlyar 1984), Balao[4,16] (Zaneveld 1983), Escribano[4,14] (Zaneveld 1983, Kotlyar 1984), Escribano de Aletas Rojas[4] (Claro 1994), Marao Fósforo[17] (Nahím and Cervigón 2003), and Saltón[14] (Kotlyar 1994)

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Common Names:
H. brasiliensis is most commonly referred to as the Ballyhoo in English (Zaneveld 1983, Erdman 1987, Cervigón *et al.* 1992, Böhlke and Chaplin 1993, Claro and Parenti 2001, McBride and Thurman 2003, Nelson *et al.* 2004). Other English language names for this species include Balahu (Butsch 1939), Ballyhoo Halfbeak (FAO-FIDI 2006), Gar (FAO-FIDI *op cit.*), Garfish (Hughes and Stewart 2006), Halfbeak (Butsch *op cit*, Zaneveld *op cit.*, Kotlyar 1984,), Halfbeaks (Kamara 1977), Redtailed Balao (Zaneveld *op cit.*), and Yellowtail Ballyhoo (Zaneveld *op cit.*). Perlmutter (1961) seems to have erroneously referred to this species as Balao.

Taxonomy:

Class:	Actinopterygii (ray-finned fishes)
Order:	Beloniformes (needle fishes)
Family:	Hemiramphidae (halfbeaks)
Genus:	*Hemiramphus*
Species:	*brasiliensis*

Figure 3.2-9. Ballyhoo (Rome Peebles 2007)

The accepted scientific name of the ballyhoo is *Hemiramphus brasiliensis* (Linnaeus 1758) (Robins and Ray 1986), which displaced the original designation of *Esox brasiliensis* (Linnaeus 1758) (Collette and Parin 1990). Three names rejected as junior synonyms include *Hemiramphus brownii* (Valenciennes 1847) (Collette and Parin *op cit.*), *Macrognathus brevirostris* (Gronow 1854)(Eschmeyer 1998), and *Hemiramphus filamentosus* (Poey 1860) (Collette and Parin *op cit.*).

Caribbean Distribution:
H. brasiliensis is native to Puerto Rico (Evermann and Marsh 1902, Fowler 1919, Erdman 1956, Bane 1964, Saunders 1966*a*, 1966*b*, Randall 1967, 1996, Martin and Patus 1973, Wallace and Sawyer 1977, Collette 1978, Williams 1982, Kimmel 1991, Friedlander 1992) and to most of the Caribbean Region, including Anguilla, St. Kitts & Nevis (FAO 1969), Antigua & Barbuda, Barbados, Costa Rica, Dominica, Dominican Republic, Grenada, Guatemala, Haiti, Honduras, Jamaica, México, Nicaragua, Panamá, St. Vincent & The Grenadines (Collette *op cit.*), Aruba, Colombia, Curaçao, Venezuela (Cervigón *et al.* 1992), Bahamas (Böhlke and Chaplin 1993), Belize (Claro 1994), British Virgin Islands (Morris 2003), Brazil, United States (Robins and Ray 1986), St. Lucia (Humann 1994), Trinidad & Tobago (Kenny 1995), and the U.S. Virgin Islands (Ogden *et al.* 1975)

Biology:
H. brasiliensis is a nearshore surface-swimming species that forms dense schools, often in association with a closely related species, *H. balao.* They feed primarily on plant materials, including benthic algae and weeds (Sierra *et al.* 1994), although almost 20% of stomach contents were found in a Puerto Rico study to consist of small bony finfish (Randall 1967). Ciguatera has been reported to occur in this species (Dammann 1969).

The life span of *H. brasiliensis* has been reported as about 4 years (McBride and Thurman 2003), with a maximum of 6 years (Fish Base 2007). This is a resilient species, with females potentially spawning during age year 0 depending on environmental conditions, while in subsequent years they spawn year around, peaking in late spring – early summer, which corresponds to the March – July spawning period off South Florida, as reported by FMRI (2003). They reach sexual maturity during their first year at 6.9 – 7.9 inches Fork Length, which we may convert to 7.6 – 8.7 inches Total Length (192 – 220 mm) using the morphometric measurements provided below.

Ballyhoo produce hydrated oocytes of approximately 2.4 mm diameter in batches of about 1164 oocytes for a 100 g female (McBride and Thurman 2003). Eggs attach to floating seagrass blades, and hatched larvae and juveniles tend to retain their proximity to floating seagrass as they develop. Their medium-minimum population doubling time = 1.4 – 4.4 years (Fish Base Summary 2007).

Morphology:
H. brasiliensis' body is elongated and compressed with sides nearly parallel and vertical (Jordan and Evermann 1902), and with an elongated lower jaw, defining it as a member of the halfbeak group. It has no dorsal or anal fin spines; the dorsal is characterized by 13-14 soft rays and the anal fin by 12-12 soft rays.

The maximum reported total length for *H. brasiliensis* is 55.0 cm (Schneider 1990) and the maximum published weight is 200 g (Cervigón *et al.* 1992). The reason for the discrepancy between this reported maximum weight and the calculated weights in the L/W graph presented below is not clear.

Morphometric measurements as a percentage of Fish Total Length are: Standard Length – 88.5%, Fork Length – 91.3%, Pre-anal Length – 75.8%, Pre-dorsal Length – 71.2%, Pre-pelvic Length – 65.4%, Pre-pectoral Length – 34.4.%, Body Depth – 10.9%, Head Length – 33.1%, Eye Diameter – 10.0% of Head Length, and Pre-orbital Length – 72.1% of Head Length (Fish Base 2007).

Length-weight parameters *a* and *b* have been variously estimated at $a = 0.0012 – 0.1050$ and $b = 2.356 – 3.370$ (Nomura 1965, Berkeley and Houde 1978, Bohnsack and Harper 1988, Claro and García-Arteaga 1994). The median values computed on Fish Base (2007) were used to construct the following length-weight curve, which is based on **Total Length**, including the bill. Note that when fishers speak of ballyhoo length, they generally refer to the total length minus the bill, i.e. from the tip of the mouth to the end of the tail.

$$\text{Weight} = a(L^b) = 0.0021\ (L^{3.2490})$$

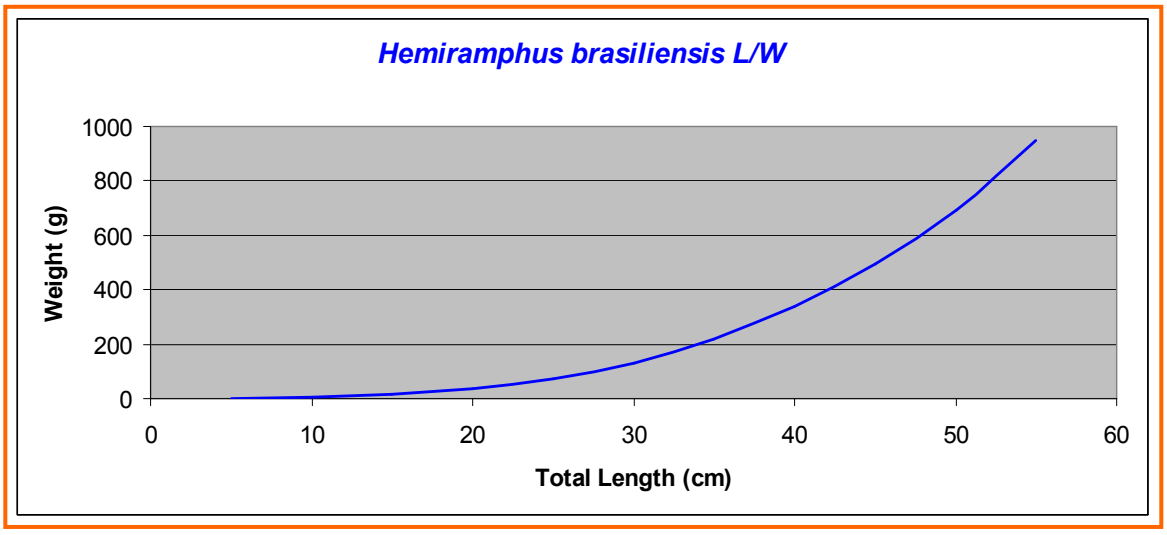


Figure 3.2-10. Length-Weight Curve for Ballyhoo

3.2.1.5 *Balao*

***Hemiramphus balao* (Lesueur, 1821)**

Spanish Common Names:
Most fishers are aware that two species exist, but in common use, most fishers refer to the Balao as "the other species of balajú," although some are aware of the name "Balao." In common practice, however, the two species are used interchangeably, with bait selection based upon individual fish size and condition, rather than on species. Agujón is also sometimes used (USGS 2000). In Spain, the Balao is referred to as Agujeta Balaju[14] (FAO-FIDI 2006) or Agujeta Balajú[14] (Collette 1981). In other areas of the Caribbean, it has been called Agujeta Balao[10] (Nelson *et al.* 2004), Balajú[5] (Silva 1994), Balao[1,4,16] (Zaneveld 1983), Escribano[4] (Zaneveld 1983.), Escribano Balao[4] (Claro 1994), and Marao Fósforo[17] (Nahím and Cervigón 2003).

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Common Names:
The prevailing English common name for *H. balao* is Balao (Zaneveld 1983, Böhlke and Chaplin, 1993, Claro and Parenti, 2001, Nelson *et al.* 2004). Other names appearing in the scientific literature include Balao Halfbeak (FAO-FIDI 2006), Blacktail Ballyhoo (Zaneveld 1983), Blue Balao (Zaneveld 1983), and Piper (Zaneveld 1983).

Taxonomy:

Class:	Actinopterygii (ray-finned fishes)
Order:	Beloniformes (needle fishes)
Family:	Hemiramphidae (halfbeaks)
Genus:	*Hemiramphus*
Species:	*balao*

Figure 3.2-11. Balao

The accepted scientific name of the balao is *Hemiramphus balao* (Lesueur, 1821), which has been chosen over a variant spelling, *Hemirhamphus balao*, in the same publication. It has been misidentified as *Hemiramphus brasiliensis*, the ballyhoo (Alfonso *et al.* 1999). Four names have been rejected as junior synonyms, including *Hemiramphus vittatus* (Valenciennes 1837-44), *Hemiramphus pleii* (Cuvier and Valenciennes 1847*b*), *Hemiramphus macrochiris* (Poey 1858-61), and *Hemiramphus guineensis* (Bleeker 1863)

Caribbean Distribution:
H. balao is native to Puerto Rico (Collette 1978, Randall 1996) and to most of the Caribbean Region, including Antigua & Barbuda, Barbados, Belize, Costa Rica, Dominica, the Dominican Republic, Grenada, Guatemala, Haiti, Honduras, Jamaica, México, Nicaragua,

Panamá, Saint Lucia, St. Kitts & Nevis, St. Vincent & The Grenadines (Collette *op cit*.), Aruba, Colombia, Curaçao, Trinidad & Tobago, Venezuela (Cervigón *et al.* 1992), the Bahamas (Böhlke and Chaplin 1993), Bermuda (Lieske and Myers 1994), Cuba (Claro and Parenti 2001), Guadeloupe, Martinique (Collette and Parin 1990), and the USA (Robins and Ray 1986).

Biology:
H. balao is a nearshore surface-swimming species that forms dense schools, often in association with a closely related species, *H. brasiliensis*, the Ballyhoo. Its diet is substantially different than the Ballyhoo, as it is primarily a hunter of macrofauna, including, in Puerto Rican waters, fish eggs and larvae, small gastropod mollusks (commonly Cavolinidae – pteropods, or "swimming butterflies"), polychaete worms, planktonic invertebrates, including shrimp and crab larvae and copepods (Randall 1967). Sierra *et al*. (1994) also report Balao feeding on bony fish (esp. *Jenkinsia* sp. – small herrings), annelids, and other planktonic invertebrates. Unlike their close relative, the Ballyhoo, there seem to be no reports of ciguatera occurring in balao.

The life span of *H. balao* has been reported as about 2 years (McBride and Thurman 2003) or 2-3 years (FMRI 2003), with a maximum of 4.5 years (Fish Base 2007). This is a resilient species, with females potentially spawning during age year 0 depending on environmental conditions, while in subsequent years they spawn year around, peaking in late spring – early summer, which corresponds to the March – July spawning period off South Florida, as reported by FMRI (2003). McBride and Thurman (*op cit.*) report that all mature female Balao spawned daily throughout the month of June in their study. Balao reach sexual maturity during their first year at 6.9 – 7.9 inches Fork Length (Berkeley and Houde 1978), which we may convert to 7.7 – 8.5 inches Total Length (196 – 216 mm) using the morphometric measurements provided below. Their minimum population doubling time is <15 months (Fish Base Summary 2007).

Balao produce hydrated oocytes of approximately 1.6 mm diameter – smaller than Ballyhoo eggs – in batches of 3,743 oocytes for a 100 g female – more than Ballyhoo (McBride and Thurman 2003). Eggs attach to floating seagrass blades, and hatched larvae and juveniles tend to retain their proximity to floating seagrass as they develop (FMRI 2003).

Morphology:
H. balao's body is elongated, "eel-like" (Randall 1996), and compressed with sides nearly parallel and vertical (Jordan and Evermann 1902), and with an elongated lower jaw, defining it as a member of the halfbeak group. It has no dorsal or anal fin spines; the dorsal is characterized by 11-15 soft rays and the anal fin by 10-13 soft rays. Its pectoral fins are longer than the distance from the origin of the fins to the front edge of nasal cavities (Randall *op cit.*).

Morphometric measurements as a percentage of Fish Total Length are: Standard Length – 89.2%, Fork Length – 92.5%, Pre-anal Length – 76.4%, Pre-dorsal Length – 74.6%, Pre-pelvic Length – 65.3%, Pre-pectoral Length – 37.7%, Body Depth – 9.9%, Head Length – 36.4%,

Eye Diameter – 10.1% of Head Length, and Pre-orbital Length – 72.9% of Head Length (Fish Base 2007).

The maximum reported total length for *H. balao* is 40.0 cm (Collette 1981). Length-weight parameters *a* and *b* have been estimated by Berkeley and Houde (1978) as 0.0023 and 3.242, respectively. These values were used to construct the following length-weight curve, which is based on **Total Length**, including the bill, or lower jaw. Note that when fishers speak of balao length, they generally refer to the total length minus the bill, i.e. from the tip of the mouth to the end of the tail.

$$\text{Weight} = a(L^b) = 0.0023\ (L^{3.242})$$

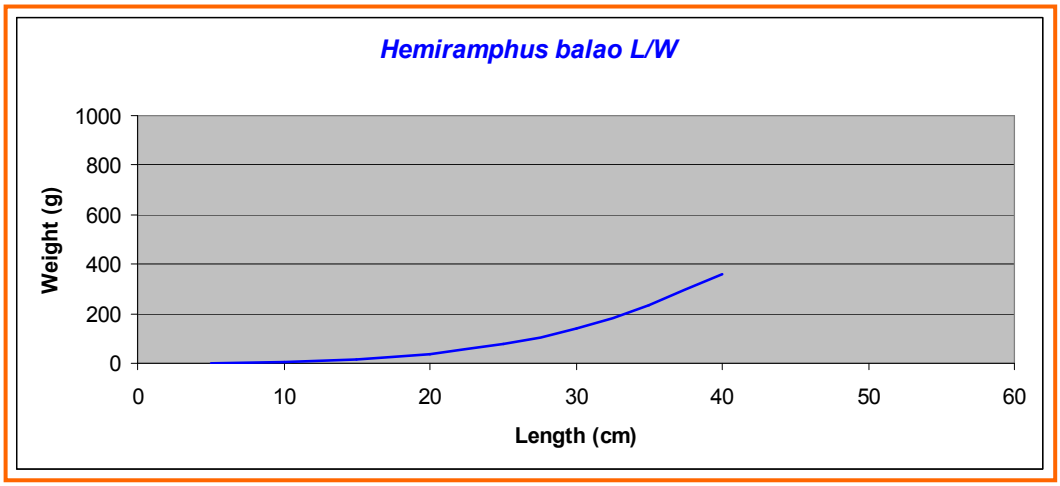


Figure 3.2-12. Length-Weight Curve for Balao

3.2.1.6 *White Mullet*

***Mugil curema* (Valenciennes 1836)**

Spanish Common Names:
The White Mullet, *Mugil curema*, is principally known locally as the **Lisa Blanca**[14], but in Puerto Rico also variously as Jarea[14], Lisa Criolla[14], Cramo[14] and Josea[14] (Erdman 1987, USGS 2000), Jarea[14] (Erdman *op cit.*; Zaneveld 1983), and Mulet[14] (Zaneveld *op cit.*). Numerous other Spanish names are used for *M. curema*, including Capiton[14] (OECD 1990), Chango[14] (Kotlyar 1984), Galupe[14] (OECD 1990), Lebrancha[10] (Anon 1994), Lebranche[5] (Silva 1994), Lisa[5,14,17] (Silva 1983, Zaneveld 1983, Kotlyar 1984), Lisa Blanca[4,10,14] (Claro 1994, Escobar-Fernández and Siri 1997, Nelson *et al.* 2004, FAO-FIDI 2006), Lisa Criolla[11,14,17] (Cervigón *et al.* 1992, Sánchez 1997, Nahím and Cervigón 2003), Liseta[10] (Anon. 1994), Liseta Plateada[14] (Chirichigno 1974), Liza Curema[14] (Schneider 1990), and Plateado[4] (Zaneveld 1983)

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Common Names:
M. curema is most commonly referred to as the White Mullet (FAO-FIDI 2006, Nelson *et al.* 2004, Zaneveld 1983, Greenfield and Thomerson 1997, Böhlke and Chaplin 1993), but has also been referred to as the Small Mullet (Zaneveld 1983), the Silver Mullet (Zaneveld 1983) the Redeye Mullet (OECD 1990), the Mulet (Hodgkinson-Clarke 1994), the Mollit (Kamara 1977), the Josea (Zaneveld 1983), the Curema Mullet (Schneider 1990), and the Blueback Mullet (Zaneveld 1983).

Taxonomy:

Class:	Actinopterygii
Order:	Perciformes
Family:	Mugilidae
Genus:	*Mugil*
Species:	*curema*

Figure 3.2-13. White Mullet

The accepted name of the white mullet is *Mugil curema* (Valenciennes 1836). The species has been misidentified in the literature as *M. gaimardianus* (discussed by Thomson 1978) and *M. brasiliensis* (discussed by Thomson 1981).

Attempts to identify *M. curema* as a new species have produced three junior synonyms: *M. metzelaari,* Chabanaud 1926 (Thomson 1981), *M. petrosus* Valenciennes 1836 (Thomson 1990),and *Myxus harengus* Günther, 1861 (Eschmeyer 1998). The name *Liza curema* has also been used inappropriately (Valenciennes 1836).

Caribbean Distribution:
M. curema is native to Puerto Rico (Evermann and Marsh 1902, Fowler 1928, Nichols 1929, Siddiqi and Cable 1960, Randall 1967, 1996, Eger 1968, 1970, Almodóvar and Pagan 1971, Austin 1971, Austin and Austin 1971, Martin and Patus 1973, Reimold 1975, Erdman 1976, Thomson 1978, Corujo-Flores 1980, Dyer *et al.* 1985, García and Williams 1985, Kimmel 1985, 1991, Stoner 1986, Acosta 1992) and to most of the Caribbean region, including Antigua, Barbados, Belize, Brazil, Costa Rica, Dominica, the Dominican Republic, Grenada, Guatemala, Haiti, Honduras, Nicaragua, Panama, St. Lucia, St. Kitts & Nevis, St. Vincent (Thomson *op cit.*), Aruba, Colombia, Curacao (Cervigón *et al.* 1992), Bahamas (Böhlke and Chaplin 1993), Bermuda, United States (Robins and Ray 1986), British Virgin Islands, Cayman Islands, Guadeloupe, Montserrat, Turks & Caicos (Smith 1997), Cuba (Claro 1994), Jamaica (Alleng 1997), Martinique (Lim *et al.* 2002), Mexico (Anonymous 1994), Netherlands Antilles (Humann 1994), Trinidad & Tobago (Ramjohn 1999), US Virgin Islands (Ogden *et al.* 1975), and Venezuela (Cervigón 1993).

Biology:
M. curema is a catadromous (Riede 2004) inhabitant of sandy coasts and littoral pools, brackish lagoons and estuaries., sometimes found in rivers and on coral reefs (Lieske and Myers 1994). Adults frequently form schools (Harrison 1995), and are omnivorous, feeding on benthic algae and seaweeds such as *Thalassia* (Randall 1967, Maitland and Campbell 1992), filamentous algae (Cervigón 1993), small bony fish, worms, nematodes, sponges, and tunicates (Blay 1995), detritus (González-Sansón and Alvarez-Lajonchere 1978, Sazima 1986, Blay *op cit.*), phytoplankton and diatoms (Sazima *op cit.*, Blay *op cit.*, Diouf 1996, Rueda 2002), zoobenthos and small benthic crustaceans (Blay *op cit.,* Keith *et al.* 2000, Rueda *op cit.*), and small mollusks (Rueda *op cit.*).

Spawning of *M. curema* is variously reported as occurring as two distinct events per year (summer and winter) in Delaware Bay (Scotton *et al*. 1973), over an extended season from March through August or September (Anderson 1957, Keith *et al.* 2000), to year-around in Cuba (García-Cagide *et al.* 1994). Ibáñez-Aguirre and Gallardo-Cabello(2004), however, reported an extended spawning season from November to February in the northern Mexican Gulf of Mexico. Marin *et al.* (2003) determined that successful spawning was apparently associated with high food availability, in their Venezuelan case associated with periods of coastal upwelling. Fecundity is high, with several million buoyant eggs with significant yolk produced (Keith *op cit.*) and ovaries containing a mean of 1,311 oocytes/gram of fish weight in a Venezuelan population (Baumar *et al.* 2006). Ibáñez-Aguirre and Gallardo-Cabello (*op cit.*) found a comparable mean fecundity in Mexico of 1,064 oocytes/g. Their medium-minimum population doubling time = 1.4 – 4.4 years (Fish Base Summary 2007).

Sexual maturity in *M. curema* has been reported (Ibáñez-Aguirre and Gallardo-Cabello 2004) as occurring at an age of 3 years at a mean length of 27.4-27.8 cm.

Morphology:
The maximum total length for *M. curema* has been reported to be 90 cm (Harrison 1995), but asymptotic growth (L_{inf}) is reported as 46 cm for females and 41 cm for males (Ibáñez-Aguirre

et al. 1999). Length at first maturity is 18.1 – 20.8 cm Total Length for males and females both, at ages "0" and "1" (Ibáñez-Aguirre *et al.* 1999).

M. curema has a total of 4-5 dorsal spines and 8-9 dorsal soft rays; and 3 anal spines with 9-10 anal soft rays. It usually has 38-39 scales in lateral series with 33-41 scales on the lateral line. Scales on the side are covered with smaller secondary scales (Smith 1997). It also has a dark spot at the base of each pectoral fin (Wood 1994).

Morphometric measurements as a percentage of Fish Total Length are: Standard Length – 81.8%, Fork Length – 93.6%, Pre-anal Length – 39.2%, Pre-dorsal Length – 39.2%, Pre-pelvic Length – 282.%, Pre-pectoral Length – 22.4%, Body Depth – 21.1%, Head Length – 21.5%, Eye Diameter – 27.1% of Head Length, and Pre-orbital Length – 19.5% of Head Length (Fish Base 2007). Ibáñez-Aguirre *et al.* (2006) reported that Atlantic and Pacific Ocean populations differ only in that the Atlantic populations have a slightly larger eye diameter.

A length-weight curve constructed from values of *a* and *b* obtained from Fish Base (2007) is provided here, where

$$\text{Weight} = a\,(L^{b}) = 0.0268(L^{2.81})$$

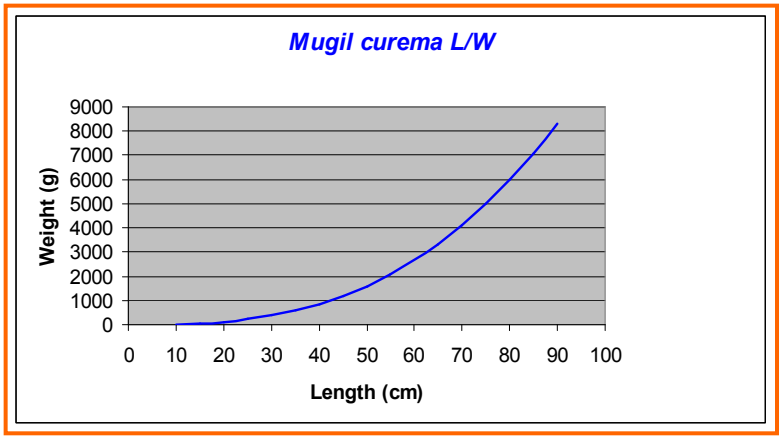


Figure 3.2-14. Length-Weight Curve for White Mullet

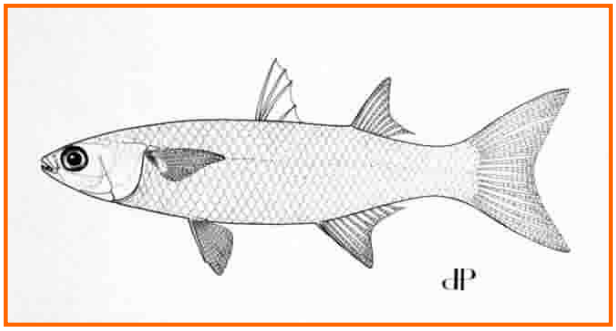


Figure 3.2-15. White Mullet Features

3.2.1.7 *Yellowfin Mojarra*

***Gerres cinereus* (Walbaum, 1792)**

Spanish Names:
The Yellowfin Mojarra is known in Puerto Rico as the **Muniama**[13] (Erdman 1987, USGS 2000). Other reported Spanish language names for this species include Chavela[12] (Chirichigno 1974), Mojarra Blanca[4,10,14,16] (Randall and Vergara 1978, Zaneveld 1983, Anon. 1994, Claro 1994), Mojarra de Casta[4,16] (Zaneveld 1983), Mojarra Plateada[10] (Escobar-Fernández and Siri 1997), Mojarra Rayada[6,10] (De La Cruz-Agüero 1997, Jiménez-Prado and Béarez 2004), Mojarra Trompetera[10] (Nelson *et al.* 2004), or simply Mojarra[3,5,6,12+Uruguay] (Chirichigno 1974, Barriga 1991, Silva 1994, Nion *et al.* 2002)

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Names:
Fish Base (2007) presents the English common name of *G. cinereus* as Yellow Fin Mojarra, which has also been used by others (Nion *et al.* 2002, FAO-FIDI 2006), but the spelling variant Yellowfin Mojarra appears to be more commonly used (Crossman 1972, Zaneveld 1983, Böhlke and Chaplin 1993, Greenfield and Thomerson 1997, Pollnac 1998, Claro and Parenti 2001, Nelson *et al.* 2004). Another very common English language name for this species is Hedow (Zaneveld 1983) and its spelling variants Haddou and Haddow (also Zaneveld 1983). Other English names are Broad Mojarra, Broad Shad, Dark-barred Mojarra, Gray Mojarra, Silver Perch (Zaneveld 1983), and Shad (Pollnac 1998).

Taxonomy:

Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Gerreidae (Mojarras)
Genus:	*Gerres*
Species:	*cinereus*

Figure 3.2-16. Yellowfin Mojarra

The original name assigned to the Yellowfin Mojarra was *Mugil cinereus* Walbaum, 1792, which subsequently was reassigned to *Gerres cinereus* Walbaum, 1792 (Walbaum 1792), its currently recognized name (Gilmore 2002, McEachran and Fechhelm 2005).

Caribbean Distribution:
G. cinereus is a Western Atlantic and Eastern Pacific species that is native to Puerto Rico (Evermann and Marsh 1902,

Nichols 1929, Erdman 1956, 1960, Siddiqi and Cable 1960, Saunders 1966*a*, 1966*b*, Randall 1967, 1996, Fish and Mowbray 1970, Pagan and Austin 1970, Almodóvar and Pagan 1971, Austin 1971, Austin and Austin 1971, Riemold 1975, Randall and Vergara 1978, Kimmel 1985, Atoner 1986, Rooker and Dennis 1991, Dennis 1992, Acosta 1992, 1994, 1997, Bunkley-Williams *et al.* 1996, Smith 1997) as well as to most of the Caribbean, including Anguilla, the Cayman Islands Guadeloupe, Montserrat, St. Kitts & Nevis, Turks & Caicos (Smith 1997), Antigua & Barbuda, Barbados, Belize, Costa Rica, Dominica, Dominican Republic, Grenada, Guatemala, Haiti, Honduras, Nicaragua, Panamá, St. Lucia, St. Vincent & The Grenadines (Randall and Vergara 1978), Aruba, Colombia, Curaçao, Venezuela (Cervigón *et al.* 1992), Bahamas (Böhlke and Chaplin 1993), Bermuda, El Salvador, USA (Robins and Ray 1986), British Virgin Islands (Morris 2003), Cuba (Claro and Parenti 2001), Jamaica (Alleng 1997), Martinique (Bouchon-Navaro and Louis 1986), México (Anon 1994), Trinidad & Tobago (Manickchand-Heileman and Flüs 1990), and the U.S. Virgin Islands (Ogden *et al.* 1975).

Biology:
The Yellowfin Mojarra is amphidromous, meaning that they move between fresh and salt water during some part of their life cycle, but not for purposes of breeding (Riede 2004), and they may be found in salt, fresh, and brackish waters (Randall and Vergara 1978). They inhabit shallow coastal waters in open sandy and surf areas, seagrass meadows, mangrove channels, and associated with reefs (Robins and Ray 1986). They may be found in small aggregations, which may or may not be habitat-related. They have been reported in association with ciguatera poisoning (Dammann 1969).

This species apparently matures at a length of about 22 cm at approximately 1.2 years of age (Báez and Alvarez-Lajonchere 1983, García-Cagide *et al.* 1994, Fish Base 2007), and has a life span of about 5 years. It has a minimum population doubling time of 1.4 – 4.4 years (Fish Base 2007). Spawning is reported to occur from April to December in Cuban waters (García-Cagide *et al.* 1994).

Yellowfin Mojarras are primarily carnivorous, feeding on benthic crustaceans including shrimps and crabs, bivalve and gastropod mollusks, polychaete worms (Randall 1967, Randall and Vergara 1978). Ostracods and benthic algae and weeds have also been reported (Austin and Austin 1971).

Morphology:
Fishes of the Family Gerreidae generally have an oblong or elongate compressed body, with a small, extremely protractile mouth descending downward when protruded. They have small teeth in the jaw, with none on the vomer or palatines; gill membranes are separate. They have a single dorsal fin with the spinous and soft parts about equally developed and usually with 9-10 spines. The anal fin is much shorter with only 2-3 spines, and the ventral fins are thoracic, with 1 spine and 5 rays (Hildebrand and Schroeder 1927). *G. cinereus* has 3 anal spines and 7 soft rays. It has a silvery color with about 7 faint pinkish vertical bars on the sides of the body, and the pelvic fins are yellow, from which it gets its common name (Randall 1996).

Morphometric measurements as a percentage of Fish Total Length are provided for two specimens by Fish Base (2007), with the two sets of measurements being significantly different from one another. One specimen was collected in the Gulf of Salamanca, Colombia, and the other in Nicaragua without an indication of which coast the fish was collected on, i.e. Atlantic or Pacific. The data set from the Colombian fish shall be provided here, as this is the specimen known to have originated in the Caribbean. For this fish, the morphometric measurements as a percentage of Fish Total Length are: Standard Length – 80.0%, Fork Length – 83.6%, Pre-anal Length – 54.7%, Pre-dorsal Length – 32.4%, Pre-pelvic Length – 30.5%, Pre-pectoral Length – 27.2%, Body Depth – 30.6%, Head Length – 25.6%, Eye Diameter – 30.9% of Head Length, and Pre-orbital Length – 33.6% of Head Length.

The maximum reported Total Length for *G. cinereus* is 41.0 cm (IGFA 2001). Length-weight parameters *a* and *b* have been variously estimated at *a* = 0.0130 – 0.0184 and *b* = 2.690 – 3.210 (Báez and Alvarez-Lajonchere 1983, Bohnsack and Harper 1988, Claro and García-Arteaga 1994, García-Arteaga *et al*. 1997), but these reports used Fork Length rather than Total Length. If we apply the morphometric relationships reported above, then the Fork Length of the largest reported *G. cinereus* = 41.0(0.836) = 34.3 cm FL. The median values provided by Bohnsack and Harper (1988) were used to construct the following length-weight curve.

$$\text{Weight} = a(L^b) = 0.0184\ (L^{3.0840}),$$
where L is in cm Fork Length

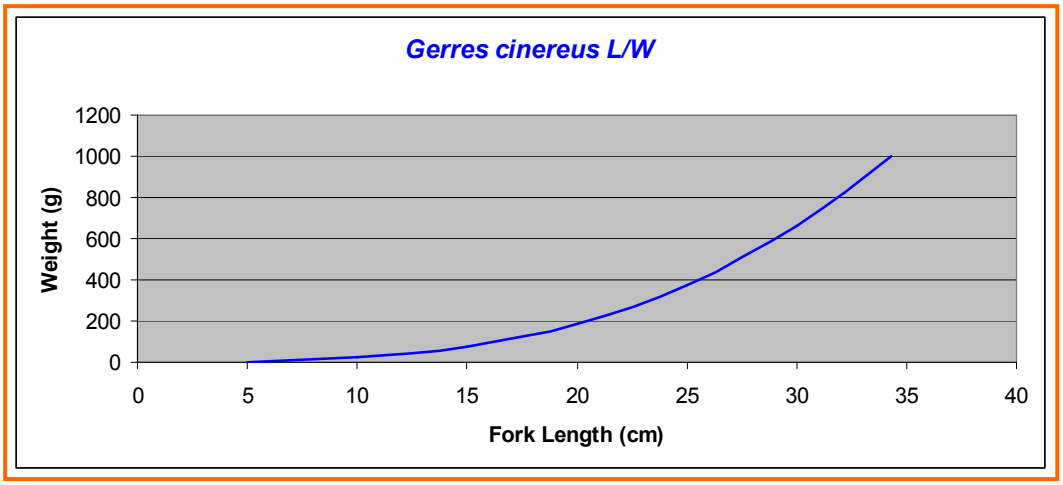
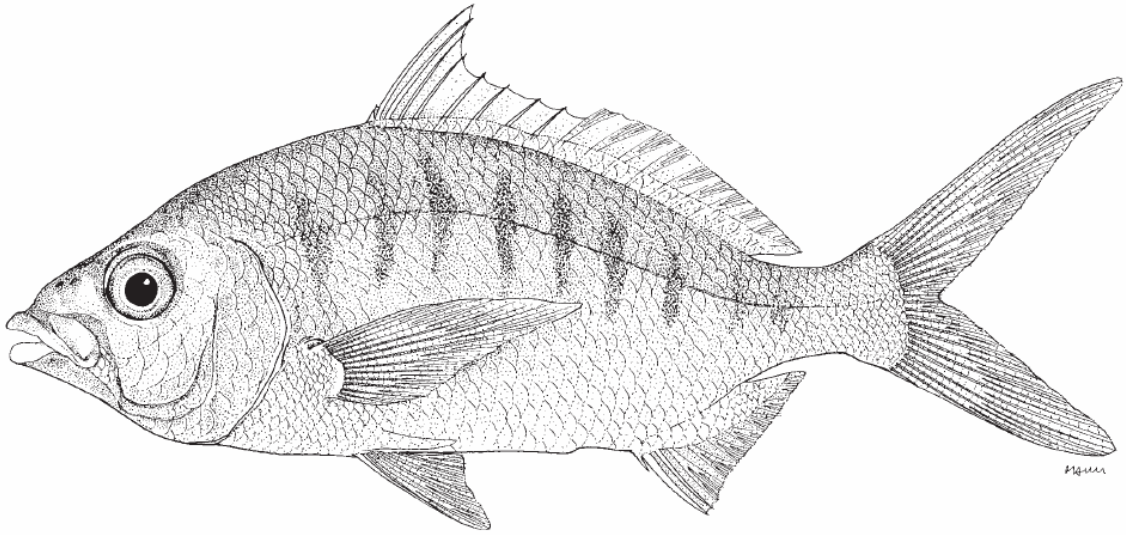


Figure 3.2-17. Length-Weight Curve for Yellowfin Mojarra

Gerres cinereus (Walbaum, 1792) GEN

Frequent synonyms/misidentifications: None / None.

FAO names: En - Yellowfin mojarra; **Fr** - Blanche cendré; **Sp** - Mojarra blanca (munama).



Diagnostic characters: Body compressed and moderately deep (depth 2.3 to 2.6 in standard length). Mouth strongly protrusible, maxilla reaching to or beyond anterior margin of pupil; **edge of preopercle smooth**; preorbital bone smooth; **posterior part of premaxillary groove** (unscaled median depressed region on snout) **broad, the scales to the side not reaching a vertical at front of eye.** Dorsal fin slightly notched, second to fourth spines much higher than remainder of fin; pectoral fins long, almost reaching to anal-fin origin when appressed; anal fin with 3 spines and 7 soft rays; second anal-fin spine not greatly enlarged. **Colour:** body silvery, with blue tinge on head and back; 7 or 8 dark bluish or pinkish vertical bars on sides; **pelvic and anal fins yellow.**

Size: Maximum to about 41 cm; common to 28 cm.

Habitat, biology, and fisheries: Inhabits shallow coastal waters, especially exposed sand flats, sand bottoms in coral reef areas, bays, bights, and mangrove-lined creeks, entering brackish and sometimes even fresh water; may occur in small aggregations. Feeds on crabs, pelecypods, gastropods, polychaetes, and miscellaneous other benthic invertebrates. Caught mainly with beach and boat seines, gill nets, trammel nets, and cast nets; also with traps. Marketed mostly fresh, although its flesh is not highly esteemed; also made into fishmeal. Separate statistics are not reported for this species.

Distribution: Bermuda; Florida south to southeast Brazil, including the Bahamas, Gulf of Mexico, coasts of Central America and northern South America. Also occurs in the eastern Pacific Ocean from Bahia Santa Maria, Baja, California to Chimbote, Peru, including the Galapagos Islands.

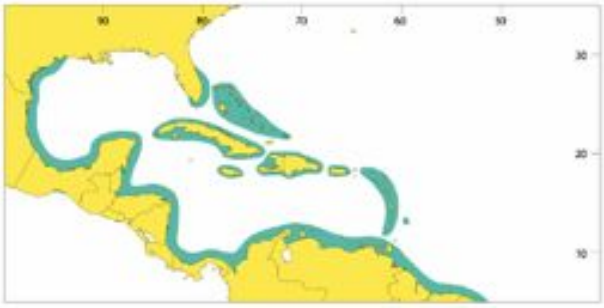


Figure 3.2-18. Yellowfin Mojarra Diagnostics from Carpenter (2002)

3.2.1.8 *Striped Mojarra*

***Eugerres (Diapterus) plumerei* (Cuvier, 1830)**

Spanish Names:
The Striped Mojarra is known in Puerto Rico as the **Espuelua**, or simply as Mojarra (Erdman 1987). Other Spanish language common names for this species include Mojarra Fina[4] and Mojarra Prieta[4] (Bussing 1998), Mojarra Rayada[10,11,14] (Randall and Vergara 1978, Sánchez 1997, Nelson *et al.* 2004), or again, simply Mojarra[3,17] (Nahím and Cervigón 2003). Patao Listado[5] and Patao Rayado[5] have also been used in Cuba (Claro 1994).

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Costa Rica
5. Cuba
6. Dominican Republic
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

English Names:
E. plumerei is virtually universally known in English as the Striped Mojarra (Randall and Vergara , 1978, Greenfield and Thomerson 1997, Claro and Parenti 2001, Nelson *et al.* 2004, Fish Base 2007) or simply Mojarra (Bussing 1998).

Taxonomy:

Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Gerreidae (Mojarras)
Genus:	*Eugerres*
Species:	*plumerei*

The original scientific name for the Striped Mojarra was *Gerres plumerei* Cuvier, 1830 (Cuvier and Valenciennes 1830), which was subsequently changed to *Diapterus plumerei* Cuvier, 1830, and later to *Eugerres plumerei* Cuvier, 1830, which is its accepted name today (Eschmeyer 2000). Two junior synonyms, which are not valid, are *Gerres embryx* Jordan & Starks, 1898 (Jordan and Evermann 1898), and *Eugerres awlae* Schultz, 1949 (Schulz 1949).

Caribbean Distribution:
The Striped Mojarra is a Western Atlantic species native to Puerto Rico (Randall and Vergara 1978), as well as to most of the Caribbean, including Aruba, Curaçao, Trinidad & Tobago (Cervigón *et al.*1992), Belize, Dominican Republic, Grenada, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panamá (Randall and Vergara 1978), Colombia (Deckert and Greenfield 1987), Costa Rica (Bussing 1998), Cuba (Claro and Parenti 2001), México, USA (Robins and Ray 1986), and Venezuela (Cervigón 1993).

Figure 3.2-19. Striped Mojarra

Biology:
The Striped Mojarra is amphidromous, meaning that they move between fresh and salt water during some part of their life cycle, but not for purposes of breeding (Riede 2004). They inhabit shallow coastal waters and commonly occur in brackish waters, often swimming a considerable distance into freshwaters (Bussing 1998). They are found mostly over mud bottoms in mangrove-lined creeks and lagoons (Randall and Vergara 1978).

This species matures at about 2.2 years of age at about 23-24 cm total length, and they live to about 9 years (Reef Base 2007). They are moderately resilient, with a minimum population doubling time of 1.4 – 4.4 years. Spawning is reported to occur throughout the entire year in Cuban waters (García-Cagide *et al.* 1994).

Striped Mojarras are primarily carnivorous, feeding on zoobenthos, including benthic crustaceans, polychaete and annelid worms and bivalves (Austin and Austin 1971, Sierra *et al.*1994), but Austin and Austin (1971) report that they also consume benthic algae and weeds, including *Thalassia* (turtle grass)*, Lyngbya majuscule* (a blue-green algae)*, Syringodium* sp. (manatee grass)*,* and *Polysiphonia* sp. (a red algae).

Morphology:
Fishes of the Family Gerreidae generally have an oblong or elongate compressed body, with a small, extremely protractile mouth descending downward when protruded. They have small teeth in the jaw, with none on the vomer or palatines; gill membranes are separate. They have a single dorsal fin with the spinous and soft parts about equally developed and usually with 9-10 spines. The anal fin is much shorter with only 2-3 spines, and the ventral fins are thoracic, with 1 spine and 5 rays (Hildebrand and Schroeder 1927). *E. plumerei* has 3 anal spines, the second of which is very strong, and 8 soft rays. There are pronounced horizontal dark stripes on the body (Carpenter 2002).

Morphometric measurements as a percentage of Fish Total Length are provided for a specimen collected in the Gulf of Salamanca, Colombia (Fish Base 2007). They are: Standard Length – 76.6%, Fork Length – 83.0%, Pre-anal Length – 51.5%, Pre-dorsal Length – 30.9%, Pre-pelvic Length – 28.1%, Pre-pectoral Length – 25.7%, Body Depth – 28.1%, Head Length – 21.8%, Eye Diameter – 36.3% of Head Length, Pre-orbital Length – 24.2% of Head Length.

The maximum reported Total Length for *E. plumerei* is 40.0 cm (Randall and Vergara 1978). Length-weight parameters *a* and *b* have been estimated at $a = 0.0062$ and $b = 2.860$ for Fork Length (Angell 1976, Claro and García-Arteaga 1994), and $a = 0.0481$ and $b = 2.930$ for Standard Length (Duarte *et al.* 1999). If we apply the morphometric relationships reported above, then the Standard Length of the largest reports *E. plumerei* = 40.0 x (0.766) = 30.6 cm Standard Length. The *a* and *b* values provided by Duarte *et al.* 1999) for Standard Length fish measurements were used to construct the following length-weight curve.

$$\text{Weight} = a(L^b) = 0.0481\ (L^{2.9300}),$$
Where L is in cm Standard Length

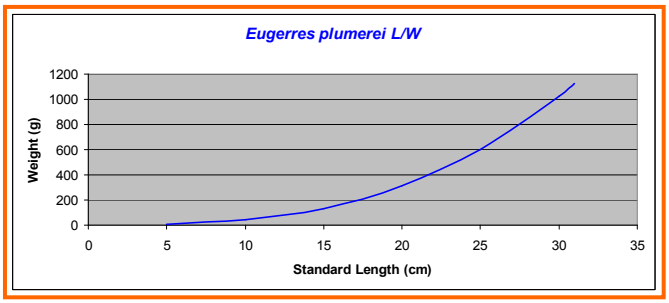


Figure 3.2-20. Length-Weight Curve for Striped Mojarra

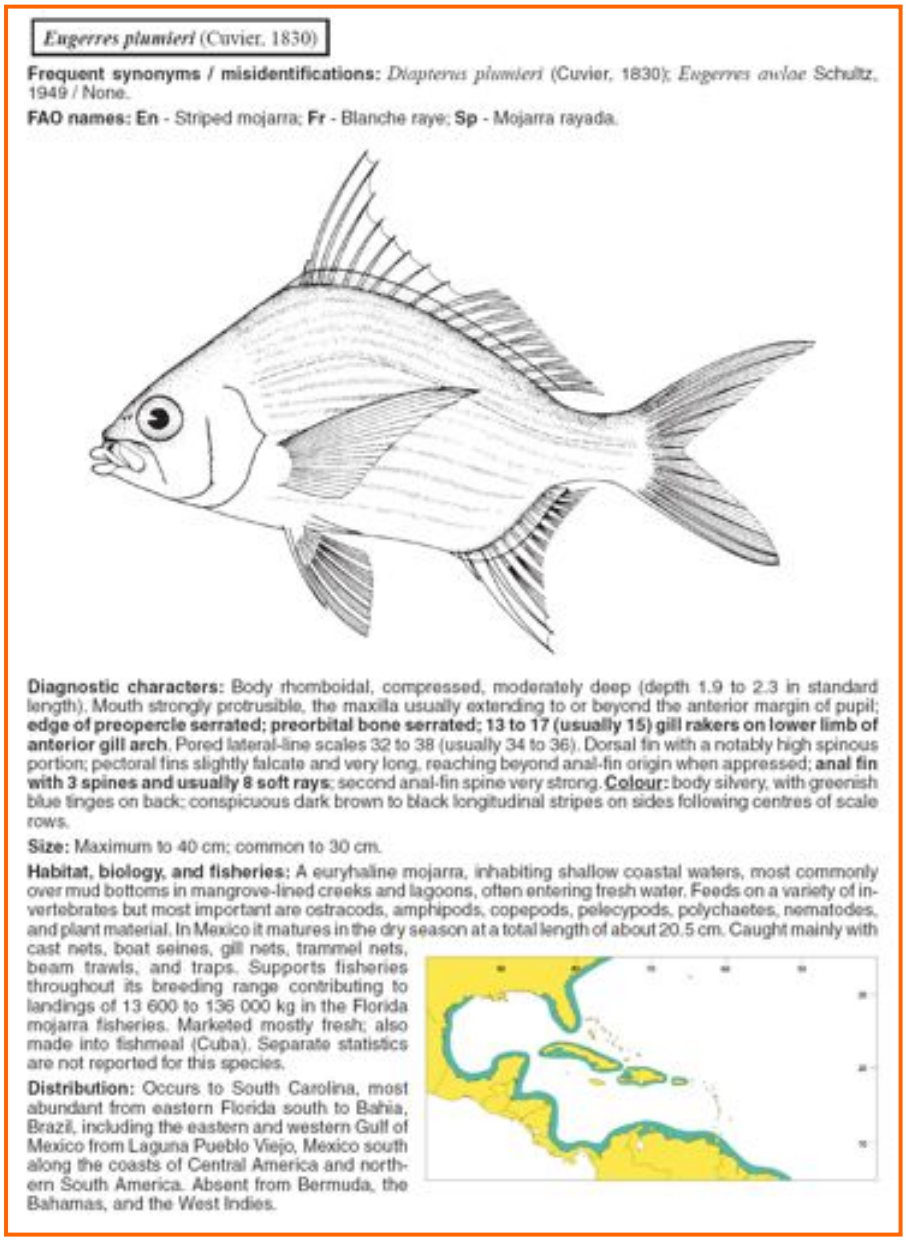


Figure 3.2-21. Striped Mojarra Diagnostics from Carpenter (2002)

3.2.1.9 *Bonefish*

***Albula vulpes* (Linnaeus, 1758)**

Spanish Names:
Albula vulpes is known in Puerto Rico variously as **Macaco**[13], **Conejo**[13], or **Ratón**[13], depending on region (Erdman 1987, Coupal *et al.* 1992, USGS 2000.), or as **Colvino**[13], **Piojo**[13], or **Macabí**[13] (Delgado 2004). In Spain it has been called Gato[14], Inliaula[14], Lisa Saltona[14], Peje Gato[14], Ratón[14], Ratón de Mar[14], Zorro[14] (Kotylar 1984), and Macabí[14] (FAO-FIDI 2006). In Ecuador, the bonefish is known as the Inllaulá[6], Liguija[6] (Béarez 1996), or Lisa Saltona[6] (Jiménez-Prado and Béarez 2004), and in Peru[12] as the Zorro (Chirichigno 1974). In the Spanish-speaking Caribbean it has been called Carajo[15] (Zaneveld 1983), Gatico[3] or Gato[3] (Coupal *et al. op cit.)*, Macabi[4,10,17] (Zaneveld 1983, Escobar-Fernández and Siri 1997, Nahím and Cervigón 2003), Macabí[4,5,10] (Coupal *et al. op cit.*, Claro 1994, De La Cruz-Agüero 1997, Nelson *et al.* 2004), Macabie[8] (Coupal *et al. op cit.*), Macabi de Hebra[11] (Sánchez 1997), Parra[4] (Coupal *et al. op cit.*), Pejegato[3] and Piojo[4] (Coupal *et al. op cit.*)), Ratón[17] (Nahím and Cervigón 2003), and Ratón de Mar[17] (Coupal *et al. op cit.*)

Superscript Country Designations:

1.Bahamas
2. Belize
3. Colombia
4. Cuba
5. Dominican Republic
6. Ecuador
7. Guadeloupe
8. Haiti
9. Martinique
10. México
11. Nicaragua
12. Peru
13. Puerto Rico
14. Spain
15. Trinidad & Tobago
16. USA
17. Venezuela

Figure 3.2-22. Bonefish

English Names:
The overwhelmingly prevalent name for *A. vulpes* in the English-speaking Greater Caribbean is "Bonefish" (Butsch 1939, Zaneveld 1983, Coupal *et al.* 1992, Böhlke and Chaplin 1993, Pollnac 1998, Claro and Parenti 2001, Nelson *et al.* 2004), but several other names also are used. These include Banana Fish (Zaneveld 1983, Kotlyar 1984), Bananafish, Banana, or Ladyfish (Zaneveld 1983), and Salmon Peel (Butsch 1939). Curiously, in India it is called the Long-Finned Eel (Talwar and Kacker 1984), and in the United Kingdom it is sometimes referred to as the Tarpon (Kotlyar 1984).

Taxonomy:

Class:	Actinopterygii (ray-finned fishes)
Order:	Albuliformes (bonefishes)
Family:	Albulidae (Bonefishes)
Subfamily:	Albulinae
Genus:	*Albula*
Species:	*vulpes*

The first recorded name for the bonefish was *Esox vulpes* (Linnaeus 1758), which was abandoned for the now accepted scientific name, *Albula vulpes* (Linnaeus, 1758). The species has in several instances been misidentified in the scientific literature. Of these, *Albula glossodonta* (Forsskål, 1775) and *Argentina glossodonta* (Forsskål, 1775), are now considered separate Indo-Pacific species (Fischer *et al.* 1990, Whitehead 1990). Others, on the other hand were simply misidentification, including *Albula argentea* (Forster, 1801) and *Esox argenteus* (Forster, 1801) (Eschmeyer 2000), and *Albula forsteri* (Vanlenciennes, 1847) and *Albula neoguinaica* (Valenciennes, 1847) (Whitehead 1990).

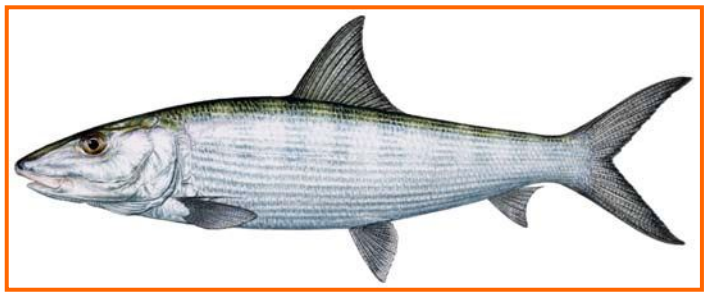


Figure 3.2-23. Bonefish (Rome Peebles 2007)

There have also been many cases of names that have been rejected as junior synonyms. These include *Clupea brasiliensis* Bloch & Schneider, 1801, *Albula conorynchus* Bloch & Schneider, 1801, *Amia immaculate* Bloch & Schneider, 1801,and *Albula plumieri* Bloch & Schneider, 1801 (Bloch and Schneider 1801); *Butyrinus bananas* Lacepède, 1803 and *Clupea macrocephala* Lacepède, 1803 (Lacepède 1803); *Engraulis bahiensis* Spix, 1829, *Glossodus forskalii* Spix & Agassiz, 1829, and *Engraulis sericus* Spix, 1829 (Spix and Agassiz 1829-31); *Albula goreensis* Valenciennes, 1847, *Albula parrae* Valenciennes, 1847, and *Albula seminuda* Valenciennes, 1847 (Cuvier and Valenciennes 1847*b*); *Albula rostrata* Gray, 1854 (Gray 1854); *Esunculus costai* Kaup, 1856 (Kaup 1856); *Atopichthys esunculus* Garman, 1899 (Garman 1899); and *Albula virgata* Jordan & Jordan, 1922 (Jordan and Jordan 1922).

Caribbean Distribution:
Albula vulpes is native to Puerto Rico (Evermann and Marsh 1902, Erdman 1960, 1967, 1976, Alexander 1961, Warmke and Erdman 1963, Saunders 1966*a*, 1966*b*, Ramsey 1967, Austoin 1971, Martin and Patus 1973, Whitehead 1978, Kimmel 1991, Dennis *et al.* 1991, Dennis 1992, Burger *et al.* 1992,) and to most of the Caribbean Region, including Antigua & Barbuda, Barbados, Belize, the British Virgin Islands, Cayman Islands, Dominica Grenada, Guadeloupe, Haiti, Jamaica, Martinique, Montserrat, Netherland Antilles, Saint Lucia, St. Vincent & The Grenadines, Turks & Caicos (Whitehead *op cit.*), Anguilla, St. Kitts & Nevis (FAO 1969), Aruba, Curaçao, Trinidad & Tobago, Venezuela (Cervigón *et al.* 1992), the Bahamas (Böhlke and Chaplin 1993), Bermuda, United States (Robins and Ray 1986), Colombia, Costa Rica, El Salvador, Guatemala, Honduras, México, Nicaragua, Panamá (Whitehead and Rodríguez-Sancez 1995), Cuba (Claro and Parenti 2001), Dominican Republic (Coupal *et al.* 1992), and the U.S. Virgin Islands (Ogden *et al.* 1975).

Biology:
A vulpes frequent the littoral and nearshore zones on sandy tropical coasts worldwide, and in the western Atlantic it ranges as far north as Long Island (Jordan and Evermann 1902). It inhabits shallow coastal waters, estuaries, and bays over sand and mud bottoms (Whitehead 1978). It is frequently found in schools, but older, larger individuals are more solitary (Robins

and Ray 1986). The bonefish can tolerate low dissolved oxygen levels by inhaling air into a lung-like air bladder (Lieske and Myers 1994).

Bonefish are able to forcefully expel water through the mouth by using the breathing mechanism as a pressure pump, with reversal of the normal direction of flow. When the fish finds a worm or mollusk on its sandy feeding grounds, it can uncover its prey by a jet of water from the mouth through the rapid adduction of gill covers (Lagler *et al.* 1962). They are also capable of producing sounds characterized as clicks, scratches, knocks, escape knocks, thumps, and booms (Fish and Mowbray 1970).

Bonefish have been reported to feed on cephalopods including squids and cuttlefish (Bruger 1974), finfish (Masuda and Allen 1993, Sierra *et al.* 1994) phytoplankton (Diouf 1996) and zoobenthos including crabs, shrimps and prawns, mollusks, and worms (Warmke and Erdman 1963, Sierra *et al.* 1994, Diouf 1996). Ciguatera poisoning has been reported in bonefish (Lagler *et al.* 1962, Halstead *et al.* 1990).

A. vulpes is a dioecious external spawner (Jones *et al.* 1978) that matures in its second year and lives to the age of about 9-10 years (Fish Base 2007). Bruger (1974) reported sexually mature females "just barely" one year old containing advanced mature oocytes. These fish were 210 – 338 mm SL, which we can convert using the morphometric measurements reported below to convert to 242 – 389 mm TL, weighing 227 – 680 g. Data provided by Alperin and Schaefer (1964) on West Indian bonefish seem to indicate that bonefish spawn in winter, November – December. Data reported by Alexander (1958, 1961), Bruger (1974), and Erdman (1960 *after* Bruger 1974) indicate spawning year around in Florida and Caribbean waters. Bonefish eggs develop into floating, nearly transparent leptocephalus larvae. *A. vulpes* has a minimum population doubling time of 1.4 – 4.4 years.

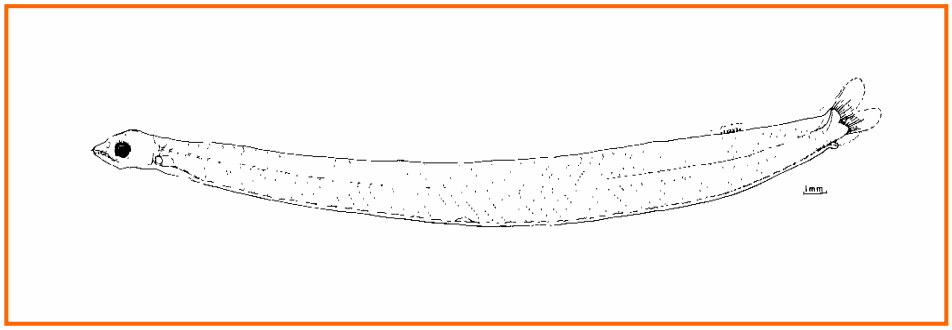


Figure 3.2-24. Bonefish Leptocephalus Larva 33.5 mm SL (after Eldred 1967)

Morphology:
The bonefish body is elongate and fusiform (Talwar and Jhingran 1991); it is brilliantly silver on its sides, with an olivaceous back, as the scales on the upper body surface have a greenish tint (Perlmutter 1961). The fish has a bluntly conical snout extending beyond an inferior mouth ((Smith 1997). Fins are plain and the upper lobe of the caudal fin is longer than the lower (Jordan and Evermann 1902). *A. vulpes* has no dorsal or anal fin spines; the dorsal fin has 15-19 soft rays and the anal fin has 7-9 soft rays; the species ha 12-14 branchiostegal rays

(Jones *et al.* 1978). Axillary scales occur on pectoral and pelvic fins, and a single long scale occurs on each side of the membrane between each ray of the dorsal and anal fins (Talwar and Jhingran 1991).

Two sets of morphometric measurements are reported in Fish Base (2007) – one specimen from Nicaragua and the other from Ecuador, which is somewhat different. This report is concerned with Caribbean populations, so the measurements reported here are from the Nicaraguan specimen. Morphometric measurements as a percentage of Fish Total Length are: Standard Length – 80.8%, Fork Length – 87.3%, Pre-anal Length – 70.9%, Pre-dorsal Length – 40.8%, Pre-pelvic Length – 50.3%, Pre-pectoral Length – 22.6%, Body Depth – 19.0%, Head Length – 22.5%, Eye Diameter – 14.7% of Head Length, Pre-orbital Length – 39.5% of Head Length (Fish Base 2007).

The maximum reported total length for *A. vulpes* is 104 cm (40.9 inches). Length-weight parameters *a* and *b* have been variously estimated at $a = 0.0073 – 0.0395$, and $b = 2.730 – 3.187$ (Campagno *et al.* 1989, Torres 1991, Claro and García-Arteaga 1994, Crabtree *et al.* 1996, García-Arteaga *et al.* 1997, García *et al.* 1998, Letourneur *et al.* 1998). The median values computed on Fish Base (2007) were used to construct the following length-weight curve.

$$\text{Weight} = a(L^b) = 0.0279\ (L^{2.8900})$$

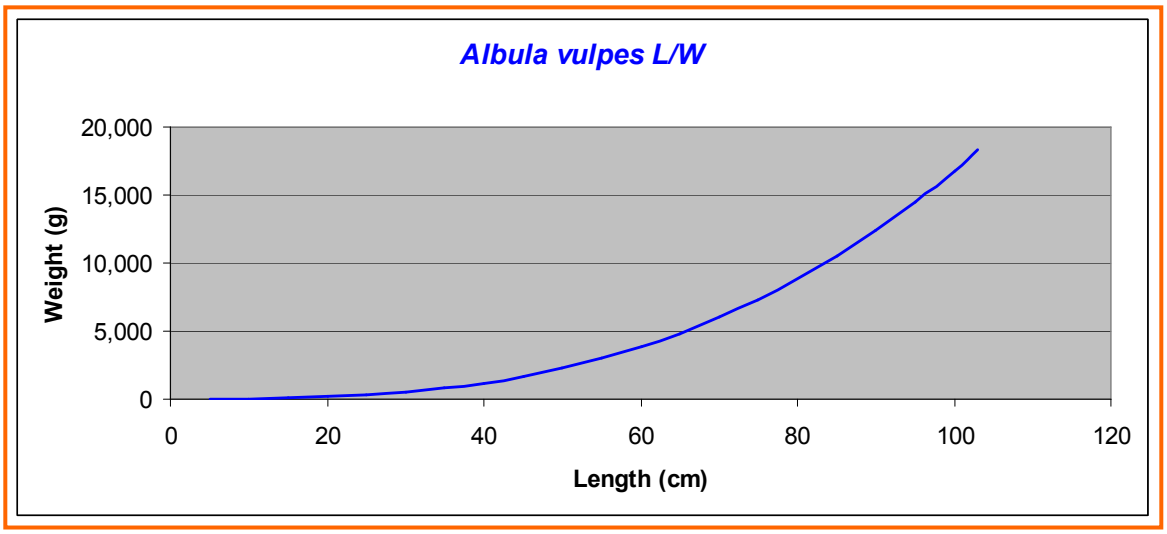


Figure 3.2-25. Length-Weight Curve for Bonefish

3.2.2 Other Species

Species discussed in this section were less frequently mentioned by interviewees during this program and were species presented above. Information presented in this section is extracted from species summaries provided by Fish Base (2007). The summary data are presented uncritically and without further cross-checking literature research, unlike some discussions presented in Subsection 3.2.1, above.

3.2.2.1 *False Herring – Harengula clupeola* (Cuvier, 1829)

Spanish Name: Escamúa

Class: Actinopterygii (ray-finned fishes)
Order: Clupeiformes (herrings)
Family: Clupeidae (herrings, shads, sardines, menhadens)

Maximum Size: 18.0 cm TL
Environment: Reef-associated; brackish; marine; depth range 0-50 m
Climate: Subtropical; 31°N - 7°S, 99°W - 47°W
Importance: Fisheries: minor commercial; usually bait
Resilience: High. Minimum population doubling time <15 months
Distribution: Western Atlantic: Gulf of Mexico and SE Florida to Northern Brazil, including Bahamas, the entire Caribbean and the West Indies
Morphology: Dorsal spines (total): 0-0; Dorsal soft rays (total): 15-21; Anal spines: 0; Anal soft rays: 12-23. Tooth-plate on tongue and tooth plate behind it (basihyal and basibranchials tooth plates) broad, their width about 3-5 times in their combined length, the basibranchial tooth plate with a distinct bulge in front. Scales fairly strongly attached, not easily lost. No dark pigment on dorsal fin tip. Silvery, with a dark greenish back. Diffuse yellow or pale orange spot at edge of opercle. Body slender, lower profile strongly curved.

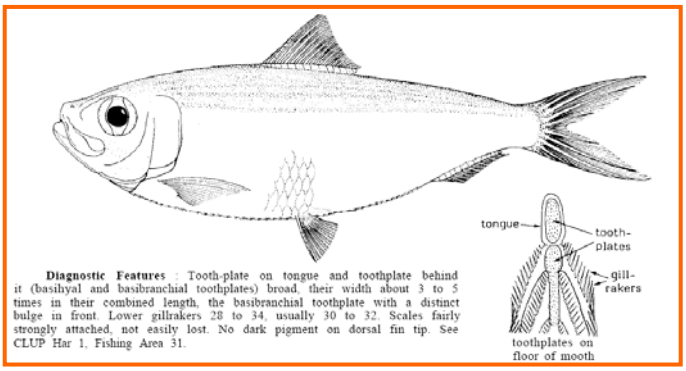


Figure 3.2-26. False Herring

Biology: Occurs in coastal waters, estuaries and lagoons, tolerating low salinities. Can tolerate a broad range of salinity levels. Forms schools, small individuals often along sandy beaches. Flesh has unpleasant odor. Utilized as fishmeal.

3.2.2.2 *Dwarf Herring – Jenkinsia lamprotaenia* (Gosse, 1851)

Spanish Name: Mijúa

Class: Actinopterygii (ray-finned fishes)
Order: Clupeiformes (herrings)
Family: Clupeidae (herrings, shads, sardines, menhadens)

Maximum Size: 7.5 cm TL
Environment: Reef-associated; marine; depth range 0-50 m
Climate: Subtropical; 34°N - 8°N, 100°W - 60°W
Importance: Fisheries: minor commercial; usually bait
Resilience: High. Minimum population doubling time <15 months
Distribution: Western Central Atlantic: Bermuda, Florida, Gulf of Mexico and Caribbean south to Tobago and Antilles.
Morphology: Dorsal spines (total): 0-0; Anal spines (total): 0; Vertebrae: 40-43 (usually 2-Venezuela). Lower gill raker counts, show some correlation with geographical area, suggesting that the species may comprise three races or subspecies. W-shaped pelvic scute; pre-maxillae toothed, 1 supra-maxilla; isthmus slender but with slight 'shoulders' anteriorly; silver lateral band not becoming narrower or fading near gill opening. Chest is slightly keeled. Small anal fin. Faintly greenish above.
Biology: A schooling species usually occurring inshore. Feeds on zooplankton. Preyed upon by many larger fishes and squids. Important as live bait for scombrids. In 1937, at Kingston, Jamaica, it spawns during the winter months. Travels long distances.

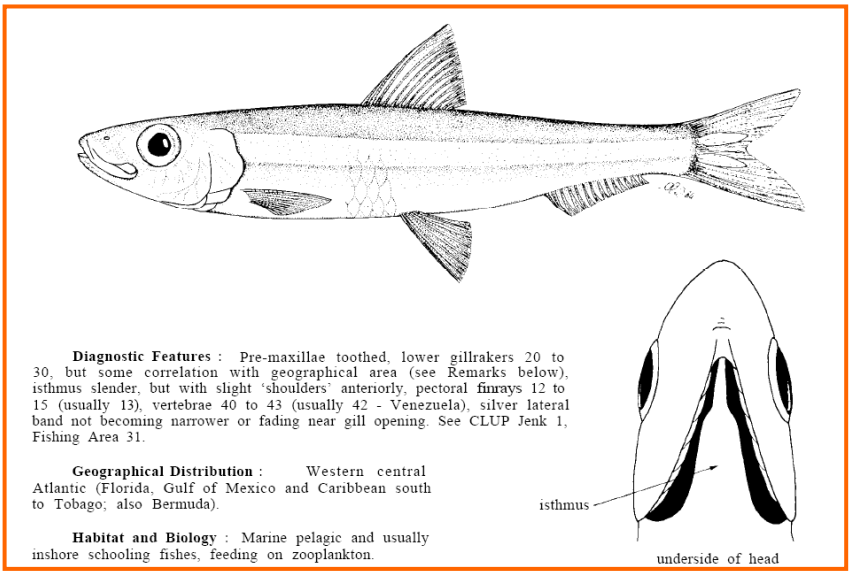


Figure 3.2-27. Dwarf Herring

3.2.2.3 *Bigeye Scad – Selar crumenophthalmus* (Bloch, 1793)

Spanish Name: Chicharro

Class: Actinopterygii (ray-finned fishes)
Order: Perciformes (perch-like fishes)
Family: Carangidae (jacks and pompanos)

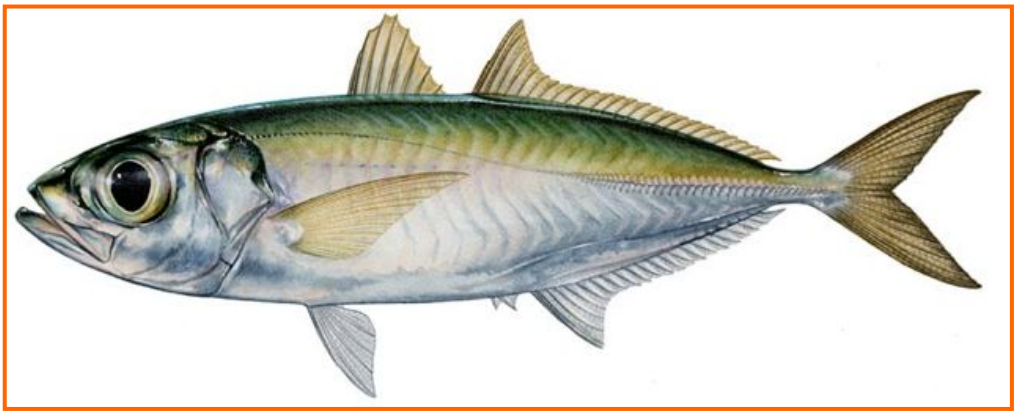


Figure 3.2-28. Bigeye Scad (Rome Peebles 2007)

Maximum Size: 70.0 cm TL
Environment: Reef-associated; marine; depth range 0-170 m
Climate: Subtropical; 47°N - 24°S, 140°W - 154°E
Importance: Fisheries: highly commercial; game fish and bait fish
Resilience: High. Minimum population doubling time <15 months
Distribution: Circumtropical. Indo-Pacific: East Africa to Rapa, north to southern Japan and the Hawaiian Islands, south to New Caledonia. Eastern Pacific: Mexico to Peru, including the Galapagos Islands. Western Atlantic: Nova Scotia, Canada and Bermuda through the Gulf of Mexico and the Caribbean to São Paulo, Brazil. Eastern Atlantic: Cape Verde to southern Angola.
Morphology: Dorsal spines (total): 9-9; Dorsal soft rays (total): 24-27; Anal spines: 3; Anal soft rays: 21-23. Body elongate and somewhat compressed; adipose eyelid very well developed, almost covering the entire eye; edge of shoulder girdle (cleithrum) with a ventral furrow, a large papilla located immediately about the furrow and another smaller one near the dorsal edge; lateral line with 29-42 scutes; lower branch of first gill arch with 27-31 gill rakers. Color metallic blue to bluish green dorsally, shade into white ventrally; the lateral yellow stripe sometimes present. Lower margin of gill opening with a deep furrow, a large papilla immediately above it and a smaller one near upper edge. Operculum with black spot. Straight part of lateral line with 0-11 scales and 29-42

cutes. First 2 anal spines detached; pectoral fins falcate.

Biology: Prefers clear oceanic waters around islands to neritic waters. Occasionally in turbid waters. Manly nocturnal. Feeds on small shrimps, benthic invertebrates, and forams when inshore, and zooplankton and fish larvae when offshore. Travels in compact groups of hundreds of thousands of fish. Marketed fresh and salted or dried. Reports of ciguatera poisoning.

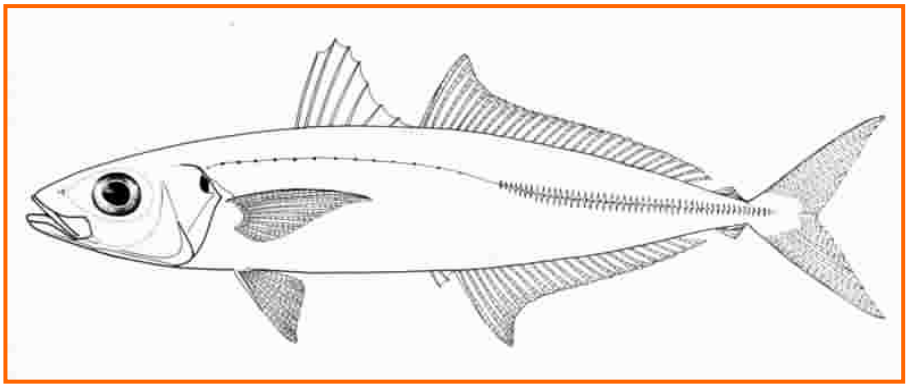


Figure 3.2-29. Bigeye Scad Features

3.2.2.4 *Liza Mullet – Mugil liza* (Valenciennes, 1836)

Spanish Name:	Lisa, Lisa Macho
Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Mugilidae (mullets)
Maximum Size:	80.0 cm TL. Maximum published weight = 9,000 g = 9.0 kg
Environment:	Demersal; freshwater; brackish; marine; depth range 10 -? M
Climate:	Subtropical; 32°N - 51°S
Importance:	Fisheries: commercial; Aquaculture: commercial
Resilience:	Medium. Minimum population doubling time = 1.4-4.4 years
Distribution:	Western Atlantic: Bermuda, Florida, Bahamas, and throughout the Caribbean Sea to Argentina
Morphology:	Dorsal spines (total): 5-5; Dorsal soft rays (total): 8-8; Anal spines: 3; Anal soft rays: 8
Biology:	Inhabits coastal marine waters and brackish estuaries; also found in hyper-saline lagoons and may enter freshwater. Never far from the sea. Forms sizeable schools. Appears to undergo trophic migrations along the coasts. Feeds on organic detritus and filamentous algae. Spawns several million eggs. Also caught with beach nets. Marketed fresh and salted. The roe is marketed salt-pickled and dried and considered a delicacy.

No Photo

3.2.2.5 *White Grunt – Haemulon plumierii* (Lacepède, 1801)

Figure 3.2-30. White Grunt

Spanish Name:	Boquicolorado
Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Haemulidae (grunts)
Maximum Size:	53.0 cm TL. Maximum published weight = 4,380 g = 4.38 kg
Environment:	Reef-associated; marine; depth range 3-40 m.
Climate:	Subtropical; 39°N - 23°S
Importance:	Fisheries: minor commercial. Game fish: yes. Public aquariums.
Resilience:	Medium. Minimum population doubling time = 1.4 – 4.4 years; Fecundity = 64,000
Distribution:	Western Atlantic: Chesapeake Bay, through the Gulf of Mexico and Caribbean
Morphology:	Dorsal spines (total): 12-12; Dorsal soft rays (total): 17-17; Anal spines: 3; Anal soft rays: 9. Side of head has narrow blue striped; scales above lateral line much larger than those below. Scale rows just below lateral line oblique; color variable but usually light yellowish.
Biology:	Found in dense aggregations during the day on patch reefs, around coral formations, or on sandy bottoms. Juveniles common in *Thalassia testudinum* beds. Feeds on crustaceans, small mollusks, and small fishes. Frequently exhibits a territorial 'kissing' display in which two contenders push each other on the lips with their mouths wide open. Marketed fresh. Has been reared in captivity. Reports of ciguatera poisoning.

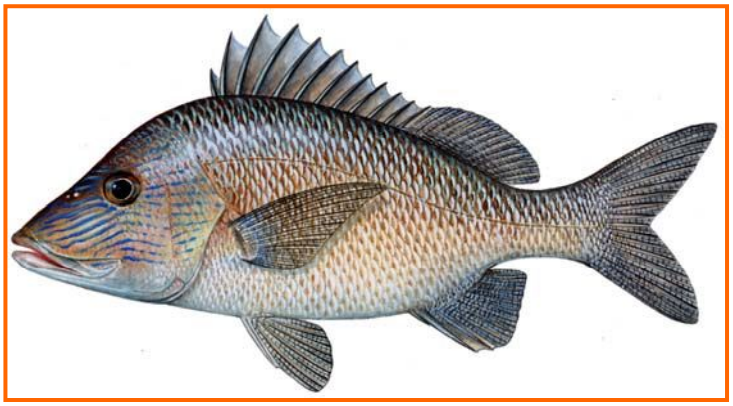


Figure 3.2-31. White Grunt (Rome Peebles 2007)

3.2.2.6 *Burro Grunt – Pomadasys crocro* (Cuvier, 1830)

Spanish Name: Viejo

Class: Actinopterygii (ray-finned fishes)
Order: Perciformes (perch-like fishes)
Family: Haemulidae (grunts)

Figure 3.2-32. Burro Grunt

Maximum Size: 38.0 cm TL. Maximum published weight = 1,850 g = 1.85 kg
Environment: Demersal; Amphidromous; freshwater; brackish; marine; depth range ? -120 m
Climate: Tropical; 25-28°C
Importance: Fisheries: minor commercial. Aquarium: public aquariums
Resilience: Medium. Minimum population doubling time = 1.4-4.4 years.
Distribution: Western Atlantic: southern Florida, northeastern Gulf of Mexico; throughout the Caribbean southward to Brazil
Biology: Inhabits rivers and creeks of low to high current velocity. Found along sandy shores and over mud bottoms in shallow water, quite common in brackish mangrove-lined lagoons. Often ascends rivers more than 100 miles from the sea. Feeds on crustaceans and small fishes. Marketed fresh.

3.2.2.7 *Rhomboid Mojarra – Diapterus rhombeus* (Cuvier, 1829)

Spanish Name:	Mojarreta
Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Gerridae (mojarras)
Maximum Size:	40.0 cm TL
Environment:	Demersal; brackish; marine; depth range 9-70 m
Climate:	Tropical
Importance:	Fisheries: minor commercial
Resilience:	Medium. Minimum population doubling time = 1.4 – 4.4 years
Distribution:	Western Atlantic: southern Gulf of Mexico, Central America and the Antilles to Brazil
Biology:	Common in mangrove-lined lagoons; also found over shallow mud and sand grounds in marine areas. Juveniles common in hypersaline lagoons and in brackish water. Probably feeds on small benthic invertebrates. Marketed fresh but not highly esteemed.

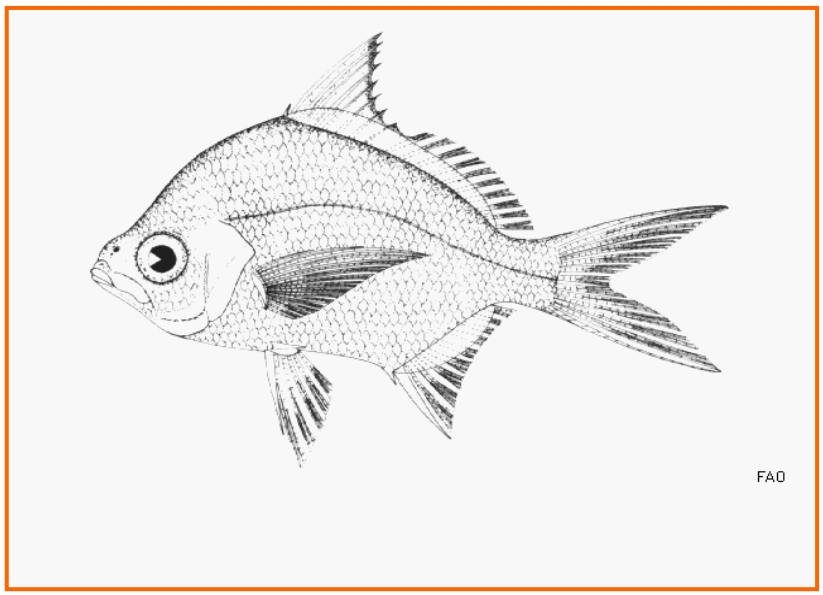


Figure 3.2-33. Rhomboid Mojarra

3.2.2.8 *Sea Bream – Archosargus rhomboidalis* (Linnaeus, 1758)

Spanish Name:	Chopa, Cagona
Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Sparidae (porgies)
Maximum Size:	33.0 cm TL. Maximum published weight = 550 g = 0.55 kg
Environment:	Reef-associated; brackish; marine
Climate:	Subtropical; 22-34°C, 41°N - 33°S
Importance:	Fisheries: commercial
Resilience:	High. Minimum population doubling time <15 months
Distribution:	Western Atlantic: New Jersey, USA and northeastern Gulf of Mexico to Argentina. Absent from the Bahamas.
Morphology:	Dorsal spines (total): 13-13; Dorsal soft rays (total): 10-11; Anal spines:3; Anal soft rays: 10-11. Large intestine makes up 90% of digestive tract and is twice the standard length, on average; the stomach with 7 digestive caeca attached near the pyloric region. Pelvic fin coloration totally or partially dark in males; orange colored in females. Large dark spot (about same size as eye) below lateral line just behind gill openings.
Biology:	Commonly found over mud bottoms in mangrove sloughs and on vegetated sand bottoms, sometimes in brackish water and occasionally also in coral reef areas near mangroves. Feeds on benthic invertebrates, including small bivalves and crustaceans, as well as on plant material.

Figure 3.2-34. Sea Bream

3.2.2.9 *Jack Crevalle – Caranx hippos* (Linnaeus, 1766)

Figure 3.2-35. Crevalle Jack

Spanish Name:	Jurel
Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Carangidae (jacks and pompanos)
Maximum Size:	124 cm TL. Maximum published weight = 32.0 kg
Environment:	Reef-associated; oceanodromous; brackish; marine; depth = 1-350 m
Climate:	Subtropical; 45°N - 33°S, 98°W - 14°E
Importance:	Fisheries: commercial; Game Fish and Public Aquariums
Resilience:	Medium. Minimum population doubling time 1.4-4.4 years
Distribution:	Eastern Atlantic: Portugal to Angola, including the western Mediterranean. Western Atlantic: Nova Scotia, Canada and northern Gulf of Mexico to Uruguay, including the Greater Antilles. Absent from eastern Lesser Antilles. Indian Ocean records are probably misidentifications of *Caranx ignobilis*. Reports from Pacific refer to *Caranx caninus*.
Morphology:	Dorsal spines (total): 9-9; Dorsal soft rays (total): 19-21; Anal spines: 3; anal soft rays: 15-17. Scutes 25to 42; no scales on chest, except for a small mid-ventral patch in front of pelvic fins; upper profile of head steep; Maxilla ending approximately below posterior edge of eye; front of soft dorsal and anal fins elevated; olivaceous to bluish green dorsally, silvery to brassy on the sides; prominent black spot posteriorly on gill cover at level of eye, another at upper axil of pectoral fins, and often a third on lower pectoral rays; caudal yellowish.

Figure 3.2-36. Crevalle Jack (Rome Peebles 2007)

Biology: Generally in neritic waters over the continental shelf. Ascends rivers. Juveniles abundant in brackish estuaries with muddy bottoms, near sandy beaches and on seagrass beds. Forms fast-moving schools, although larger fish may be solitary. Feeds on smaller fish, shrimp, and other invertebrates. Reports of ciguatera poisoning.

3.2.2.10 *Cero Mackerel – Scomberomorous regalis* (Bloch, 1793)

Spanish Name: Sierra Alasasna

Class: Actinopterygii (ray-finned fishes)
Order: Perciformes (perch-like fishes)
Family: Scombridae (mackerels, tunas, bonitos)

Figure 3.2-37. Cero Mackerel (Rome Peebles 2007)

Maximum Size: 183 cm TL. Maximum published weight = 7,760 g = 7.76 kg
Environment: Reef-associated; oceanodromous; marine; depth range 1-20 m
Climate: Tropical; 41°N - 5°N, 99°W - 53°W
Importance: Fisheries: minor commercial; Game fish
Resilience: Medium. Minimum population doubling time = 1.4 -44. years; Fecundity = 160,000
Distribution: Western Atlantic: Massachusetts USA to Brazil, including the Bahamas and West Indies
Morphology: Dorsal spines (total): 16-18; Dorsal soft rays (total): 15-19' Anal spines:0; Anal soft rays: 15-20; Vertebrae: 47-48. Interpelvic process small and bifid. Lateral line gently curving down toward caudal peduncle. Intestine with 2 folds and 3 limbs. Swim bladder absent. Body covered with small scales. Anterior third of first dorsal fin black. Pelvic fins relatively long. Sides silvery with one long mid-lateral stripe and with several rows of yellow-orange streaks of variable length and small yellow spots above and below the stripe.
Biology: Most abundant in clear waters around coral reefs, occasionally forming schools. Feeds on clupeoids (*Harengula, Jenkinsia* and *Opisthonema*) and atherinids (*Allanetta* = *Craterocephalus*), squids and shrimps. Good food and game fish. Utilized fresh, smoked and frozen; consumed pan-fried, broiled and baked. Sometimes called the "Painted Mackerel." Reports of ciguatera poisoning.

3.2.2.11 *King Mackerel – Scomberomorous cavalla* (Cuvier, 1829)

Spanish Name: Carite,Sierra

Class: Actinopterygii (ray-finned fishes)
Order: Perciformes (perch-like fishes)
Family: Scombridae (mackerels, tunas, bonitos)

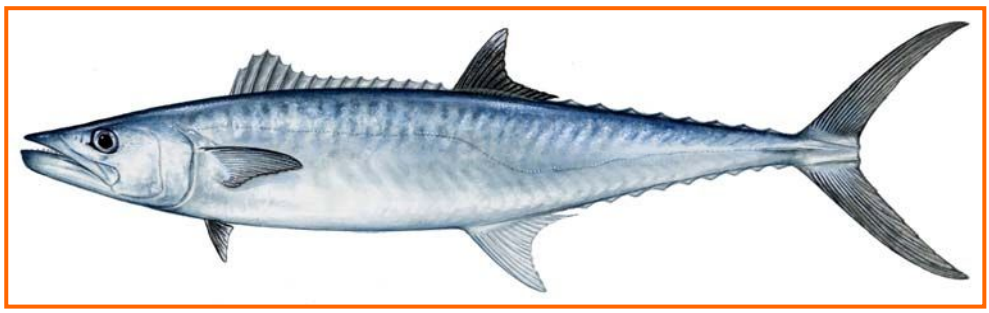


Figure 3.2-38. King Mackerel (Rome Peebles 2007)

Maximum Size: 184 cm TL. Maximum published weight = 45.0 kg. Maximum reported age = 14 years.
Environment: Reef-associated; oceanodromous; marine; depth range 5-140 m
Climate: Tropical; 44°N - 22°S, 98°W - 34°W
Importance: Fisheries: commercial; Game Fish
Resilience: Low. Minimum population doubling time = 4.5 – 14 years; Fecundity = 70,000
Distribution: Western Atlantic: Massachusetts USA to São Paulo, Brazil. Eastern Central Atlantic: St. Paul's Rocks.
Morphology: Dorsal spines (total): 12-18; Dorsal soft rays (total): 15-18; Anal spines: 0; Anal soft rays: 16-20; Vertebrae: 41-43. Interpelvic process small and bifid. Swim bladder absent. Lateral line abruptly curving downward below second dorsal fin. Intestine with 2 folds and 3 limbs. Adults have no black area on the anterior part of the first dorsal fin. Juveniles with bronze spots in 5 or 6 irregular rows. Body entirely covered with scales.
Biology: Often found in outer reef areas. Larvae are encountered in surface waters of 26.3 - 31°C and 26.9 – 35 ppt. Feeds primarily on fishes with smaller quantities of penaeid shrimps and squids. Large schools have been found to migrate over considerable distances along the Atlantic US coast, water temperature permitting. This is an important species for recreational, commercial, and artisanal fisheries throughout its range. Most of the catch is processed into steaks or sold fresh, or sometimes canned and salted. Also prepared smoked and frozen. Potentially ciguatoxic in certain areas.

3.2.2.12 *Albacore – Thunnus alalunga* (Bonnaterre, 1788)

Spanish Name:	Albacora
Class:	Actinopterygii (ray-finned fishes)
Order:	Perciformes (perch-like fishes)
Family:	Scombridae (mackerels, tunas, bonitos)
Maximum Size:	140 cm FL. Maximum published weight = 60.3 kg
Environment:	Pelagic; oceanodromous; marine; depth range 0-600 m
Climate:	Subtropical; 10-25°C; 59°N - 46°S, 180°W - 180°E
Importance:	Fisheries: highly commercial; Game Fish
Resilience:	Medium. Minimum population doubling time = 1.4 – 4.4 years; Fecundity = 2 million
Distribution:	Cosmopolitan in tropical and temperate waters of all oceans including the Mediterranean Sea, but not at the surface between 10°N and 10°S. Western Pacific: range extends in a broad band between 40°N and 40°S. Often confused with juvenile *Thunnus obesus* which also have very long pectorals but with rounded tips. Highly migratory species, Annex I of the 1982 Convention on the Law of the Sea.
Morphology:	Dorsal spines (total): 11-14; Dorsal soft rays (total): 12-16; Anal spines: 0; Anal soft rays: 11-16. Anterior spines much higher than posterior spines, giving the fin a strongly concave outline. Interpelvic process small and bifid. Body with very small scales. Pectoral fins remarkably long, about 30% of Fork length or longer in 50 cm or longer fish. Ventral surface of liver striated and the central lobe is largest.
Biology:	An epipelagic and mesopelagic, oceanic species, abundant in surface waters of 15.6° to 19.4°C; deeper swimming, large albacore are found in waters of 13.5 – 25.2°C; temperatures as low as 9.5°C may be tolerated for short periods. Known to concentrate along thermal discontinuities. Form mixed schools with skipjack tuna (*Katsuwonus pelamis*), Yellowfin tuna (*Thunnus albacares*) and bluefin tuna (*T. maccoyii*); schools may be associated with floating objects, including Sargassum weeds. Feed on fishes, crustaceans and squids. Highly appreciated and marketed fresh, smoked, deep frozen or canned. Eaten steamed, broiled, fried and micro-waved. Sexual maturity reached at 90 cm.

Figure 3.2-39. Albacore

3.2.2.13 *Little Tunny – Euthynnus alletteratus* (Rafinesque, 1810)

Spanish Name: Vaca, Bonito

Class: Actinopterygii (ray-finned fishes)
Order: Perciformes (perch-like fishes)
Family: Scombridae (mackerels, tunas, bonitos)

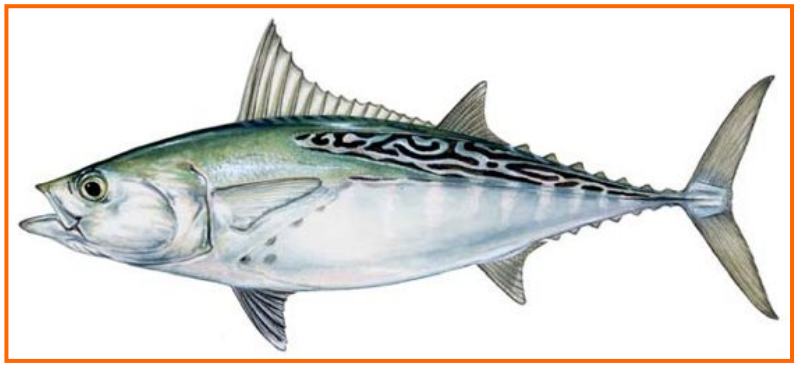


Figure 3.2-40. Little Tunny (Rome Peebles 2007)

Maximum Size: 122 cm FL. Maximum published weight = 16.5 kg. Maximum reported age = 10 years.
Environment: Reef associated; oceanodromous; brackish; marine; depth range 1-150m
Climate: Tropical; 56°N - 30°S, 92°W - 42°E
Importance: Fisheries: Commercial; Game Fish
Resilience: Medium. Minimum population doubling time = 1.4 – 4.4 years; Fecundity = 71,000
Distribution: Atlantic Ocean: in tropical and subtropical waters, including the Mediterranean, Black Sea, Caribbean Sea and Gulf of Mexico. Highly Migratory Species, Annex I of the 1982 Convention on the Law of the Sea.
Morphology: Dorsal spines (total): 15-16; Dorsal soft rays (total): 11-13; Anal spines: 0; Anal soft rays: 11-15; Vertebrae: 39. Anterior spines of first dorsal fin much higher than those mid-way, giving the fin a strongly concave outline. Interpelvic process small and bifid. Body naked except for corselet and lateral line. Swim bladder absent. Incipient protuberances on 33rd and 34th vertebrae. Back with broken oblique stripes. Caudle peduncle with 7-8 finlets. Dark stripes on the back and with 3-7 dark spots between pelvic and pectoral fins.
Biology: Found in neritic waters close inshore. This schooling species is an opportunistic predator feeding on virtually everything within its range, i.e. crustaceans, fishes (mainly clupeoid), squids, heteropods, and tunicates. Specialized traps (madragues) are used in Tunisia and Morocco. Diving bird flocks may indicate large schools. Utilized fish, dried-salted, smoked, canned and frozen. A popular game fish. Reports of ciguatera poisoning.

3.3 RIGS AND RIGGING

Terminal tackle used with natural baits in Puerto Rico ranges from the very simple and straightforward to very sophisticated. The rig used depends upon the area fished, target species, bait availability, cost, and level of expertise or energy of the fisher. Terminal tackle is as variable as the number of fishers, so it is impossible to consider every variable here, but several of the more common rigging options are discussed below.

3.3.1 Inshore and Bottom Rigs

"Free-lining" uses the very simplest terminal tackle possible, as it consists merely of a hook tied to the end of the line. It may be fished this simply, or the angler may elect to insert a leader between the line and the hook, either as a "shock leader" to absorb the sudden force from a fish strike, to increase abrasion-resistance, or to reduce line visibility. The bait, which may be alive or dead, is impaled on the hook, and cast into the water. The idea is to minimize drag on the bait so that a live bait will swim freely, although attractively distressed, and a dead bait will behave like a piece of freely floating or drifting meat. Because the object is to minimize tackle weight or "drag," in-line swivels and clips are generally not used when free-lining.

Figure 3.3-1. Lip-hooked mojarra for free-lining. Note that the hook is inserted in the over-lip for secure hookup.

Figure 3.3-2. Bottom Rig

Many fishers using a hand line yo-yo or rod and reel to fish on the bottom use a simple bottom rig consisting of a weight or sinker tied onto the end of the line, and one or two dropper lines with hooks tied into the rig above the weight. The dropper lines may be attached using three-way swivels, but they are more commonly attached using an overhand loop knot (See Fig. 3.3-19) or a surgeon's loop knot (McNally 1993)(See Fig. 3.3-20). Dropper loops are occasionally seen (Budworth 1999, TPI, Inc. 1995) (See Fig. 3.3-21).

Figure 3.3-3. Slip sinker rig for mutton snapper

Another bottom rig sometimes seen, such as among mutton snapper fishers in the Piñones area, is a kind of fish-finder rig, or sliding egg sinker rig (Dunaway 1984). The line or leader is inserted into one or two egg sinkers, and a swivel is then tied onto the line. A leader with a hook is then tied to the other end of the swivel to complete the rig. If a swivel is not desired other stoppers may be used, such as a split shot, a split ring, or any other

small device. The idea of this rig is that a fish may take the bait and begin to carry it away without being frightened away by feeling resistance.

Another effective rig used offshore of Manaubo Municipality consists of a wire leader attached to the main monofilament line. A sliding egg sinker is slid onto the wire leader, and a weighted jig is attached to the terminal end of the wire leader. The wire leader was about 4 ft long and a wire crimp was attached about half-way along its length, with the egg sinker placed above the crimp. The egg sinker is therefore free to slide between the line attachment and the crimp, but the crimp keeps it about 2 ft from the jig. This rig may be fished with our without natural bait on the jig, as the fisher wishes, and depending upon the kind of jig used.

Figure 3.3-4. A palangre, or Christmas tree rig

A more ambitious rig that blurs the line between recreational and commercial fishing is the commonly used Christmas Tree Rig (or vertical "Palangre"), which is similar to the bottom rig discussed above, but incorporates 10-12 dropper hooks rather than 1-2. Circle hooks are often used on these rigs so that fish tend to hook themselves without the line having to be constantly tended. Fishers using this rig frequently deploy multiple lines leaving them in the water attached to floats while they tend additional lines. Lead window sash weights are commonly tied onto the terminal end of these rigs. After a period of time, usually about an hour, they are hauled aboard the boat using a winch or motorized reel. In effect, these rigs are miniature vertical longlines. The typical recreational fisher will use 1-3 of these rigs concurrently, and has been known to sell extra fish at the end of the day.

Figure 3.3-5. A Dacron-rigged palangre

Figure 3.3-6. A 3-way swivel rig

Figure 3.3-7. Sash weights

3.3.2 Offshore Trolling Rigs

Offshore fishers spend a great deal of time seeking their quarry by trolling over large expanses of water at speeds of 6-10 knots, with the higher end of this range being used primarily for artificial baits. When a concentration of fish is found, anglers will sometimes cast or slow troll live or dead natural baits as well as artificial lures, but the majority of time is spent in exploratory trolling. Many natural bait species are used in trolling, including small tunas and mackerels, bonefish, mullet, and other small species, but by far the most commonly trolled natural bait in Puerto Rico is the Ballyhoo (*Hemiramphus brasiliensis*), or Balao (*H. balao*). Other species may be used when they are opportunistically available, but all offshore anglers use Ballyhoo and Balao on a routine basis.

Figure 3.3-8. Rigging a Ballyhoo

Figure 3.3-9. Ready to fish

The basic trolling rig for Ballyhoo is constructed by inserting a hook under the gill plate, extending the hook into the body, and bringing the hook point through the belly to protrude under the fish. The head area is then secured to the hook using any of several commonly used methods.

Figure 3.3-10. Pin rig with rigging wire attached

For marlin and other billfish, both wire and heavy monofilament leaders are used. If wire, then the hook is generally attached using a haywire twist, leaving a small "pin" of wire sticking up from the leader when breaking or trimming the tag end of the wire. This pin is inserted through the lower jaw of the bait, through its mouth, and all the way through the top of its head to help maintain the position of the bait on the hook. A short piece of rigging wire is also attached to the hook, and is used to tie the head of the bait to the hook by passing it through the baits eye cavities and around the bait's head and bill, then around the hook shank and leader to hold them securely together. There is no exact routine for wrapping this wire, and numerous methods were observed during this program, but all require that the head is wrapped tightly to maintain the position of the "pin," and the bill is wrapped securely to the leader (Dunaway 1984). The rigged bait may then be trolled "naked," or with a skirted lure such as a squid-type skirt over it. These skirts serve as attractants as well as to protect the bait, making them serviceable for longer durations. To fish these baits a bit deeper, slip-sinker weights are also sometimes added to these rigs, either held in place with the rigging wire or slid onto the leader between the Ballyhoo and the squid skirt.

Figure 3.3-11. Single-hook Ballyhoo Rig

Figure 3.3-12. Ballyhoo rig with artificial skirt

Ballyhoo also are sometimes rigged with a second hook behind the first, or with a "stinger" hook, when baits are being "short-struck" with few hookups. For the most part, however, most fishers use a single hook rig.

When fishing for Wahoo and Dorado, many fishers simplify this Ballyhoo rig with a quicker, but more fragile, version. In this case, a monofilament leader is crimped to the hook leaving a small tag piece outside the crimp. This piece is then bent upward and trimmed at an angle to make a sharp point. This point is then inserted through the head of the bait, serving as the "pin" described above. Rather than wrapping the bait with rigging wire, however, a small rubber band is placed over this monofilament pin and around the bait's head once or twice, then over the pin again, securing the head to the leader (Figure 3.3-26). This rig is considered adequate for Wahoo and Dorado, which generally strike the bait aggressively, but it is not considered adequate for Marlin, which are said to "play" with the bait, potentially disrupting its presentation and making it unattractive to the target fish. In the latter case, a more substantial rigging is regarded as necessary (Figure 3.3-25).

Figure 3.3-13. Ballyhoo rig with small skirt

The classic rig for mullet, mackerel and similar bait species is constructed somewhat differently. In this case, the eye of the hook remains inside the bait's mouth, and is held in place with the leader material. The hook is first laid along the bait with the eye of the hook even with the eye of the bait fish, and the location where the hook will exit the body is noted. A small hole is then made in the belly at this point, and the hook is inserted into this hole eye-first, maneuvering the eye into the bait's mouth from behind, and positioning the eye under or very slightly ahead of the bait's eyes. The leader material – wire or monofilament – is then run through the bottom jaw, through the hook eye, and then through the top of the bait's head. The tag end is then brought forward and is attached to the standing line using a Haywire Twist for wire leader, or a crimp for a mono leader. The leader should be secured close enough to the bait's mouth to keep it closed when trolling, but the mouth and the gills may also be sewn closed to secure them. Excellent illustrations of this method are provided by McEnally and McEnally (2006, p. 62).

A wide variety of rig variations is used by individual fishers or at different times under different conditions, but the rigs discussed above probably account for >95% of the angling time in Puerto Rico. Steps involved in making these basic Ballyhoo rigs are demonstrated here in Figures 3.3-22 to 3.3-26.

Slow trolling with live bait is often done by simply hooking the bait through its nose, side to side. The baits do not last long using this method, however, so a longer lasting bait is often

rigged using a "bridle." A common configuration is made by tying a short length of leader material to the bend of the hook. The other end is then sewn through the bait's head using a needle inserted at the forward edge of the bait's eye cavity, exiting at the forward edge of the other eye. This tag end is then also secured to the bend of the hook, which is then centered on the bait's head. The hook is therefore not in the bait, but is ahead of the bait as it is trolled. A simpler method of accomplishing the same thing is to substitute a plastic electrician's cable tie, which is inserted through the bait's head, as above. It is then secured to itself in front of the bait's head, and the hook is inserted behind the tie, which serves as a bridle.

Many other rigs are occasionally used, and good descriptions may be found in several references, including Dunaway (1984), Goadby (1991, 1996), Hall (2002), McEnally and McEnally (2006), TPI (1994, 1997) as examples. An excellent article describing several methods for rigging small mackerel is provided by Wright (2006).

Figure 3.3-14. Strip bait lure

Another natural bait commonly used for trolling, especially for Wahoo and Dorado, is the cut strip bait, which consists of strips cut from the white under part of a baitfish. In Puerto Rico, they are commonly cut from small tuna, but they may also be taken from mackerel, Dorado, Barracuda, or any other fish with a white belly. The strip is fished with either a two-hook rig or with a single hook rig employing a pin similar to a Ballyhoo rig. The pin or forward hook is required to keep the bait from sliding down the rear hook, which would detract from its attractiveness as bait. The strip is usually cut in a teardrop or wedge shape, and is generally about ¼ inch thick, and it is usually fished with an artificial skirt or squid.

Figure 3.3-15. Cutting Strip Baits

Figure 3.3-16. Strip Bait Donor

Circle hooks are now required by NOAA when using natural baits during billfish tournaments in U.S. waters. These hooks do not perform as designed if they are embedded in the bait; the inside gap of the circle hook must be unobstructed so that the bend of the hook may curl around the margin of the target fish's mouth and hook it properly.

Figure 3.3-17. Typical Circle Hook Rig

The circle hook is properly rigged with a bridle similar to that described for slow trolling live bait,

above, but additional support is required for higher speed trolling of dead natural baits. There are several methods for accomplishing this.

One method uses a length of rigging wire on which a small loop is tied onto one end with a haywire twist (WCBRT 2007). The other end of the wire is passed downward through the Ballyhoo head and lower jaw, then through the eye sockets, down around the belly and upward behind the gill plate, thence over the back and down behind the other gill plate. The wire is then passed upward through the head using the same holes as made earlier, and is then wrapped around the ballyhoo head, bill and the looped end of the wire to secure them together. The circle hook is then passed through the loop for trolling. Other methods for constructing a circle hook bridle from 35-lb test floss are clearly presented by Hamlin (2002).

3.3.3 The Circle Hook

Use of the circle hook deserves special discussion as it relates to the recreational fisheries of Puerto Rico. This hook has been used for some time by the long line industry, because it increases fish hookups and decreases turtle mortalities on untended lines as compared to the traditional "J" hook, but its use in recreational fisheries has increased in recent years because it results in decreased mortality among released fish. The decreased mortality has been appreciated by commercial fishing guides whose livelihood depends on catch-and-release fisheries such as tarpon and snook, and they are using these hooks almost exclusively. In addition, the National Oceanic and Atmospheric Administration recently promulgated new regulations requiring the use of circle hooks when natural baits are used in billfish tournaments in United States waters.

Figure 3.3-18. Circle Hook

A recent study by Horodysky and Graves (2005) determined that circle hooks decreased mortality among released white marlin by two-thirds as compared to J hooks. Similarly a recent review of 43 studies of circle hooks determined that release survival was generally about twice as high with circle hooks compared to J hooks (Cook and Suski 2004).

Because the circle hooks point is directed at the shaft of the hook, it tends to be prevented from catching in the throat of the biting fish, especially in the case of the non-offset type of circle hook. As the line tightens and drags the hook across the corner of the swimming fish's mouth, the hook's configuration causes it to turn on itself, tending to hook on the outside margin of the jaw, where mortal damage is unlikely. Hook removal is also easier when the fish is hooked in the corner of the jaw rather than in the throat or gut. Fisher satisfaction is also greater when he observes a released healthy fish swimming away, as opposed to watching a dying and distressed victim floating away.

The beneficial hooking characteristics of the circle hook are magnified if a proper snelling knot is used to connect it to the line. The advent of this hook and its benefits are notable, and considered worthy of attention and promotion. Four knots appropriate for snelling a circle hook are therefore illustrated here. These are (1) the "quick" (McNally 1993) or "simple" (Budworth 1999) snell, (2) the traditional or "Salmon" snell (McNally 1993), (3) the Uni-knot (Dunaway 1984), and (4) a knot shown us by Jerry Perez of Puerto Real (Cabo Rojo) which we refer to as the "inside-out" snell because of its configuration, or as the Guatemalen snell, because this is where Jerry learned the knot.

The quick snell is tied by passing the line through the hook eye, wrapping 4-6 turns around the shank starting behind the eye and toward the hook bend, then inserting the tag end between the standing line and the hook eye, behind the eye. The knot is then pulled tight (Figure 3.3-27).

The traditional snell knot is tied by passing the line through the hook eye and making a doubling loop. The loop is then grasped and wound around the shank from the eye toward the bend, making sure that the entire loop passes over the bend of the hook at each turn. After 4-6 loops are made, the knot may be tightened by pulling on the tag end while holding the standing line. An additional following hook may be added to this rig by making the tag end long enough to extend behind this hook long enough to use the same knot on a second hook (Figures 3.3-28 and 3.3-29).

The Uni-Knot is made by passing the line through the hook eye and making a doubling loop with the tag end passing toward the bend of the hook. The tag end is then wrapped around the hook shank 4-6 times, passing through the loop with each turn. The knot may then be tightened by pulling on the standing line while holding onto the tag end (Figure 3.3-30).

Finally, the "inside-out" snell is tied by passing the line through the hook eye, doubling the line, and then wrapping the tag end around both the shank of the hook and the standing line, beginning at the hook bend and progressing toward the eye. After 4-6 turns, the tag end is then passed through the loop at the tail of the know – or at the bend of the hook -- and the know is tightened by pulling on the standing line while holding the tag end tightly. Note that the portion of the line passing from the head of this knot to the insertion point at the tail lies outside the knot's coil. In the traditional snell, this portion is inside the coil, which is the reason for referring to this know as the inside-out snell (Figures 3.3-31 and 3.3-32).

Any of these knots may be serviceably used with the circle hook, but the most dependable are probably the traditional snell and the Uni-Knot. The quick snell is not as stable and has been known to come undone if not completed properly. The inside-out snell is also dependable, but having the tag end secured by the coil would appear to give an edge to the traditional snell knot.

Basic Knots

Figure 3.3-19a. Form loop to begin Overhand Loop Knot

Figure 3.3-19b. Form doubled Overhand Knot

Figure 3.3-19c. Completed Overhand Loop Knot

Figure 3.3-20a. Make one additional turn to form a Surgeon's Loop Knot

Figure 3.3-20b. Completed Surgeon's Loop Knot

Figure 3.3-21a. Begin Dropper Loop with turn in line

Figure 3.3-21b. Turn loop on itself

Figure 3.3-21c. Continue turn around standing line

Figure 3.3-21d. Form additional turns

Figure 3.3-21e. Make 4-5 turns total

Figure 3.3-21f. Open center turn

Figure 3.3-21g. Insert loop through center turn

Figure 3.3-21h. Tighten to complete Dropper Loop

Monofilament Leader

Figure 3.3-22a. Insert crimping sleeve on leader ahead of hook

Figure 3.3-22b. Turn tag end back through crimping sleeve

Figure 3.3-22c. Push crimping sleeve close to hook

Figure 3.3-22d. Crimp sleeve with crimping pliers

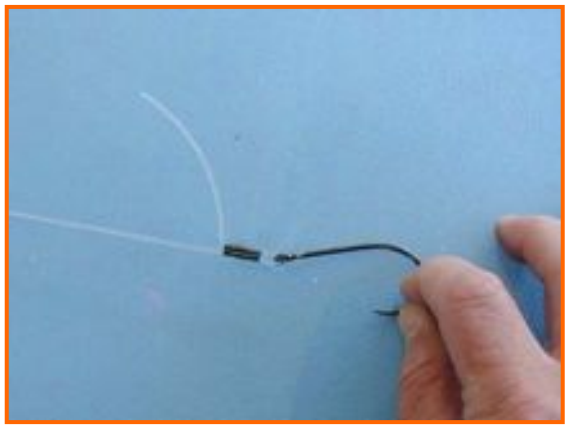


Figure 3.3-22e. Competed crimp

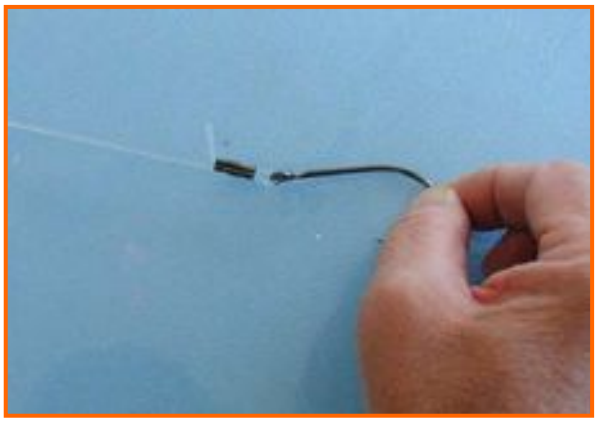


Figure 3.3-22f. Tag end may be trimmed to form "pin"

Figure 3.3-22g. Rigging wire may be crimped with leader

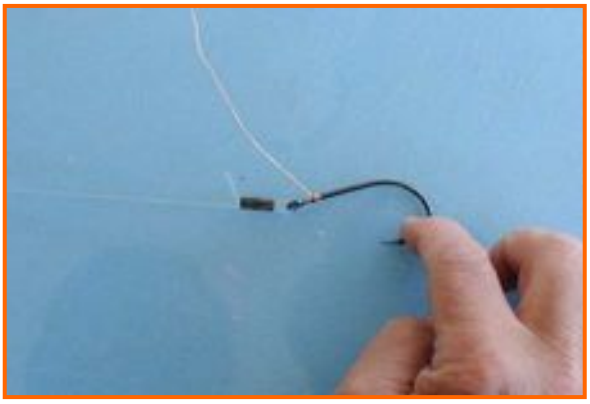


Figure 3.3-22h. Rigging wire may also be wrapped onto hook shank

Haywire Twist

Figure 3.3-23a. The Haywire Twist is used to fasten wire leader to hook. It is demonstrated here using rope for clarity. The two strands are first wrapped together, turning both at the same time. Many crews make 8-10 haywire wraps, but other more cautious crews use up to 20-22 wraps (Goadby 1996).

Figure 3.3-23b. The haywire wraps are followed with a series of tight barrel wraps to secure the connection. The tag end may be broken off or trimmed to form a bait-holding "pin"

Figure 3.3-24a. Eyes are removed from Ballyhoo prior to rigging. If not removed, they tend to bloat during use, reducing the bait's useful life.

Bait Preparation

Figure 3.3-24b. Removal of all "mucous" between eyes also makes rigging easier.

Figure 3.3-24c. Some anglers believe trimming the caudal fin improves the bait's attractiveness, but most do not bother.

Figure 3.3-24d. The same is true for trimming pelvic fins.

Figure 3.3-25a. The classic Ballyhoo rig begins by inserting the hook through the gill chamber. Note the bait's bill has already been snapped off.

Figure 3.3-25b. The pre-attached rigging wire is then inserted through the lower jaw.

Figure 3.3-25c. The wire is pulled through the top of the bait's head . . .

Figure 3.3-25d. . . . then inserted through the eye socket . . .

Figure 3.3-25e. . . . and wrapped around the bottom of the head and through the eye socket once more.

Figure 3.3-25f. The wire is then passed through the jaw using the same holes as previously, and then wrapped around the bait's bill and the leader.

Figure 3.3-25g. Finished Classic Pin Rig

Rubber Band Rig

Figure 3.3-26a. Begin rubber band rig by lining hook up on bait to determine exit point of hook.

Figure 3.3-26b. Puncture bait at hook exit point

Figure 3.3-26c. Insert the hook through the gill cavity

Figure 3.3-26d. Bring hook out through the puncture

Figure 3.3-26e. Insert monofilament leader "pin" through lower jaw and head

Figure 3.3-26f. Loop rubber band over pin and wrap it twice around the head

Figure 3.3-26g. Secure the rubber band by looping it again over the pin

Figure 3.3-26h. Break off the front of the lower jaw, or "bill"

Figure 3.3-26i. Completed rubber band-secured bait

"Quick," or "Simple" Snell

Figure 3.3-27a. Thread the line through the hook eye and makes several wraps around the hook shank.

Figure 3.3-27b. Insert the tag end between the wraps and the hook eye.

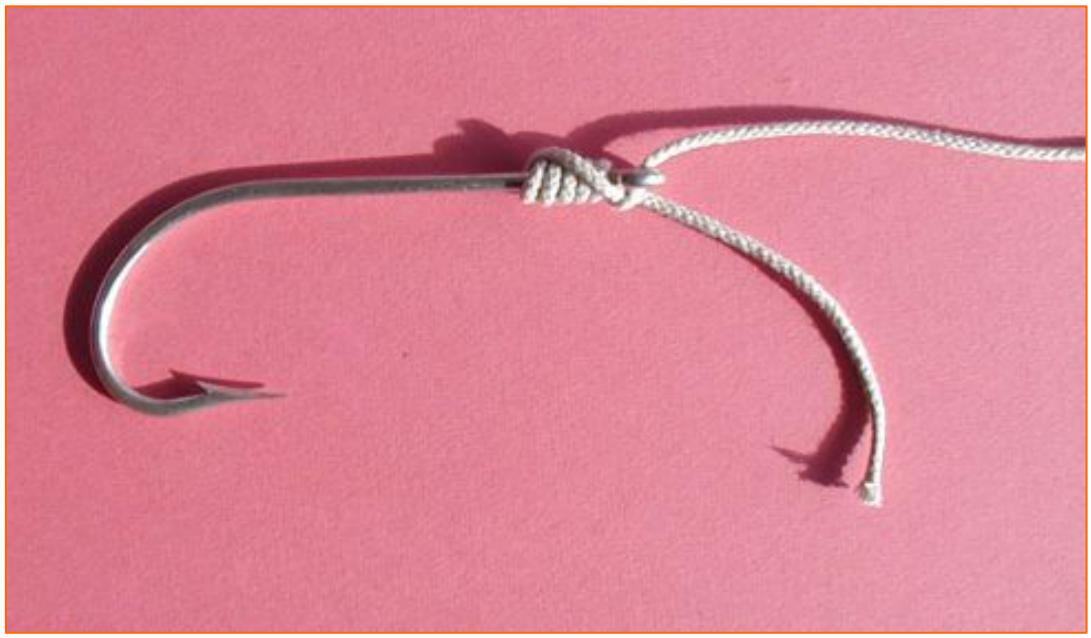


Figure 3.3-27c. Snug up both the tag end and standing line while keeping tension on the hook bend to complete the knot.

Traditional Snell Knot Example 1

Figure 3.3-28a. Begin by making a loop over the hook shank

Figure 3.3-28b. Make several wraps around the hook shank with the rear strand of the loop

Figure 3.3-28c. Hold the wraps to the shank of the hook with fingers of one hand while pulling on the tag end of the leader with the other hand to tighten the knot. Trim excess.

Traditional Snell Knot Example 2

Figure 3.3-29a. Form loop with leader

Figure 3.3-29b. Overwrap shank and leader with rear strand of loop material

Figure 3.3-29c. Make several wraps

Figure 3.3-29d. Pull on tag end while holding wraps

Figure 3.3-29e. Snug the wraps

Figure 3.3-29f. Trim tag end to complete the knot

Figure 3.3-29g. For two-hook snell, tie first hook with a long tag end

Figure 3.3-29h. Tie the second snell exactly as the first and trim excess tag

Uni-Knot Snell

Figure 3.3-30a. Form a loop over the hook shank

Figure 3.3-30b. Wrap the tag end around hook shank and through the loop

Figure 3.3-30c. Make several turns

Figure 3.3-30d. Tighten knot by pulling on standing line while maintaining tension on tag end

Figure 3.3-30e. Trim tag end to complete knot

"Inside-Out" Snell Example 1

Figure 3.3-31a. Double leader along hook shank

Figure 3.3-31b. Wrap tag end over shank and leader from bend toward eye

Figure 3.3-31c. Insert tag through loop at bend of hook

Figure 3.3-31d. Pull tag through, then pull on standing line to tighten knot

Figure 3.3-31e. Finished Knot

"Inside-Out" Snell Example 2

Figure 3.3-32a. Form loop along hook shank

Figure 3.3-32b. Wrap over shank and leader

Figure 3.3-32c. Make several wraps

Figure 3.3-32d. Insert tag through loop at hook bend

Figure 3.3-32e. Finished Knot

4.0 DISCUSSION

4.1 BAIT FISHERY IMPACTS

Impacts on Habitat:
A serious question to be answered by this program is whether recreational bait fisheries in Puerto Rico have the potential for impacting essential marine habitats. As described previously, most of the natural baits taken from Puerto Rican waters for recreational fishing is captured by cast-net. These nets are used along beaches, adjacent to mangrove shoreline, and in the area of seagrass beds. They are seldom used around coral reefs, which would seriously damage the nets. It is not anticipated that this use of cast-nets presents a serious threat to essential marine habitat in Puerto Rico. Weights on cast-nets are fairly light, and they tend to roll on the lead line as the net is retrieved, rather than digging into the substrate. Even use in seagrass areas is not believed to present serious concern.

The Ballyhoo fishery uses almost entirely floating gill nets that do not come into contact with habitat other than the water column. These nets therefore are not considered a threat to habitat. It is possible that the very limited used of beach seines for capturing Ballyhoo may present more of a habitat threat, but this form of fishing was recently prohibited by regulation, and is therefore not considered further.

Gill nets set nearshore for larger fish such as mullet have the potential for a bit more concern, depending upon the kinds of habitat in which they are set. Nets set along sandy beaches are of little concern, but nets set in seagrass beds may have the potential for dragging during retrieval, causing damage to the grass beds. This study was unable to determine, however, the prevalence of gill netting in seagrass beds for mullet. It certainly occurs, but this information was difficult to glean from fisher interviews.

No indications were obtained that traps of any kind are used in these fisheries.

For the most part, however, damage to essential marine habitat caused by recreational bait fisheries is not an acute concern. This evaluation does not speak to commercial bait fishing, which is outside the purview of this effort.

Impacts on Baitfish Populations:
This program was not designed as a population study, but it would appear that for the most part, there is little indication of overfishing of the primary recreational bait fishes. No shortages were reported, as fishers seem able to readily capture baits as needed. It also is noted that most of the species commonly utilized by the recreational fisheries are very resilient from a population perspective, with high reproductive potential and rapid growth. Exceptions to this generalization may concern Bonefish and White Mullet, but we have little quantitative data on which to base alarm signals.

The most organized bait fishery, for Ballyhoo and Balao, seems capable of readily satisfying the market for recreational baits. Shortages have not been reported. Fishers may have to sometimes work harder to find them, but this appears to relate more to natural baitfish schooling and movement behaviors than to shortages. Indeed, there are some signals that some Ballyhoo fishers have thoughts of expanding Ballyhoo exports, which would be unlikely in the face of supply shortages.

4.2 RECOMMENDATIONS

While no alarm signals were detected during this program, there are a few questions that would benefit from further inquiry.

Ballyhoo Fishery:
Based upon history and fisher interviews, the Ballyhoo populations around Puerto Rico appear able to satisfy demand in Puerto Rico on a sustained basis. Indications that an export fishery may be contemplated in some quarters raises questions, however. The export Ballyhoo fishery presently appears to be small and irregular, with only occasional sales, but the apparent profits are very attractive to Ballyhoo fishers, and are being discussed among them.

No population studies of Ballyhoo or Balao have been done in Puerto Rico, which should be rectified as a first step in evaluating the desirability of an export fishery for these species. These evaluations would provide a basis for estimating anticipated impacts of supplying the export fishery, and levels of export that the local populations can sustainably support. In addition, it may be appropriate to consider a catch- and sales-reporting system if an export fishery is allowed. The supply of domestic recreational fisheries is very informal, and would be difficult to track and quantify, but these issues may be more readily overcome in an export fishery, just as they are in Puerto Rico's marine ornamental fisheries.

Bonefish Issues:
The potential for a lucrative recreational or recreational/tourism fishery for bonefish seems unappreciated in Puerto Rico. In most parts of the world, use of bonefish for bait is prohibited, and the ban is largely supported by local fishers and business interests, because the economic value of the species is widely recognized. Puerto Rico is not noted for large bonefish, but this may be partially due to the harvest of the species for use as cut bait. The recent DNER Fishery Regulation recognizes Bonefish as a recreational catch and release fishery, but this relatively new provision has not yet taken root among the fishing community. It would be interesting to learn what the effects on these populations would be if a ban on the capture and use of this species were supported by local fishers for a period of a few years.

Game Fish as Bait:
Many small fish species are available for use as bait in the Puerto Rican marine recreational fisheries, and it would seem unnecessary to use small individuals of very

valuable recreational species, such as King Mackerel and Albacore. Harvest of such species before they are mature enough to reproduce is an unwise and ultimately unsustainable practice. The IGFA world record recreational catch of King Mackerel was made in the San Juan area of Puerto Rico, and it is ironic that the smallest King Mackerel caught and kept in the world also probably occur in Puerto Rico – for use as billfish bait. It is suggested that a long-term public relations effort might deflect public behavior from this inappropriate practice.

White Mullet Population Dynamics:
This program provided no basis for evaluating sustainability of Puerto Rico's White Mullet fishery. It is recommended that a population study of this species be encouraged, either through regulatory agency auspices or in academic circles, to quantitatively clarify the dynamics of this species in Puerto Rico.

Promotion of Circle Hook Use
Every recreational fisher releases some of his catch, usually of the smaller specimens captured, and some percentage of these released fish subsequently die from hook injury. It is well established that these mortalities may be significantly curtailed by common and every day use of circle hooks. NOAA recently requested that States and Territories track the recreational use of circle hooks, and encourage use of non-stainless steel circle hooks (C. Lilyestrom *pers. comm.*). This subject would seem appropriate as a component of any public relations or public awareness efforts made by resource managers in Puerto Rico.

Anchovy Taxonomy and Fishery
The taxonomy of anchovies in Puerto Rico proved a bit too complex for the resources committed to this program. There are several anchovy species utilized, and despite their similarities, it is likely that life history differences among them may require differentiated management strategies. There is risk associated with regulating anchovies as a homogenous group without appreciation of these potential differences. It is recommended, therefore, that a study of anchovies in Puerto Rico be encouraged in cooperation with the University of Puerto Rico or another academic institution. This effort should include differentiation of species and their life histories, their various uses, and population studies to the extent practicable.

5.0 REFERENCES CITED

Acosta, A. 1992. A preliminary study of gillnet, trammel net, and beach seine catches from southwest Puerto Rico with notes on length frequency. Proc. Gulf Carib. Fish. Inst. 41: 123-149.

Acosta, A. 1994. Soak time and net length effects on catch rate of entangling nets in coral reef areas. Fish. Res. 19: 105-119.

Acosta, A. 1997. Use of multi-mesh gillnets and trammel nets to estimate fish species composition in coral reef and mangroves in the southwest coast of Puerto Rico. Carib. J. Sci. 33(1-2): 45-57.

Alexander, E.C. 1958. A contribution to the life history, biology, and geographic distribution of the bonefish, *Albula vulpes* (Linnaeus). M.S. Thesis, Univ. Miami. 137 p. *After* Bruger 1974.

Alexander, E.C. 1961. A contribution to the life history, biology and geographical distribution of the bonefish, *Albula vulpes* (Linnaeus). Dana Report. Carlsberg Foundation 53. 51 p.

Alleng, G.P. 1997. The fauna of the Port Royal Mangal, Kingston, Jamaica. Stud. Nat. Hist. Caribb. Reg. 73:25-42.

Almodóvar. L.R. and F.A. Pagan. 1971. Notes on a mangrove lagoon and mangrove channels at La Parguera, Puerto Rico. Nova Hedwigia 21: 241-253.

Alperin, I.M. and R.H. Schaefer. 1964. Juvenile bonefish (*Albula vulpes*) in Great South Bay, New York. NY Fish and Game J. 11(1): 1-12.

Anderson, W.W. 1957. Early development, spawning, growth, and occurrence of the silver mullet (*Mugil curema*) along the south Atlantic coast of the United States. Fish. Bull. 57(119): 397-414.

Angell, Ch. 1976. Una contribución a la biologia de la Mojarra *Eugerres plumerei*. Mem. Soc. Cienc. Nat. La Salle 36(105): 297-310.

Anonymous. 1994. Atlas Pesquero de México. Instituto Nacional de la Pesca. 234 p. *After* I. Harrison. 2007. Fishbase *Mugil curema* species summary. Internet URL: http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema

Anonymous. 1999. Fish collection database of the Natural History Museum, London. (Formerly British Mus. Of Natural Hist.) (BMNH). *After* Fish Base 2007.

Anonymous. 2003. Fish collection of the Scripps Inst. of Oceanogr., Univ. California, San Diego, La Jolla. *After* Fish Base 2007.

Arce, M. and J. Sanchez. 1991. Growth and mortality of the thread herring, (*Opisthonema oglinum* Le Sueur) from Celestun, Yucatan, Mexico. (abstr.) Amer Fish Soc 121st Mtng., San Antonio, Texas USA, p. 56.

Austin, H.M. 1971. A survey of the ichthyofauna of the mangroves of western Puerto Rico during December 1967 – August 1968. Carib. J. Sci. 11: 27-39.

Austin, H. and S. Austin. 1971. The feeding habits of some marine fishes from the mangroves in western Puerto Rico. Carib. J. Sci. 11: 171-178.

Báez, M. and L. Alvarez-Lajonchere. 1983. Edad crecimiento y reproducción de la mojarra *Gerres cinereus* (Walbaum, 1792) en Tunas de Zaza, Cuba. Rev. Invest. Mar. 4(3): 41-76.

Bane, G.W. 1964. Exploratory fishing for tuna in the Mona Passage. Proc. Gulf. Carib. Fish. Inst. 7: 55-61.

Barriga, R. 1991. Peces de agua dulce del Ecuador. Revista de Información tecnico-cientifica, Ecuador, Politecnica 16(3): 7-88.

Baumar, J. E. Marin and J.J. Dodson. 2006. Age, growth and fecundity of the silver mullet *Mugil curema* (Pisces: Mugilidae) in coastal areas of Northeastern Venezuela. Rev. Biol. Trop. 48(2-3): 389-398.

Béarez, P. 1996. Lista de los peces marinos del Ecuador continental. Rev. Biol. Trop. 44(2): 731-741

Beets, J. and J.A. LaPlace. 1991. Virgin Islands baitfish survey: October to December 1986. Gulf & Carib. Fisheries Inst. 40: 55-63.

Berkeley, S.A. and E.D. Houde. 1978. Biology of two exploited species of halfbeaks, *Hemiramphus brasiliensis* and *H. Balao* from Southeast Florida. Bull. Mar. Sci. 28(4): 624-644.

Berkeley, S.A. and E.D. Houde. 1984. Age, growth and mortality of coastal herrings in the eastern Gulf of Mexico. Final Rept. To Gulf and S. Atl. Fish Devel. Foundation, Inc., Proj. No. 21-12-32272.

Berrios, J.M., E.I. Medina, H. Ferrer, and I. Diaz. 1989. Marine sport fisheries creel survey. Final Report, Project F-5-6. Puerto Rico Department of Natural Resources, San Juan, P.R. 184 p.

Bezerra, R.C. 1968. Relacâo comprimento-peso sardinha-bandeira, *Opisthonema oglinum* (LeSueur), no estado do Ceará. Arq. Est. Mar. Univ. Fed. Ceará 8(2):225-227.

Bigelow, H.B., M.G. Bradbury, J.R. Dymond, J.R. Greeley, S.F. Hildebrand, G.W. Mead, R.R. Miller, L.R. Rivas, W.L. Schroeder, R.D. Suttkus, and V.D. Vladykov. 1963. Fishes of the Western North Atlantic. Part Three. New Haven, Sears Foundation. Marine Res., Yale University.

Blay, J. Jr. 1995. Food and feeding habits of four species of juvenile mullet (Mugilidae) in a tidal lagoon in Ghana. J. Fish. Biol. 46: 134-141.

Bleeker, P. 1863. Mémoire sur les poisons de la côte de Guinée. Natuurk. Verh. Holland. Maatsch. Wet. Haarlem. (Ser. 2): 1-136.

Bloch, M.E. and J.G. Schneider. 1801. M.E. Blochii, Systema Ichthyologiae iconibus ex illustratum. Post obitum auctoris opus inchoatum absolvit, correxit, interpolavit Jo. Gottlob Schneider, Saxo. Berolini. Sumtibus Auctoris Impressum et Bibliopolio Sanderiano Commissum. Systema Ichthyol. i-lx + 1-584. *After* Eschmeyer 2000.

Böhlke, J.E. and C.C.G. Chaplin. 1993. Fishes of the Bahamas and adjacent tropical waters. 2nd Ed. Univ. of Texas Press. Austin.

Bohnsack, J.A. and D.E. Harper. 1988. Length-weight relationships of selected marine reef fishes from the southeastern United States and the Caribbean. NOAA Tech. Mem. NMFS-SEFC-215. 31 p.

Bouchon-Navaro, Y. and M. Louis. 1986. Les poisons des formations corallienes de la Martinique. Ann. Inst. Océanogr., Paris 62(2): 251-270.

Bowman, R.E., C.E. Stillwell, W.L. Michaels, and M.D. Grosslein. 2000. Food of northwest Atlantic food fishes and two common species of squid. NOAA Tech. Memo. NMFS-NE 155. 138 p.

Bruger, G.E. 1974. Age, growth, food habits, and reproduction of bonefish, *Albula vulpes*, in South Florida Waters. Fla. Mar. Res. Pub. 3: 1-20.

Budworth, G. 1999. The complete book of fishing knots. ISBN: 1-55821-907-2. The Lyons Press, Guilford, Connecticut USA. 144 p.

Bunkley-Williams, L. W.G. Dyer and E.H. Williams. 1996. Some aspidogastrid and digenean trematodes of Puerto Rico marine fishes. J. Aquat. Animal Health 8(1): 87-92.

Burger, J., K. Cooper, J. Saliva, D. Gochfeld, D. Lipsky and M. Gochfeld. 1992. Mercury bioaccumulation in organisms from three Puerto Rican estuaries. Environ.Monit. Assess. 22: 181-197.

Burgess, W.E., H.R. Axelrod and R.E. Hunziker III. Undated. Dr. Burgess's atlas of marine aquarium fishes, 3rd. Ed. T.F.H. Pubs, Inc. Neptune City, NJ. 784 p.

Bussing, W.A. 1998. Peces de las aguas continentales de Costa Rica. 2nd ed. San José. Editorial de la Universidad de Costa Rica. 468 p.

Butsch, R.S. 1939. A list of Barbadian fishes. J. B.M.H.S. 7(1): 17-31.

Carpenter, K.E. 2002. (Ed.) The living marine resources of the Western Central Atlantic. Vol. 3. Bony fishes part 2 (Opistognatha to Molidae). FAO species identification guide for fishery purposes and Amer. Soc. Ichthyologists and Herpetologists Spec. Publ. No. 5. FAO, Rome v. 3: i-vi + 1375-2127.

Carr, W.E.S. and C.A. Adams. 1973. Food habits of juvenile marine fishes occupying seagrass beds in the estuarine zone near Crystal River, Florida. Trans. Amer. Fish. Soc. 102(3): 511-540.

Cervigón, F., R. Cipriani, W. Fischer, L. Garibaldi, M. Hendrickx, A.J. Lemus, R. Márquez, J.M. Poutiers, G. Robaina, and B. Rodriguez. 1992. Fichas FAO de identificación de especies para los fines de la pesca. Guía de campo de las especies comerciales marinas y de aguas salobres de la costa septentrional de Sur América. FAO, Rome. 513 p. Preparado con el financiamento de la Comisión de Comunidades Europeas y de NORAD.

Cervigón, F. 1993. Los peces marinos de Venezuela. Vol. 2. Fundación Cientifica Los Roques. Caracas, Venezuela. 497 p.

Chirichigno, N.F. 1974. Clave para identificar los peces marinos del Perú. Inf. Inst. Mar Perú, 44: 387 p.

Claro, R. 1994. Características generales de la ictiofauna. P. 55-70 In R. Claro (ed.) Ecología de los peces marinos de Cuba. Instituto de Oceanología Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo. *After* I. Harrison. 2007. Fishbase *Mugil curema* species summary. Internet URL: http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema

Claro, R. and J.P. García-Arteaga. 1994. Crecimiento, p. 321-402 *In:* R. Claro (ed). Ecología de los peces marinos de Cuba. Inst. de Oceanologia Academia de Ciencias de Cuba y Centro de Investigaciones de Quintana Roo. (CIQRO), México.

Claro, R. and L.R. Parenti. 2001. The marine ichthyofauna of Cuba. pp. 21-57 *In*: R. Claro, K.C. Lindeman and L.R. Parenti (eds.). Ecology of the marine fishes of Cuba. Smithsonian Institution Press, Washington and London. 253 p.

Collette, B.B. 1978. Hemiramphidae. *In:* W. Fischer (ed.). FAO species identification sheets for fishery purposes. Western Central Atlantic (Fishing Area 31), Vol. 2. FAO Rome.

Collette, B.B. 1981. Hemiramphidae. *In:* W. Fisher, G. Bianchi and W.B. Scott (eds). FAO species identification sheets for fishery purposes. Eastern Central Atlantic (Fishing Areas 34, 47 (in part)). Vol. 2. Dept. of Fisheries And Oceans Canada and FAO Rome.

Collette, B.B. and N.V. Parin. 1990. Hemiramphidae. Pp 579-582 *In:* J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds). Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 2.

Compagno, L.J.V., D.A. Ebert and M.J. Smale. 1989. Guide to the sharks and rays of southern Africa. New Holland (Publ.) Ltd, London. 158 p.

Cook, S.J. and C.D. Suski. 2004. Are circle hooks effective tools for conserving freshwater and marine recreational catch-and-release fisheries? Aquatic Conservation: Marine and Freshwater Ecosystems. 14: 299-326.

Cooper, M. 1974. A survey and comparison of the fish fauna found in two common species of tropical Atlantic sea grasses. M.S. Thesis, Univ. Puerto Rico, Mayagüez. 45 p.

Cortés, Z. and T. Irrizary. 2003. Puerto Rico Marine Recreational Fishery Statistics Program, Annual Report 2002. Puerto Rico DNER, Fish and Wildlife Negotiate, Marine Resources Div., San Juan, P.R.

Corujo-Flores, I.N. 1980. A study of fish populations in the Espiritu Santo River estuary. M.S. Thesis, Univ. Puerto Rico, Río Piedras. 83 p.

Coupal, L. E. Bédard, C. Peguer and I.S. Durante. 1992. Repertorio ictionímici de la República Dominicana. Fáscículo I: Acanthuridae – Carangidae. LIRD.

Crabtree, R.E., C.W. Harnden, D. Snodgrass and C. Stevens. 1996. Age, growth, and mortality of bonefish, *Albula vulpes*, from the waters of the Florida Keys. Fish. Bull. 94: 442-451.

Crespo, J., J. Gajate and R. Ponce. 2001. Clasificación cientifica e identificación de nombres vernáculos existentes en la base de datos de seguimiento informático de recursos naturales oceánicos. Inst. Español de Oceanografia, Madrid, España.

Crossman, E.J. 1972. Collecting trip to St. Lucia. Dept. Ichthyol. & Herpeteol. 32 p. *After* Fish Base 2007.

Cuvier, G. 1829. Le Règne Animal, distribute d'après son organization, pour server de base à l'histoire naturelle des animaux et d'introduction à l'anatomie compare. Ed. 2, Règne Animal (ed. 2) i-xv + 1-406. *After* Eschmeyer 2000.

Cuvier, G. and A. Valenciennes. 1830. Histoire naturelle des poissons. Tome Sixième. Partie I. Des Sparoïdes; Partie II. Des Ménides. Hist. Nat. Poiss. i-xxiv + 6 pp + 1-559.

Cuvier, G. and A. Valenciennes. 1847*a*. Histoire naturelle des poisons. Tome vingtième. Livre vingt et unième. De la famille des Clupéoïdes. Hist. Nat. Poiss. I-xviii + 1 p. + 1-472. *After* Eschmeyer 2000.

Cuvier, G. and A. Valenciennes. 1847*b*. Histoire naturelle des poissons. Tome dix-neuvième. Suite du livre dix-neuvième. Brochets ou Lucioïdes. Livre vingtième. De quelques familles de Malacoptérygiens, intermediaries entre les Brochets et les Clupes. Hist. Nat. Poiss. I-xix + 1-544 + 6 pp. *After* Eschmeyer 2000.

Dammann, A.E. 1969. Study of the fisheries potential of the Virgin Islands. Special Report, Contribution No. 1, Virgin Islands Ecological Research Station.

Deckert, G.D. and D.W. Greenfield. 1987. A review of the Western Atlantic species of the genera *Diapterus* and *Eugerres* (Pisces: Gerreidae). Copeia (1): 182-194.

DeKay, J.E. 1842. Zoology of New-York, or the New-York fauna; comprising detailed descriptions of all the animals hitherto observed within the state of New-York, with brief notices of those occasionally found near its borders, and accompanied by appropriate illustrations. Part IV. Fishes. W&A White & J. Visscher, Albany. (Part of: Natural History of New York). Zool. New York i-xv + 1-415.

De La Cruz-Agüero, J. 1997. Catalogo de los peces marinos de Baja California Sur. IPN-CICIMAR, La Paz, México. P. 341.

Delgado, P./ 2004. Wetlands & Fish: a vital connection. Fish, crustaceans, and mollusks found in U.S. Caribbean wetlands. NOAA, MNFS, Office of Habitat Conservation. 93 p.

Dennis. G.D. 1992. Island mangrove habitats as spawning and nursery areas for commercially important fishes in the Caribbean. Proc. Gulf Carib. Fish. Inst. 41: 205-225.

Dennis, G.D., D. Goulet and J.R. Rooker. 1991. Ichthyoplankton assemblages sampled by night lighting in nearshore habitats of southwestern Puerto Rico. NOAA Tech. Rep. 95: 89-97.

Diouf, P.S. 1996. Les peuplements de poissons des milieux estuariens de l'Afrique de l'Ouest: L'exemple de l'estuaire hyperhalin du Sine-Saloum. Université de Montpellier II. Théses et Documents Microfiches No. 156. ORSTOM, Paris. 276 p. *After* I. Harrison. 2007. Fishbase *Mugil curema* species summary. Internet URL: http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema

Dunaway,V. 1984. Vic Dunaway's complete book of baits, rigs & tackle. ISBN: 0-936240-02-4. Wickstrom Publishers, Inc., 5901 S.W. 74th St., Miami, FL 33143 USA. 223 p.

Dyer, W.G., E.H. Williams and L. Bunkley-Williams. 1985. Digenetic trematodes of marine fishes of the western and southwestern coasts of Puerto Rico. Proc. Helminthol. Soc. Wash. 52(1): 85-94.

Eger, W.H. 1970. Fishes. Pp. 113-124 *In:* M.J. Cerame-Vivas (ed.). A synoptic base-line study of Yabucoa Bay, Yabucoa, Puerto Rico. Report of Dept. Marine Sci, Univ. Puerto Rico, Mayagüez.

Eldred, B. 1967. Larval bonefish, *Albula vulpes* (Linnaeus, 1758), (Albulidae) in Florida and adjacent waters. Fla. Board Conserv. Mar. Lab, Leaflet Ser. Vol. IV, Part 1, No. 3: 4p.

Erdman, D.S. 1956. Recent fish records from Puerto Rico. Bull. Marine Sci. Gulf Carib. 6: 315-340.

Erdman, D.S. 1960. Notes on the biology of the bonefish and its sports fishery in Puerto Rico. Paper prepared for the 5th Interntl. Game Fish Conf. , Miami Beach, Fl. *After* Bruger 1974.

Erdman, D.S. 1967. Spawning seasons of some game fishes around Puerto Rico. 12th International Game Fish Conf. 12: 11-19.

Erdman, D.S. 1976. Spawning patterns of fishes from the northeastern Caribbean. Contributions Dept. Ag. Puerto Rico No. 8(2): 36 p.

Erdman, D.S. 1987. Nombres vulgares de peces en Puerto Rico; Common names of fishes in Puerto Rico. 2nd Ed. Corporación para el Desarrollo y Administración de los Recursos Marinos, Lacustres y Fluviales de Puerto Rico, Vol. 3, No. 2. 44 p.

Eschmeyer, W.N. Editor. 1998. Catalog of fishes. Special Publ. of the Center for Biodiversity Research and Information No. 1, California Academy of Sciences, San Francisco, USA. 3 Vols. 2905 p.

Eschmeyer, W.N. Editor. 2000. Catalog of fishes. Updated database version of November 2000. Catalog databases as made available to FishBase in November 2000.

Escobar-Fernández, R. and M. Siri. 1997. Nombres vernáculos y cientificos de los peces del Pacifico Mexicano. Unviersidád Autónoma de Baja California, Soc. Ict. Mexicana. A.C. México.

Etchevers, S.L. 1975. La relacion longitud-peso en 7 peces de interes comercial en nororiente de Venezuela. Bol. Inst. Oceanogr. Univ. Oriente 14(2): 243-246.

Evermann, B.W. and M.C. Marsh. 1902. The fishes of Porto Rico. Investigations of the aquatic resources and fisheries of Porto Rico by the United States Fish Commission Steamer FISH HAWK. Bull. U.S. Fish. Comm. 1900, (20)1: 49-350.

FAO. 1969. Report to the government of St. Kitts, Nevis and Anguilla on exploratory and experimental fishing around St. Kitts and Nevis. Rep. FAO (TA 2272). 28 p.

FAO-FIDI. 2006. Aquatic Sciences and Fisheries Information System (ASFIS) species list. Internet URL: http://www.fao.org/fi/statist/fisoft/asfis/asfis.asp, 26 April 2006.

Feltrim, M.C. and P.R. Schwingel. 2005. *Opisthonema oglinum* (Lesueur, 1818). P. 112-115 *In:* M.C. Cergole, A.O., A.O. Ávila-da-Silva and C.L.D.B. Rossi-Wongtchowski (eds). Análise das principais pescarias commerciais da região sudeste-sul do Brasil: dinâmica populacional das espécies em explotaçao. São Paulo: Inst. Oceanográfico.

Finucane, J.H. and R.N. Vaught. 1986. Species profile of Atlantic thread herring *Opisthonema oglinum* (Lesueur 1818). NOAA Tech. Mem. NMFS-SEFC-182. 30 p.

Fischer, W., I. Sousa, C. Silva, A. de Freitas, J.M. Poutiers, W. Schneider, T.C. Borges, J.P. Feral and A. Massinga. 1990. Fichas FAO de identificaçao de espécies para actividades de pesca. Guia de campo das espécies comerciais marinhas e de agues slobras de Moçambique. Publcaçao preparada em collaboraçao com o Instituto de Investigaçao Pesquiera de Moçambique, com financiamento do Projecto PNUD/FAO MOZ/86/030 e de NORAD. Roma, FAO. 424 p.

Fish Base Summary. 2007. Internet URL = www.fishbase.org.

Fish, M.P. and W.H. Mowbray. 1970. Sounds of Western North Atlantic fishes. A reference file of biological underwater sounds. The Johns Hopkins Press, Baltimore MD USA.

FMRI. 2003. Ballyhoo. Species Fact Sheet. Florida Fish & Wildlife Conservation Commission. 4 p.

Fowler, H.W. 1911. Notes on clupeoid fishes. Proc. Acad. Nat. Sci. Philadelphia 63: 204-221.

Fowler, H.W. 1919. Notes on synentognathus fishes. Proc. Acad. Nat. Sci. Philadelphia 71: 2-15.

Fowler, H.W. 1928. Fishes from Florida and the West Indies. Proc. Acad. Nat. Sci. Philadelphia 71: 2-15.

Fowler, H.W. 1958. Some new taxonomic names of fishlike vertebrates. Not. Nat. (Phila.) 1-16. *After* Eschmeyer 2000.

Friedlander, A. 1992. A comparison of fishing methods associated with fish aggregating devices (FADs) off Puerto Rico. Proc. Gulf Carib. Fish. Inst. 42: 233-246.

Fuss, C.M., Jr., J.A. Kelly, Jr., and K.W. Prest, Jr. 1969. Gulf Thread herring: aspects of the developing fishery and biological research. Proc. Gulf. Carib. Fish. Inst. 21: 111-125.

García, C.B., L.O. Duarte, N. Sandoval, D. von Schiller, G. Melo, and P. Navajas. 1998. Length-weight relationships of demersal fishes from the Gulf of Salamanca, Colombia. Naga ICLARM Q.

García, M. 2002. Puerto Rico Clean Vessel Program, Final Report. Puerto Rico DNER, Fish and Wildlife Bureau, Marine Resources Div., San Juan, P.R.

García, J.R. and E.H. Williams. 1985. Temporal dynamics of metazoan parasite infections in the white mullet *Mugil curema* Valenciennes from Joyuda Lagoon, Puerto Rico. Carib. J. Sci. 21(1-2): 39-53.

García-Arteaga, J.P. 1993. Edad y crecimiento de lay sardine de ley, *Harengula humeralis* (Pisces: Clupeidae) en la plataforma SW de Cuba. Avicennia 0: 14-25.

García-Arteaga, J.P., R. Claro and S. Valle. 1997. Length-weight relationships of Cuban marine fishes. Naga ICLARM Q. 20(1): 38-43.

García-Cagide, A. 1988. Particularidades de la reproducción de la sardina de ley, *Harengula humeralis* (Cuvier 1829), en la region oriental del Golfo de Batabano, Cuba. Rep. Invest. Inst. Oceanol. Acad. Cienc. Cuba. 12: 1-15.

García-Cagide, A., R. Claro and B.V. Koshelev. 1994. Reproducción. P 187-262 *In*: R. Claro (ed.). Ecología de los peces marinos de Cuba. Inst. Oceanol. Acad. Cienc. Cuba and Cen. Invest. Quintana Roo, (CIQRO), México.

Garman, S. 1899. The Fishes. *In:* Reports on an exploration off the west coasts of Mexico, Central and South America, and off the Galapagos Islands . . . by the U.S. Fish Commission Steamer "Albatross," during 1891 . . . No. XXVI. Mem. Mus. Comp. Zool. Text: 1-431. *After* Eschmeyer 2000.

Gasparini, J.L. and S.R. Floeter. 2001. The shore fishes of Trinidad Island, western South Atlantic. J. Nat. Hist. 35: 1639-1656.

Gilmore, R.G., Jr. 2002. Gerridae, pp. 1506-1521 *In:* Carpenter 2002.

Goadby, P. 1996. Billfishing. The quest for marlin, swordfish, spearfish and sailfish. Pub. International Marine Publishing, Div. McGraw-Hill, P.O. Box 220, Camden, Maine 04843 USA. 208 p.

Goadby, P. 2003. Saltwater Gamefishing, offshore and onshore. Pub. International Marine Publishing, Div. McGraw-Hill, P.O. Box 220, Camden, Maine 04843 USA. 342 p.

González-Sansón, G., and L.S. Alvarez-Lajonchere. 1978. Alimentación natural de *Mugil liza, M. curema, M. trichodon* and *M. hospes* (Pisces, Mugilidae) en las lagunas costeras de Tunas de Zaza, Cuba. Cienc. Invest. Mar. 41: 1-40.

Goode, G.B. and T.H. Bean. 1879. Catalogue of a collection of fishes sent from Pensacole, Florida and vicinity, by Mr. Silas Stearns, with descriptions of six new species. Proc. U.S. Natl. Mus. 121-156. *After* Eschmeyer 2000.

Gosse, P.H. 1851. A naturalist's sojourn in Jamaica. London. Sojourn Jamaica i-xxiv + 1-508.

Grand Illusion. 2007. Promotional Internet Site. Internet URL: http://www.worldwidefishing.com/puertorico/b429/index.html?page_type=salt&state_page=puertorico&company=Grand+Illusion+Charter

Gray, J.E. 1854. Catalogue of fish collected and described by Laurence Theodore Gronow, now in the British Museum. London. Cat. Fish Gronow i-vii + 1-196. *After* Eschmeyer 2000.

Greenfield, D.W. and J.E. Thomerson. 1997. Fishes of the continental waters of Belize. Univ. Florida Press, Gainesville. 311 p.

Gunter, G. 1945. Studies on marine fishes of Texas. Pub. Inst. Marine Sci. Univ. Texas 1: 1-90.

Hall, B. 2002. Marlin Fishing. ISBN: 1-877256-23-4. The Halcyon Press, Auckland, NZ. 367 p.

Halstead, B.W. 1970. Results of a field survey on fish poisoning in the Virgin and Leeward Islands during 7-18th January 1970. p. 15 *In:* UNDP/FAO Caribbean Fisheries Devel. Proj., Barbados.

Halstead, B.W., P.S. Auerbach and D.R. Campbell. 1990. A colour atlas of dangerous marine animals. Wolfe Medical Publications Ltd., W.S. Cowell Ltd., Ipswich, England. 192 p.

Hamlin, Capt. R. 2002. Tips and techniques: Rigging circle hooks for billfishing. VHS Video. Bennett Marine Video Presentation, 2321 Abbot Kinney Blvd., Venice, CA 90291. Tel: (310) 827-8064. Fax: (310) 827-8074. info@bennettmarine.com. URL = www.bennettmarine.com.

Harrison, I.J. 1995. Mugilidae. Lisas. Pp. 1293-1298 *In:* W. Fischer, F. Krupp, W. Schneider, C. Sommer, K.E. Carpenter and V. Niem (eds.). Guia FAO para Identification de Especies para lo Fines de la Pesca. Pacifico Centro-Oriental. 3 Vols. FAO, Rome.

Harrison, I.J. 2002. Mugilidae. Mullets. Pp. 1071-085. In: K.E. Carpenter (ed). FAO species identification guide for fishery purposes. The living marine resources of the Western Cnetral Atlantic. Vol. 2: Bony fishes part 1 (Acipenseridae to Grammatidae). (Key No. 961).

Hildebrand, S.F. and W.C. Schroeder. 1927. Fishes of Chesapeake Bay. Bull. U.S. Bureau of Fisheries, Vol XLIII. Bureau of Fish. Doc. No. 1024. Reprinted 1972 by T.F.H. Publications, Neptune, NJ 07753 USA. For sale by Smithsonian Inst. Press, Washington DC 20560 USA. 388 p.

Hodgkinson-Clarke, F. 1994. The construction and operation of artisanal gillnets in Trinidad. Fish. Occas. Paper Series (): 49 p.

Horodysky, A.Z. and J.E. Graves. 2005. Application of pop-up satellite archival tag technology to estimate postrelease survival of white marlin (*Tetrapturus albidus*) caught on circle and straight-shank ("J") hooks in the western North Atlantic recreational fishery. Fish. Bull. 103: 84-96.

Houde, E.D., C. Grall, and S.A. Berkeley. 1983. Population parameter estimates for three shoaling pelagic fishes in the eastern Gulf of Mexico. Int. Counc. Explor. Sea, Pelagic Fish Committee, C.M. 1983/H: 43, 11 p.

Hubold, G. and M.V. Mazzetti. 1982. Growth, morphometry and aspects of the life history of the scaled sardine *Harengula jaguana* Poey, 1865 in the Guanabara Bay (Brazil). Meeresforschung 2: 80-88.

Hughes, J.M. and J. Stewart. 2006. Reproductive biology of three commercially important Hemiramphid species in South-eastern Australia. Env. Biol. Fishes 75(2): 237-256.

Humann, P. 1994. Reef fish identification: Florida, Caribbean, Bahamas. New World Publications. Jacksonville, Florida, USA. 426 p.

Ibáñez-Aquirre, A.L., M. Gallardo-Cabello and X. Chiappa-Carrara. 1999. Growth analysis of striped mullet, *Mugil cephalus*, and white mullet, *M. curema* (Pisces: Mugilidae) in the Gulf of Mexico. Fish. Bull. 97: 861-872.

Ibáñez-Aquirre, A.L. and M. Gallardo-Cabello. 2004. Reproduction of *Mugil cephalus* and *M. curema* (Pisces: Mugilidae) from a coastal lagoon in the Gulf of Mexico. Bull. Marine Sci. 75(1): 37-49.

Ibáñez-Aquirre, A.L., E. Cabral-Solís, M. Gallardo-Cabello and E. Espino-Barr. 2006. Comparative morphometrics of two populations of *Mugil curema* (Pisces: Mugilidae) on the Atlantic and Mexican Pacific Coasts. Sci. Mar. 70(1): 139-145.

IGFA. 2001. Database of IGFA angling records until 2001. International Game Fish Association, Fort Lauderdale, Florida, USA.

Jiménez-Prado, P. and P. Béarez. 2004. Peces marinos del Ecuador continental. Tomo 2: Guía de Especies / Marine fishes of continental Ecuador. Vol. 2: Species Guide. SIMBIOE/NAZCA/IFEA.

Jones, P.W., F.D. Martin and J.D. Hardy, Jr. 1978. Development of fishes of the Mid-Atlantic Bight. An atlas of eggs, larval and juvenile stages. Vol. 1. Acipenseridae through Ictaluridae. USF&WS Biol. Serv. Program. FWS/OBS-78/12. 336 p.

Jordan, D.S. and B.W. Evermann. 1898. The fishes of North and Middle America: a descriptive catalogue of the species of fish-like invertebrates found in the waters of North America, north of the Isthmus of Panama. Part II. Bull. U.S. Natl. Mus. I-xxx + 1241-2183.

Jordan, D.S. and B.W. Evermann. 1902. American food and game fishes. Reprinted 1969. Dover Publications, NYC. 574 p.

Jordan. D.S. and E.K. Jordan. 1922. A list of the fishes of Hawaii, with notes and descriptions of new species. Mem. Carnegie Mus. 1-92. *After* Eschmeyer 2000.

Kamara, A.B. 1977. A list of the estuarine and marine fishes and some shellfishes of Sierra Leone, with their common names in either Krio or English. *In*: W. Okera (ed.), Bull. Inst. Marine Biol. And Oceanography, Fourah Bay College, Univ. of Sierra Leone. Vol. 2(1): 47-56.

Kaup, J.J. 1856. Catalogue of the apodal fish in the collection of the British Museum. London. Cat. Apodal Fish 1-163. *After* Eschmeyer 2000.

Keith, P., O.-Y. Le Bail, and P. Planquette. 2000. Atlas de poisons d'eau douce de Guyane (tome 2, fascicule I). Publications scientifiques du M.N.H.N., Paris. 286 p.

Kenny, J.S. 1995. Views from the bridge: a memoir on the freshwater fishes of Trinidad. Julian S. Kenny, Maracas, St. Joseph, Trinidad & Tobago. 98 p.

Kimmel, J.J. 1985. A characterization of Puerto Rican fish assemblages. Ph.D. Dissertation, Univ. Puerto Rico, Mayagüez. 106 p.

Kimmel, J.J. 1991. A fisheries dependent survey of baitfishes in Puerto Rico, Proc. Gulf Carib. Fish. Inst. 40: 64-81

Kotlyar, A.N. 1984. Dictionary of names of marine fishes in the six languages. All Union Research Institute of Marine Fisheries and Oceanography, Moscow, Soviet Union. 288 p.

Lacepède, B.G.E. 1803. Histoire naturelle des poissons. Hist. Nat. Poiss. i-lxviii + 1-803 + index. *After* Eschmeyer 2000.

Lagler, K.F., J.E. Bardach and R.R. Miller. 1962. Ichthyology. John Wiley and Sons, Inc. New York, London. 545 p.

Larsen, L. 2007. Fat Lady's Marlin. Internet URL: http://www.b-v-i.com/Activities/Fishing/FatLadysMarlin.htm.

Lesueur, C.A. 1818. Description of several new species of North American fishes. J. Acad. Nat. Sci. Phila. 222-235 (May publishing); 359-368 (September publishing).

Lesueur, C.A. 1821. Observations on several genera and species of fish, belonging to the natural family of the Esoces. J. Acad. Nat. Sci. Philadelphia: 124-138.

Letourneur, Y., M. Kulbicki and P. Labrosse. 1998. Length-weight relationships of fish from coral reefs and lagoons of New Caledonia, southwestern Pacific Ocean: an update. Naga ICLARM Q. 21(4): 39-46.

Lieske, E. and R. Myers. 1994. Collins Pocket Guide, Coral Reef Fishes, Indo-Pacific & Caribbean including the Red Sea. Harper Collins Publishers. 400 p.

Light Tackle Adventure. 2007. Promotional Internet Site. Internet URL: http://travelandsports.com/prn660.htm

Light Tackle Paradise. 2007. Promotional Internet Site. Internet URL: http://www.worldwidefishing.com/puertorico/b1579/index.html?page_type=salt&state_page=.

Lim, P., F.J. Meunier, P. Keith, and P.Y. Noël. 2002. Atlas des poissons et des crustacés d'eau douce de la Martinique. Muséum National d'Histoire Naturelle. Paris, France. Patrimoines Naturels, 51: 120 p.

Linnaeus, C. 1758. Systema Naturae, E. X. (Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus differentiis, synonymis, locis. Tomus I. Editio decimal, reformata.) Holmiae. Systema Nat. ed. 10 i-ii + 1-824.

Low, R.A., Jr. 1973. Shoreline grassbed fishes in Biscayne Bay, Florida, with notes on the availability of clupeid fishes. M.S. Thesis, Univ. Miami, Coral Gables, FL. 145 p. *After* Pierce *et al.* 2001.

Maitland, P.S. and R.N. Campbell. 1992. Freshwater fishes of the British Isles. Harper Collins Publishers. London. 368 p. *After* I. Harrison. 2007. Fishbase *Mugil curema* species summary. Internet URL: http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema

Manickchand-Heileman, S. and J. Flüs. 1990. Species composition and seasonality of coastal demersal fish stock in Trinidad, West Indies. Carib. Marine Studies 1: 1-21.

Marin, E, J. Baumar, A. Quintero, D. Bussiere and J.J. Dodson. 2003. Reproduction and recruitment of white mullet (*Mugil curema*) to a tropical lagoon (Margarita Island, Venezuela) as revealed by otolith microstructure. Fish. Bull (Seattle) 101(4): 809-821.

Martin, F.D. and J.W. Patus. 1973. A comparison of fish faunas in a highly stressed and a less stressed tropical bay – Guayanilla and Jobos Bay, Puerto Rico. Ann. Conf. S.E. Assoc. Game & Fish Commission 27: 675-688.

Martinez, S. and E.D. Houde. 1975. Fecundity, sexual maturation, and spawning of scaled sardine (*Harengula jaguana* Poey). Bull. Marine Sci. 25: 35-45.

Masuda, H. and G.R. Allen. 1993. Meeresfische der Welt – Gross – Indopazifische Region. Tetra Verlag, Herrenteich, Melle. 528 p.

McBride, R.S. and J.R. Styer. 2002. Species composition, catch rates, and size structure of fishes captured in the South Florida Lampara Net Fishery. Marine Fisheries Review, 64(1): 21-27.

McBride, R.S. J.R. Styer and R. Hudson. 2003. Spawning cycles and habitats for ballyhoo (*Hemiramphus brasiliensis*) and Balao (*H. Balao*) in South Florida. Fishery Bull (Seattle), 101(3): 583-589.

McBride, R.S. and P.E. Thurman. 2003. Reproductive biology of *Hemiramphus brasiliensis* and *H. Balao* (Hemiramphidae): maturation, spawning frequency, and fecundity. Biol. Bull. 204(1): 57-67.

McEachran, J.D. and J.D. Fechhelm. 2005. Fishes of the Gulf of Mexico. Vol. 2: Scorpaeniformes to Tetraodontiformes. Univ. Texas Press, Austin. I-viii + 1-1004.

McEnally, J. and L. McEnally. 2006. Bluewater fishing, Offshore techniques and tactics. Pub. Australian Fishing Network Pty Ltd, 48 Centre Way, South Croydon, VIC 3136. ISBN 186513 0850. 140 p.

McNally, B. 1993. Fishermen's knots, fishing rigs, and how to use them. ISBN: 0-9646265-1-9. Publ. McNally Outdoor Productions, Jacksonville, FL USA. Printed by Atlantic Pub. Co., P.O. Box 67, Tabor City, NC 28463 USA. 286 p.

Modde, T. 1980. Growth and residency of juvenile fishes within a surf zone habitat in the Gulf of Mexico. Gulf Res. Rep. 6(4): 377-385.

Modde, T. and S.T. Ross. 1980. Seasonality of fishes occupying a surf zone habitat in the northern Gulf of Mexico. Fish. Bull. 78(4): 911-922.

Modde, T. and S.T. Ross. 1983. Trophic relationships of fishes occurring within a surf zone habitat in the northern Gulf of Mexico. Northwest Gulf Sci. 6(2): 109-120.

Morris, A. 2003. Checklist of the fishes of the British Virgin Islands (UK). Unpublished. *After* B.B. Collette. 2007. Fishbase *Hemiramphus brasiliensis* species summary. Internet URL: http://www.fishbase.org/Summary/speciesSummary.php?ID=1059&genusname=Hemiramphus&speciesname=brasiliensis

Motta, P.J., K.B. Clifton, P. Hernandez, B.T. Eggold, S.D. Giordano and R. Wilcox. 1995. Feeding relationships among nine species of seagrass fishes of Tampa Bay. Florida Bull. Marine Sci. 56(1): 185-200.

MRFSS. 2000. Recreational fishing and fisheries management: The MRFSS. Internet URL: http://www.st.nmfs.gov/st1/recreational/queries/index.html

Munroe, T.A. 2002. Herrings: Family Clupeidae. P. 111-160 *In:* B.B. Collette and G. Klein-MacPhee (eds). Bigelow and Schroeder's Fishes of the Gulf of Maine, Third Ed. Smithsonian Inst. Press, Washington, DC.

Murdy, E.O., R.S. Birdspong, and J.A. Musick. 1997. Fishes of the Chesapeake Bay. Smithsonian Inst. Press. Washington, DC. Xi + 324 p.

Nahím, H.R. and F. Cervigón. 2003. Peces del archipiélago Los Roques. Agencia Española de Cooperación Internacional. 304 p.

Nelson, J.S., E.J. Crossman, H. Espinoza-Pérez, L.T. Findley, C.R. Gilbert, R.N. Lea, and J.D. Williams. 2004. Common and scientific names of fishes from the united States, Canada, and Mexico. Amer. Fish. Soc., Special Publ. 29, Bethesda, MD USA.

Nichols, J.T. 1929. The fishes of Porto Rico and the Virgin Islands. Branchiostomidae to Sciaenidae. Scientific survey of Port Rico and the Virgin Islands. New York Acad. Sci. 10(2): 161-295.

Nion, H., C. Rios and P. Meneses. 2002. Peces del Uruguay: Lista sistemática y nombres comunes. Montevideo, DINARA, Infopesca.

Nomura, H. 1965. Length-weight tables of some fish species from Northeastern Brazil. Arq. Est. Biol. Mar. Univ. Fed. Ceará 5(2): 103-105.

Norse, E.A. 1993. Global Marine Biological Diversity, a strategy for building conservation into decision making. Island Press, Washington DC, Covelo, California USA. 383 p.

Odum, W.E. and E.J. Heald. 1972. Trophic analysis of an estuarine mangrove community. Bull. Marine Sci. 22(3): 671-738.

OECD. 1990. Multilingual dictionary of fish and fish products. Organisation for Economic Co-operation and Development. Fishing New Books, Oxford, England.

Ogden, J.C., J.A. Yntema, and I. Clavijo. 1975. An annotated list of the fishes of St. Croix, U.S. Virgin Islands. Spec. Pub. No. 3. *After* I. Harrison. 2007. Fishbase *Mugil curema* species summary. Internet URL: http://www.fishbase.org/Summary/speciesSummary.php?ID=1086&genusname=Mugil&speciesname=curema

Ortaz, M., M.E. Rocha and J.M. Posada. 1996. Food habits of the sympatric fishes *Harengula humeralis* and *H. clupeola* (Clupeidae) in the Archipélago de Los Roques National Park, Venezuela. Caribb. J. Sci. 32(1): 26-32.

Pagan, F.A. and H.M. Austin. 1970. Report on a fish kill at Laguna Joyuda western Puerto Rico in the summer, 1967. Carib. J. Sci. 10: 203-208.

Parrish, J.D. 1982. Fishes at a Puerto Rican coral reef: distribution, behavior, and response to passive fishing gear. Carib. J. Sci. 18: 9-20.

Parrish, J.D. and R.J. Zimmerman. 1977. Utilization of space and food resources on an offshore Puerto Rican coral reef and its surroundings. Proc. 3rd Internatl. Coral Reef Symp., Miami. 1: 297-303.

Pérez, R.N., A.M. Román, and G.A. Rivera. 1992. Investigation of the reproductive dynamics and preliminary evaluation of landings data fo the dolphinfish *Coryphaena hippurus* L. Final Report, Project F26-1. Puerto Rico DNER, San Juan, P.R. 95 p.

Perlmutter, A. 1961. Guide to Marine Fishes. New York Univ. Press. NYC. 431 p.

Peters, D.J. and W.G. Nelson. 1987. The seasonality and spatial patterns of juvenile surf zone fishes of the Florida east coast. Florida Scientist 50(2): 85-99.

Pierce, D.J., B. Mahmoudi and R.R. Wilson, Jr. 2001. Age and growth of the scaled herring, *Harengula jaguana*, from Florida waters, as indicated by microstructure of the sagittae. Fish. Bull. 99: 202-209.

Poey, F. 1858-61. Memorias sobra la histoira natural de la Isla de Cuba, acompañadas de sumarios Latinos y extractos en Francés. Tomo 2. La Habana. Mem. Hist. Nat. Cuba: 1-96 (1858), 97-336 (1860), 337-442 (1861).

Poey, F. 1865. Peces nuevos de la Isla de Cuba. Repertorio Fisico-Natural de la Isla de Cuba 181-192. *After* Eschmeyer 2000.

Pollnac, R.B. 1998. Aspects of the human ecology of the coral reefs of Discovery Bay. Pp 141-199 *In:* R.B. Pollnac (ed.) Rapid assessment of management parameters for coral reefs. Coastal Resources Center, Univ. Rhode Island. CMR 2205, ICLARM 1445.

Poveromo, G. 1995. Guide to successful offshore bait rigging. VHS Video. The Signature Series. Produced by High Hook, Inc. 9930 NW 59th Court, Parkland, FL 33076 USA.

Prest, K.W. 1971. Fundamentals of sexual maturation, spawning and fecundity of thread herring (*Opisthonema oglinum*) in the eastern Gulf of Mexico. Natl. Mar. Fish. Serv., St. Petersburg, FL. (mimeo)

Puerto Rico Angling. 2007. Promotional Internet Site. Internet URL: http://www.worldwidefishing.com/puertorico/b300/.

Puerto Rico Tarpon. 2007. Promotional Internet Site. Internet URL: http://www.puertoricotarpon.com/index.html.

Quick Silver. 2007. Promotional Internet Site. Internet URL: http://www.worldwidefishing.com/puertorico/b1854/index.html?page_type=salt&state_page=.

Ramjohn, D.D. 1999. Checklist of coastal and marine fishes of Trinidad & Tobago. Marine Fishery Analysis Unit, Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Trinidad & Tobago. Fisheries Information Series 8. 151 p.

Ramsey, J.S. 1967. Distribution of fishes trawled in Mayagüez and Boqueron Bays, western Puerto Rico: ecological aspects of pollution in Mayagüez Bay. Final Rep. to Water Resources Research Inst., Univ. Puerto Rico, Mayagüez. 40 p.

Randall, J.E. 1967. Food habits of reef fishes of the West Indies. Stud. Trop. Oceanogr. Miami 5: 665-847.

Randall, J.E. 1996. Caribbean Reef Fishes. Third Edition – revised and enlarged. T.F.H. Pubs., Inc., Ltd. Hong Kong. 368 p.

Randall, J.E. and R. Vergara. 1978. Gerridae. *In:* W. Fischer (ed.). FAO species identification sheets for fishery purposes. Western Central Atlantic (Fishing Area 31). Vol. 2.

Reintjes, J.W. 1979. Coastal herrings and associated species: a profile of species or groups of species, their biology, ecology, current exploitation with economic and social information. Rept Prepared for Gulf Mex Fish Mgmnt Council, SE Fish Sci Center, National Marine Fish Svc, NOAA, Beaufort, NC USA. 170 p.

Riede, K. 2004. Global register of migratory species – from global to regional scales. Final Report, R&D Projekt 808 05 081. Federal Agency for Nature Conservation, Bonn, Germany. 329 p.

Riemold, R.J. 1975. Chlorinated hydrocarbon pesticides and mercury in coastal biota: Puerto Rico and the U.S. Virgin Islands, 1972-1974. Pesticides Monit. J. 9: 39-43.

Rivas, L.R. 1972. *Opisthonema captivai*, a new western Atlantic clupeid fish from Colombia. Copeia 1-3.

Robins, R.C., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, *et al.* 1980. A list of common and scientific names of fishes from the United States and Canada. 4th Ed. Amer. Fish Soc. Special Pub. No 12. Amer. Fish. Soc. Bethesda, MD USA.

Robins, R.C., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner *et al.* 1980. A list of common and scientific names of fishes from the United States and Canada, 4th ed. Amer. Fish Soc. Special Pub. No 12. Amer. Fish. Soc. Bethesda, MD USA. 174 p.

Robins, R.C., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner *et al.* 1991. Common and scientific names of fishes from the United States and Canada, 5th ed. Amer. Fish Soc. Special Pub. No 20. Amer. Fish. Soc. Bethesda, MD USA.

Robins, C.R. and G.C. Ray. 1986. A field guide to Atlantic coast fishes of North America. Houghton Mifflin Co. Boston, USA. 354p.

Rodriguez, G. and J. Rodriguez. 2003. Puerto Rico fishing tournaments 2002. Annual Report for Project F-42. Puerto Rico DNER, Fish and Wildlife Negotiate, Marine Resources Div., San Juan, P.R.

Rodriguez-Ferrer, G. and Y. Rodriguez-Ferrer. 2006. Puerto Rico marine recreational fisheries statistics program, Recreational fishing tournaments 2006 Annual Report. Proj. F-42. Puerto Rico DNER, Fish and Wildlife Bureau, Marine Resources Div., San Juan, P.R. 15 p.

Rome Peebles. 2007. Illustrated by Diane Rome Peebles. Provided by the Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries Management.

Rooker, J.R. and G.D. Dennis. 1991. Diel, lunar, and seasonal changes in a mangrove fish assemblage off southwestern Puerto Rico. Bull. Marine Sci. 49(3): 684-698.

Rounsefell, G.A. and W.H. Everhart. 1965. Fishery science, Its methods and applications, 4th printing. John Wiley and Sons, NYS, London, Sydney. 444 p.

Rueda, P.S. 2002. Stomach content analysis of *Mugil cephalus* and *Mugil curema* (Mugiliformes: Mugilidae) with emphasis on diatoms in the Tamiahua Lagoon, Mexico. Rev. Biol. Trop. 50(1): 245-252.

Ruple, D.L. 1984. Occurrence of larval fishes in the surf zone of a northern Gulf of Mexico barrier island. Estuarine, Coastal and Shelf Sci. 18(2): 191-208.

Sánchez, A.C. 1997. Listado taxonomico de las especies marinas indentificadas en los océanos Pacífico y Atlántico (Caribe) de Nicaragua. Ministerio de Economía y Desarrollo. MEDE PESCA. Managua. 28 p.

Sanvicente-Añorve, L., C. Flores-Coto, and X. Chiappa-Carrara. 2000. Temporal and spatial scales of Ichthyoplankton distribution in the southern Gulf of Mexico. Estuar. Coast Shelf Sci. 51(4): 463-475.

Saunders, D.C. 1966*a*. A survey of the blood parasites of the marine fishes of Puerto Rico. Trans. Amer. Microsc. Soc. 85(2): 193-199.

Saunders, D.C. 1966*b*. Differential blood cell counts of 121 species of marine fishes of Puerto Rico. Trans. Amer. Microsc. Soc. 85(3): 427-449.

Sazima, I. 1986. Similarities in feeding behavior between some marine and freshwater fishes in two tropical communities. J. Fish. Biol. 29: 53-65.

Schmied, R.L. 1989. The nature and extent of marine recreational fishing and associated development efforts in the Caribbean. Gulf & Carib. Fisheries Inst. 39: 37-50.

Schneider, W. 1990. FAO species identification sheets for fishery purposes. Field guide to the commercial marine resources of the Gulf of Guinea. Prepared and published with support of the FAO Regional Office for Africa. FAO, Rome. 268 p.

Schomburgh, R.H. 1848. The history of Barbados; comprising a geographical description of the island and an account of its geology and natural productions. London. Hist. Barbados i-xx + 1-722. *After* Eschmeyer 2000.

Schultz, L.P. 1949. A further contribution to the ichthyology of Venezuela. Proc. U.S. Natl. Mus. 1-211.

Scotton, L.N., R.E. Smith, N.S. Smith, K.S. Price, and D.P. de Sylva. 1973. Pictorial guide to fish larvae of Delaware Bay with information and bibliographies useful for the study of fish larvae. Delaware Bay Report Series, Vol. 7, Coll. Marine Studies, Univ. Delaware. 205 p.

Siddiqi, A.H. and R.M. Cable. 1960. Digenetic trematodes of marine fishes of Puerto Rico. New York Acad. Sci. 17: 257-368.

Sierra, L.M., R. Claro and O.A. Popova. 1994. Alimentación relaciones tróficas. P. 263-284 *In:* R. Claro (ed.). Ecologia de los Peces Marinos de Cuba. Inst. de Oceanología Acad. De Cienc. De Cuba y Centro de Invest. De Quintna Roo, México.

Silva, M. 1994. Especies identificadas en las pesquerias costeras artesanales del Suroeste de la República Dominica. Reportes del Propescar-Sur: contribuciones al conocimiento de las pesquerías en la República Dominicana. Vol. 1: 47 p.

Smith, C.L. 1997. National Audubon Society field guide to tropical marine fishes of the Caribbean, the Gulf of Mexico, Florida, the Bahamas, and Bermuda. Alfred A. Knopf, Inc. New York, USA. 720 p.

Smith, J.W. 1994. Biology and fishery for Atlantic threadfin herring, *Opisthonema oglinum*, along the North Caroline coast. Marine Fish Rev, Sept 22.

Sogard, S.M., G.V.N. Powell and J.G. Holmquist. 1989. Utilization by fishes of shallow, seagrass-covered banks in Florida Bay: 2. diel and tidal patterns. Env. Biol. Of Fishes 24(2): 81-92.

Spix, J.B. von and L. Agassiz. 1829-31. Selecta genera et species piscicum quos in itinere per Brasiliam annos MDCCCXVII-MDCCCXX jussu et auspiciis Maximiliana Josephi I. . . colleget et pingendso curavit Dr. J.B. de Spix . . . Monachi. Selecta Piscium Brasiliam Part I: i-xvi + i-ii + 1-82, Pls. 1-48. *After* Eschmeyer 2000.

Springer, V.G. and K.D. Woodburn. 1960. An ecological study of the fishes of the Tampa Bay area. FL Dept. Natural Resources, FL State Board Conservations Marine Lab., Prof. Paper Ser. 1. 104 p.

Stevens, D. 2004. Spanish for the fisherman. 5th Printing. Publ. by Dick Stevens, 2719 S. Depew St., Denver, CO 80227 USA. E-mail: richcoast@aol.com or richcoast3@comcast.net. 54 p.

Stoner, A.W. 1986. Community structure of the demersal fish species of Laguna Joyuda, Puerto Rico. Estuaries 9: 142-152.

Storey, M.H. 1938. West Indian clupeid fishes of the genus *Harengula* with notes on *H. thrissina* from the Pacific coast. Stanfoed Ichthyol. Bull. 3-56.

Suáreaz-Caabro, J.A., P.P. Duarte-Bello and J. Alvarez-Reguera. 1961. Biología y tecnología de las sardines cubanas. I. *Harengula pensacolae cubana* Rivas y *Harengula humeralis* (Cuvier). Inst. Cubano Invest. Tec. Series de Estudios de Trabajos de Investicación, La Habana 19: 1-87.

Talwar, P.K. and R.K. Kacker. 1984. Commercial sea fishes of India. Zoological Survey of India, Calcutta. 997 p.

Talwar, P.K. and A.G. Jhingran. 1991. Inland fishes of India and adjacent countries. Vol. 1. A.A. Balkema, Rotterdam. 541 p.

TPI, Inc. 1994. Bait rigging for trolling, live baiting & bottom fishing; bait rigging chart #1. Tightlines Pubs. Inc., P.O. Box 4397, Deerfield Beach, FL 33442 USA. 2 p.

TPI, Inc. 1995. Fishermen's knots, quick-reference illustrations, fishermen's knot-tying chart #1. Tightlines Pubs. Inc., P.O. Box 4397, Deerfield Beach, FL 33442 USA. 2 p.

TPI, Inc. 1996. Fishermen's knots, quick-reference illustrations, fishermen's knot-tying chart #2. Tightlines Pubs. Inc., P.O. Box 4397, Deerfield Beach, FL 33442 USA. 2 p.

TPI, Inc. 1997. Offshore big gamefish ballyhoo rigs, offshore ballyhoo rigs #3. Tightlines Pubs. Inc., P.O. Box 4397, Deerfield Beach, FL 33442 USA. 2 p.

Tight Loop Charters. 2007. Promotional Internet Site. Internet URL: http://www.worldwidefishing.com/puertorico/b2566/index.html?page_type=salt&state_page=.

Thomson, J.M. 1978. Mugilidae. In W. Fischer (ed.) FAO species identification sheets for fishery purposes. West Central Atlantic (Fishing Area 31). Vol. 3. FAO, Rome.

Thomson, J.M. 1981. Mugilidae. In W. Fischer, G. Bianchi and W.B. Scott (eds). FAO species identification sheets for fishery purposes. Eastern Central Atlantic; fishing areas 34, 47 (in part). Dept. of Fisheries and Oceans Canada and FAO. Vol. 3: var.

Thomson, J.M. 1990. Mugilidae. Pp. 855-859 In J.C. Quero, J.C. Hureau, C. Karrer, A. Post, and L. Saldanha (eds). Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris.Vol. 2.

Torres, F.S.B., Jr. 1991. Tabular data on marine fishes from southern Africa, Part I. Length-weight relationships. Fishbyte 9(1): 50-53.

USGS. 2000. Annotated checklist of shallow-water marine fishes from the Puerto Rico Plateau including Puerto Rico, Culebra, Vieques, St. Thomas, St. John, Tortola, Virgin Gorda, and Anegada. Published on the Internet; URL = http://cars.er.usgs.gov/Marine_Puerto_Rico_Plateau/marine_puerto_rico_plateau.html

Valdés, E. and M. Sotolongo. 1983. Algunos aspectos de la biología y pesquería del machuelo (*Opisthonema oglinum*) de la plataforma sur-occidental cubana. Rev. Cubana Invest. Pesq. 8(1): 66-96.

Valenciennes, A. 1837-44. Ichthyologie des îles Canaries, ou histoire naturelle des poisons rapports par Webb & Berthelot. *In:* P.B. Webb and S. Berthelot. Histoire naturelle des îles Canaries. Paris, 1835-1850. Ichthyol. Canaries: 1-109.

Vega-Cendejas, M.E., M. Hernandez and F. Arreguin-Sanchez. 1994. Trophic interrelations in a beach seine fishery from the northwestern coast of the Yucatan peninsula. J. Fish. Biol. 44: 647-659.

Walbaum, J.J. 1792. Petri Artedi sueci genera piscium. In quibus systema totum ichthyologiae proponitur cum classibus, ordinibus, generum characteribus, specierum differentiis, observationibus plurimis. Redactis speciebus 242 ad genera 52. Ichthyologiae pars III. Ant. Ferdin. Rose, Grypeswaldiae [Greifswald]. Artedi Piscium [i-viii] + 1-723. *After* Eschmeyer 2000.

Wallace, R.K. and R.T. Sawyer. 1977. Occurrence of *Malmiama philotherma* (Annelida: Hirudinea) on *Hemiramphus brasiliensis* (Pisces: Hemiramphidae) in Puerto Rico. Bull. Marine Sci. 27: 347-348.

Warmke, G.L. and D.S. Erdman. 1963. Records of marine mollusks eaten by bonefish in Puerto Rican waters. Nautilus 76(4): 115-120.

WCBRT. 2007. World Championship Billfish Release Tournament. Internet URL = http://www.wcbrt.com/circle-hook-rigging.htm

Whitehead, P.J.P. 1978. Albulidae. *In:* W. Fischer (ed.). FAO species identification sheets for fishery purposes. West Atlantic (Fishing Area 31). Volume 1. FAO, Rome.

Whitehead, P.J.P. 1985. FAO Species Catalogue. Vol. 7. Clupeoid fishes of the world (suborder Clupeioidei). An annotated and illustrated catalogue of the herrings, sardines, pilchards, sprats, shads, anchovies and wolf herrings. Part 1 – Chirocentridae, Clupeidae and Pristigasteridae. FAO Fish Synop. 125(7/1): 1-303.

Whitehead, P.J.P. 1990. Albulidae. P. 122-124 *In:* J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.). Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris, Vol. 1.

Whitehead, P.J.P. and R. Rodríguez-Sancez. 1995. Albulidae. Macabíes. P. 851-853 *In:* W. Fischer, F. Krupp, W. Schneider, C. Sommer, K.E. Carpenter and V. Niem (eds.) Guia FAO para identificacion de especies para lo fines de la pesca. Pacifico Centro-Oriental. 3 Vols. FAO, Rome.

Williams, E.H. 1982. Leeches of some marine fishes from Puerto Rico and adjacent regions. Proc. Helminthol. Soc. Wash. 49: 323-325.

Wood, I. 1994. The Dorling Kindersley encyclopedia of fishing: the complete guide to the fish, tackle, & techniques of fresh & saltwater angling. ISBN: 1-56458-492-5. Dorling Kindersley, Inc. NYC. 288 p.

Wright, P.B. 2006. Great mackerel rigs. Marlin: the international sportfishing magazine. July. 25(4): 50-55.

Zaneveld, J.S. 1983. Caribbean Fish Life. Index to the local and scientific names of the marine fishes and fishlike invertebrates of the Caribbean area (Tropical Western Central Atlantic Ocean). E.J. Brill / Dr. W. Backhuys, Leiden. 163p.

APPENDIX A

Contact coordinates for individuals interviewed during the course of this effort are provided in the following table.

Puerto Rico Natural Baits Project Contact List

Name	Title	Affiliation	Address	Telephone	Cell	E-mail
"Johnny"	Bait Fisher		La Playa Salinas			
"Tavin"	Bait Fisher		Las Croabas area			
Aldaña, Miguel	Boat Captain	Charter Guide	"The Grand Illusion" San Juan Bay Marina	787/380-4645		masvfishing@yahoo.com
Alfonso, Jose "Pepi"	Boat Captain	Charter Guide	P.O. Box 257 Rincón, PR 00677	787/823-4391	787/299-7374	makaira@caribe.net
Alvarez, Miguel	Fisher	Pescaderia	East End of Route 692 Vega Baja	787/855-6661	787/346-0601	
Amador, Mickey	Boat Captain	Charter Guide	Parguera Fishing Charters P.O. Box 386 Lajas, PR 00667	787/382-4698		mareja@aol.com
Anderson, Frank "Moondog"	Boat Captain	Charter Guide	Moondog Charters Rincón, PR	787/823-3059		moondogcharters@yahoo.com
Arce, Raúl	Tackle Shop Owner	Arecibo Fishing Shop	Barrio Islote 2 # 475 Carr. 681 Arecibo, PR 00612	787/878-9024		
Attendant		Pescaderia Sardinera	Puerto Fajardo, PR			
Attendant		Pescaderia Rio Grande	Rio Grande, PR			
Attendant		Piñones Pescaderia	Piñones, PR			
Attendant		Pescaderia Maternillo	Punta Real, PR			
Benitez, Mike	Boat Captain	Charter Guide		787/723-2292	787/724-6265	fishpr2001@yahoo.com
Burleson, Bill	Boat Captain	Charter Guide	Palmas del Mar Mail: P.O. Box 8270 Humacao, PR 00792	787/850-7442	787/637-7992	
Calvo Batista, Victor		Pescaderia El Indio	Juana Díaz, PR			
Camacho Rodríguez, María Del Carmen	Biólogo de Vida Silvestre	DRNA	Box 3665, Marína Sta. Mayagüez, PR 00681	787/832-5574	787/439-4126	marykayito@yahoo.com
Campos, Jose Jr.	Boat Captain	Charter Guide	Congrejos Yacht Club	787/724-2079		prangling@prtc.net
Campos, Jose Sr.	Boat Captain	Charter Guide	Congrejos Yacht Club Mail: P.O. Box 9065622 San Juan, PR 00906	787/724-2079	787/234-8849	prangling@prtc.net

Cancel, Madeleina	Pescaderia Owner	Alga Marine	Guanica, PR	787/821-4164		algamarine@caribe.net
Cortéz-Rodríguez, Zulena	Biologist	DNER		787/999-2200 ext. 2743		zcortes@drna.gobierno.pr
Díaz, Israel Jr.	Boat Captain	Fisher	Palmas del Mar			
Díaz, Israel Sr.	Dock Master	Club Nautico	San Juan, PR		787/667-9713	
Figerola, Miguel	Biologist	DRNA Fisheries Lab	Cabo Rojo, PR	787/833-2025		m.figuerola@gmail.com
Fishers		Municpality Pescaderia	Manuaubo, PR			
Fishers	Pescaderia Users	Coral Marine, Inc.	Pescaderia Arroyo Arroyo, PR			
García, "Tonito"	Bait Fisher	Toño's son	La Parguera area	787/458-9478		
García, Antonio "Toño"	Bait Fisher	Self Employed	12th Avenue La Parguera			
García, Edgardo	Bait Fisher	Toño's son	La Parguera area	787/590-2725		
Gonzalez, Jose A. "Nego"	Vice-President	Ponce Fishing Association	Villa Pesquera P.O. Box 34387 Ponce, PR 00134-4387	787/502-3262		
Hanke, Marcos	Boat Captain	Charter Guide	El Conquistador Fajardo	787/874-2294	787/646-2585	hankeg@prtc.net
Hensley, Dannie	Professor	Univ. Puerto Rico	P.O. Box 908 Lajas, PR 00667	787/899-2048 ext. 252		hensley@caribe.net
Hernandez, Ramberto	Pescaderia Owner	Pescaderia Hernandez	El Parguera			
Hernandez, Roberto	Attendant	Pescador de Niños	Fajardo, PR			
Lugo, Felix "Junior"	Bait Fisher	Self Employed	Calle Julio Camacho 7e El Corozo, Cabo Rojo	787/851-5747		
Maldonado, Jaime	Bait Fisher	Self Employed	P.O. Box 294 Puerto Real, PR 00740	787/435-9553		
Martinez Morales, Cruz	Tesorero	Ponce Fishing Association	Villa Pesquera P.O. Box 34387 Ponce, PR 00134-4387			
Martínez-Rivera, Eloy	Student	Univ. Puerto Rico	Hidalgo St. AK-72 Bayamón, PR 00956	787/478-4142		eloymartinezrivera@gmail.com
Menendez, Luis "Wiso"	Bait Fisher	Frigorifico Gloriluis Seafood	Calle Aduana No. 3 Punta Santiago Humacao	787/285-8811		

Nemeth, Michael					787/319-1880	michaelnemeth@hotmail.com
Ojeda, Edgardo	Asociado en Inv.	Sea Grant	UPR, P.O. Box 9011 Mayaguez, PR 00681-9011	787/832-8045	787/265-2880	e_ojeda@rumac.uprm.edu eojeda@coqui.net
Orraca, Omar	Boat Captain	Charter Guide	Caribbean Outfitters Congrejos Yacht Club San Juan, PR	787/727-1215	787/396-8346	tarpon@fishinginpuertorico.com
Pérez, Jerry	Owner	M.B. Fishing Tackle Shop & Supplies	1158 Calle Principal Carr.308, Puerto Real Cabo Rojo, PR 00623	787/255-3536		
Rodriguez, Samuel	Store Owner	Samuel's Store	El Parguera			
Roman, Manuel "Neco"	Bait Fisher	Self Employed	Route 3661 Guanica Bay area			
Rosario, Francisco "Pochy"	Boat Captain	Charter Guide	Boqueron-Rincón areas	787/849-1430	787/547-7380	tarponhombre@yahoo.com
Ruiz, Hector	Student	Univ. Puerto Rico	Lajas, PR		787/691-7410	astreoids@hotmail.com
Sales Staff		Villa Pesquera Punta Pozuelo, Inc.	Barrio Pozuelo Carr. 7710 Guayama, PR 00784	787/864-5522		
Sales Staff		Al Anda Cafeteries & Pescaderia	Isabela, PR	787/872-4099		
Vega, Marilyn		Charter Guide	Shiraz Charters Palmas del Mar	**OUT OF BUSINESS**		
Vendrell, Fernándo	Fisher & Associate	La Guancha Pescaderia	Ponce, PR	787/431-4126		
Weil, Ernesto	Scientist	Univ de P.R. Dept. Ciencias Marinas	P.O. Box 908 Lajas, PR 00667	787/899-2048		
Whitley, Chris	Fisher				787/568-5858	
Williams, Bert						fishparasite@choicecable.net
Williams, Lucy					787/467-2179	fishparasite@choicecable.net