Species Composition, Catch Rates, and Size Structure of Fishes Captured in the South Florida Lampara Net Fishery

RICHARD S. MCBRIDE and JUSTIN R. STYER

Introduction

South Florida's lampara net fishery has been a small but valuable bait fishery targeting halfbeaks (Hemiramphidae) for more than a half century (McBride, 2001). The two primary target species, ballyhoo, *Hemiramphus brasiliensis*, and balao, *H. balao*, are short-lived, fast-growing pelagic species (Berkely and Houde, 1978; McBride and Thurman, 2003). Little attention has been paid to the overall catch composition of this fishery, although Berkeley et al. (1975) and McBride et al. (1996) reported that only needlefishes (Belonidae) and flyingfishes (Exocoetidae) consistently occur with halfbeaks in these catches.

There are three reasons to examine the species composition, catch rates, and size structure of fishes captured in the south Florida lampara net fishery. First, the effect on catch composition, resulting from the recent geographic expansion of this fishery, has not been examined. In the early 1990's this fishery expanded from the Atlantic Ocean into Florida Bay (Fig. 1; McBride, 2001), and it seemed likely that catches from lagoon and bank habitats of Florida Bay would differ in some manner from catches from the historical fishing areas, which are Atlantic Ocean reef habitats. Second, markets for and landings of flyingfishes appear to be expanding, and this part of the fishery should be examined. Although a flyingfish fishery is mostly of local interest, it shows that fishery markets continue to develop in the southeastern United States. Last, bycatch in any fishery represents waste that should be described, monitored, and managed carefully (Alverson and Hughes, 1996; Schmitten, 1998; Boreman, 1998).

Because the term bycatch has been used in several ways, it deserves clarification here. Hall (1996) categorized all animals captured by fishing gear in one of three ways: catch, bycatch, or released. Catch consists of target and nontarget species that are kept onboard to be sold later. Unsold catch, rejects, or processing waste are treated as separate categories of catch by Hall (1996). Bycatch comprises target and nontarget fishes that are discarded as dead (or likely to die) at sea because they have little or no economic value or keeping them is not legal. In contrast to bycatch, released fish are those returned to the sea that can be expected to survive. Fish that are not captured, yet die because of fishing operations, are not categorized as bycatch by Hall (1996) but as collateral mortalities. The above terminology is used in interpreting the results of this study.

This study describes the complete species composition of the south Florida lampara net fishery. We examined the landings data reported by this fishery since 1986, although these data were limited because fish sizes, bycatch, and released species did not have to be reported. To overcome this limitation in the reported data, a biologist collected data while onboard commercial fishing vessels, during normal fishing operations in the years 1995–99, as part of a cooperative program with the lampara net fishing industry.

Materials and Methods

Since 1986, transactions between a harvester and a wholesale dealer for marine organisms landed within Florida have been required by law to be reported to the Florida Fish and Wildlife Conservation Commission. The processed data concerning these transactions are maintained in the Florida Marine Fisheries Information System (MFIS).

Halfbeak landings (i.e. undifferentiated hemiramphids) in pounds, deter-

The authors are with the Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission, 100 8th Avenue S.E., St. Petersburg, FL 33701 [richard.mcbride@fwc.state.fl.us].

ABSTRACT—Reported landings for the years 1986–2001 and recent data from onboard observations (1995–99) were examined to describe the catch composition, including bycatch, of the south Florida lampara net fishery. Landings of the primary target species, ballyhoo, Hemiramphus brasiliensis*, and balao,* H. balao*, have remained stable since 1986. Ballyhoo is the dominant species in the catch, particularly during winter months when lampara net catch rates are highest. However, since the inshore fishing areas were closed to lampara nets in 1995, more balao are landed by the fishery because balao are more abundant than ballyhoo in offshore waters. A new market for flyingfishes (Exocoetidae) has emerged, and landings of flyingfishes have steadily increased in the last decade. Balao and flyingfishes are more abundant in lampara net landings during the summer. Needlefishes (Belonidae) are regularly caught but have not been marketed successfully. The amount of bycatch in the lampara net fishery is very low compared to that in other commercial fisheries. Fishing with lampara nets in Florida Bay, which developed during the early 1990's, is different than fishing in the Atlantic Ocean. In Florida Bay, balao and flyingfishes do not occur, halfbeaks (Hemiramphidae) other than ballyhoo and balao are occasionally caught, benthic species appear frequently in the catches, reported catch rates are higher than in the Atlantic, and ballyhoo are larger on average than in the Atlantic.*

mined from Florida's MFIS data, were summarized previously (McBride et al., 1996; McBride, 2001), but herein these landings are reported as the number of individuals harvested. Landings for the south Florida lampara net fishery were typically reported "by the piece" (i.e. individual fish). Bulk weights of halfbeaks were reported separately (Table 1), and we converted these bulk values to numbers by using an average of 5.7143 halfbeaks/lb (12.572 halfbeaks/kg, from McBride, 2001). This is a conservative estimate of the number of halfbeaks sold in bulk, because halfbeaks that are reported by weight are generally small or damaged fish.

Bulk weights of flyingfishes were also kept separate from the numbers of flyingfishes landed, but these weights were not converted to numbers of fish. Flyingfishes sold by the piece were not identified to species, but they are typically one of two genera, *Exocoetus* or *Cypselurus*. Flyingfishes sold by weight were generally a different and smaller species, (sailfin flyingfish, *Parexocoetus brachypterus*), or damaged *Exocoetus*/*Cypselurus*.

A variety of needlefish species (Belonidae) were captured, with only a few sold by the piece, and no bulk sales of needlefish were reported. Fishing-effort information from Florida's MFIS was reported as day trips or converted to day trips from multiple-trip records. Annual landings were aggregated by a fishing year, July–June, because peak catches of the primary target species (ballyhoo and balao) occurred during winter. Catch rates were calculated as the geometric mean number of halfbeaks landed per fishing day (i.e. backtransformed values of $\log_e$-transformed data; Sokal and Rohlf, 1981).

Commercial lampara net fishing trips were monitored by an onboard biologist during as many as four trips per month, from November 1995 to April 1999. A subsample of every observed set was obtained by filling a 20-l bucket as the catch was transferred from the net to holding boxes. This bucket could hold 100–200 individuals, and all collected fishes were measured to the nearest mm fork length (FL; from the tip of the upper jaw to the fork of the tail). In addition, fishes from the first set of every fishing day were kept on ice and brought back to the laboratory, where lengths and weights were measured for up to 30 fish of each sex for each species. Whole body weight was recorded to the nearest 0.1 g. Most weight measurements were made during the period July 1997–October 1998. Species-specific length-weight conversion equations were estimated by linear least-squares regression of

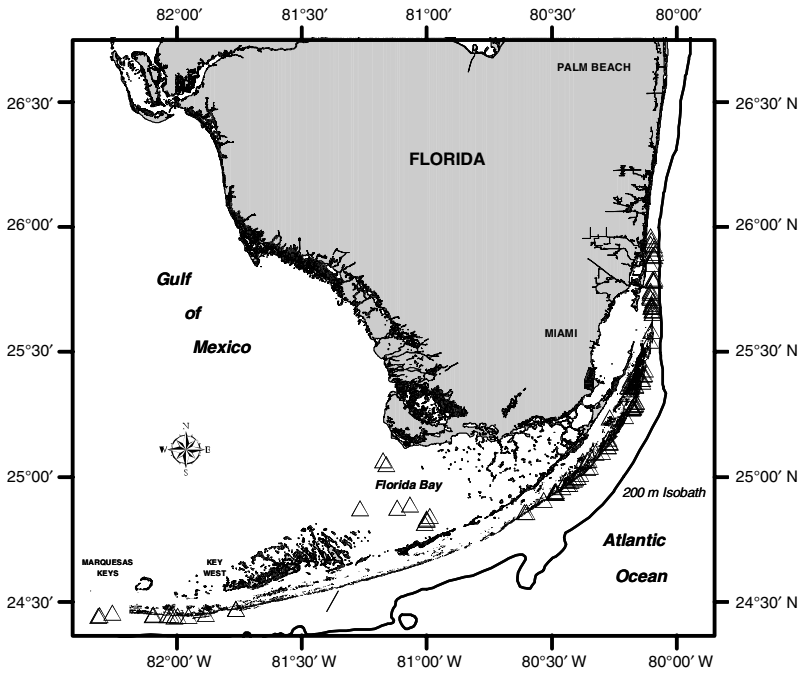

Figure 1.—Map of south Florida identifying the major fishing areas of the lampara net fishery. The fishing grounds were distributed in the Atlantic Ocean prior to the 1990's and fishing expanded into Florida Bay during the early 1990's. Triangles indicate locations of observed lampara net sets by commercial fishing vessels during the period July 1997–October 1998.

Table 1.—Annual reported landings (in numbers of fish [*n*] or pounds) and number of day trips in which halfbeaks (Hemiramphidae), flyingfishes (Exocoetidae), and needlefishes (Belonidae) were caught in the south Florida lampara net fishery since 1986. Total number of halfbeaks landed was estimated by converting additional pounds into numbers, assuming an average of 5.7143 halfbeaks per pound (from McBride, 2001), and adding that to the reported number of fish sold as individual fish. A fishing year of July–June is used. Data source: Florida's Marine Fisheries Information System. Data for 2000–01 are preliminary.

	Halfbeaks				Flyingfishes			Needlefishes	
Fishing Year	*n*	Additional pounds	Total *n*	Day trips	*n*	Additional pounds	Day trips	*n*	Day trips
1986–87	4,057,778	206,517	5,237,878	1,151					
1987–88	5,938,096	156,636	6,833,161	1,530					
1988–89	5,679,168	171,884	6,661,365	1,565					
1989–90	6,762,960	121,742	7,458,630	1,411					
1990–91	6,092,953	149,164	6,945,321	1,379	1,268		6		
1991–92	9,002,342	186,720	10,069,316	1,603	4,352		19		
1992–93	4,836,715	156,289	5,729,797	1,059	8,077		27		
1993–94	7,902,374	172,051	8,885,525	1,313	13,777		66		
1994–95	8,066,121	151,259	8,930,460	1,301	5,625		28		
1995–96	7,197,303	157,304	8,096,185	1,215	66,474	2,336	106	32	13
1996–97	4,578,287	68,229	4,968,168	814	27,029	1,959	64		
1997–98	5,466,287	106,652	6,075,729	915	80,918	2,210	104	924	7
1998–99	9,172,621	129,285	9,911,394	1,145	51,255	578	77		
1999–2000	3,899,987	57,464	4,228,354	789	41,050	4,096	58	6	1
2000–01	6,054,111	38,113	6,271,900	836	98,795	48	104		

log-transformed fork lengths and body weights, and these equations were used to calculate weights for fish that were measured only for FL. A student's *t*-test was used for each statistical test of fish sizes and evaluated at $P < 0.01$ (Sokal and Rohlf, 1981).

Results

Fishery Landings

Since 1986, the estimated total number of landed halfbeaks has ranged from 4.2 to 10.1 million fish annually (Table 1). Halfbeak landings were highest in 1991–92, but have fluctuated considerably between years. The reported number of trips during which halfbeaks were caught reached a high of 1,603 day trips during the year of peak landings, 1991–92, and fell to a low of 789 day trips in 1999–2000 (Table 1). Reported catch of halfbeaks per trip was consistently higher in Florida Bay fishing grounds compared to the Atlantic Ocean (Fig. 2). Species composition of halfbeak landings were not reported to Florida's MFIS, but they were identified through interviews with industry participants. In general, these landings were dominated by ballyhoo and the balance of halfbeak landings were balao. The silverstripe halfbeak, *Hyporhamphus* sp.[1], occasionally occurred in Florida Bay catches, and all other hemiramphid species were rare.

Landings of flyingfishes were not reported until the early 1990's (Table 1). Flyingfish landings have increased dramatically from 1,000 to nearly 100,000 fish annually. The number of day trips reporting flyingfish landings has increased during the past 11 years from as few as 6 in 1990–91 to more than 100 in recent years (Table 1). Flyingfish landings occurred only in Atlantic Ocean fishing grounds and were highest in the summer (Fig. 2). Although flyingfish landings were not reported by species, interviews indicated that nearly all flyingfishes reported by number of fish were larger species of two genera (*Cypselurus* and *Exocoetus*), whereas flyingfishes landed in bulk were either damaged fish (*Cypselurus* or *Exocoetus*) or a smaller species, sailfin flyingfish.

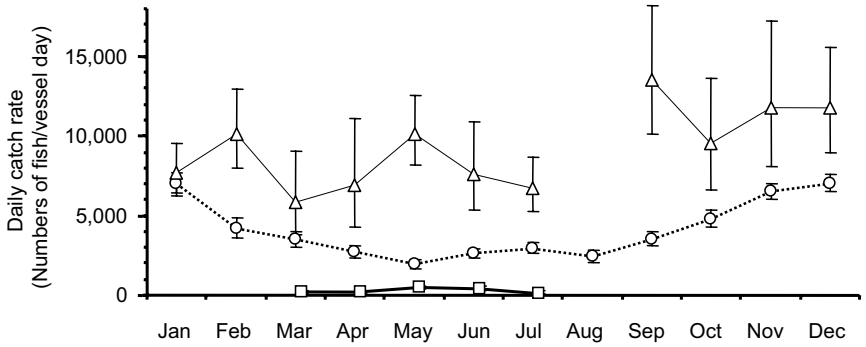

Figure 2.—Daily catch rates (numbers landed per fishing vessel day) of the primary target species (Hemiramphidae and Exocoetidae) in the south Florida lampara net fishery. Catch rates for halfbeaks (*Hemiramphus* spp., *Hyporhamphus* sp.) in the Atlantic Ocean (circles) and Florida Bay (triangles) fishing grounds are shown separately. Flyingfishes (*Cypselurus* sp., *Exocoetus* sp.) were reported for the Atlantic Ocean only (squares). Catch rates are geometric means ± 95% confidence limits for each calendar month calculated from data for the 5-year period July 1996–June 2001. Only the months in which > 30 observations per taxa were reported are shown. Data source: Florida's Marine Fisheries Information System.

All other fish species reported in south Florida lampara net landings appeared to be not targeted. Needlefishes were caught consistently throughout the year, but needlefish landings have been reported for only 3 years and have totaled less than 1,000 fish per year. Interviews indicated that needlefish species commonly landed were flat needlefish, *Ablennes hians*; agujon, *Tylosurus acus*; and houndfish, *T. crocodilus*. Reported landings identified blue runner, *Caranx crysos*; shrimp, Penaeidae; and bigeye scad, *Selar crumenophthalmus*, as uncommon, and all other species were either rare or reported in miscellaneous categories such as "baitfish" or "industrial fish" (Table 2).

Table 2.—Top ten categories of catch reported as landed in the south Florida lampara net fishery during the 10-year period July 1991–June 2001. Halfbeaks are listed for both trips that reported landings as individual fish (numbers) and by weight (pounds). Frequency is the total number of daily trips that reported catching each category of landings. Percent of each category caught is also given. "All other categories," a total of 24 different fish categories, were mostly single reports of individual species. Data source: Florida's Marine Fisheries Information System.

Category	Frequency	Percent
Halfbeaks (no.)	17,613	74.76
Halfbeaks (lb.)	4,679	19.86
Flyingfishes (no.)	544	2.31
Miscellaneous baitfish (no.)	332	1.41
Flyingfishes (lb.)	70	0.30
Blue runner	65	0.28
Miscellaneous baitfish (lb.)	54	0.23
Miscellaneous industrial fish	49	0.21
Miscellaneous shrimp	45	0.19
Bigeye scad (lb.)	22	0.09
All other categories	86	0.37

Onboard Observations

A biologist was aboard on 107 lampara net fishing trips in south Florida, and 225 sets were witnessed from November 1995 to April 1999. Both ballyhoo and balao were caught in the majority of sets (n=137), but the catches were dominated by ballyhoo in terms of both numbers (Table 3) and weight (Fig. 3). Only ballyhoo (no balao) were caught in 60 sets. Only balao (no ballyhoo) were caught on six sets in the Atlantic Ocean, and balao was never collected in Florida Bay. Neither ballyhoo nor balao were caught in the remaining 22 sets.[2]

In Atlantic waters, ballyhoo and balao dominated the catches (Table 3, Fig. 3). Needlefishes (flat needlefish, *Ablennes hians*; keeltail needlefish, *Platybelone argalus*; agujon, *Tylosurus acus*; and houndfish, *T. crocodilus*) were common year-round. Flyingfishes (*Cypselurus* sp.;

[1]A new species, *Hyporhampus meeki*, was reported by Banford and Collette (1993). We did not distinguish between *H. unifasciatus* and *H. meeki*.

[2]Although sets are made only after visually scanning the water surface for high densities of fish, on occasion a set will yield no fish. This typically occurred when rapid currents collapsed the net or equipment failure cut short the set.

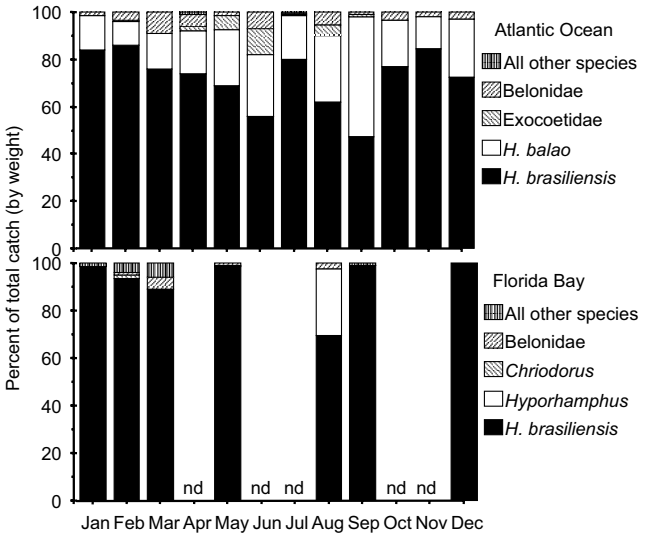

Figure 3.—Percent composition of the catch, by species or family, in the south Florida lampara net fishery (1995–99) based on data provided by onboard observers. Data are shown separately for the Atlantic Ocean (above) and Florida Bay (below) fishing grounds. Ballyhoo, balao, silverstripe halfbeak, hardhead halfbeak, flyingfishes (Exocoetidae: *Cypselurus, Exocoetus, Parexocoetus*); and needlefishes (Belonidae: *Ablennes, Platybelone, Strongylura, and Tylosurus*) are reported separately. All other species are combined. No data=nd.

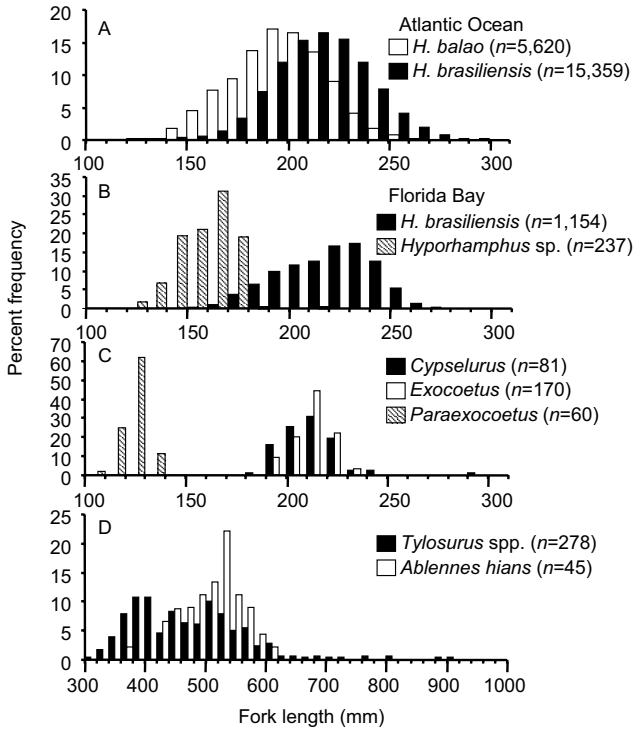

Figure 4.—Fork-length frequencies of target and selected nontarget species captured in the south Florida lampara net fishery (1995–99). A) Ballyhoo and balao captured in the Atlantic Ocean fishing areas. B) Ballyhoo and silverstripe halfbeak captured in Florida Bay fishing areas. C) Flyingfishes (*Cypselurus sp., Exocoetus sp., Parexocoetus brachypterus*) captured in the Atlantic Ocean fishing areas. D) Needlefish (*Ablennes hians, Tylosurus* spp.) captured in the Atlantic Ocean fishing areas. Sample size=*n*.

Exocoetus sp.; and sailfin flyingfish) were common during the summer. All other species caught in Atlantic waters were uncommon or rare. Several leatherjackets (*Aluterus* sp.; gray triggerfish, *Balistes capriscus*; fringed filefish, *Monacanthus ciliatus*; and planehead filefish, *M. hispidus*) were caught, but these were all juveniles and were mostly caught in a single haul that contained an unusual amount of the macroaglae *Sargassum*. Jacks (blue runner, *Caranx crysos*; bar jack, *C. ruber*; and juvenile *Seriola* sp.) and herrings (scaled sardine, *Harengula jaguana*; and Spanish sardine, *Sardinella aurita*) were rare. Individual smallwing flyingfish, *Oxyporhamphus micropterus*; Bermuda chub, *Kyphosus sectatrix*; and green razorfish, *Hemipteronotus splendens,* were observed only once.

In Florida Bay, aside from the dominant proportions of ballyhoo, only the silverstripe halfbeak[1], was found in appreciable numbers (Table 3; Fig. 3). Herrings (Atlantic thread herring, *Opisthonema oglinum*) and needlefishes (redfin needlefish, *Strongylura notata*; and *Tylosurus* sp.) were found in about half the catches in Florida Bay and were relatively common numerically. The pelagic species hardhead halfbeak, *Chriodorus atherinoides*, and leatherjack, *Oligoplites saurus*, were not common, and the scrawled cowfish, *Lactophrys quadricornis*; the striped burrfish, *Chilomycterus schoepfi*; and the great barracuda, *Sphyraena barracuda*, were all observed only once. Several demersal species were netted in Florida Bay (i.e. *Eucinostomus* sp.; *Calamus* sp.; pinfish, *Lagodon rhomboides*; and white grunt, *Haemulon plumieri*), which indicated that the lampara net commonly tended the substrate in this shallow, lagoon system.

Ballyhoo and balao sizes overlapped broadly, but ballyhoo were bigger in general (Fig. 4A). Ballyhoo were also larger than silverstripe halfbeak[1] in Florida Bay, where these species both occurred (Fig. 4B). There were seasonal, geographic, and sex-specific size differences observed for ballyhoo and balao. First, the size-structure of both species changed rapidly between months (Fig. 5). Age-0 ballyhoo recruited to the fishery in June and age-0 balao recruited in August. Geographically, ballyhoo were significantly larger in Florida Bay than in the Atlantic (Figs. 4A, B, 6). And female halfbeaks were significantly larger than male conspecifics (Fig. 6). The pattern of larger ballyhoo in Florida Bay, compared to the Atlantic Ocean, was at least partly the result of skewed sex ratios (i.e. nearly double the number of females; Fig. 6) in Florida Bay catches.

The larger flyingfishes, *Cypselurus* and *Exocoetus*, were similar in length to halfbeaks (Fig. 4C), although they were

heavier than halfbeaks at a common length. The average weight of 72 specimens (*Cypselurus* and *Exocoetus*; range: 193–231 mm FL) was 119.2 g; this is 50% heavier than the average weight of halfbeaks (*Hemiramphus* spp.; 79.5 g/fish; McBride, 2001). The sailfin flyingfish was much shorter—and the needlefishes (*Tylosurus* and *Ablennes*) were much longer—than halfbeaks or *Cypselurus/Exocoetus* (Fig. 4C, D).

Discussion

The catch of the south Florida lampara net fishery consists of four target species and at least five nontarget species. The target species are sold by the piece as bait, whereas the nontarget species are marketed in different ways as bait. Ballyhoo and balao were the primary target species historically and still are today. They are both marketed only as "ballyhoo." These halfbeaks are either sold fresh (on ice directly from the day's catch), or they are sorted by size, vacuum-packed by number (i.e. 1–12 per pack), and flash-frozen for retail sales later. Processing and grading, and the markets for ballyhoo and balao have changed little since being described by McBride et al. (1996).

During summer months, balao becomes more common than ballyhoo, but daily catch rates of both halfbeak species are low, so the overall value of the fishery drops. This is a predictable seasonal trend and most boats even take time off during the late summer months (McBride et al., 1996; McBride, 2001). The two larger flyingfishes (*Cypselurus* sp. and *Exocoetus* sp.) that have been targeted in recent years help augment the fishermen's summer incomes when catches of halfbeaks are low.

The larger flyingfishes are vacuum-packed by number and flash-frozen, and like the *Hemiramphus* halfbeaks, some are sold rigged with heavy wire leaders and single or multiple hooks. The silverstripe halfbeak[1], are not targeted, but they are occasionally taken in Florida Bay and processed by the piece. The hardhead halfbeak, *Chriodorus atherinoides*, and sailfin flyingfish are also not targeted but are caught incidentally and sold primarily in bulk. None of these nontargeted species constitute a consistent proportion of the market.

Attempts to sell needlefishes, such as rigging *Ablennes* or *Tylosurus* fillets and marketing them as 'trolling strips', have met limited success to date, and no belonid is targeted by the fishery. Needlefishes occur in the catch year-round and they are large enough to be seen in a pursed net so that they can be picked out alive and tossed back into the sea. However, no special effort is made to release them, and needlefishes not released end up mostly as chum or as free bait for local trap fisheries. Most of the additional nontargeted fish are small jacks (Carangidae) and herrings (Clupeidae); these are either packaged for cut bait or ground into chum. Foodfish or sportfish were generally not caught in this lampara net fishery, although there were some exceptions, such as white grunt caught in Florida Bay.

Halfbeaks, and any co-mingled fishes, were released alive from the pursed net on occasion. During winter months, in particular, catches occasionally exceeded the number of storage boxes onboard and the excess fish captured were released from the net.[3] Catches exceeded the storage capacity onboard on a total of 5 of 107 fishing trips made during 1995–99 when an observer was onboard. These trips occurred during October–February, and on average, an estimated 1,120 lb (510 kg) of fish were released alive from the pursed net.

The target species are typically sold by the piece—if not as fresh bait, then packaged as frozen bait. Fish are sold whole, so there is no processing waste to speak of in this fishery. Halfbeaks are graded by size for market, and larger fish are more likely to be female. At this time, sex-specific size differences (data herein and Berkeley and Houde, 1978) have not been identified as a management issue. Fish smaller than about 180 mm FL, which present more of a concern in terms of growth overfishing, are sold in bulk along with damaged fish. These smaller-sized fish are frequently encountered during June–September. They can be avoided by fishermen who spot them from the boat before a net is set or by fishermen who reduce their fishing effort during these months (McBride, 2001).

Table 3.—Species composition of catches made in the Atlantic Ocean and Florida Bay from data compiled by onboard observers of the south Florida lampara net fishery during 1995–99. Frequency refers to the number of individual sets observed (a total of 205 sets in the Atlantic Ocean and 20 sets in Florida Bay). Number indicates the total count of individuals from subsamples of the catch, and percentages were calculated from these numbers of fish by each fishing area. Hemiramphidae are identified to species (except that the silverstripe halfbeak refers only to *Hyporhamphus* sp.), and other fishes are grouped by family. Family and common names are from Robins et al. (1991) and Collette et al. (1984).

Fishing area	Family	Common name	Frequency	*n*	Percentage
Atlantic Ocean	Hemiramphidae	Ballyhoo	185	15,280	70.64
	Hemiramphidae	Balao	143	5,515	25.50
	Belonidae	Needlefishes	107	360	1.66
	Exocoetidae	Flyingfishes	37	360	1.66
	Balistidae	Leatherjackets	5	94	0.44
	Carangidae	Jacks	7	17	0.08
	Clupeidae	Herrings	2	3	0.01
	Hemiramphidae	Smallwing flyingfish	1	1	<0.01
	Kyphosidae	Sea chubs	1	1	<0.01
	Labridae	Wrasses	1	1	<0.01
Florida Bay	Hemiramphidae	Ballyhoo	12	1,095	73.59
	Hemiramphidae	Silverstripe halfbeak	5	330	22.18
	Clupeidae	Herrings	7	31	2.08
	Sparidae	Porgies	3	10	0.67
	Belonidae	Needlefishes	5	7	0.47
	Hemiramphidae	Hardhead halfbeak	2	6	0.40
	Carangidae	Jacks	1	2	0.13
	Gerreidae	Mojarras	2	2	0.13
	Haemulidae	Grunts	2	2	0.13
	Ostraciidae	Boxfishes	1	1	0.07
	Sphyraenidae	Barracudas	1	1	0.07
	Tetradontidae	Puffers	1	1	0.07

[3]Nearly all lampara net fishing vessels fishing in 1999 were 34–42 ft (10–13 m), so they have similar maximum storage capacity. Smaller fishing vessels reported by Berkeley et al. (1975) and McBride et al. (1996) have disappeared from the fishery.

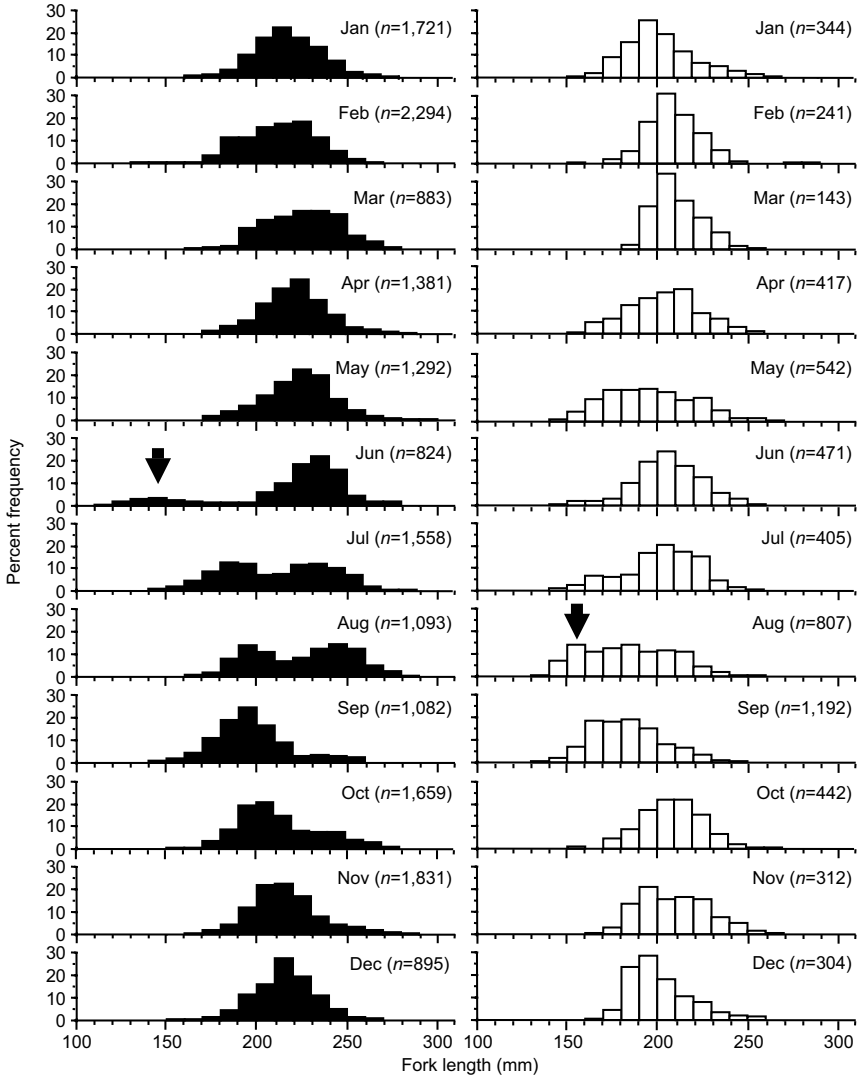

Figure 5.—Monthly fork-length frequencies of ballyhoo (filled bars), and balao (open bars), based on pooled observer data for the years 1995–99. Arrows indicate the initial recruitment event of age-0 fishes into the fishery. Sample size=*n*.

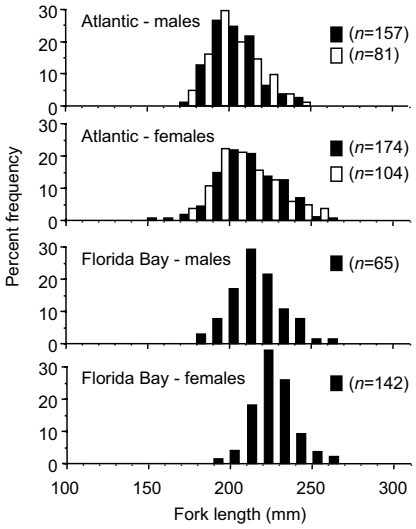

Figure 6.—Fork-length frequencies of ballyhoo (filled bars) and balao (open bars) captured during winter (December–January, 1995–99). Data are plotted by sex and by fishing area. In all three paired-sex comparisons possible, females were significantly ($P< 0.01$) larger than male conspecifics. Sample size=*n* (samples sizes are smaller than those reported in Figures 4 and 5 because not all individuals collected were identified by sex).

Both ballyhoo and balao are short-lived (Berkeley and Houde, 1978; McBride and Thurman, 2003). The annual life cycle of balao is identifiable by length-mode analysis (Fig. 5): age-0 balao recruit into the fishery in August and only a single mode progresses through the remaining annual cycle. Ballyhoo lives slightly longer (max. = 4 yr), and there is a distinctly bimodal length-frequency distribution for this species during the summer. The smaller mode represents age-0 ballyhoo, recruiting to the fishery as early as June, and rapid growth is indicated by the monthly progression of length modes. Considering this rapid turnover by both species, avoidance of smaller fish during summer reduces the potential for growth overfishing of these populations.

Lampara net fishing gear can be selective on surface-oriented fishes because the net is less than 8 ft (2.4 m) deep and designed to fish above the substrate. The method of fishing the shallow lampara nets largely avoids contact with the reef, so corals experience very little damage. The net more often contacts the substrate during fishing in Florida Bay, where depths are shallow (McBride et al., 2003). Little collateral mortality was observed except on the occasions when a stream of halfbeaks exited through a hole in the net and some individuals were eaten by reef predators such as groupers. These lampara nets are actively fished, so gear does not get lost.

The amount of bycatch in this lampara net fishery is virtually zero because of the net design, the fishing methods, and the surface-oriented behaviors of the targeted fish. In addition, most nontarget fish are processed as chum instead of becoming bycatch. For the purposes of comparisons between this and other fisheries, we determined the monthly incidental catch rate as the fish biomass of all families except Hemiramphidae and Exocoetidae as a proportion of total biomass observed in lampara net sets.

This monthly incidental catch rate was never more than 0.11 in either fishing area. On a year-round basis, the incidental catch rate was 0.037 in the Atlantic

Ocean fishing area and 0.031 in Florida Bay (Fig. 3). Most of this incidental catch is needlefish; if all needlefishes were discarded dead, the bycatch of needlefishes would average 0.036 in the Atlantic Ocean fishing areas and 0.013 in Florida Bay. In comparison, incidental catch rates are as high as 0.71 in crab fisheries and 0.84 in shrimp fisheries (Hall, 1999).

Although these ratios are relatively small for the south Florida lampara net fishery, we have not estimated the effects of this repeated biomass removal on the pelagic or reef ecosystem, nor have we calculated the biomass removal of halfbeaks or flyingfishes for bait by the commercial guides or noncommercial fishermen using small hooks or cast nets. Nonetheless, this paper offers an initial multi-species perspective of the south Florida lampara net fishery effects.

One noticeable change in the fishery since the early 1990's is the year-round presence of balao in the landings at a level much higher than reported by McBride et al. (1996). Balao, as a percentage of both ballyhoo and balao biomass from the Atlantic Ocean, ranged from a monthly minimum of 9.9% during February to a maximum of 51.1% during September during the period 1995–99. During 1988–91, however, the percentage of balao would typically be < 5% during the winter months (McBride et al., 1996). Earlier still, during 1974–75, balao were absent from catches during the winter months (Berkeley et al., 1975). This increase in balao proportions is probably due to a net-limitation regulation put into effect during the mid 1990's (McBride, 2001). Historically, ballyhoo and balao could have been targeted separately because ballyhoo occurs without balao inshore of the coral reef crest (i.e. balao occurs without ballyhoo offshore of the reef crest in south Florida; McBride et al., 2003). Ballyhoo can be considered the primary target species for the entire lampara net fishery because it grows larger, has a larger size range, and holds up better as bait during trolling than balao does. Targeting ballyhoo alone has become more difficult since 1 July 1995, because statewide regulations have prohibited lampara net fishing inshore of 1 mile on the Atlantic Ocean and of 3 miles in Florida Bay and Gulf of Mexico waters. Thus, it is likely that balao makes up a greater proportion of the catch in the past several years simply because targeting ballyhoo by fishing close to shore is no longer legal in Florida.

In conclusion, halfbeak landings by the south Florida lampara net fishery have been relatively stable since 1986, and a new source of summer revenue has developed from flyingfishes. The expansion of lampara net fishing into Florida Bay, in the mid 1990's, has brought about changes in the species composition, catch rates, and sizes of halfbeaks in the fishery. Bycatch and incidental catch rates are much lower in this fishery, particularly true for the Atlantic Ocean fishing areas, than in other fisheries.

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