Landings, Value, and Fishing Effort for Halfbeaks, *Hemiramphus* spp., in the South Florida Lampara Net Fishery

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ABSTRACT

Two halfbeak species, ballyhoo (*Hemiramphus brasiliensis*) and balao (*H. balao*), are targeted by lampara net fishers in south Florida. This report examines data from Florida's Marine Fisheries Information System (MFIS) to assess the status and trends of this bait fishery. Since 1986, when Florida's MFIS began, annual halfbeak landings have been relatively stable (median = 1.2 million lb or 0.54 million kg). In the early 1990s, halfbeak landings peaked temporarily in association with development of halfbeak fishing in Florida Bay. These increases were offset somewhat by declines in landings and effort in Palm Beach County, which occurred in response to Florida's 1995 ban on certain types of fishing nets. Ex-vessel prices have remained relatively stable and suggest that the dockside value of this fishery is more than $ 0.5 million annually. Annual halfbeak fishing trips were negatively correlated with the number of days that named storms (tropical storms or hurricanes) occurred in vicinity of Florida ($r^2 = 0.48$; $p = 0.009$). As a trend, the number of daily fishing trips by halfbeak fishers has declined since 1986. Increased storm activity in the last three years (1996 - 1999) may also explain why landings for these same years were below average. Overall, halfbeak harvest rates have been increasing since 1986, and variations in landings and fishing effort were largely explained by environmental factors. The status of this valuable living marine resource appears very good.

KEY WORDS: Bait fishery, stock assessment, storm effect

INTRODUCTION

Combined landings of ballyhoo, *Hemiramphus brasiliensis*, and balao, *H. balao*, constitute a small but valuable bait fishery in Florida (Berkeley et al. 1975, McBride et al. 1996). The two species are similar in appearance and are marketed together only as 'ballyhoo'. These halfbeak species are harvested with lampara nets in coastal waters of south Florida and sold as bait to anglers seeking gamefishes and foodfishes. Markets for fresh halfbeaks exist throughout the Florida Keys and as far north as Palm Beach County. Frozen, vacuum-packed halfbeaks are marketed widely throughout Florida, the middle Atlantic states, and the Caribbean region. Regional sport anglers also catch their own halfbeaks with cast nets and small (i.e.,

Sabiki) hooks, and they fish in areas where halfbeaks congregate. Therefore, the status and trends of the halfbeak fishery and its resource populations are of interest to a regional commercial fishery and an international fishing community.

This stock assessment is an extension of previous studies investigating the halfbeak fishery, particularly the trend of higher halfbeak landings in the early 1990s compared to the late 1980s (McBride 1996, McBride et al. 1996). There were also questions about how enactment of Florida's net ban referendum in July, 1995 would affect halfbeak landings and fishing effort. This regulation (s. 16, Art. X of the Florida Constitution) prohibits entangling nets in waters inshore of three miles on the Atlantic coast and nine miles on the Gulf coast of Florida. It also prohibits non-entangling nets larger than 500 ft^2 (such as those nets used by commercial halfbeak fishers), in waters less than 1 mile of Florida's Atlantic coast and three miles of the Gulf coast. Entangling nets are not used in the halfbeak fishery, so their prohibition in coastal waters would not directly affect the halfbeak fishery. But Florida's net ban could affect the ballyhoo fishery indirectly if bait became more valuable and fishers displaced from other fisheries entered the halfbeak fishery. These events prompted a reexamination of Florida's halfbeak fishery.

In this paper, I examine halfbeak landings, value, and fishing effort based on information reported to Florida's Marine Fisheries Information System (MFIS). Since 1986, Florida law requires wholesale transactions of marine organisms landed within the state to be reported to the MFIS. Because a majority of halfbeak landings are reported by piece rather than by weight, I begin with an analysis of how best to render the MFIS halfbeak piece data as pounds landed. Conversion factors were developed from measurements of fish from fishery catches. Also included is an analysis of how storm frequency affects this fishery, and how changes in fishing effort were associated with changes in catch-per-unit-effort. The purpose of this study was to assess the status of this valuable bait fishery in south Florida.

MATERIALS AND METHODS

An initial task of this study was to examine assumptions previously relied upon (e.g., McBride et al. 1996) to convert numbers of fish to pounds. From November 1995 to October 1998, ballyhoo and balao were collected randomly during 73 days of fishing. These fish were collected by a biologist onboard commercial fishing vessels in south Florida. A subsample of fish was collected from the first set completed each day by filling a 5 - gallon bucket with fish as the catch was transferred from the lampara net to holding boxes. A single subsample contained about 100 halfbeaks (approx. range: 50 - 200). Fish were kept on ice and brought back to the laboratory, where whole body weight (0.1 g) was measured for up to 30 fish per sex per species.

Commercial fishery data were available from Florida's MFIS. Although data exist for halfbeak landings since 1950, only data collected since 1986 are reviewed

herein because earlier data were collected differently, which makes direct comparisons difficult (McBride et al. 1996). Annual landings were grouped as a fishing year (July - June), because halfbeak landings are highest during winter and grouping landings by a calendar year splits the peak landing period inappropriately (McBride 1996, McBride et al. 1996). Data for the south Florida lampara net fishery represent nearly all halfbeak landings and were kept separate from data for all other fishing locations and gear. Halfbeak landings for counties north of Brevard (east coast) and north of Pinellas (west coast) and for all other commercial gear (e.g., cast net, rod and reel) were less than 5%, and generally less than 1%, of the annual harvest. These minor catches were deleted from most analyses except where noted.

Average price per pound data was estimated for each fishing year from 1993 to 1999 using MFIS data. Halfbeak prices were not required to be reported to Florida's MFIS until January, 1995, so samples sizes prior to that date were small or not available. Price data for 1988 - 1989 and 1989 - 1990 were available to me from notes supplied by fishers. As noted above, because halfbeaks are mostly sold by the piece, most price data had to be converted to price per pound. In the MFIS database values for halfbeak price per pound exist, but this specific parameter refers to bulk fish that are usually damaged or too small to sell individually. A daily mean price per pound for halfbeaks was converted from price per piece data as a weighted average following these steps: Halfbeak numbers were converted to pounds by first multiplying the number of fish in each size category by the median fish weight for that size category (taken from McBride et al. 1996). The fish weight per category per trip was multiplied by the total price for the fish landed in that category for that trip. The weighted price per pound was calculated as the average value of all size categories reported for each trip (Sokal and Rohlf 1981). Finally, annual prices reported here are arithmetic means of all daily weighted price estimates available for each fishing year.

RESULTS AND DISCUSSION

Mean fish weight was generally lower in summer-autumn and higher in winter-spring (Table 1). Most ballyhoo and balao harvested are young-of-the-year (age-0) or have overwintered only once (age-1), and because few individuals live longer than one year, halfbeak numbers and biomass change dramatically from month to month. Young-of-the-year ballyhoo and balao first appear in commercial catches during summer and they appear to be fully recruited to the fishery by October (Berkeley et al. 1975, Berkeley and Houde 1978, McBride et al. in prep.). Thus, one would expect that the largest fish are found during winter-spring. In addition, ballyhoo are larger on average than balao, so the mean fish size in mixed landings depends on the proportions of each species. Because landings are greatest during winter, when large ballyhoo dominate the catches (Berkeley et al. 1975, McBride et al. 1996, McBride

and Styer in prep.), using month-specific conversion factors could be more accurate than a single conversion factor.

Table 1. Combined mean fish weight of ballyhoo and balao for each month. Samples were collected by commercial lampara nets in south Florida from November 1995 to October 1998. Sample size refers to number of fish.

Month	Mean (lbs/fish)	Standard deviation	Sample size (n)
January	0.167	0.050	456
February	0.183	0.052	525
March	0.194	0.053	216
April	0.190	0.054	462
May	0.169	0.057	487
June	0.169	0.063	450
July	0.179	0.069	724
August	0.167	0.080	679
September	0.145	0.054	601
October	0.191	0.070	784
November	0.174	0.063	481
December	0.179	0.052	335
All months	0.175	0.064	6200

The average halfbeak, sampled from year-round commercial catches of ballyhoo and balao, weighed 0.175 lb (Table 1). Using this single value, I converted the number of fish recorded in the MFIS database into pounds of fish landed annually, and I compared the result to the annual landings estimated using month-specific conversion factors. Both methods produced annual landings values within 2% of each other. In practice, either method is suitable for examining long-term trends in landings as long as seasonal landings or species ratios do not vary significantly between years. The previous conversion factor used to render numbers of fish into pounds landed (0.1429 lbs/fish) was calculated from a small number of fish from a single sample and was much lower than the factor calculated here. Consequently, annual landings reported here are higher than, but should be more accurate than, those previously reported (e.g., McBride et al. 1996).

Annual halfbeak landings from the south Florida lampara net fishery were relatively stable from 1986 - 1999 (Figure 1). The median value during this period was 1.2 million lb (0.54 million kg), and landings ranged from 0.87 to 1.8 million lb (0.40 - 0.82 million kg). The south Florida halfbeak fishery appears to be the largest halfbeak fishery in the Gulf-Caribbean region. Landings have been reported for Panama (Meek and Hildbrand 1923), Curacao (Zaneveld 1962), South America

(Collette 1978), Virgin Islands (Beets and LaPlace 1991), and Puerto Rico (Kimmel 1987, Holliday 1997), but none approach one million pounds of annual landings. Historically, south Florida's halfbeak landings were low and stable prior to the late 1960s and then increased dramatically in response to increasing demand for bait and to improvements in fishing methods (Berkeley et al. 1975, McBride et al. 1996). During the 1970s and 1980s, landings appeared to be relatively stable at this increased level. In the early 1990s, however, landings increased to the highest levels ever reported for this fishery.

The temporary increase in halfbeak landings in the early 1990s was associated with geographic shifts in fishing effort. A direct analysis of fishing areas was not possible here, because fishers were not required to report fishing area until 1995. The MFIS database has required fishers to report the counties in which the fish were landed, however, and this can be used as a reasonable proxy for fishing location. Since 1986, both harvest and effort have increased in Monroe County relative to other counties (Figure 2). The percentages of the landings and trips that took place in Monroe County were both about 25 - 30% of all halfbeak landings and trips in the mid-1980s. Landings and trips for Monroe County increased rapidly in the early 1990s and have leveled off at about 60 - 70% since the mid-1990s. A previous survey of commercial halfbeak fishing for 1988 - 1991 (McBride et al. 1996) observed fishing activities offshore of Palm Beach, Dade, and Monroe counties, but at that time, there was no record of halfbeak fishing in the middle Keys or in Florida Bay, as there is now. The increased landings and effort that are evident for Monroe County today appear to be largely the result of the development of halfbeak fishing in Florida Bay in the early 1990s.

Implementation of the net ban in 1995 effectively eliminated halfbeak fishing in Palm Beach County, which also had the effect of shifting the halfbeak fishery farther south. Florida's net ban (see Introduction) essentially eliminated halfbeak fishing areas offshore of Palm Beach County because the continental shelf is so close to shore that a boat fishing one mile offshore is in water too deep for halfbeak fishing. These halfbeak fishers have either left the fishery or are fishing in Dade County since the net ban. The net ban had less effect on halfbeak fishing offshore of Dade and Monroe counties because there are numerous shallow areas beyond one mile where halfbeaks congregate in Atlantic waters offshore of these counties. In these counties the main effect of the net ban appears to be that fuel costs have risen on average because the legal fishing areas have moved farther offshore.

At the time of the implementation of the net ban referendum in 1995, there was concern that fishers displaced from other fisheries would shift to the halfbeak fishery and increase fishing pressure further. This concern does not appear to have materialized significantly. McBride et al. (1996) noted that 10 vessels were operating in the south Florida lampara net fishery during 1988 - 1991. During

1995-1998, a total of 14 boats were observed operating in the fishery; however, by 1999, 3 of the 14 had dropped out.

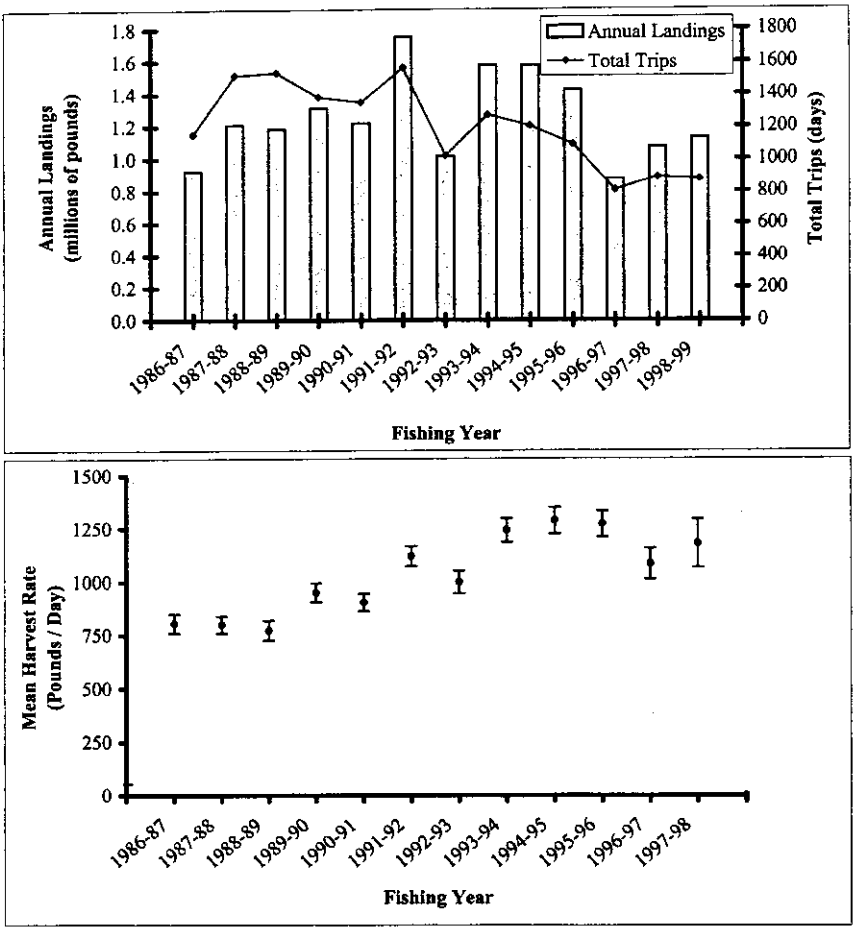

Figure 1. Halfbeak catch-and-effort data for the south Florida lampara net fishery reported to Florida's Marine Fisheries Information System. Annual landings and total number of trips reported separately (top). Mean daily harvest (lbs) ± 95% confidence limits for each fishing year (bottom). Data for 1998 - 1999 are incomplete (Up to April 1999 [Batch #564]).

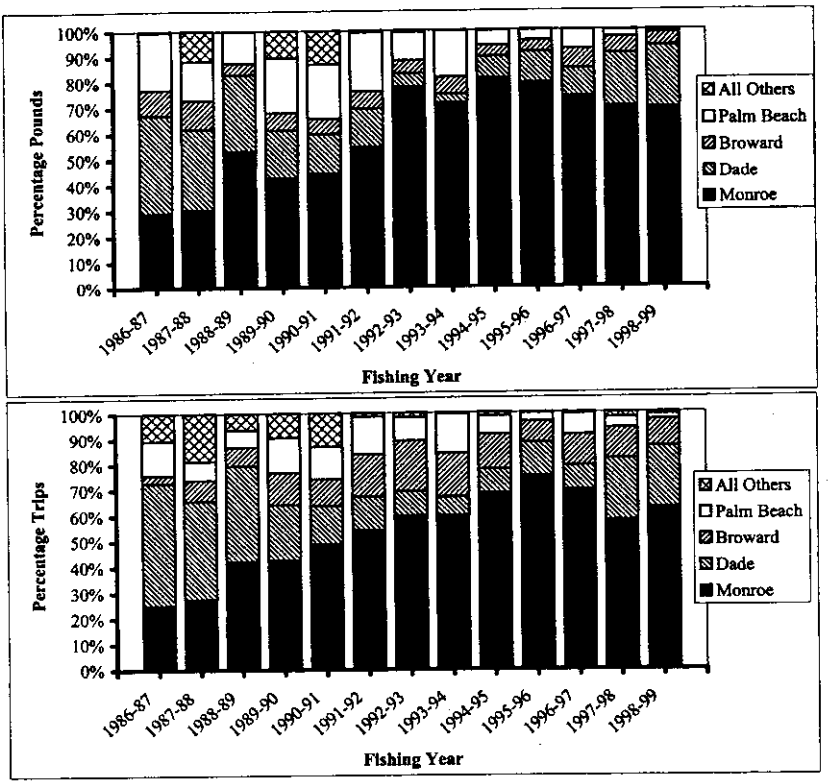

Figure 2. Percentage contribution to halfbeak landings (top) and fishing trips (bottom) per county as reported to Florida's Marine Fisheries Information System. Data includes all gear used statewide. Data for 1998 - 1999 are incomplete (up to April 1999 [Batch #563])

Ex-vessel prices (i.e., those paid directly to fishers) were relatively flat during the 1990s and averaged $0.52/lb (Table 2). This price stability may explain why the number of fishing vessels did not increase beyond one new boat in the late 1990s. In comparison to the monetary value of other bait fisheries in Florida, an average price of $0.52/lb is relatively high, and it suggests that the overall ex-vessel value of the halfbeak fishery is $0.5 - 1.0 million annually. Combined landings of Spanish sardines and Atlantic thread herring totaled more than 5.0 million pounds in 1996, but because these baitfishes were valued at only $0.14-

0.20/lb that year (MFIS unpublished data), their combined value is about equivalent to the value of south Florida's halfbeaks alone. The special onboard processing of halfbeaks and their demand as fresh bait increase their value, at least relative to other baitfishes that are sold frozen, ungraded, and without vacuum-sealed packaging (McBride et al. 1996).

Table 2. The mean ex-vessel (=dockside) price per lb for halfbeaks, ballyhoo and balao, sold from the south Florida lampara net fishery. Sample size refers to the number of trips reporting complete information to Florida's Marine Fisheries Information System. See text for methods of calculating price. Data for 1998 – 1999 are incomplete (up to April 1999 [Batch #564]).

Fishing Year	Mean price per lb (U.S. $)	Standard deviation	Sample size (n)
1988-89	0.69	0.32	4
1989-90	0.58	0.24	17
1993-94	0.41	0.18	16
1994-95	0.50	0.20	18
1995-96	0.46	0.20	117
1996-97	0.41	0.09	119
1997-98	0.60	0.56	210
1998-99	0.50	0.19	220
Overall mean	0.52		

An obvious trend in the MFIS data was that the total number of daily trips declined from 1200 - 1600 during the late 1980s to 800 - 1000 during the late 1990s (Figure 1). If one considers that the 11 boats currently operating in the fishery will fish for approximately 200 working days per year each, then the projected maximum number of total fishing days for this fishery is 2200. In recent years, boats fished less than half of those working days. Because this decline was evident during the early 1990s, it could not be associated with the implementation of Florida's net ban. Instead, this trend appears to be largely the result of weather-related phenomena, particularly the presence of named storms (i.e., tropical storm or hurricane) in the western Atlantic (Figure 3). Named storms in the vicinity of Florida (here the area chosen was bounded by 20°N, 30°N, 70°W, and 90°W) can produce winds and wave action that interfere with fishing in south Florida. A linear, least-squares regression predicted that 27 fishing days were lost for every day that the center of a named storm was present within this area.

This weather vs. fishing effort model does not account for the severity of individual storms, and adjustments for storm severity could improve the model's fit. For example, the most significant hurricane to hit south Florida during this study period was Andrew, which hit Homestead in August 1992 and disrupted local

commerce for weeks to months. Both halfbeak landings and trips for 1992 - 1993 were the third-lowest measured, even though the total number of storm-days was only 13 (mean storm-days per year = 12.5; Figure 3). Other weather patterns also affect the number of commercial halfbeak fishing trips and cause variation not explained by this simple linear model. During the El Niño year of 1997 - 1998, when only 12 storm-days occurred, approximately 70 days were too windy or rainy for ballyhoo fishing, according to records supplied by halfbeak fishers. These same records indicate that another 20 - 30 days can be lost to engine or gear repairs (observers witnessed 8 breakdowns at sea during 107 trips). In addition, most fishers do not fish for halfbeaks during August, when catch rates are very low compared to catch rates in other months. At this time, fishers may schedule boat maintenance, vacations, or participate in other types of fisheries. Increased storm activity in recent years caused some fishers to take off earlier in the summer or extend this vacation period, according to interviews with halfbeak fishers.

Among the many variables affecting the number of fishing days, days lost to weather may vary greatly between years, and virtually all south Florida halfbeak fishers are affected by the same bad weather. The number of storm-days explained nearly half the variability in number of fishing days each year (Figure 3). Further improvements to this model could be made with supplemental weather data, but the predictive outcome is already evident: during years of "average" or "better" weather, there will be more fishing days than during years of "poor" weather, but as long as the number of fishing vessels remains stable these increases should not be taken as a sign that the fishery is expanding.

Annual halfbeak landings had been relatively stable even though fishing effort had declined during the period 1986 - 1999, which resulted in increasing daily harvests from 750 - 1000 lbs to 1000-1250 lbs (Figure 1). There has been no recent improvement in fishing methods to account for an increase in harvest efficiency. There is also no evidence or even anecdotal suggestion that halfbeak abundance had increased steadily during this period. No previous study has investigated factors that may control the number of recruits to the halfbeak fishery. Ballyhoo and balao have maximum life spans of about one year (Berkeley and Houde 1978), however, so strong or weak year-classes are unlikely to directly affect population size for more than a single year.

In theory, as the number of halfbeak fishing trips declined, harvest rates could increase because of increases in marginal yield (Gulland 1968). I tested for such a biological response by modeling halfbeak harvest rates as a parabolic function of fishing trips (Schaefer 1954) but the model was not significant (Figure 4). This model attempts to identify rates of fishing that are beyond sustainable levels. This may be difficult to detect for halfbeaks because ballyhoo and balao are highly mobile and their geographic distributions are widespread relative to the distribution of this fishery (Collette 1965). Still, during years of better than average weather

when the number of fishing trips can be quite high, local depletions could theoretically occur in certain areas of south Florida, at least until movements by ballyhoo and balao redistribute their populations into exploitable densities. While plausible, modeling the data did not support this.

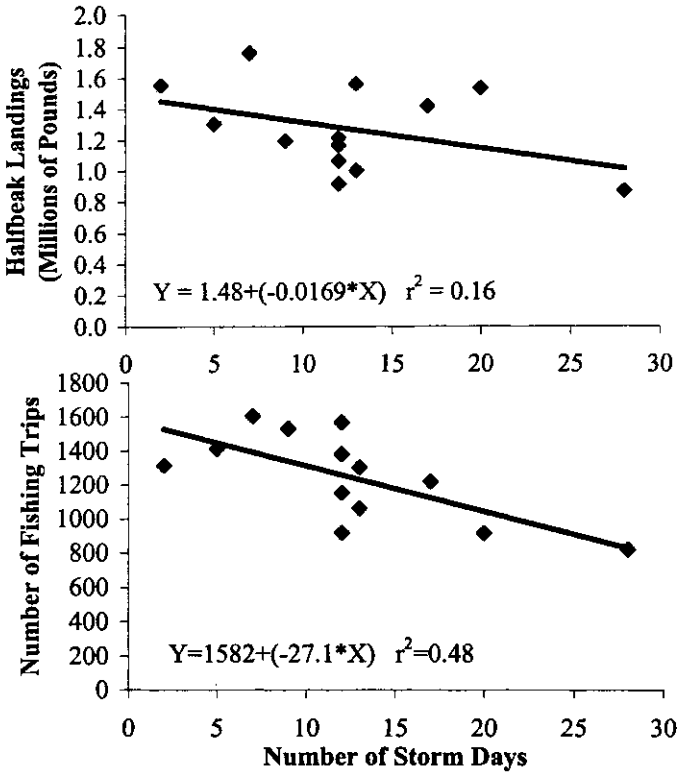

Figure 3. Annual landings (top) and number of halfbeak fishing trips (bottom) by lampara net fishers in south Florida plotted against the number of storm-days in each year, 1986 - 1999. A storm-day is defined as each day the center of a named storm was present within the area bounded by 20°N - 30°N and 70°W - 90°W; storm-days were counted from images obtained from the National Hurricane Center (www.nhc.noaa.gov). The number of storm-days was not significantly correlated with annual landings ($p = 0.17$), but it did explain a signficant amount of the variability in fishing trips between years ($p = 0.009$). Data for 1998 - 1999 are incomplete (up to April 1999 [Batch #564]).

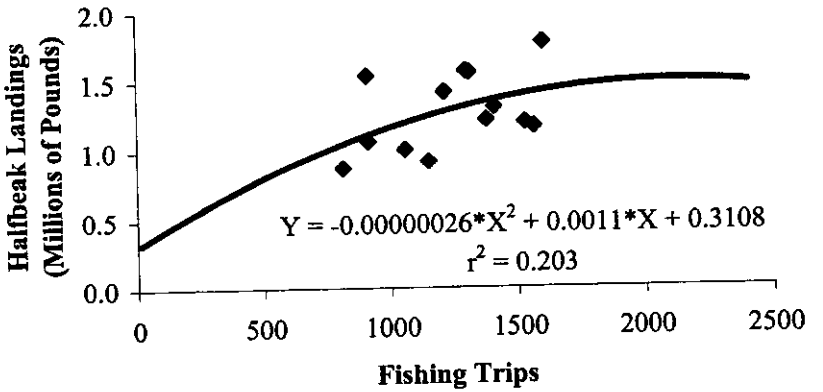

Figure 4. Annual landings as a parabolic function of the number of halfbeak fishing trips by lampara net fishers in south Florida for 1986 - 1999. This model was not significant (p = 0.32). Data for 1998 - 1999 are incomplete (up to April 1999 [Batch #564]).

Increasing halfbeak harvest rates relative to a declining number of fishing days could also arise by another process, one that would be relatively unusual compared to other fisheries. During winter and spring, harvest rates are often driven more by demand for halfbeak bait than by exploitable supply, so that realized daily harvests are lower than potential daily catches. Target harvests are set by most fish houses based on the perceived market demand for fresh bait as well as the capacity of these fish houses to sort and package frozen halfbeaks. During winter, halfbeak biomass and numbers are high, and daily harvests are three to four times higher than during summer (McBride et al. 1996). Winter harvests can frequently meet the maximum storage capacity onboard, about 2,600 lbs or 1,200 kg of halfbeaks for most vessels. The higher catch rates during winter also result in shorter fishing days during winter than summer. In this context, a reduced number of trips in years of 'poor' weather may lead to shortfalls in cumulative landings relative to demand for bait, so that in late winter or spring months, while catch rates are still high, fish houses allow higher daily target harvests on average. The relationship between the number of storm days and landings was not significant (Figure 3), which suggests that fishers can increase their harvest rates somewhat when fishing days are reduced.

This process is most likely limited, however, because during most of the year fishers can not catch full boat loads. In addition, interviews with fishers indicated that demand decreased in recent years in certain markets, because increased storm activity also suppresses demand for bait. Notably, frequent storm activity in the last three years (1996 - 1999), for example, may explain why landings for these same years were below average. Market forces certainly affect halfbeak landings and fishing effort to some degree, and they may at least partially explain increasing harvest rates in recent years for the reasons outlined above.

Overall, increasing harvest rates in the halfbeak fishery suggests that the status of this resource is very good. Currently, no impact can be estimated for recreational fishers and charter boat captains who collect halfbeaks for bait, but this examination of Florida's MFIS database showed no indication of negative fishing effects by the commercial halfbeak fishery. Variations in commercial halfbeak landings and fishing effort were largely explained by environmental factors and these should be accounted for in future assessments.

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