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LARGE PELAGICS IN THE SOUTHERN SECTION OF THE SEAFLOWER MARINE PROTECTED AREA, SAN ANDRES ARCHIPELAGO, COLOMBIA: A FISHERY IN EXPANSION

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ABSTRACT Isolated and sparse reef atolls comprising the southern section of the Seaflower MPA have been traditionally exploited by artisanal fishers using handlines. These practices have severely depleted the demersal fish stock and now fishers have shifted there efforts to the pelagic stock. The pelagic fishery included the extraction of more than 25 species, with *Thunnus atlanticus, Acanthocybium solandri, Coryphaena hippurus,* and *Katsuwonus pelamis* being the most common. Three years of fishery-dependent data (2004–2006) were used to describe traditional fishing methods and techniques, and to document, for the first time, a declining trend in the large pelagic stock. Pelagic landings accounts for more than 70% of the total landings, and are extracting important fraction of the juveniles depending on the species. Significant changes in CPUE were associated with greater distance from port, although not in the expected order. The status of the large pelagic fish stocks in the archipelago is still unknown, but the results presented in this paper provide baseline information needed to determine the effectiveness of the recently established Seaflower MPA. They also illustrated how primitive gear can still produce a severe reduction in abundances of several stocks, particularly when exploiting remote, small, isolated atolls prone to a serial depletion phenomenon.

RESUMEN Los aislados y dispersos atolones arrecifales de la sección sur del AMP *Seaflower* han sido tradicionalmente explotados por pescadores artesanales utilizando líneas de mano. Estas prácticas han disminuido significativamente el *stock* de peces demersales y ahora los pescadores han reorientado estos esfuerzos hacia el *stock* pelágico. La pesquería pelágica incluye la extracción de más de 25 especies, con *Thunnus atlanticus, Acanthocybium solandri, Coryphaena hippurus* y *Katsuwonus pelamis siendo las* especies más comunes. Tres años de datos dependientes de la pesquería (2004–2006) fueron usados para describir los métodos y técnicas de pesca, y para documentar, por primera vez, una tendencia decreciente del *stock* de grandes pelágicos. Los desembarcos pelágicos contribuyen con más del 70% del total de las capturas, y dependiendo de la especie se extrae una fracción importante de juveniles. Cambios significativos en CPUE fueron asociados con mayores distancias desde el puerto, aunque no en el orden esperado. El estatus de los *stocks* de peces de grandes pelágicos en el archipiélago es aún desconocido, pero los resultados presentados en este trabajo proveen información de línea base necesaria para determinar la efectividad del AMP *Seaflower* recientemente establecida. También se ilustra cómo artes de pesca simples pueden producir una reducción severa en las abundancias de varios *stocks*, particularmente cuando se explotan en atolones remotos, pequeños y aislados propensos a un fenómeno de agotamiento en serie.

INTRODUCTION

Located in the western Atlantic, the archipelago of San Andres, Providence and Santa Catalina extends over 250,000 km^2 of oceanic waters and scattered atolls covered by well developed coral reefs (Diaz et al. 2000). People in the islands and from neighboring countries work for Colombian companies that have been fishing these reefs at artisanal and industrial levels, extracting mainly spiny lobster (*Panulirus argus*), queen conch (*Strombus gigas*) and several species of reef fish (*Lutjanus vivannus, Etelis oculatus, Mycteroperca venenosa, M. bonaci*, among others). As a consequence, declining trends in the reef associated fisheries have been experiencing all levels of extraction (Caldas and Santos 2004, Prada and Castro 2004).

With diminishing demersal stocks, fishing for pelagic fishes has significantly increased, especially in the southern atolls which have narrow insular shelves and are constantly exploited by artisanal fishers (Diaz et al. 1995). Unfortunately, the lack of fishing regulations on any fish stocks has resulted in limited statistics and reduced the capability to scientifically demonstrate any real growth of this fishery, despite the continued use of primitive fishing equipment and gear.

Shifting from a reef dominated fishery to a pelagic dominated fishery should have happened prior to 1995 when pelagic landings accounted for about 50–60% of total landings in the southern atolls (Pomare 1999). Slight increases in pelagic landings (70%) were later reported by Grandas and Castro (2004) and Castro (2005). However, 3 decades ago, artisanal fishers maintained a dominant presence of reef fishes in these areas (Barriga et al. 1969).

Pelagic stocks in the islands included a group characterized for their large size, highly migratory movements

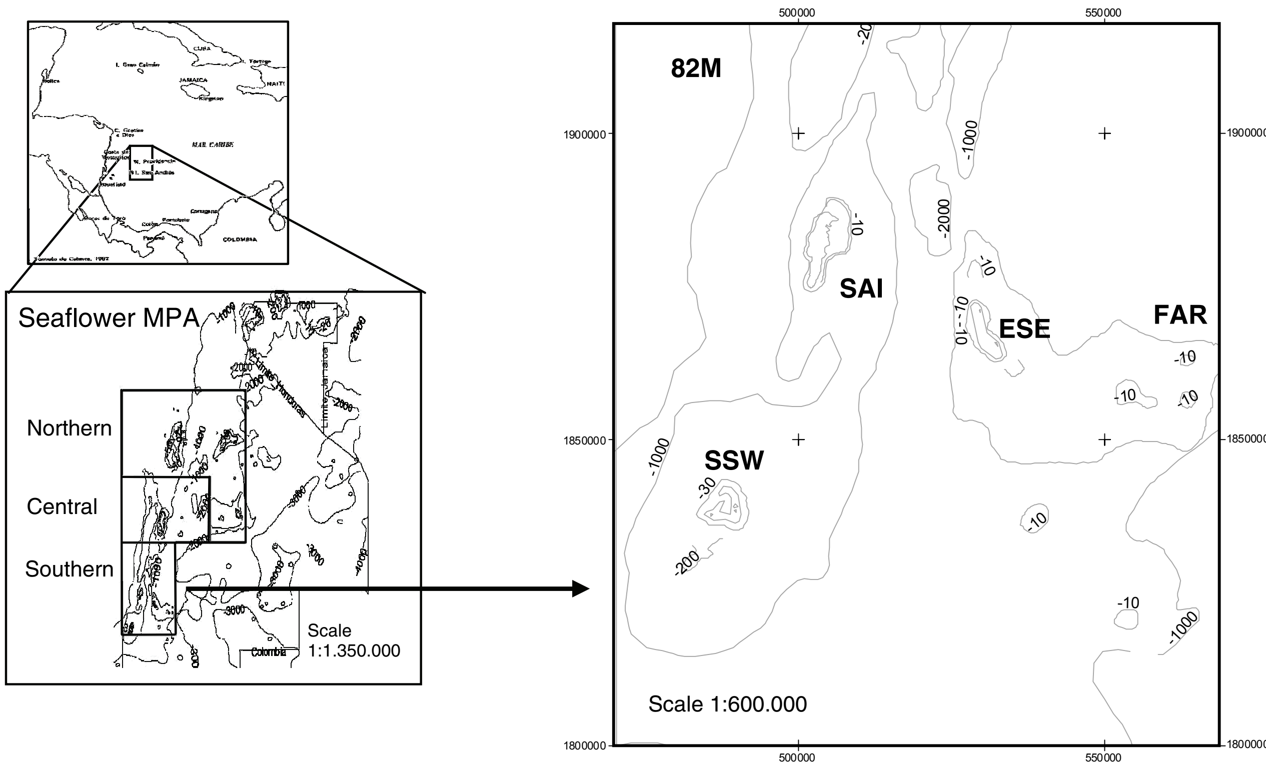

Figure 1. Spatial location of the fishing areas at the southern Seaflower MPA. SAI stands for San Andres Island, ESE for East-South-East reef, SSW for South-South-West reef, FAR for Far Bank and 82M for areas of the 82 Meridian under Colombia jurisdiction.

and trans-boundary distribution. In the islands, they are represented by *Thunnus atlanticus* (blackfin tuna), *T. obesus* (bigeye tuna), *Acanthocybium solandri* (wahoo), *Coryphaena hippurus* (dolphinfish) *and Katsuwonus pelamis* (skipjack tuna), among other species. In addition, there is a second group comprised of those pelagic species living near reefs in coastal waters with a reduced territory (distribution is largely confined to the Western Caribbean) which locally includes *Elagatis bipinnulata* (rainbow runner), *Canthidermis sufflamen* (ocean triggerfish), *Seriola fasciata* (lesser amberjack), *Caranx ruber* (bar jack) *and Caranx latus* (horse-eye jack), among others.

The reduction in fisheries production and the improvement in biodiversity conservation policies have contributed to the implementation of a new economical development model based on the sustainable use of the marine resources. UNESCO declared the archipelago as the Seaflower Biosphere Reserve (BR) in November 2000. Three large sections (65,000 km^2) within the BR were designated the Seaflower multiple use Marine Protected Area (MPA) by the Ministry of Environment and CORALINA (the environmental authority in the islands) in June 2005. The existence of closed areas and more efficient fishery management regulations are expected to facilitate a change in the fisheries declines currently experienced, but poorly documented.

This paper analyzed 3 years of fishery-dependent data (2004–2006) on large pelagics from the southern Seaflower MPA region to document fishing techniques and gear, changes in fish landings, species composition and their spatial and temporal patterns from the perspective of the artisanal fishery. It is hypothesized that a) large pelagic CPUE (Catch Per Unit Effort) will decrease with increasing distance from home ports, and b) 50% of the large pelagic landings of the 4 most common species are juveniles. Results from this study can be used by MPA managers to determine baseline information for future assessment of MPA effectiveness on the large pelagics and provide insight towards the debate of a large MPA in the Caribbean could benefit large pelagics.

MATERIALS AND METHODS

Study Area

The colombian Archipelago, comprised by 3 small inhabited islands (San Andres, Providencia and Santa Catalina) and 7 uninhabited cays and coral banks, is located between 11º30'N to 16º30'N and 78º28'W to 82ºW (Figure 1). The archipelago includes a total insular shelf area of 57 km^2 and an open water marine area of about 250,000 km^2 surrounded by a deep oceanic environment (maximum

5,000 m). Atolls are aligned in a north-northeasterly direction (Geister 1997), vary in shape and extension, and can be hundreds of nautical miles apart. Each atoll has distinct habitats and productivity rates, thus conferring them with unique ecological characteristics, despite their geologic similarity. In general, reef complexes in the archipelago are characterized by the presence of barrier reefs with shallow and/or deep fore-reefs on the windward side, a central reef lagoon with coral reef patches and slopes of varying grades on the leeward side.

The study area is confined to the southern section of the Seaflower MPA comprised by 3 reef atolls: San Andres (SAI), East-South-East (ESE) and South-South-West (SSW), as well as 2 non-emergent reef banks (FAR and 82M). The 82M is situated on the section of the Nicaraguan rise that belongs to Colombia. According to IGAC (1986), SAI is located between 12º32'N and 81º43'W, ESE is found 16 nm south-east of SAI (between 12º24'N and 81º28'W), and SSW emerges 22 nm south-west of SAI (between 12º10'N and 81º51'W). There are about 300 fishers who regularly exploit the study area and represent a minority community of long tradition among the 60,000 inhabitants of San Andres Island.

Methods

Data used in this study was collected by technicians of the local management authority office of the Fishery and Agriculture Department from January 2004 to December 2006. During the study, an observer traveled daily to the 4 ports on San Andres early in the morning to register the number of boats present, assuming any missing vessels were out fishing. This information was used to estimate effective boat activity and the actual number of fishing trips.

The total fish landings and the large pelagic landings were randomly sampled 12 d of each month at each of the 4 ports where artisanal fishers sell their products, including North End, Cove Sea Side, San Luis and Newball Avenue. At each site, number of boats using handline gears remained similar throughout the study, with North End supporting the majority (50%), San Luis 24%, Newball Avenue 14% and Cove 12%. Fishers clearly identified the reef origin of their captures making it possible to couple spatial variability with the landing data.

During sampling days, between 80 and 100% of the active fleet were sampled. On each inspected boat, data on total landings were obtained using 15 or 50 kg portable weights, registering each pelagic species separately. In addition, every captain was interviewed to obtain information on fishing effort. Questions pertained to the trip duration, effective fishing hours, number of active fishers, the type of fishing gear used and the area visited. Because most boats fishing for large pelagics are similar in structure and use similar fishing techniques, fishing effort was standardized to one fisher and one day. Another 43 older fishermen were interviewed to collect information on social perspective and complementary traditional knowledge.

A total of 377 specimens were measured (total length) to the nearest centimeter to determine the size frequency distribution for the most common large pelagic species. A plot of the size distribution referred to the length at first maturity (Lm) to establish the proportion of juveniles being caught at the species level. Information on Lm was obtained from previous isolated studies and published on-line information as follow: for blackfin tuna (Garcia-Cagide et al. 1994); for skipjack tuna (Collete and Nauen 1983); for wahoo (Brown-Peterson et al. 2000); and for dolphinfish (Oxenford 1999). The species identifications were based on the International Standard Statistical Classification of Aquatic Animals and Plants (FAO 2005).

A sample of 2,019 landings was then extrapolated to total landings using daily boat activity registry but CPUE was estimated for every fishing trip and species considered within the large pelagic group. To determine differences in mean CPUE by year and fishing zone, descriptive statistics were calculated and a one-way ANOVA was completed with Minitab™ (vers. 13.1), following verification of the test assumptions. If a significant F-value was estimated, a HSD-Tukey multiple range test ($P < 0.05$) identified homogeneous groups and temporal patterns in fish landings by month and year.

Results

The Fishers and Their Fishing Activities

From the 300 active artisanal fishermen using the southern section of the Seaflower MPA, 71.2% predominantly used handlines, while the remaining 28.8% were free divers. Ages of fishers ranged from 30–50 yrs old, with the free divers in the younger age classes. Many fishermen were raised fishing alongside their fishermen fathers and have learned the skills from childhood. Progressive changes in fishing techniques were visible 30 years ago with the replacement of wooden boats with fiberglass boats and outboard engines replacing traditional sails. In contrast, the fishing gear has not exhibited significant changes during the same time period.

A regular fishing trip may use a handline or free diving, although the time dedicated is usually dependent on the location, weather conditions and the fisher's age. During this study, the handline fleet was comprised of 65 boats in 2004, 76 in 2006. On average, fishing boats are

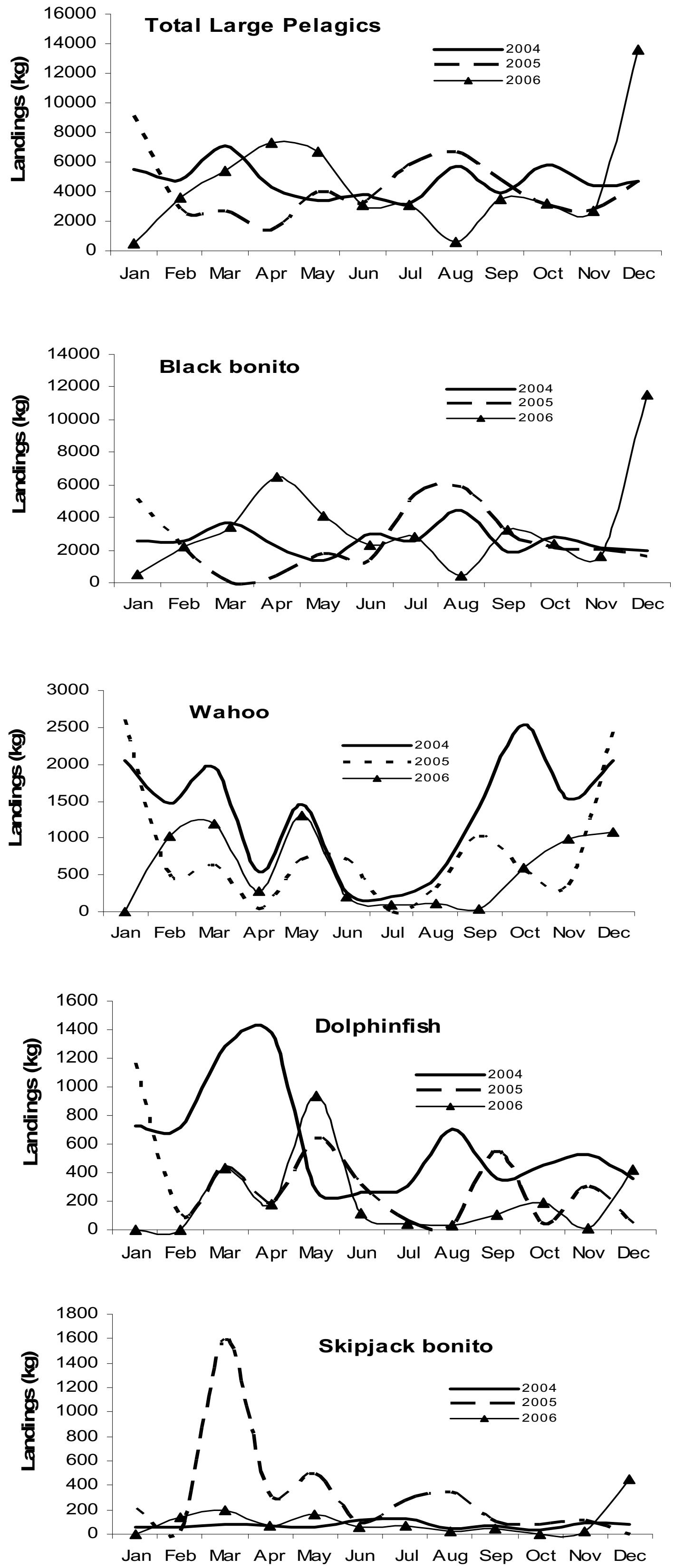

Figure 2. Monthly variation in large pelagic landings from the artisanal fishery in the southern section of the Seaflower MPA between 2004–2006.

TABLE 1

Estimated landings (kg) of the large pelagic fishes in the southern section of the Seaflower MPA discriminated by species and year.

Group	Scientific name	Common name	2004	2005	2006	Total
Offshore	*Thunnus atlanticus*	Blackfin tuna	31,219	30,884	41,058	103,161
	Katsuwonus pelamis	Skipjack tuna	890	3,663	1,224	5,777
	Thunnus obesus	Bigeye tuna	627	88	1,208	1,923
	Makaira nigricans	Black marlin		1041		1,041
	Euthynnus alletteratus	Little tunny	141	462	158	760
	Thunnus albacares	Yellowfin tuna		617		617
	Auxis thazard	Frigate tuna			4	4
Coastal	*Acanthocybium solandri*	Wahoo	15,941	9,906	6,949	32,797
	Coryphaena hippurus	Dolphinfish	7,344	3,889	2,459	13,693
	Scomberomorus cavalla	Sierra	502	462	134	1098
	Total		56,664	51,012	53,194	16,0871

7 m long (range 3 to 9 m) and propelled by one outboard engine between 40–75 HP. Fisherman leave early in the morning (04:00 to 06:00), commonly with 2 fishermen per boat. First they fish for bait and then troll for large pelagics for the remainder of the day. After trolling, some fishermen move to shallower waters in search of additional demersal catches. Handline test varied between 60 and 250 kg depending on the species. Usually, fishing for offshore pelagic species uses fresh blackfin tuna meat as bait, while coastal species utilizes homemade lures with 2 fish hooks and green or yellow phosphorescent trimmers. Species such as black marlin, wahoo, bigeye tuna require large hooks (00, 2, 3), and species such as blackfin tuna, skipjack tuna, dolphinfish are caught with smaller hooks (5, 6).

The catch is immediately eviscerated and stored under/between the boat seats or inside an ice box. Upon arrival to the port, the product is sold to small scale business men who begin a trade chain through the local restaurants, stores and general community. Only a small fraction of the total catch is actually bought by the fishing cooperatives. The price is fixed and determined annually by the government and classified into 2 categories: 1) red fishes consisting of snappers, groupers and wahoo with high market value, and 2) black fishes, consisting of barracudas, blackfin tuna, jacks, wave runner, trigger fish, grunts and others with lower market value.

Large Pelagic Fish Composition and Landings

It was estimated that large pelagic landings totaled 56,664 kg in 2004, 51,012 in 2005 and 53,194 in 2006. These captures represented on average 51% (± 5.6 standard deviation; SD) of the total artisanal landings. The large pelagic fish community was comprised of 8 species belonging to 3 families (Scombridae, Coryphenidae and Istiophoridae) (Table 1). The blackfin tuna (*Thunnus atlanticus*) dominated the landings and accounted for 55% of the catch in 2004, 61% in 2005 and 78% in 2006. The second most abundant species was wahoo (*Acanthocybium solandri*) comprising 28%, 19% and 13% of the annual large pelagic landings, respectively.

There were no clear patterns in the monthly variation of large pelagic landings. In fact, the largest peak found in December 2006 of 13.6 m-ton was not consistent with patterns in previous years because maximum landings in 2004 occurred in March 2004 with 7.0 m-ton and in January 2005 with 9.1 m-ton (Figure 2). The 2006 peak was influenced largely by blackfin tuna landings (11.5 m-ton), a species which also contributed to the maximum landings in 2004 and 2005. However, maximum landings in March 2004 and January 2005 also included significant proportions of wahoo and dolphinfish (Figure 2). Temporal variation in landings for the most common species allowed identification of additional patterns (Figure 2). For example, blackfin tuna peaked in June–August, while wahoo had a primary peak in November–January and secondary peaks in April and July–August. Moreover, dolphinfish landings peaked from February–May and skipjack tuna peaked in March, with a secondary peak in June–July. Interestingly, the peak of skipjack tuna landings noted in March 2005 of 1.59 m-ton coincided with an absence of blackfin tuna landings. Abundance of this species was low in all other months and years, not exceeding 0.4 m-ton.

It was found that the large pelagic fish community was caught predominantly around SAI with decreased landings with distance from home port. During this study, captures from SAI accounted for up to 50.2% and decreased to

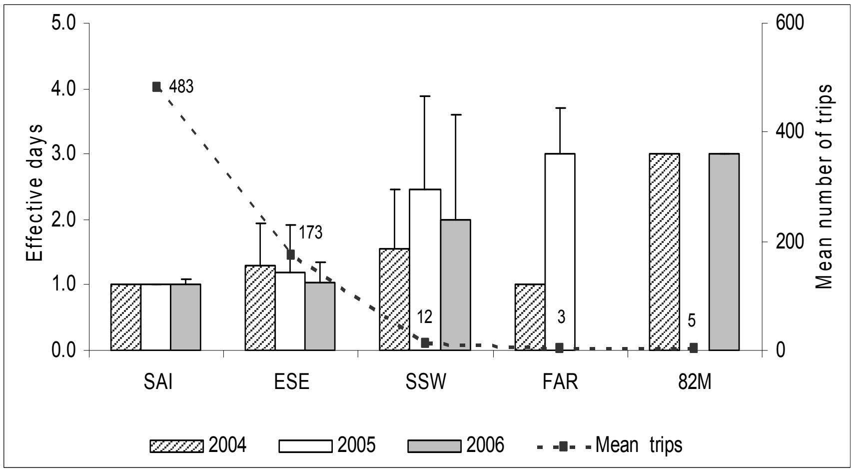

Figure 3. Variation in the mean number of effective days for the large pelagic artisanal fishery in the southern section of the Seaflower MPA. Errors bars indicate one standard deviation. Values on the secondary plots are the total number of trips at each fishing zone. See geographic locations of the fishing zones in Figure 1.

45.4% in ESE (16 nm from SAI), to 3.5 % in SSW (22 nm from SAI), to less than 1% in FAR and 82M (35–45 nm from SAI). Only at the 3 most distant reefs are landings still comprised of reef associated fish species, a result that is related to greater fishing effort exercised around SAI (Figure 3).

Catch Per Unit Effort (CPUE)

Mean values of CPUE were lowest around SAI, despite the significant landings and fishing trips, with values comparable to those distant areas supporting minimal effort targeting large pelagics (Figure 4). Higher values in CPUE were found in ESE and SSW with a mean of 12.5 kg/fisher-day (± 11.0 SD) and 9.2 kg/fisher-day (± 7.8 SD), respectively. The highest mean CPUE value found at the medium distance fishing grounds around ESE was indeed significantly different from CPUE value found around SAI ($F = 101.33$, $P < 0.001$). Due to the minimal data entries from distance reefs (FAR and 82M), data from these locations were excluded from the One-way ANOVA.

Pooling CPUE by year showed that 2006 had the highest values with a mean of 8.5 kg/fisher-day (± 9.9 SD) followed by 2004 data with 8.2 kg/fisher-day (± 7.3 SD) and 2005 with 7.3 kg/fisher-day (± 9.1 SD). These mean landings data differed significantly ($F = 3.17$, $p = 0.042$), with 2006 landings being >2005 but not 2004 nor was 2005 different than 2004 landings.

Length Frequency Distribution of Common Species

The large pelagic artisanal fishery in the southern section of the Seaflower MPA is extracting individuals below their length at first maturity (Lm) compared with published values, but the degree of juvenile proportions being caught varies depending on the species (Figure 5). In the case of blackfin tuna, juveniles comprise up to 75.3% of the landings, while wahoo and dolphinfish represent 17.9% and 8.3% of the juvenile population, respectively.

DISCUSSION

Results presented here illustrate how the large pelagic fish group around the southern section of the Sealfower MPA experienced slight but progressive reductions in mean CPUE during the 3 years of collected data which affected each reef differently. For instance, species captured in SAI with the highest landings also resulted in low CPUE values, while medium distance reefs (ESE and SSW) appear to have highest CPUE. The most distant reefs are not important sites for large pelagic fishes, but are for reef associated species. In fact during the study, large pelagics did not exceed 2% of the total landings in FAR or 82M. A distance gradient appears to exist, but it was not clear as higher landings could have shifted from the closer reefs to medium distance reefs, as the former showed reduced catches. Therefore, the initial hypothesis was not fully tested.

Fishing zones in the southern reefs are likely experiencing a serial depletion phenomenon, obligating fishers to travel further to maintain similar catch levels and still make a profit. This progressive depletion can be seen in the case of the blackfin tuna, the most abundant species in the landings with more than 70% caught as juveniles. However, the presence of additional large pelagic species in the fishery (wahoo, dolphinfish, etc.) may also explain why this fishery has not yet completely crashed.

Figure 4. Variation in mean CPUE of the large pelagic fish groups at the Southern section of the Seaflower MPA. Error bars are 95% Tukey HSD confidence intervals.

Based on fishermen's traditional knowledge, fishing around SAI was dominated by reef associated stocks which were depleted in about 15–20 yrs. Fishing communities then redirected their effort to pelagic species. Now, 10 yrs later and with an increased effort to target those communities, the pelagic stocks is being significantly reduced. The depletion phenomenon observed around SAI may now be appearing at medium distance reefs and threaten more distant reefs.

The status of the large pelagic fish stocks in the archipelago is still unknown, as well as their spatial and temporal dynamics. Therefore, it is unclear exactly what is contributing to the low abundances observed. However, the results presented provide baseline information needed to determine the effectiveness of the recently established Seaflower MPA. Results also illustrate how primitive gear can still produce a severe reduction in abundances of several stocks, particularly when exploiting remote, small and isolated atolls. This is especially important because of the progressive increases seen in fishing effort through time. In fact, the number of regular fishermen in the 1970's were only 45 (Castro 2005) and this increased to 300 in 2006 (Table 2). Similarly, the number of handline boats were around 49 in 1995 (Castro 2005) and by 2006 there were 75 registered.

In addition, negative trends can be associated with the extraction of juvenile individuals of several pelagic species. Unexpected results showed how higher proportions of juveniles are taken from offshore environment (up to 76% for blackfin tuna and skipjack tuna) than the coastal ones (18% for wahoo and 4% for dolphinfish). It may be possible that areas around the southern reefs serve as juvenile habitats, but theory has not yet been investigated. Another unexpected result was the peak of skipjack tuna landings in March 2005. Although we do not know why this occurred, it is also noted that a similar peak for the species occurred between January and February 1995. Landings in 1995 were similar to those in 2005 with 3.2

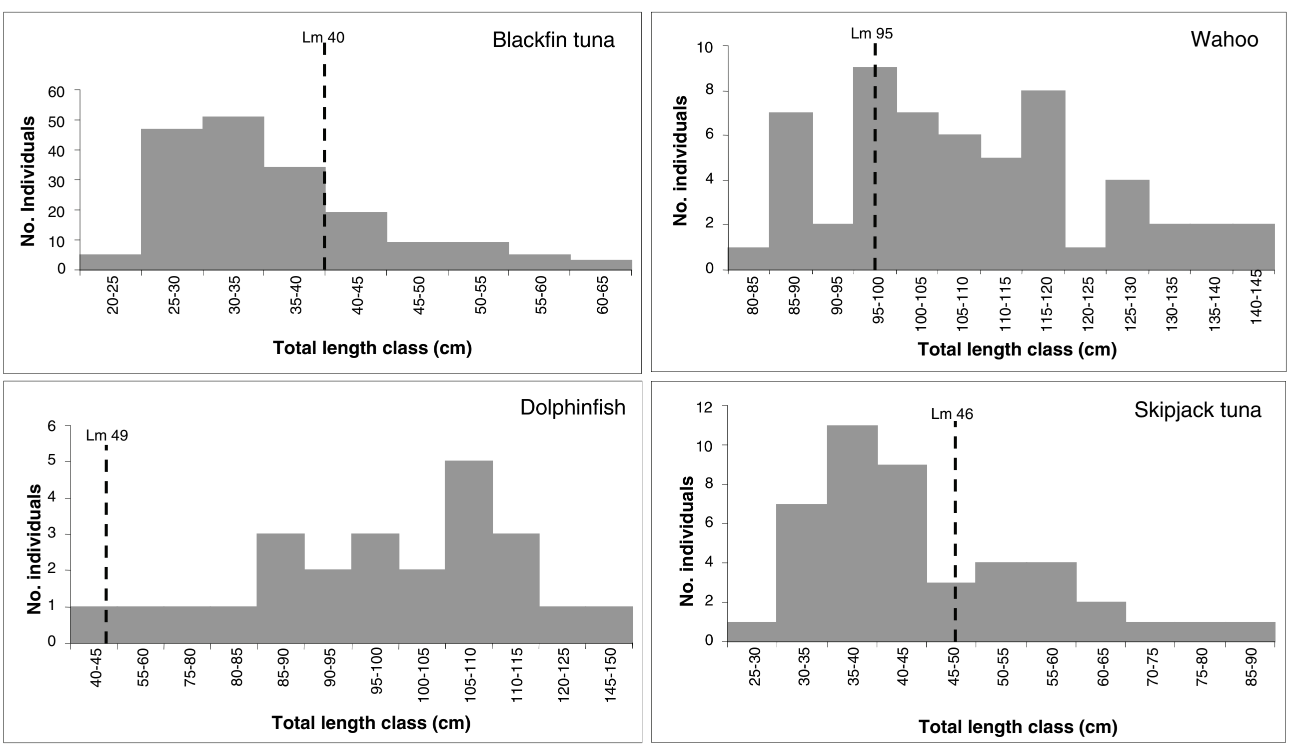

Figure 5. Length frequency distributions for the most abundant coastal and offshore pelagics. The dash line indicates length at first maturity (Lm).

TABLE 2

Progressive increases in artisanal fishing effort fishing at the Archipelago southern reefs. Data taken from Pomare 1999 and Castro 2005.

Year	No. fishermen	No. of handline boats
1972	45	–
1980	170	–
1984	128	–
1994	163	–
1995	–	49
1997	206	–
2001	–	61
2002	225	–
2005	–	65
2006	300	75

m-ton and represented 66% of the total landings for that year (Pomare 1999).

Despite previous results, there is a general perception that pelagic species are less vulnerable to over-fishing and therefore there is no need to implement stricter fishing regulations. Given this, local managers face a difficult situation reversing the negative trends while mediating increasing fishermen conflicts, and the deterioration of their quality of life. The long term expected MPA benefits and alternative economical activities should be carefully explored. Perhaps, with the integration of existing initiatives and regional programs focused on management of the large pelagic fisheries, such as those of the Caribbean Community Countries (CARICOM), the International Commission for the Conservation of Atlantics Tunas (ICCAT) and the Western Central Atlantic Fisheries Commission (WECAF), there is potential for the evaluation and subsequent recommendation for more appropriate management of these stocks. Good perceptions and positive changes in abundance, as well as better understanding and management policies are possible only if they properly address the biology of the species and the components of its complete life cycle (Mahon and McConney 2004).

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LITERATURE CITED

Barriga, E., J. Hernández, R. Jaramillo, L.E. Mora, P. Pinto, and P. Ruiz. 1969. La Isla de San Andrés. Contribuciones al conocimiento de su ecología, flora, fauna y pesca. Dirección de Divulgación Cultural de la Universidad Nacional de Colombia, Bogota, Colombia, 152 p.

Brown-Peterson, N.J., J.S. Franks, and B.A. Meahin. 2000. Preliminary observation on the biology of Wahoo, *Acanthocybium solandri*, from the northern gulf of Mexico and Bimini, Bahamas. Proceedings of the Gulf and Caribbean Fishery Institute 51:414–427.

Caldas, J.P. and A.M. Santos. 2004. Estado actual y tendencias históricas de las pesquerías en el Archipiélago de San Andrés, Providencia y Santa Catalina. Reporte técnico, programa de ordenación, manejo y conservación de los recursos pesqueros en la Reserva de Biosfera Seaflower, Archipiélago de San Andrés, Providencia y Santa Catalina, Caribe Colombia, 45 p.

Castro, E.R. 2005. Caracterización del régimen de pesca artesanal en la isla de San Andrés, Caribe colombiano: Inferencias sobre la estructura de la comunidad íctica. Ms.C. thesis. Universidad Nacional de Colombia, San Andrés, Colombia, 140 p.

Collete, B.B. and C.E. Nauen. 1983. FAO Species catalogue. Scombrids of the World. An annoted and illustated catalogue of tunas, mackerels, bonitos and related species known to date. FAO Fisheries Synopsis 125(2):137 p.

Díaz, J.M., J. Garzón-Ferreira, and S. Zea. 1995. Los arrecifes coralinos de la Isla de San Andrés. Colombia: estado actual y perspectivas para su conservación. Academia Colombiana de Ciencias Exactas, Físicas y Naturales. Colección Jorge Alvarez Lleras. No. 7, Santa Fe de Bogotá, Colombia, 150 p.

Díaz, J.M., L.M. Barrios, M.H. Cendales, J. Garzón-Ferreira, J. Geister, M. López-Victoria, G.H. Ospina, F. Parra-Velandia, J. Pinzón, B. Vargas-Ángel, F.A. Zapata, and S. Zea. 2000. Áreas Coralinas de Colombia. INVEMAR, Santa Marta, Serie Publicaciones Especiales 5:175 p.

IGAC. 1986. San Andrés y Providencia. Aspectos geográficos. Instituto Geográfico Agustin Codazzi, Bogotá, Colombia, 156 p.

FAO. 2005. Review of the state of world marine fishery resources. FAO Fisheries Technical Paper, No. 457. FAO Marine Resources Service, Fishery Resources Division, Rome, Italy, 235 p.

García-Cagide, A., R. Claro, and B.V. Koshelev. 1994. Reproducción. In: R. Claro, ed. Ecología de los peces marinos de Cuba. Instituto de Oceanología de la Academia de Ciencias de Cuba y el Centro de Investigaciones Marinas de Quintana Roo, Mexico, p. 187–262.

Grandas, Y. and E.R. Castro. 2004. Régimen de captura y esfuerzo en la pesquería artesanal de especies pelágicas en la isla de San Andrés, Caribe occidental. Proceedings of the Gulf and Caribbean Fisheries Institute 55:223–235.

Geister, J. and J.M. Díaz. 1997. A field guide to the oceanic barrier reefs and atolls of the southwestern Caribbean (Archipelago of San Andres and Providencia, Colombia). Procceding 8th Coral Reef Symposium 1:232–262.

Mahon, R. and P.A. McConney. 2004. Management of large pelagic fisheries in CARICOM countries. FAO Fisheries Technical Paper, No. 464. FAO, Rome, Italy, 149 p.

Oxenford, H.A. 1999. Biology of the dolphinfish (*Coryphaena hippurus*) in the western central atlantic: A review. Scientia Marina 63(3/4):277–301.

Prada, M.C. and E.R. Castro. 2004. Diagnóstico de la Pesquería de langosta espinosa (*Panulirus argus*) y caracol de pala (*Strombus gigas*) en el Archipiélago de San Andrés y Providencia. Reporte técnico. Programa de ordenación, manejo y conservación de los recursos pesqueros en la Reserva de Biosfera Seaflower, Archipiélago de San Andrés, Providencia y Santa Catalina, Caribe Colombia, 53 p.

Pomare, C. 1999. Caracterización de la pesquería artesanal de San Andrés, y algunos aspectos biológicos y pesqueros de la saltona (*Ocyurus chrysurus*) y el bonito (*Thunnus atlanticus*). Thesis pregrado biología Marina. Universidad Jorge Tadeo Lozano, Bogotá, Colombia, 85 p.