

# The Nassau Grouper Spawning Aggregation Fishery of the Cayman Islands – An Historical and Management Perspective

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## ABSTRACT

The reproductive characteristics of mass spawning at predictable times and places have made the Nassau grouper, *Epinephelus striatus*, vulnerable to over fishing. Historically in the Cayman Islands, five Nassau grouper spawning aggregations provided an important seasonal artisanal fishery for local fishermen from which fish were harvested by the thousands. In 1986, fishermen began complaining of reduced catch and size of fish taken from the fishery. Since 1987, the fishery has been monitored. Data on age, size, catch, and catch-per-unit-effort (CPUE) was collected. Fifty-two percent of fish aged were seven and eight years old, indicating full recruitment to the fishery by this age. Analyses of data show overall declines in catch, CPUE, and size. In 2001 a sixth aggregation was discovered and heavily fished. In 2002, an 'Alternate Year Fishing' law was passed to reduce fishing mortality. In 2003, an 8-year ban on fishing in all designated grouper spawning areas was implemented when it became apparent that further fishing could irreversibly compromise the viability of the 'new' aggregation. Of the six known Nassau grouper spawning aggregations sites in the Cayman Islands, three are fished out, two are in serious decline, and one, though affected by fishing, is still comparatively healthy. Additionally, two other areas were designated as potential spawning sites. The Cayman Islands case is one typical of the depletion pattern of 'boom-and-bust' Nassau-grouper aggregation fisheries seen throughout the region over the past three decades. Despite the current ban on this activity locally, our goal is to convince the local populace that this practice is unsustainable, and should permanently cease.

**KEY WORDS** Nassau grouper, spawning aggregation, Cayman Islands, restricted marine areas

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## El Proceso de Apareamiento en las Islas Caimanes del Nassau Grouper del Punto Perspectivo Historico y de Manejamiento

Las características de reproducción del Nassau Grouper (*Epinephelus striatus*) en tiempos y lugares predecibles los ha hecho vulnerable a la sobre pesca. En las Islas Caimanes históricamente 5 agregaciones de apareamiento del Nassau Grouper proveían una importante pesca temporal. Sin embargo en 1986, los pescadores locales comenzaron a notar la reducción de la cantidad y el tamaño del pez obtenido.

La captura ha sido monitoreada por los últimos 14 años, durante este tiempo los datos como la edad, tamaño, cantidad y cantidad de unidad de esfuerzo, fueron obtenidos y analizados. 52% de la edad de los peces fue 7 (26%) y 8 (25.9%) años de edad, indicaron completo reclutamiento de este grupo de edad en las pesca. Analisis de los datos señalaron todavía reducción en las pesca, CPUE, y tamaño.

En el año 2001 una Sexta agregación fue descubierta y violentamente pescada. En el 2002 una ley de alternar un año de pesca fue obtenida con la idea de reducir la mortalidad. Pero cuando fue evidente que más pescas iban a comprometer irreversiblemente la posibilidad de sobrevivencia de la nueva agregación se implantó una nueva ley de 8 años de prohibición de captura en todas las áreas designadas de apareamiento del Nassau Grouper.

De las seis conocidas agregaciones de apareamiento del Nassau Grouper situadas en las Islas Caimanes tres han desaparecidos, dos han declinado seriamente y una a pesar del impacto sigue relativamente saludable.

Las Islas Caimanes es un caso típico de las poblaciones de explotar sobre 3 décadas la abundancia de la pesca del Nassau Grouper. A pesar de la prohibición de la actividad pesquera local. Nuestra objective es de convencer y educar la población local que esta practica es inconveniente y debe cesar permanentemente.

**PALABRAS CLAVES:** Nassau Grouper, características de reproducción, las Islas Caimanes

### INTRODUCTION

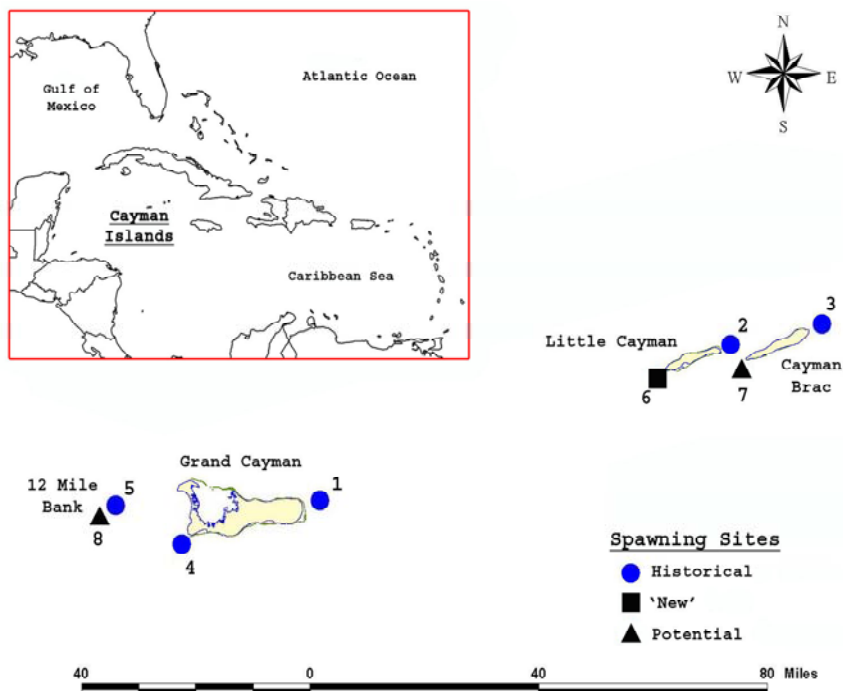
The reproductive characteristic of aggregation spawning at predictable sites and times have made the Nassau grouper, *Epinephelus striatus* (Bloch 1792), vulnerable to overfishing. As a result, many of the known spawning aggregations of this species, are no longer viable (Sadovy and Eklund 1999).

The Cayman Islands (Grand Cayman, Little Cayman, and Cayman Brac) lie between 19°15' and 19°45'N latitude and between 79°44' and 81°27'W longitude, and Nassau grouper are relatively abundant when compared to many other locations (Patengill-Semmens and Semmens 2003). A traditional fishing culture has evolved into one economically dependent on marine tourism and finance over the past 30 years.

Historically, there were five Nassau grouper spawning aggregation sites (Tucker et al. 1993): one at the southeast corners of each of the three islands,

one at the southwestern corner of Grand Cayman, and another at the southeast corner of the Twelve Mile Banks west of Grand Cayman (Figure 1). Another aggregation exists at Pickle Bank (44 nautical miles north of Little Cayman) whose political jurisdiction is undetermined. The aggregations at the eastern ends of the islands are the most well known, and have traditionally been exploited since the early 1900s with the use of small open boats and hand lines. In 1985, recognizing the importance of these three spawning areas, a general license was issued under the Restricted Marine Areas (Designation) Regulations allowing access by residents, but restricting them to fishing by hook-and-line only.

In 1986, increasing complaints from fishermen of a decline in both numbers and size of fish taken from the fishery during the last several years prompted the implementation of a monitoring program by the Department of the Environment.



**Figure 1.** Map showing current Restricted Marine (Grouper Spawning) Areas, (1) Grand Cayman - northeast point, (2) Little Cayman - northeast point, (3) Cayman Brac - northeast point, (4) Grand Cayman -southwest point, (5) 12-Mile Bank - northeast end, (6) Little Cayman - southwest point, (7) Cayman Brac - southwest point, (8) 12-Mile Bank - southwest end.

## METHODS

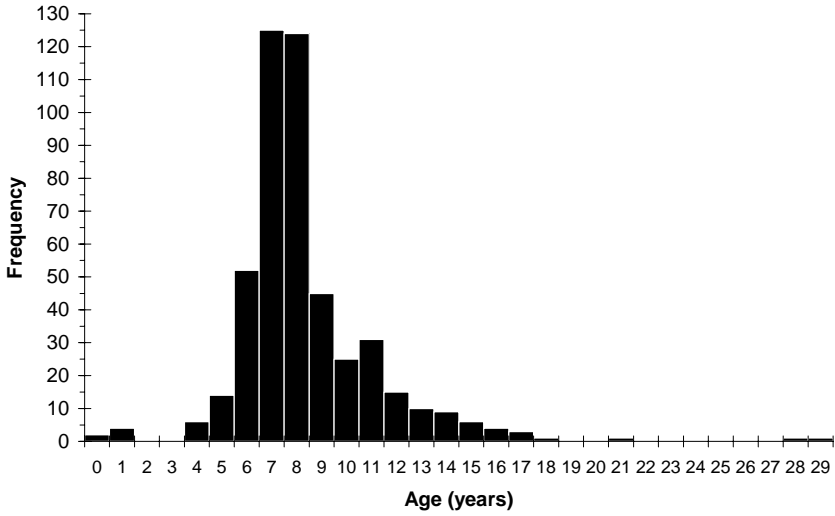
From 1987 through 1992, data on catch, catch-per-unit-effort, and size, were collected during spawning season from the three main spawning sites. Catch data was recorded on a per boat basis. CPUE was determined by dividing annual catch by the number of boat trips. Total length (TL) in centimeters was measured using a graduated board.

Age data was obtained by analyzing sagittal otoliths taken from 479 fish, and the aging technique was validated in 1992 by use of captive fish injected with oxytetracycline (Bush et al 1996). Sampling of catch and size data from the three main aggregations continued through 2001. Sex and weight data was initially collected, but was discontinued due to manpower and time restraints. Data from the southwest point of Grand Cayman, Twelve-Mile Bank, and Pickle Bank was sporadic and is not reported herein.

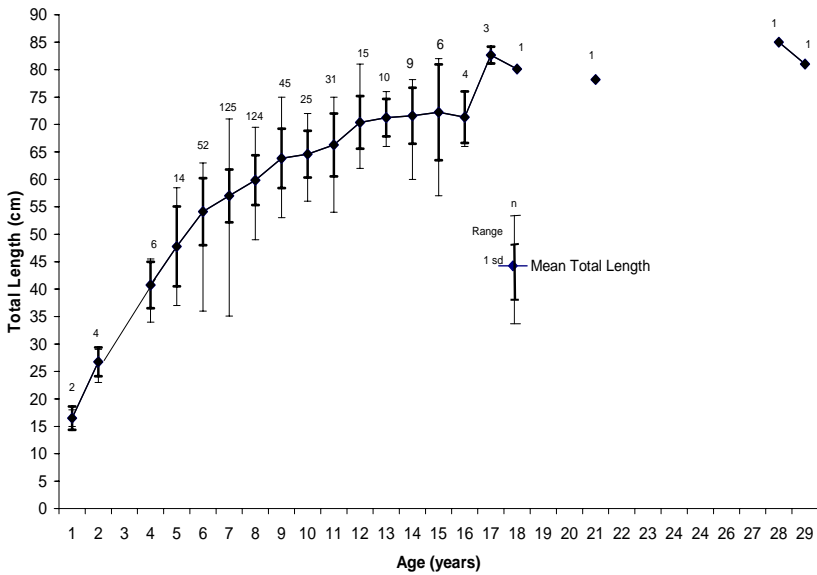
## RESULTS AND DISCUSSION

### Fishery Data

Most grouper in the spawning aggregations (84%) are between the ages of six and 11 with 52% of the fish either ages seven (26.1%) or 8(25.9%). These two dominant year classes (seven and eight) indicate the age at full recruitment to the fishery (Figure 2). The oldest fish (29 years) exceeds the oldest age reported for Nassau grouper (Olsen and LaPlace, 1978) by 13 years. A length at age curve was generated (Figure 3) and fitted to the von Bertalanffy growth equation in order to compare the equation parameters with those published for *E. striatus* (Manooch 1987, Valle et al 1997).  $L_{\infty}$ , average asymptotic length, =  $765 \pm 30$  mm with 95% confidence limits; K, growth coefficient, 0.282 (per yr.); and  $t_0$ , theoretical age at 0 length, -0.638 yrs.; were calculated from a regression of the Ford/Walford line ( $l_{t+1} = 140.04 + 0.82l_t$ ,  $r^2 = 0.96$ ) to where  $l_t = l_{t+1}$ ;  $l_t$  is the mean length at any given age. By restricting the ages used to calculate the von Bertalanffy growth parameters to those with a minimum of 10 fish in any age group (i.e., ages 5 - 13) a close fit of calculated and observed lengths was obtained between those ages (Table 1). Manooch (1987), Pauly and Binohlan (1996), and Valle et al (1997) summarize parameters of Nassau grouper:  $L_{\infty}$  from 900TL -1130mm TL, with one exception (760 mm TL from NE Cuba, Claro et al 1991), K's from 0.060-0.224 (per year), and  $t_0$  -3.27 - 0.488 (year). Our calculated growth parameters differ from those published;  $L_{\infty} = 765$  mm TL and  $t_0 = -0.638$ , are lower than previously published with the exception of one  $L_{\infty}$  estimate by Claro et al 1991. Our growth coefficient  $K = 0.202$  is slightly higher than those reported by Manooch (1987), Pauly and Binohlan (1996), and Valle (1997), with one exception, 0.224 reported by Randall (1962). The low  $L_{\infty}$  and high K would indicate that Nassau grouper around the Cayman Islands have a high early growth rate to ages 10 or 11 but a lower terminal size than other stocks.



**Figure 2.** Age frequency distribution of 479 *E. striatus* from 1987 – 1992.

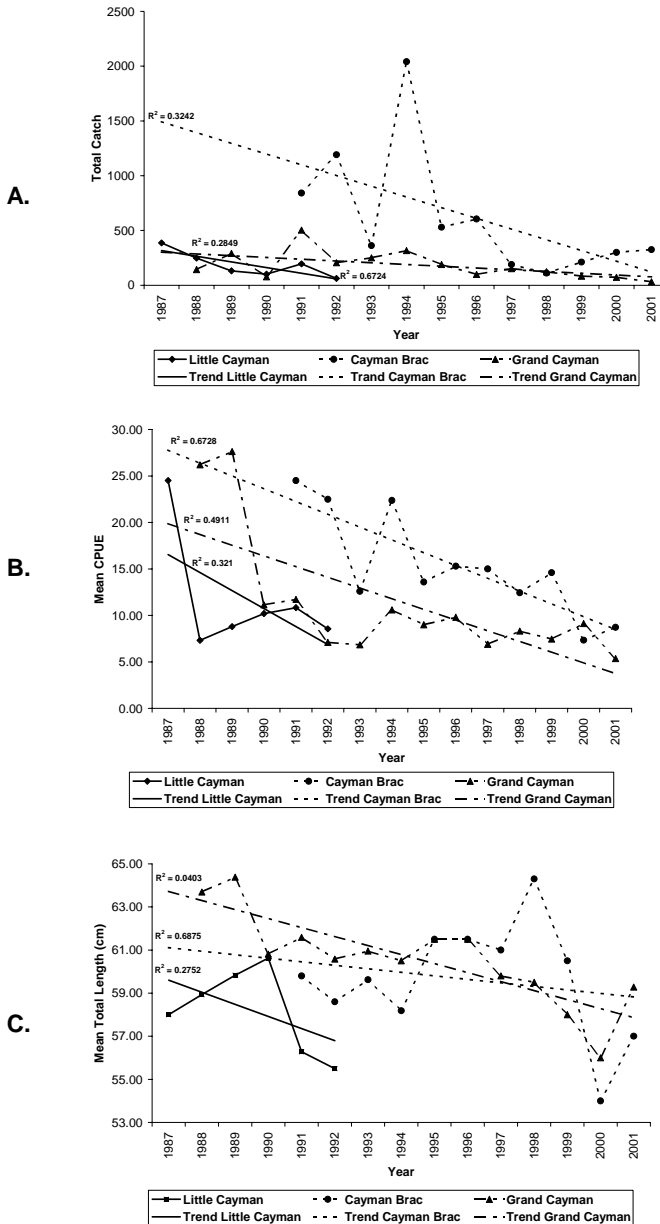


**Figure 3.** Growth curve for *E. striatus* sampled from aggregations 1987 – 1992.

**Table 1.** Age vs. Length data of 479 Nassau grouper from the Cayman Islands. Predicted mean lengths fitting the data between ages 5 and 13 to the von Bertalanffy growth equation:  $L_t = 765[1 - e^{-0.202(t+0.638)}]$

Age years	Total Lengths (mm)			No. Fish	Predicted Length
	Range	Mean	Standard Deviation		
0	150-180	-	-	2	93
1	230-290	268	-	4	216
4	340-445	408	42.3	6	398
5	365-585	478	72.7	14	465
6	360-630	541	61.1	52	520
7	345-710	570	48.2	125	565
8	490-695	599	45.4	124	601
9	530-750	638	54.1	45	631
10	555-720	646	42.8	25	655
11	540-750	663	57.2	31	675
12	620-710	704	47.9	15	692
13	660-760	713	34.1	10	705
14	600-735	716	50.9	9	716
15	565-820	722	87.2	6	725
16	660-760	714	-	4	733
17	810-840	827	-	3	738
18	801	-	-	1	743
21	782	-	-	1	753
28	850	-	-	1	762
29	810	-	-	1	763

Catch, CPUE, and Size from these three spawning aggregations have declined over the 15 year period. Catch (Figure 4a) from Grand Cayman and Little Cayman during the early years of the monitoring period was in the low hundreds and has since dwindled. In Cayman Brac, while catch was in the low thousands during the initial years following the re-discovery of the spawning aggregation, it too has declined drastically in the last six years. Catch-per-unit-effort and size (Figure 4b,c) for all three islands show similar marked trends. The Little Cayman site was abandoned in 1993 when the aggregation ceased to form.



**Figure 4.** 15-year trends in (A) Annual catch, (B) Annual catch-per-unit-effort and (C) Annual size from the three northeastern grouper spawning aggregations.

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**Chronology of Fishing Activity**

Between 1984 and 1990, the Cayman Brac site was dormant and the fishing fleet of Cayman Brac targeted the northeast SPAG of Little Cayman (the two islands are five nautical miles apart). In 1991, an aggregation was found approximately 1.2 km north of the dormant Cayman Brac site, and has been heavily fished.

By 1993, the Little Cayman site was inactive. Continued monitoring through 2001 showed continuing declines in both catch and size of fish from the aggregations of Grand Cayman and Cayman Brac. Of the two other aggregations, located near Grand Cayman, one (Southwest site) was fished until 1990, after which it no longer formed, and the other (Twelve-Mile Bank) still yields a variable, albeit low, number of fish.

In 2001, another aggregation which (according to anecdotal reports) had not been fished since the late 1960s, was 're-discovered' at the western end of Little Cayman, and heavily fished during the 2001 and 2002 spawning season. Approximately 4,000 fish were taken from this aggregation during 20 days of fishing (Whaylen et al 2004). Pre-fishing abundance for this aggregation is estimated at over 7,000 fish. This aggregation is believed to be the last healthy spawning aggregation of Nassau groupers in the Cayman Islands.

**Chronology of Management Measures**

In 1995, after the first six years of data showed a decline in all parameters, a recommendation was made to implement an 'Alternate Year Fishing' strategy in order to reduce fishing mortality by half. However, due to lack of political support, this was not implemented.

In 1998, the three main spawning areas at the eastern ends of the islands were formally demarcated as 'Restricted Marine Areas' for which access required licensing by the Marine Conservation Board (the statutory authority responsible for the administration of the Marine Conservation Law).

Following public controversy regarding the mass harvest of fish in 2001, and again in 2002, the Marine Conservation Board and the Department of Environment campaigned for support to protect the Nassau grouper spawning aggregations by holding a series of meetings with government, the watersports, and restaurant sectors of the Cayman Islands Tourism Association, as well as fishermen. Protective legislation was passed in February of 2002 (Whaylen et al. 2004). This legislation defined a spawning season of November 1 to March 31, and implemented the 'Alternate Year Fishing' law (first recommended in 1995) to reduce fishing mortality in the designated grouper spawning areas. This law allowed fishing every other year with the first non-fishing year starting with 2003, and also set a catch limit of 12 Nassau grouper per boat per day during fishing years. The law also defined one nautical mile 'no trapping' zones around each spawning site, and set a minimum size limit of 12 inches for Nassau grouper. Finally, a significant aspect of the law provided power to the Marine Conservation Board to change these restrictions to any or all of the designated spawning areas.

In mid-December of 2002, the other two of the five original spawning areas, and the new one at the west end of Little Cayman, were designated as restricted marine areas. In addition, two more areas were designated, due to



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their potential to accommodate spawning aggregations, and the possibility of spawning aggregations shifting. These were the southwest end of 12 Mile Bank and the southwest end of Cayman Brac, both of which have the geomorphological and oceanographic characteristics common to such spawning areas.

With the approaching spawning season of 2004, it was realized that the new 'alternate-year-fishing' management strategy would not accomplish the goal for which it was originally intended. Our calculations showed that, despite the new catch limits, fishing during the 2004 season could compromise the viability of this relatively healthy aggregation. Assuming that fishing effort would be similar to that of 2001 and 2002, most of the estimated 3,000 surviving fish in the 'new' spawning aggregation at the west end of Little Cayman, would be removed. As a result of this, on the 29<sup>th</sup> December of 2003, the Marine Conservation Board exercised its powers to change the 'Alternate-Year-Fishing' portion of the law to an eight year ban on fishing within all designated grouper spawning areas. It was thought that this time period representing one reproductive cycle for the species, was the minimum needed to realize any benefits to replenishment.

#### CONCLUSION

The Cayman Islands case is typical of the depletion pattern of 'boom-and-bust' grouper aggregation fisheries seen through out the region over the past three decades. Lack of effective management has resulted in the demise of many spawning aggregations, including some local ones, and the species is now absent in many locations.

It is important that fisheries management authorities be empowered to respond quickly to problems as the timeliness of the response is critical if it is to succeed.

The seven year delay in implementation of the alternate year strategy, combined with continued heavy fishing, almost certainly would have compromised the strategy's intended effect as reproductive stock became depleted.

The Cayman islands now have a total of eight designated grouper spawning areas covering an area of 17.56 square kilometers. Of the six known Nassau grouper spawning aggregations sites in the Cayman Islands, three are fished out, two are in serious decline, and one, though affected by two years of heavy fishing, still relatively healthy. Despite the current ban on fishing local aggregations, our goal is to convince residents that this practice is unsustainable in any measure, and should permanently cease. In the interim, we believe that the management measures implemented, along with adequate enforcement, will contribute effectively to the perpetuation of this species in the Cayman Islands.

Immediate future plans for the Little Cayman aggregation include continued in-situ monitoring, as well as a tagging and tracking project. Eventually assessments will be carried out on all known spawning aggregations sites, with a view to monitoring any replenishment or re-habilitation. Other sites possessing other locations possessing similar geo-morphological

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and oceanographic conditions will also be investigated.

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