

INVESTIGATION OF THE SPAWNING AGGREGATION OF MUTTON SNAPPER, *Lutjanus analis* (Cuvier), ON THE SOUTHWESTERN SHELF OF ST. CROIX, U.S. VIRGIN ISLANDS

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Introduction

Targeted fishing of spawning aggregations in the US Virgin Islands (USVI) occurred in the 1960's and 1970's resulting in the loss of a Nassau grouper (*Epinephelus striatus*) aggregation on St. Croix by 1971 and the sharp decline in an aggregation off St. Thomas in 1975-76 (Olson and LaPlace 1978) with the eventual loss of the aggregation in the 1980's. The loss of the Nassau grouper spawning aggregation focused fisher attention on the importance of protecting spawning aggregations and resulted in seasonal closure of a red hind (*E. guttatus*) spawning aggregation south of St. Thomas. There is evidence that fishing of spawning aggregations of snappers has also caused their decline (Claro et al. 2009).

In 1993, the US Department of Commerce established the Mutton Snapper Seasonal Closed Area (MSSCA) from March 1 to June 30 to protect a spawning aggregation of *Lutjanus analis* (mutton snapper) in the southwest corner of St. Croix (see Quinn and Kojis 2010 for location map). Because only a portion of the spawning area occurred in federal waters, joint territorial and federal protection was essential to protect the spawning aggregation. In 1994, the USVI government established compatible regulations within their area of jurisdiction to ensure that the MSSCA was adequately sized to protect the mutton snapper spawning aggregation. The mutton snapper aggregation within the MSSCA had been fished for many years even, to some extent, after the implementation of the seasonal closed area. Enforcement of the MSSCA regulations was difficult because most fishing occurred after dusk. In order to increase compliance, regulations were implemented prohibiting the possession of mutton snapper during the presumed peak spawning months, April 1 to June 30, in both federal and territorial waters.

USVI fishers have expressed dissatisfaction with the lack of monitoring of management regulations related to spawning aggregations. The prohibition of possession of a particular species during a seasonal closing of a spawning area greatly diminishes fishers' ability to profit from the high CPUE that occurs during spawning aggregations. Assessing the effectiveness of regulations protecting spawning aggregations was needed. Prior to the establishment of regulations protecting the mutton snapper spawning aggregation, biostatistical data obtained from individual commercial fisher catches indicated a decline in landings and size of fish caught from the spawning aggregation.

This study was conducted to provide information on the status of the *Lutjanus analis* spawning aggregation on the southwest waters off St. Croix, USVI, verify the spawning period for this species, and provide life history information.

Materials and Methods

Fishing dates and method

Spawning of *Lutjanus analis* has been recorded around full moon in the spring and early summer in the Caribbean. In the USVI, mutton snapper are thought to congregate for spawning from March to June. *L. analis* were fished inside the MSSCA in 2009 around the full moon in April, May, and June (Table 1). Fishing was conducted by experienced St. Croix fishermen as well as scientific personnel each fishing day from an anchored 7m boat. Fishing commenced at dusk at around 18:15h in April, 18:30h in May and 19:00h in June and continued until no later than 23:30h on nights when none or few *L. analis* were caught or until about half the permitted quota of fish per month was caught.

Table 1 Dates fished for *Lutjanus analis* in relation to full moon (0 = date of full moon, numbers refer to days before (-) or after full moon).

Day of month	April Sampling dates	Full moon	May Sampling dates	Full moon	June Sampling days	Full moon
6	x	-3		-3		-1
7	x	-2		-2		0
8		-1		-1		1
9		0		0	x	2
10		1		1		3
11		2	x	2	x	4
12		3	x	3	x	5
13	x	4		4		6

Fishers used hand lines with 60 - 200 lb test line and primarily single J hooks (hook size 7-8). Occasionally weights were used. Hooks were baited with round robin (scad), sprat, or ballyhoo and the waters chummed with primarily ballyhoo. Lines were paid out until the bait was just above the bottom.

Scuba diving searches for Lutjanus analis

In May and June 2009 and May, June, and July 2010, divers searched for mutton snapper along and adjacent to the insular shelf edge primarily within the MSSCA. In 2010, searches were also conducted to the west of the MSSCA and near the red marker buoy at the southwest corner of the St. Croix shelf. In May and June 2009, several dives were conducted on the fishing sites for about an hour prior to fishing. In 2010, some dives commenced at sites successfully fished in 2009 and at sites known by local fishers as excellent fishing sites for *L. analis*. Diver searches were conducted at 20-30m and lasted 50-60 min. Two or three divers swam at a constant speed and surveyed an area approximately 10m wide while towing a surface buoy. A Garmin GPSmap 67Cx on the boat tracked the divers.

Mutton Snapper Abundance Assessment by Fishing Effort

To determine fishing effort, the number of lines in the water, start and finish time for fishing and number of individuals of each species of fish caught were recorded for each fishing date.

Biometric and Gonadal Analysis

Lutjanus analis were purchased from fishers in March and July 2009 and in March 2010 before and after the seasonal closure. Fish purchased prior to and after the closure, as well as fish caught during the closure, were weighed, fork length measured, and gonads and otoliths removed, photographed and weighed. The otolith data will be analyzed in a subsequent paper.

Results

Catch per Unit Effort (CPUE)

The catch rate for *Lutjanus analis* was highest in May and June 2009 (Figure 1). In April 2009, fishing was done on three nights, two nights before the full moon and one night after the full moon (Table 1). Only a few *L. analis* were caught in April, and only on fishing nights before the full moon. No fish were caught four days after full moon in April, even though 13 *L. analis* were caught in less than three hrs on the 4th day after full moon in June 2009 (Table 1).

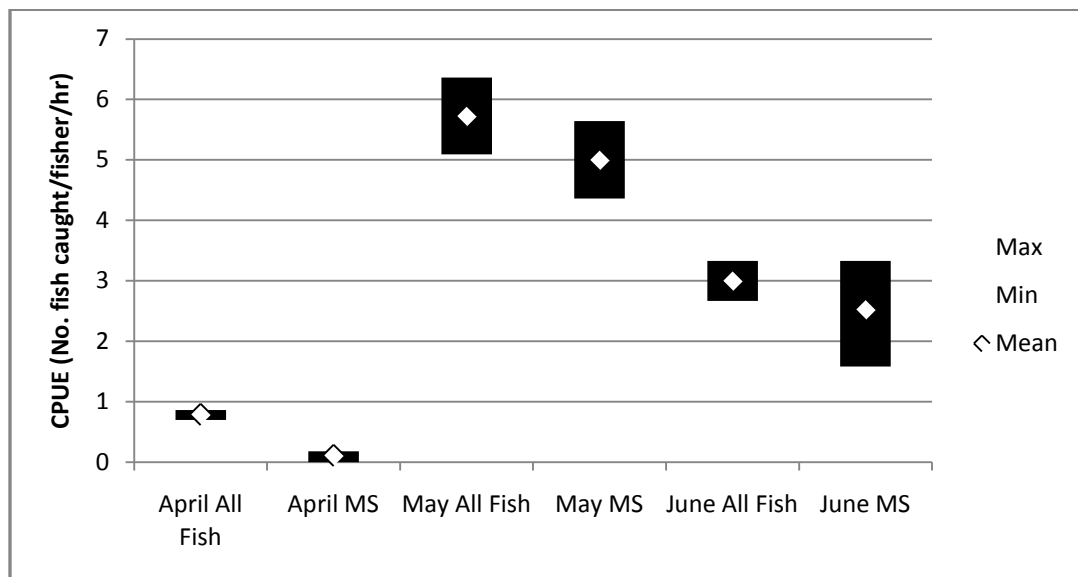


Figure 1 Mean and range of CPUE for all fish and *Lutjanus analis* (MS) caught in 2009. Number of fishing days/fish caught per month: April = 3/5, May = 2/59, June = 3/31.

In situ observation with Scuba

Mutton Snapper Seasonal Closed Area

Divers did not locate any spawning aggregation within the MSSCA in a total of 82 dives (16 dedicated mutton snapper searches and 51 habitat related fish censuses) in 2009 and 42 dives (29 searches and 13 fish censuses) in 2010. No more than four mutton snapper were seen on individual dives within and adjacent to the MSSCA conducted in 2009 and 2010, even when dives were conducted immediately before fishing commenced.

Red Buoy Site

Several dives were conducted at a reef 1km west of the red buoy marking the St. Croix shelf edge for shipping. During four dives on 2 May 2010, large schools of *Lutjanus cyanopterus* (cubera snapper), *Trachinotus falcatus* (permit), *Caranx crysos* (blue runner), *Chaetodipterus faber* (Atlantic spadefish), and *Lutjanus analis* (mutton snapper) were observed. About 200 mutton snapper were observed in an aggregation located over sand adjacent to the reef; no spawning was observed. On 29 May 2010, only one large school of fish (>50 fish), *Aluterus schoepfli* (orange filefish), was observed on the reef.

Reproductive Aspects

Lutjanus analis was dioecious with males being over twice as abundant as females (N=95) (Table 2). The gonad somatic index (GSI - gonad weight (g)*100/weight of fish (g)) was highest in April, May and June (Figure 2, Table 3). July was the only month in which a female was found with spent gonads (July 18, 2009, 11 days after full moon).

Table 2 Ratio of male (♂) to female (♀) *Lutjanus analis* caught in 2009.

Month	♂	♀	Sex Ratio
April	2	3	0.7
May	43	16	2.7
June	21	10	2.0
Total	66	29	2.3

Table 3 Mean GSI and standard error (SE) for males (♂) and females (♀) and mean fork length (FL) (mm) and range of FL of *Lutjanus analis*.

	March '09		April '09		May '09		June '09		July '09		March '10	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
N	2	4	3	2	16	43	10	20	4	3	5	14
GSI	0.28	0.12	2.94	2.14	3.04	2.86	3.12	2.98	1.82	0.93	0.47	1.38
(SE)	(0.14)	(0.05)	(0.46)	(1.86)	(0.22)	(0.21)	(0.37)	(0.30)	(0.75)	(0.24)	0.13	0.23
FL	493	427	615	555	539	472	525	503	601.5	628	453	497
(range)	(386- 599)	(369- 475)	(590 - 635)	(490- 620)	(410 - 633)	(367 - 600)	(393- 625)	(375- 660)	(550 - 653)	(605- 644)	(340- 513)	(373- 598)

Length weight ratio

The length weight relationship for male and female *Lutjanus analis* collected between 24 March 2009 and 20 March 2010 was calculated using a power regression (Figure 3) (P<0.001).

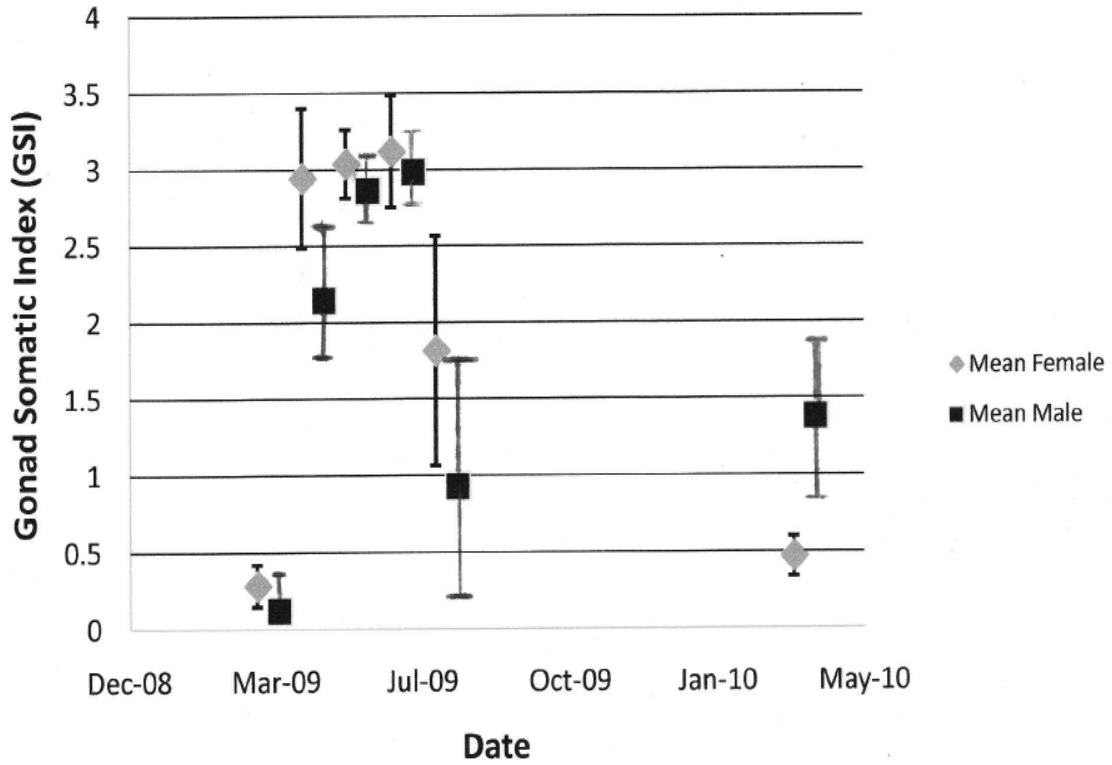


Figure 2. *Lutjanus analis* - Female and Male mean monthly GSI, with SE bars. N values in Table 3.

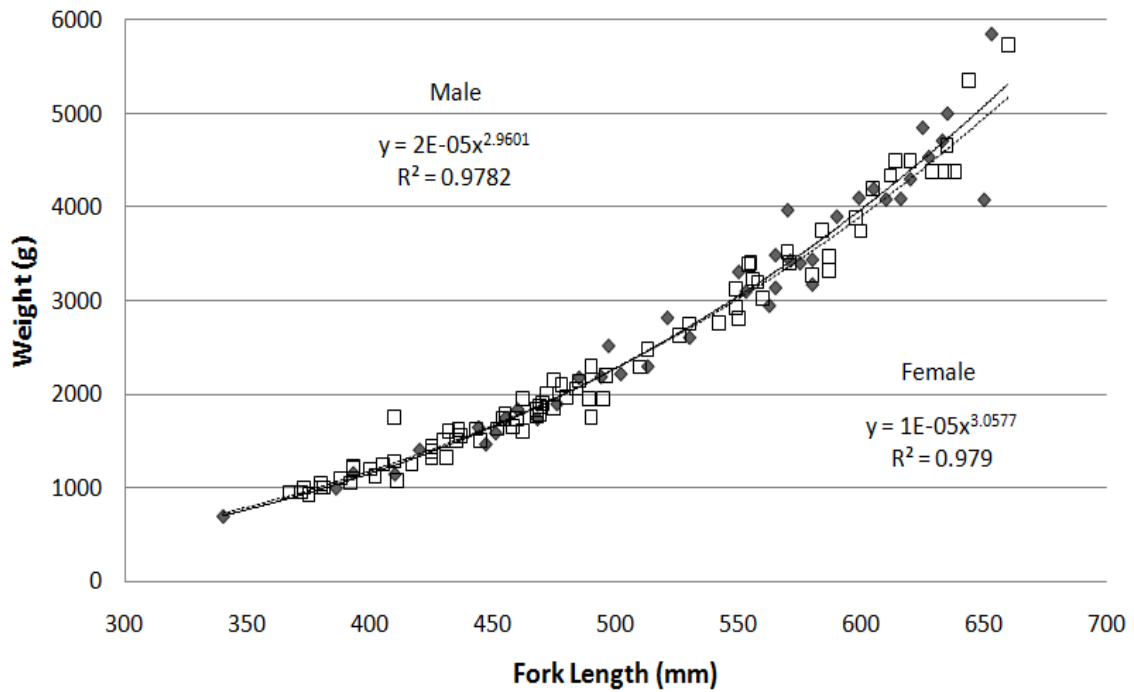


Figure 3 Length weight relationship for male (open squares, black line) and female (black diamonds, dashed line) *Lutjanus analis*. N: ♀ = 41, ♂ = 85.

Discussion

Spawning in *Lutjanus analis* has been recorded from February to September in the Caribbean (Table 4) with the peak spawning period in May and June (Claro et al. 2009) and April to June (Heyman and Kjerfve 2000). Spawning months on St. Croix show a similar pattern to Cuba and Puerto Rico except that the spawning season is not as lengthy as in Cuba and occurs one month later than in Puerto Rico. Because fish were not sampled in August or September, it is not known if they spawn in these months as well. However, the declining GSI in males and females in July (Figure 2 and Table 3) and the occurrence of a spent ovary in a female collected July 18, 11 days after full moon, suggests that the annual spawning cycle is at or near its end in July.

Table 4 Months with documented spawning of *Lutjanus analis* from the Caribbean. Primary spawning months in St. Croix are shown in capitals.

Location	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Cuba ¹			x	x	x	x	x	
Cuba ²			x	x	x	x	x	x
Puerto Rico ³			x	x	x			
Belize ⁴	x	x	x	x	x	x	x	
This study			x	X	X	x		

¹Claro et al. 2009

²Claro et al. 2003 Summary of all sites - spawning months varied among sites.

³Matos-Caraballo et al. 2006

⁴Heyman and Kjerfve 2000

Although the MSSCA has been under government management since 1994, this was the first survey of the *Lutjanus analis* population in the MSSCA. While, no aggregation was detected during dives in 2009 and 2010, the high CPUE in May and June 2009 and the high GSI values from March through July indicated that mutton snapper still aggregate to spawn within or in the vicinity of the MSSCA and, likely, in fairly large numbers.

The most likely location of the spawning aggregation in the area of the MSSCA is the SW corner of St. Croix. This corner has geomorphological characteristics of mutton snapper spawning sites at other locations, i.e. a promontory close to a sharp bend in the shelf (Anon. 2005). Mutton snapper appear to be vulnerable to fishing several km from an aggregation site, since, in this study, the fishing site and only confirmed aggregation site were several km apart.

Within the MSSCA, no spawning behavior or increase in mutton snapper abundance was observed. Considering that a number of dives were conducted at fishing sites just prior to dusk and that these dives were done as unobtrusively as possible with only 2-3 divers in the water, it is difficult to explain why divers saw no or only a few mutton snapper, and yet less than 30 minutes after dives were completed in May and June 2009 mutton snapper were easily caught. Possibly, fish were migrating to a spawning aggregation site

at depths deeper than the divers searched and darkness, along with chumming and the light on the boat drew them to shallower waters.

Recommendations

Future research on the mutton snapper spawning aggregation should concentrate on the southwest corner of St. Croix. This is the only location where a spawning aggregation of mutton snapper was found and has similar geomorphological characteristics to other mutton snapper spawning sites. The seasonal closure of the mutton snapper should be maintained, since the actual location of the aggregation appears to be outside the closed area. Also, it appears that reproductive fish migrating to the aggregation site are vulnerable to fishing at least several km from the site.

Acknowledgements

Lutjanus analis were caught in the MSSCA under a letter of acknowledgement from the US Department of Commerce, NOAA, National Marine Fisheries Service, Southeast Regional Office and the Government of the USVI. We gratefully recognize the assistance from G. Martinez, S. Martinez–Corcino, and L. Carr. Financial support and technical assistance came from the Caribbean Fisheries Management Council for which we thank M. Rolon and G. Garcia-Moliner. The Tropical Discovery Fund is acknowledged for financial support allowing us to participate in the conference.

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