A Preliminary Summary of Yellowtail Parrotfish (*Sparisoma rubripinne*) Acoustic Tracking at Spawning Aggregations in Reef Bay, St. John USVI

Un Resumen Preliminar de Acústica de Pez Loro (Sparisoma rubripinne) Seguimiento en Agregaciones de Reef Bay, St. John USVI

Un Résumé Préliminaire des Acoustiques de Perroquets (Sparisoma rubripinne) Limande à Queue Jaune Suivi de Fraye des Agrégations dans Reef Bay, St. John USVI

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ABSTRACT

Sparisoma rubripinne form a primary fish spawning aggregation (P FSA) off the western border of Reef Bay, St John, US Virgin Islands. While observations of the aggregation have been documented, individual visitation frequencies and duration of visitation is unknown. This project passively tracked individuals (n = 25) through a hydroacoustic array in Reef Bay. About half (12 of 25) of tagged individuals frequented the P FSA and two new FSA sites that were discovered, one northwest of the primary site (NW FSA) and one on the eastern side of the bay (E FSA). Five *S. rubripinne* tagged from eastern Reef Bay frequented only E FSA. For *S. rubripinne* tagged from western Reef Bay, five individuals frequented both P FSA and NW FSA, and two individuals frequented only NW FSA. Frequency of visitation varied across individuals, ranging from 19 d to 403 d. The average daily duration for individuals across FSAs was significantly different ($\chi^2 = 289.5773$, $p < .0001$), with P FSA averaging the longest daily duration ($\mu = 33.5$ min). Spatial patterns of migration were observed by five fish at the NW FSA. *S. rubripinne* individuals, and females, did not display a consistent temporal pattern for FSA visitation or duration; however female size may affect spawning frequencies and duration. Further analyses are necessary to determine correlations between environmental factors and spawning characteristics.

KEY WORDS: Spawning aggregation, parrotfish, *Sparisoma rubripinne,* acoustic tracking

INTRODUCTION

Initial phase yellowtail parrotfish (*Sparisoma rubripinne*) are resident group spawners that form a daily fish spawning aggregation (FSA) off the southern coast of St John, US Virgin Islands. Along the western edge of Reef Bay, *S. rubripinne* aggregate spawn over the most seaward extension of fringing reef during afternoon hours (15:00 to 18:00). The primary FSA (P FSA) was first documented and observed by Randall and Randall in 1960, and has since been visited and documented by various researchers (Randall and Randall 1963, Colin and Clavijo 1988, Colin 1996, Colin and Domeier 1997, personal observation 2011 - 2013).

Randall and Randall (1963) provided observations of the aggregation site (19.8 m depth, aggregate reef promontory), size (100 - 400 fish), formation (daily, year-round), behavior (group spawning bursts involving a single female and 2 - 15 males), and sex ratio (3:1 male to female), as well as detailed courtship behaviors and reproductive development. The goal for this project is to determine how often individuals are visiting the aggregation (frequency of visitation) and also how long individuals stay on average (duration) during one day of visitation.

METHODS

S. rubripinne were tracked from Sept 2011 to Feb 2012 by 12 Vemco VR2W hydroacoustic receivers. In Sept 2011, 20 *S. rubripinne* were captured at night from four evenly distributed inshore areas within Reef Bay, two areas east of the bay (N=10) and two west of the bay (n = 10). In March 2012, five *S. rubripinne* were captured at the P FSA during afternoon spawning hours. Acoustic tags (v7 or v9 transmitters) were surgically implanted into the ventral, abdominal body cavity of fish. *S. rubripinne* were sexed through visual observations of gonads through the body wall before surgeries were completed. All fish were released at capture sites.

The tracking period (FSA detection span) for each individual fish was calculated as the difference in the number of days between the first detection at an FSA and the last detection at an FSA. The total number of days each fish was detected at an FSA was totaled, and then divided by its FSA detection span in order to determine the ratio for an individual's frequency of visitation. Duration of visitation was determined by the elapsed time span (minutes) between the first time of detection at an FSA to the last time of detection for a single day.

RESULTS & DISCUSSION

Of 25 *S. rubripinne* captured and tagged (8 female, 2 male, 15 unknown), 19 were detected within the array and only 12 were detected at FSA sites. *S. rubripinne* captured on the western side of Reef Bay only visited western FSAs (n = 7; 2-NW

FSA, 5-NW & P FSAs), and *S. rubripinne* captured on the eastern side of Reef Bay only visited eastern FSAs (n = 5). A total of 11,760 detections were recorded across Reef Bay. P FSA (receiver 1, Figure 1) and E FSA (receiver 11) recorded the highest number of fish detections (5,300 and 3,649; 76% of all detections). FSA detection span and number of days ranged from 24 - 413 days and 19 - 403 days (Table 1).

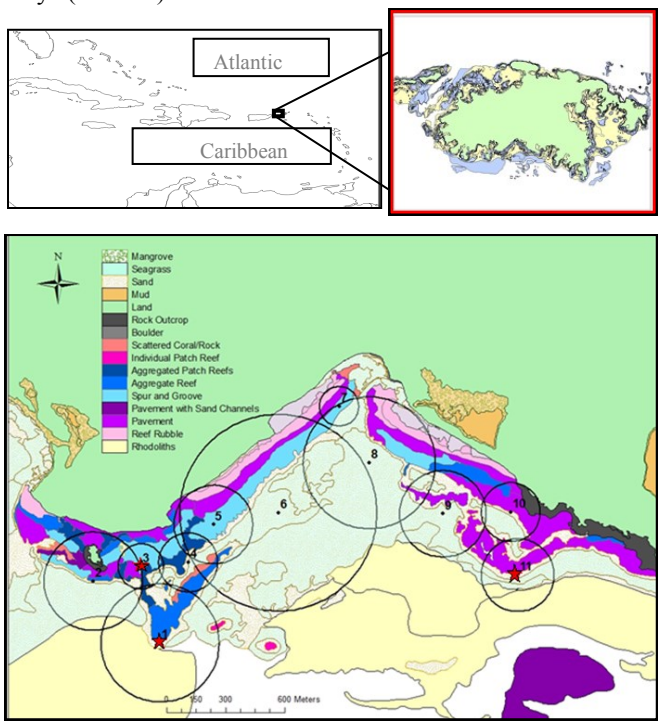

Figure 1. (**top**) A map of the Caribbean highlighting location of St John, US Virgin Islands. (**bottom**) A detailed benthic habitat map of Reef Bay with labeled receiver locations. Black circles indicate approximate detection ranges for individual receivers (100 m - 520 m radius). Red stars highlight FSA receiver locations (1 P FSA, 3 = NW FSA, 11 = E FSA).

Spawning and gamete release were observed at P FSA and NW FSA but not at E FSA. However, *S. rubripinne* visitation patterns at receiver 11 (Figure 1) paralleled the visitation patterns at the known P FSA, suggesting an eastern spawning site (E FSA). The site is a reef promontory ~18 m depth that extends from the inshore reef. An additional western FSA was located at receiver 3 along a shallow (7.6 m) reef extension ~400 m northwest of the P FSA (NW FSA, Fig 1). At times, fish were detected at both the NW and P FSA sites within the same afternoon. However, due to the brevity and chronological order of detections, most detections at the NW FSA was suspected to reflect migration to the P FSA (i.e. first appearance at NW FSA, then P FSA, then NW FSA). Suspect detection time was not included in the duration of FSA visitation.

There was a significant difference in the average duration of daily visitation across FSAs including all fish ($\chi^2 = 289.5773$, $p < 0.0001$; **P**–n = 262, μ = 33.5 ± 1.6; **E**–n = 724, μ = 18.4 ± 0.8; **NW**–n = 256, μ = 5.3 ± 0.6; Figure 2a.). Exclusively female *S. rubripinne* (n = 4; 2-E FSA, 2-P FSA) also did not show a significant difference in average duration of visitation ($\chi^2 = 204.7639$, $p < 0.0001$**; 3010**-n = 328, μ = 17.5 min ± 1.1**; 3014**-n = 243, μ = 9.8 min ± 0.7**; 3376**-n = 101, μ = 49.6 min ± 2.1**; 17883**-n = 22, μ = 10.6 min±2.6; Figure 2c.).

During the month of February 2012, ten *S. rubripinne* were active at FSAs. The earliest time of arrival for any fish at an FSA was 15:16:05. The latest time of departure was 17:41:40 with sun set falling between 18:13:00 and 18:25:00. There was a significant difference in the average daily duration of visitation across the three FSAs including all fish ($\chi^2 = 32.3121$, $p < 0.0001$); **P**–n = 69, μ = 24.9 min ± 2.8 SEM; **E**–n = 79, μ = 25.2 min ± 2.8; **NW**-n = 41, μ = 5.6 ± 1.2; Figure 2b.). However, excluding the NW FSA, there was no significant difference between P and E FSA ($\chi^2 = 0.0892$, $p < 0.7653$).

Table 1. *S. rubripinne* acoustic tracking results at FSAs. Individuals are grouped by FSA with fish tag ID and known sex (Fm = female, M = male), total length in cm (TL), the number of detections at an FSA (Detects), number of days in the tracking period (Span), number of days detected at FSA (Days), ratio of the number of days detected at an FSA to the tracking period (Ratio), the average time a fish spent at an FSA per day of visitation (Avg. min), and the total amount of time a fish spent at an FSA (Total Min).

FSA	Fish ID	TL	Detects	Span	Days	Ratio	Avg Min	Total Min
	3010 (Fm)	31.2	3002	413	403	0.98	17.6	5784
	3013	31.2	79	24	19	0.79	26.8	456
E	3014 (Fm)	29.6	692	326	250	0.77	9.9	2396
	3372 (M)	29.2	72	115	41	0.36	10.7	441
	3375	28.3	804	118	96	0.81	45.2	4295
	3369	26.5	35	176	32	0.18	2.9	93
NW	17882	26.3	254	302	186	0.62	3.4	632
	17883 (Fm)	32	154	184	29	0.16	10.7	235
	4558	30	853	52	50	0.96	45.7	2150
P	3374	29	1426	194	115	0.59	18.9	1679
	3376 (Fm)	27.8	3064	200	170	0.85	49.7	5023
	61231	25	150	95	49	0.52	8.7	356

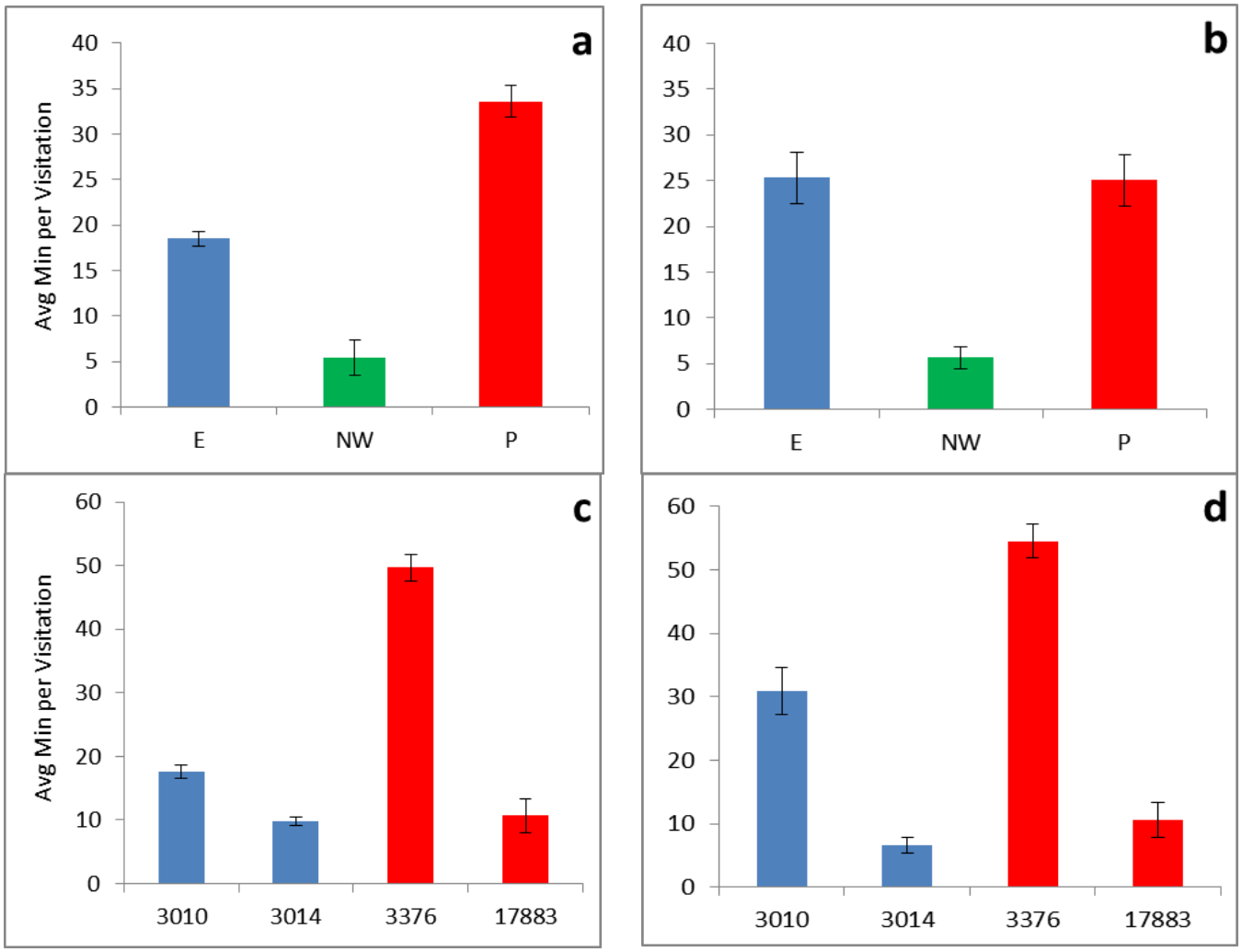

Figure 2. **(top)** Plots for average daily duration (minutes) for all *S. rubripinne* by FSA (x-axis = FSA location) for the duration of the study (**a.**) and for the month of Feb 2012 (**b.**). (**bottom**) Plots for average daily duration for confirmed female *S. rubripinne* (x axis = tag ID) for the duration of the study (**c.**) and for the month of Feb 2012 (**d**.). Blue bars represent fish at the E FSA and red bars represent fish at the P FSA.

While multiple FSAs exist within Reef Bay, they are not all used in the same capacity. Spawning at the NW FSA has not been observed as a daily event and has significantly lower fish visitation and durations than the P and E FSAs. The habitat similarities between the P and E FSA indicate that S. *rubripinne* prefer reef promontories for the purpose of aggregate spawning, potentially around 18 m, which is deeper than their typical inshore, shallow water dwelling. It is likely the NW FSA site is used as either a staging area (Nemeth, 2012) where fish mill about and congregate before migrating in groups to the P FSA, or as an opportunistic spillover site when aggregation numbers may be high at P FSA site or when certain environmental conditions favor this inshore site.

In February, there was a significant difference in female duration of visitation across individuals (χ^2 = 65.0777, $p < 0.0001$; **3010**-n = 29, μ = 30.8 ± 3.8; **3014**-n = 22, μ = 6.6 ± 1.2; **3376**-n = 23, μ = 54.4 ± 2.7; **17883**-n = 20, μ = 10.5 ± 2.8; Figure 2d.) and between females at the P and E FSA sites (χ^2 = 7.2818, $p < 0.0070$; **P**–n = 40, μ = 35.2 min ± 4.1; **E**–n = 51, μ = 20.4 min ± 2.8). Females did not display a similar temporal or spatial pattern of visitation or duration; however, the smallest tagged female (27.8 cm TL) notably recorded the highest number of detections (3,064), averaged the longest daily duration of visitation (49.7 min), and totaled the second highest number of minutes for overall duration (5,023 min). This finding suggests that smaller females may frequent FSAs more often and for longer lengths of time compared to larger females.

S. rubripinne differ significantly in the frequency and duration of visitation across all individuals, females, and aggregation sites when considering the 16 month extent of the project. When focused on one month (February), average durations of the P and E FSA were nearly the same

(~25 min); however this pattern was not seen across other months with high abundance of tagged *S. rubripinne* (Figure 3). From this monthly comparison of FSA durations, it is highly unlikely that lunar cycle influences aggregation characteristics. It is clear that more detailed analyses are needed to determine if seasonality and/or environmental factors affect temporal or spatial spawning characteristics.

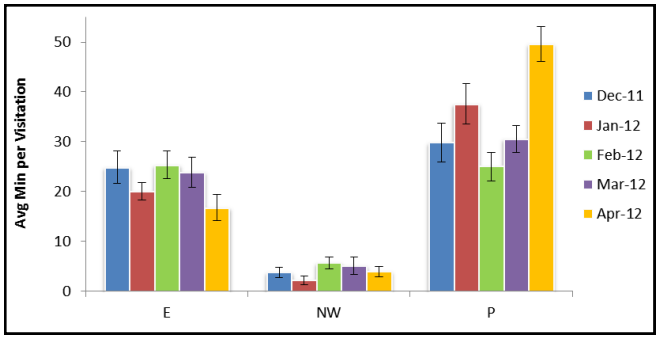

Figure 3. A comparison of FSA duration of visitation for each of the five months with highest abundance of actively tagged *S. rubripinne* (Dec'11-n = 7 *S. rubripinne*; Jan'12- n = 9; Feb'12-n = 10; Mar'12-n = 11; Apr'12-n = 9).

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