

# Australian Acoustic Tracking and Monitoring System (AATAMS)

## Receiver Pool Application 2015-16

### Final Report

15 June 2016

#### Examining the spawning aggregation dynamics of coral reef fishes



Setting up remote acoustic receivers to monitor the spawning aggregation dynamics of *Siganus doliatus* (Siganidae) shown here.

**Project title: Examining the spawning aggregation dynamics of coral reef fishes (rabbitfishes, Siganidae)**

**Project leader:** Dr Rebecca J Fox, Postdoctoral Research Fellow, School of Life Sciences, University of Technology Sydney, Broadway, Ultimo, NSW 2007

**Co-investigator:** Prof. William Gladstone (UTS)

**Project summary:**

Globally, approximately 500 million people rely on coral reefs for their food or livelihood. Managing reef ecosystems for food security or biodiversity conservation requires an understanding of how and from where reef fish stocks are replenished, including how dependent these reproductive processes are on the availability of particular habitat. Across the tropical Indo-Pacific, species of rabbitfish (family Siganidae) are essential providers of multiple ecosystem services, being a key source of dietary protein, an economically important component of fisheries landings<sup>[1,2,3]</sup>, and a critical ecological group in terms of their functional role (herbivores that control algal growth on reefs)<sup>[4,5]</sup>. Despite their importance as a food source and the existence of fisheries offering the potential for over-exploitation, we know next to nothing of their reproductive ecology in the wild. It appears that adult rabbitfish undertake regular monthly migrations to spawning aggregation sites<sup>[6,7,8]</sup> however this has yet to be confirmed for many species<sup>[9,10]</sup>. The lack of quantitative data on the migratory connectivity exhibited by rabbitfish populations and whether their natural patterns of spawning and site selection are strongly tied to particular habitat attributes is currently a key obstacle to the development of effective species management plans. A better understanding of both their spawning behaviour, and the dependence that rabbitfish have on particular spawning site habitats is needed in order to equip resource managers with data for appropriate fisheries management plans and effective marine protected area planning. This project will use acoustic telemetry to track the reproductive migrations undertaken by rabbitfish whose mating behaviour is currently unknown and will also monitor the use of particular spawning sites over time to determine the role of habitat fidelity in the life-cycle of this important foodfish species.

**Project aims:**

- To document the reproductive ecology (including patterns of mating behaviour, extent of reproductive migratory connectivity, and spawning aggregation dynamics) of the tropical marine fish *Siganus doliatus* which form part of reef and lagoon fishery landings in the Indo-Pacific.

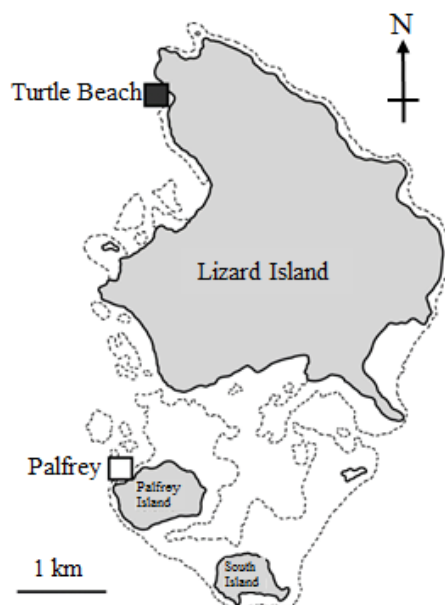
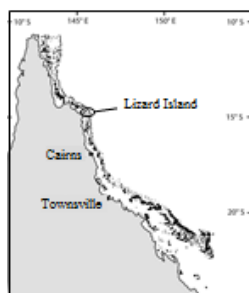
Specifically the project aimed to:

1. Determine the location of spawning aggregation sites for unfished populations of this species on the Great Barrier Reef,
2. Determine the dynamics of rabbitfish spawning aggregations, specifically
  - (i) the residency times of individuals at monthly spawning events,
  - (ii) the number of monthly spawning events an individual attends within a reproductive season,
  - (iii) the fidelity of individual fish to particular spawning sites within a reproductive season, and
  - (iv) the permanency of spawning sites between reproductive seasons.

### **Summary of achievements against aims:**

*Aim 1:* Two populations of the species *Siganus doliatus* at Lizard Island, Great Barrier Reef (14°40'S, 145°28'E), were manually tracked over the period 11-23 Oct 2015 to locate their spawning aggregation sites. Unfortunately the populations did not migrate spawn in this month (data from remote receivers confirmed that the start of spawning was delayed in 2015 and only commenced in the November at this location) and so this aim was not accomplished. However data from the VR2Ws has enabled us to narrow down the approximate spawning location for one of the two populations.

*Aim 2:* Dynamics of rabbitfish spawning aggregations, including fidelity of individuals to particular aggregations.



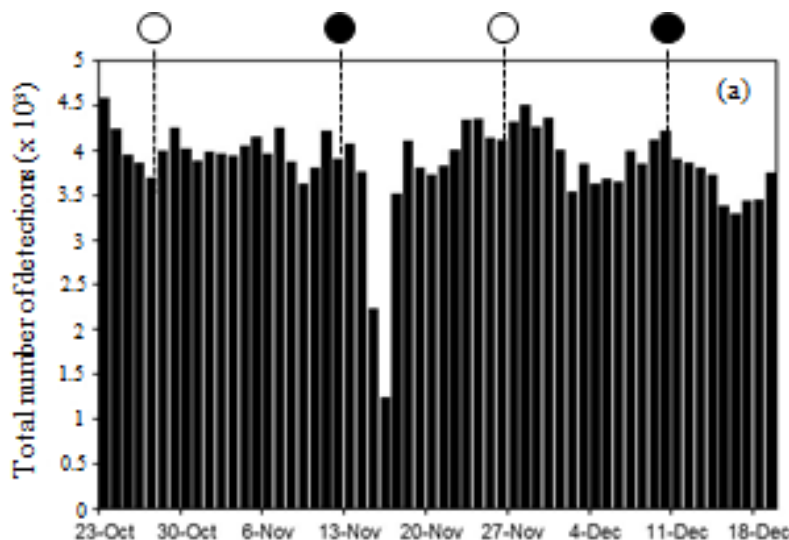
A total of 30 individuals from two populations of the species *Siganus doliatus* at Lizard Island, Great Barrier Reef (Fig. 1) were remotely tracked at their home territories from 22 Oct 2015 and the resulting patterns of detections combined with behavioural observations collected *in situ* over the period 9-20 Dec 2015.

**Fig. 1:** Map of study site showing the location of two populations of *Siganus doliatus* (Turtle Beach and Palfrey) that were remotely tracked.

- The telemetry data revealed that, at one site (Palfrey), fish undertook monthly migrations for spawning, leaving their territories on days 3-6 of the lunar month and returning 12-48h later. Whilst at the other site (Turtle Beach), fish did not migrate to spawn. The *in situ* observations of fish abundances at the two sites through time corroborated the detection data.
- The number of spawning migrations undertaken per season varied across individuals.
- Individuals appeared to migrate to the same site over a season, as detections showed the same directional pattern across months. Fishes from the Palfrey site migrated around the western tip of the island and appear to spawn at a location along the south-west face of Palfrey Island.

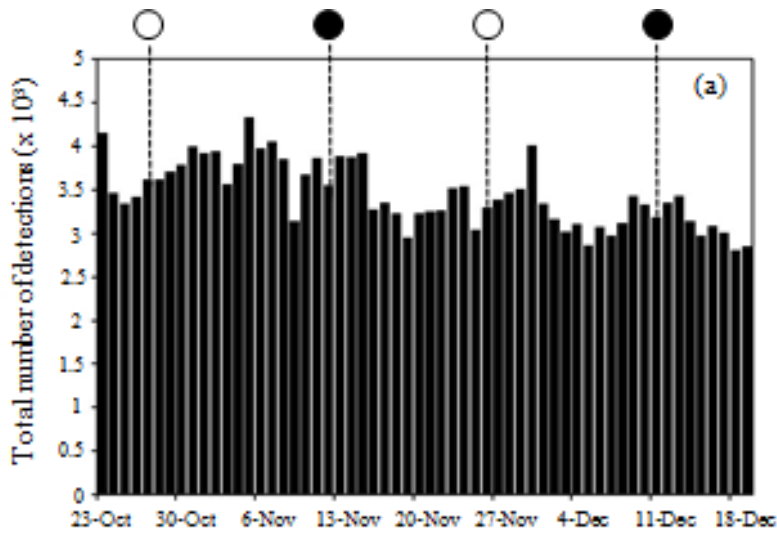
### Results in detail:

At the Palfrey site, total daily detections of tagged *S. doliatus* at their home territories showed distinct decreases on particular days of the month (shown in Fig 2 for November and December).



**Fig 2:** (a) Total number of daily detections of tagged *S. doliatus* recorded at Palfrey home territories over the period 23 Oct-19 Dec 2015. Dates of the new moon (shaded circle) and full moon (open circle) in each month are indicated.

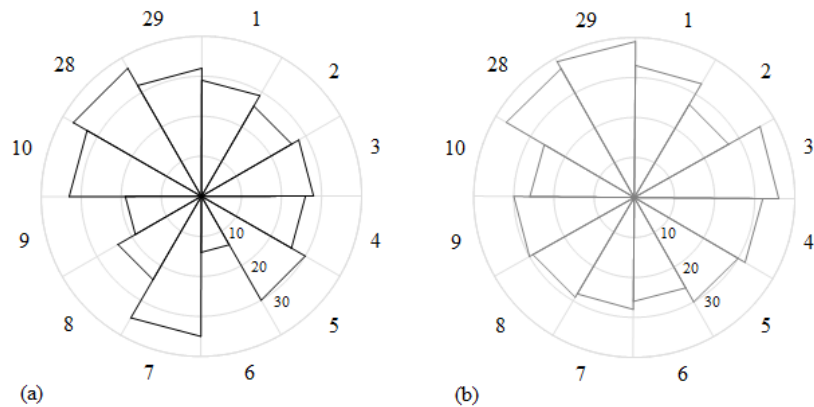
Whereas at the Turtle Beach site, total daily detections at home territories showed no distinct rhythm (shown in Fig. 3 for November and December), with autocorrelation analysis revealing significant correlations at multiple lags.



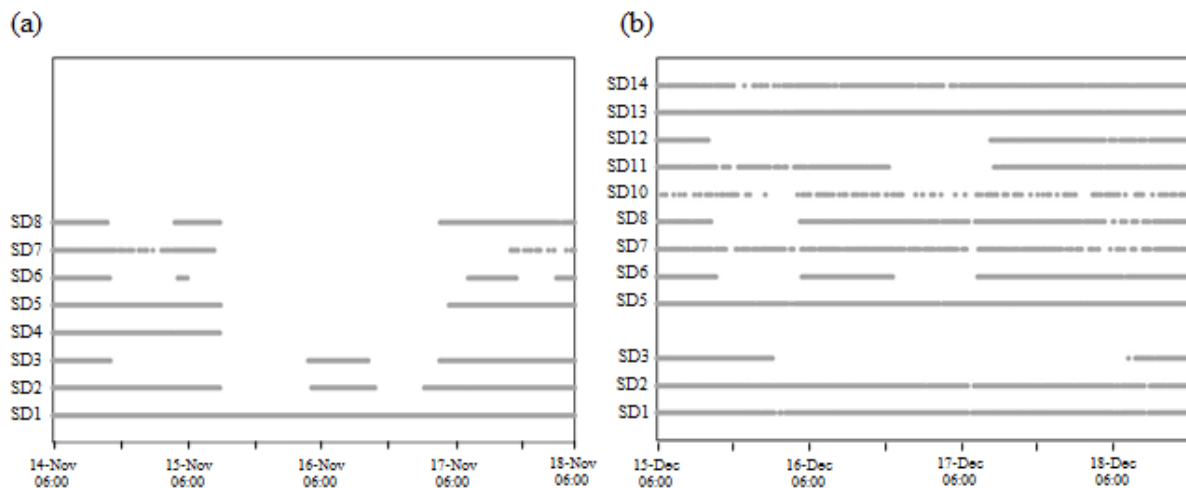
**Fig. 3:** Total number of daily detections of tagged *S. doliatus* recorded at Turtle Beach home territories over the period 23 Oct-19 Dec 2015. Dates of the new moon (shaded circle) and full moon (open circle) in each month are indicated.

Visual censuses conducted at the sites over the period 9-20 Dec confirmed the differences in behavioural patterns between the sites seen in the detection data. At the Palfrey site, abundances of *S. doliatus* declined on Day 6 of the lunar month (Fig. 4), corresponding with the day on which total receiver detections declined (cross correlation analysis of detection totals and fish abundance showed significant lag at 0 days).

**Fig. 4:** Observed abundances of *S. doliatus* at (a) Palfrey and (b) Turtle Beach over the period 9-20 Dec 2015. Calendar dates are translated to their respective day of the lunar month, with 1 being the day of the new moon.



Not every individual at the Palfrey site spawned in every month. For example, seven of the eight tagged fish migrated in the November cycle, while in the December cycle, just five of the 12 fish still being detected left the site (Fig. 5).



**Fig. 5:** Abacus plot of transmitter detections of tagged fishes at Palfrey over the period (a) 14-18 Nov 2015 and (b) 15-18 Dec 2015 showing the observed break in detections for fish that migrated from their territories for spawning. The dates shown relate to Days 3-7 of the lunar month in November (new moon was on 12 Nov) and Days 5-8 of the lunar month in December (new moon was on 11 Dec).

## Discussion

The period of remote tracking enabled us to determine that *S. doliaetus* undertakes migrations from its home territories consistent with a synchronous lunar spawning cycle concentrated in the period 2-6 d after the new moon, but that this migratory behaviour varies between locations. Whether the migrations undertaken by fishes from the Palfrey population resulted in a spawning aggregation, or ‘simple migratory spawning’ can only be known once the destination of these individuals is established, the number and density of fishes present at the spawning site censused, and spawning observed. Data collection to answer these questions and our remaining research aim of establishing the fidelity of individuals to particular spawning sites between reproductive seasons is ongoing at the study site.

## Acknowledgments:

We thank AATAMS for the loan of VR2W receivers that made this project possible, the University of Technology Sydney (Chancellor’s Postdoctoral Fellowship Scheme), Ian Potter Foundation (Science Award) and UTS Faculty of Science for project funding, staff at Lizard Island Research Station for the provision of essential facilities and support and K Motson, S Smith, F Gladstone, A Hoey, Z Loffler and C Pisapia for field assistance.

## Outputs:

### Publications

**Fox RJ**, Bellwood DR, Jennions MD (2015) Why pair? Evidence of aggregative mating in a socially monogamous marine fish (*Siganus doliatus*, Siganidae). *Royal Society Open Science* **2**: 150252.

**Fox RJ**, Gladstone W (submitted 24/05/15) Acoustic telemetry suggests intraspecific variation in the reproductive behaviour of a coral reef fish.

**Fox RJ**, Gladstone W (in prep) Spawning patterns of the pencil-streaked rabbitfish, *Siganus doliatus* on the Great Barrier Reef.

### Presentations

'Monogamy without the sex? Remote acoustic telemetry provides new insights into the basis of pairing in tropical marine fishes'. **34<sup>th</sup> International Ethological Conference (Behaviour2015)**, Cairns, Australia, August 2015. (Oral presentation)

### Funding awards leveraged on the back of AATAMS Loan Pool Award

- Ian Potter Foundation Science Award (\$20,000 over 2 years), CI: Rebecca Fox
- UTS Science Faculty (\$3,200 cash for equipment purchases, VR2W receivers), CI: Rebecca Fox

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