

## **No Such Thing as a Free Lunch? Monitoring One of the Most Valuable Ecotourism Animals, Southern Stingrays of Stingray City, Grand Cayman**

### **No Existe tal Cosa como un Almuerzo Gratis? El Seguimiento de Uno de los Animales Más Valiosos de Ecoturismo, Rayas del Sur de la Ciudad de la Rayas, Gran Caimán**

### **Rien de Tel Qu'un Repas Gratuit? Surveiller L'un des Animaux D'écotourisme les Plus Précieux, Pastenagues Sud de Stingray City, Grand Cayman**

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#### **EXTENDED ABSTRACT**

Ecotourism encounters with wildlife have become increasingly popular world-wide, including interactions with marine wildlife (Orams 2002). Marine wildlife-oriented ecotourism often involves provisioning of animals to increase the reliability of human-animal interactions. While these practices may increase the enjoyment of tourists, the long-term effects on wildlife are often unclear. The Stingray City Sandbar (SCS), Grand Cayman, is a location where southern stingrays, *Hypanus americana*, are provisioned for ecotourism and is one of the world's most famous marine wildlife interaction sites. A number of behavioral and physiological changes in the SCS stingrays have been documented (Seminuk et al. 2008, 2009), although the long-term effects of site attachment to the SCS on stingrays is unknown. Because of the immense economic value of this tour operation concerns have been raised about the number and health of stingrays at SCS. However, understanding of the dynamics of the SCS has been hampered by lack of information about the composition of the aggregation. We investigated movements of stingrays in relation to the feeding site using acoustic telemetry and characterized demographic and temporal patterns of this stingray aggregation by examining 13+ years of tagging data and began intense monitoring of the aggregation by implementing structured censuses of the aggregation.

Movements of stingrays were examined using three methods:

- i) Active tracking of stingrays using externally attached acoustic transmitters,
- ii) Passive monitoring of presence of stingrays carrying internally planted acoustic transmitters at the SCS through acoustic receivers over the span of one year, and
- iii) Extensive tagging of stingrays with passive integrated transponders (PIT) tags accompanied by regular surveys to quantify stingrays with PIT tags.

Censuses conducted at the SCS demonstrated that the aggregation has been dominated by mature females (~80%) over the course of the study (2002 - 2017), with mature males and immature rays present in much smaller proportions. Active tracking of stingrays revealed a striking reversal of natural behavior, from classic nocturnal behavior exhibited by non-provisioned stingrays to diurnal patterns of activity of provisioned stingrays (Corcoran et al 2013). Active tracking also illustrated marked differences in movements between mature females and mature males. Females exhibited extremely high site fidelity to the SCS, actively moving among humans on the sandbar throughout the day, followed by movements to deeper sandy substrate a short distance from the SCS, where they remained largely stationary throughout the night, subsequently returning to the SCS early the following morning. Males were also highly active at the SCS during daytime, but remained active throughout the night as well, continuously moving along reef edges to distances several km from the SCS, also returning to the SCS the following morning. Passive acoustic telemetry of five mature females demonstrated that all five females returned to the SCS every day over the monitoring period (slightly greater than one year).

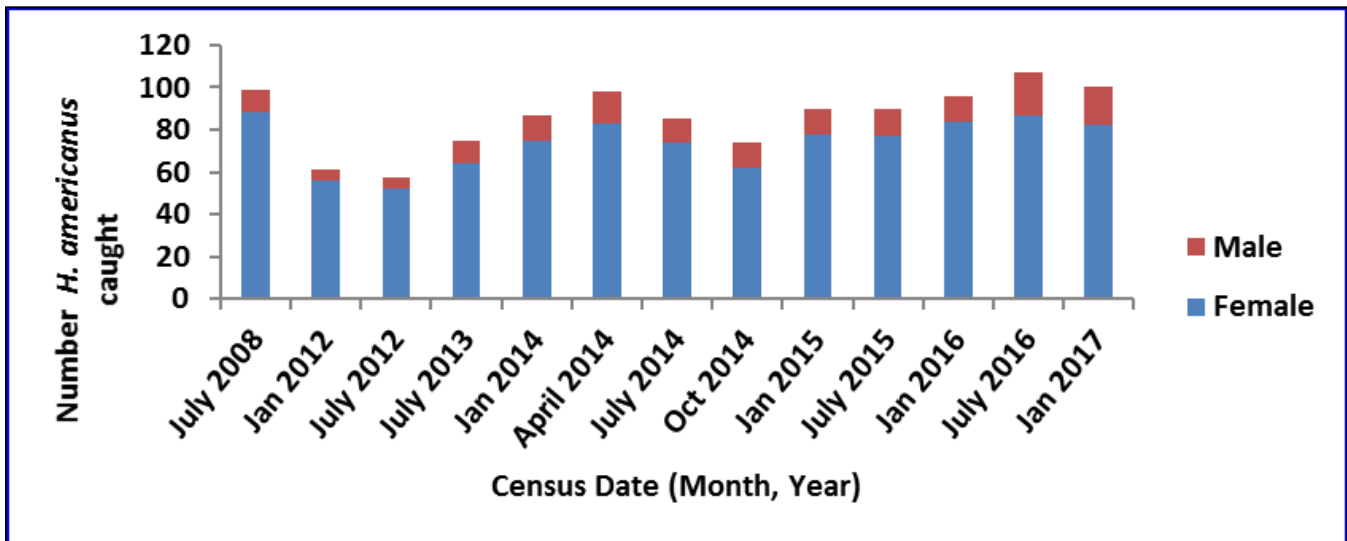
Tag and recapture components of the study have resulted in tagging of over 300 unique individuals at the SCS and capture of over 1500 rays (new and recaptured combined) since 2002. Capture of fewer than five stingrays at sites other than their tagging location supports findings of high site fidelity determined by our acoustic tracking studies. The proportion of untagged stingrays captured during censuses has fluctuated slightly around an average of 14% since 2008. When initial tagging began in 2002 the size of the aggregation was estimated at over 160 individuals, with similar numbers present when surveyed in 2008, although complete censuses were not conducted. By 2012 the aggregation had declined to a low of 57 stingrays captured in an exhaustive census (sampling until no new individuals were encountered over a three day period). Since 2012, stingray numbers have increased and have stabilized at ~90 stingrays (Figure 1). Females were residents of the aggregation over longer periods of time than males, with ~20% of recaptured females present for 10+ years, whereas males typically were present for only 3 years. The turnover of males was substantially higher than females over time the span of tagging (Vaudo et al., *In press*).

Our studies have revealed that although site fidelity of stingrays to the SCS is high, particularly among females, the SCS aggregation has continuously been replenished from recruitment of a small, but relatively constant number of new individuals from the general Cayman Islands-wide population. Cause of the decline in the size of the stingray aggregation that occurred between 2008 and 2012 is not known, but the rebound in aggregation size, chronic presence of nearly one quarter of the stingrays for over a decade and a large proportion of pregnant females at the SCS indicate that negative effects associated with consumption of an unnatural diet by the stingrays are limited. Fluctuations in the size of this extremely economically valuable resource illustrate that the aggregation is susceptible to natural and/or human perturbations and that success of management of ecotourism activities at the SCS has benefited from policies implemented by the Cayman Islands Department of the Environment, Cayman Island-wide protection of the southern stingray and will continue to benefit from regular monitoring of stingrays in the future.

KEYWORDS: Stingrays, aggregation, ecotourism, Cayman Islands

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**Figure 1.** Number of southern stingrays caught at the Sandbar during exhaustive censuses conducted between 2008 and 2017.