Emigration Patterns and Den Shifting for Two Life-Stages of *Panulirus argus* (Latreille, 1804) in the Florida Keys, Florida, USA

Patrones de Emigración y Desplazamiento en el Den son Diferentes para las Etapas de Vida de los Adultos y Sub-adultos de *Panulirus argus* (Latreille, 1804) en los Florida Keys, Florida, USA

Modèles d'Émigration et Déplacement de Tanière pour Deux Stades de Développement de *Panulirus argus* (Latreille, 1804) dans les Florida Keys, Floride, États-Unis

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EXTENDED ABSTRACT

Ontogenetic changes in behaviour are often associated with life-history stage. Subadult and adult Caribbean spiny lobsters, *Panulirus argus*, have considerable overlap in size and the late onset of morphological differences often prevents their differentiation. However, these stages exhibit distinct behavioural differences that are relevant to both lobster fishery management and understanding lobster ecology. The rate and direction of *P. argus* emigration and distance moved when selecting dens were measured at three sites in the Florida Keys to better understand the effects of life-history stage on lobster behaviour. Our understanding of lobster movement has evolved from that first described by Crawford and Smidt's (1922) as "rather sluggish" and "not seem probable to return to the same shelter except by accident" to recognize that lobsters have highly specific movement patterns and navigational abilities that are specific to life history stage.

We deployed acoustic receivers with overlapping detection areas to estimate locations of lobsters tagged at each of three sites. Acoustic data were processed and analysed using SPSS, Microsoft Excel, Table Curve 2D, ArcGIS, and programs written in Visual Basic to calculate two basic movement events, net daily movement and emigration. Net daily movement is the distance between two daytime shelters for a given lobster. Distance moved can be zero meters if the lobster returns to the same den. Emigration is a straight-line movement initiated during the night where a lobster leaves a denning and foraging area and does not return. The distributions of net daily movements among the three study sites were compared using a Kolmogorov-Smirnov test. The Watson's U^2 test was used to determine if the bearings of lobsters emigrating at each site were random (in many directions) or uniform (in a common direction).

Three study sites were selected to include locations containing lobsters of different sizes and different life history stages. Coral Gardens is an approximately 0.6 km diameter patch reef habitat located in the nearshore waters of the Atlantic Ocean within 5 km of lower Matecumbe Key. Fourteen lobsters (58 - 90 mm CL) were tracked from June 6, 2014 to July 28, 2014. None of these lobsters showed any evidence of sexual maturity. The "Snipe Point" location is a flat hard bottom site located in the Gulf of Mexico 10 km north of Snipe Key in the Lower Florida Keys. Here we tracked 31 (76 - 96 mm CL) lobsters from May 25, 2011 to July 26, 2011. Sexually mature lobsters can be found here but are very rare. Western Sambo contains multiple patch reefs and is located 10 km south of Boca Chica Key in the Atlantic Ocean. Here, we tracked 39 lobsters (66 - 134 mm CL) from June 6, 2004 to July 27, 2004. Sexually mature lobsters are common at this site.

The fine detail and timing of movements measured by acoustic technology in this study provides the level of detail necessary to put into context past research on lobster movement and migration that utilized tag-recapture methods. Movement and emigration appear to be less dependent on the size of the lobster, and more dependent on the life-history stage and the growth rate of those lobsters.

KEYWORDS: Acoustic, spiny lobster, Florida Keys