

Using Knowledge of Lionfish Ecology to Inform Management

Utilizando el Conocimiento sobre la Ecología del Pez León Para un Manejo Informado

En Utilisant les Connaissances de L'écologie Poisson Lion D'informer la Direction de Management

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ABSTRACT

Lionfish are the first marine fish invader from the Western Pacific to the Atlantic. In the space of around 30 years in their invasive range, lionfish have infiltrated a diverse array of habitats, inhabited a depth range of > 300 m and exceeded the size and density reported in the native range, demonstrating the difficulty of effective lionfish management. If left unmanaged, lionfish pose a significant, but still uncertain, threat to Caribbean ecosystems thereby warranting the need for effective and efficient, tailored management schemes based on lionfish ecology within invaded habitats. During a monitoring period between 2009 - 2013, more than 10,000 lionfish specimens from Bonaire, Klein Bonaire, and Curacao were documented, measured and weighed, with their feeding and reproductive ecology analysed in relation to local management strategies and timing. Management actions affected population size-structure, and the time taken for population size structure to rebound following management removal can be used to infer population growth rates and to suggest most effective times and strategies for lionfish removal. Due to their extensive dispersal, lionfish is a regional problem, requiring a dedicated, co-operative but resource intensive effort, but local populations may require locally tailored approaches to maximise the efficiency and effectiveness of enacted control and management programs.

KEY WORDS: Marine, invasive, Caribbean, conservation, control

INTRODUCTION

Second only to habitat loss and fragmentation, invasive species are considered to be the most important causes of global biodiversity loss (Mack et al. 2000, Parker et al. 2001). An indication of a successful invasive species management strategy is a general reduction in the average body size of individuals over time (Frazer et al. 2002, Cote et al. 2013, de Leon et al. 2013). Thus, studying the population dynamics and size class distribution of an invasive species helps to assess the effectiveness of current control strategies and gain knowledge to enhance future management. Lionfish were first confirmed in Bonaire and Curacao between October 26 - 28, 2009 (de Leon et al. 2013). Since then various management strategies have been instilled in an attempt to quell their further spread and also to control current populations. An extensive monitoring program was established in Bonaire whereby specimens were continually submitted over a four-year invasion period, allowing for their growth, dispersal, feeding, and reproductive ecology to be monitored over time.

METHODS

Between October 26th, 2009 and November 24th, 2013 a total of 11,161 lionfish were collected in Bonaire, Klein Bonaire, and Curacao during the hours of 07:30 to 23:00. Trained volunteers collected all specimens using scuba gear at the dive sites surrounding Bonaire, Klein Bonaire, and Curacao. These sites consisted of high profile coral reefs and patch reefs, ranging in depth from 0.3 to 91.5m. Collections were achieved using hand nets, pole spears or the use of the Eradicating Lionfish Tool (ELF Tool) ELF Tool, and caught specimens were stored in containment devices such dry bags or the Zookeeper™. Upon capture of specimens, data was collected on the date, time, location, and depth of capture, and the lionfish were measured (Standard Length, Total Length, Wet Weight). Specimens were also visually examined for the presence of supra-ocular tentacles and external parasites, and their gonads visually examined to determine sex and maturity.

RESULTS AND DISCUSSION

A total of 11,161 lionfish ranging between 21 to 455 mm TL were collected and analysed between October 26, 2009 and November 24, 2013. Lionfish in Bonaire were on average smaller when compared to Klein Bonaire and Curacao (Figure 1), which is an indication of a successful lionfish management strategy because of the overall reduction in lionfish size over time (Frazer et al. 2002, Cote et al. 2013, de Leon et al. 2013) due primarily to the rapid response approach to management in Bonaire. Lionfish within this study are demonstrating general growth patterns similar to the rest of the invaded range, but greatly exceed the previously reported maximum size of 350 mm total length (TL) attained in the Indo Pacific (Morris 2009, Munoz et al. 2011) which can be attributed to the hypothesis that lionfish are growing twice as fast, here in their invaded range (Cote et al. 2013). Over the four year sampling period, the depth associations of specific size classes did not change, but instead it was found that focusing removal efforts within the 15 – 25 m depth range would allow for removal of a higher proportion of fish within the 101 – 200 mm size class. A cyclical relationship was observed (Figure 2) whereby it took lionfish 5 - 6 months to recover from one peak in maximum size anomaly to the next. After being confirmed in late October 2009, lionfish began to continually increase in size until June 2010 where a 'new generation' of lionfish (i.e. juvenile fish ~50 mm TL) began showing up, thereby lowering the average TL and accounting for the first

sharp decline in size anomaly. Subsequent to this the peaks in lionfish size coincide with targeted removal efforts at areas not as regularly controlled.

CONCLUSION

It has been shown that an indication of a successful management programme is a reduction in average lionfish size over time. The observed variation in lionfish size amongst islands and also within Bonaire likely reflects the management strategies instilled along with the ease of accessibility for lionfish removal. If left unmanaged,

lionfish pose a significant, but still uncertain, threat to Caribbean ecosystems thereby warranting the need for effective and efficient, tailored management schemes based on lionfish ecology within invaded habitats.

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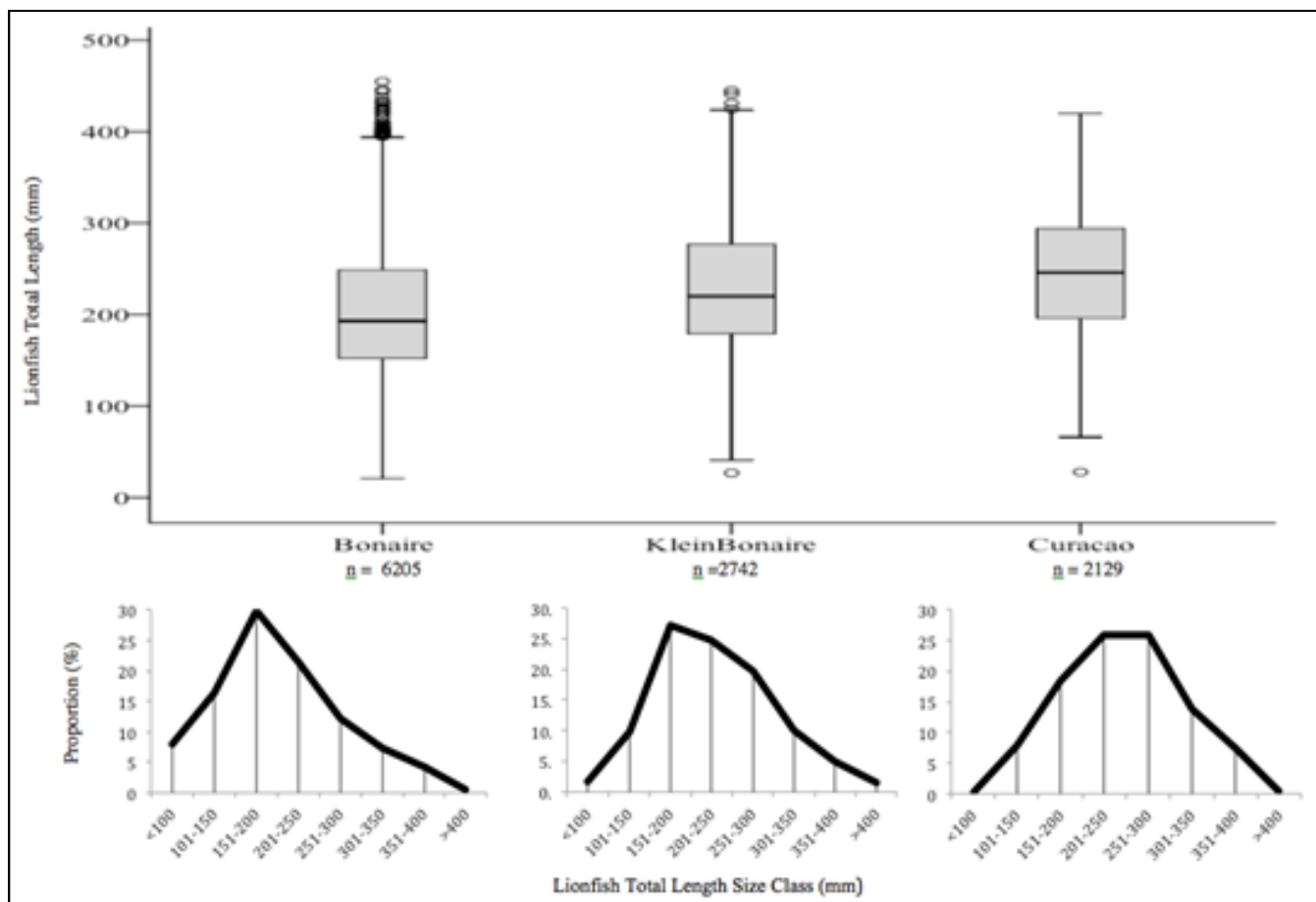


Figure 1. Size distribution of lionfish in Bonaire, Klein Bonaire and Curacao

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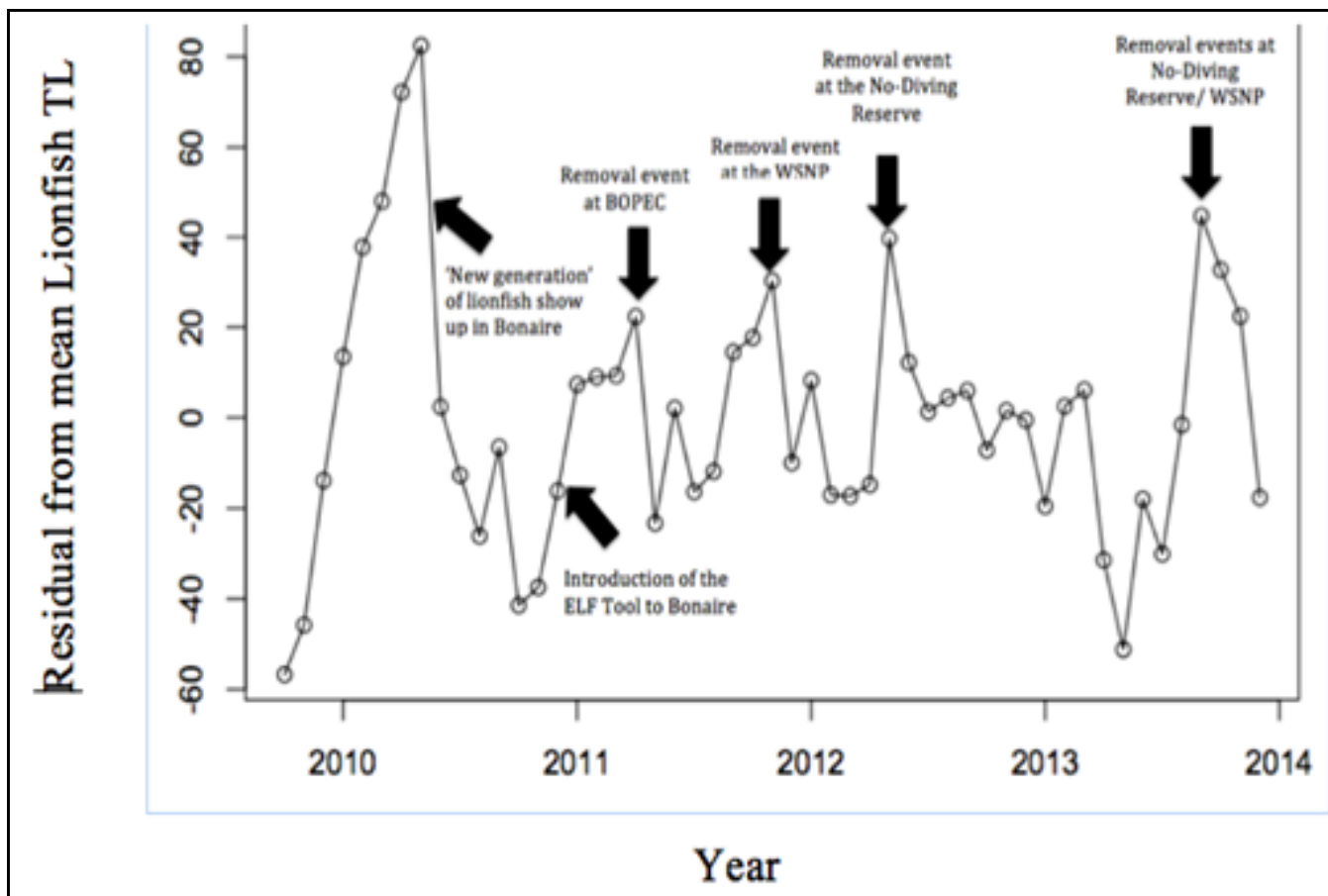


Figure 2. Temporal fluctuations in lionfish size based on residuals from a Loess smoother linking mean TL and month.