Invasion, Distribution, and Abundance of the Indo-Pacific Lionfish in the US Virgin Islands

La Invasión, la Distribución y Abundancia del Pez León Indo-Pacífico en las Islas Vírgenes de E.U.

Invasion, la Distribution et L'abondance de la Rascasse Volante Indo-Pacifique dans les Îles Vierges Américaines

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ABSTRACT

The Indo-Pacific lionfish (*P. volitans/P. miles*) was rapidly established throughout the Atlantic and Caribbean region over the last decade, inhabiting a range of habitats (i.e. coral reefs, seagrass beds, mangroves) and depths. We investigated the lionfish invasion by examining their abundance and density at different depths and reef types as part of the US Virgin Islands long-term Territorial Coral Reef Monitoring Program (TCRMP). This study utilized both roving diver and belt transects at 33 permanent monitoring sites. In 2008, the first lionfish was reported by a recreational diver in the U.S. Virgin Islands. Lionfish were first observed on TCRMP sites in 2009 in St. Croix and 2010 in St. Thomas. Since that time its population on shallow reef sites increased dramatically then showed a slight decline or leveling off before increasing again. The slight reductions in numbers in shallow reef sites may be due, in part, by removal efforts that have largely been focused within recreational diving limits on reefs less than 30m. The recent increase in lionfish numbers has occurred mostly on mesophotic reef sites. This study highlights the importance of collecting more quantitative data on lionfish impacts on native reef fishes in mesophotic depths and informing managers to develop new strategies to effectively reduce their numbers.

KEY WORDS: Invasive species, habitat distribution, mesophotic reefs, monitoring, fisheries management

INTRODUCTION

The Indo-Pacific lionfish (*P. volitans/P. miles*) is the first marine fish to successfully invade the Atlantic and Caribbean region. Introduced, likely through multiple releases, to the coastal waters of Florida as far back as the 1980s, lionfish are now established across the western North Atlantic, Caribbean, and Gulf of Mexico (Schofield 2009). The lack of predators and abundance of naïve prey have contributed to its success in their invaded range. As a result, lionfish are more abundant, reaching over 400 ha-1 in some areas (Green and Cote 2009), and larger in size, compared to its native range (Darling et al. 2011). The potential impact of the lionfish invasion has become a growing concern on the sustainability of native fish populations and the Caribbean marine ecosystem.

Lionfish occupy a variety of habitat types being found mostly on coral reefs but also mangrove and seagrass habitats (Biggs and Olden 2011, Barbour et al. 2010). The majority of studies to date have focused on coral reef and associated habitats less than 20 m deep. However, lionfish distributions are known to extend beyond recreational diving depths and include mesophotic reefs (Lesser and Slattery 2011). Mesophotic coral ecosystems (MCE) represent important habitats which are 30 – 150m depth (Lesser et al. 2009). Using data from the USVI long-term Territorial Coral Reef Monitoring Program, this paper reports on the lionfish invasion across a range of depths and reef types.

MATERIALS AND METHODS

The Virgin Islands Territorial Coral Reef Monitoring Program (TCRMP) has annually monitored coral reefs in the USVI since 2002 using standard benthic and reef fish assessment techniques (Smith et al. 2012). TCRMP sites occur across a range of habitat types and include 33 sites (Figure 1) – 19 sites at St. Thomas (STT) and St. John (STJ) and 14 sites at St. Croix (STX) – that range from 5 to 45m in depth. Reef types included nearshore shallow (5 - 15 m depth), offshore (15 - 30 m depth) and mesophotic (30 - 45 m depth). Roving fish surveys conducted at each site consisted of two 30 minute surveys for sites less than 30 m or four 15 minute surveys for sites greater then 30 m depth. We also conducted ten 25 x 4 m belt transects at each site. The mean number of lionfish sighted per year in roving surveys was calculated as well as the rate of increase for the territory and shelf (STT/STJ and STX shelf). Kruskal-Wallis test on transect data was used to test for effects of reef type on lionfish density from 2011 to 2014 and Dunn's pairwise comparison test examined differences among reef types.

RESULTS

Lionfish were first observed on roving dives at the TCMRP sites in 2010 in STX and 2011 in STT/STJ, two years after the first sightings were reported from each island, respectively. By 2012, lionfish sightings increased nearly 200% for STT and STJ John while STX had a decrease of 61% (Figure 2). A total of 152 lionfish were recorded on the TCRMP sites (STT/STJ: n = 95 and STX: n = 57) with 73 lionfish recorded during roving and 79 recorded on transects. In St. Croix, lionfish were seen on 15% of the sites in 2010, 50% of the sites in 2011, and 58% of the sites in 2012. In St. Thomas, no lionfish were seen in 2010, but lionfish were seen on 26% of the sites in 2011 and 68% of the sites in 2012. From 2011 to 2014, significantly higher lionfish densities have been found on mesophotic reef sites (5.9 ± 0.01 s.e./100m^2) than on offshore (1.3 ± 0.001 s.e./100m^2) and nearshore (0.4 ± 0.001 s.e. /100m^2) sites ($H = 20.21$, d.f. = 2, $p < 0.001$; Figure 3).

DISCUSSION

Lionfish have been observed in a wide range of depths from less than 5 m to over 50m in their native range (Fishelson 1975). In the Atlantic, however, they have been found greater than 300 m deep (Albins and Hixon 2011). In the USVI the largest increases in lionfish numbers have been occurring on MCE sites 30 - 65 m depth. Long-term monitoring of lionfish populations showed an initial rapid increase over the course of three years followed by a leveling off or slight decline followed by another increase. The initial decline may have been due to lionfish reaching their carrying capacity or may have resulted from removal efforts by divers (Green et al. 2014). The differential impact of the lionfish removal at shallow sites versus MCE sites is already apparent in monitoring data from the USVI. Fixed site monitoring at all TCRMP sites showed expansion of lionfish to new sites and an increase in their numbers between 2011 and 2014. At shallow sites where removals by divers were occurring, lionfish abundances were lower or absent by 2013 and have remained low in 2014. In contrast, MCE sites showed either the same level or an increase in lionfish abundance between 2012 and 2014. Clearly, different strategies for lionfish control are needed in areas such as MCE. The rapid increase of lionfish in mesophotic reefs can potentially reduce native Caribbean reef fish populations, especially ecologically important reef fish (Bejarano 2014). Species, like herbivores, are essential for the success of reefs by controlling the growth of algae on corals (Mumby et al. 2006). Albins and Hixon (2008) showed that lionfish reduced fish recruitment by nearly 80% on Bahamian patch reefs. Considering lionfish use of MCE and their capacity to reduce native fish recruitment, it is likely that lionfish will have an adverse effect on local fisheries in the future since most fishing effort takes place on offshore and MCE reefs. In order to understand the magnitude of lionfish abundance and the impact on MCE reef populations, more quantitative data is needed.

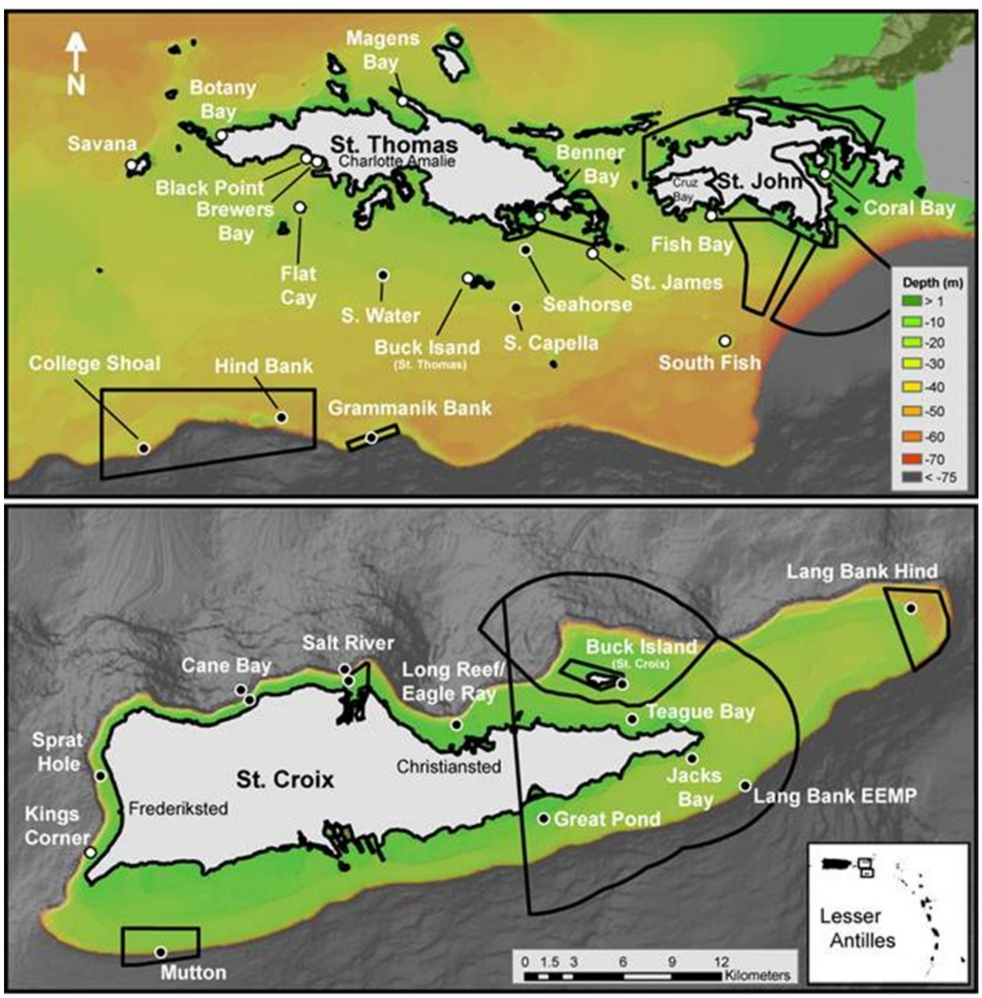

Figure 1. Map of Territorial Coral Reef Monitoring sites on St. Thomas, St. John and St. Croix.

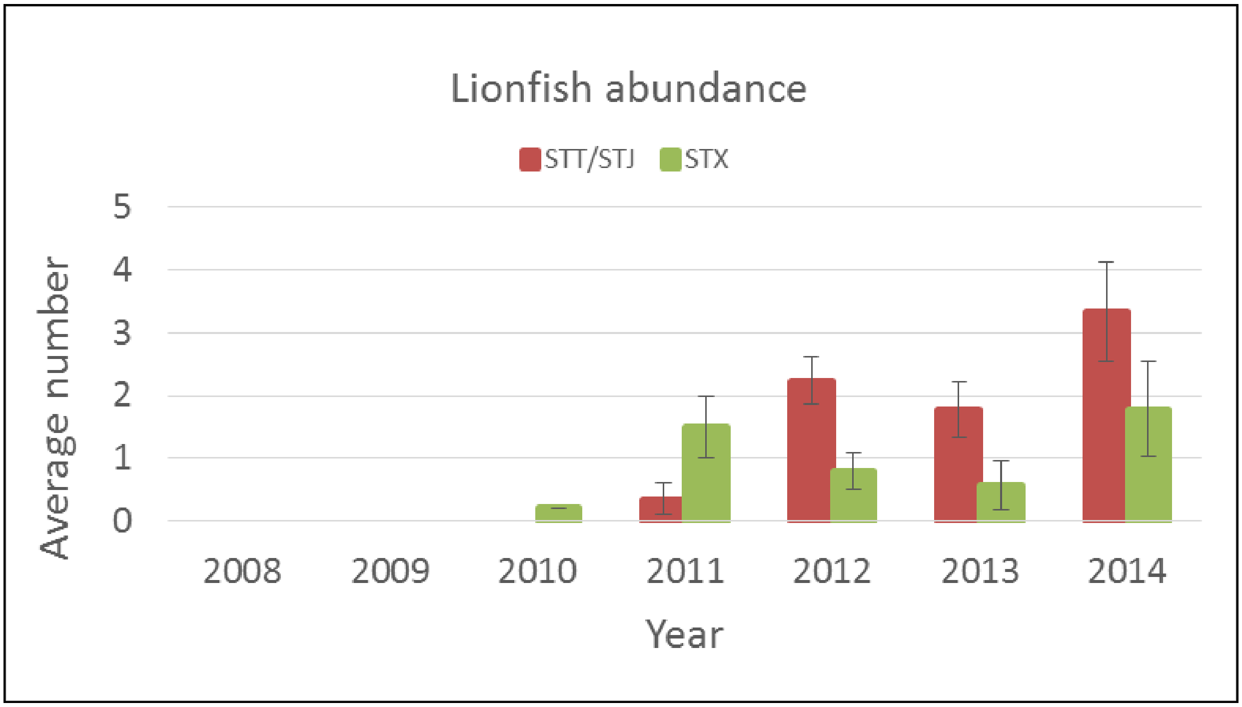

Figure 2. Mean number of lionfish seen during roving dives at TCRMP sites (± SEM) in St. Thomas/St. John (STT/STJ) and St. Croix (STX)

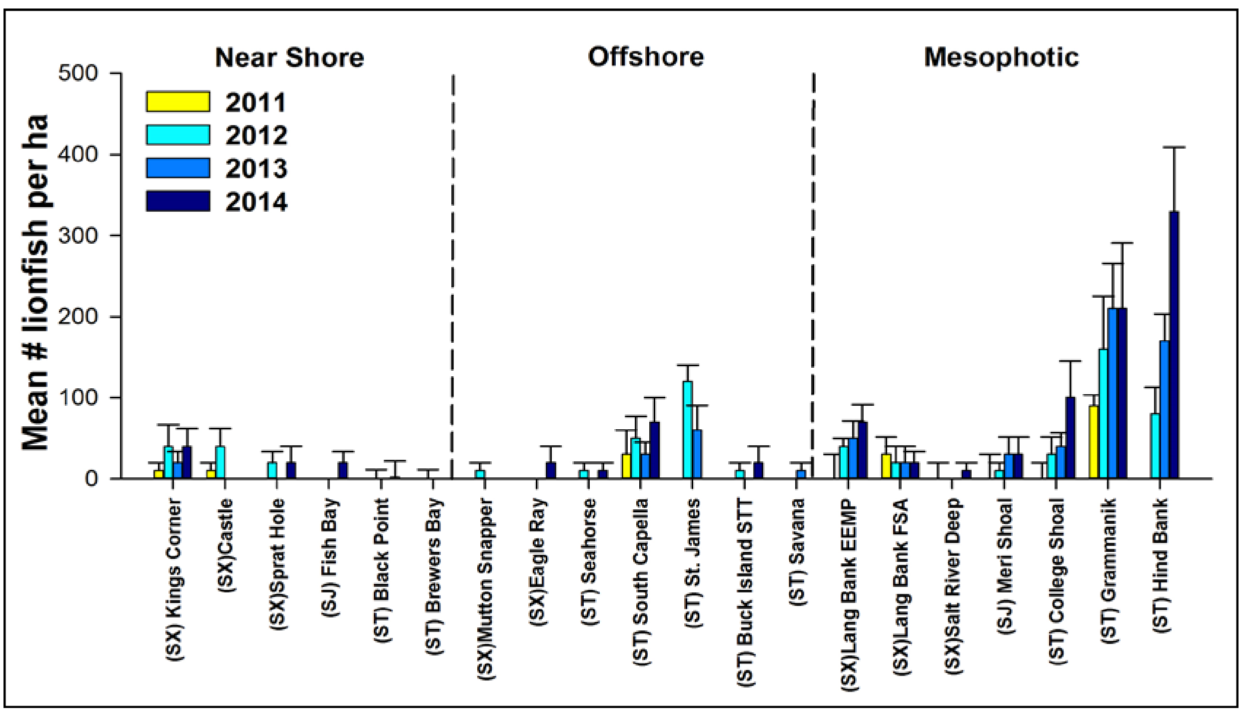

Figure 3. Densities (± SE) of lionfish observed in transects at Territorial Coral Reef Monitoring Program (TCRMP) sites in years 2011 – 2014 (n = 10 transects per site per year). Letters in parentheses indicate the island associated with each site: St. Croix = SX, St. John = SJ, and St. Thomas = ST.

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