

**Regional synthesis of invasive lionfish citizen science programs in the Tropical Western Atlantic**  
**Síntesis regional de programas de ciencia ciudadana sobre el pez león invasor en el Atlántico occidental tropical**  
**Synthèse régionale des programmes scientifiques citoyens envahissants du poisson-lion dans l'Atlantique occidental tropical**

PHILIP KARP,<sup>1</sup> FADILAH Z. ALI<sup>2</sup>, KAYLIN R. CLEMENTS<sup>3</sup>, ALEXANDER Q. FOGG<sup>4</sup>, HOLDEN E. HARRIS<sup>5</sup>

<sup>1</sup>7700 East Gainey Ranch Road, Scottsdale, AZ 85258 United States [pkarp24@gmail.com](mailto:pkarp24@gmail.com)

<sup>2</sup>Gulf and Caribbean Fisheries Institute Gulf and Caribbean Fisheries Institute 2796 Overseas Highway, Ste. 119  
Marathon Florida 33050 United States [fadilah.ali@gcfi.org](mailto:fadilah.ali@gcfi.org)

<sup>3</sup>Human Dimensions of Natural Resources, Colorado State University 1001 Amy Van Dyken Way, Fort Collins, CO 80523  
United States [kaylinrclements@gmail.com](mailto:kaylinrclements@gmail.com)

<sup>4</sup>Destin - Fort Walton Beach Okaloosa County Board of County Commissioners 1540 Miracle Strip Pkwy SE Fort Walton  
Beach FL 32548 United States [afogg@myokaloosa.com](mailto:afogg@myokaloosa.com)

<sup>5</sup>Nature Coast Biological Station, Institute of Food and Agriculture Sciences, University of Florida 1604 McCarty Dr #1008  
Gainesville Florida 32603 United States [holdenharris@ufl.edu](mailto:holdenharris@ufl.edu)

**EXTENDED ABSTRACT**

The spatial scale of marine ecosystems severely limits our capacity to monitor the distributions of organisms in time and space. Consequently, invasive species and their consequent impacts remain largely unrecorded (Azzurro et al. 2013). There remain major challenges to develop methods to control invasive species efficiently and effectively and avert their social, economic and ecological impacts (Crall et al. 2010). In particular, research in marine systems is often restrained by monetary, spatial and temporal constraints as well as the availability of human resources (Danielsen et al. 2005, Crall et al. 2010). Increased utilization of “citizen science” in data collection and management (Lopez-Gomez et al. 2014) using non-specialist volunteers in scientifically focused studies (Kruger and Shannon 2000, Lopez-Gomez et al. 2014) has the potential to gather information at more extensive temporal and spatial scales (Tulloch et al. 2013) than could be otherwise achievable. Citizen scientists can assist in the early detection and control of invasive species (Delaney et al. 2008) since increased effort leads to higher likelihood of detection, especially when at lower abundance (Mehta et al. 2007, Lopez-Gomez et al. 2014). Citizen science can monitor the structure, distribution, behavior and dynamics of invasive species and their populations and contribute to their removal (Bodilis et al. 2014, Lopez-Gomez et al. 2014).

Invasive Indo-Pacific lionfish (*Pterois volitans* and *P. miles*) in the Western Atlantic Ocean are the most successful marine fish invasion (Côté et al. 2013; Cure et al. 2014). Lionfish superior life history characteristics such as generalist diet and habitat requirements, high reproductive output, feeding and growth rates, early maturation, year-round reproduction, and the lack of natural predators (Green and Côté 2014), and have had demonstrable effects on native species, fisheries, biodiversity, and ecosystem processes (Dahl et al. 2016, Kindinger & Albins 2017, Chagaris et al. 2020). Various management measures have been initiated (Morris et al. 2010) and there is evidence that negative impacts on local marine ecosystems can be mitigated through regular, site-specific removals (Green and Côté 2014, Chagaris et al. 2017). However, it is clear that effective management of this invasion is proving to be beyond the financial and human resource capacity of natural resource management agencies alone. Although complete eradication of lionfish remains highly unlikely, local control efforts have proven increasingly successful at reducing lionfish populations (Frazer et al., 2012, Côté et al. 2014, Lopez-Gomez et al. 2014, Green et al. 2017). The success of lionfish removal at the local level has been underpinned by the involvement of citizen scientists and volunteers, due primarily to increased detection and removal rates (de Leon et al. 2013, Lopez-Gomez et al. 2014, Green et al. 2017). In response, government entities and other groups throughout the Western Atlantic region have mobilized citizen groups, particularly SCUBA divers, to physically remove lionfish and to collect important data needed to manage the invasion (Morris 2012). Regional control will require high rates of fishing mortality throughout their invaded range (Barbour et al., 2011; Johnston and Purkis, 2015).

Lionfish citizen science and removal efforts to date have been accomplished by decentralized organizations and individuals throughout their invaded range. Previous studies have focused on selected individual country- or organization-specific initiatives. Here, we inventory initiatives of organizations from across the invaded range and synthesize their relative successes and challenges. Our upcoming study will implement a structured survey as well as semi-structured interviews with representatives from these organizations to assess engagement with citizen scientists, member composition, cooperation with local governments, financial support mechanisms, operations, objectives, and scientific involvement. We will categorize these operations based on their development, structure, and perceived effectiveness. Semi-structured interviews will focus on case studies that represent specific categories of initiatives, including (i) organized removal and awareness raising events; (ii) market-based approaches; (iii) volunteer and adventure tourism; (iv) culling programs; and (v) local and international awareness raising campaigns. We consider how lessons from lionfish programs in the Western

Atlantic can inform groups working on the novel invasion in the Mediterranean (Kletou et al. 2016, Ulman et al. 2020, Savva et al. 2020). Patterns from the broad emergence of lionfish citizen science initiatives and groups can increase public engagement-in and scientific impact-from other environmental citizen science programs.

**KEYWORDS:** Marine management, Invasive species, Citizen science, Caribbean

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