Dynamic Analysis of the Lionfish Diffusion in the Caribbean Sea and Development of a Policy Game

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Extended Abstract

Introduction & Problem Statement

The lionfish is one of the worst marine invaders of all time. The lack of predators and their rapid reproduction process lead them spread throughout the Caribbean Sea within only 30 years (USGS, 2016). The beautiful but dangerous lionfish highly influences the invaded areas: the diversity of reef fish declines rapidly and the whole ecosystem is disrupted (Green, Akins, Maljković & Côté, 2012). To fight the lionfish invasion, an understanding of its historic development is required.

Research Questions & Expected Contribution

The research aims to explain the rapid and successful diffusion of the lionfish in the Caribbean Sea and parts of the Atlantic Ocean. The explanatory model is complemented by a policy model and a simulation game. The policy model provides a dynamic framework for the discussion of potential countermeasures. The simulation game illustrate the importance of harmonized policies of interdependent decision makers in complex, interconnected ecological systems. The combination of the three models build a foundation for explaining, discussing and visualizing the problematic situation.

Methodology

The research is based on a literature review of lionfish monitoring data and population dynamics (Morris & Whitfield, 2009; Green et al., 2012; USGS, 2016). The model implements a dynamic hypothesis for the rapid diffusion between 2000 and 2015 based on the reference mode drawn from the data provided by USGS (2016). Policy suggestions from the research of Morris & James (2012) are discussed and their impact on the diffusion dynamics is investigated within a simplified policy model. Drawing upon the insights of the explanatory model and the policy model, a simulation game is created to create an interactive learning environment for the user.

Findings

The explanatory model considers the reproduction process and explains the mechanisms of the lionfish larval dispersal by natural water movements. The lionfish reproduces in an area from where its larvae is distributed to connected regions through currents. The high reproduction rate as well as the long delay of perceiving the regional invasion contributed to the fast diffusion in the Caribbean Sea.

The policy model discusses the impacts of three policy alternatives: increasing monitoring efforts, conducting scientific research and providing regional educational programs. Improved monitoring and regional harvesting programs could provide time and save the reefs until broader solutions through research are found. Research on the lionfish population claims that long-term manual removals can already have significant impact on the rehabilitation of the reef ecosystem (Green et al., 2012).

Planning local lionfish removal programs, the communication between regional neighbors and the harmonization of their efforts is essential for the effectiveness of the removals. The simulations of the policy model show how the diffusion from invaded areas counteracts the local reduction of lionfish. The policy game illustrate these insights in an interactive environment.

Conclusion & Discussion

The developed model provides a foundation for discussions of the lionfish diffusion and potential policy countermeasures. The number and diffusion of lionfish can be controlled through harmonized, effective policy measures. The awareness of the problematic situation increases throughout the last years, now actions need to be taken.

Further research is required to strengthen the understanding of the lionfish population dynamics, to extend the population dynamics and to implement additional policies within the model. The relevance of the model could further be increased by involving local stakeholders. Representing the perspectives and decisions of national marine managers, the model could be used as a support tool for policy-planning and harmonization between regions.

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