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Bioeconomic Modeling and Sustainable Management of Prey-Predator Dynamics: A Case Study of Blackspot Seabream and Portuguese Dogfish under Fear and Refuge Effects

Communication Info

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Abstract

This study investigates the complex dynamics of deep-sea ecosystems by focusing on the interaction between the Blackspot Seabream (Pagellus bogaraveo) and the Portuguese Dogfish (Centroscymnus coelolepis). We develop a nonlinear mathematical model that incorporates two critical ecological factors: the cost of fear, which reduces the prey's birth rate, and the presence of physical refuges that protect a portion of the prey population from predation [1]. The model also accounts for the predator's ability to utilize alternative resources, ensuring biological realism even when the primary prey is scarce [2]. Qualitative analysis confirms the positivity and boundedness of solutions, while stability analysis identifies the conditions under which both species can coexist sustainably [3]. By integrating bioeconomic parameters, we evaluate the impact of fishing efforts and market fluctuations on population biomass and total revenue. Our findings reveal that higher refuge availability and the stabilizing influence of fear are essential for maintaining ecosystem resilience [4]. The results suggest that sustainable management of these commercially valuable species requires adaptive strategies that protect essential habitats and maintain predator-prey balance in the face of increasing human pressure [5].

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