Título: AN EVALUATION OF INTERNATIONAL POLICIES AND LOCAL MANAGEMENT STRATEGIES TO REDUCE MARINE MAMMAL BYCATCH

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Resumen: Bycatch, the incidental capture of non-target species in active fishing gear, is the most significant human threat to coastal marine mammals and a severe conservation problem. Some species face extinction from unsustainable rates of capture and removal by fisheries. Characterizing the effects of bycatch through space and time is similar to finding a needle in a haystack: relatively small populations and limited interactions with dispersed fishing vessels. The behaviors of both parties are unpredictable, and therefore a challenge for researchers to collect data and managers to effectively manage. Bycatch impacts to marine species are difficult to observe and quantify, particularly in small-scale fisheries (SSF) where data on fishing effort and marine mammal abundance and distribution are often limited. Further adding to the problem, a lack of risk frameworks that can integrate and visualize existing datasets has hindered the ability to describe and quantify bycatch risk.

This is a knowledge gap worth exploring because ocean data and the systems developed to monitor marine ecosystems are now more sophisticated and cheaper to deploy.

The guiding question of this thesis is: how can we better leverage existing data to characterize the likelihood of bycatch and its consequences to marine mammal populations? When working in developing countries or at local scales these data are often inaccessible, of low quality, or dispersed among multiple sources. Therefore, I investigate how a participatory management tool that combines stakeholder engagement with geospatial analysis can be applied to characterize the distribution of fishing effort, marine mammal species, and their interaction rates (Chapter 2). I build temporally stratified models to estimate dolphin distribution and infer seasonal habitat importance (Chapter 3). Finally, I conduct three case studies with transboundary fishing fleets and high rates of cetacean bycatch to analyze how well current legal instruments to monitor and protect vulnerable species are performing in the United States and European Union (Chapter 4). Overall, I aim to increase data availability and quality in marine mammal conservation research through community involvement, stakeholder review, and revision that turns existing information into action.

I report three interrelated avenues of research in this thesis. First, I describe the design and application of a new fisheries management tool built specifically to analyze bycatch in data-limited fisheries, the Bycatch Risk Assessment (ByRA). Using marine mammals in Malaysia and Vietnam as test cases, I assess the risks posed to Irrawaddy dolphins (Orcaella brevirostris) and dugongs (Dugong dugon) by five SSF gear types (hook and line, nets, longlines, pots and traps, and trawls). The evaluation of each species-gear interaction proceeds as three steps: (1) map the distribution of fishing activities and marine mammals, often drawing on species distribution models; (2) score interaction rates guided by primary and secondary data sources, including field observations, literature review, and expert opinion; and (3) estimate bycatch risk, with data inputs and model assumptions communicated.

Second, a more detailed understanding of marine mammal habitat preferences and distribution can aid in the identification of areas to target for monitoring and conservation, which is particularly challenging in data-limited nations of Southeast Asia. Baseline knowledge on dolphin distribution can guide regional conservation efforts considering the seasonality of the species and supporting the design of tailored management strategies that address specific threats. I test the hypothesis that accurate seasonal habitat models, relying on environmental data and species occurrences alone, can be used to describe the ecological processes governing abundance for the resident Irrawaddy dolphin population of the Kep Archipelago, Cambodia.

Finally, fisheries bycatch is an underreported and largely unregulated threat to marine mammals worldwide. In the United States (U.S.) and European Union (E.U.), however, the conservation of small cetaceans is prioritized through regulations, policy directives, and international agreements. A review of the bycatch situation for common dolphins (Delphinus delphis) in the Bay of Biscay and harbor porpoises (Phocoena phocoena) of the Baltic Proper and U.S. Gulf of Maine highlights management strategies identified to monitor, research, and mitigate bycatch and specific conditions that enable or límit conservation policy implementation.

The methodological approach aims to meet a critical need of fisheries managers: to identify emergent interaction patterns between fishing gears and marine mammals and support the development of management actions that can lead to sustainable fisheries and mitigate bycatch risk for species of conservation concern. Community-led

research involving fishers and other stakeholders can access latent knowledge and support the design and implementation of policies designed to monitor (e.g., onboard observers, abundance surveys), mitigate, and report bycatch required by law. Altogether, I leverage existing knowledge and participatory engagement to garner new insights about complex species-fishery interactions and systematically screen large areas and data-limited fisheries. Insights from each case serve as a foundation for future bycatch assessments that can address data insufficiencies, guide future monitoring to areas and seasons of greatest concern, and involve key sectors in a policy implementation process that considers marine fisheries and biodiversity conservation objectives.