Opinion Article

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Insights in Aquaculture and Biotechnology

2023
Vol.7 No.2:57

Impact on Gillnet Size Selectivity of Shark and Ray Species

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Received date: May 02, 2023, Manuscript No. IPIAB-23-17372; **Editor assigned date:** May 04, 2023, PreQC No. IPIAB-23-17372 (PQ); **Reviewed date:** May 18, 2023, QC No. IPIAB-23-17372; **Revised date:** May 25, 2023, Manuscript No. IPIAB-23-17372 (R); **Published date:** June 01, 2023, DOI: 10.36648/Ipiab.7.2.57

Citation: Hohlman C (2023) Impact on Gillnet Size Selectivity of Shark and Ray Species. Insights Aquac Cult Biotechnol Vol.7 No. 2: 57.

Introduction

Gillnets are widely used fishing gears that have been known to unintentionally capture and harm non-target species, including sharks and rays. The size selectivity of gillnets plays a crucial role in determining which species are captured, their size composition, and the potential impact on their populations. This article delves into the complex issue of gillnet size selectivity in relation to shark and ray species, highlighting its implications for conservation efforts and sustainable fisheries management.

Global elasmobranch (shark and ray) catches that exceed sustainable levels have resulted in more than 37% of species being listed as threatened globally. These declines have occurred because of a lack of, or ineffective, management of most stocks, despite the demonstrated potential for some species to be fished sustainably. Sharks and rays are especially susceptible to overfishing because they have k-selected life history strategies (low fecundity, late maturing, and slow growing), that limits their ability to sustain removals or recover from depletion. However, using size selectivity can enhance sustainable outcomes to overcome some life history limitations. For example, limiting catch to sexually immature individuals can facilitate a gauntlet effect, to help sustain populations by enabling adults to continue to breed without significant fishing pressure, thereby ensuring ongoing recruitment. Thus, in addition to adjusting fishing efforts or catches to achieve sustainable harvest, size selectivity of fishing gear can be used to control the size and maturity of animals caught, and hence contribute to sustainability.

Gillnet Size Selectivity

Increases in shark landings in the early 2000s led to rising concerns over shark exploitation within the Great Barrier Reef World Heritage Area, with most sharks and rays caught in gillnet fisheries of the Queensland East Coast Inshore Finfish Fishery (ECIFF). The fishery's main target species are barramundi, threadfin salmon, mackerels, and tropical sharks. Target shark species include the blacktip shark complex (Carcharhinus limbatus and C. tilstoni) and spottail shark (Carcharhinus sorrah), but at least another 27 shark and 14 ray species are also captured. From 2006 to 2021, a 600 t competitive total allowable catch in the fishery was divided between two zones, although this limit has not been reached in recent years. In late 2021, the TAC was reduced to 400 t across five zones but excluded hammerhead sharks that were managed separately. Requiem sharks (family Carcharhinidae) were the largest component of the catch in this fishery and were some of the most at-risk species, which suggested one risk mitigation strategy to use smaller mesh sizes to target smaller (younger) individuals of larger species (the gauntlet approach, The ECIFF does not currently specify mesh sizes of gillnets for the fishery, although they do specify a maximum mesh size permissible (8-inch stretch mesh) (Australian Government Department of the Environment and Energy). Thus, stricter specifications of mesh size in the ECIFF could enhance the sustainability of target species and reduce unwanted bycatch. However, data on the size selectivity of gillnets for the species in question are required.

Experimental studies involving multiple panel gillnets of varying mesh sizes can be used to collect size data to fit size selectivity models. These models reveal the probability of capture of a particular species length class given certain mesh sizes of gillnets and can be used to determine mesh size to optimize catches at sustainable levels. Despite the usefulness of these types of studies, only nine studies of gillnet mesh selectivity of sharks and one on rays have been published. These studies reveal similarities in selectivity parameters and suggest species with similar morphology within the same genus have similar size selectivities. Additionally, knowledge of size selectivity for bycatch species can aid in gear modifications to reduce bycatch, as demonstrated by Thorpe and Frierson for reduction in Carcharhinus limbatus catches. Creating size selectivity models for target and bycatch species can improve management and promote sustainability of a broad range of species.

Sustainable Fisheries Management

Given the potential benefits of adjusting gillnet sizes to improve the sustainability of sharks and rays caught in the Queensland ECIFF, we estimated size selectivity parameters for a range of target and bycatch species. We used data collected during observer studies on commercial gillnet vessels using a variety of mesh sizes to estimate selectivity parameters for use in stock assessments and ecological risk assessments to evaluate optimal mesh sizes for the fishery. Multi-panel gillnets were not used to collect the data, rather the use of different mesh sizes by fishers was the basis for data collection. This enabled the

testing of whether size selection parameters could be estimated using a less structured approach to sampling. By comparing the results to other similar studies of sharks and rays, we were able to test if the results from this approach were similar to those from specialized nets and also to identify patterns in selectivity parameters that may allow inference to other species for which experimental studies have not been performed.