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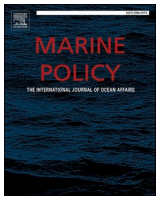

Reconsidering the longline ban in the Galapagos Marine Reserve

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ABSTRACT

In 2000, longline fishing was banned inside the Galapagos Marine Reserve to prevent illegal fishing of sharks and bycatch of endangered, threatened, and protected (ETP) species. Despite local management institutions possess one of the most sophisticated control and surveillance systems in the Eastern Tropical Central Pacific, statistical and anecdotic evidence suggest the longline ban has been ineffective in eradicating illegal, unreported and unregulated (IUU) fishing for the last two decades. This short communication examines the legal, institutional, and socio-economic factors that have prevented the effective implementation of the longline ban and proposes an ecosystem approach to fisheries to maintain bycatch mortality rates below biologically based limits, facilitating the recovery of ETP species while safeguarding a sustainable development of the Galapagos small-scale tuna fishery. Significant investments in science, technology, and innovation are necessary to encourage gradual and adaptive improvements in fishing practices to reduce IUU fishing and bycatch.

The Galapagos Marine Reserve (GMR) represents one the most iconic multiple use marine protected areas of the world. In 2000, longlining inside the reserve was banned to prevent the illegal fishing of sharks and bycatch of endangered, threatened, and protected (ETP) species. Thanks to the support of international cooperation, local management institutions possess one of the most sophisticated control and surveillance systems in the Eastern Tropical Central Pacific [1]. Despite these advances, statistical and anecdotic evidence suggest that illegal longlining is a recurrent problem in the GMR, whose frequency has increased in recent years [2–5].

Several legal, institutional, and socioeconomic factors have prevented the effective implementation of the longline ban. One of the most relevant factors is the existence of loopholes in the legal framework, which prevent park rangers from apprehending offenders. Fishing regulations explicitly sanction the use of longlines, but not their transport and possession [3]. This legal vacuum makes it impossible to confiscate longlines in fishing ports, creating an opportunity for poaching on the high seas. Furthermore, although enforcement authorities monitor continuously the movement of the entire fishing fleet that operates inside and around the GMR, they lack a fishery observer program or an electronic monitoring system to verify the type of fishing gear used and species caught. In addition, control and surveillance operations have a limited effect due to the lack of follow-up on detected infringements and the limited prosecution of offenders [6].

Another relevant institutional weakness is the lack of an advanced information system to facilitate the systematization and analysis of control and surveillance data. Therefore, the availability, accessibility and transparency of information is quite limited. Consequently, there is a lack of comprehensive assessments on the effectiveness of control and surveillance activities to enforce the longline ban, including the conditions that facilitates the occurrence of illegal longlining inside the reserve.

Furthermore, there are no market incentives in place that encourage tuna fishing with more selective gear. The profitability of the Galapagos tuna fishery is based on quantity rather than quality [7]. Therefore, there are not local markets that pay a better price for longline-free tuna, discouraging the use of more selective gears. On the other hand, fishers' representatives claim that the longlining ban is illegitimate because it violates their fundamental right to work, reducing the level of compliance of this regulation [3].

The legitimacy of the longline ban has been affected by lack of conclusive studies on the social-ecological impact of this fishing gear in the GMR. Between 2000 and 2013, five research projects were conducted to assess the impact of longlining on ETP species (Fig. 1). The type of longline evaluated and the number of fishing trips and sets, among other factors, have varied over time. Therefore, the robustness, representativeness, and quality of the studies have been questioned by small-scale fishing sector's representatives and conservationist groups,

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affecting the legitimacy of the results [8].

In response to this governance crisis, the Governing Council of the Galapagos Special Regime (CGREG) approved a new research project in 2016 to evaluate the impact of vertical and horizontal midwater longlining in the Galapagos small-scale tuna fishery [9]. However, the completion of this study has been overdue for six years because lack of financial, political, and technical support. In consequence, the decision to ratify or repel the longline ban has been deferred for over 22 years, making it one of the most controversial issues facing the management of small-scale fisheries in the GMR.

Considering that the longlining ban has been ineffective in eradicating IUU fishing in the GMR for the last two decades [2–5], we suggest re-evaluating the feasibility and usefulness of this regulation to ensure the conservation of ETP species. International scientific research experience has shown operational changes, in combination with emerging technologies, spatiotemporal measures, and market incentives, represent effective solutions to ensure that longline tuna fisheries are developed profitably for fishers while minimizing their ecological impact on ETP species [10–12]. Therefore, we recommend implementing a wide range of complementary, science-based solutions to minimize ETP species bycatch across the reserve, while ensuring the eradication of IUU fishing and the sustainable development of the Galapagos small-scale tuna fishery. To this end, we suggest adopting an ecosystem approach to fisheries (EAF) to achieve a balance between diverse societal objectives by considering the knowledge, uncertainties, and interactions of biotic, abiotic, and human components of the social-ecological fishery system, within ecologically meaningful boundaries [13].

The decision support tool for integrated fisheries bycatch management developed by Gilman et al. [14] could facilitate the transition of the Galapagos small-scale fishery toward an EAF. Such methodological framework evaluates the efficacy of alternative bycatch mitigation strategies at achieving specific and measurable objectives and performance standards to minimize the incidental catch and mortality of ETP species, taking into consideration the feasibility, acceptability, and simplicity of implementation of each strategy, including the tradeoffs between bycatch minimization and target catch optimization objectives [14]. The process involves compiling a comprehensive dataset of mitigation measures for vulnerable bycatch species for a specific gear type, categorizing them based on predefined hierarchies, and involving stakeholders to plan and implement an integrated bycatch management framework [15]. The framework is periodically adapted based on performance assessments, updated ecological risk assessments, changes in the fishery, and new research findings to improve the efficacy of the decision support tool.

To adapt the decision support tool developed by Gilman et al. [14] for the Galapagos small-scale tuna fishery, we suggest following five basic steps described in Fig. 2. The first step is to characterize and assess the Galapagos small-scale tuna fishery to identify the improvements needed in the monitoring, surveillance and control system, and regulatory and legal framework, to address illegal longlining and to reduce incidental catch and mortality of ETP species inside the GMR (Fig. 2).

This performance assessment should include an evaluation of the social-ecological impacts generated by the longline ban, including a comprehensive assessment of the effectiveness of precautionary measures implemented by the Ecuadorian government to reduce the illegal and incidental catch of sharks and other migratory species within and beyond GMR's boundaries. The measures include a marine zoning system with a network of no-take zones, a nationwide ban on shark fishing and finning, regulation of shark bycatch marketing, and a new large-scale protected area called the "*Reserva Hermandad*", located on the northeast side of the Insular Exclusive Economic Zone of Ecuador, where small and large-scale longlining is prohibited (Fig. 1).

During the second step, we suggest conducting an ERA to determine whether the regulated use of longline, and alternative fishing gears, would cause significant risk of severe or irreversible harm to ETP species (Fig. 2). The ERA should assess the potential adverse ecological effects of human activities and natural stressors on different species and their habitats [14]. It considers the magnitude and likelihood of harm caused by these stressors to determine the level of risk to the environment. This ERA should also assess the sustainability of fishing practices because reference points are not available due to limited data on bycatch species [3,8]. This analytical approach could be primarily implemented in the GRM using qualitative methods driven by expert opinion until more data-intensive quantitative models that consider spatially explicit population dynamics could be developed [14]. By considering the potential ecological risks of different fishing gears and stressors, the ERA can inform better decision-making towards achieving sustainable fishing practices that minimize harm to the environment, and findings be used to prioritize fishery- and species-specific research programs and/or mitigation measures to keep the incidental catch of ETP species within

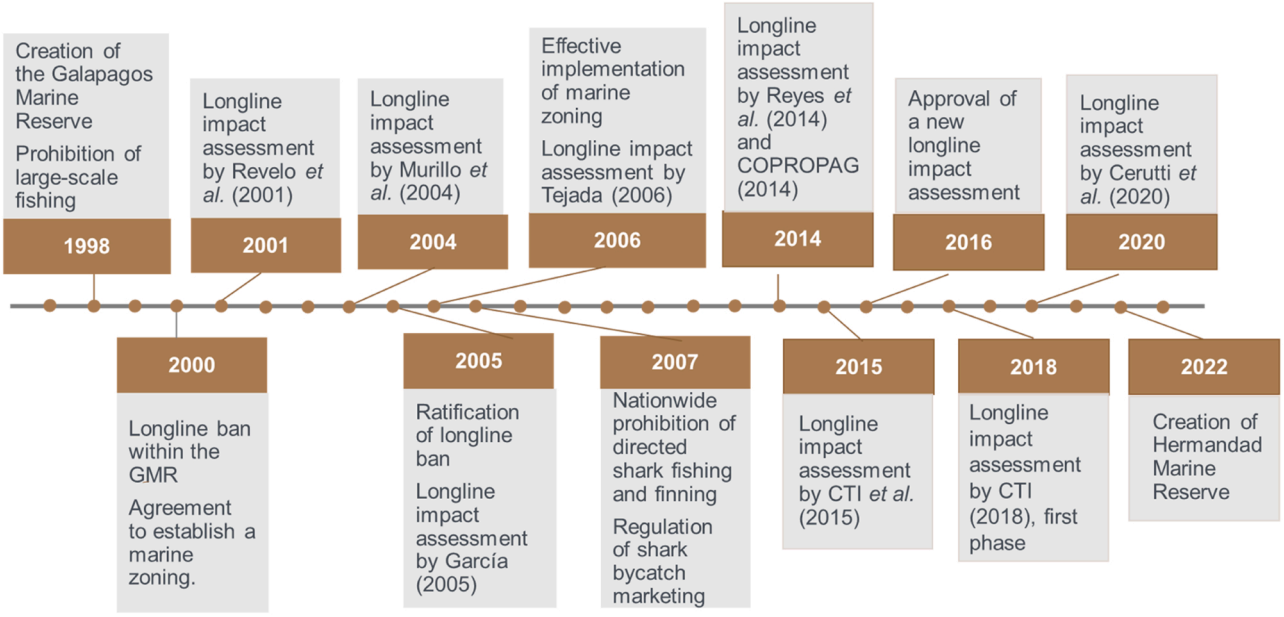

Fig. 1. Historical milestones that influence the regulation of longline tuna fishing and the conservation of endangered, threatened, and protected species in the Galapagos Marine Reserve from 1998 to 2022.

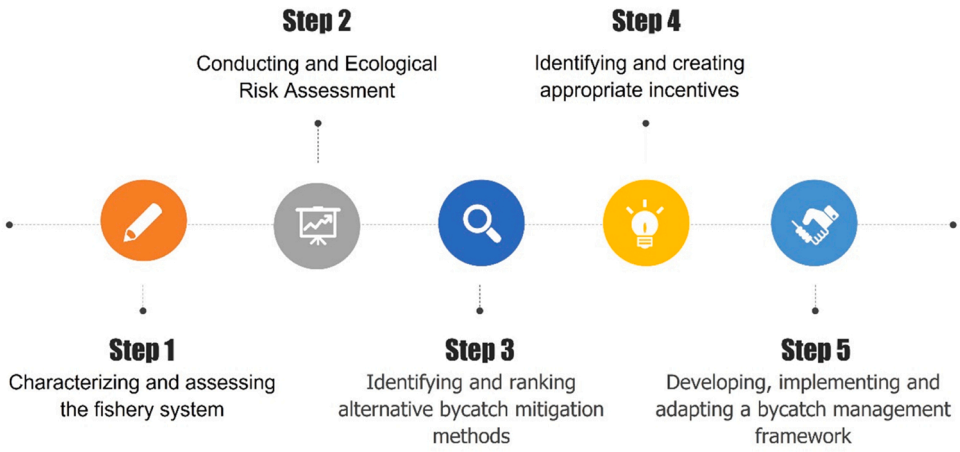

Fig. 2. Decision support tool for integrated fisheries bycatch management proposed to facilitate the transition of the Galapagos small-scale fishery toward an ecosystem approach to fisheries.
Adapted from Gilman et al. [14].

ecologically meaningful boundaries [14,16].

The proposed third stage involves conducting a systematic and unbiased literature review of existing bycatch mitigation methods for longline and other alternative fishing gears (Fig. 2). The most effective mitigation measures to minimize the risk of incidental catch and discard of sharks, the main taxonomic group affected by longlining in the GMR [11], include deep sets, reduced soak time, avoiding wire leader, and hook and bait changes [10]. Circle hooks, night sets, line weighting, bird-scaring lines, and hook-shielding and bird exclusion devices are also effective to reduce the incidental catch of marine turtles and seabirds [10–12,17]. Other bycatch mitigation measures, such as dynamic time and area closures [18], and the adoption of more selective fishing gears (e.g., green sticks and harpoons) could also be included [11,15].

For each bycatch mitigation method, and combinations of methods, the decision tool could be useful to evaluate and rank their efficacy, economic viability, practicality, safety, and ability to facilitate compliance monitoring, as well as cross-taxa conflicts resulting from each method, and the potential negative impacts on non-target species or the broader ecosystem [14,15]. Then, the top-ranked bycatch mitigation methods could be identified and subjected to experimental testing during the fifth stage to determine their effectiveness in reducing bycatch while maintaining a profitable and sustainable fishery. By incorporating a comprehensive evaluation of different bycatch mitigation methods, this process can help to identify the most effective, practical, and sustainable solutions for reducing bycatch in the Galapagos small-scale tuna fishery.

In the fourth stage, we propose identifying appropriate incentives to encourage the gradual and adaptive introduction of fishing practices to reduce bycatch and IUU fishing in the GMR (Fig. 2). This could imply the development of market incentives, such as social enterprises and a voluntary ecolabelling program, or certification of origin scheme, to encourage fishers to adopt cutting-edge monitoring, control, and traceability technology from the hook to the final consumer. A complementary set of incentives could be used to reward fishers for reducing bycatch through cash or in-kind benefits or penalizing them for failing to meet a performance standard for minimizing bycatch (e.g., bycatch quota per vessel) through taxes or in-kind sanctions (e.g., reduction of fishing days or withdrawal of fishing licenses) [19].

The development and implementation of a bycatch management framework represents the fifth step of the decision process (Fig. 2). During this stage, a participatory decision tool (e.g., multi-criterion decision analysis, conjoint analysis, and choice-based survey approaches) to define goals, objectives, and performance standards, based on the information compiled in the previous stages [14]. The participatory bycatch management framework should define the management actions and milestones that could be implemented to meet the objectives agreed upon. This could imply improvements in monitoring, surveillance and control systems, legal and regulatory framework amendments, and experimental testing of new fishing gears and other methods for bycatch mitigation. The bycatch management framework must include a workplan for implementing the actions and achieving each milestone, including a budget, source of funding and responsible for the implementation of each action agreed upon [14]. This bycatch management framework should be adapted by updated performance assessments and ERAs, which should be conducted periodically by impartial parties [15].

The decision support tool for integrated fisheries bycatch management outlined earlier will contribute to addressing illegal longlining in the GMR through an EAF approach. The primary goal is to maintain bycatch mortality rates below biologically based limits, facilitating the recovery of ETP species while safeguarding the sustainable development of the Galapagos small-scale tuna fishery. However, to implement this fisheries management approach, significant investments in science, technology, and innovation are necessary to encourage gradual and adaptive improvements in fishing practices to reduce IUU fishing and bycatch within and beyond GMR boundaries.

Data availability

No data was used for the research described in the article.

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