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Data Limited Issue Toward Implementing Ecological Risk Assessment for Sea Turtles and a Proposal for Future Research Plans

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Abstract

In the context of the proposed revisions to sea turtle interaction data collection requirements under CMM 2018-04, this paper identifies key issues in currently available datasets and proposes improvements for scientifically robust sea turtle bycatch risk assessment. Logbook data carry significant uncertainty arising from species misidentification, underreporting, and inconsistent recording practices across vessels and fleets, limiting their reliability as a primary input to quantitative bycatch estimation and ecological risk assessment frameworks. Observer data coverage alone is not a sufficient determinant of analytical precision; datasets should integrate longline and purse seine records across multiple CCMs and broad spatial areas to improve statistical robustness at scientifically-sounds scale, supported by rigorous species-identification practices such as at-sea photo documentation followed by shore-based expert verification, as already implemented in the Japanese national observer program. Evaluating the efficacy of mitigation techniques such as circle hooks and bait substitution requires controlled, comparable experimental designs—using research vessels and cooperating observer-carrying vessels—rather than reliance on operational data collection alone. Finally, incorporating species-specific ecological information on sea turtle distribution, migration, and population/demographic status, following approaches already applied in seabird ecological risk assessment by other tuna RFMOs and in comparable sea turtle frameworks, can reduce uncertainty stemming from data-limited bycatch records. Building a scientifically defensible data collection framework for sea turtles therefore requires attention to data quality, study design, and ecological data integration, beyond simply expanding the list of reporting requirements.

1. Introduction

The CMM 2018-04 which is conservation and management of sea turtles in the WCPFC requires CCMs to report sea turtle interaction and mitigation data through Part 2 Annual Reports, ROP observer records, and shallow-set longline incident reports (paragraphs 2, 3, 5(b)-(c), 7(d)-(e)). The Science Committee has been continuing its discussion on whether additional data items related to this measure should be included as SciData. We argue that the scientific value of new reporting items depends heavily on the “purpose” for which the data will eventually be used, and on the statistical

characteristics of the underlying data collection process, and that these factors should be clearly evaluated before finalizing the requirements.

2. Statistical Limitations of Logbook-Derived Interaction Data

Logbook-derived data includes operational information (e.g., fishing date, time, and location) and catch information (e.g., species, number, and weight). are collected and reported through logbooks. These data are recorded by the master of vessel and are collected to provide information on fishing operations and catches for use as official catch and effort data in stock assessments and other fisheries science and management applications.

Logbook-based bycatch data are subject to well-documented sources of bias and variance inflation, including species misidentification (particularly among hard-shelled turtle species), non-reporting of discarded or released individuals, and inter-vessel heterogeneity in recording practice. These properties violate key assumptions underlying standard catch-per-unit-effort (CPUE) extrapolation methods and more sophisticated risk assessment frameworks, which require unbiased, taxonomically resolved interaction records as input. We recommend that the SC characterize the magnitude and direction of these biases—e.g., via comparison with paired observer records—before logbook data are treated as a primary input to bycatch estimation, and that any expanded logbook field be justified with reference to a specific estimator that will use it.

3. Design Considerations for Observer-Derived Datasets

Under the current WCPFC ROP minimum standard data fields, in addition to the information collected through the logbook, the gear attributes regarding the materials of mainline and branch line and hook type and size at a set level in longline fisheries and detailed FADs information in purse seine fisheries, information of bycaught sea turtles (e.g., species, number of bycaught, length of individual and release condition) and bycatch mitigation measures in both fisheries are also collected.

Statistical power and bias in observer-based bycatch rate estimation are governed jointly by sample size, spatial-temporal stratification, and identification accuracy—not by nominal coverage rate alone. Comparable assessment trials in ICCAT for terminal gear assessment and IOTC shark risk assessments have shown that combining observer records across multiple CCMs and fishing grounds substantially improves the spatial resolution and statistical robustness of bycatch-per-unit-effort (BPUE) estimates by species in spatio-temporal scales. We suggest that the SC prioritize (a) protocols for pooling multi-CCM, multi-fleet observer datasets at the spatial scale, and (b) standardized at-sea photographic documentation of bycaught individuals, followed by post-landing expert taxonomic verification—a practice already implemented in the Japanese national observer program—to reduce species-identification error rates in the resulting dataset.

4. Experimental Design for Evaluating Mitigation Efficacy

Attributing observed changes in interaction rates to specific mitigation measures, such as large circle hooks or finfish bait substitution referenced under paragraph 7(a), requires a comparative or quasi-experimental design with defined treatment and control conditions; retrospective analysis of aggregate operational data reported under paragraph 7(b) is generally insufficient to support causal inference, given confounding by area, season, target species, and vessel-level effects. We propose that the SC develop a standardized experimental protocol—implemented via research vessels and cooperating commercial vessels carrying trained observers—that specifies randomization or paired comparison of treatment conditions, minimum sample size, and reporting format, consistent with methods used to evaluate mitigation efficacy in other RFMO contexts.

In evaluating the effectiveness of mitigation measures, the following information should, at a minimum, be considered. In addition to the existing ROP minimum standard data fields and information on the mitigation measures applied, this includes sea surface temperature during the operations, branch line depth, hook and bait configuration, and information on the catch/bycatch species. Sea surface temperature should be considered because it strongly influences the distribution of many species, including sea turtles. Branch line depth and hook and bait configuration are important because their relationship with the depths at which sea turtle interaction occurs needs to be evaluated. Catch and bycatch species information is also necessary because both the positive and negative effects of sea turtle mitigation measures on other species should be considered.

5. Integration of Life-History and Distributional Data into Risk Assessment

Assessing the risks that fisheries pose to sea turtles is a fundamental component of ecosystem-based fisheries management. Bycatch of species such as sea turtles can lead to population decline even when target fish stocks are sustainably managed. Robust ecological risk assessments (ERAs) provide a scientific basis for identifying species at higher risk, prioritizing conservation and management actions, evaluating the effectiveness of bycatch mitigation measures, and supporting the sustainable use of marine resources.

Traditionally, the impacts of fisheries on sea turtles have been assessed by estimating the total number of individuals caught as bycatch from fishing effort and bycatch rates (CPUE). However, this approach alone is insufficient to adequately evaluate the impacts of fisheries on the populations of sea turtles (Hobday et al., 2011; Patrick et al., 2009; Angel et al., 2014). This is because the distribution of sea turtles subject to risk assessment is rarely uniform across fishing grounds, and, as these species are not the target of the fishery, their spatial distribution is often only weakly related, or entirely unrelated, to the distribution of fishing effort. Consequently, estimates based solely on fishing effort and bycatch rates may not accurately reflect the actual level of risk faced by a sea turtle.

Therefore, ecological risk assessments should incorporate not only data describing interactions

between fisheries and sea turtles, but also information on the population status, life-history characteristics, and ecological traits of the sea turtles concerned. Life-history traits, including longevity, age at maturity, clutch size, number of clutches, reproductive frequency, growth rate, and natural mortality, determine the resilience of populations to additional mortality caused by fisheries. Likewise, ecological traits, including habitat use, three-dimensional distribution in the water column, feeding ecology, and seasonal movements, influence the spatial and temporal overlap between species and fishing operations, as well as the probability of encounters with fishing gear. Incorporating these biological and ecological characteristics into ecological risk assessments enables more realistic evaluations of sea turtle vulnerability, facilitates the identification of areas and periods where bycatch risk is highest, and provides a scientific basis for designing more effective and efficient bycatch mitigation measures.

Integrating fisheries data with species-specific life-history and ecological information enables bycatch risk to be assessed in a more comprehensive and biologically realistic manner. Such an integrated approach improves the prioritization of vulnerable species, strengthens the scientific basis for conservation and management decisions, and contributes significantly to the development and evaluation of effective bycatch mitigation measures that support both biodiversity conservation and sustainable fisheries.

Quantitative ecological risk assessment frameworks already applied to CCSBT and partially WCPFC (CCSBT 2025; Peatman et al. 2019) seabird bycatch combine fishery-independent biological parameters—population productivity, distribution, and exposure to fishing effort—with bycatch records to reduce the variance associated with data-limited species. Comparable spatially explicit approaches, including the spatially explicit fisheries risk assessment (SEFRA; Ochi et al. 2018, Peatman et al. 2019, CCSBT 2025) approach, have been developed for sea birds in CCSBT contexts, using seasonal and spatial distribution, demographic, and exposure data as core inputs.

6. Suggested Recommendations

The SC recommends that:

- reporting requirements be revised based on an explicit assessment of whether each data element is usable for risk assessment on sea turtle bycatch and/or for evaluating the effectiveness of bycatch mitigation measures, rather than being added as a general reporting obligation;
- logbook-based data collection be treated as a lower priority relative to other data sources, given the statistical limitations, namely species misidentification, underreporting, and inconsistent recording practices;
- observer datasets be pooled across multiple fleets to improve spatio-temporal coverage for risk analysis, rather than relying on increases in nominal coverage alone;
- standardized identification protocols of sea turtle species be developed for observer programs,

which may include but are not limited to at-sea photographic documentation followed by shore-based expert verification;

- risk assessment models and mitigation efficacy verification frameworks for sea turtles be designed with reference to comparable approaches applied to other bycatch species and to relevant initiatives undertaken by other tuna RFMOs.

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