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Observer coverage for monitoring bycatch of seabirds and other ETP species in pelagic longline fisheries

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SUMMARY

Fisheries observers collect vital information for understanding interactions between fisheries, and seabirds and other endangered, threatened and protected species (ETP). This paper presents a review of the levels of observer coverage required to estimate and monitor both commonly and rarely bycaught ETP. Factors affecting the robustness of bycatch estimates and monitoring are also considered.

Among most Regional Fisheries Management Organisations managing tuna fisheries (tRFMOs), the required level of observer coverage is 5%. (Exceptions are 10% for the Commission for the Conservation of Southern Bluefin tuna, and 10% or 20% for some vessels under the International Commission for the Conservation of Atlantic Tunas). Despite wide recognition of the benefits of higher levels of coverage, required levels have not increased across tRFMOs in recent years. Coverage levels of 5 – 10% do not provide for a robust understanding of the nature and extent of ETP bycatch, e.g., captures of particularly rare species and trends in bycatch rates. Moreover, the required levels of observer coverage are often not met by Member States.

Overall, the current situation impedes effective fisheries management. To address this, monitoring coverage must be increased significantly from the levels that tRFMOs currently require. Increasing required coverage levels to 20% of fishing effort is a pragmatic step forward though higher levels should be targeted, in a timebound manner, to characterise interactions with rare species. In cases where members are not yet meeting tRFMO coverage requirements, addressing the barriers to implementation is urgent and critical.

Alongside improving coverage by human observers, it is recommended that tRFMOs continue to integrate electronic monitoring into their monitoring frameworks, and that this monitoring method becomes a routine part of fishing operations and culture.

Without increased monitoring, tRFMOs are unable to effectively manage the impacts of pelagic longline fisheries on ETP. Without effective fisheries management, the credibility of these organisations is undermined.

1. INTRODUCTION

Independent monitoring by observers is well recognized as an essential component of fisheries management (e.g. FAO 1995, UNFSA[1]). Globally, human observers are a mainstay of fisheries monitoring, often deployed alongside other monitoring tools (Flewwelling et al. 2002; Anonymous 2016). As well as supporting the management of target species catch, observer data can provide anaccurateunderstandingofthe effects of fishing on non-target species, including seabirds and other endangered, threatened and protected species (ETP) (FAO 2009; Lutchman 2014). Beyond the direct benefits that observer data provides for fisheries management, making observer information publicly available enables stakeholder confidence and trust in management regimes to grow (Ceo et al. 2012; Clark et al. 2015).

Diverse drivers typically influence observer coverage levels and objectives, such asinternational obligations (e.g. requirements of Regional Fisheries Management Organisations (RFMOs)), domestic legislation and policy (e.g. National Plans of Action – Seabirds), and best practice guidance (e.g. FAO 2009). For ETP for example, observer coverage may be intended to obtain basic information about whether ETP bycatch occurs in a fishery. Alternatively, sufficient observer data may be required to estimate bycatch rates, with a specific level of precision. Usually, observer programs are designed to span objectives that have inherently different demands in terms of the amount of coverage required, and how that coverage is allocated in space and time. For example, as well as quantifying catch, documenting compliance with mandatory fishery management measures is often a key element of programme design (Ceo et al. 2012).

Although seldom possible due to practical constraints, observer coverage would ideally be implemented such that the data collected are representative of the focal fleet(e.g. spatial and temporal fishing patterns, gear setups, bycatch mitigation used). Where operational practices change in an observer's presence ('observer effects', Babcock et al. 2003; Piasente et al. 2012), data collected are non-representative. The consequences of non-representative data collection include bias in estimates of bycatch rates. Non-random placement of observers also contributes to bias. These mathematical challenges are compounded when sample sizes are small (Babcock et al. 2003; Ferguson et al. 2017; Stock et al. 2019).

Characteristics of ETP interactions with fisheries also influence the level of coverage that is necessary to achieve some monitoring objectives. Each bycatch event may comprise a small number of individuals (e.g. one or two), through to much higher numbers of individuals (e.g. tens or hundreds). Some ETPspecies are caught more frequently than others (Brothers et al. 2010; Abraham et al. 2017). Higher coverage levels are required to detect the capture of rarely caught species and to develop robust bycatch estimates of specific precision for these species, compared to more commonly caught species. Similarly, higher coverage is also required to estimate(with comparable levels of precision)bycatch of a species that is caught in multiples very rarely, compared to a species caught in ones or twos more often (Babcock et al. 2003; Debski et al. 2016).

The purpose of this paper is to consider levels of observer coverage that meet different monitoring objectives for seabirds and other ETP interacting with pelagic longline fisheries[2]. Specifically, and focused on pelagic longline fisheries, this paper reviews:

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[1] United Nations Fish Stocks Agreement (Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks).

[2] This review does not consider unobserved or unobservable (cryptic) mortality of ETP.

- the quality, robustness, and constraints associated with information gathered on ETP bycatch from different levels of observer coverage
- observer coverage in place, and required, among Regional Fisheries Management Organisations managing tuna fisheries (tRFMOs), and,
- the application of electronic monitoring using on-vessel cameras to document ETP bycatch and risk factors associated with that bycatch.

Recommendations are provided to improve ETP bycatch monitoring, thereby enabling better management of pelagic longline fisheries.

3. OBSERVER COVERAGE FOR MONITORING OF ETP BYCATCH

3.1 Levels of coverage

The levels of observer coverage required to determine the nature and extent of ETP bycatch have been examined for a variety of fishing methods and fisheries, e.g. pelagic and demersal longline, trawl, purse seine (Babcock et al. 2003; Lawson 2006; Sànchez et al. 2007; Amandè et al. 2012; Debski and Pierre 2014; Wakefield et al. 2018). In general, and assuming observer monitoring is appropriately structured (e.g. such that data collected is representative (Babcock et al. 2003; Wanless and Small 2017)), coverage of 5% of fishing effort is likely be adequate for detecting whether ETP bycatch occurs in a fishery. However, coverage at 5%does not enable theestimation of bycatch rates with high levels of precision. Further, at such coverage levels,firm conclusions cannot be drawn about the full range of species beingbycaught (Babcock et al. 2003; Gilman et al. 2012; Wanless and Small 2017) andthe effects of bycatch on seabird populations are impossible to determine with confidence, even when other information is available (e.g. Richard and Abraham 2015; Abraham et al. 2017).

The accuracy of bycatch estimates increases exponentially as coverage levels increase to 20% of fishing effort (Lawson 2006). For example, at around 20% coverage, species that comprise 35% of the catch will be estimated within 10% of their actual catch level 90% of the time (Babcock et al. 2003). As coverage levels increase beyond 20%, the accuracy of bycatch estimates increases more slowly (Lawson 2006). An example of increased precision with increasing observer coverage is shown for New Zealand pelagic longline fisheries in Figure 1. In these fisheries, confidence intervals around seabird bycatch estimates are much more variable at lower levels ofobservercoverage.

To effectively monitor captures of species caught more rarely, higher levels of observer coverage are required. For example, for species that comprise <0.1% of the catch, more than 50% observer coverage is required to estimate captures within 10% of true levels 90% of the time (Babcock et al. 2003). The value of coverage levels at or close to 100% for documenting captures of particularly rare species is well recognised (Bravington et al. 2002; Lawson 2006; Debski et al. 2016; ICCAT 2018). In addition, monitoring 100% of fishing effort also addresses sampling issues such as representativeness. Monitoring regimes that include 100% observer coverage are already in place in some fisheries in which ETP of extremely high interest may be bycaught (e.g. sea turtles, Swimmer et al. 2017).

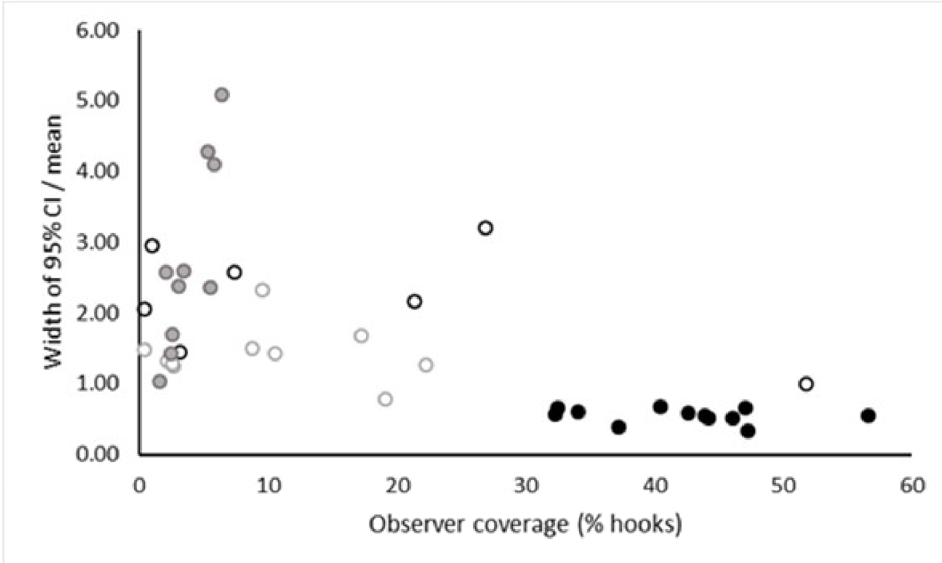

Figure 1. The ratio of the width of the 95% confidence interval to the mean of estimated seabird captures plotted against the percentage of observer coverage for New Zealand pelagic longline fisheries 2003-2014. Symbols relate to target species: Solid black = southern bluefin tuna, open black = albacore, solid grey = bigeye tuna, open grey = swordfish. (Source: Debski et al. 2016).

3.2 What is observed

Having an observer present on a vessel while fishing occurs is one step towards achieving effective monitoring. In practical terms, an observer cannot cover all parts of the fishing operation completely. For example, if the observer is located away from the hauling area during the longline haul (e.g. if they are measuring fish below deck), they are unlikely to detect all ETP captures on the hauled line. Therefore, understanding the part of the fishing cycle that observer data are sourced from (i.e. how much of the fishing effort is actively monitored, when, and at which stages of the fishing cycle) provides significant benefitsfor understanding and estimating captures.For example, knowing how many longline hooks the observer watched being retrieved during line hauling, and the times of day that those hooks were set and hauled,will improve the quality of bycatch estimates. Knowing when captures occur during the fishing cycle (e.g. set, soak, and haul, and the times of day when these stages took place) and how ETP are caught in the gear (e.g. hooked, entangled) will also inform the development of effective management and mitigation measures (Brothers 2010, 2016; Gilman et al. 2014; Pierre 2018a).

Given the benefits of clarity around how much fishing effort is actually monitored by observers, flexible definitions of how required coverage levels are met are unhelpful (e.g. effort defined as trips, days, vessels or hooks). These confound analyses(including comparisons among vessels that may be in the same fleet) and reduce the overall utility of data that are collected (Peatman et al. 2018; Williams et al. 2018a).

3.3 Implementation trade-offs

Before observer coverage is implemented at sea, practical matters such as the availability of observers, deployment costs, logistics, and health and safety of observers on vessels, must be reconciled. These issues affect fishing operations differently and often result in non-representative coverage. For example, smaller vessels may have difficulty accommodating observers and meeting safety standards, and their fishing schedules may frequently change at short notice (Kennelly 2016). Globally, these challenges for observer deployments are often reflected by small-vessel exclusions from observer requirements or lower levels of coverage on smaller compared to larger vessels. Nonetheless, small- and larger-vessel operations can both present significant bycatch risks to ETP (e.g. Richard and Abraham 2015) and so should be included in observer programmes.

Among tRFMO members, challenges to achieving representative observer coverage include:

- extremely large numbers of artisanal vessels (e.g. approximately 27,000 operating in Oman (IOTC 2015))
- balancing observer capacity requirements for monitoring of foreign-charter vessels with domestic vessels operating in the same fishery (e.g. New Zealand, Ministry for Primary Industries 2018)
- vessels making shorter trips when observers are aboard (e.g. Palau, Gilman and Zimring 2018)
- moving observers betweenvessels on the fishing grounds (e.g. CCSBT, SPRFMO Secretariat 2016), and,
- placementsbeing focusedon vessels willing to carry observers (Babcock et al. 2003), which may reflect a higher standard of fishing operation and a lower risk of ETP captures.

In most cases globally, observer coverage falls short of delivering a representative or comprehensive characterisation of ETP bycatch due to trade-offs between technical and practical issues. This is likely to compromise the management of fishery impacts on ETP.

4.CURRENTOBSERVER COVERAGE IN TUNA RFMOS

The challenge for Regional Fisheries Management Organisations is twofold:

- they must implement levels of observer coveragethat are sufficientto enable robust management of the fisheries in their purview, and,
- they must ensure that members deliver on requirements for observer coverage that are in place.

To date however, the level of observer coverage required among tRFMOs remains at 5 - 10% in almost all cases (Table 1). Further, smaller vessels may be excluded from these requirements. In addition,wherethe percentage of monitoring required may be delivered by defining fishing effort different ways (e.g. trips, fishing days, sets, or vessels with observers onboard), the resulting coverage is typicallyless than the specified percentage of actual hooks set (e.g. 5% coverage, Peatman et al. 2018; Williams et al. 2018a). Even if monitoring is deployed in a representative manner, 5 – 10% cannot be expectedto enable the characterisation of ETP interactions with high levels of precision.

Table 1. Observer coverage levels required or targeted in pelagic longline fisheries by Regional Fisheries Management Organisations (tRFMOs). CCSBT = Commission for the Conservation of Southern Bluefin Tuna, IATTC = Inter-American Tropical Tuna Commission, ICCAT = International Commission for the Conservation of Atlantic Tunas, IOTC = Indian Ocean Tuna Commission, WCPFC = Western and Central Pacific Fisheries Commission, CMM = Conservation and Management Measure

tRFMO	CCSBT	IATTC	ICCAT	IOTC	WCPFC
Coverage required	10%	5%, vessels > 20 m	5% 10% chartered vessels 20% bluefin tuna fishery, vessels > 15 m	5%, vessels > 24 m, vessels < 24 m outside their EEZ	5%
Source	CCSBT 2018b	Resolution C-11-08	Recommendations 13-14, 16-14, 17-07	Resolution 11/04	CMM 2018-05

While there are some members of tRFMOs reporting observer coverage at higher rates (Williams et al. 2016; CCSBT 2018a; IOTC Secretariat 2018), at a whole-of-RFMO level the delivery of coverage has been below required levels over time (CCSBT 2017a; IATTC 2017; ICCAT 2018; IOTC Secretariat 2018; Peatman et a. 2018). Two case studies illustrate this, from recent years of observer information reported to WCPFC and IOTC (Williams et al. 2016, 2018b; IOTC Secretariat 2018; Peatman et al. 2018):

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- Observers monitored 1 – 4.5% of longline hooks set (2003 – 2017)
- Coverage levels by member varied significantly (e.g. 0 – 27% of hooks)
- No consistent trend for increasing coverage over time, where the required 5% was not reported.

Indian Ocean Tuna Commission

- Observers monitored 0.08 – 1.1% of longline hooks set (2011 – 2017)
- Observer coverage of <1% of hooks in 75% of 107 member reports in that period
- No consistent trend for increasing coverage over time, where the required 5% was not reported.

As a consequence of the overall low levels of observer coverage, accurately estimating bycatch rates for ETP species across tRFMO areas is challenging or impossible. When estimates of ETP species catch rates are possible, they are typically associated with high levels of uncertainty. For example, in the WCPFC Convention Area, estimates of ETP bycatch in longline fisheries are associated with coefficients of variation of 60 – 350% for sea turtles, 40% for marine mammals, 7 – 90% for some shark species (Peatman et al. 2018), and 30 – 60% for preliminary estimates of bycatch of some seabird groups (Peatman and Smith 2018). In some cases, estimates cannot be made at all due to a lack of available or accessible data (e.g. seabird and sea turtle mortalities in ICCAT longline fisheries, ICCAT 2018).

The constraints that low levels of observer coverage impose on understanding and managing longline fishery impacts on ETP are well recognised among the tRFMO community. Approaches to addressing these constraints include using additional data sources to evaluate bycatch risks (e.g. distribution and population data), mathematical approaches that are suited to small datasets, and short-term intensive data collection by observers to build an understanding of ETP catch rates (IOTC Resolution 16/04; Komoroske and Lewison 2015; Ferguson et al. 2017). Further, there are calls among tRFMO participants and staff for increased levels of observer coverage. For example, discussions at both IATTC and ICCAT have included recommendations to increase observer coverage in longline fisheries to 20% (ICCAT 2016; IATTC 2017).

At this point in time, implementing even 5% observer coverage where it is required in pelagic longline fisheries managed by tRFMOs would provide a better, albeit very basic, understanding of ETP captures among data-poor fleets. Moving to 20% across all tRFMOs would enable bycatch to be estimated for more commonly caught ETP, and this level of coverage was identified as a minimum during tRFMO harmonisation work (Anonymous 2015). However, to understand the nature and extent of ETP bycatch (including rare species) and be effective in managing it well, much higher levels of coverage are required (such as 85% - 100%, see previous references). Therefore, work to increase observer coverage should retain such targets. Work among tRFMO members and groups with the capacity and capability to address barriers to increasing observer coverage must also remain a priority (e.g. IOTC 2015).

5. ELECTRONIC MONITORING OF ETP BYCATCH

Challenges with achieving representative observer coverage, the cost of observer programmes, the safety of observers at sea, and ever-increasing technological capabilities, have catalysed the investigation of remote electronic monitoring methods, including on-vessel cameras (e.g. Piasente et al. 2012; Hosken et al. 2016; NOAA 2016; Ruiz et al. 2015; SPC and FFA 2017; Zimring and Sweeney 2018). Camera-based electronic monitoring (EM) systems have been deployed in pilot and operational monitoring programmes across a range of fishing methods in the last 15 years, including in pelagic longline fisheries (Pierre 2018b). As a supplementary or alternative monitoring method to human observers, the potential of EM to deliver fisheries monitoring (including ETP interactions) is well-recognised among tRFMOs (CCSBT 2017b; Emery and Nicol 2017; Emery et al. 2018; IATTC 2018; Pierre 2018b).

In pelagic longline fisheries, data critical to understanding ETP interactions with pelagic longline fisheries can be collected using either EM or human observers (Emery et al. 2018; Gilman and Zimring 2018; Pierre 2018b). For example, with appropriate system setup, EM records imagery and associated information including set and haul characteristics (e.g. date, time, location, number of hooks), gear characteristics, ETP captures, use of some mitigation measures (e.g. tori lines, night-setting, blue-dyed bait), and actions taken to release ETP captured in fishing gear. Imagery review also enables an assessment of ETP life status on landing and release, and species (or species group) identification. Review of EM can readily be scaled, such that if 100% of fishing activity is recorded, anything up to 100% monitoring coverage can be achieved at review.

Given its monitoring capabilities, integrating EM into the legal and policy frameworks of tRFMOs and setting standards at the programme level are critical steps to mainstreaming this monitoring method (e.g. standards for EM processes, data, and quality assurance) (Pierre 2018b). Embedding EM as a part of the culture of fishing operations is equally important for its long-term success as a monitoring tool. Significant progress has already been made in some of these areas, including among regional bodies and tRFMOs (Pierre 2018b).

In addition to the benefits identified above, there is also an unprecedented opportunity for harmonisation across tRFMOs moving to adopt EM to monitor longline fisheries.

6. RECOMMENDATIONS

Human observers are a critical component of pelagic longline fisheries management regimes. Their work, and the implementation of complementary monitoring methods such as EM, are essential for enabling tRFMOs to manage the effects of pelagic longline fishing on ETP.

Monitoring must increase significantly in pelagic longline fisheries to understand the impacts of these fisheries on ETP and to inform management and bycatch mitigation approaches, noting that:

- monitoring levels close to 100% are necessary to reliably detect bycatch of particularly rare ETP and to estimate bycatch rates of these species with confidence
- requiring 20% coverage of fishing effort (defined as hooks set) could be practical as an initial timebound goal, with tRFMOs specifying their provisions to increase that over time in conservation measures
- as with current observer coverage, any increase in required monitoring effort should ideally be distributed among fleets in a representative manner (bearing in mind the practical constraints to this goal that inevitably apply)
- barriers to achieving monitoring requirements already set by tRFMOs must be addressed, and collaboration among RFMO members will be essential in that regard
- incentives for implementing increased levels of monitoring could be a useful catalyst for change, and warrant investigation
- EM can address many of the issues associated with human observer deployments, and consequently, should contribute significantly to achieving coverage goals in future, and,
- the benefits of better monitoring are clear, and this should be progressed by tRFMOs as a priority.

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