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Observer coverage to monitor seabird captures in demersal longline and trawl fisheries

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Purpose

The Roadmap for the Scientific Committee (Annex D of the Report on the Second Meeting of the Commission of SPRFMO) requests that the Scientific Committee evaluate the level and type of observer coverage that is recommended for demersal longline and trawl fisheries to provide a statistically reliable estimate of seabird mortality associated with that fishery. This paper reviews observer coverage in place in longline and trawl fisheries internationally, identifies limitations inherent in suboptimal levels of coverage, and provides guidance on levels of observer coverage appropriate to developing bycatch estimates for SPRFMO fisheries. Whilst this paper is focussed on seabirds, as tasked in the Roadmap, similar principles will apply to the consideration of observer coverage required to monitor the bycatch of other species of concern (e.g. marine mammals and reptiles).

Background

The deployment of independent fisheries observers is widely recognised as a key component of best practice fisheries management (e.g., FAO 1995, 2009). In addition to supporting the management of target catch, observer data is fundamental to assessments of the effects of fishing on non-target species, including seabirds, and the marine environment (e.g., Ministry for Primary Industries 2013a, b; Richard and Abraham 2013).

The proportion of fishing gear monitored by observers, the spread of observer coverage across vessels in a fleet, and the geographical and temporal spread of observer coverage across the fishing effort all have direct bearing on the robustness of any resultant understanding of bycatch patterns, including estimates of the extent of bycatch. Ensuring that the fishery management objectives or data needs to be addressed by observer coverage are matched by the delivery of appropriate levels of coverage is vital.

Observer coverage in other jurisdictions

Gilman et al. (2012) examined observer coverage across 12 regional fisheries management organisations (RFMOs)[1] in the context of the governance of fisheries bycatch and discards. Their review found that regional observer coverage rates varied from 0 – 87.5% on average, but that only about a quarter of the RFMO-managed fisheries had ≥5% coverage. Target or required percentages of coverage were typically stipulated in RFMO documentation (e.g., Western and Central Pacific Fisheries Commission[2]), with the data collected at sea sometimes being examined to assess whether the objectives of coverage were being met (e.g., Agnew et al. 2010). For one RFMO developing observer coverage including to monitor seabird bycatch, initial coverage levels of 25-30% across fleets have been recommended (Black et al. 2007).

As an alternative to achieving a prescribed proportion of coverage of fishing effort, some observer programmes are guided by the requirement to reach a target coefficient of variation (CV), that is, a specific level of accuracy in the estimated captures of protected species. For example, the National Working Group on Bycatch (Wigley et al. 2007) recommended that at-sea observation effort be tailored to reach a recommended precision goal of 20-30% CV for estimates of bycatch by species (or stock) in a fishery. Subsequently, a CV of 30% has been used for identifying the days of observer coverage required and for monitoring delivery of coverage (e.g., NOAA Fisheries 2011).

Efficacy of different levels of observer coverage

Observer coverage delivers the most complete suite of information when 100% of fishing effort is monitored. However, when full coverage is not achieved, limitations of the data collected must be recognised and information collected must be scaled up to fleet level as appropriately as possible. Given seabird bycatch is a statistically rare event, scaling up observer data creates mathematical challenges, as well as accuracy issues. For example, captures of rare species are more likely to be missed when coverage levels are lower and confidence in the bycatch estimates generated is inherently lower. It must also be noted that observer coverage levels for seabird bycatch generally refer to the percentage of gear retrieved observed, and not simply the percentage of vessels or trips observed. For example, on longline vessels the haul may last several hours, and even when an observer is onboard, only a proportion of hooks haul may actually be observed due to competing demands on the observer or rest breaks. Similarly, on trawl vessels that fish 24 hours a day it is possible that not all trawl hauls will be observed even if an observer is onboard.

In general, observer coverage of 5% of fishing effort may be adequate for information collection to identify the existence of some bycatch issues, but is inadequate to monitor the frequency of bycatch species' interactions with fishing gear (Gilman et al. 2012). Exponential increases in the accuracy of bycatch estimates occur as observer coverage levels increase to around 20% of fishing effort (Lawson 2006). At that level of coverage, species comprising 35% of the catch will be estimated within 10% of their actual catch level 90% of the time (Babcock et al. 2003). For seabirds caught in CCAMLR demersal longline fisheries, 25% coverage has been considered broadly adequate to detect increases in bycatch when birds are captured at rates of around 0.2 birds/1000 hooks (Ashford 2002).

Beyond observer coverage of around 20% of fishing effort, increases in the accuracy of bycatch estimates are accrued at slower rates (Lawson 2006). However, the need for higher rates of coverage to detect the capture of rare species, and to estimate the levels of captures of species that

[1] For this analysis, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was included alongside RMFOs.
[2] http://www.wcpfc.int/system/files/ROP%20Standards%20.pdf

rarely interact with fishing gear, is well recognised. Where species comprising <0.1% of the catch interact with fishing gear, more than 50% observer coverage was required to estimate captures within 10% of true levels 90% of the time (Babcock et al. 2003). Where species and interactions are especially rare, the need for coverage levels of close to 100% has been recognised (Lawson 2006).

While general guidelines are well established (as above), the level of coverage required to deliver a particular level of precision in bycatch estimates varies in accordance with a number of factors. The key factors and type of variation are summarised in Table 1. In addition to these variables, the relative occurrence of multiple capture events also influences the ability to accurately extrapolate observed bycatch data, i.e. if a seabird is predominantly captured in large numbers in single rare events then higher levels of coverage may be required compared to a species more frequently captured in low numbers per event.

Table 1. Key factors influencing levels of observer coverage required to estimate seabird bycatch.

Factor	Type of variation			
	Day/night	Annual/Seasonal	Spatial	Vessel to vessel
Fishing effort		✓	✓	✓
Seabird abundance		✓	✓	
Seabird behaviour	✓	✓	✓	
Vessel characteristics		✓		✓
Vessel behaviour	✓	✓	✓	✓
Mitigation use	✓			✓

Examples from New Zealand demersal longline and trawl fisheries

In New Zealand, government fisheries observers have monitored seabird bycatch in demersal longline and trawl fisheries for approximately 20 years. Levels of observer coverage have varied through time and space as well as amongst fishing methods. Bycatch estimates based on data collected at varying levels of observer coverage for selected fisheries are presented below (Tables 2-4[3]), together with the uncertainty associated with the estimates (being the ratio of the width of the 95% confidence interval of the estimate to the estimated mean). Full details of fishery definitions and the methods used to estimate bycatch are described by Abraham and Thompson (2011). As expected, the accuracy of estimates generally increases with increasing coverage (Figure 1), though absolute values and year to year variation vary by fishery. The least accurate estimates are those where observer coverage levels are less than 5%. Other factors such as the spread of observer coverage across vessels (i.e., representativeness of coverage) and occurrence of significant bycatch events may also have also influenced the confidence levels of estimates produced.

[3] https://data.dragonfly.co.nz/psc/

Table 2. Demersal longline vessels >28 m in overall length targeting ling (*Genypterus blacodes*) in New Zealand waters: seabird bycatch rates observed 2003-2011. Definitions and estimation methods are described in Abraham and Thompson (2011).

Fishing year ended	Fishing effort (hooks)	Observed capture rate (captures/1000 hooks)	% effort observed	Estimated captures	95% confidence interval (CI) width	95% CI width/ mean
2003	19,754,899	0.028	54	784	427	0.54
2004	24,780,070	0.009	20	286	185	0.65
2005	21,566,771	0.007	12	310	233	0.75
2006	16,239,401	0.008	22	237	179	0.76
2007	16,855,796	0.024	13	317	228	0.72
2008	19,007,405	0.007	17	368	276	0.75
2009	17,582,914	0.002	21	302	296	0.98
2010	18,394,593	0.006	9	256	202	0.79
2011	18,299,212	0.019	8	570	559	0.98

Table 3. Trawl vessels >28 m in overall length targeting ling (*Genypterus blacodes*) in New Zealand waters: Seabird bycatch rates observed 2003-2011. Definitions and estimation methods are described in Abraham and Thompson (2011).

Fishing year ended	Fishing effort (trawls)	Observed capture rate (captures/100 tows)	% effort observed	Estimated captures	95% confidence interval (CI) width	95% CI width/ mean
2003	632	0.000	3	16	44	2.75
2004	572	0.000	4	11	26	2.36
2005	988	3.947	8	29	35	1.21
2006	1,394	2.655	8	45	55	1.22
2007	1,660	1.274	9	29	35	1.21
2008	2,226	2.905	11	48	54	1.13
2009	1,409	2.759	10	40	48	1.20
2010	1,197	5.528	17	32	38	1.19
2011	1,109	7.692	9	34	45	1.32

Table 4. Trawl vessels >28 m in overall length targeting deepwater species including orange roughy (*Hoplostethus atlanticus*) in the Chatham Rise area of New Zealand waters: seabird bycatch rates observed 2003-2011. Definitions and estimation methods are described in Abraham and Thompson (2011).

Fishing year ended	Fishing effort (sets)	Observed capture rate (captures/100 tows)	% effort observed	Estimated captures	95% confidence interval (CI) width	95% CI width/ mean
2003	3,295	0.000	20	11	17	1.55
2004	3,435	0.495	18	15	20	1.33
2005	3,194	0.980	29	21	21	1.00
2006	3,346	0.496	18	18	23	1.28
2007	3,021	0.148	22	10	15	1.50
2008	2,703	0.157	47	14	20	1.43
2009	2,497	0.475	51	15	16	1.07
2010	2,069	1.836	50	26	13	0.50
2011	963	0.813	26	12	23	1.92

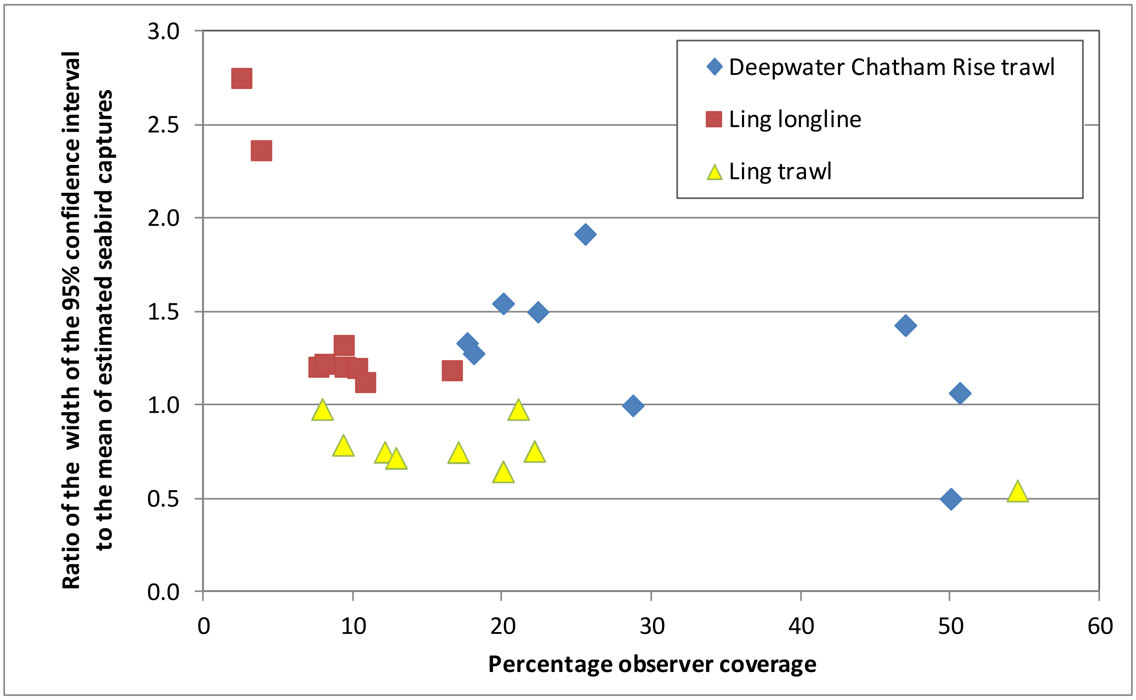

Figure 1: The ratio of the width of the 95% confidence interval to the mean of estimated seabird captures plotted against the percentage of observer coverage for selected fisheries 2003-2011. The data are presented in Tables 2-4

The application of observer data to risk assessments

The use of risk assessments to explore the impacts of fisheries on non-target species such as seabirds is increasing globally (e.g., Small et al. 2013). In New Zealand, data on seabird bycatch collected by fisheries observers is one input into a semi-quantitative risk assessment which has identified seabird species for which estimated fatalities in commercial fisheries are most likely higher than populations can sustain (Richard and Abraham 2013). The extent of observer data available from the fisheries of interest is a key determinant of the confidence with which risk to seabird populations can be estimated. For example, the black petrel (*Procellaria parkinsoni*) has emerged as the seabird most likely being captured in New Zealand commercial fisheries at levels exceeding its sustainability limits (Richard and Abraham 2013). However, uncertainties in the estimates of potential fatalities are high, in part because key fisheries in which this species was reported captured were covered by observers at levels less than < 2% of fishing effort per year. Overall, of the 70 species considered by Richard and Abraham (2013), assessed risk for 35 species was most sensitive to confidence in bycatch estimates, which in turn depended on observer coverage, rather than other inputs such as adult survival or number of breeding pairs. The risk assessment also made allowance for cryptic, or unobserved, seabird mortality, such as aerial warp strikes in trawl fisheries, or loss of birds from longline hooks. Mean multipliers of between 1.30 and 8.66 times observed mortality from trawl fisheries, for different types of seabirds, and 2.08 times observed mortality from longline fisheries, were used.

While attempts to estimate the risk fisheries represent to seabird populations are constrained where data are sparse, risk assessments are of particular value for highlighting what additional information is needed and for prioritising data collection approaches. In the case of the black petrel, concerns that fisheries captures are unsustainable, and that existing estimates of mortalities are imprecise, have led to management actions including the prescription of higher levels of observer coverage (Department of Conservation 2013).

Following the update of the semi-quantitative risk assessment (this is currently underway), it is planned to utilise this framework to estimate the levels of observer coverage required to demonstrate that seabird bycatch is at an assumed sustainable level of capture with enough precision to meet the management criteria as determined by the risk criteria (see Richard and Abraham 2013).

Discussion

Information collected by fisheries observers is instrumental in quantitative determinations of the risks that fisheries interactions represent to seabird populations. This review has highlighted that the level of observer coverage needed to obtain robust estimates of seabird bycatch can vary substantially according to the management objective as well as with characteristics of the fishery being monitored, species of interest, and bycatch patterns.

Where fisheries management objectives are developed to understand levels of bycatch, it is useful for those objectives to specify an acceptable level of certainty required by the estimates (e.g. specifying a CV to ensure that an observed trend is real rather than noise in the underlying data). In order to ascertain specific coverage levels appropriate in SPRFMO fisheries to addressing such objectives it will be necessary to further examine existing data from SPRFMO or similar demersal longline and trawl fisheries. Ongoing review of observer coverage levels implemented in SPRFMO fisheries would also be recommended in order to ensure coverage is appropriate to delivering bycatch estimates of the precision required.

The development of observer programmes tasked with collecting seabird bycatch data can also be easily expanded to collect equivalent data on other species of concern, including marine mammals and reptiles, as similar observation and recording protocols are used.

Recommendations

This paper **recommends that the Scientific Committee recognise** that:

- the extent of observer coverage needed to generate robust bycatch estimates varies with the characteristics of the fishery being monitored, species of interest, and bycatch patterns; and
- observer coverage levels of 5% may be adequate to collect information identifying some bycatch risks and issues; and
- in general, to robustly estimate bycatch levels of more frequently caught species, observer coverage levels of 20% or more may be necessary, whereas to estimate bycatch of species caught infrequently, coverage levels of 50% to almost 100% may be necessary; and
- even with high levels of observer coverage there can be unobserved bycatch (i.e. “cryptic” mortality), and this can vary substantially between fisheries.

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