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REPLY COMMENT

Scale-dependence of seabird–fishery data analysis and management: Reply to Croxall et al. (2013)

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ABSTRACT: Croxall et al. (2013; Mar Ecol Prog Ser 493:297–300) assert that fine-scale analysis of seabird–fisheries overlap, such as that presented in Torres et al. (2013; Mar Ecol Prog Ser 473:275–289), is of limited value for the assessment and management of seabird bycatch. In contrast, we consider that the highly dynamic movement patterns of both seabirds and fishing vessels necessitate analyses at multiple scales to fully understand the spatio-temporal variation in their associations. Conservation management of seabird bycatch in fishing operations can be applied at multiple scales from large ocean basins to small sub-national management units. We argue that the appropriate scale of analysis of seabird–fishery overlap is dependent on the data available and on the scale of management to be applied. The criticism by Croxall et al. (2013) of our analytical methods and interpretation of results does not affect the derived rates of overlap between Buller's albatrosses and fishing vessels. Studies of seabird–fisheries overlap at all scales are trending toward analyses at smaller spatial and temporal scales, supporting the conclusion of Torres et al. (2013) that scaling down such analyses is valuable for improving our ecological understanding of seabird–fishery associations and for the conservation management of seabird bycatch.

KEY WORDS: Foraging behavior · Scale · Seabird · Distribution · Overlap · Fisheries interaction · GPS tracking · Buller's albatross

Introduction

In Torres et al. (2013) we combined new data sources (GPS tracks of albatrosses, and fine-scale fishing vessel distribution and effort) and employed novel methods to explore in unprecedented detail the interactions between individual birds and fishing vessels in ways that are impossible with large-scale overlap metrics.

Scale dependence

Croxall et al. (2013) contend that the management of seabird bycatch is best addressed at large or medium scales and disregard the value of results derived from recent fine-scale studies of seabird–vessel overlap and interaction (e.g. Votier et al. 2010, Granadeiro et al. 2011, Torres et al. 2011, 2013, Catry et al. 2013). We agree that management of seabird bycatch across large ocean parcels, such as the areas covered by Regional Fisheries Management Organizations, is most appropriately conducted at large scales given the broad spatial extents, multiple fleets involved, and lack of fine-scale seabird or fisheries distribution data. However, in areas where management takes place within national and sub-national boundaries, fine-scale data on overlap between seabirds and individual vessels can provide information at the level of e.g. species, age-class, sex, season and fishery. In Torres et al. (2013) we demonstrate the advantages of a fine-scale analysis of seabird–fish-

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eries overlap relative to a large-scale approach. This information is valuable in advising management responses such as time–area closures, offal management protocols, and risk assessments. We assert that the appropriate scale of analysis of seabird–fishery overlap depends on the spatial and temporal resolution of available data on bird and vessel movements, and the management response is dictated by the size of the management unit.

Fine-scale analysis

In our study, we did not emphasize the value of large-scale analyses of seabird–fishery overlap to estimate the spatial and temporal bycatch risk faced by seabird populations across ocean basins. However, our fine-scale methods are robust, and the inclusion in our analyses of the various factors listed by Croxall et al. (2013) (e.g. information on offal management and use of mitigation by individual vessels, inter-specific competition, availability of natural prey to Buller's albatrosses, and weather) would not have altered the estimated overlap rates. Nor were these factors incorporated into the other recent fine-scale studies of seabird–fishery overlap (Votier et al. 2010, Granadeiro et al. 2011, Torres et al. 2011, Catry et al. 2013), with the exception of wind speed, which was included in Catry et al. (2013). Furthermore, these data were not available in our study, with the exception of remotely sensed wind vectors. Croxall et al. (2013) also listed time of day of active fishing operations, since albatrosses are less active at night; yet this diurnal behaviour pattern was largely accounted for in our study by removing all 'drift' portions of GPS tracks where birds were considered to be resting on the water. The alternative, to only include overlap events during daylight, would have biased the calculation of overlap rates.

Trawling was the dominant fishing method in the region during the period of the study (93% of fishing events; see Fig. 2 in Torres et al. 2013), and trawlers are the major source of fisheries-related mortality for Buller's albatrosses in New Zealand waters; the estimated annual mean number of Buller's albatrosses killed is 864, 188 and 44, from trawl, pelagic longline and bottom longline fishing, respectively (Richard et al. 2011). Therefore, by concentrating on overlap between Buller's albatross and trawlers, the results of our study are highly relevant for the development of management strategies to reduce bycatch of this species in national waters. Although our paper did not report bycatch rates, nowhere do we assume low bycatch rates of Buller's albatrosses, as Croxall et al. (2013) contend. We emphasize that the low calculated overlap rate was at odds with the conventional view that albatrosses are always at high risk of mortality in fisheries, and we subsequently proposed 3 non-exclusive hypotheses for this incongruity. Furthermore, the low overlap rate between birds and vessels that we documented is consistent with other recent studies using fine-scale analysis methods (Votier et al. 2010, Granadeiro et al. 2011, Torres et al. 2011, Catry et al. 2013).

Scales of seabird-fisheries interactions

Croxall et al. (2013) contend that seabird–fishery management at all scales would benefit more from direct observations of interactions rather than inferences from tracking data. However, direct observations are inherently biased towards birds that follow vessels. If these birds are unringed, which is usually the case, they provide no information on whether ship-following is a foraging specialisation, nor is it possible to assess the proportion of the population that does not associate with fisheries; this severely limits the ability to calculate interaction rates by e.g. sex or age, and to assess risk for individuals and populations. Both direct observations and tracking data are relevant and necessary for understanding and managing seabird–fishery interactions.

We agree with Croxall et al. (2013) that fisheries management measures should be effective for all seabirds within the region and not tailored specifically to individual species or age, sex and breeding class. Croxall et al. (2013) criticize our study for not including tracking data of individuals from multiple life-history stages; yet the same criticism applies to most large-scale analyses of overlap, few of which included tracking data from birds other than established breeders during the breeding and nonbreeding periods. Furthermore, our extrapolation of results derived for Buller's albatross to other seabirds follows the scientific tradition of generalizing the ecological patterns observed in one species.

The fine-scale methods applied in our paper are based on the dynamic nature of both seabird and fisheries distribution patterns. The literature referenced by Croxall et al. (2013) to defend the rigor of large-scale analysis of seabird-fishery interactions are irrelevant because they do not incorporate fisheries data in any form (BirdLife International 2009, 2010, 2011), maintain a static representation of a highly dynamic situation by restricting the datasets to large spatial (5° × 5°) and temporal (fisheries data are aggregated over 8 yr) scales (Waugh et al. 2012), or implement finer resolution overlap analyses (ACAP unpubl. data[1] and the integrated population modelling of Tuck et al. 2001 and Thomson et al. 2009) that actually supports our premise in Torres et al. (2013) that scaling down the analysis of seabird–fisheries overlap is beneficial.

Croxall et al. (2013) disagree with the proposition in Torres et al. (2013) that bycatch management should be designed to minimize burdens to fisheries. Minimizing burdens on the fishing industry is not the same as condoning seabird bycatch during operations, and although we agree entirely that the fishing industry has an obligation to conduct environmentally sustainable practices, the likelihood of this becoming reality depends on accessible, manageable, and feasible regulations. Management regimes that are burdensome to fishing vessels are less likely to be properly implemented. Due to the global demand for seafood, fisheries will continue to operate and, if economically viable, to expand, such that effective conservation management solutions will be those that simultaneously maintain fishery capture efficiency while ensuring environmental protection.

Conclusion

In contrast to the paradigm that populations of scavenging seabirds have high overlap rates with fishing vessels, recent fine-scale studies of seabird–fishery overlap have revealed that often only a small proportion of the population does so and that overlap rates vary considerably by species and fishery (Votier et al. 2010, Granadeiro et al. 2011, Torres et al. 2011, 2013, Catry et al. 2013). Such studies provide much more accurate indices of interaction than those at larger scales, thus improving our understanding of the processes that lead to seabirds attending vessels and the associated risk, allowing more targeted management efforts. The appropriate resolution to examine seabird–fishery overlap is largely a function of the scale of the fishery that is being studied or managed. Certainly, GPS data from seabirds would not be useful for managing fisheries at ocean basin scales without equivalent fine-scale information on vessel locations. However, when dealing with fisheries that operate at national or smaller scales (e.g. Fisheries Management Areas, as in New Zealand), the use of GPS data can be very enlightening for managers who seek finer-scale approaches to mitigation (e.g. time–area closures). Our fine-scale analysis represents a methodological advancement and provides novel and accurate results on overlap rates between Buller's albatrosses and fisheries with direct application to conservation management.

[1]ACAP (Agreement on the Conservation of Albatrosses and Petrels) (2008) Albatross and petrel distribution within the IATTC area. Paper submitted to the 9th stock assessment review meeting of the Inter-American Tropical Tuna Commission, La Jolla, California, 12–16 May 2008 (available at www.iattc.org/PDFFiles2/SAR-7-05b-Albatross-and-petrel-distribution.pdf)

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