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COMMENTARY

Minimizing seabird by-catch in industrial fisheries

C. Boyd

Scripps Institution of Oceanography, University of California, San Diego, CA, USA

Correspondence
Charlotte Boyd, Scripps Institution of Oceanography, University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093, USA.
Email: c2boyd@ucsd.edu

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Minimizing seabird by-catch requires fisheries management strategies that will ensure the effective implementation of best practices and achieve by-catch reduction targets. This is the major current challenge. In their featured paper, Maree and colleagues conclude that their results provide 'a strong case for the mandatory adoption of bird-scaring lines in trawl fisheries with high densities of scavenging seabirds' (Maree *et al*., 2014, p.1). However, there are two broad approaches to managing fisheries for by-catch reduction: command-and-control approaches based on mandatory area/seasonal closures, fishing practices, gear modifications and by-catch reduction devices (BRDs); and incentive-based approaches designed to motivate fishers to minimize by-catch through a combination of incentives to reduce by-catch and penalties for failure. Below, I discuss the advantages of incentive-based approaches over command-and-control, and summarize the lessons learned from successful strategies.

Incentive-based approaches are designed to align fishers' incentives with societal goals, and have several advantages for by-catch reduction in fisheries (Hall & Mainprize, 2005; Pascoe *et al*., 2010). Management is focused directly on by-catch reduction targets, such as reducing the number of seabird mortalities, rather than the technical details of specific by-catch reduction measures, such as the material, length and colour of bird-scaring lines. Regulations can be simpler and adjusted more easily, allowing for stronger targets over time and adaptive management of changing fisheries in dynamic ecosystems. In most fisheries, single by-catch reduction measures are insufficient, and a combination of changes in fishing practices, gear modifications and BRDs is required. Incentive-based approaches are flexible, enabling captains and vessel owners to decide on the specific suite of by-catch reduction measures that will be most cost-effective for a given set of conditions. This can stimulate innovation and collaborative experimental research aimed at improving the cost-effectiveness of by-catch reduction measures (Melvin *et al*., 2001). Indeed, the most cost-effective by-catch solutions are often identified by fishers themselves (Hall, Alverson & Metuzals, 2000). Incentive-based approaches can also foster information-sharing on best practices and areas with high by-catch rates, and investment in compensatory mitigation including contributions to by-catch reduction in lower-value fisheries. In contrast, command-and-control approaches do not provide incentives for further innovation, and are often poorly implemented because fishers are not motivated to implement them effectively (Branch *et al*., 2006; Pascoe *et al*., 2010).

Industrial fisheries that have already achieved substantial reductions in seabird by-catch can provide insights into the key elements of successful strategies. Successful strategies integrate clear objectives and targets, a range of accepted best practices, appropriate incentives, and effective monitoring. Leadership may be provided by government agencies, major wholesale seafood buyers like Walmart or sustainable seafood certification programmes such as the Marine Stewardship Council.

The broad goal of minimizing seabird by-catch needs to be translated into more specific management objectives and measurable targets, such as the reduction of seabird mortalities in each fleet below a predefined number per unit of fishing effort. For threatened species, targets may be designed to reduce by-catch below levels that would have a measurable effect on population dynamics. These targets can be strengthened over time.

There is a growing body of research on best practice in seabird by-catch in industrial fisheries (see Agreement on the Conservation of Albatrosses and Petrels by-catch mitigation fact sheets, available at http://www.acap.aq). In industrial trawl fisheries, bird-scaring lines are accepted best practice and are mandatory in some fisheries, including the South African deep-water hake trawl fishery. While bird-scaring lines can be highly effective, they do not eliminate seabird by-catch entirely and may have unintended consequences, such as shifting by-catch from one species group to another (Maree *et al*., 2014). In contrast, avoiding discards and offal discharge can reduce by-catch of all seabird groups to negligible levels by removing the feature that attracts seabirds during fishing operations (ACAP, 2013). While several options for reducing discharges have been identified, including onboard fish meal plants and batch processing, these can be costly and are rarely implemented on smaller and older vessels. The challenge remains to develop management frameworks that will motivate fishers to

reduce discards and offal discharge, and stimulate research into lower-cost solutions. Solutions will be context-specific. The scope for investment in by-catch reduction will depend on the value of the fishery, and on the major markets in the case of market-based incentives.

Management frameworks may be based on a combination of fleet-wide performance standards and vessel-level incentives. Fleet-wide standards are designed to ensure that by-catch reduction targets are achieved at the fleet level. Strong safeguards can be developed to prevent unacceptable levels of by-catch at this level. Alaskan fishing fleets, for example, face time-consuming consultations with management agencies and possible closure if by-catch of the endangered short-tailed albatross (*Phoebastria albatrus*) exceeds a set number of individuals over a multi-year period (Dietrich, Parrish & Melvin, 2009). Wholesale purchase agreements and certification may also be made conditional on reducing fleet-wide by-catch below predefined levels (Hall & Mainprize, 2005). Ultimately, however, decisions are made at the vessel level, implying that individual vessel-level incentives and accountability are also important (Dietrich *et al*., 2009). Vessel-level incentives can be achieved through a variety of mechanisms, such as individual by-catch quotas or increasing target catch quotas for low–by-catch vessels (Dietrich *et al*., 2009; Pascoe *et al*., 2010). At this level, graduated rather than knife-edge incentives can avoid penalizing individuals harshly for occasional rare by-catch events that are beyond their control. When the costs of failing to meet fleet-level by-catch targets are high, peer monitoring can also provide strong incentives for individual vessels to minimize by-catch.

Both command-and-control and incentive-based approaches require extensive or comprehensive monitoring systems. It is essential to evaluate the level of coverage that will ensure meaningful compliance. Fleet-wide compliance is unrealistic without effective monitoring, even in the case of low-cost and simple technologies such as bird-scaring lines. Well-trained observers and fisheries monitors can also provide valuable assistance in implementing by-catch reduction measures. In the featured study, observers ensured that bird-scaring lines were in good repair and correctly deployed (Maree *et al*., 2014). Electronic monitoring is also emerging as a cost-effective monitoring tool in some fisheries, including industrial trawl fisheries.

In conclusion, managing fisheries is about managing people (Hilborn, 2007). Vessel owners will invest in new practices or technologies if they can increase their profits by doing so. The key to minimizing seabird by-catch in all fisheries is therefore to develop management frameworks that align fishers' incentives with by-catch reduction targets (Hall & Mainprize, 2005).

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