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Best practice seabird bycatch mitigation for pelagic longline fisheries targeting tuna and related species

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ABSTRACT

We comprehensively tested combinations of three primary mitigation measures in a pelagic longline fishery with one of the highest rates of interaction with what may be the world's most challenging seabird assemblage (dominated by *Procellaria* genus petrels), aboard fishing vessels typical of the Asian distant water fleet. Multiple measures were used to compare the performance of weighted vs. unweighted branch lines set with two bird-scaring lines – hybrid lines with long and short streamers – during daytime and nighttime. The weights used were a novel double-weight configuration. Secondary attacks on baits brought to the surface by white-chinned petrels drove albatross mortality. Regardless of time of day, weighted branch lines with two bird-scaring lines, deployed and maintained with an aerial extent of 100 m, reduced bird attacks by a factor of four, and secondary attacks and seabird mortality by a factor of seven, compared to unweighted branch lines, with little effect on fish catch rates and with no injuries to crew. This combination yielded zero bird mortalities when gear was set at night. We conclude that the simultaneous use of two bird-scaring lines, weighted branch lines and night setting meet our criteria for best-practice seabird bycatch mitigation for the joint-venture fleet targeting tuna and related species in the South African EEZ. To be successful, the aerial extent of bird-scaring lines should be aligned with the distance astern that baited hooks sink beyond the foraging depth of the dominant seabird – in this case white-chinned petrels to a depth near 5 m. Given that these measures were successful in one of the most challenging pelagic longline fisheries, they are likely to be widely applicable to pelagic longline fisheries using similar gear.

1. Introduction

Stemming the incidental mortality (bycatch) of non-target species in marine fisheries to maintain species diversity and ecosystem integrity is fundamental to ecosystem-based fisheries management (Crowder et al., 2008; FAO, 1995; Smith et al., 2007). Species that are highly sensitive to adult mortality, such as sea turtles, marine mammals, and seabirds, are particularly vulnerable (Croxall et al., 2012; Lewison et al., 2004). In the case of seabirds, fisheries mortality is considered the most pervasive and immediate threat to many albatross and petrel species (Croxall et al., 2012). Albatrosses are especially vulnerable, with 18 of 22 species threatened with extinction, they are the most threatened of any bird family (Phillips, 2013). Declines and poor recovery of seabird populations in the Southern Hemisphere have been repeatedly linked to mortality in longline fisheries (Gales, 1998; Tuck et al., 2001; Weimerskirch et al., 1997). The threat posed to seabirds by longline and later, other fisheries, triggered international efforts to characterize and reduce this mortality. These included The United Nations International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (FAO, 1999) and the Agreement for the Conservation of Albatrosses and Petrels, which came into force in 2004 (ACAP, 2001, 2012).

Seabird mortality occurs in longline fisheries when seabirds forage on sinking baited hooks during deployment, become hooked, and drown (Brothers, 1991; Løkkeborg, 2008, 2011). In addition to the negative consequences to bird populations, baits lost to birds increase fishing costs and reduce fish catch (Brothers et al., 1999a; Gandini and Frere, 2012; Løkkeborg, 2008, 2011; Sánchez and Belda, 2003). In some fisheries, excessive seabird mortality can lead to lost fishing opportunities due to suspensions or exclusion from a fishing area (South Africa, 2012) and, possibly, to loss of market share due to negative perceptions of fishery practices (Kirby et al., 2013). The development and implementation of best-practice seabird bycatch mitigation technologies is essential to stemming fishery-related seabird mortality and to maintaining efficient and

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sustainable fisheries (Bull, 2007; Croxall et al., 2012; Løkkeborg, 2008, 2011). We define best-practice mitigation as technologies and practices that reduce the incidental mortality of seabirds to the lowest achievable levels; are practical, safe and cost-effective; do not increase the bycatch of other taxa; and maintain or enhance the catch of target species. Experimental research comparing the performance of candidate mitigation technologies to a control of no deterrent, where possible, or to the status quo, yields definitive results; research results from tests using fishery observer data are frequently confounded (Løkkeborg, 2008, 2011; Melvin and Robertson, 2000). Carefully designed studies testing candidate best-practice mitigation technologies using multiple metrics of evaluation are key to understanding and ultimately reducing seabird mortality in marine fisheries.

Among fisheries, pelagic longline fisheries targeting tuna and billfishes and managed by international agreements (Regional Fishery Management Organizations, or RFMOs) may pose the greatest fisheries-related threat. Their wide spatial and temporal extent – over 90% of the world's oceans at all times of year – coupled with high fishing effort, high rates of seabird bycatch and minimal monitoring make them a constant risk to wide-ranging seabirds (see Melvin et al., 2013). Despite a clear and critical need, comprehensive research to develop best practice seabird bycatch mitigation technologies specific to pelagic longline fisheries is lacking (Anderson et al., 2011; Løkkeborg, 2008, 2011) creating considerable uncertainty and debate among member nations of tuna commissions regarding best-practice mitigation. In contrast, seabird bycatch mitigation is well studied and well understood for demersal longline fisheries. Experimental research established line weighting, bird-scaring lines, and night setting as accepted best practice mitigation for demersal longline fisheries, and implementation of these measures dramatically improved fishery performance (ACAP, 2013a; CCAMLR, 2011; Croxall and Nicol, 2004). Weighting longlines reduces the amount of time and the distance beyond a vessel that baited hooks take to sink below the foraging depth of seabirds. Bird-scaring lines exclude birds from the area where baits are accessible. Albatross species, and to a lesser extent petrel species, forage less and with reduced efficiency at night (Catry et al., 2004; Phalan et al., 2007; Mackley et al., 2011).

The configuration of pelagic longline gear creates unique challenges for the application of bird-scaring lines and line weighting. Surface floats used to suspend longlines from the water surface can tangle with bird-scaring lines as they are deployed, leading to problems with crew safety and crew efficiency, and in some cases, lost fishing gear (Melvin et al., 2013). Adding lead weights to the long branch lines typical of pelagic fisheries can pose serious safety issues: when a hook is suddenly released from a fish as it is landed and the weight recoils at high speed toward crew members, there is a high risk of injury (Anderson and McArdle, 2002; Boggs, 2001; Løkkeborg, 2008, 2011). Weighting branch lines may also reduce the catch rates of target fishes (Robertson et al., 2013). Fishers can be averse to setting longlines (pelagic or demersal) at night for reasons that include scheduling difficulties, safety concerns and possible effects on catch rates of some fishes.

Our comparison of the efficacy of two bird-scaring line designs in the South African tuna joint venture fishery in 2009 found that bird-scaring lines could not prevent bird attacks on unweighted branch lines. Hooks sank beyond the range of diving petrels at a distance of more than 300 m astern, three times the span of the aerial extent of bird-scaring lines (100 m; Melvin et al., 2013). Slow sinking unweighted lines caused most bird attacks, and presumably most mortalities, to occur in areas beyond the protection of two bird-scaring lines. Albatrosses attacking diving birds (white chinned petrels, *Procellaria aequinoctialis*) that had brought a baited hook to surface (secondary attacks) compounded this dynamic. Anticipating this outcome, we carried out a preliminary trial in which weighted branch lines dramatically reduced seabird mortalities compared to unweighted lines: weighted lines sank to a depth beyond the reach of white-chinned petrels within the bird-scaring line aerial extent and with no detectable effect on target fish catch day or night. Based on these results, we hypothesized that, to be effective, the aerial extent of bird-scaring lines should span the distance astern of the vessel that baited hooks were accessible to birds – a concept we referred to as 'shrink and defend'.

Here we report findings of further trials in the South African joint venture tuna fishery, comparing the performance of weighted vs. unweighted branch lines set with two bird-scaring lines during daytime and nighttime using multiple metrics. Our goals were to: (1) provide experimental evidence of the merits of combined mitigation measures, (2) shed light on the underlying mechanisms that drive seabird bycatch; (3) identify best-practice seabird bycatch mitigation measures for the South African tuna joint venture fishery, and (4) by working on vessels typical of the Asian distant water fleet and in a system with some of the highest seabird interaction rates recorded, provide recommendations for pelagic longline fisheries managed by international tuna commissions.

2. Methods

2.1. The South African tuna joint venture fishery

The Agulhas Current and the Benguela Current, which extend into the South African Exclusive Economic Zone (EEZ), are major current systems of great importance to seabirds (Croxall et al., 2012). Some 24 species of albatrosses and petrels, most of which are threatened with extinction, forage in South African waters (Petersen et al., 2009). An initial assessment of seabird bycatch in the pelagic longline fisheries targeting primarily tunas and billfishes (1998–2000) found that the South African pelagic longline fishery had one of the highest seabird bycatch rates in the world (1.6 birds/1000 hooks) killing up to 30,000 birds per year (Ryan et al., 2002). The rate was highest in the Asian fleet fishing in winter, 4.46 birds/1000 hooks. The most recent assessment, based on more complete data and assuming better compliance with bycatch mitigation measures, estimated the average bycatch rate over the eight years from 1998 to 2005 to be considerably less (0.44 birds/1000 hooks, with 1800–5900 birds killed each year) than the original estimate. Eight of the 11 confirmed species killed were threatened with extinction (Petersen et al., 2009). This analysis confirmed that the winter Asian joint venture tuna fishery had the highest bycatch rate (0.58 birds/1000 hooks). These updated bycatch rates are considerably higher than those estimated from comparable data sets of Southern Hemisphere pelagic longline fisheries (0.2–0.4 birds/1000 hooks; Bugoni et al., 2008). The South African tuna joint venture fishery met our criteria for staging research in a worst-case seabird-interaction fishery.

In 2010, foreign flagged vessels participating in the South African tuna joint venture fishery were required to fish exclusively at night (between nautical dawn and nautical dusk) and to use a single bird-scaring line of a specific design and other practices to minimize seabird mortality. If an individual permit holder exceed an annual mortality limit of 25 birds, fishing could be allowed but only with weighted branch lines (60 g within 2 m of the hook) or no fishing in the days bracketing the full moon. If bycatch exceeded 50 birds, fishing might be allowed to continue under certain conditions, including mandatory use of weighted branch lines at all times (South Africa, 2010).