South Pacific Regional Fisheries Management Organisation

**2nd Meeting of the Scientific Committee**

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# Seabird cryptic mortality and risk from 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 the Scientific Committee to consider the level of risk to seabird species in a range of trawl fisheries (with reference to discarding of biological material). This paper introduces the concept of seabird cryptic mortality, reviews existing research and illustrates estimation methods that allow for consideration of the full extent of risk that fisheries pose to seabird species through bycatch. While the focus of this paper is on trawl fisheries, longline methods are also covered.

## Background

Interactions between seabirds and fishing gear may be lethal or non-lethal. Mortalities due to injuries incurred during these interactions can result in the death of seabirds at the time interactions occur, or sometime afterwards (Bull 2007, Braccini et al. 2012). Challenges with detecting mortalities when they occur (e.g., due to dead animals not being landed on the vessel deck) or when mortalities are delayed (e.g., due to injuries that eventually cause death) result in underestimates of the true extent of seabird bycatch, as observers are typically tasked with recording dead animals landed on deck. Unseen mortalities occurring in such circumstances are termed “cryptic” or unobserved mortalities. It is worth noting that observers can be tasked to record mortality events, such as warp strikes, normally classified as cryptic mortality (e.g. Maree et al 2014). However, this requires observers specially trained and with time dedicated to these duties, and still relies on visual observations made at some distance, resulting in a certain degree of subjectivity in classifying a mortality observation.

Gilman et al. (2013) distinguished five components of cryptic fishing mortality:

- pre-catch losses, when a mortality occurs due to the fishing operation but the carcass is not landed;
- ghost-fishing by lost or abandoned gear;
- post-release mortality, when animals are released alive but die subsequently, for example, as a result of injuries incurred;
- "collateral mortalities" for example resulting from exclusion from habitat by fisheries and predation of animals released alive following capture; and,
- mortality resulting from the cumulative effects of stress and injury resulting from fishing operations.

It is logical that many of these components will also apply to bycatch (including seabirds) as well as target fish catch but both their relative and absolute importance may be different. Indeed, the seminal work of Brothers et al. (2010) on seabird cryptic mortality in pelagic longline fisheries concluded that actual seabird bycatch levels may be up to double those identified using longline haul data alone, because birds captured on setting were not always retrieved at the haul.

**Cryptic mortality in a fisheries management framework**

New Zealand is an example of where a fisheries management framework has been developed that accounts for seabird cryptic mortality. This has been enabled by using the seabird risk assessment described by Richard and Abraham (2013). In estimating the risk New Zealand commercial fisheries present to seabird populations, this assessment took a multiplier approach to allow for cryptic mortality. Scalars were developed for trawl and longline fisheries based on past work including Watkins et al. (2008), Abraham (2010), and Brothers et al. (2010). However, uncertainty associated with these scalars limits the confidence with which they can be applied. This paper describes how Richard and Abraham (2013) developed the scalars they used in New Zealand in order illustrate a possible method that could be applied more wide in the management of other fisheries.

**Cryptic mortality in longline fisheries**

To date, investigations of seabird cryptic mortalities in longline fisheries has focussed on pelagic rather than demersal longlines.

Brothers et al. (2010) found that amongst 11 longliners over a 15-year period, 176 seabirds were observed caught on longline hooks during setting, and apparently unable to free themselves. Of these birds, only 85 carcasses were retrieved on hauling. Richard and Abraham (2013) used these results to derive a probability distribution for cryptic mortalities, based on the binomial distribution. On that basis, a multiplier was generated of mean 2.08, and 95 % confidence interval 1.79 - 2.44. This was applied across all surface longline fisheries for all seabird species. Therefore, the total annual potential fatalities calculated by Richard and Abraham (2013) comprised the estimated observable captures multiplied by a sample from the cryptic mortality probability distribution.

Richard and Abraham (2013) applied the same multiplier developed for pelagic longline to demersal longline because of the lack of information on cryptic mortalities associated with demersal longline. Two considerations affecting the appropriateness of such an extrapolation are the extent of commonalities in the seabird assemblages interacting with the two methods and the characteristics of fishing operations. Key differences occur between these fisheries, including differences in line-weighting, snood length, hook size and type, fishing depth and target fish species, which may all affect cryptic mortality rates. More research on cryptic mortality in demersal longlines is required to quantify the extent to which these factors play a role.

**Cryptic mortality in trawl fisheries**

The approach used by Richard and Abraham (2013) to explore cryptic mortality in trawl fisheries considered three causes of mortality: net entanglement, surface warp strike, and aerial warp strike. The multipliers developed below were applied across all trawl fisheries considered, and all birds landed enmeshed in trawl nets were considered as (observed) fatalities, including when released alive, given that the long-term impacts of such captures on individuals are unknown.

Cryptic mortalities resulting from interactions with trawl nets were considered to only comprise birds that were entangled in meshes but subsequently became separated from trawl nets (e.g., through carcasses falling off gear into the water during net hauling) and birds caught inside the trawl net that fell out into the water, before being detected. As quantitative data describing the relationship between observed and cryptic net mortalities was unavailable to Richard and Abraham (2013), they implemented an approach following Richard et al. (2011). The ratio between cryptic and observable mortalities was given an assumed value (0.3) and distribution (log-normal with an associated 95% confidence interval of 0.1 to 0.7). Then, the total number of seabird fatalities due to entanglement or capture in trawl nets comprised the sum of the observed captures and cryptic fatalities.

Warp strikes were evaluated separately with respect to location (occurring on the sea surface and in the air), and were evaluated separately for large (all albatross species, giant petrel *Macronectes* spp., Subantartic skua *Catharacta antarctica*) and small (all other) seabirds. Further, small seabirds were grouped as fastflying (e.g., white-chinned petrel *Procellaria aequinoctialis*), slow-flying (e.g., broad-billed prion *Pachyptila vittata*), or diving (e.g., penguins and shags) species, on the assumption that these characteristics affect the species' vulnerability to capture. Seabirds categorised as diving birds were excluded from further consideration as these species were not considered to experience mortality due to warp interactions (i.e. fatalities of these species were restricted to those resulting from interactions with the trawl net).

Richard and Abraham (2013) considered large birds to be particularly vulnerable to surface warp strikes, given the tendency for their wings to wrap around trawl warps. While still considered susceptible to surface strikes, fast-flying and slow-flying small birds were considered much less likely to be entangled and were very rarely observed as warp captures. Amongst fast-flying and slow-flying small birds, slow-flying species were considered less susceptible to surface warp strikes. Aerial warp strikes were assumed to not result in warp captures (but could result in fatalities).

In contrast to the absence of information relating to observed and cryptic fatalities due to trawl nets, a limited amount of information was available to Richard and Abraham (2013) to inform a quantitative consideration of the extent of cryptic mortalities due to trawl warp strikes. Two studies were considered. These were conducted in South Africa (Watkins et al. 2008) and New Zealand (Abraham 2010). The information contained in these sources was applied to develop (either log-normal or beta) probability distributions from which the relationship of fatalities and captures were characterised. Thus, the number of large-bird fatalities per surface warp capture was estimated at 18.54 (95% confidence interval 10.88–28.8). For small birds, this value was 111.35 (95% confidence interval 26.95–295.44). Fatalities resulting from aerial strikes on trawl warps were considered to be entirely cryptic. Therefore, a multiplier was not calculated in relation to consequent warp captures. However, the number of aerial strikes was estimated in relation to surface strikes, which was estimated relative to warp captures. Richard and Abraham (2013) speculated that fatality rates for aerial warp strikes would be low overall (e.g., 0 to 5%), whilst being highest for large birds, moderate for small fast-flying birds, low for small slow-flying birds (for which strikes were considered to mostly arise from the lateral movement of the trawl warp), and non-existent for small diving birds. Fatality rates due to aerial warp strikes were described using a beta distribution with a coefficient of variation of 0.2. Following Richard et al. (2011), mean fatality rates were 2% for large birds, 1% for small fast-flying birds, and 0.5% for small slow-flying birds.

Using the above information and assigned values, Richard and Abraham (2013) estimated the number of fatalities due to aerial warp strike per observed seabird capture was 3.2 (95% confidence interval 1.86–5.05) for large birds, 72.79 (95% confidence interval 24.1–175.27) for small fast-flying birds and 36.5 (95% confidence interval 11.93–81.95) for slow-flying birds.

Since the work of Richard and Abraham (2013) one notable at-sea research project investigating seabird cryptic mortality in a South Atlantic trawl fishery has been described by Parker et al (2013). The study investigated whether the outcome of interactions between seabirds and warp cables (particularly heavy contacts with warps) could be confirmed by observing the wake of the trawler, beyond the detection range of observer(s) positioned on the fishing vessel, for injured or dead birds. They also trialled the use of a warp attachment device to investigate whether it would increase the probability that seabirds killed on trawl warps would be retained until hauling. Early results highlighted that data obtained by observers located on trawlers underestimate seabird mortality rates.

**Discussion**

Whilst research in this field is still in its early stages, it has been demonstrated that observed seabird bycatch in trawl and longline fisheries is likely to underestimate the true number of fishing related seabird mortalities. Despite the paucity of quantitative information on cryptic mortality rates, methods have been developed that allow the integration of cryptic mortality into seabird risk assessments used in a fisheries management context. These methods suggest the relative rate of seabird cryptic mortality to observed bycatch may be particularly in trawl fisheries, and varies between seabird species. A number of fishery operational factors are likely to influence this relative rate, and more research is needed, across a range of fisheries, to improve our understanding and estimation of seabird cryptic mortality.

**Recommendations**

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

- seabird cryptic mortality refers to unobserved mortality of seabirds interacting with fishing gear;
- there are a number of components of cryptic mortality, in both longline and trawl fisheries;
- the number of seabirds observed bycaught in both trawl and longline fishing methods is likely to underestimate the true mortality of seabirds interacting with fishing gear;
- research to quantify cryptic mortality is limited and further work is encouraged;
- numerical methods exist to extrapolate observed seabird bycatch to total bycatch but there is substantial uncertainty due to limited quantitative data on cryptic mortality;
- cryptic mortality extrapolation multipliers are particularly high in trawl fisheries and vary between seabird species; and
- it is appropriate that total mortality of seabirds, including cryptic mortality, be considered when assessing the risk that fisheries pose to seabirds.

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