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# Preliminary identification of minimum elements to review the effectiveness of seabird bycatch mitigation regulations in tuna RFMOs

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## Summary

The five tuna regional fishery management organizations (RFMOs) have established requirements for their pelagic longline vessels to use seabird bycatch mitigation measures in most areas overlapping with albatrosses, petrels, and other seabirds impacted by bycatch, and have plans to monitor and review the effectiveness of these measures. However, methodologies or criteria for undertaking such reviews have not yet been defined. This paper summarizes the preliminary views of an ACAP (Agreement on the Conservation of Albatrosses and Petrels) intersessional group that has been formed to discuss what the minimum elements may be for such reviews. This paper recommends the following four elements should be part of monitoring the effectiveness of the seabird conservation measures adopted by IOTC in 2014 (Res 12-06):

1. *The extent to which the tuna RFMO seabird conservation and management measure(s) reflects 'best practice' for pelagic longline fisheries, and has appropriate spatial, temporal and vessel application.*
2. *The quality and representativeness of the data available for the review.*
3. *The degree of implementation by vessels (compliance).*
4. *Analysis and monitoring of seabird bycatch levels over time, most likely including*
    a. *Reported bycatch rates (birds per 1000 hooks)*
    b. *Total number of birds killed per tuna RFMO per year*

In addition, the paper recommends adoption of harmonized review methods across tuna RFMOs, in addition to ongoing efforts to harmonize tuna RFMO bycatch data collection, reporting and storage mechanisms.

## 1. Background

All five tuna commissions have established seabird bycatch mitigation requirements for longline vessels in most areas overlapping with the distribution of albatrosses and petrels, although with some variation in the specific mitigation measures required (Table 1). All seabird bycatch conservation and management measures adopted by tuna RFMOs have provisions for reviewing the effectiveness of these measures. In ICCAT and IOTC there are specific commitments to reviews in 2015 and 2016, respectively, whereas in the others there are commitments to review regularly, but with unspecified time frames (Table 1). The methods or criteria for such reviews have not yet been formally established.

In the case of the IOTC, it is expected that the Scientific Committee, based on the work of the Working Party on Ecosystems and Bycatch, and information from CPCs, will assess the impact of Res 12-06 on seabird bycatch by the 2016 meeting of the IOTC Commission. Although Res 12-06 has only recently (1 July 2014) come into force, it would be useful to consider the methods and criteria that will be used in this review.

In April 2013, at the seventh meeting of the Advisory Committee of the Agreement for the Conservation of Albatrosses and Petrels, an intersessional group was formed to discuss what methods might be most appropriate, and to identify minimum elements that it believes should be considered in reviewing and monitoring the effectiveness of seabird bycatch mitigation measures in tuna RFMOs (ACAP 2013). The ACAP intersessional group presented a paper on this work to the August 2013 meeting of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) Ecologically Related Species Working Group (ERSWG). On the basis of the paper, and discussions at the ERSWG meeting, a Technical Group was established and a workshop planned for November 2014 to progress this work and to provide advice to ERSWG on optimal approaches for measuring and monitoring the effectiveness of seabird bycatch mitigation measures in Southern Bluefin Tuna longline fisheries. A similar paper was presented to the September 2014 meeting of ICCAT's Sub-Committee on Ecosystems. On the basis of the paper and discussions at the meeting, a number of actions have been identified that should be progressed in 2015 in preparation for a formal review of ICCAT's seabird conservation measure, Rec 11-09 (ICCAT 2015).

The seabird conservation and management measures adopted by tuna RFMOs are currently largely focused on addressing the seabird bycatch issue in relation to albatrosses and petrels, and this document therefore focuses on these species, but the elements presented below are intended to be applicable for all seabird species affected by bycatch in IOTC fisheries.

## 2. Minimum elements for reviews of seabird conservation and management measures in tuna RFMOs

This document provides a preliminary summary on views collected during ACAP intersessional discussions. These discussions have also drawn from previous papers submitted to ACAP (including Wolfaardt 2011, Anderson and Small 2012, Small 2013, Turner & Papworth 2013). At the ACAP Advisory Committee meeting in April 2013, the group recognized that methods proposed must take into account the availability of data (quantity of data and level of detail), as well as realistic capacity of tuna RFMOs to analyze and review data. It is also important that RFMOs have effective formal mechanisms to monitor and ensure implementation of the required bycatch mitigation measures. It is recommended that the following four elements be part of monitoring the effectiveness of tuna RFMO seabird measures, including in IOTC.

### 2.1 Content of tuna RFMO seabird conservation measures

This element is most closely linked to the process of review that is already ongoing in the ecosystem or bycatch working groups of most tuna RFMOs, has been underway for several years, and has led to the establishment of the existing tuna RFMO seabird bycatch conservation measures. However, it is

important to maintain (and formalize where not yet formalized) the existing process by which the tuna RFMOs regularly consider updated information on bycatch mitigation best practice. We recommend that this must include:

- Assessment of the extent to which the current tuna RFMO seabird conservation and management measures reflect best practice (bycatch mitigation requirements and their technical specifications), including the advice developed and updated by the ACAP Seabird Bycatch Working Group.
- Assessment of the spatial and temporal application of the bycatch mitigation requirements.
- Assessment of the range of vessels to which the bycatch mitigation requirements applies.
- Assessment of new scientific work to test and develop seabird bycatch mitigation measures. This could be achieved by making use of advice provided by scientific review groups, such as the ACAP Seabird Bycatch Working Group.

Currently, each tuna RFMO conducts this review independently of the other tuna RFMOs, but other options could be considered, such as using the joint tuna bycatch expert group. The best practice advice that is developed and updated by the ACAP Seabird Bycatch Working Group provides a useful resource for the review process.

**2.2 Data collected and reported by tuna RFMO longline fleets**

The results and usefulness of any review will depend on the quantity, quality and representativeness of the data available. The data collection and reporting requirements therefore need to be clearly outlined and monitored. Data availability will also determine the methods that can be used for a review. The key IOTC Resolutions regarding data collection and reporting, include Resolutions 12/06 (on reducing the incidental bycatch of seabirds in longline fisheries), Resolution 13/03 (on the recording of catch and effort by fishing vessels in the IOTC area of competence), Resolution 11/04 (on a regional observer scheme) and Resolution 10/02 (on mandatory statistical requirements for IOTC members and CPCs).

***Bycatch data collection***

All tuna RFMOs have established requirements for their longline fleets to have at least 5% observer coverage, with CCSBT having a recommendation of 10% observer coverage since 2001. CCSBT, IOTC and WCPFC have established data collection standards for their longline observer programs and the process is underway in IATTC. There remains a need for harmonization of minimum observer data standards for longline vessels across tuna RFMOs. A workshop is scheduled for January 2015 to develop such standards, with funding support from the International Sustainable Seafood Foundation (Nicol & Clarke 2014). Comparisons of existing tuna RFMO observer data collection methods have been undertaken in, for example, Wolfaardt (2011), Anderson and Small (2012) and Turner and Papworth (2013).

Minimum observer data collection standards for bycatch have been discussed in a variety of fora, with ACAP recommendations for tuna RFMOs in Wolfaardt (2011). These suggest that the key elements that should be assessed in relation to availability of data include:

- Observer coverage (% total effort observed), and its spatial and temporal representativeness.
- The proportion of national reports (or % total effort these fleet represent) that provide data on the number of birds caught as bycatch, recorded to species level.
- Data on the use of mitigation measures, and on other factors that affect bycatch rates.

In addition, it is widely recognised that 5% coverage is insufficient to accurately monitor rare catch events such as those for seabird and turtles, and that the current 5% target is the result of a pragmatic approach to increase observer coverage from current very low levels. However, attention needs to be given to how to monitor bycatch when observer coverage rates remain low, and how coverage levels could be increased to 20% and above. This may be achieved, for example, by supplementing observer data collection with the use of electronic monitoring. Compliance procedures to enforce data collection standards and reporting should also be elements of the review.

***Bycatch and fishing effort data reporting***

Given the variable nature of bycatch and fishing effort, both in space and time, bycatch and fishing effort data collected through observer programmes need to be reported in a spatially and temporally stratified manner in order for meaningful analysis and comparisons of seabird bycatch rates to be conducted. Seabird work to date within the tuna RFMOs has mostly used a resolution of analysis of 5x5 degrees and year quarter. This reflects a balance between the need to incorporate spatial and temporal variability in seabird distribution and bycatch rates, and the realities of the amount and resolution of data currently available (bycatch data, fishing effort data and seabird distribution data). Work undertaken by ICCAT and IOTC Secretariats to fill effort data gaps has been important in facilitating seabird risk assessments to date. Reporting is needed on all elements identified in the section above.

Currently, WCPFC requires member states to submit raw observer data to the WCPFC Secretariat (WCPFC CMM 07-01), and IOTC also has agreed detailed reporting protocols, which includes recommended spatial (1x1°) and temporal stratification of observer data (IOTC Resolution 11-04). In 2012, CCSBT refined its reporting requirements for national reports submitted to the Ecologically Related Species Working Group (CCSBT 2012). ICCAT and IATTC have not yet agreed their reporting requirements, although these are under discussion. The CCSBT ERSWG and the ICCAT Sub-Committee on Ecosystems have noted that it would be highly beneficial for reporting requirements to be harmonized across the tuna commissions in order to be able to assess cumulative impacts on non-target species (CCSBT 2012, ICCAT 2012). The IOTC has agreed data confidentiality and data sharing provisions, which could be useful templates for the other tuna RFMOs.

**2.3 Degree of implementation**

Measurement of the degree of implementation of bycatch mitigation measures at the level of (i) the fleet, and, (ii) the set, is central to understanding whether seabird conservation measures have been effective. However, methods to monitor compliance with bycatch mitigation measure requirements are yet to be agreed by tuna RFMOs' compliance committees.

In order to assess the degree of implementation, the following four elements could be measured:

- The proportion of sets in which the required bycatch mitigation measures were used when fishing in the specified areas of application, based on self reporting via log books. The flag states would report this proportion to the Ecosystem or Bycatch working group of the relevant tuna RFMO.
- The proportion of sets in which the required bycatch mitigation measures were used when fishing in the specified areas of application, verified by an independent source. This independent source could be: (i) data recorded by observers, although recognizing that required observer coverage is only 5%, (ii) port inspection, although recognizing that the presence of bycatch mitigation devices in port does not indicate whether they have been in use, (iii) data reported to the flag state from VMS or electronic monitoring to establish whether mitigation measures were used (for example, night setting, bird scaring lines or appropriate line weighting).
- The proportion of vessels (or captains/crew) that have received educational material or attended courses in bycatch mitigation within the last 1 or 2 years. This information could be provided as part of the annual reporting requirements.
- The extent to which the observers have received training on recording bycatch, including species identification. The key training elements should be defined.

Suitable systems and arrangements for reporting the use of mitigation measures are not yet widespread. ICCAT has not yet established minimum requirements for reporting of observer data. However, CCSBT's new Template for the Annual Report to the Ecologically Related Species Working Group, agreed at the ERSWG 9 meeting in 2012, includes the request for member states to report compliance with seabird bycatch mitigation requirements (CCSBT 2012 Attachment 4). Both the IOTC and WCPFC regional observer program data collection forms also require information on the seabird bycatch mitigation measures used in each set (including night setting, appropriate line weighting, bird scaring line) (IOTC 2013, WCPFC 2013a). In addition, WCPFC requires member states to report data in logbooks on start time of each set (WCPFC 2012), and the WCPFC seabird measure has a general requirement for member states to report on mitigation used (paragraph 9, WCPFC CMM 2012-07), although there is not a specific part of the Annual Report template that addresses this (WCPFC 2013b).

Across the tuna RFMOs, work is ongoing to elaborate monitoring, control and surveillance systems, with developments across all tuna RFMO Compliance Committees. If bycatch conservation measures are to be effective, and if their effectiveness is to be monitored, the assessment of compliance with non-target species requirements (specifically relating to bycatch mitigation) will need to form part of the work of these Compliance Committees. This should include when port inspection, at-sea inspection, electronic monitoring or observer program protocols are developed.

**2.4 Assessment and monitoring of seabird bycatch**

There are a range of methods that might be used to monitor levels of tuna RFMO seabird bycatch, or seabird bycatch impacts, ranging from simple to more complex. Examples of possible approaches are shown in Table 2.

A decision on the most appropriate method will be guided by factors such as data availability, capacity and resources for undertaking the review. The influence of data availability on analytical methods was discussed at the ACAP Seabird Bycatch Working Group in April 2012, and a summary is provided in Table 3.

Based on the level of data that are likely to be available to tuna RFMOs in the near future, we recommend that the most feasible approaches to monitor the effect of tuna RFMO seabird conservation measures on seabird bycatch rates/levels/impacts are:

- Measuring seabird bycatch rates (birds per 1000 hooks), tracked over time, with information on spatial and temporal distribution (see recommendation in 2.2 above regarding spatial and temporal resolution of reported data), and a measure of robustness of bycatch estimates.
- Estimating the total number of birds killed per tuna RFMO per year, tracked over time, and including measures of error. On the basis of the recommendation above (in section 2.2) regarding the reporting resolution (by 5x5 grid square and year quarter), it should be possible to provide this information at a finer scale (e.g. per fleet, or areas).

Bycatch rates (birds per 1000 hooks) are included because these should become readily available from tuna RFMO observer programs. It will be important to stratify bycatch rates both spatially and temporally (as outlined in 2.2), and for estimates of bycatch to include error estimates, with information on how the bycatch rates were estimated.

Because a reduction in bycatch rates does not necessarily mean that the total number of birds killed is reduced (for example if the total fishing effort in areas overlapping with albatrosses and petrels increases), and *vice versa* (a reduction in the total number of birds killed does not necessarily imply a reduction in bycatch rates) there is also a need to monitor the total number of birds estimated killed per year, which can be tracked over time. A request for WCPFC and IOTC Scientific Committees to estimate total number of seabirds killed per year is included in the current WCPFC seabird measure (CMM 2012-07), and was in IOTC Resolution 10-06, although is not in the current IOTC Resolution 12-06.

Ecological Risk Assessments (ERAs) have been used increasingly to assess the impacts of fishing activities on seabirds and other taxa (e.g. Tuck et al. 2011; Jiménez et al. 2012; Waugh et al. 2012; Richard and Abraham 2013; Richard et al. 2013; Small et al. 2013). As with other methods, ERAs range from basic (largely qualitative) to very complex, highly quantitative, approaches. It is also possible, as was the case in the ICCAT seabird assessment, to use a multilevel framework, in which the species considered of lower risk are subject to lower level assessment, while the more intensive analyses are limited to the higher risk species. In very simple terms, data on seabird distribution and fishing effort are combined with a species' vulnerability to bycatch, where *vulnerability* is derived from a detailed observer data set in which bycatch rates by species are compared to estimates of their distribution. By weighting seabird distribution by population size, an estimate of the number of birds caught can be developed, and this can be compared to estimates of Potential Biological Removal, if the necessary seabird demographic data are available. Given the data requirements for this type of analysis, it may not the most feasible monitoring tool at the RFMO level.

More sophisticated methods of monitoring bycatch levels and the consequent population-level or conservation impacts, such as the inclusion of population modeling, may be possible for some species or colonies. However, several factors restrict the circumstances in which population modeling is possible: (i) few observer programs are currently able to identify seabird bycatch to species level, (ii) demographic models to date have focused on birds from a single island group, but for species that have a wider breeding distribution, provenance can rarely be resolved at the island group level, (iii) the time lag between bycatch reductions and demographic response makes it more difficult to determine impacts, (iv) many species are killed in non-tuna fisheries, (v) other factors affect demography, including climate change. However, population modeling can contribute important additional insights into understanding impacts of bycatch, including identification of (i) life-history or breeding stages most vulnerable to fishing impacts (by fleet/area/time), (ii) whether current levels of predicted bycatch are sustainable, (iii) identifying other measures that may be effective e.g. spatial management. In addition, some seabird species may be more amenable to population modeling, for example those that breed on single, well-monitored islands or island groups, which would allow provenance of bycatch to be assigned with confidence. Further, it may be necessary that a review of effectiveness of seabird bycatch mitigation measure includes some evaluation of population level impacts.

Use of seabird population status (e.g. trend) as an indicator of effectiveness of tuna RFMO seabird measures is also complicated because of factors such as (i) the assumption that tuna fleets have an impact that is large relative to other fleets, i.e. sufficiently large to detect an impact, (ii) the impact of other fleets and non-fishing factors on the population (iii) time lag between management measure effectiveness and demographic response (iv) the difficulty in assigning management effectiveness in one area to specific colonies. However, improved population trend and status is clearly an ultimate objective of seabird bycatch mitigation efforts.

Following discussions at the September 2014 meeting, ACAP's Seabird Bycatch Working Group will be progressing work to develop advice on analytical methods for estimating bycatch. This is also something that ICCAT's Sub-Committee on Ecosystems have agreed to develop intersessionally, and will likely also be discussed at the meeting of the Effectiveness of Seabird Mitigation Measures Technical Group of CCSBT that will be taking place in Japan on 4-6 November 2014. The outcomes of these discussions and processes should provide useful advice on the best analytical approaches to estimating seabird bycatch in both data rich and data poor scenarios.

**3. Harmonization of review across tuna RFMOs**

Given that many albatross and petrel species migrate between the areas of jurisdiction of more than one tuna RFMO, harmonizing the system for monitoring overall seabird bycatch and conservation measure effectiveness is necessary in order that cumulative impacts on each species can be assessed. In addition, assessment of the effectiveness of the tuna RFMO seabird measures would benefit from a centralised approach to bycatch data management at the tuna RFMO level (or even joint tuna RFMO level). It could provide a useful gap analysis in terms of low levels of observer coverage and/or data accessibility. This would require a centralised database, managed by one or more RFMO Secretariats.

## 4. Conclusion

Given that all five tuna RFMOs have now established seabird bycatch mitigation requirements, it is a useful time to consider how the effectiveness of these measures might best be monitored, or at least to identify minimum essential elements that reviews should include, and to consider the data collection and reporting that would be needed in order to facilitate this analysis. We recommend four elements to include in such reviews. In addition, if review methods were harmonized, this would facilitate seabird bycatch comparisons between tuna RFMOs. For those seabird species that are distributed across multiple tuna RFMO areas, this is necessary in order to assess cumulative impacts on these species.

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**Table 1. Currently active tuna RFMO seabird conservation and management measures and plans to review the effectiveness of these measures**

| Tuna RFMO seabird measure | Seabird bycatch mitigation requirements | Intent to review |
|---|---|---|
| ICCAT Recommendation 11-09 | Use at least two of the following mitigation measures: night setting with minimum deck lighting, bird-scaring lines, or line weighting in the area south of 25˚S with minimum technical standards. Use bird-scaring lines in the area between 20˚S to 25˚S (swordfish vessels can instead set lines at night and use line weights of >=60g within 3 m of the hook). Vessels in the Mediterranean are encouraged to use mitigation measures on a voluntary basis. | Paragraph 8. In 2015, the SCRS shall conduct another fishery impact assessment to evaluate the efficacy of these mitigation measures. Based on this fishery impact assessment, the SCRS shall make appropriate recommendations, if necessary, to the Commission on any modifications. |
| IOTC Resolution 12-06 | Use at least two of the following measures: night setting with minimum deck lighting, bird-scaring lines (tori lines) or line weighting in the area south of 25˚S with the minimum technical standards | Paragraph 6. The Scientific Committee, based notably on the work of the WPEB and information from CPCs, will analyse the impact of this Resolution on seabird bycatch no later than for the 2016 meeting of the Commission. It shall advise the Commission on any modifications that are required, based on experience to date of the operation of the Resolution and/or further international studies, research or advice on best practice on the issue, in order to make the Resolution more effective |
| WCPFC CMM 2012-07 | Use two of weighted branch lines, night setting or tori lines, in the area south of 30˚S; use at least two of bird streamer line, line weights, night setting, side setting with a bird curtain, blue-dyed bait, line shooter, offal management, including at least one of the first four of these, in the area north of 23˚N. CCMs are required to report annually on mitigation used, bycatch rates and total number of birds killed; vessels encouraged to undertake research and ensure safe handling and release; | Paragraph 6. The SC and TCC will annually review any new information on new or existing mitigation measures or on seabird interactions from observer or other monitoring programmes. Where necessary, an updated suite of mitigation measures, specifications for mitigation measures, or recommendations for areas of application will then be provided to the Commission. Paragraph 8: The intersessional working group for the regional observer programme will take into account the need to obtain detailed information on seabird interactions to allow analysis of the effects of fisheries on seabirds and evaluation of the effectiveness of bycatch mitigation measures. |

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|---|---|---|
| IATTC Resolution C-11-08 | Use at least two of the following mitigation measures: bird scaring line, line weights, night setting, side setting with a bird curtain, blue-dyed bait, line shooter, offal management, underwater setting chute, including at least one the first four of these, in the area north of 23˚N and south of 30˚S, plus the area bounded by the coastline at 2˚N, west to 2˚N-95˚W, south to 15˚S-95˚W, east to 15˚S-85˚W, and south to 30˚S, with minimum technical standards. | Paragraph 11: The effectiveness of this resolution to reduce seabird bycatch in the EPO, including the mitigation measures in Table 1, the area of application, and the minimum technical specifications adopted pursuant to this resolution, shall be subject to review and possible modification, taking into account the scientific advice from the Working Group on Bycatch, the SAC, and the IATTC scientific staff. |
| CCSBT ERS Recommendation 2011 | Comply with all IOTC, WCPFC and ICCAT measures; report data on interactions to the Commission which is authorized to exchange it with other tuna RFMOs | Paragraph 6: The Extended Commission will review the operation of this Recommendation with a view to enhancing the protection of ecologically related species from the impacts of fishing for southern bluefin tuna. |

**Table 2. Examples of methods that could be used to measure seabird bycatch rates, levels or impacts over time in tuna RFMOs as part of a review of the effectiveness of the tuna RFMO seabird conservation measures**

| Method | Description | Examples of use |
|---|---|---|
| Track reported seabird bycatch rates | Tuna RFMOs could monitor reported seabird bycatch rates (birds caught/1000 hooks) over time, with expectations that rates would decrease as mitigation measures are implemented, and with the potential to make comparisons between different fleets. However, this approach would need to be able to account of non-reporting fleets, as well as account for bias that may occur from data reported from low or non-representative observer coverage. In addition, given that bycatch rates vary spatially and temporally, it may be that the bycatch rate needs to be standardised to take into account variations in fishing effort distribution. However, currently, ICCAT and IATTC do not require fleets to report their raw or spatially and temporally stratified observer data to RFMO Secretariats, so standardisation would not be feasible. IOTC and WCPFC do have requirements to submit stratified observer data, but very few data have been submitted to date. An additional factor is that impact on seabirds could increase if fishing effort goes up, even if bycatch rates go down: this issue can be overcome by also tracking fishing effort. In some cases decreases/increases in bycatch rates could reflect declining/increasing populations, although this will be a problem for a number of these methods. | Widespread |
| Estimate number of birds killed per year | Use best available seabird bycatch rate data together with estimates of fishing effort in order to estimate the number of birds killed per year. Spatial and temporal stratification can be used (e.g. best available bycatch rate for each 5x5 degree square and year quarter, multiplied by fishing effort). Bycatch rates may be estimated for non-reporting fleets using the nearest bycatch rate estimate. Estimates of the number of each species killed could be made if reliable species level data were available. The 2012 meeting of the CCSBT Ecologically Related Species Working Group recommended that data be reported in such a stratified way that CCSBT could estimate total seabird mortality, and that such reporting be harmonized with other tuna RFMOs as far as possible (paras 32 and 56, CCSBT 2012). | Klaer 2012, Yeh et al. 2013. |
| Risk assessment | Estimate and monitor bycatch risk using data on seabird distribution and fishing effort combined with a measure of a species' vulnerability to bycatch, where *vulnerability* is derived from a detailed observer data set in which bycatch rates by species are compared to estimated species distribution. An estimate of the number of birds caught can be created by weighting seabird distribution by population size, and this can be compared to estimates of Potential Biological Removal, if demographic parameters are available. *Vulnerability* will be affected by the degree of implementation of seabird bycatch mitigation measures, therefore to track the | Waugh et al 2012<br><br>Richard and Abraham 2013<br><br>Richard et al. |

| Method | Description | Examples of use |
|---|---|---|
| | effectiveness of tuna RFMO seabird measures, the *vulnerability* measure (or at least degree of bycatch mitigation measure implementation) would need to be tracked for each fleet. Given the data requirements for this type of analysis, this may not be a feasible monitoring tool at the RFMO level. | 2013 |
| Population modelling | For those species for which sufficient demographic and population data are available, population models can be constructed which model impact of tuna pelagic longline fisheries at a colony or population level. However, given levels of background noise in such analyses, and impacts of non-tuna fleets, it may not be possible to use this to monitor impacts of seabird bycatch mitigation measures in the tuna pelagic longline fleets. | Tuck *et al.* 2011 |
| Population status | Monitor the population trends and responses of relevant albatross and petrel colonies. However, colonies will be impacted factors other than tuna pelagic longline fleets. | |

**Table 3. Types of approaches possible in assessing the impact of fisheries on seabird bycatch depending on the spatial/temporal resolution of the data available. The purpose of this information is to provide an indication of how the available data influence the type of assessments that can be carried out (Annex 8, ACAP 2013).**

| | |
|---|---|
| **Type 1: Fleet footprint data only** | • Summaries of change in the fishing footprint over time.<br>• Low quality risk assessment (possible only if seabird distribution information is available) |
| **Type 2: Fleet wide effort data only** | • Annual summary of fishery effort.<br>• Only provides a good indicator of trends in fishing effort if the fishery is stable by season and area through time (not normally the case). Determining the impact on seabirds requires data on seabird bycatch (and distribution of that bycatch) |
| **Type 3: Spatial and temporal effort data (e.g. 5x5 degrees, quarterly)** | • Annual spatial and temporal summaries of fishery effort data.<br>• Improved description of fishery effort that accounts for major spatial and/or temporal shifts common in fisheries.<br>• Impact on seabirds requires data on seabird bycatch (and distribution of that bycatch). |
| **Type 4: Spatial and temporal effort data + spatial foraging distributions of interacting birds by species** | • An overlap index could be calculated and tracked over time.<br>• While not providing a direct measure of bycatch, an overlap index can give a relative indication of potential interaction. For example, if a fishery relocated to another area beyond the normal range of previously impacted seabirds, the level of bycatch as well as the overlap index would be expected to decline. |
| **Type 5: Bycatch rate data for fleet only** | • Annual trends in bycatch rate for fleets could be tracked.<br>• Integration of fleets not examined. |
| **Type 6: Bycatch rate analysis + spatial and temporal effort data available** | • Matching corresponding (in space and time) bycatch rates with effort, allowing an estimate of total bycatch (total and by area, time and fleet).<br>• This is what is recommended for ACAP |
| **Type 7: Bycatch rate analysis with seabird species composition + spatial and temporal effort data available** | • As above but by species/population |
| **Type 8: Bycatch rate analysis by seabird species + spatial and temporal effort data available + demography parameters** | • A population level impact assessment could be conducted; this would enable the estimated bycatch totals (e.g. from 7 above) to be related to the consequent population impact. This can be important as tracking bycatch totals alone may not be giving an indication of population impact. |