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WORKING GROUP TO REVIEW STOCK ASSESSMENTS

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SEABIRDS and FISHERIES in the IATTC AREA: ASSESSMENT, DATA COLLECTION, MITIGATION

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Introduction:

Since 2005, the IATTC has increasingly been addressing seabird-related issues. Actions and recommendations have included:

- Resolution C-05-01 on Incidental Mortality of Seabirds (73rd Meeting IATTC, 2005);
- that the Commission coordinate with the Western & Central Pacific Fisheries Commission (WCPFC), and other tuna Regional Fisheries Management Organizations (RFMOs) as appropriate, in its implementation of seabird resolutions and the development of scientific information and reports that support this implementation. This could include practical areas of cooperation on the mitigation of seabird bycatch. (7th Meeting of the IATTC's Stock Assessment Working Group (SAWG), 2006);
- The IATTC should develop, in coordination with the other RFMOs, a strategy to mitigate bycatches in the different fisheries involved. The program should include standardization of data collection (whenever possible), discussion of research programs and activities to be undertaken in each, and a mechanism for the timely sharing of results. This item could be included in the agenda of the upcoming Kobe meeting. (7th Meeting SAWG, 2006);
- The Stock Assessment Working Group suggest areas where mitigation measures for reducing seabird mortality could be most effectively adopted (*i.e.*, where bird distributions and longline effort overlap), as well as suggest possible mitigation measures in these areas of vulnerability. The Commission should then consider mitigation measures at its June 2007 meeting. (6th Meeting of the IATTC's Bycatch Working Group (BWG), 2007); and that
- Seabird bycatch data be collected from all tuna longliners, with consideration given to making the provision of such data mandatory. (6th Meeting BWG, 2007).

This report addresses these actions and recommendations in the following key areas:

- ✓ Assessment
- ✓ Geographic areas where fisheries and seabirds overlap and potential interactions could occur
- ✓ Best practice data collection for seabirds and other protected species
- ✓ Possible mitigation measures

Assessment:

IATTC's Resolution C-05-01 calls on the Stock Assessment Working Group to present to the Commission an assessment of the impact of incidental catch of seabirds resulting from the activities of all the vessels fishing for tunas and tuna-like species, in the eastern Pacific Ocean. This assessment should include an identification of the geographic areas where there could be interactions between longline fisheries and seabirds.

Recall that in addition to direct fishery impacts, indirect impacts of the IATTC fisheries on seabirds have also been identified (IATTC Document SAR-7-05c). Distinct seabird species assemblages form feeding flocks in association with tunas and dolphins and depend upon these predators to drive prey closer to the surface (IATTC Document BWG-5-05.a.i). For example, associations of yellowfin tuna and several seabird species highlight the significance of the yellowfin tuna as a keystone species in the Eastern Tropical Pacific (see survey data in next section for tuna-dependent seabird species). It follows that activities that directly impact tuna stock or biomass (i.e. harvest strategies) can be expected to indirectly affect the diverse and abundant community of seabird species that closely associate with and depend upon them (IATTC Document SAR-7-05c). Although quantifying these indirect impacts may be problematic, assessments on the impacts of IATTC fisheries on seabirds should address both direct and indirect effects, to the extent feasible.

An initial assessment was presented at the 5th meeting of the BWG (IATTC Document BWG-5-05.a.i, 2006). Work is ongoing to improve this assessment.

Given last year's recommendation by the SAWG to coordinate with WCPFC and other tuna RFMOs in respective implementation of seabird resolutions, it's helpful to review what other RFMOs may be doing to conduct assessments. WCPFC's Scientific Committee considered an ecological risk assessment as a means for comparative analysis for the numerous species impacted by fisheries. Typically data collection for target species is presently far more complete and accurate than for non-target species and so full stock assessments are not routinely carried out for non-target associated and dependent species. Other methods must therefore be used to assess fishing impacts for these species (Kirby, 2006). A Productivity-Susceptibility Analysis (PSA) was discussed and its purpose is to provide an objective biological basis for assessing the risk of adverse fisheries impacts upon species caught. Life-history characteristics and measures of fisheries interactions are scored and plotted along two respective axes: productivity and susceptibility. The WCPFC Scientific Committee endorsed this assessment exercise in general, and the PSA in particular, as an appropriate way to assist the WCPFC in prioritizing species for management action or further research. There was agreement to further refine the PSA risk assessment approach and to encourage members to further develop this approach (WCPFC Scientific Committee, Second Regular Session, 2006). Due to budget constraints realized at the 3rd Session of the WCPFC Commission meeting, it may be 2008 before limited PSA work is done and non-target species will be prioritized.

ICCAT's Sub-Committee on Ecosystems met in February 2007 to develop a workplan for a seabird assessment. They agreed to advance the stages of a seabird assessment as follows: 1) Identify seabird species most at risk from fishing in the ICCAT Convention area, 2) collate available data on at-sea distribution of these species, 3) analyze the spatial and temporal overlap between species distribution and ICCAT longline fishing effort, 4) collate and review by-catch rate data, 5) estimate the total annual by-catch of seabirds in the ICCAT fisheries, and 6) assess the likely impact of this by-catch on seabird populations. The Sub-Committee will work intersessionally and likely meeting in September 2007 to review progress on the assessment (Report of the 2007 Meeting of the Sub-Committee on Ecosystems, Madrid, Spain, February 19 to 23, 2007).

<u>Geographic areas where fisheries and seabirds overlap and potential interactions could occur:</u>

Seabird distribution in the Eastern Pacific Ocean (EPO) has been considered in several ways, including species recorded by IATTC observers (IATTC Document SAR-7-10, 2006), results from a global *Procellariiform* tracking database (IATTC Document SAR-7-05b, 2006), species recorded by US observers (IATTC Document SAR-7-05c, 2006) and documentation from the scientific literature (IATTC Document SAR-7-10, 2006). Based on this information, several seabird species of concern were noted: Waved Albatross (*Phoebastria irrorata*), Laysan Albatross (*P. mutabilis*), Black-footed Albatross (*P. nigripes*), Black-browed Albatross (*Thalassarche melanophrys*), Chatham Albatross (*T. eremita*), Buller's Albatross (*T. bulleri*), Salvin's Albatross *T. salvini*). Other seabird species of potential concern were: Short-tailed Albatross (*P. albatrus*), Black (or Parkinson's) Petrel (*Procellaria parkinsoni*), Antipodean Albatross (*Diomedea antipodensis*), Southern Royal Albatross (*D. epomophora*), Northern Royal Albatross (*D. sanfordi*) (IATTC, 2006).

The following information from NOAA Fisheries Cetacean and Ecosystem Assessment cruises conducted by the Southwest Fisheries Science Center provides yet another source of information on seabird distribution in the EPO. These cruises have been ongoing since 1988. Their primary objective is to investigate trends in abundance of dolphins most affected by the tuna purse seine fishery. Cetacean data are collected using state of the art line transect methods and an ecosystem approach in sampling and analysis is used. In addition to dolphins, research is conducted on physical and biological oceanography (dolphin habitat), mid trophic-level fishes and squids (dolphin prey), and seabirds, marine turtles, and other cetaceans (dolphin commensals, competitors, and predators). These data not only allow for investigation of dolphin population trends, but also enable investigations of the function of tropical ocean ecosystems and the impact of climate change on living marine resources. Additional information may be obtained at http://swfsc.noaa.gov/star.aspx

Methods

Data were collected aboard two NOAA research vessels during approximately 240 sea days in the austral fall (August – November) of 1988, 1989, 1990, 1998, 1999, 2000, 2003, and 2006. (Three ships and approximately 360 sea days were used in 1998.) Standard strip transect methods were used, with a single observer on effort at any one time, generally for a two-hour period, weather permitting, during all daylight hours. The observer recorded all seabirds within 300 m of the ship that entered a quadrant between 0° and 90° (to the right or left side of the ship, corresponding to the side with best visibility conditions). Additional methodological details can be found in Philbrick et al. (2003).

Four categories of seabirds were chosen to represent a variety of feeding guilds with potential interactions with fisheries in the eastern tropical Pacific.

1. "Tuna-Dependent Species" feed in multispecies flocks in association with schools of yellowfin tuna, often accompanied by spotted and/or spinner dolphins (*Stenella attenuata* and *S. longirostris*, respectively; Au and Pitman 1986; Ballance et al. 1997). These seabirds do not have direct interaction with fisheries, but the indirect interaction could be significant. Because these species depend on tuna for successful feeding opportunities, a decline in tuna abundance could have severe negative implications for seabirds (Pitman and Ballance, unpublished data). Ninety species from 27 genera have been recorded to feed this way (Ballance 1993). Four of the most abundant species were chosen to represent this group: Juan Fernandez Petrel (*Pterodroma externa*), Wedge-tailed Shearwater (*Puffinus pacificus*), Red-footed Booby (*Sula sula*), and Sooty Tern (*Sterna fuscata*).

2. "Scavenging Species" feed on dead or dying organisms, both planktonic and nektonic. These species can feed in association with large-bodied marine predators (e.g. Pitman and Ballance 1992), or alone (Ballance and Pitman 1999). Because of their scavenging habits, they often follow ships and can be susceptible to incidental mortality particularly due to longline fisheries. Two species were chosen to represent this group: Parkinson's Petrel and Tahiti Petrel (*Pseudobulweria rostrata*).

3. Waved Albatross is a rare and localized species, endemic to the Galápagos Islands (Anderson et al. 2003). It is a scavenging, and ship-following species and is particularly susceptible to incidental mortality from longline fisheries (Jahncke et al. 2001).

4. "Micronekton Feeding Species" feed on planktonic or micronektonic invertebrates and fishes, generally at frontal regions which are known to concentrate such prey (Ballance and Pitman 1999, Spear et al. 2001). These species are not expected to be directly and significantly impacted by fisheries in the eastern tropical Pacific. Two species were chosen to represent this group: Leach's and Band-rumped storm petrel (*Oceanodroma leucorhoa* and *O. tethys*, respectively).

Distribution maps of these groups from all survey years were plotted over ship tracklines, the latter to illustrate sighting effort. For three groups, annual distribution maps were also produced. These maps show the geographic location of potential direct interactions with fisheries operations.

Black-footed and Laysan Albatross nest on Guadulupe Island (and San Benedicto Island for Laysan) and are seen in the survey study area but only in very low numbers. Neither species commonly forages in the study area, as they travel to the California Current and beyond (upwelling areas of high productivity). This is a characteristic of albatross species breeding in tropical areas (Hawaii, Mexico, Galapagos) to travel great distances (Bering Sea, Gulf of Alaska, California Current, Humboldt Current) at certain times of year to forage in areas of higher productivity (Fernandez et al 2001; Anderson et al 2003).

Results

Distribution maps of the four groups, all survey years, are illustrated in Figures 1 – 4.

Figure 1. Distribution of Yellowfin Tuna-Dependent Seabird Species, 1988 – 2006.

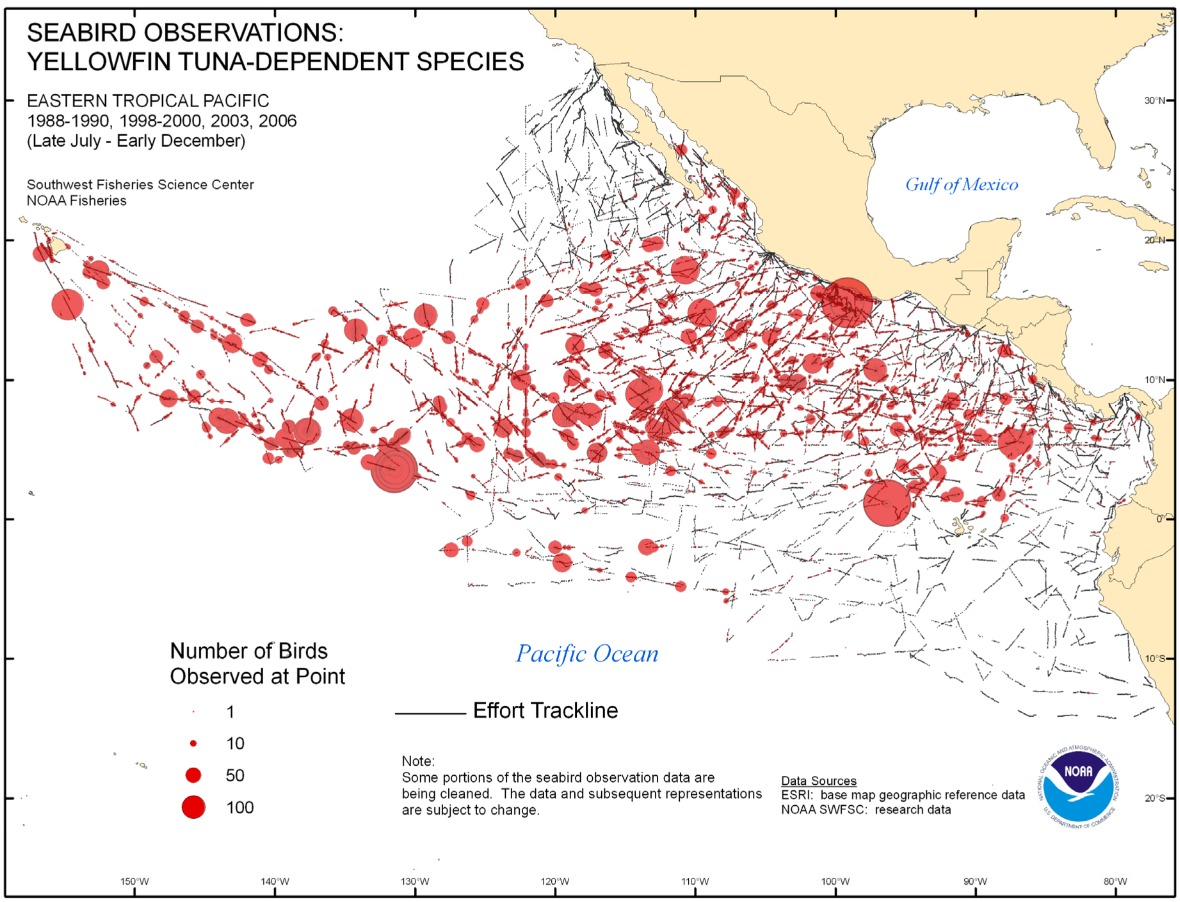


Figure 2. Distribution of Scavenging Seabird Species, 1988 – 2006.

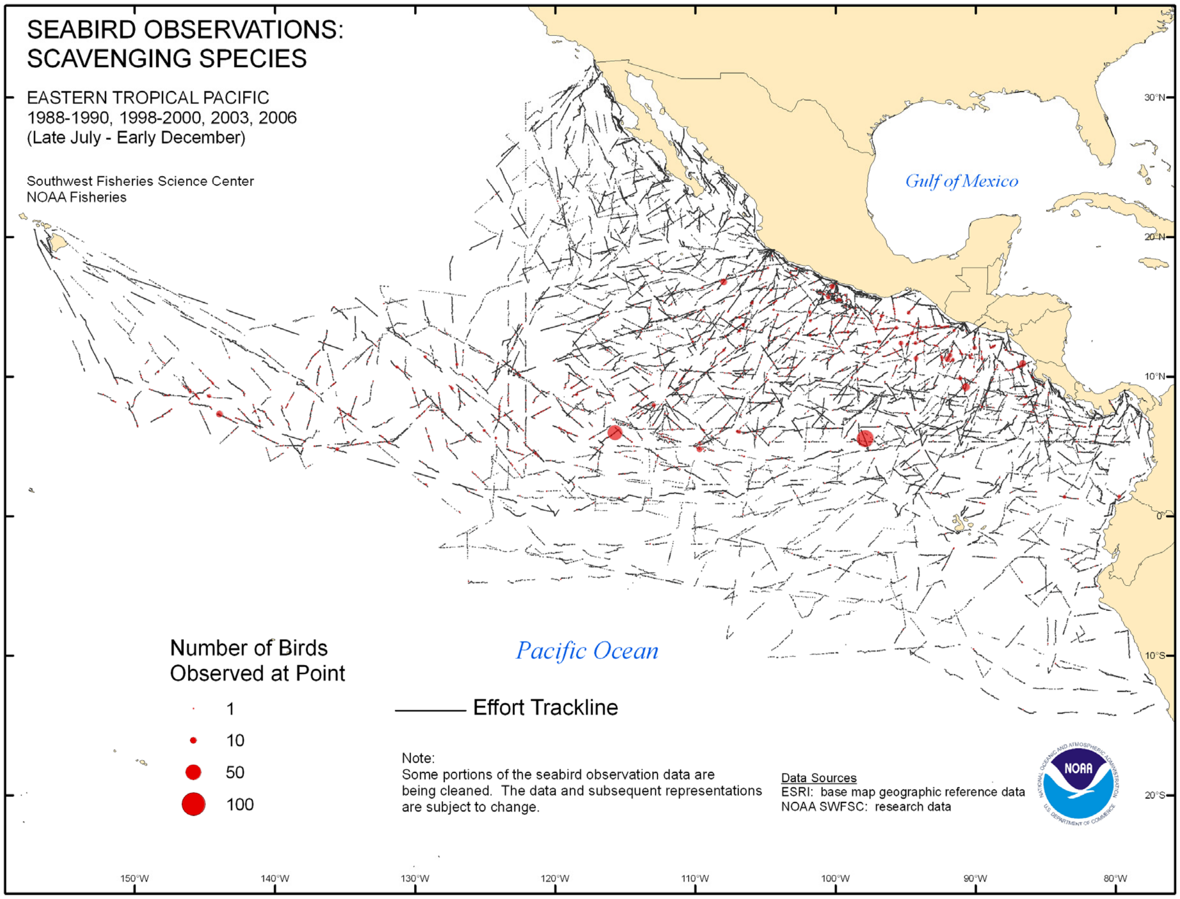


Figure 3. Distribution of Waved Albatross, 1988 – 2006.

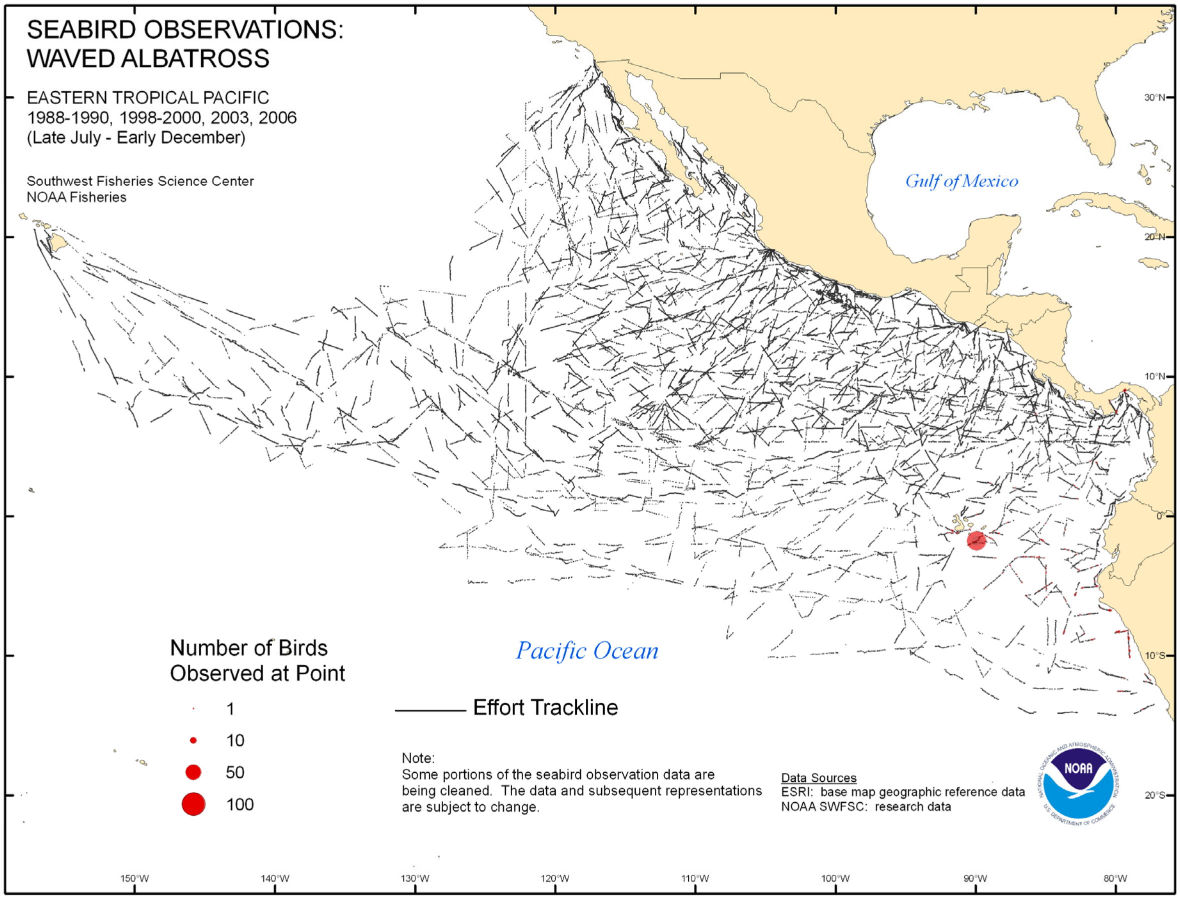
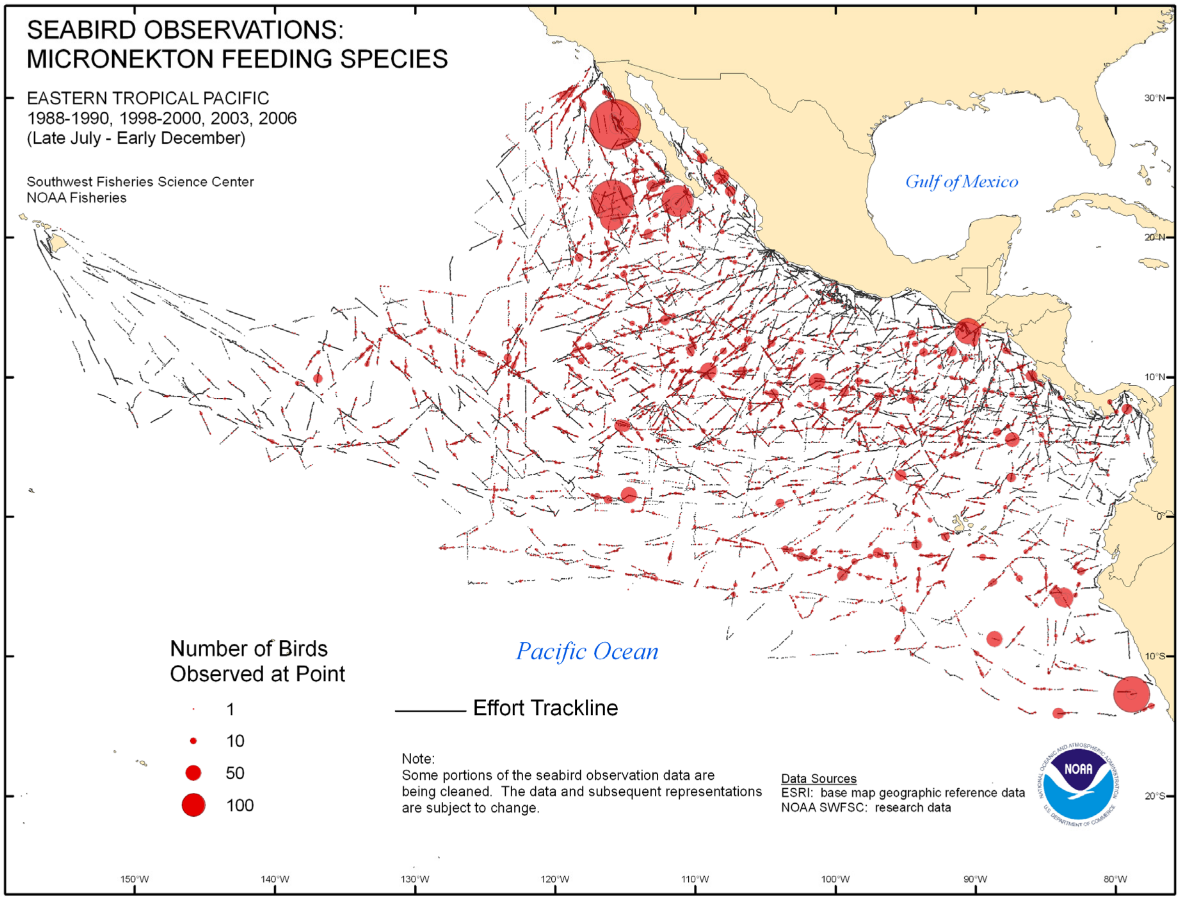


Figure 4. Distribution of Micronekton Feeding Seabird Species, 1988 – 2006.



Although large spatial scale distribution patterns hold across years, there is clear interannual variation in distribution patterns within a single group. This is illustrated for one of the four groups, Yellowfin Tuna-Dependent Species, in Figures 5 – 12.

Figure 5. Distribution of Yellowfin Tuna-Dependent Seabird Species, 1988.

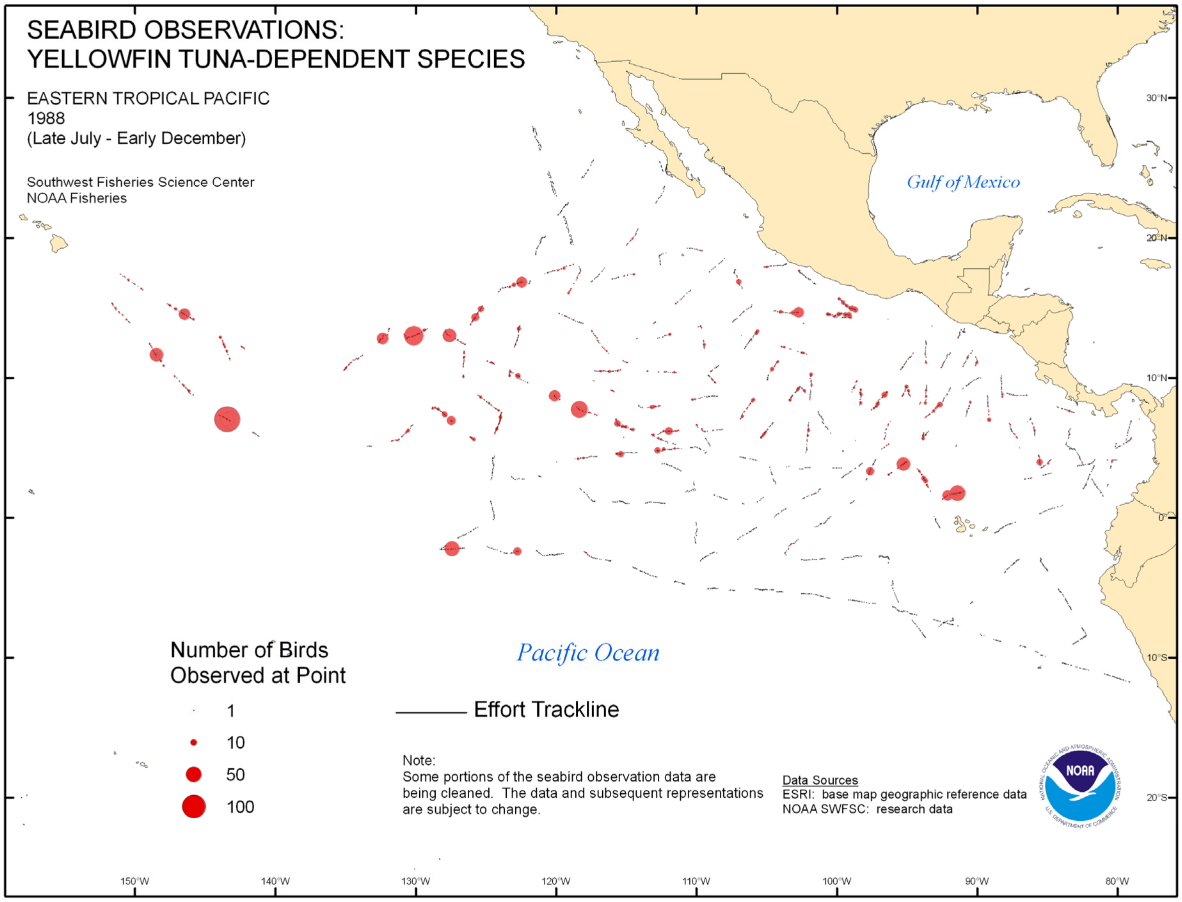


Figure 6. Distribution of Yellowfin Tuna-Dependent Seabird Species, 1989.

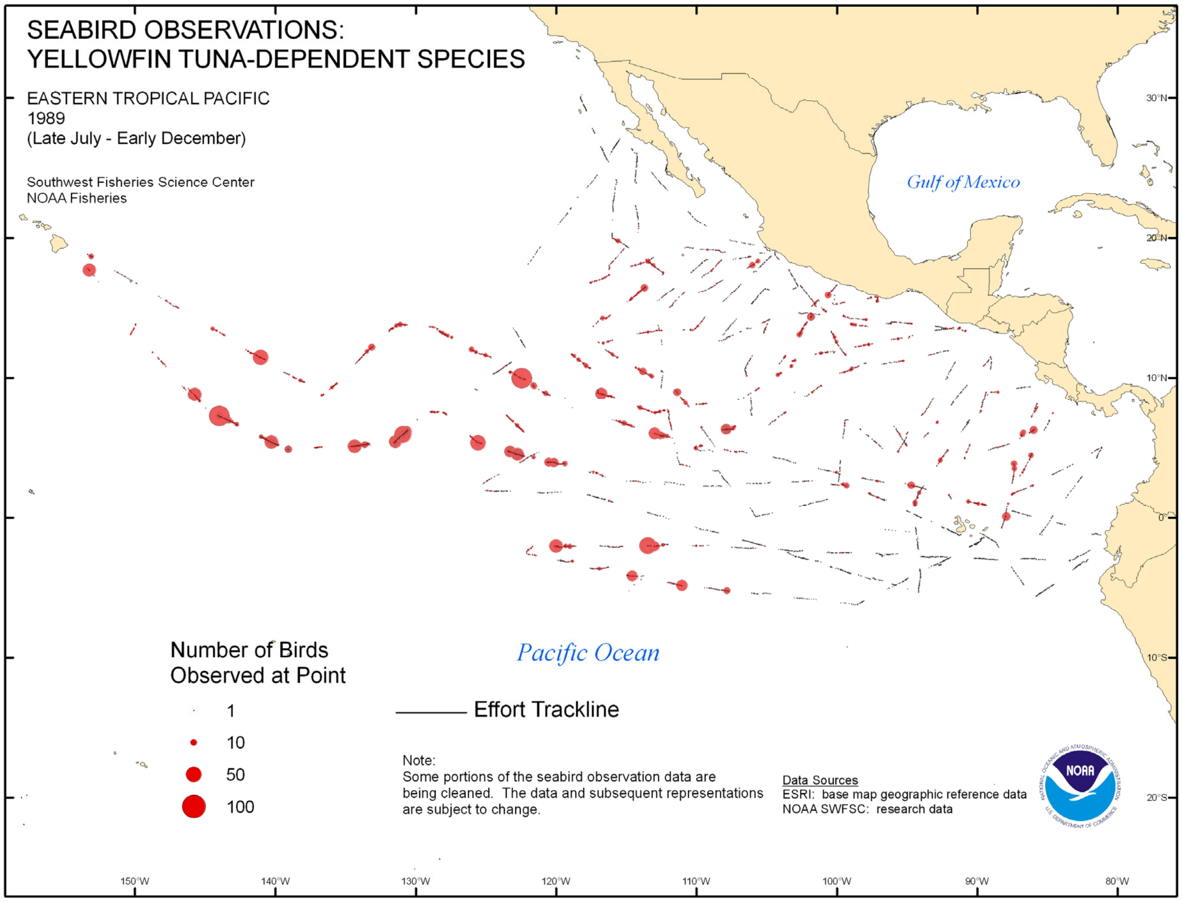


Figure 7. Distribution of Yellowfin Tuna-Dependent Seabird Species, 1990.

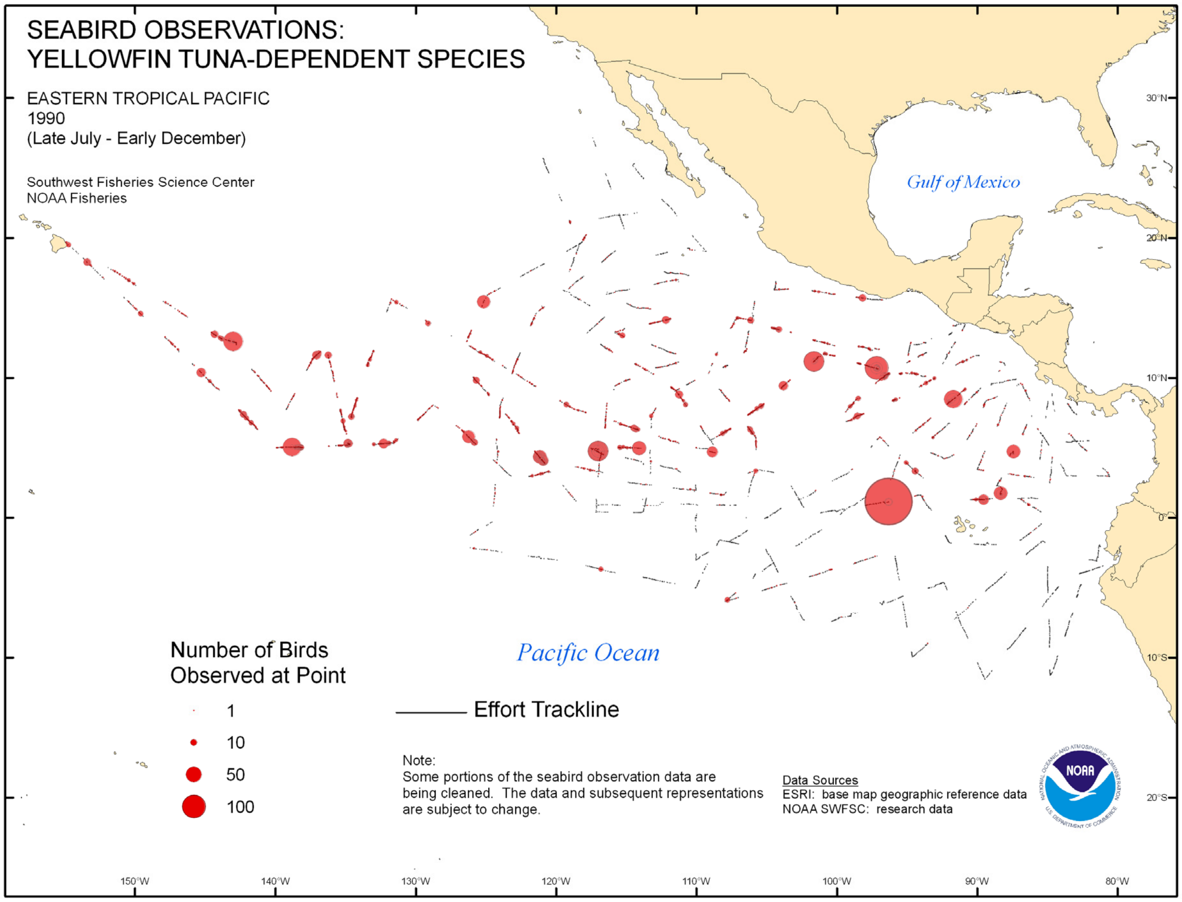


Figure 8. Distribution of Yellowfin Tuna-Dependent Seabird Species, 1998.

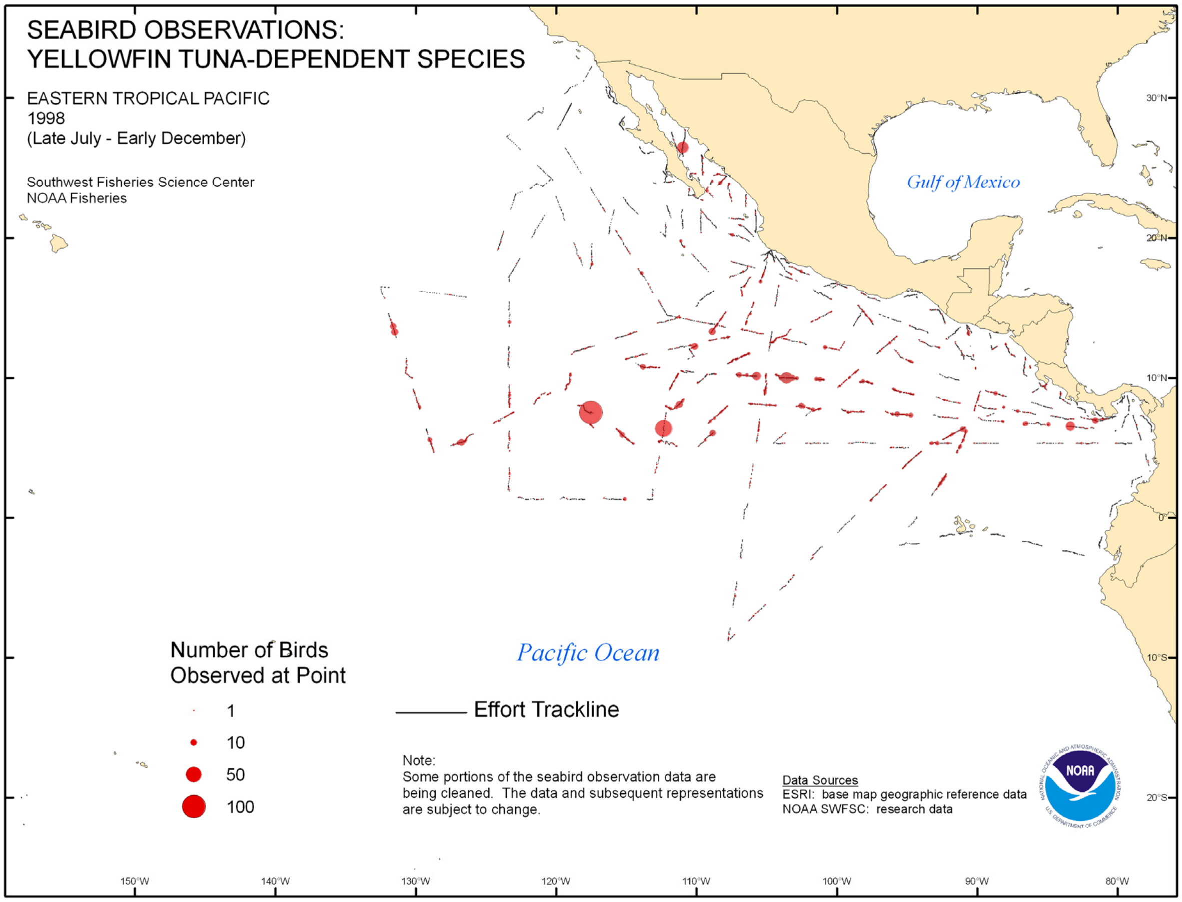


Figure 9. Distribution of Yellowfin Tuna-Dependent Seabird Species, 1999.

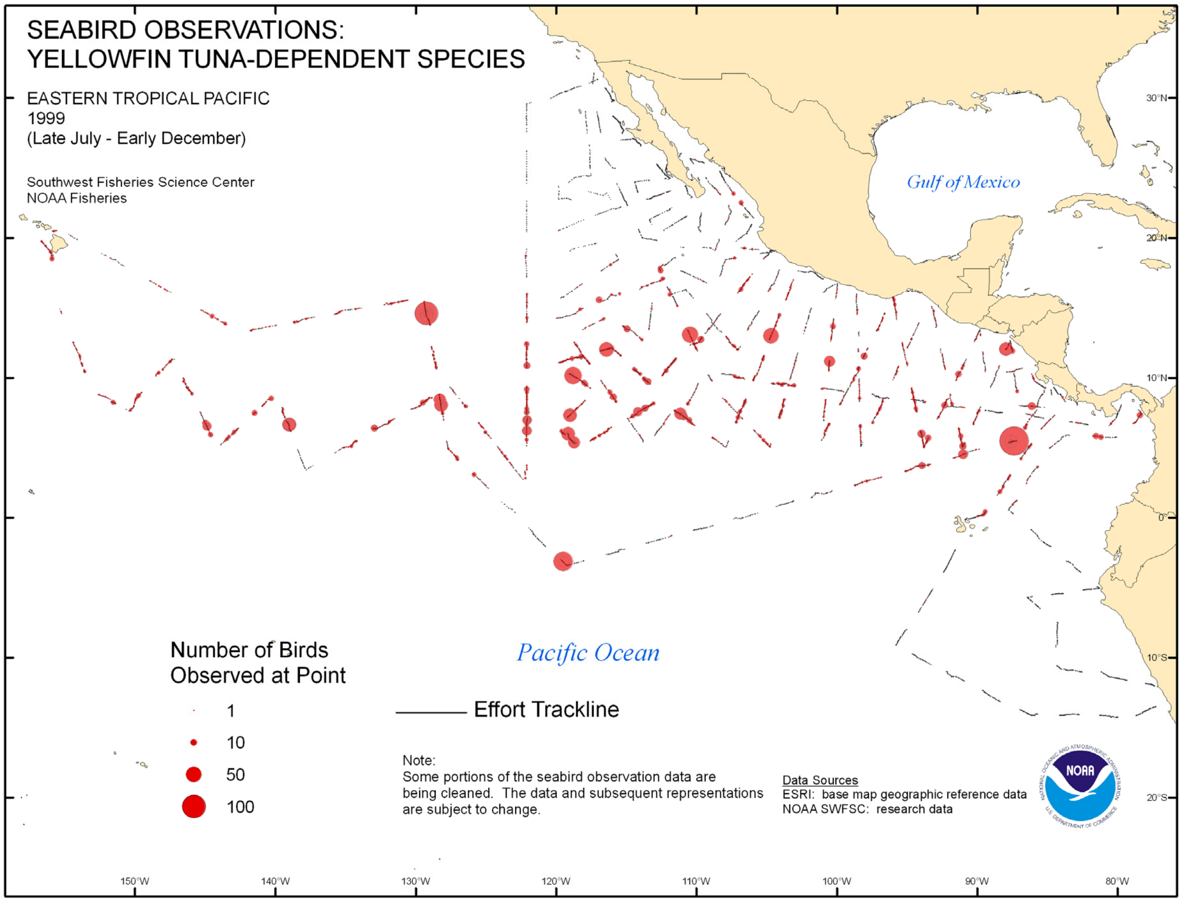


Figure 10. Distribution of Yellowfin Tuna-Dependent Seabird Species, 2000.

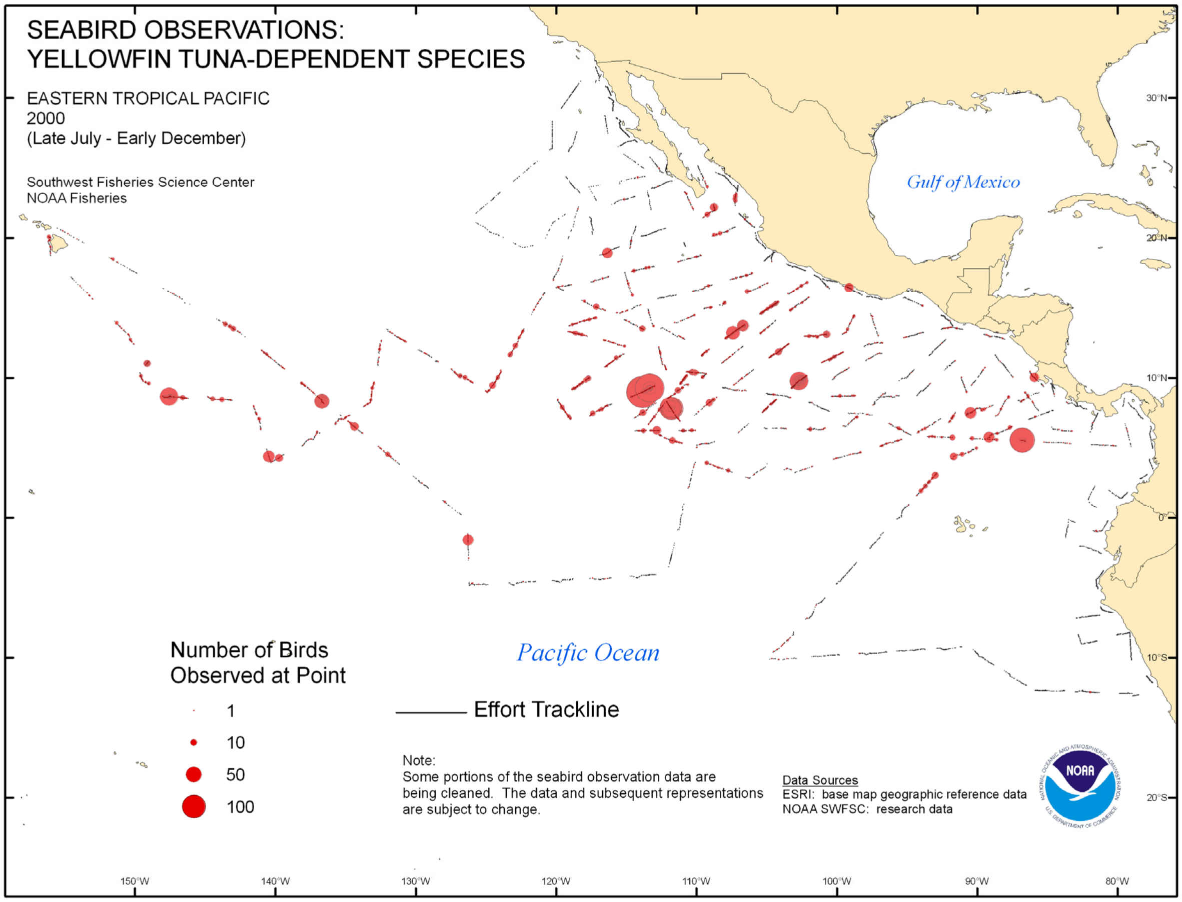


Figure 11. Distribution of Yellowfin Tuna-Dependent Seabird Species, 2003.

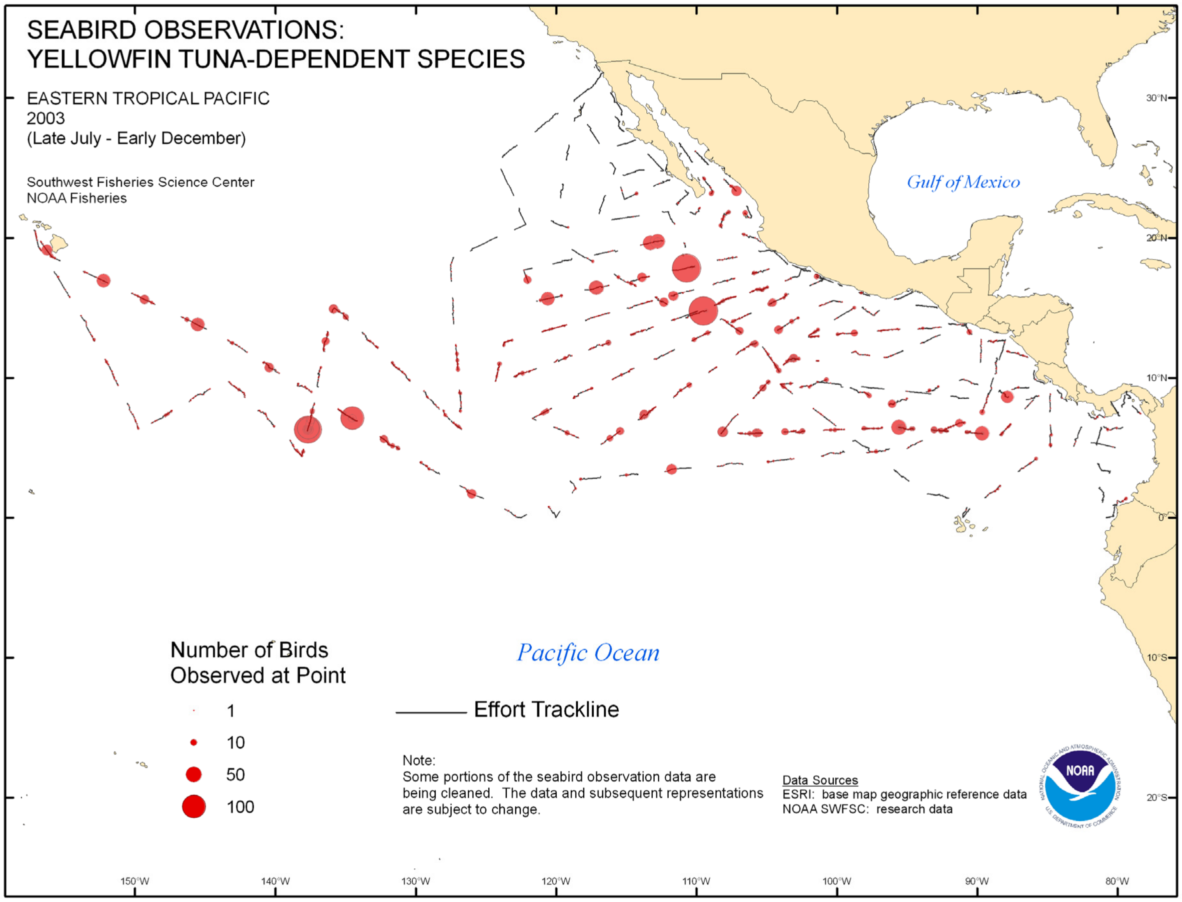
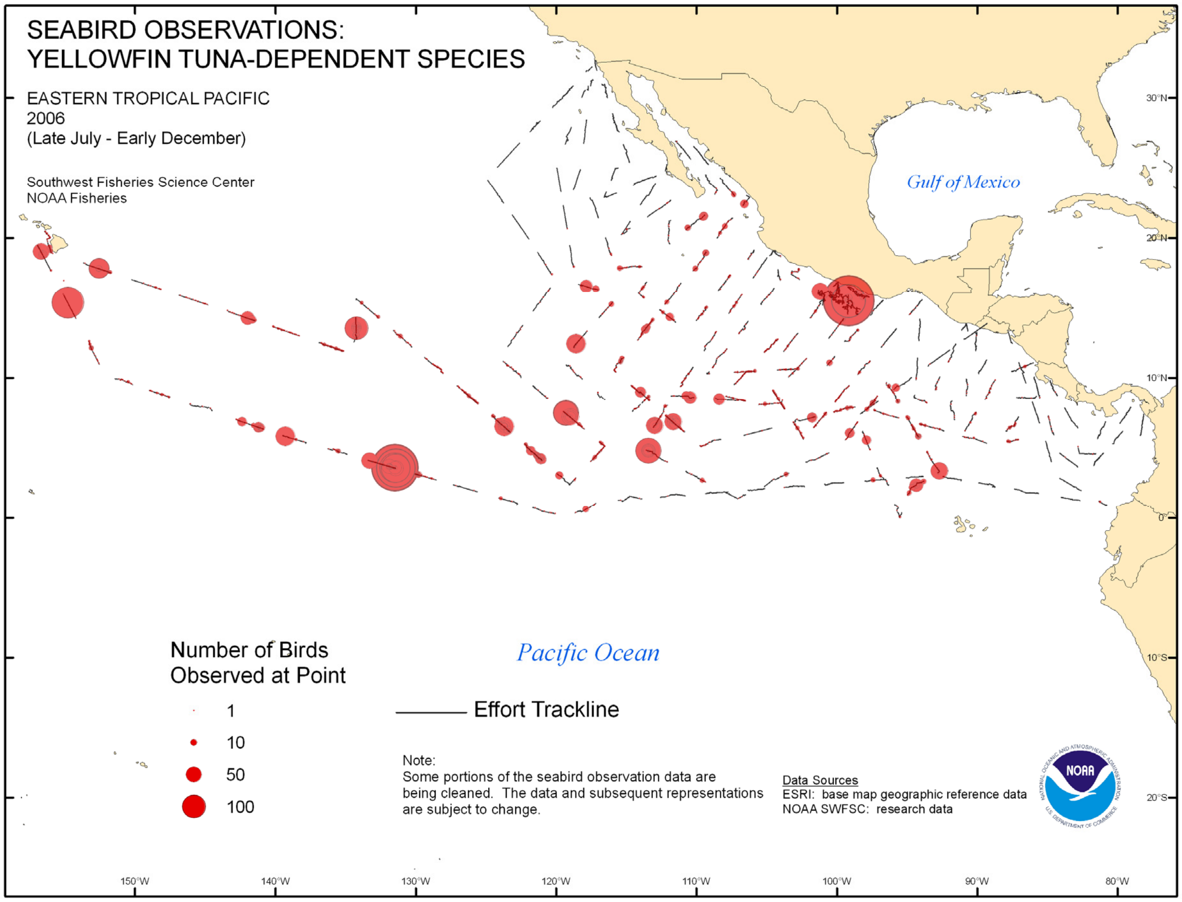


Figure 12. Distribution of Yellowfin Tuna-Dependent Seabird Species, 2006.



Conclusion

Data from the NOAA Fisheries Cetacean and Ecosystem Assessment cruises corroborates the potential for both direct and indirect interactions of some seabird species with IATTC fisheries. Indirect interactions may occur with yellowfin tuna-dependent seabird species (e.g. Juan Fernandez Petrel, Wedge-tailed Shearwater, Red-footed Booby, and Sooty Tern) (Figure 1). Figures 5-12 illustrate the interannual variation of the seabird associations with yellowfin tuna, assumedly related to the interannual variability of the tuna and their prey species as well. The survey data also supports the concern for possible direct interaction between IATTC longline fisheries that occur in the survey area and the Waved Albatross and Parkinson's Petrel. Although these results do not indicate a high degree of overlap with the Black-footed and Laysan Albatross during the survey months (August to November) in the survey area, overlap with these species does occur at other times of year and in other areas as documented by satellite tagging data (BirdLife International 2006). Laysan Albatross tracked during the breeding season from Hawaii and Guadulupe Island and Black-footed Albatross captured at-sea and tracked during the non-breeding season did overlap with the IATTC area and longline fishing effort.

Observer Data Collection:

At its 7th meeting in 2006, the Stock Assessment Working Group recommended that IATTC should develop, in coordination with the other RFMOs, a strategy to mitigate bycatches in the different fisheries involved and that the program should include standardization of data collection (whenever possible). In 2004, NOAA Fisheries conducted a workshop in conjunction with the International Fisheries Observer Conference in Sydney, Australia, to address the development of best practices for the collection of longline data to facilitate research and analysis to reduce bycatch of protected species (seabirds, sea turtles, marine mammals).

The development and implementation of data collection standards for longline fishery observer programs is challenging at many levels. First, there is the lack of detail in the recommendations regarding what data collections need to be standardized. Second, observer programs worldwide have diverse objectives that may make standardization seem unfeasible or unwarranted. For example, if bycatch monitoring is not the primary objective of a given observer program, increasing observer data collection responsibilities regarding seabirds, sea turtles, and marine mammals may be seen as infringing on the ability of an observer to collect data for a program's primary objectives. Finally, instituting the use of consistent data fields at the observer program level may impact long-term data series, add to database management costs, and increase time required for observer training. Despite these challenges, there are benefits to standardizing certain aspects of observer data collection procedures for longline fisheries. Information collected consistently could improve global assessments of the impacts of longline fisheries on bycatch species, and facilitate research to develop gear modifications or changes in fishing practices to reduce bycatch (Dietrich et al 2007).

Recommendations for best practices

Based on the responses provided by observer program data users in a pre-workshop survey and discussions by workshop participants, a list of variables was compiled that represent "best practices" that should be included in the collection of longline data by fisheries observers (Table 1). The workshop participants generally agreed with the list of variables identified as **critical** or **preferred** by data users in the pre-workshop survey, but in some cases other variables were added to the list based on further discussions at the workshop.

Table1: Best Practices--Recommended minimum variables to be collected in all longline fisheries. (from Dietrich et al 2007, executive summary)

Gear Type Fished	Category	Variables
All	Temporal	Date gear was deployed Start time of gear deployment End time of gear deployment Date gear was retrieved Start time of gear retrieval End time of gear retrieval
Pelagic	Spatial	Latitude at beginning of gear deployment Longitude at beginning of gear deployment Latitude at end of gear deployment Longitude at end of gear deployment Latitude at beginning of gear retrieval Longitude at beginning of gear retrieval Latitude at end of gear retrieval Longitude at end of gear retrieval
Demersal[a]		Latitude at beginning of either gear deployment or retrieval Longitude at beginning of either gear deployment or retrieval Latitude at end of either gear deployment or retrieval Longitude at end of either gear deployment or retrieval
Pelagic	Physical and Environmental	Sea surface temperature Depth fished at beginning of gear deployment [b] Depth fished at end of gear deployment [b] Depth of bottom at beginning of gear deployment Depth of bottom at end of gear deployment
Demersal		Sea surface temperature Depth fished at beginning of gear deployment[b,c] Depth fished at end of gear deployment[b,c] Depth of bottom at beginning of gear deployment Depth of bottom at end of gear deployment
All	Vessel and Fishing	Unique vessel identifier Unique observer identifier Vessel length Total number of hooks deployed Direction of haulback Target species[d] Bait species Bait condition (live/fresh/frozen/thawed, whole/cut) Autobaiter used? (if used, also record bait efficiency) Weight of added weight (if used) Direction of gear retrieval
All	Gear[e]	Groundline/mainline length[f] Branchline/gangion length Distance between branchlines Hook size[g] Hook type
All	Catch	Total catch, actual or estimated (number and/or weight) Catch by species (number and/or weight) Observed effort (total number of hooks observed during retrieval)
All	Mitigation Measure/ Deterrent Device	Presence of any type of deterrent used or required to be used, and how it was used

Gear Type Fished	Category	Variables
All	Bycatch	Species identification Number of each species captured Type of interaction (hooking/entanglement) Disposition (dead/alive) Description of condition/viability of the animal upon release (if released alive)

[a] Demersal gear fished on the bottom is stationary, thus collecting data on either where gear is deployed or retrieved is sufficient.
[b] In some observer programs, fishing depth is derived from the sum of the floatline/dropline length and the branchline/gangion length.
[c] For demersal gear, depth fished should also be collected it if is different than bottom depth.
[d] Target species may be derived in some programs from the catch composition.
[e] Although $\geq$50% data users responding to the pre-workshop survey identified these 5 gear variables as critical or preferred, workshop attendees were reluctant to identify specific gear variables for inclusion as best practices, instead noting these will vary by fishery depending on bycatch species and regulatory measures in place. Emphasis was instead placed on standardized definitions of terms and data collection methods.
[f] Groundline/mainline length is rarely an exact measurement, due to the length of the line. Instead it is either derived (by multiplying distance between floats by number of floats), estimated by the observer, or reported by the vessel.
[g] Hook size is often reported by the vessel or provided by the manufacturer rather than measured by the observer.

Optimal data specific to bycatch species was identified by data users in the pre-workshop survey and workshop participants. They recommended the following variables and material be collected when possible:

- Collection of whole carcasses (seabirds) or parts/biopsies (sea turtles and marine mammals)
- Photographs and species identification forms
- Age (as derived from collection of teeth or other samples)
- Sex (observed, or blood sample/biopsy dart if cannot be observed)
- Size of animal (type of measurements vary by species, and may be limited to an estimate of total length if animal is not boarded)
- Time and location of capture of bycatch species within the set (although there may be constraints on the precision of these variables)
- Systematic sightings of protected species around gear during gear deployment/retrieval
- Tags (presence/absence, attached prior to release)
- Evidence of depredation on catch (by marine mammals or other species), including species of fish damaged, description of type of damage, photographs of damaged fish, and number of fish damaged.

Data variables considered **not important** for data collection were not discussed in detail at the workshop, as there were very few responses in this category. The lack of responses indicating a particular variable was not important made interpretation of the survey results difficult and subject to potential bias.

When incorporating these best practices into observer data collections, workshop participants recommended that each program should:

- Establish a process for periodically reviewing and prioritizing data needs, in coordination with data users. Priorities may be set according to fishery-specific data needs, but should incorporate broader priorities where possible.
- Clearly communicate data collection priorities to all stakeholders.
- Establish and disseminate metadata for observer databases that describe each variable collected, how it is collected and when data collection methods change, why it is collected (long-term operational vs. short-term research project), and the level of precision of measurements.
- Identify which variables are or can be derived from other variables; consider eliminating collection of variables that can be derived from other variables.

- Ensure the use of standard and objective definitions and data collection methodologies.
- Clarify when data are "reported" (by the vessel or some other entity) as opposed to "measured independently" (by the observer).
- Strive to meet data collection needs while keeping observer health and safety a priority.
- Keep informed regarding current bycatch reduction research and emerging data needs to support research.

As IATTC and other RFMOs and IATTC parties are considering observer programs (regional and national, respectively) and data collections, it will be worthwhile to consider these recommendations for best practices.

<u>Effective Seabird Mitigation Devices and Methods:</u>

At its meeting in 2007, the IATTC Bycatch Working Group recommended that the Stock Assessment Working Group suggest areas where mitigation measures for reducing seabird mortality could be most effectively adopted (*i.e.*, where bird distributions and longline effort overlap), as well as suggest possible mitigation measures in these areas of vulnerability. The Commission should then consider mitigation measures at its June 2007 meeting.

In 2006, two tuna RFMOs, WCPFC and the Indian Ocean Tuna Commission (IOTC) adopted binding seabird mitigation measures for longline vessels (IATTC Document SAR-8-14). The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) also requires longline vessels to use seabird mitigation measures (www.ccsbt.org). These measures could provide the initial basis for IATTC's consideration of appropriate measures for use in the IATTC area.

Recent reviews of seabird mitigation measures indicate a suite of measures that are available or under development and highlight that measures need to: reduce or minimize bird interactions with fishing gear, be practical and easy to implement in commercial fishing, be available at minimal cost, not increase the bycatch of other taxa or decrease the catch of target species, be enforceable, and provide fishermen with incentives to employ them (Lokkeborg, in press; Melvin and Baker 2006; Bull 2007). Also, multiple measures should be employed as no single measure alone is known to effectively reduce bycatch in a wide array of applications.

Lokkeborg (in press) identifies 4 main categories for longline fishing seabird mitigation measures: 1) avoid peak areas and periods of bird foraging (e.g. night-setting, area and seasonal closures); 2) limit bird access to baited hooks (e.g underwater setting funnel, weighted lines, thawed bait, side-setting); 3) deter birds from taking baited hooks (e.g. bird scaring (streamer) lines); and 4) reduce the attractiveness of visibility of the baited hooks (dumping of offal, artificial baits, blue-dyed bait). Lokkeborg stressed the need to apply an experimental approach to fine-tune the most promising mitigation measures, such as: streamer line design, weighted longlines, and side-setting.

Participants at a workshop on Seabird Bycatch in Pelagic Longline Fisheries in October 2006 in Hobart, Australia, evaluated and ranked the most promising mitigation measures for future research (Melvin and Baker 2006). Streamer lines, a bait-setting capsule (protects baits from attacks by seabirds), and side-setting were ranked of highest priority. Weighted branch lines, a bait pod (similar concept to capsule), and circle hooks received the second highest ranking and all other methods were ranked low (underwater setting chute, night setting, fish oil, bait placement, line shooters, thawed bait, and strategic offal discharge).

Workshop participants raised concerns about the possible use or institution of measures as seabird avoidance measures before they had been adequately tested and proven. Particular reference was made to bait-casting machines and to line shooters. Early models of some bait-casting machines included features which allowed for the control of the distance at which baits are cast. This is a necessary feature to allow for accurate delivery of baits under a bird scaring line. Subsequent models underwent cost savings and these features were not retained (Bull 2007). Line shooters set longlines without tension, enabling the line to set closer to the vessel and perhaps increase the sink rate. The device consists of a pair of hydraulically operated wheels that pull the line through the auto-baiter, delivering the line slack into the water (Bull 2007). Line shooters have not been tested in pelagic longline fisheries for demonstrating reductions in seabird bycatch and tests in demersal longline fisheries have demonstrated contrasting results (Melvin and Baker 2006).

Workshop efforts like this will help focus and identify and research priorities that are most likely to result in effective and practical seabird mitigation measures that can then be used in pelagic longline fisheries managed by RFMOs and within EEZs.

Bull (2007) suggests that a minimum requirement of line weighting that achieves hook sink rates minimizing seabird bycatch rates should be tailored with a combination of strategic offal and discard management, bird-scaring lines, and night-setting, particularly in Southern Hemisphere fisheries. Bull also highlights that with this combination of measures in use, even within a fishery it is likely to be necessary to refine the techniques used by individual vessels in order to maximize their effectiveness at reducing seabird bycatch (Bull 2007).

Preliminary analysis of data collected by the NMFS Pelagic Observer Program on 6,949 observed longline sets on US vessels in Atlantic pelagic longline fisheries indicate that more seabirds may be incidentally caught on J hooks than on circle hooks (Hata 2006). Due to small sample sizes in this analysis, it will be important for additional information to be collected before definitive statements can be made about the efficacy of circle hooks at reducing seabird bycatch. Thus, researchers studying circle hooks are encouraged to analyze the impact of circle hooks on the incidental catch of seabirds.

Summary of Seabird Priorities for Stock Assessment Working Group Consideration:

- Continued improvements and progress on an assessment of IATTC fishery impacts on seabirds, including both direct and indirect ecosystem effects;
- ‘Best practice’ seabird bycatch data collection on industrial and artisanal longliners;
- Continued coordination with other tuna RFMOs and gear mitigation scientists at identifying appropriate and effective technical specifications for seabird mitigation measures;
- Circle hook research should measure the impacts of circle hooks vs. other hook types on seabird bycatch levels; and
- Require effective seabird mitigation measures on industrial longliners in IATTC areas of highest likelihood for interactions.

Acknowledgments

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