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Thinking big – taking a large-scale approach to seabird bycatch

Title: Thinking big – taking a large-scale approach to seabird bycatch

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Seabird bycatch in industrial fisheries has been the focus of research and conservation concern since the early 1990's (Weimerskirch & Joventin 1987, Bartle 1991, Brothers 1991). Recent research has explored the impact of seabird bycatch in longline (Tuck *et al.* 2001, Lewison & Crowder 2003) as well as in trawl fisheries (Weimerskirch *et al*. 2000, Sullivan & Reid 2003). Understanding the impact of fisheries bycatch for seabird species involves both quantifying the number of individuals affected (including lethal or sub-lethal effects) as well as determining what effect, if any, bycatch could have at the population or community level.

Fisheries bycatch is only one of several human-mediated disturbances that may threaten seabird populations. Introduced predators, toxin contamination and disease are also likely to negatively impact populations (Arcos *et al.* 2002, Finkelstein *et al.* 2003, Weimerskirch 2004). Ideally, the goal is to understand the relative effects of each of these putative threats on population growth. However, data limitations (quantity and quality), uncertainty with analytical methods and assumptions, and the difficulties associated with understanding dynamic, natural systems present formidable obstacles to quantifying the effects of fisheries bycatch and other disturbances.

Despite these challenges, there is a growing body of bycatch data and research. Figure 1 illustrates published or released seabird bycatch data from longline and trawl fisheries through 2004. These data come from observer programs and experimental fisheries. Although bycatch coverage is still small relative to fishing effort, the existing body of data continues to grow in size and detail. For some fisheries, there is bycatch data that extend over more than a decade. Carcass recovery programs point to sex-biased mortality in some regions. Bycatch studies in the Patagonian shelf area and around Prince Edward Islands found a strong adult male bias in bycatch mortality (Nel *et al.* 2002, Ryan & Boix-Hinzen 1999) for three species (*Procellaria aequinoctalis, Thalassarche chrysostoma*, *T. chlororhynchos*), whereas studies around New Zealand, South Georgia and Crozet Islands have found adult, female-biased bycatch mortality for *Procellaria cinerea* and *Diomedea exulans* (Weimerskirch & Joventin 1987, Croxall & Prince 1990, Murray *et al.* 1993). Knowing how bycatch patterns have changed over time and which age/sex classes interact with fishing gear is essential to understanding how current bycatch levels may affect future seabird populations.

Beyond data limitations and uncertainty, another less obvious challenge to bycatch research is the issue of scale. Fishing effort is globally distributed: some areas are subject to fishing pressure from multiple fisheries, but there are few (if any) ocean regions that remain entirely unfished. A map of pelagic longline fishing effort in 2000 provides one example of the global nature of industrial fisheries (Figure 2). Telemetry studies indicate that some seabirds also can have ocean-wide distributions, traveling hundreds of kilometers in days (Weimerskirch *et al.* 1999, Weimerskirch & Wilson 2000, Croxall *et al.* 2005). Although efforts are underway to release more detailed distribution data (BLI 2004), estimated distributions for albatross and petrel species of conservation concern suggest that seabirds can encounter as many as 12 sovereign nations, which likely represent just as many fishing fleets (Table 1). Because seabirds encounter many fishing fleets, bycatch assessments at the national, or fleet-specific, level can only represent a small fraction of the bycatch from a much larger total. Although national bycatch assessments can address important local conservation concerns, for many seabird species, these small-scale analyses will not be indicative of the conservation status of the population or species as a whole.

Given the wide distributions of many seabird species and the highly mobile, multi-national fishing fleets with which they interact, a large-scale perspective is required to accurately characterize the magnitude and extent of bycatch effects. This ‘big picture’ perspective will also be critical to tracking the efficacy of bycatch mitigation measures implemented across fleets. Recognizing the international nature of seabird bycatch also highlights the critical role that regional fisheries management organizations (RFMOs) must play in implementing and enforcing effective international bycatch mitigation management. RFMOs, as one of the few entities charged with the management of international (‘high seas’) fisheries, can provide a much-needed forum for coordination and proactive conservation of bycatch species (Small 2005).

To further the state of bycatch research, it is essential that researchers begin to consider the effects of bycatch from multinational fleets across large ocean regions. Taking a large-scale approach will facilitate a more integrated approach to understanding and managing the impact of fisheries bycatch. Across regions, research combining fishing effort, bycatch, oceanographic conditions and seabird distribution data can provide an ecological understanding of what generates bycatch hotspots. Although more data will always be warranted, for some regions, existing bycatch data can be used for these large-scale analyses.

A large-scale approach will only be possible with international coordination and collaboration. Such a synthesis will require attention to issues of data sharing and propriety. However, given the conservation concern for many species and the potential for bycatch research to move beyond a single-species to a more ecological focus, the sometimes daunting logistics of international collaboration are worth tackling. Regional and ocean-wide analyses that synthesize smaller data sets into a larger, ecologically relevant context are needed for innovation and progress in seabird bycatch research.

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Table and Figure captions

Table 1. The number of nations likely to be encountered by seabirds of conservation concern as they travel across breeding and foraging areas.

Figure 1. Map of published or released seabird bycatch data from longline fisheries through 2003. Triangles represent an approximated region of data collection.

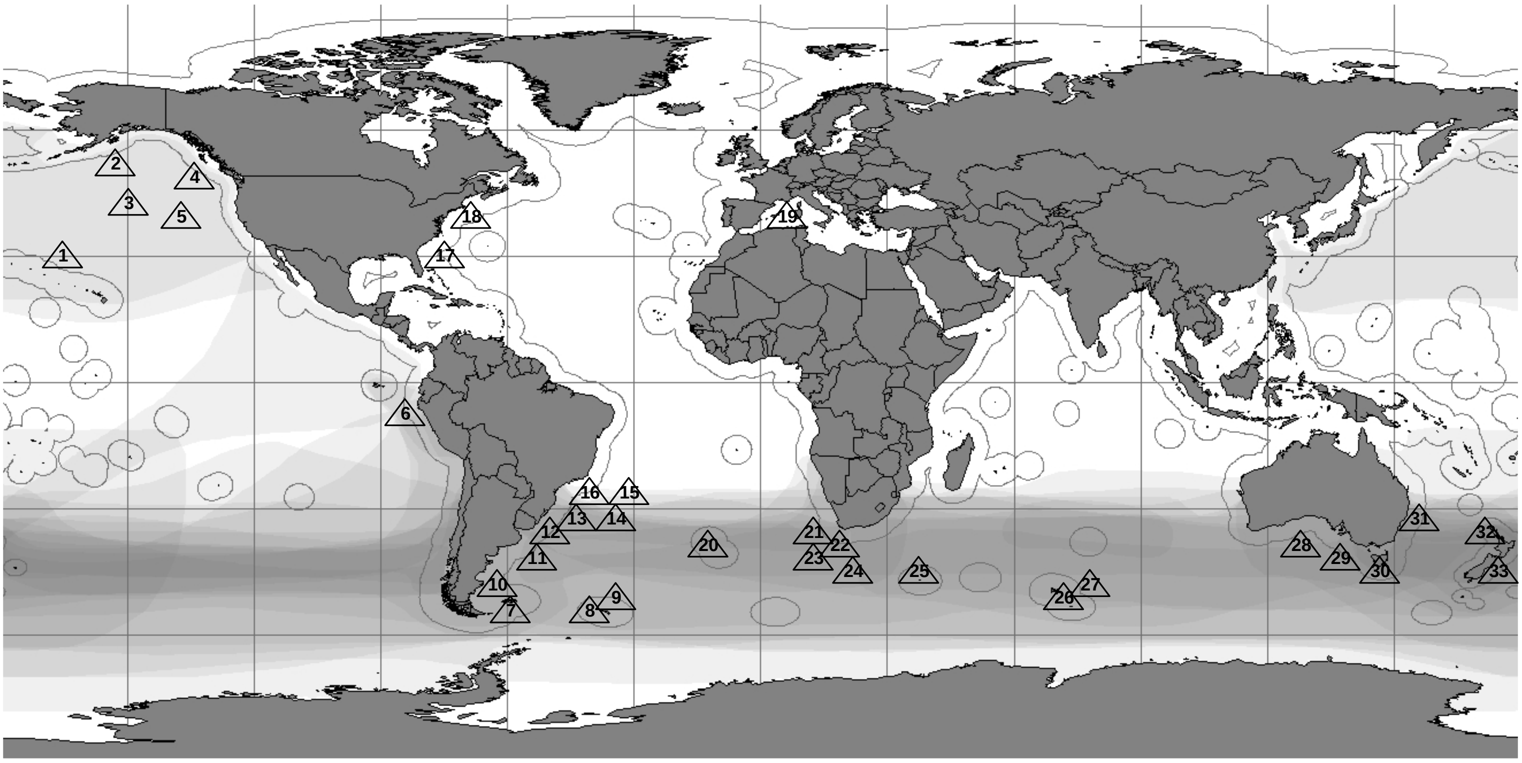
Figure 2. An example of the global nature of industrial fisheries – pelagic longline fishing effort in 2000. The darker areas represent areas of higher fishing effort (from Lewison *et al.* 2004).

Table 1.

	Species	Amsterdam Albatross *Diomedea amsterdamensis*	Antipodean Albatross *Diomedea antipodensis*	Black-browed Albatross *Thalassarche melanophrys*	Black-footed Albatross *Phoebastria nigripes*	Buller's Albatross *Thalassarche bulleri*	Cambell Albatross *Thalassarche impavida*	Chatham Albatross *Thalassarche eremita*	Grey-headed Albatross *Thalassarche chrysostoma*	Indian Yellow-nosed Albatross *Thalassarche carteri*	Northern Royal Albatross *Diomedea sanfordi*	Southern Royal Albatross *Diomedea epomophora*	Salvin's Albatross *Thalassarche salvini*	Short-tailed Albatross *Phoebastria albatrus*	Sooty Albatross *Phoebetria fusca*	Tristan Albatross *Diomedea dabbenena*	Wandering Albatross *Diomedea exulans*	Waved Albatross *Phoebastria irrorata*	Southern Giant Petrel *Macronectes giganteus*	Black Petrel *Procellaria parkinsoni*	Spectacled Petrel *Procellaria conspicillata*	Westland Petrel *Procellaria westlandica*	White-chinned Petrel *Procellaria aequinoctialis*
	Conservation Status	CE	V	V	E	V	V	CE	V	V	E	V	V	V	V	E	V	V	V	V	CE	V	V
Breeding areas	Argentina																		X				
	Australia			X					X								X		X				X
	Chile			X					X										X				
	Ecuador																	X					
	France [1]	X		X					X	X					X		X		X				X
	Japan				X									X									
	New Zealand		X	X		X	X	X	X		X	X	X							X		X	X
	South Africa								X	X					X		X		X				X
	UK [2]			X					X						X	X	X		X		X		X
	USA				X																		
Foraging range (EEZs)	Angola			X																			
	Argentina			X					X		X	X			X		X		X				X
	Australia		X	X		X	X	X	X	X	X	X	X		X		X		X				X
	Brazil			X							X	X			X	X					X		X
	Canada				X									X									
	Chile		X	X		X		X	X		X	X	X				X		X			X	X
	China				X									X									
	Columbia																			X			
	Ecuador					X												X		X			
	Japan				X									X									
	Mozambique									X													
	Madagascar									X													
	Mexico																			X			
	Namibia			X									X			X	X		X				X
	New Zealand		X	X		X	X	X	X	X	X	X	X				X		X	X	X	X	X
	Panama																			X			
	Peru			X		X		X					X					X		X		X	X
	Russia				X									X									
	South Africa			X						X	X	X	X		X	X	X		X		X		X
	South Korea				X									X									
	Taiwan				X									X									
	Uruguay			X					X		X	X			X	X			X		X		X
	USA				X									X									
	# OF NATIONS	**1**	**3**	**12**	**7**	**5**	**2**	**4**	**8**	**7**	**8**	**7**	**6**	**7**	**7**	**5**	**8**	**3**	**9**	**6**	**5**	**3**	**11**

[1] French Southern Territories
[2] United Kingdom Overseas Territories
CE = Critically Endangered; E = Endangered; V = Vulnerable

Figure 1.



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2. U.S. National Marine Fisheries Service, Observer program
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30. Brothers 1991
31. Klaer & Polacheck 1997
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33. Baird 2005

Figure 2.