FISHING ACTIVITY AND SEABIRD VESSEL ATTENDANCE NEAR THE NORTHERN ANTARCTIC PENINSULA

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SUMMARY

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We conducted a survey to investigate the factors influencing the number of seabirds attending a research vessel during scientific trawling activities near the northern Antarctic Peninsula. Our objective was to assess whether seabirds exhibited varying levels of attendance that may be attributed to fishing activity. Counts of seabirds attending the vessel were made during non-fishing periods, net deployment, towing and retrieving. We also monitored environmental variables (e.g. pressure, wind speed and direction) and discards of fish and offal to determine whether those variables could be used to explain variability in seabird attendance. Three species, the Black-browed Albatross *Thalassarche melanophris,* Cape (or Pintado) Petrel *Daption capense* and Wilson's Storm-Petrel *Oceanites oceanicus* were the most common seabirds attending the vessel. We found that abundance of seabirds did not vary between fishing activities, although the presence of discards caused an increase in the numbers of petrels and albatrosses. Our study is the first to examine seabird-vessel attendance to scientific trawling activities in Antarctic waters where a moratorium on commercial finfish fishing is in place. In comparison with other studies, the level of fishing conducted during this study does not come close to approaching that of commercial fishing (i.e. catch rate and fishing duration). Nevertheless, it is important to monitor seabird attendance at fishing vessels so that proper mitigation and conservation actions are met to protect seabirds.

Key words: Antarctic Peninsula, attendance, fishing activities, trawling, seabird-fishery interactions, Black-browed Albatross, Cape Petrel, Wilson's Storm-Petrel

INTRODUCTION

Many species of seabirds are attracted to vessels at sea (e.g. Griffiths 1982, Tasker *et al.* 1984, Hudson & Furness 1988). Fishing vessels are particularly attractive because of the discard of fish and offal. Although seabirds may view fishing vessels as a source of food, there is a potential for negative interactions between fishing activities and seabirds (Montevecchi 2002). For example, Sullivan *et al.* (2006) reported that, during commercial finfish trawling activities, more Black-browed Albatross *Thalassarche melanophrys* cable interactions occurred when albatross abundance was higher—a situation that may lead to higher mortality. Weimerskirch *et al.* (2000) showed that offal discard during trawling activities increased the abundance of albatross species attending the vessel. Seabirds may be injured or killed during trawling activities through collision with various cables or entanglement in gear (Bartle 1991). The interaction between seabirds and fishing vessels is complex, and it is imperative that studies be conducted to elucidate the main factors influencing seabird attendance at fishing vessels.

The duration of fishing activities varies depending on the target fish species, but is generally separated into periods of fishing and non-fishing, with gear deployment and retrieval occurring between fishing efforts (Sullivan *et al.* 2006, Dietrich & Melvin 2008). Fishing activities may also be conducted while discarding portions of the catch, which may thereby effectively increase the number of seabirds attending fishing vessels (Hudson & Furness 1988, Garthe & Huppop 1994). Gonzalez-Zevallos and Yorio (2006) reported significant differences in seabird abundance around fishing trawlers in Argentina depending on vessel activity. They found that more birds were present during gear retrieval (hauling) and discarding while towing than during tow periods without discarding fish. They also reported inter- and intra-annual differences in attendance and species present. Near Kerguelen Island in the southern Indian Ocean, Weimerskirch *et al.* (2000) noted differences in peak abundance with differences in vessel activity, although these were not significant. Weimerskirch *et al.* (2000) also found that time of year was significant for nearly all species analyzed, indicating that seabird vessel attendance may vary depending on seasonal cycles.

Little information is available regarding seabird attraction to trawlers in Antarctic waters (below 60°S). Our study occurred in February–March 2006 near the northern Antarctic Peninsula in coordination with the US Antarctic Marine Living Resources Program. Several finfish stocks (Chaenichthyidae) were nearly depleted near the Northwestern Antarctic Peninsula region because of unregulated trawling activity during 1978/79 through 1989 (Kock *et al.* 2004). After 1990, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) imposed a moratorium on the finfish fishery in that area. Since then, the fishery has been closed, and few stock assessments have been conducted to determine the recovery of the finfish population (Kock *et al.* 2004, Jones *et al.* 2006). Our objective was to assess factors potentially influencing seabird attendance at a research trawl vessel in an area in which commercial fishing has been absent since 1989 (CCAMLR Subarea 48.1).

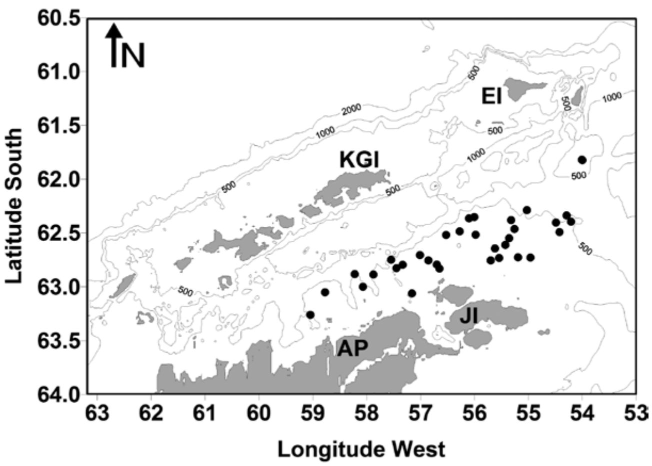

Fig. 1. Map of trawling locations during February–March 2006. AP = Antarctic Peninsula; EI = Elephant Island; KGI = King George Island; JI = Joinville Island.

METHODS

TRAWL SURVEY

Trawling operations were conducted aboard the R/V *Yuzhmorgeologiya* from 19 February to 16 March 2006. The fishing gear used was a Hard Bottom Snapper Trawl with vented

TABLE 1
Type and definition of variables collected during observations

Variable	Type	Description
Vessel activity	Categorical	Non-fishing, net deployment, towing, net retrieval
Discards	Logical	Presence or absence of discards during observation
Vessel speed	Continuous	Knots
Position	Continuous	Latitude and longitude
Visibility	Categorical	5 = clear horizon; 4 = fuzzy horizon; 3 = no visible horizon; 2 = no visible horizon, but can see at least 300 m; 1 = visibility <300 m
Wind speed	Continuous	Knots
Air temperature	Continuous	Degrees Celsius
Pressure	Continuous	Millibars

TABLE 2
Relative abundance of species observed during the survey

Common name	Species name	Total		Aggregate[a]	
		(n)	(%)	(n)	(%)
Cape Petrel	*Daption capense*	1421	40.0	70	51.5
Black-browed Albatross	*Thalassarche melanophris*	1026	28.9	77	56.6
Wilson's Storm-Petrel	*Oceanites oceanicus*	625	17.6	89	65.4
Antarctic Fulmar	*Fulmarus glaciodes*	209	5.9	38	27.9
Giant petrels	*Macronectes* spp.	188	5.3	63	46.3
Grey-headed Albatross	*Thalassarche chrysostoma*	38	1.1	19	14.0
Snow Petrel	*Pagodroma nivea*	9	0.25	6	4.4
Skuas	*Catharacta* spp.	8	0.2	5	3.7
Antarctic Tern	*Sterna vittata*	8	0.2	4	2.9
White-chinned Petrel	*Procellaria aequinoctialis*	5	0.1	2	1.5
Black-bellied Storm-Petrel	*Fregetta tropica*	4	0.1	3	2.2
Gentoo Penguin	*Pygoscelis papua*	4	0.1	3	2.2
Chinstrap Penguin	*Pygoscelis antarctica*	2	0.05	1	0.7
Greater Sheathbill	*Chionis alba*	2	0.05	2	1.5
Prions	*Pachyptila* spp.	1	0.03	1	0.7
Wandering Albatross	*Diomedea exulans*	1	0.03	1	0.7
TOTAL		3551		(136 cases)	

[a] The mean number of birds binned into 136 usable cases for statistical analyses.

V-doors (Net Systems, Bainbridge Island, WA, USA). The trawl was deployed from a 1.98-m × 3.84-m (width × diameter) net reel, a 3.56-m × 3.65 m (length × diameter) stern roller, two trawl winches, instrumented trawl blocks, and a third wire winch. In total, 61 trawls were completed near the northern Antarctic Peninsula (Jones *et al.* 2006; Fig. 1).

Seabird observations

Counts of seabird abundance were estimated for species within a 300-m hemisphere astern of the vessel. Observations were conducted by two trained observers. Observations occurred approximately every 30 minutes during non-fishing periods and every five minutes during three trawling periods: net deployment, towing (net at fishing depth) and net retrieval. Tow time was limited to 30 minutes, and the other fishing periods depended on bottom depth. Visibility and discard occurrence were recorded for each observation, and position, wind speed and direction, vessel speed, and air temperature and pressure were recorded every second by the underway Scientific Computing System [SCS (Table 1)].

The trawling design included a third cable system that is known to cause indirect seabird mortality through collision during trawling (Bartle 1991). Unfortunately, observations of seabird–cable interactions were not recorded because of other required duties (i.e. seabird observers dedicated solely to watching cable interactions were not on board).

Analytical methods

Because observations were likely not independent (i.e. consecutive counts often included the same individuals following the ship), the analysis was performed on data aggregated (means) by station and activity type during fishing and by three vessel speed categories (0 to <4 knots, 4 knots to 8 knots, >8 knots) and the presence of discards during non-fishing periods. Records with visibility less than 300 m (i.e. visibility codes <2) were also excluded from the analysis.

We used generalized additive models (GAMs) to assess factors influencing seabird vessel attendance. The GAMs were fitted using S-Plus 2000 (Insightful Corporation, Seattle, WA, USA). Counts of seabirds attending fishing vessels are often not normally distributed; therefore, GAMs were specified with a quasi-likelihood estimate of the error distribution, which included a log link and variance equal to the mean [μ—i.e. the same form as the Poisson distribution, except for a constant of proportionality: $Var\,(y_i) = \phi E\,(y_i)$]. Quasi-likelihood methods allow for the estimation of the dispersion parameter, ϕ, and inclusion of the dispersion estimate in *F*-tests for model comparisons (Chambers & Hastie 1992). Model selection was based on a forward-and-backward stepwise process using all of the variables (Table 1).

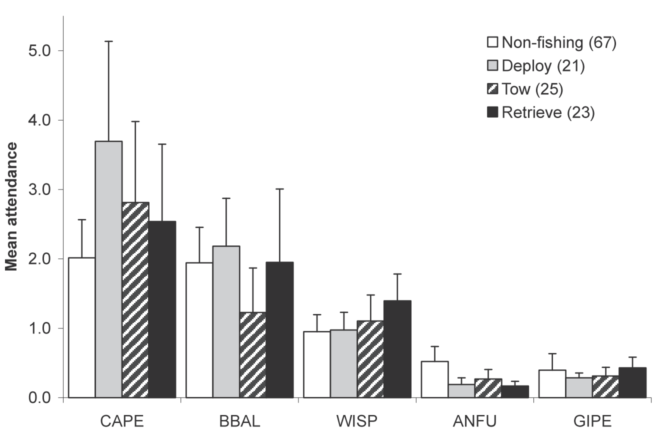

Fig. 2. Attendance of species by vessel activity. CAPE = Cape Petrel *Daption capense*; BBAL = Black-browed Albatross *Thalassarche melanophris*; WISP = Wilson's Storm-Petrel *Oceanites oceanicus*; ANFU = Antarctic Fulmar *Fulmarus glaciodes*; GIPE = giant petrels *Macronectes* spp. Numbers in parentheses are the sample size for each activity type. Standard error is indicated for each bar.

RESULTS

We observed 16 species during the survey (Table 2) for a total of 3551 seabirds during 594 observation periods. The maximum number of seabirds occurring in the observation zone was 105. To our knowledge, no birds were caught or killed during the course of the survey.

Observations were aggregated into 136 useable cases. Wilson's Storm-Petrel *Oceanites oceanicus,* Black-browed Albatross, Cape Petrel *Daption capense,* and giant petrels *Macronectes* spp. were the most ubiquitous, occurring during 65%, 57%, 51% and 46% of the observations respectively. The remaining species were sighted during fewer than 8% of the observations. Separate models were created for the three most abundant species—Wilson's Storm-Petrels, Black-browed Albatross and Cape Petrels—which together accounted for more than 80% of abundance during the non-fishing periods and 90% during the three fishing periods.

No discarding of fish occurred during any of the fishing periods (i.e. net setting, towing and retrieving), and so we were unable to assess whether fish discard influenced seabird attendance during fishing periods. However, the presence of discards during non-fishing periods increased the attendance of Black-browed Albatrosses and Cape Petrels during non-towing periods. Although differences for

TABLE 3
Significance of variables in GAM models assessing seabird vessel attendance for the three most abundant seabirds

Variable	Species		
	CAPE (69%)[a]	BBAL (56%)[a]	WISP (38%)[a]
Vessel activity	—	—	—
Discards	0.02323	0.02620	—
Vessel speed	—	—	—
Position	0.00000	0.00000	0.00000
Visibility	0.00000	—	0.00297
Wind speed	—	—	—
Air temperature	—	—	—
Pressure	—	0.00000	—

[a] Percent deviance explained by the model.
CAPE = Cape Petrel *Daption capense*; BBAL = Black-browed Albatross *Thalassarche melanophris*; WISP = Wilson's Storm-Petrel *Oceanites oceanicus.*

each species between activity types were apparent (Fig. 2), subsequent accounting for the variation of additional variables (e.g. location, presence of discards, pressure, visibility), fishing activity was not a significant predictor for attendance of Wilson's Storm-Petrels, Black-browed Albatrosses or Cape Petrels (Table 3).

Position, loaded as a loess-smoothed surface of latitude and longitude, was significant for all three species (Table 3), indicating that the number of seabirds attending the vessel in some regions was greater than would be attributable to chance. The attendance of Black-browed Albatrosses decreased when barometric pressure was low. Visibility was a significant variable for explaining variability in attendance models of Cape Petrel and Wilson's Storm-Petrel, although the relationship with increased visibility was not clear.

DISCUSSION

Seabird attendance was not influenced by vessel activity, although the presence of discards coincided with an increase in numbers of Black-browed Albatrosses and Cape Petrels. Location was also an important factor for explaining seabird vessel attendance, although we may have sampled in regions in which seabirds were aggregated because of prey and physical oceanographic boundaries. Interestingly, the attendance of Black-browed Albatrosses decreased when barometric pressure was low. This finding could be attributed to changes in the physiology and behavior of albatrosses in response to physical stresses (e.g. low depressions, storms) in the environment (Wingfield & Kitayskay 2002).

Our project differs from most published accounts of seabird attendance at trawlers in that the vessel was not fishing commercially or continuously, and was catching at least one order of magnitude less fish than a typical commercial fishing operation would. In addition, seabird numbers may have also been much lower than during other studies (Weimerskirch *et al.* 2000, Sullivan *et al.* 2006) because of a much smaller observation zone (300-m hemisphere versus 500-m hemisphere or square). Although the level of fishing activity during this study was not near that of a commercial fishery, our study is significant because it assesses seabird attendance in relation to research fishing vessel activity in a region in which finfish fishing has been absent for nearly 20 years. Moreover, the region contains important foraging habitat for threatened seabirds (e.g. Black-browed and Grey-headed *T. chrysostoma* albatrosses—IUCN 2009, BirdLife International 2004), and information is needed to determine whether fishing activity may cause incidental mortality. Routine monitoring of fishing activity and seabird vessel attendance should be conducted whenever possible for providing information to ongoing management and conservation strategies. We have shown that research vessels operating in Antarctic waters closed to commercial fishing provide unique opportunities for assessing interactions between foraging seabirds and fishing activity. Such a framework should be useful for conducting future observations and for assessing potential threats to seabirds.

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