

**MARINE DEBRIS AND FISHING GEAR ASSOCIATED WITH SEABIRDS
AT SUB-ANTARCTIC MARION ISLAND, 1996/97 AND 1997/98:
IN RELATION TO LONGLINE FISHING ACTIVITY**

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Abstract

Marine debris found in association with seabirds at sub-Antarctic Marion Island for the period May 1996 to April 1998 is reported. Standardised searches and incidental finds show a large increase between the 1996/97 and the 1997/98 field seasons. Fishing gear increased at a rate 10 times higher than 'other' (non-fishing) marine debris over this period. Sixty 'rope nooses' apparently used for suspending Patagonian toothfish (*Dissostichus eleginoides*) in blast freezers and 23 toothfish hooks were found. Prior to this study only three hooks (all from the southern bluefin tuna longline industry) had been found in association with seabird nests at Marion Island. Fishery-related marine debris was found most frequently in association with wandering albatross nests, while 'other' (non-fishing) marine debris was found most frequently in association with grey-headed albatrosses and southern giant petrels. Three seabirds (a southern giant petrel, a northern giant petrel, and a sub-Antarctic skua) were found entangled in fishing gear, while five seabird carcasses (three wandering albatross chicks, one white-chinned petrel chick and a southern giant petrel adult) were found to contain ingested fishing gear.

Résumé

Analyse de la présence de débris marins sur une île subantarctique, l'île Marion, de mai 1996 à avril 1998 en fonction des oiseaux de mer. Les recherches normalisées et les découvertes fortuites laissent apparaître une forte augmentation entre les saisons sur le terrain 1996/97 et 1997/98. Pendant cette période, le nombre d'engins de pêche s'est accru à un taux 10 fois plus élevé que celui des 'autres' débris marins (non liés à la pêche). Soixante cordes en forme de nœuds coulant servant apparemment à suspendre les légines australes (*Dissostichus eleginoides*) dans les congélateurs à ventilation et 23 hameçons à légine ont été trouvés. Jusqu'à la présente étude, seuls trois hameçons (provenant tous de l'industrie de pêche à la palangre du thon rouge) ont pu être associés à des nids d'oiseaux de mer à l'île Marion. Les débris marins liés à la pêche étaient le plus souvent associés aux nids de grands albatros, alors que les 'autres' (non liés à la pêche) l'étaient aux albatros à tête grise et aux pétrels géants antarctiques. Trois oiseaux (un pétrel géant antarctique, un pétrel géant subantarctique, et un skua subantarctique) s'étaient enchevêtrés dans des engins de pêche, et cinq carcasses d'oiseaux (trois jeunes grands albatros, un jeune pétrel à menton blanc et un pétrel géant subantarctique adulte) qui avaient ingéré des débris d'engin de pêche ont été trouvés.

Резюме

В настоящей статье представлены данные о морских отбросах, обнаруженных в ассоциации с морскими птицами на субантарктическом острове Марион за период с мая 1996 г. по апрель 1998 г. Результаты стандартных поисков и случайных находок выявили большое возрастание между полевыми сезонами 1996/97 и 1997/98 гг. В этот период промысловые снасти скапливались в 10 раз быстрее, чем другие непромысловые морские отбросы. Было найдено 60 веревочных петель, использовавшихся для подвески патагонского клыкача (*Dissostichus eleginoides*) в морозильных камерах, а также 23 крючка для лова клыкача. До этого исследования на острове Марион было найдено всего лишь 3 крючка (все для лова южного голубого тунца) у гнезд морских птиц. Промысловые морские отбросы чаще всего встречались у гнезд странствующего

альбатроса, а другие отбросы – у гнезд сероголового альбатроса и южного гигантского буревестника. Три особи птиц (южный гигантский буревестник, северный гигантский буревестник и субантарктический поморник) были найдены запутавшимися в промысловых снастях, в то время как проглоченные предметы орудий лова были найдены в тушках пяти птиц (три птенца странствующего альбатроса, один птенец белогорлого буревестника и один взрослый южный гигантский буревестник).

Resumen

Se ha notificado la presencia de desechos marinos en las colonias de aves marinas en la isla subantártica Marion entre mayo de 1996 y abril de 1998. Las búsquedas efectuadas de acuerdo a un patrón estándar y los recuentos casuales de desechos muestran un aumento notable entre las temporadas de terreno de 1996/97 y 1997/98. La tasa de aumento de los artes de pesca encontrados entre los desechos durante este período aumentó en un orden de magnitud (10 veces) con respecto a los desechos de otro tipo. Se encontraron sesenta 'lazos corredizos' del tipo utilizado para suspender a los bacalaos de profundidad (*Dissostichus eleginoides*) en los frigoríficos de congelado rápido, y 23 anzuelos utilizados en la pesca de esta especie. Con anterioridad a este estudio sólo se habían encontrado tres anzuelos (todos provenientes de la pesca de palangre del atún rojo) cerca de los nidos de aves marinas en isla Marion. Los desechos provenientes de las pesquerías se encontraron con más frecuencia en los nidos del albatros errante mientras que los desechos de otro tipo se encontraron más frecuentemente asociados con el albatros de cabeza gris y el petrel gigante antártico. Se encontraron tres aves marinas (un petrel gigante antártico, un petrel gigante subantártico y un skúa subantártico) enredadas en restos de artes de pesca, y cinco aves muertas (tres polluelos de albatros errante, un polluelo de petrel de mentón blanco y un petrel antártico adulto) que habían ingerido este tipo de basura.

Keywords: marine debris, seabirds, incidental mortality, longline fishing, toothfish, *Dissostichus eleginoides*, Marion Island, CCAMLR

INTRODUCTION

Anthropogenic items floating at the surface of the sea are frequently ingested by certain species of seabirds. Albatrosses and petrels (procellariiformes), because of their habits of feeding close to the sea surface and scavenging behind vessels, are particularly prone to ingesting large volumes of marine debris (Ryan, 1987). Collection of marine debris found in association with these seabirds at their breeding colonies is a non-destructive sampling technique that can provide us with much-needed information about the amount and type of marine debris available within their foraging ranges, as well as the level of interaction between these species and sources of marine debris (e.g. unregulated fishing vessels).

The interaction of procellariiformes with longline fishing vessels has been well documented (e.g. Brothers, 1991; Cherel and Weimerskirch, 1996; Ryan et al., 1997), and the global population decline of several species of albatross has been largely attributed to the incidental mortality caused by this fishing practice (Croxall and Gales, 1997). Less well documented is the effect that

marine debris, obtained on the open ocean or from waste jettisoned by fishing vessels, may be having on populations.

The Japanese longline fishery for southern bluefin tuna (SBT) (*Thunnus maccoyii*) in the South Indian Ocean peaked in the mid-1980s and has since decreased during the early to mid-1990s (Polacheck and Tuck 1995; Weimerskirch et al., 1997). However, more recently the development of longline fishing for Patagonian toothfish (*Dissostichus eleginoides*) on the shelf areas surrounding certain sub-Antarctic islands is cause for concern (e.g. Ashford et al., 1995; Croxall and Prince, 1996). Both unregulated and sanctioned longline fishing for Patagonian toothfish within the 20 n mile Economic Exclusive Zone (EEZ) around Marion Island (46°55'S, 37°45'E) began during the spring of 1996 (Ryan et al., 1997; Purves, 1997) and continued for the time period of this study.

This paper reports on marine debris and fishing gear found in association with seabirds on Marion Island during the period from May 1996 to April 1998. Historic trends of longline fishing

hooks found in wandering albatross (*Diomedea exulans*) study colonies during standardised nest checks are also compared.

METHODS

Both authors were based on Marion Island for the duration of the study. During this period marine debris was collected and recorded both incidentally and by means of standardised searches. Debris was found next to nests or within colonies, either as individual items or as part of a pellet of indigestible prey remains which had been regurgitated. In order to analyse trends, the data has been divided into the two field seasons: May 1996 to the end of April 1997 (hereafter referred to as 1996/97), and May 1997 to the end of April 1998 (referred to as 1997/98).

By the term 'marine debris' we refer exclusively to items which are of anthropogenic origin. The origin of fishery-related items was ascertained through communication with scientific observers aboard sanctioned toothfish longline fishing vessels and inspection of vessels operating from Cape Town, South Africa. Toothfish hooks are easily distinguished from SBT hooks by their size and shape. SBT hooks have shorter shanks and are made of thicker metal, and often have a swivel eye.

Incidental Finds

All items of marine debris found next to seabird nests or within colonies by field biologists during their normal work routine were collected and recorded. As we consistently collected *all* marine debris found, we do not expect that there will be any bias in the proportions of the types of debris collected (i.e. the proportion of fisheries-related items to non fisheries-related items). It should be noted that the work routines during the two field seasons were very similar, and therefore search effort was comparable.

Standardised Searches of Wandering Albatross Nests

Three wandering albatross colonies on the northeastern side of the island, which are subject to long-term monitoring, were checked at 10-day intervals between December (egg laying) and April (end of brood phase) and at monthly intervals between May and November/December (chick fledging). This has been a standard method

since 1987. From April 1996 all nests in the colonies were actively searched for marine debris during each check. Prior to 1996, field workers did not actively search for marine debris, however obvious large marine debris, such as fishing hooks with line attached, would have almost certainly been spotted and recorded (pers. comms from previous field ornithologists based on Marion Island). One of the authors of this paper also conducted ornithological fieldwork during the 1993/94 season and certainly would have noted any large items of marine debris (such as hooks) at these colonies.

All wandering albatross nests on Marion Island were searched for marine debris during a whole-island census during early incubation in January 1998. The monitoring colonies were excluded from this survey.

Entanglements and Marine Debris in Carcasses

Incidents of seabirds entangled in marine debris were recorded and all fresh carcasses were dissected and inspected for debris.

RESULTS

Incidental Finds

A total of 264 items of marine debris were found in association with seabird nests at Marion Island during this study (Table 1), of which most (80%) were from the 1997/98 field season. This was mostly due to an almost 10-fold increase in items originating from the fishing industry. Other (non-fishing) items doubled over the same time period. The proportion of debris originating from the fishing industry increased from 22% in 1996/97 to 54% during the 1997/98 season. The most numerous single item was 'rope nooses' ($n = 60$), all of which were from the 1997/98 season. These 'rope nooses' are pieces of rope (of varying colour) which are knotted in an identical manner (Figure 1). Initial enquiries revealed that they were used for hanging fish in the blast freezers of certain longline vessels fishing for toothfish (R. Wanless and M. Purves, pers. comms). From a total of 23 toothfish longline hooks, 19 were collected during the 1997/98 field season. Only three hooks have previously been found in association with seabirds on Marion Island, all of which were SBT longline hooks found in association with wandering albatrosses.

Most marine debris was found in association with wandering albatross ($n = 101$), southern giant petrel (*Macronectus giganteus*) ($n = 72$) and grey-headed albatross (*Diomedea (Thalassarche) chrysostoma*) ($n = 70$) nests (Table 1). The proportion of fishery-related marine debris to 'other' (non-fishing) marine debris varied greatly between these three species (Figure 2). More than three quarters of the marine debris (78%) found next to wandering albatross nests was fishing gear, while only 33% of southern giant petrel, and 25% of grey-headed albatross nest debris originated from the fishing industry.

Standardised Checks of Wandering Albatross Nests

Of the 55 items collected in the three wandering albatross monitoring colonies during standardised checks, most (69%) was fishing gear. The number of items collected per 100 nests more than doubled from the 1997 to the 1998 season, which was mostly due to a three-fold increase in the amount of fishing gear collected (Table 2). The proportion of debris originating from the fishing industry increased from 53% during 1996/97 to 75% during the 1997/98 season. The 27 items of fishing gear collected during the 1997/98 season were collected in 25 separate events.

All 18 hooks found in this study were from Patagonian toothfish longline operations. In three instances two hooks were found next to the same nest and, in these cases, one hook appeared more degraded than the other. Prior to this study, only one hook had been found in these monitoring colonies since 1987. This was an SBT longline hook, which was found lodged in the neck of an incubating female during January 1996 (D. Keith, pers. comm.).

During our 1998 whole-island census of incubating wandering albatrosses, we found a significantly higher density of marine debris next to nests on the northern side of the island compared to the rest of the island ($p < 0.001$) (Table 3).

Entanglements

Four seabird entanglements were observed during the two years of this study, three of which involved toothfish longline fishing hooks and lines. All three of these incidents were observed

during the 1997/98 season. Prior to this report, only five reports existed of entanglements of seabirds at Marion Island since 1986 (Cooper and Huyser, 1995; D. Keith, pers. comm.), of which only two involved fishing gear.

During the 1996/97 season, a macaroni penguin (*Eudyptes chrysolophus*) was observed with the ring from a plastic bottle top around its upper beak. During the 1997/98 season a southern giant petrel was observed with a toothfish hook (with 7 cm of monofilament nylon snood attached to it) through its leg, a sub-Antarctic skua (*Catharacta antarctica*) was observed with a monofilament nylon snood sticking out of its beak and a northern giant petrel (*Macronectes halli*) was found entangled with two toothfish hooks attached to each other by a single piece of monofilament nylon. One hook was lodged in the oesophagus of the bird while the other was embedded in its wing.

Marine Debris in Carcasses

Ten seabird carcasses were found to contain anthropogenic items. Five of these (three lesser sheathbills (*Chionis minor*), a southern giant petrel and a white-chinned petrel (*Procellaria aequinoctialis*)) contained small amounts of industrial pellets and other plastic pieces in the gizzard, while five (three wandering albatrosses, a southern giant petrel and a white-chinned petrel) contained large loads of marine debris ($>100 \text{ cm}^3$) situated in the proventriculus. All five of these incidents involved marine debris from the toothfish fishery. A wandering albatross chick and a white-chinned petrel chick were found dead with toothfish hooks in their stomachs. The hook found in the white-chinned petrel chick stomach had a 59 cm monofilament nylon snood attached to it, and together had an estimated total volume of 150 cm^3 . Three carcasses (two wandering albatross chicks and one southern giant petrel) contained 'rope nooses'. One wandering albatross chick carcass contained seven 'rope nooses', which were entangled in squid beaks to make up a total volume of about $1\,000 \text{ cm}^3$.

DISCUSSION AND CONCLUSIONS

Incidental Finds

These data show a large increase in both the total amount of debris collected, as well as the proportion of debris originating from the fishing

industry. As we collected *all* debris (i.e. there was no bias in the *type* of debris collected), we conclude that the observed increase in the proportion of fishery-related items reflects an increased association of the large procellariiformes breeding on Marion Island with fishing vessels. As all the hooks found in this study originated from toothfish longline operations, this interaction was almost certainly with the toothfish vessels operating around Marion Island. There are probably two reasons for the comparatively low number of SBT longline hooks found on Marion Island prior to this study. Firstly, the SBT longline fishery is concentrated along the subtropical convergence and thus less accessible to breeding birds. Secondly, albatrosses and petrels obtain most toothfish hooks from toothfish heads which are removed during processing and dumped without the hooks being removed (Huain and Croxall, 1996; M. Purves and R. Wanless, pers. comms). Only the fins of SBT are removed during processing (Robertson, 1998), thus precluding this route of acquiring hooks.

Marine debris associated with wandering albatrosses contained the highest proportion of fishing gear (78%), followed by southern giant petrels (33%) and grey-headed albatrosses (25%). This trend follows a decrease in body size, and can be explained by the fact that most of the fishing gear found on the island (i.e. hooks and 'rope nooses') is attached to large items of offal when jettisoned from the vessels (e.g. hooks are embedded in toothfish heads or whole specimens of fish by-catch). While smaller seabird species are able to rip pieces of flesh from these large items of offal, only the larger birds are able to swallow them whole, thus ingesting the attached fishing gear. This has been verified by scientific observers aboard sanctioned toothfish longliners (J. Enticott, M. Purves, R. Wanless and B. Watkins, pers. comms). Large body size is also an advantage in the intense competition for offal around these vessels.

The total of 15 toothfish hooks found in association with wandering albatross nests at Marion Island during 1997/98 is lower than the total of 27 hooks found associated with wandering albatrosses at Bird Island, South Georgia, during 1993/94 (Huain and Croxall, 1996). This is notwithstanding the fact that Marion Island has a larger breeding population (approximately 1 700 pairs as opposed to 1 300 (Gales, 1998)) and that the amount of hooks set in the respective years was very similar (4.3 million for Marion

Island (Ryan and Purves, 1998) and 4.4 million for South Georgia (Huain and Croxall, 1996)). The amount of hooks set around Marion Island was almost certainly even higher, due to the presence of a substantial illegal fishing fleet (Ryan and Purves, 1998). As toothfish longlining in the close vicinity of South Georgia started a lot earlier than at Marion Island, a higher level of familiarity of South Georgia wandering albatrosses with scavenging offal from toothfish vessels could account for these observed differences.

Standardised Checks of Wandering Albatross Colonies

This study quantifiably confirmed the increase in marine debris and fishing gear associated with seabirds from 1996/97 to 1997/98. This increase was once again largely due to a three-fold increase in fishing gear, while the amount of 'other' (non-fishing) debris remained similar between the two seasons. This large increase is particularly interesting when we consider that the large influx of illegal fishing vessels took place during the latter half of 1996 and dropped off during the 1997/98 season (Purves, 1997). One explanation of this apparent anomaly is that the birds needed some time to adapt to exploiting this new resource efficiently.

Three records of two hooks (of different ages) at a single nest indicate that certain breeding adults may be using offal from fishing vessels as an easy source of food on a repeated basis, thus exposing themselves to the accumulative dangers of debris ingestion and incidental mortality.

The significantly higher density of nest debris on the northern side of the island is interesting, as most of the toothfish sets took place off the northern and eastern side of the island (Marine and Coastal Management, unpublished data). This seems to indicate that some segregation in foraging zones utilised by breeding adults during short foraging trips could exist at different locations on Marion Island. This will result in different longline-related impacts at these sites.

Entanglements and Debris Found in Carcasses

More seabird entanglements and carcasses containing fishing gear were observed during the last eight months of this study than over the past 11 years. The fact that some hooks were severely

corroded by digestive fluids indicates that birds could be absorbing harmful chemicals into their systems from these items. Ryan et al. (1988) showed a positive correlation between plastic loads in the stomachs of great shearwaters (*Puffinus gravis*) and polychlorinated biphenyls (PCBs) in their fat tissues, indicating the possibility of harmful chemicals from marine debris being absorbed in the digestive tract. These chemicals may lead to indirect effects on body condition, and thus survival. Large pollutant loads, as observed in some carcasses during this study, can also impair feeding activity (Ryan, 1988), which will in turn lead to reduced body condition and possible mortality.

These indirect impacts on both chicks and adults should be taken into account when the impact of longline fisheries on seabird populations is considered as a whole. We recommend that scientific observers aboard sanctioned fishing vessels be meticulous in recording whether or not marine debris (especially hooks in fish heads) is thrown overboard (as required by South African and CCAMLR fishery regulations).

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Table 1: Summary of all marine debris found next to seabird nests at Marion Island (both incidentally and by means of standardised searches) from May 1996 to April 1998.

Type of Pollutant	Species	1996/97	1997/98	Total
Fishery-related debris:				
Hooks	Grey-headed albatross		1	1
	Southern giant petrel		3	3
	Sub-Antarctic skua	1		1
	Wandering albatross	3	15	18
		4	19	23
Snoods ¹	Grey-headed albatross		3	3
	Southern giant petrel		1	1
	Wandering albatross	5	2	7
	White-chinned petrel		2	2
		5	8	13
Rope	Grey-headed albatross	1	8	9
	Macaroni penguin		1	1
	Southern giant petrel		3	3
	Wandering albatross		4	4
		1	16	17
Rope nooses ²	Southern giant petrel		11	11
	Sub-Antarctic skua		1	1
	Wandering albatross		48	48
		0	60	60
Other fishing equipment	Grey-headed albatross		4	4
	Northern giant petrel		1	1
	Southern giant petrel	1	3	4
	Wandering albatross	1	2	3
		2	10	12
Fishery-related debris total		12 (22%)	113 (54%)	125
Other (non-fishing) debris:				
Pieces of bottles	Grey-headed albatross	2	5	7
	Northern giant petrel		1	1
	Southern giant petrel	2	7	9
	Wandering albatross		1	1
		4	14	18
Other plastics	Grey-headed albatross	12	28	40
	Northern giant petrel	1	1	2
	Southern giant petrel	4	23	27
	Lesser sheathbill		1	1
	Sub-Antarctic skua	1	3	4
	Wandering albatross	7	6	13
	White-chinned petrel		1	1
		25	63	88
Packaging	Grey-headed albatross	1	7	8
	Northern giant petrel	3		3
	Salvin's Prion		1	1
	Southern giant petrel	5	6	11
	Sub-Antarctic skua	1		1
	Wandering albatross	3	5	8
White-chinned petrel		1	1	
		13	20	33
Other (non-fishing) debris total		42 (78%)	97 (46%)	139
Grand Total		54	210	264

¹ Snoods are the pieces of line that attach the hooks to the main line.

² Rope nooses are pieces of rope used to suspend toothfish in blast freezers (see Figure 1).

Table 2: Marine debris found in wandering albatross study colonies on Marion Island during standardised checks from May 1996 to April 1998.

Season: (Number of Nests in Colonies):	1996/97 (n = 263)	1997/98 (n = 290)
Fishery-related debris:		
Hooks and snoods ¹	7	11
Rope pieces	0	2
Rope nooses ²	0	16
Other fishing equipment	1	1
Fishery-related debris total	8 (53%)	30 (75%)
Fishery-related items per 100 nests	3.04	10.3
Other (non-fishing) debris:		
Other plastics	4	5
Packaging	3	5
Other (non-fishing) debris total	7 (47%)	10 (25%)
Other (non-fishing) items per 100 nests	2.7	3.4
Grand Total Items per 100 nest	15 5.7	40 13.8

¹ Snoods are pieces of line that attach the hooks to the main line.

² Rope nooses are pieces of rope used to suspend toothfish in blast freezers (see Figure 1).

Table 3: The density of marine debris found next to wandering albatross nests on Marion Island during the 1998 whole-island census of incubating birds.

Sector of the Island	Nests Searched	Debris per 100 Nests
North	801	2.25
East	116	0.86
South	25	0
West	640	0.31
Total	1 582	1.33

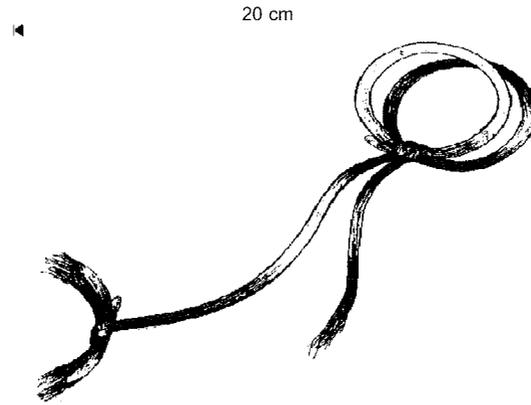


Figure 1: An illustration of a 'rope noose', as frequently found in association with seabird nests on Marion Island during the 1997/98 season.

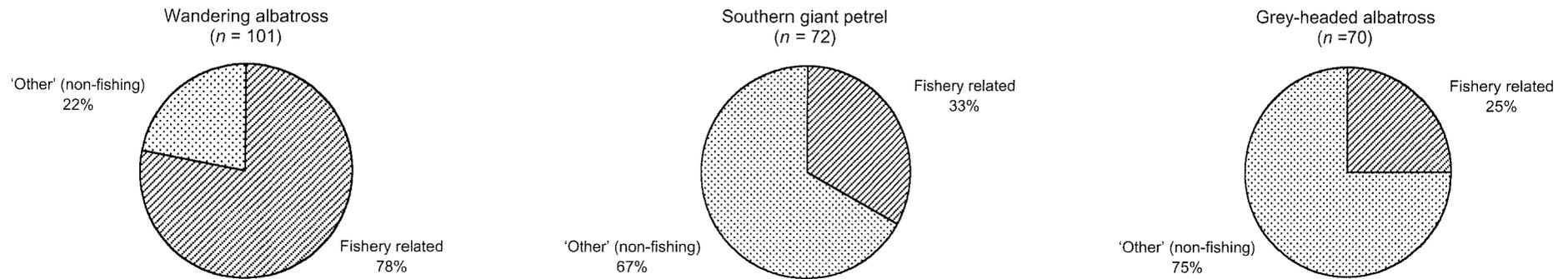


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