Autopsy report for seabirds killed and returned from observed New Zealand fisheries

1 October 2007 to 30 September 2008

DOC MARINE CONSERVATION SERVICES SERIES 5

Department of Conservation
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1 October 2007 to 30 September 2008

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A B S T R A C T

Large numbers of seabirds frequent New Zealand commercial fishing waters. The accurate determination of the taxa of seabirds captured in New Zealand fisheries is vital for examining the potential threat to population viability posed by incidental fisheries captures, and to help reduce future captures. The assessment of the age-class, sex and provenance of captured individuals requires autopsy in the majority of cases. Between 1 October 2007 and 30 September 2008 (the 2007/08 fishing year), a total of 251 seabirds comprising 20 taxa were incidentally killed as bycatch and returned for autopsy by on-board government observers. Birds were returned from longline, trawl and setnet vessels. Seabirds returned during the 2007/08 fishing year were dominated numerically by two species (sooty shearwater *Puffinus griseus* and white-chinned petrel *Procellaria aequinoctialis*) which, combined, accounted for 54% of all specimens. Of birds returned from longline fisheries, 46% had injuries consistent with being hooked or entangled in the bill or throat, with albatross taxa comprising 70% of specimens killed in this way. In contrast, 86% of all returns from trawl fisheries were killed through entanglement in the net, of which 76% were non-albatross taxa. Warp interaction was the likely cause of death in only 14% of trawl specimens, of which 92% were albatross taxa. Mean fat scores were generally higher in birds from the 2007/08 fishing year than in most previous years, although for all but one of the six most commonly returned species (grey petrel *Procellaria cinerea*), mean fat scores were lower in 2007/08 than in both 2005/06 and 2006/07. Seabirds returned from the 2007/08 fishing year, and from trawl fisheries in particular, continued to show clear size-related differences in the likely cause of death, and offal appears to continue to be an attractant for many taxa, particularly in trawl fisheries.

Keywords: commercial fishing, seabirds, autopsy, incidental mortalities, longline, trawl, setnet

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1. Introduction

The identification of seabirds killed by commercial fishing operations is a necessary and crucial first step towards gaining a better understanding of which species and populations may be at risk from such operations. Therefore, in keeping with previous fishing years, during the 2007/08 fishing year (1 October 2007 to 30 September 2008), government observers were present on a non-random selection of fishing trips within New Zealand's Exclusive Economic Zone (EEZ).

Government fisheries observers are placed on a range of commercial fishing vessels including longline, trawl and setnet vessels to monitor protected species interactions with fishing activities. The Department of Conservation (DOC), through the Conservation Services Programme, requests observers to return for autopsy all seabirds caught and killed as incidental byctach during fishing operations. Ancillary information (for example, vessel name, location of capture as latitude and longitude coordinates, date of capture, and additional comments provided by the observer) is also recorded by the observers.

Furthermore, although at-sea identifications by observers of birds killed as bycatch are usually (but not always) accurate, post mortem analysis is generally required in order to correctly assign gender to specimens and provide information on status, dietary preferences, condition and provenance.

Because of the non-random nature of seabird capture and return, the totals for each species of seabird presented in this report do not reflect 'catch rates' for particular fishing methods or fisheries generally. Specific catch locations and the names of vessels from which specimens were returned have not been provided in this report on the grounds of commercial sensitivity.

2. Methods

Autopsy methods followed those described by Bartle (2000) and used in autopsies in subsequent fishing years (Robertson 2000; Robertson & Bell 2002a, b; Robertson et al. 2003, 2004; Conservation Services Programme 2008; Thompson 2009, 2010). The author undertook all autopsies and identifications, to species where possible. Common and scientific names of all species referred to in this report are provided in Table 1. Nomenclature generally follows Marchant & Higgins (1990), but for the albatrosses where current taxonomy and nomenclature is in a state of flux, it follows a combination of Nunn et al. (1996), Robertson & Nunn (1998) and BirdLife International (see www.birdlife.org; viewed May 2009).

Birds were sexed by internal examination during dissection, except where this was precluded through damage from fishing gear and machinery or from sea lice. Birds were categorised as breeding adult, adult, non-breeding adult or juvenile based on a combination of plumage and other morphological characteristics (for e.g. bill morphology), gonadal characteristics and brood patch characteristics. Breeding adults were birds considered to be actively breeding at the time of capture; adults were birds that had breeding adult morphology but for which active breeding could not be confirmed; non-breeding adults were definitely not actively breeding at the time of capture (based on main feather moult and gonadal evidence); and juveniles were birds in non-adult plumage/morphology.

TABLE 1. LIST OF COMMON AND SCIENTIFIC NAMES OF ALL TAXA REFERRED TO IN THIS REPORT.

COMMON NAME	SCIENTIFIC NAME
Antipodean albatross	*Diomedea antipodensis antipodensis*
Black petrel	*Procellaria parkinsoni*
Buller's albatross	*Thalassarche bulleri bulleri*
Campbell albatross	*Thalassarche impavida*
Cattle egret	*Bubulcus ibis*
Fairy prion	*Pachyptila turtur*
Flesh-footed shearwater	*Puffinus carneipes*
Gibson's albatross	*Diomedea antipodensis gibsoni*
Grey petrel	*Procellaria cinerea*
Grey-faced petrel	*Pterodroma macroptera gouldi*
Salvin's albatross	*Thalassarche salvini*
Short-tailed shearwater	*Puffinus tenuirostris*
Sooty shearwater	*Puffinus griseus*
Southern royal albatross	*Diomedea epomophora*
Wandering albatross	*Diomedea exulans*
Westland petrel	*Procellaria westlandica*
White-capped albatross	*Thalassarche steadi*
White-chinned petrel	*Procellaria aequinoctialis*
White-faced storm petrel	*Pelagodroma marina*
Yellow-eyed penguin	*Megadyptes antipodes*

As in previous years, body condition was assessed by assigning a fat score, initially based on the relative amount of subcutaneous fat and, more recently, including an assessment of the amount of fat deposited on and around organs and structures within the body cavity (Bartle 2000; Conservation Services Programme 2008; Thompson 2009). Fat scores presented in this report combine an assessment of the amount of both subcutaneous fat under the skin in the pectoral region and fat deposited on and around organs within the body cavity. Fat scores ascend from '1' = no fat, to '2' = little fat, to '3' = moderate fat, to '4' = fat to '5' = extremely fat (or fat to an extent that internal examination becomes difficult).

For each specimen, feather moult and the condition of the brood patch were recorded, as was the nature of the injuries sustained. This information was then combined with observer comments on the autopsy tag to determine a most likely cause of death.

Contents of the proventriculus (stomach) and ventriculus (gizzard) were identified to broad dietary groupings (squid, fish, crustaceans), and any hard parts (cephalopod beaks, otoliths) were retained for future identification. Other materials, such as plastic, stones, algae and goose barnacle plates were recorded. Fishing-related items such as bait material, offal or other discarded material, were recorded. In this report, 'offal' refers to any discarded material, not just internal organs.

Each autopsy specimen was allocated a unique number. Details relating to each specimen are available on request from the Manager, Marine Conservation Services, DOC (email csp@doc.govt.nz). In some cases, e.g. those specimens damaged by fishing gear and machinery or by sea lice, it was not possible to determine species, sex, or cause of death. These are reported as 'unidentified' or 'unknown' in the summary tables presented in this report.

3. Results

3.1 SPECIES RETURNED

During the 2007/08 fishing year, a total of 251 seabirds were killed as bycatch and returned for autopsy from 61 separate fishing trips undertaken by 45 different vessels. Amongst these, eight vessels made two separate trips, one vessel made three separate trips and two vessels made four separate trips from which birds were returned. Two unobserved trips, operating under Special Licence from the Ministry of Fisheries, voluntarily returned 26 seabirds (18 Buller's albatrosses *Thalassarche bulleri bulleri*, one Campbell albatross *T. impavida*, one Gibson's albatross *Diomedea antipodensis gibsoni* and six white-chinned petrels *Procellaria aequinoctialis*) and one seabird (Buller's albatross), respectively. These 27 specimens have not been considered further and do not contribute to any of the summary statistics included in this report. Specimens were identified to one of 20 taxa (distinct species), with two specimens (each an incomplete collection of bones and assorted feathers only) identified to genus, and recorded as 'unknown *Thalassarche* albatross' (Table 2). The locations of seabird captures are shown in Appendix 1.

Seabirds returned during the 2007/08 fishing year were dominated numerically by four species which, combined, accounted for 81% of all specimens. Sooty shearwater *Puffinus griseus* was the most numerous species returned (72 birds, 29% of the total), followed by white-chinned petrel (62 birds, 25%), white-capped albatross *Thalassarche steadi* (42, 17%) and Buller's albatross (26, 10%) (Table 2). All of the remaining species returned during the 2007/08 fishing year amounted to single-figure totals, with grey petrel *Procellaria cinerea*, grey-faced petrel *Pterodroma macroptera gouldi* and Salvin's albatross *Thalassarche salvini* each represented by six individuals (2% of the total; Table 2). An additional seven species were represented by only one specimen each (Table 2).

Six specimens were returned with uniquely-numbered metal leg bands: a black petrel *Procellaria parkinsoni*, band number H-27085, banded as a chick at Great Barrier Island (Aotea Island) on 1 May 1987 (i.e. 21 years old); a Buller's albatross, band number M-81756, banded as a chick at North East Island, The Snares, on 27 July 2003 (i.e. 5 years old); a Buller's albatross, band number M-83448, banded as a non-breeding adult at Big Solander Island on 5 March 2001 (note: this specimen was returned from an unobserved vessel); a Campbell albatross, band number M-45226, banded as an adult at Campbell Island/Motu Ihupuku on 19 April 1985 (i.e. at least 23 years old); a Gibson's albatross, band number R-57259, banded as an adult at Adams Island on 5 January 2006; and a sooty shearwater, band number Z-27825, banded as an adult at Mana Island on 1 February 1994 (i.e. at least 14 years old). The single cattle egret *Bubulcus ibis* returned in 2007/08 represented a new taxon to be identified and autopsied by the programme. The single short-tailed shearwater *Puffinus tenuirostris* returned in 2007/08 represented the first specimen to be returned from New Zealand's Antarctic toothfish *Dissostichus mawsoni* fishery, although it should be noted this fatality resulted from deckstrike rather than capture on gear.

TABLE 2. SPECIES AND NUMBERS OF SEABIRDS KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2007 AND 30 SEPTEMBER 2008, BY MONTH OF CAPTURE, SEX (M = MALE, F = FEMALE, U = UNKNOWN) AND AGE (BA = BREEDING ADULT, A = ADULT, N = NON-BREEDING ADULT, J = JUVENILE (IMMATURE), U = UNKNOWN).

SPECIES	MONTH												SEX			AGE					TOTAL	% TOTAL
	J	F	M	A	M	J	J	A	S	O	N	D	M	F	U	BA	A	N	J	U		
Antipodean albatross				3		1							2	2			2		2		4	2
Black petrel			1		3								3	1			4				4	2
Buller's albatross	1	3		10	2	2	5	3					14	11	1	12	13		1		26	10
Campbell albatross				1	3					1			4	1		1		2	2		5	2
Cattle egret				1											1		1				1	<1
Fairy prion						1					1		1	1		1	1				2	1
Flesh-footed shearwater			3	1								1	4	1		1	4				5	2
Gibson's albatross	1													1		1					1	<1
Grey petrel						1	4	1					3	2	1	1	5				6	2
Grey-faced petrel					6									6		2	4				6	2
Salvin's albatross		1						1		1	3		4	2		3	2		1		6	2
Short-tailed shearwater		1											1			1					1	<1
Sooty shearwater	1	38	13	10	3					5	2		68	3	1	5	67				72	29
Southern royal albatross		1												1		1					1	<1
Unidentified *Thalassarche* albatross			1	1											2					2	2	1
Wandering albatross						1								1				1			1	<1
Westland petrel								2					1	1			2				2	1
White-capped albatross		7	22	12	1								21	12	9	10	30	1		1	42	17
White-chinned petrel	1	21	12	19	3					4	1	1	43	19		2	60				62	25
White-faced storm petrel		1											1				1				1	<1
Yellow-eyed penguin												1		1		1					1	<1
Total	**4**	**73**	**52**	**58**	**21**	**6**	**9**	**7**		**11**	**7**	**3**	**170**	**66**	**15**	**42**	**196**	**4**	**6**	**3**	**251**	
% Total	**2**	**29**	**21**	**23**	**8**	**2**	**4**	**3**		**4**	**3**	**1**	**68**	**26**	**6**	**17**	**78**	**2**	**2**	**1**		

The monthly distribution of returned specimens was clearly not evenly spread across the fishing year, reflecting an interaction between timing of seabird breeding, and therefore presence and availability within New Zealand's EEZ, timing and location of fishery operations, and observer coverage. The highest monthly total occurred in February, with 73 specimens representing 29% of all birds returned. Overall, 81% of all specimens were returned during the period February to May (Table 2). This 'unevenness' in timing of returns is exemplified by the four most numerous species returned (Fig. 1). For example, 53% of all sooty shearwaters were returned in February, and 84% of all white-chinned petrels were returned in February to April (Table 2; Fig. 1).

In keeping with previous years' findings, the majority of birds returned were males (68% of all birds, and 72% of sexed birds; Table 2). This pattern was particularly strong for sooty shearwaters, where males comprised 94% of birds returned. In only one species were females clearly more numerous than males—all six grey-faced petrels returned were female (Table 2). There was a similarly strong bias in the age/status of birds returned, with approximately 96% classified as either breeding adults, adults or non-breeding adults (Table 2). Intra-specific, competitive exclusion is a possible explanation for the almost complete absence of juvenile birds returned: older, more experienced and dominant adult birds will likely preclude younger birds from gaining access to food sources around fishing vessels.

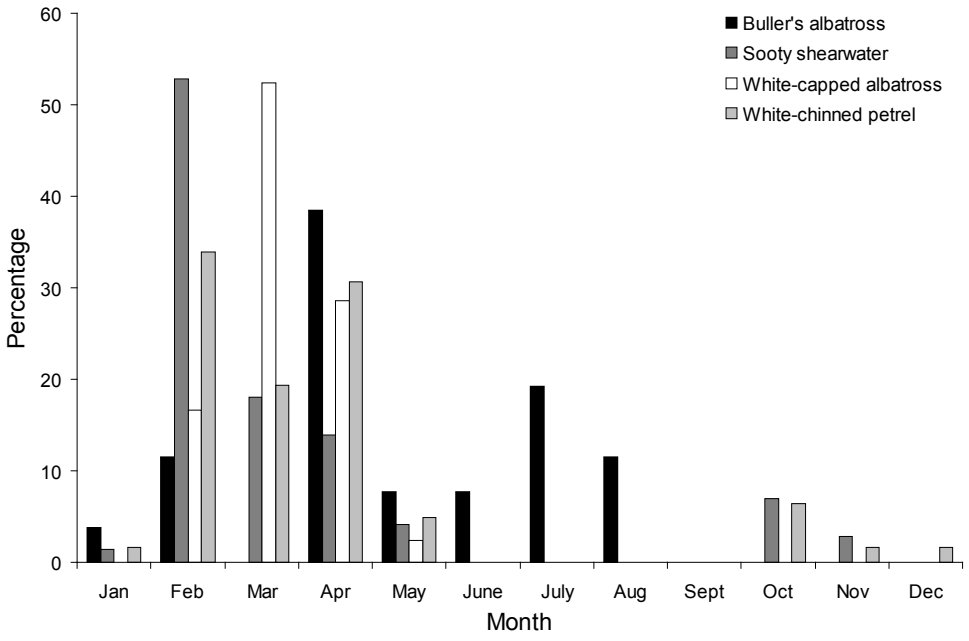

Figure 1. Proportions of Buller's albatross *Thalassarche bulleri bulleri*, sooty shearwater *Puffinus griseus*, white-capped albatross *Thalassarche steadi* and white-chinned petrel *Procellaria aequinoctialis* killed and returned from observed fishing boats between 1 October 2007 and 30 September 2008, by month.

3.2 TARGET FISHERIES AND VESSELS

Longline fisheries returned a total of 60 birds (24% of total returns), spread relatively evenly across all of the fisheries (Table 3). Target fisheries classified as 'other, longline' included Antarctic toothfish, bass *Polyprion americanus*, bluenose *Hyperoglyphe antarctica* and hapuku *P. oxygeneios*. Trawl fisheries combined returned a total of 189 birds (75% of total returns), with boats targeting squid accounting for 137 birds, or 72% of all trawl returns (Table 3). It should be noted, however, that there were far more observed trawl trips targeting one or more fishery (51 in total) than observed longline trips (16 in total; Table 3). Trawlers targeting hoki *Macruronus novaezelandiae* returned 23 birds (9% of all trawl returns). Trawlers targeting 'other' species returned 19 specimens, or 8% of the total trawl returns. Species targeted in this category were barracouta *Thyrsites atun*, hake *Merluccius australis*, jack mackerel *Trachurus* spp., ling *Genypterus blacodes*, red cod *Pseudophycis bachus*, silver warehou *Seriolella punctata* and southern blue whiting *Micromesistius australis*.

TABLE 3. SPECIES AND NUMBERS OF SEABIRDS KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2007 AND 30 SEPTEMBER 2008, BY TARGET FISHERY.

	LONGLINE				TRAWL				SETNET	TOTAL
SPECIES	CHARTERED TUNA	DOMESTIC TUNA	LING	OTHER	HOKI	SQUID	SCAMPI	OTHER	ALL TARGETS	
Antipodean albatross		4								4
Black petrel				3			1			4
Buller's albatross	8	3		2	9	2		2		26
Campbell albatross		1		3				1		5
Cattle egret						1				1
Fairy prion					1			1		2
Flesh-footed shearwater					1		4			5
Gibson's albatross		1								1
Grey petrel		1	4					1		6
Grey-faced petrel				6						6
Salvin's albatross		1					3	2		6
Short-tailed shearwater				1						1
Sooty shearwater			5	1	3	57	2	3	1	72
Southern royal albatross						1				1
Unid. *Thalassarche* albatross						2				2
Wandering albatross		1								1
Westland petrel					1			1		2
White-capped albatross	3					39				42
White-chinned petrel	4		7	1	8	34		8		62
White-faced storm petrel						1				1
Yellow-eyed penguin									1	1
Total	**15**	**12**	**16**	**17**	**23**	**137**	**10**	**19**	**2**	**251**
% Total	**6**	**5**	**6**	**7**	**9**	**55**	**4**	**8**	**1**	
Obs. Trips	**2**	**5**	**4**	**5**	**9**	**22**	**5**	**15**	**2**	

Two birds were returned from setnet fisheries: a single sooty shearwater from a vessel targeting moki *Latridopsis ciliaris* and a single yellow-eyed penguin *Megadyptes antipodes* from a vessel targeting school shark *Galeorhinus galeus* (Table 3).

The pattern of most trips and vessels returning relatively low numbers of birds, and a small number of trips and vessels returning relatively large numbers of birds is highlighted in Fig. 2. As expected, the frequency plots show a 'shift to the right' from birds per trip to birds per vessel, as 11 vessels made more than one trip from which birds were returned (see above). It is worth noting that generally the numbers of birds killed on the 27 separate trips for these 11 vessels were uniformly low, with only one of the 27 trips returning more than ten birds.

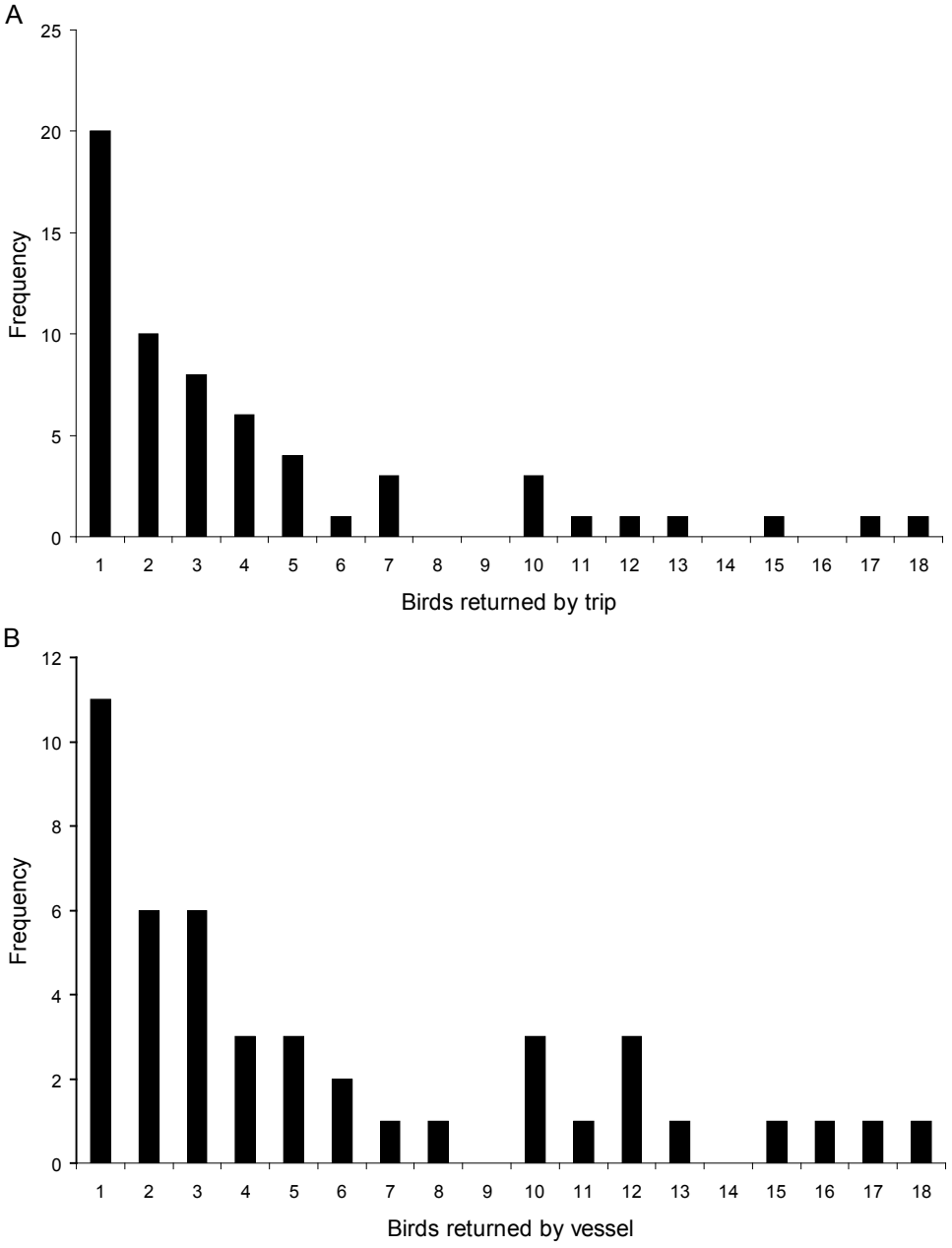

Figure 2. Number of seabirds killed and returned from A. each observed trip and B. each observed vessel between 1 October 2007 and 30 September 2008. Trips and vessels that returned no birds are not included.

For the 2007/08 fishing year, five species were caught exclusively by longline fisheries: Antipodean wandering albatross *Diomedea antipodensis antipodensis*, Gibson's albatross, grey-faced petrel, short-tailed shearwater and wandering albatross *D. exulans* (Table 3). Fairy prion *Pachyptila turtur*, flesh-footed shearwater *Puffinus carneipes*, southern royal albatross *D. epomophora*, Westland petrel *Procellaria westlandica* and white-faced storm petrel *Pelagodroma marina* were captured exclusively in trawl fisheries (Table 3). Remaining species were captured across both longline and trawl boats, with the exception of yellow-eyed penguin *Megadyptes antipodes*, which was only captured in setnets (Table 3).

In longline fisheries overall, albatross taxa made up 45% of returned birds, but this proportion increased to 92% and 73% in domestic tuna and chartered tuna fisheries, respectively (Fig. 3). In trawl fisheries overall, non-albatross taxa made up 68% of all returns, with little variation around this value across all trawl fisheries (Fig. 3).

3.3 INJURIES OF RETURNED BIRDS AND LIKELY CAUSE OF DEATH

Returned birds exhibited diverse injuries. As in previous years, at one extreme, birds were described as having 'no obvious injury', and were in excellent condition both externally and internally. At the other extreme, some specimens were returned in a completely mangled state, with multiple fractures, crush injuries, pulped internal organs and missing entire organs and/or body parts. Often injury classifications were not exclusive, such that some birds exhibited many separate injuries.

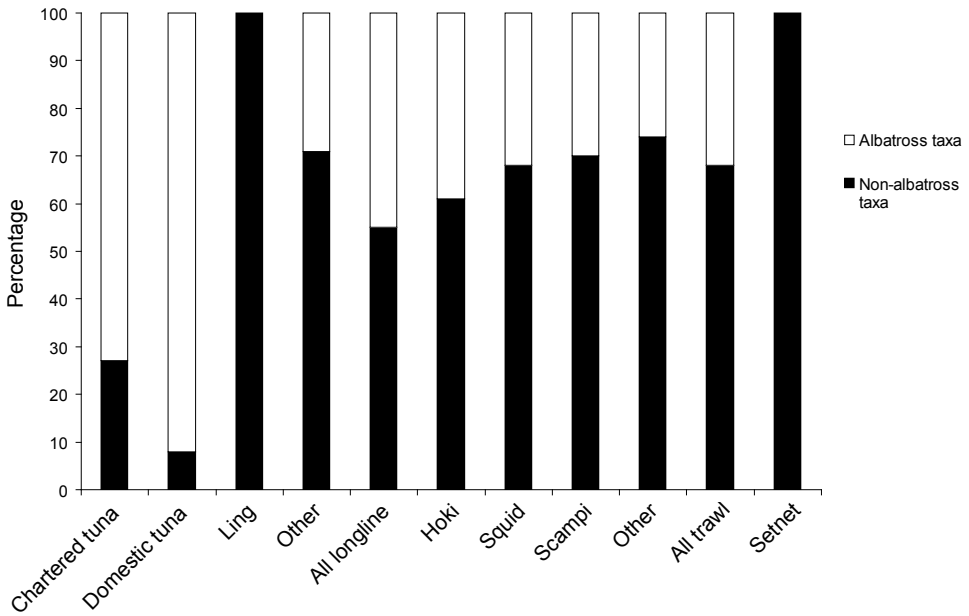

Figure 3. Proportion of albatross and non-albatross taxa returned for autopsy between 1 October 2007 and 30 September 2008, by target fishery.

Not surprisingly, injuries involving hooks and snoods were recorded exclusively from birds captured in longline fisheries. Of all birds (60) returned from all longline fisheries, 46 (77%) had injuries consistent with hook impalement or snood entanglement. Of these, the majority (59%) had injuries to the bill or throat. Albatross taxa were far more likely to exhibit hook injuries to the bill or throat (70% of 27 birds) than non-albatross taxa (24% of 33 birds), whereas albatross taxa were less likely to exhibit hook and/or entanglement damage to the wing(s) (11%) compared with non-albatross taxa (39%). In 24% of all birds returned from longline fisheries there was no obvious sign of injury.

In contrast to birds from longline fisheries, and in keeping with findings from previous fishing years (summaries in Robertson et al. 2004; Conservation Services Programme 2008; Thompson 2009, 2010), birds returned from trawl fisheries exhibited a different set of predominant injuries. For example, of the 189 birds returned from trawl fisheries, 22% had broken or badly damaged wings, but the proportion of albatrosses with wing injuries (59% of 61 birds) was far greater than that in non-albatross taxa (4% of 128 birds). In albatross taxa, wing injuries were often consistent with collision with warps, and included fractures, ripped skin and lacerations at the 'elbow'. They were often associated with thick, brown grease, as reported previously (Robertson et al. 2004). Among albatrosses, 31% of birds exhibited grease on the plumage, whereas no non-albatross taxa were found with brown grease on the plumage. Of non-albatross taxa trawl returns, 18% exhibited broken or badly damaged legs. Overall, 49% of trawl returns showed no obvious injury: 21% of albatrosses fell into this category compared with 63% of non-albatross taxa.

Using information on injuries obtained from autopsy, and incorporating extremely valuable comments on how birds were captured (recorded by observers on the autopsy label attached to each bird), the most likely cause of death has been assigned to each bird (Table 4). For birds returned from longline fisheries, the likely cause of death mirrors, to a large extent, the main injuries sustained, and obviously entailed being hooked or entangled by the snood somewhere on the body. Birds were hooked in the bill or throat in 46% of all cases, and hooked or entangled in the wing(s) in 27% of cases, in the legs/feet in 2% of cases and in the body in 2% of cases (Table 4). In the remaining 24% of birds returned from longline fisheries, it was not obvious how the bird died (Table 4). Of birds hooked in the bill or throat, 70% were albatrosses (Table 4).

Birds returned from trawl fisheries were assigned to one of two likely cause of death categories: warp interaction and net. Specimens assigned to the 'warp interaction' category were not necessarily recovered from the warp itself, as birds that hit a warp (as shown by their injuries) could ultimately be recovered from the net. However, birds assigned to the 'net' category exhibited none of the injuries typical of interacting with a warp, never had brown grease on the wings and often had fish scales on the plumage (indicative of time spent in the net and/or fish pound). For all trawl fisheries combined, there were striking differences in the likely cause of death between albatross and non-albatross taxa. Although only 14% of trawl specimens could be assigned to warp interaction, 92% of these birds were albatrosses, primarily white-capped albatross (Table 4). Conversely, 86% of all birds likely died as a result of becoming entangled in the net or from diving into the net itself and, of these, 76% were non-albatross taxa, primarily sooty shearwaters and white-chinned petrels (Table 4). Indeed,

TABLE 4. LIKELY CAUSE OF DEATH OF SEABIRD SPECIES KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2007 AND 30 SEPTEMBER 2008.

Note: longline specimens were either hooked or entangled by the snood, and 'not obvious' indicates that it was not possible to identify a specific part of the body where this occurred. Trawl specimens classified as 'net' were deemed to have been either entangled in, or recovered from, the net.

SPECIES	LONGLINE HOOK/SNOOD					TRAWL		SET-NET	DECK-STRIKE	TOTAL
	BILL/ THROAT	WINGS	LEGS/ FEET	BODY	NOT OBVIOUS	WARP INTER-ACTION	NET			
Antipodean albatross	1				3					4
Black petrel		3					1			4
Buller's albatross	11				2	6	7			26
Campbell albatross	3	1					1			5
Cattle egret									1	1
Fairy prion									2	2
Flesh-footed shearwater							5*			5
Gibson's albatross		1								1
Grey petrel	1	2	1		1		1			6
Grey-faced petrel	1				5					6
Salvin's albatross	1					2	3			6
Short-tailed shearwater									1	1
Sooty shearwater	3	1		1	1	1	64	1		72
Southern royal albatross							1			1
Unid. *Thalassarche* albatross							2			2
Wandering albatross	1									1
Westland petrel							1		1	2
White-capped albatross	2	1				15	24			42
White-chinned petrel	3	7			2	1	49			62
White-faced storm petrel									1	1
Yellow-eyed penguin								1		1
% of total longline or trawl	**46**	**27**	**2**	**2**	**24**	**14**	**86**			
Albatrosses (%)	**70**	**19**	**0**	**0**	**36**	**92**	**24**	**0**	**0**	
Others (%)	**30**	**81**	**100**	**100**	**64**	**8**	**76**	**100**	**100**	

* Three birds trawled up tangled in fishing line.

of the 65 sooty shearwaters returned from trawl fisheries, all but one likely died from interactions with the net. Similarly, all but one of the 50 white-chinned petrel trawl returns were net captures (Table 4). Interestingly, and in contrast to previous years, during the 2007/08 fishing year there were more white-capped albatross trawl returns that likely died as a result of interacting with the net (24 birds) than likely died through interacting with a warp (15 birds).

Two birds (a yellow-eyed penguin and a sooty shearwater) returned during 2007/08 died as a result of entanglement in setnets, and six returned birds were classified as killed through deckstrike (Table 4), based mainly on observer comments. Of the five flesh-footed shearwaters returned from trawlers, three were described by the observer as being 'tangled in fishing lines' and 'brought up from [the] bottom by net' (Table 4), suggestive of their having been killed by recreational fishing activity prior to capture by the observed commercial trawler.

3.4 BODY CONDITION

For the six most numerous species returned historically (Table 5), mean fat scores were generally lower in birds from the 2007/08 fishing year than in the previous two fishing years, but at or above mean levels for the years 1997/98 through to 2004/05 (summaries in Robertson et al. 2004; Conservation Services Programme 2008; Thompson 2009, 2010). During the 8 years between 1997/98 and 2004/05, the mean seabird fat score was only infrequently at '3' or higher (Conservation Services Programme 2008). In contrast, during both 2005/06 and 2006/07, the mean seabird fat scores for five of the commonly-returned species were '3' or higher (only grey petrel had mean fat scores less than '3' in both of these years). Mean fat scores for the 2007/08 fishing year (Table 5) show a return to relatively low scores reported in years prior to 2005/06.

There remains the possibility that interpretation of the fat score criteria was different between 2005/06 and 2007/08 and all other years. This is entirely feasible, as no comparisons were made between fat scores assigned to the same birds by different workers. However, the 1–5-point fat score is relatively restricted, given that a score of '1' represents 'no fat' and a score of '5' represents 'very fat' (Bartle 2000), or that a bird was so fat that 'examination of the body cavity becomes difficult' (Conservation Services Programme 2008).

TABLE 5. FAT SCORES FOR THE MOST NUMEROUS SIX SPECIES RETURNED HISTORICALLY.

Fat scores given on a scale of 1–5, where 1 = no fat, 2 = little fat, 3 = moderate fat, 4 = fat and 5 = very fat or so fat that examination of the body cavity was difficult; U = unknown.

SPECIES	FAT SCORE						TOTAL	MEAN ± SD
	1	2	3	4	5	U		
Buller's albatross	2	3	12	8		1	26	3.0 ± 0.9
Grey petrel		1	4			1	6	2.8 ± 0.4
Salvin's albatross	1	2	2		1		6	2.7 ± 1.7
Sooty shearwater	6	23	38	4		1	72	2.6 ± 0.7
White-capped albatross	2	7	15	6	1	11	42	2.9 ± 0.9
White-chinned petrel		27	28	6	1		62	2.7 ± 0.7
Total	**11**	**63**	**99**	**24**	**3**	**14**	**214**	
% Total	**5**	**29**	**46**	**11**	**1**	**7**		

3.5 STOMACH CONTENTS

In keeping with previous years, stomach (proventriculus) contents have been tentatively identified (presence-absence) as falling within one of nine categories, with 'no stomach' making up a tenth category (see Table 6). Ultimately, it is hoped that it will be possible to produce a more quantitative and detailed dietary account, particularly for the more commonly-caught species but, to date, accurate identification of many prey remains (particularly of very small cephalopod beaks and small otoliths, which are often eroded) has proved extremely difficult.

TABLE 6. STOMACH (PROVENTRICULUS) CONTENTS OF ALBATROSS AND NON-ALBATROSS TAXA KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2007 AND 30 SEPTEMBER 2008, BY TARGET FISHERY.
Stomach content values are percentages of birds within each category.

STOMACH CONTENTS	LONGLINE				TRAWL				SET-NET
	CHARTERED TUNA	DOMESTIC TUNA	LING	OTHER	HOKI	SQUID	SCAMPI	OTHER	ALL TARGETS
ALBATROSS TAXA									
No stomach	9	27			11	33			
Empty	36	64			22	31	33	40	
Natural?						2	67		
Sludge					11				
Bait	45	9		80					
Bait + natural									
Bait + offal									
Offal	9			20	56	33		60	
Offal + natural									
Bait + offal + natural									
Number of birds	**11**	**11**	**0**	**5**	**9**	**42**	**3**	**5**	**0**
NON-ALBATROSS TAXA									
No stomach			6			3			
Empty	25	100	13	25	54	49	14	21	50
Natural?	25		13	25	8	15	43	29	50
Sludge			6						
Bait	25		25	50					
Bait + natural	25								
Bait + offal	5								
Offal			38		38	29	43	50	
Offal + natural						3	0		
Bait + Offal + Natural									
Number of birds	**4**	**1**	**16**	**12**	**13**	**93**	**7**	**14**	**2**

For longline fisheries, bait alone was recorded in stomachs of birds returned from all fisheries, occurring in 80% of albatross and in 50% of non-albatross taxa returned from 'other' longline fisheries (where 'other' refers to Antarctic toothfish, bass, bluenose and hapuku). Offal (including any form of discarded material) was recorded from a relatively small proportion of birds returned from longline fisheries, reaching a maximum of 38% in non-albatross taxa returned from longline boats targeting ling (Table 6). Food remains identified as natural were recorded only in non-albatross taxa returned from longline fisheries (Table 6).

For birds returned from trawl fisheries, offal alone was present in 33%–60% of albatross stomachs and in 29%–50% of stomachs from non-albatross taxa (Table 6). Natural food remains were recorded from returns from all trawl fisheries for non-albatross taxa, but only from trawlers targeting scampi and rarely from trawlers targeting squid for albatross taxa (Table 6).

Across all fisheries, empty stomachs made up 22%–64% of albatross returns and 13%–100% of non-albatross returns (Table 6).

3.6 SEABIRD IDENTIFICATION

Table 7 summarises identification information provided by observers on board fishing vessels, and returned on the autopsy tag attached to each specimen. The majority (69%) of seabirds from the 2007/08 fishing year were identified correctly to species, with only 16% of identifications inaccurate. Inaccurate identifications fell to 12% if those birds defined as 'ID as correct spp. group' were excluded from the 'wrong' total (Table 7). Eight birds fell into this category—four Antipodean albatrosses and four Campbell albatrosses. A relatively large proportion of sooty shearwaters were mis-identified during 2007/08 (21% of 72 birds returned; Table 7). A total of 11 birds were identified as either 'black petrel' (five birds) or 'white-chinned petrel' (six birds), and a further four birds were identified as 'petrel or prion unidentified' (Table 7).

TABLE 7. SUMMARY OF IDENTIFICATIONS RECORDED BY ON-BOARD OBSERVERS AT SEA COMPARED WITH AUTOPSY IDENTIFICATIONS FOR SEABIRDS KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2007 AND 30 SEPTEMBER 2008.

SPECIES	ID CORRECT	ID WRONG	ID AS CORRECT 'SPP.' GROUP	ID AS SEABIRD LARGE OR ALBATROSS	ID AS PETREL OR PRION UNIDENTIFIED	ID AS SEABIRD, SEABIRD SMALL OR SEAGULL	ID NOT ON LABEL	TOTAL
Antipodean albatross		4	(4)					4
Black petrel	3	1						4
Buller's albatross	24	1					1	26
Campbell albatross		4	(4)				1	5
Cattle egret							1	1
Fairy prion	1	1						2
Flesh-footed shearwater		5						5
Gibson's albatross				1				1
Grey petrel	6							6
Grey-faced petrel	6							6
Salvin's albatross	5						1	6
Short-tailed shearwater		1						1
Sooty shearwater	54	11			4		3	72
Southern royal albatross							1	1
Wandering albatross				1				1
Westland petrel		1					1	2
White-capped albatross	35	4		2			1	42
White-chinned petrel	38	6			12		6	62
White-faced storm petrel						1		1
Yellow-eyed penguin	1							1
Total	**173**	**39**		**4**	**16**	**1**	**16**	**249***
% Total	**69**	**16**		**2**	**6**	**<1**	**6**	

* Excludes two birds recorded as 'unidentified *Thalassarche* albatross', and 27 birds returned from two unobserved trips.

4. Acknowledgements

This work and report would not have been possible without the sterling efforts of government observers, who not only retained the birds for autopsy but, in many cases, augmented the autopsy tags with invaluable and specific comments which helped identify or define the cause of death. Stephanie Rowe provided the important link through the Department of Conservation to the Observer Programme, and helped with disentangling the occasional discrepancy with autopsy tag data. Suze Baird and Lynda Griggs (both NIWA, Greta Point) helped ensure the autopsy data were consistent with other databases. This research was funded through the Conservation Services Programme (INT 2007/02), Department of Conservation.

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Appendix 1

CATCH LOCATIONS OF ALL SEABIRDS RETURNED FOR AUTOPSY AND OF LOCATIONS OF THE FOUR MOST NUMEROUS SPECIES BY TARGET FISHERY

Bathymetric contours are 500 m, 1000 m, 2000 m and 3000 m.

New Zealand's Exclusive Economic Zone (EEZ) is shown, and broken down into Fishery Management Areas (FMAs) as follows:

- FMA1—Auckland (East)
- FMA2—Central (East)
- FMA3—South-East (Coast)
- FMA4—South-East (Chatham Rise)
- FMA5—Southland
- FMA6—Sub-Antarctic
- FMA7—Challenger/Central (Plataeu)
- FMA8—Central (Egmont)
- FMA9—Auckland (West)
- FMA10—Kermadec

Note that some catch location symbols may be obscured by overlying symbols. For example, where several individuals were captured from the same tow or set, each bird will have the same catch location and appear on the maps as a single symbol.

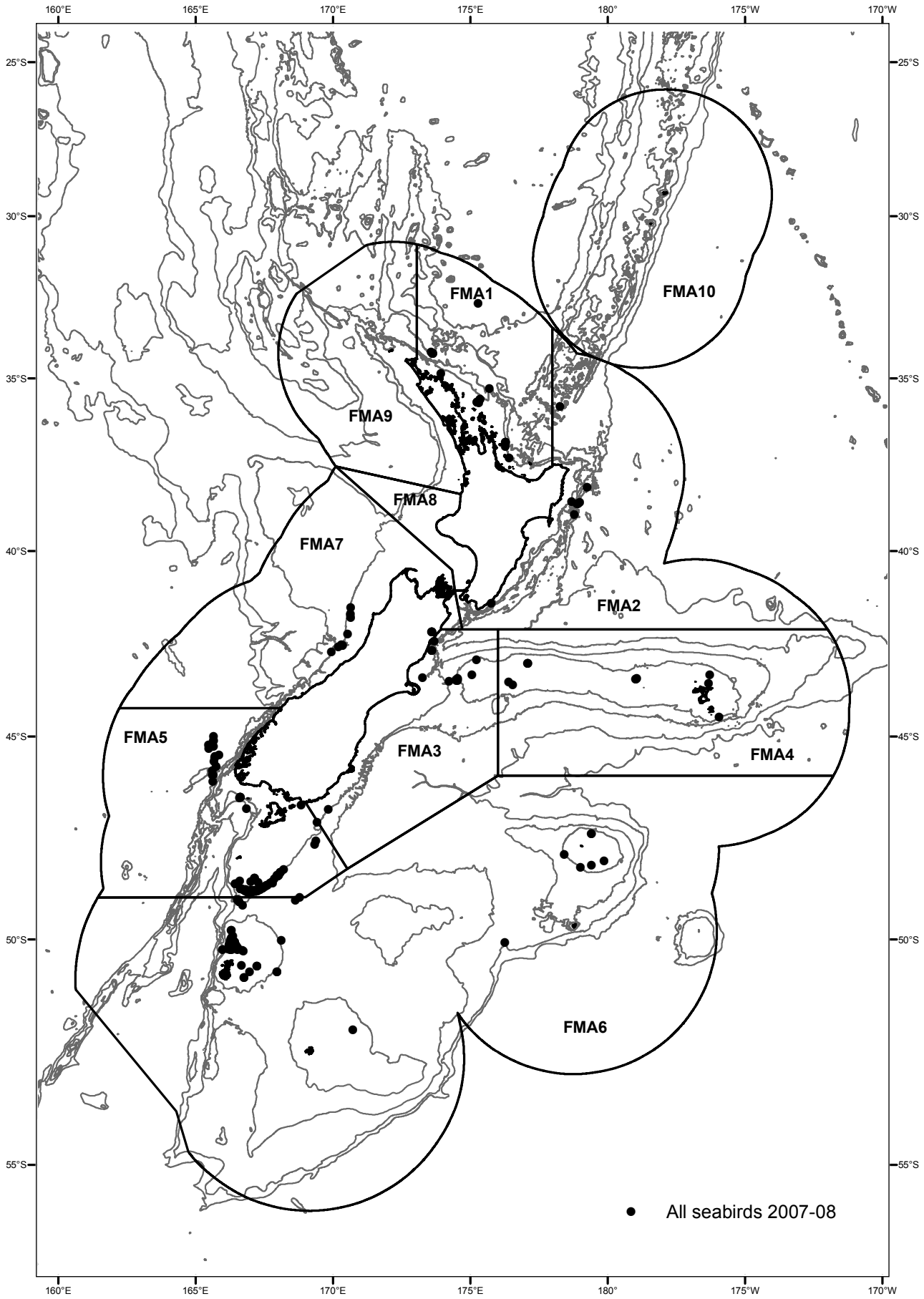

Figure A1.1. Catch locations of all seabirds killed and returned for autopsy during the period 1 October 2007 to 30 September 2008.

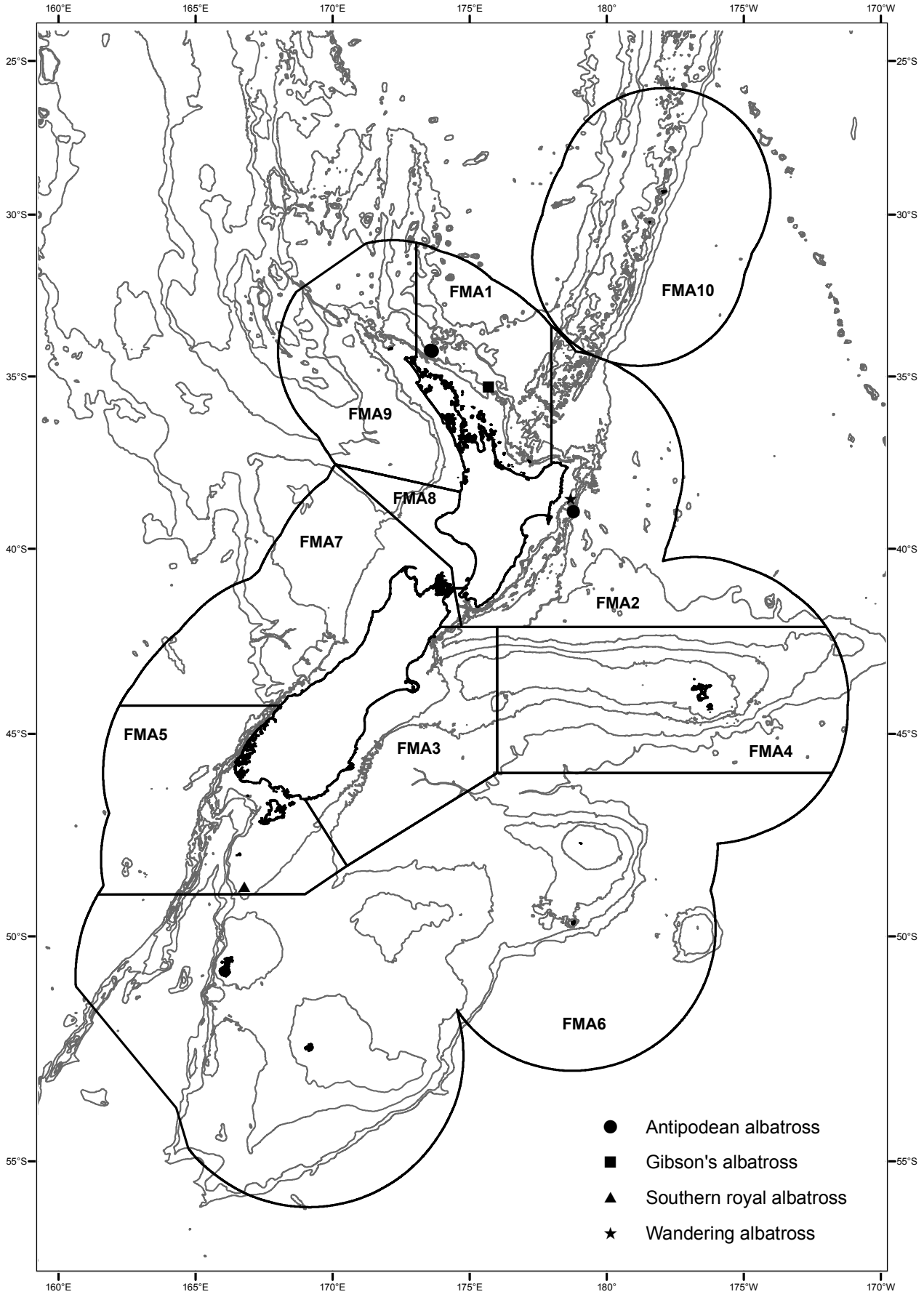

Figure A1.2. Catch locations of Antipodean albatross *Diomedea antipodensis antipodensis*, Gibson's albatross *D. a. gibsoni*, southern royal albatross *D. epomophora* and wandering albatross *D. exulans* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008.

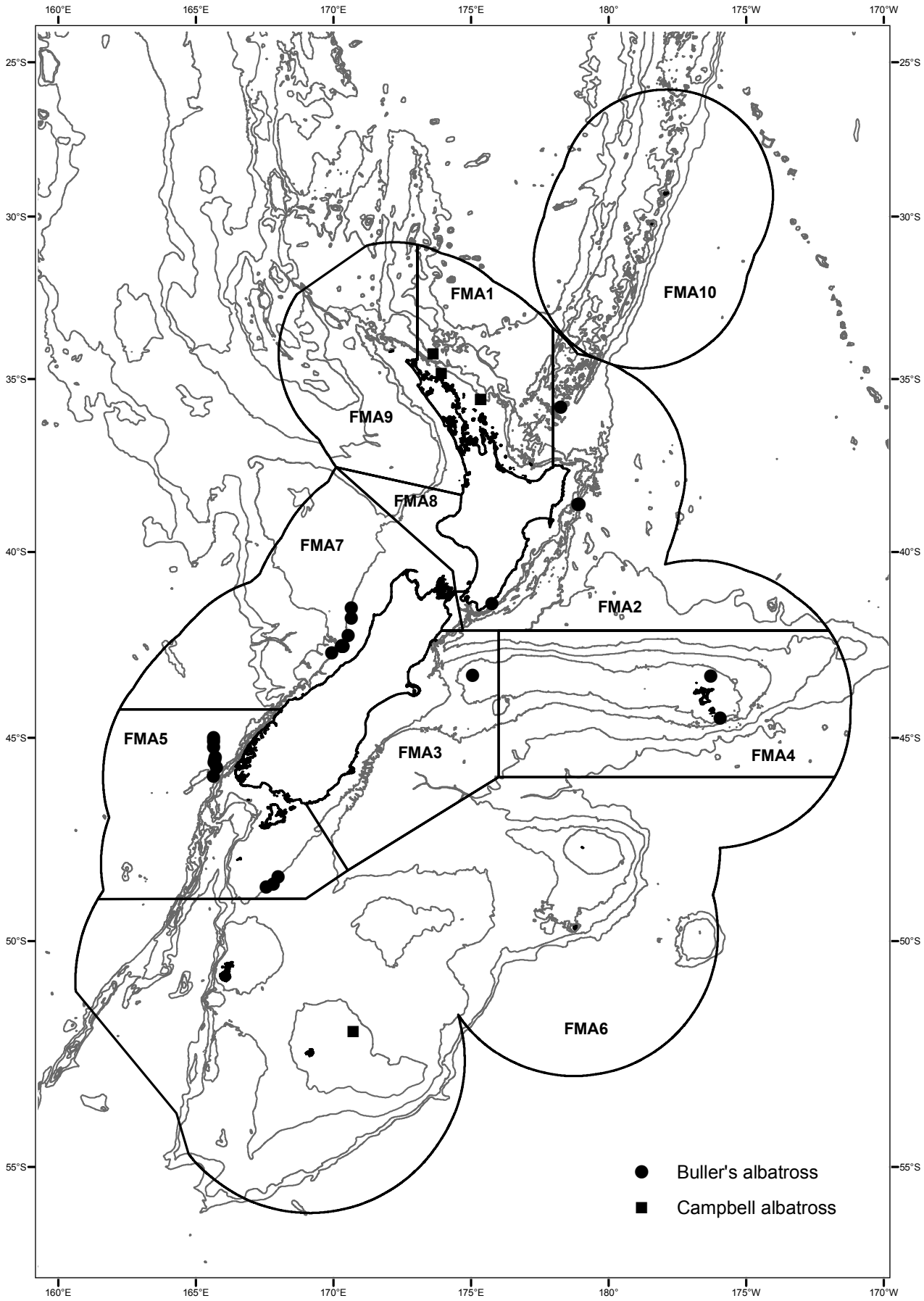

Figure A1.3. Catch locations of Buller's albatross *Thalassarche bulleri bulleri* and Campbell albatross *T. impavida* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008.

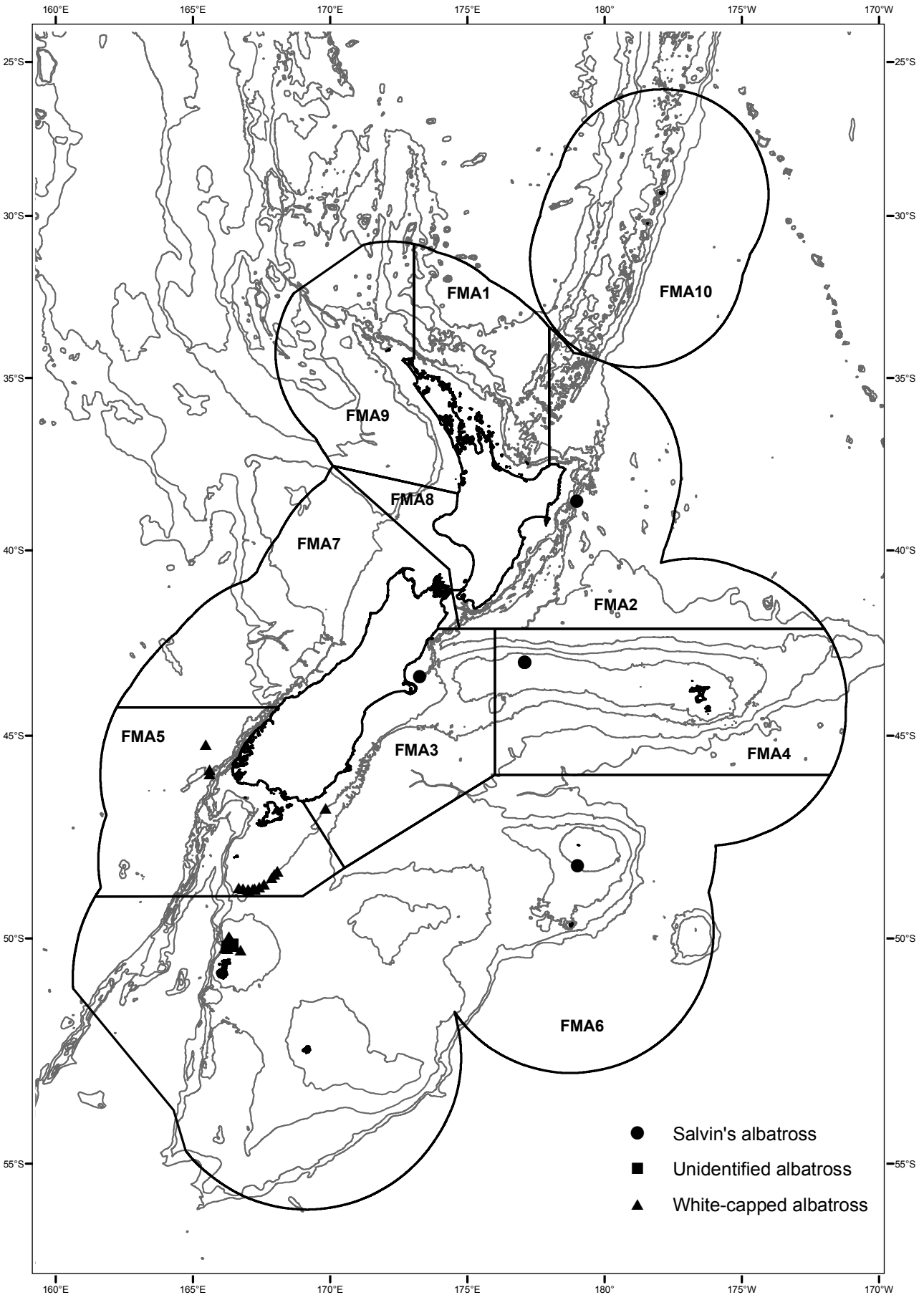

Figure A1.4. Catch locations of Salvin's albatross *Thalassarche salvini*, white-capped albatross *T. steadi* and an unidentified *Thalassarche* species killed and returned for autopsy during the period 1 October 2007 to 30 September 2008.

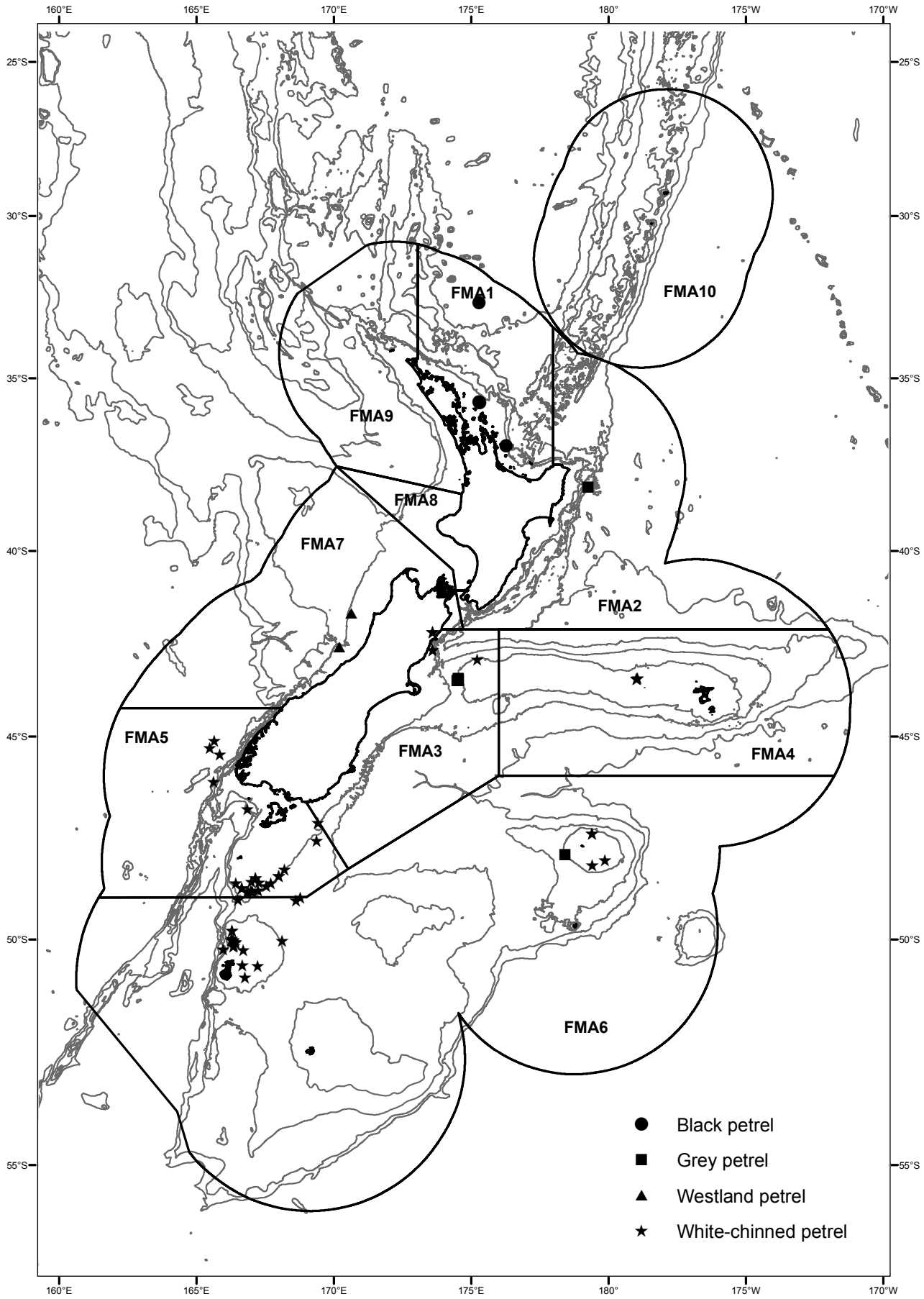

Figure A1.5. Catch locations of black petrel *Procellaria parkinsoni*, grey petrel *P. cinerea*, Westland petrel *P. westlandica* and white-chinned petrel *P. aequinoctialis* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008.

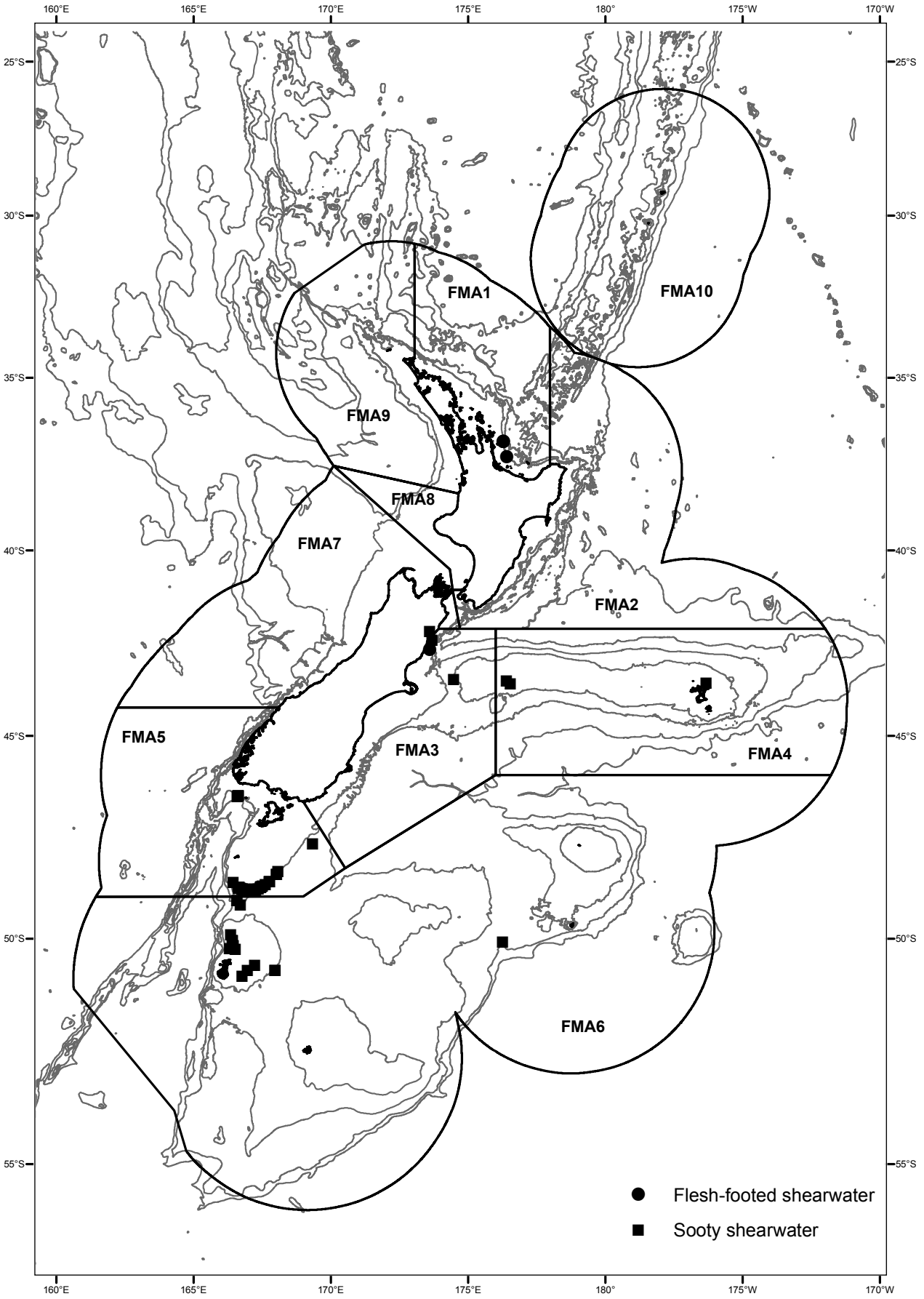

Figure A1.6. Catch locations of flesh-footed shearwater *Puffinus carneipes* and sooty shearwater *P. griseus* killed during the period 1 October 2007 to 30 September 2008, and returned for autopsy. The single short-tailed shearwater *P. tenuirostris* returned during this year is not shown in this plot, but was captured at 65°S,176.6°E.

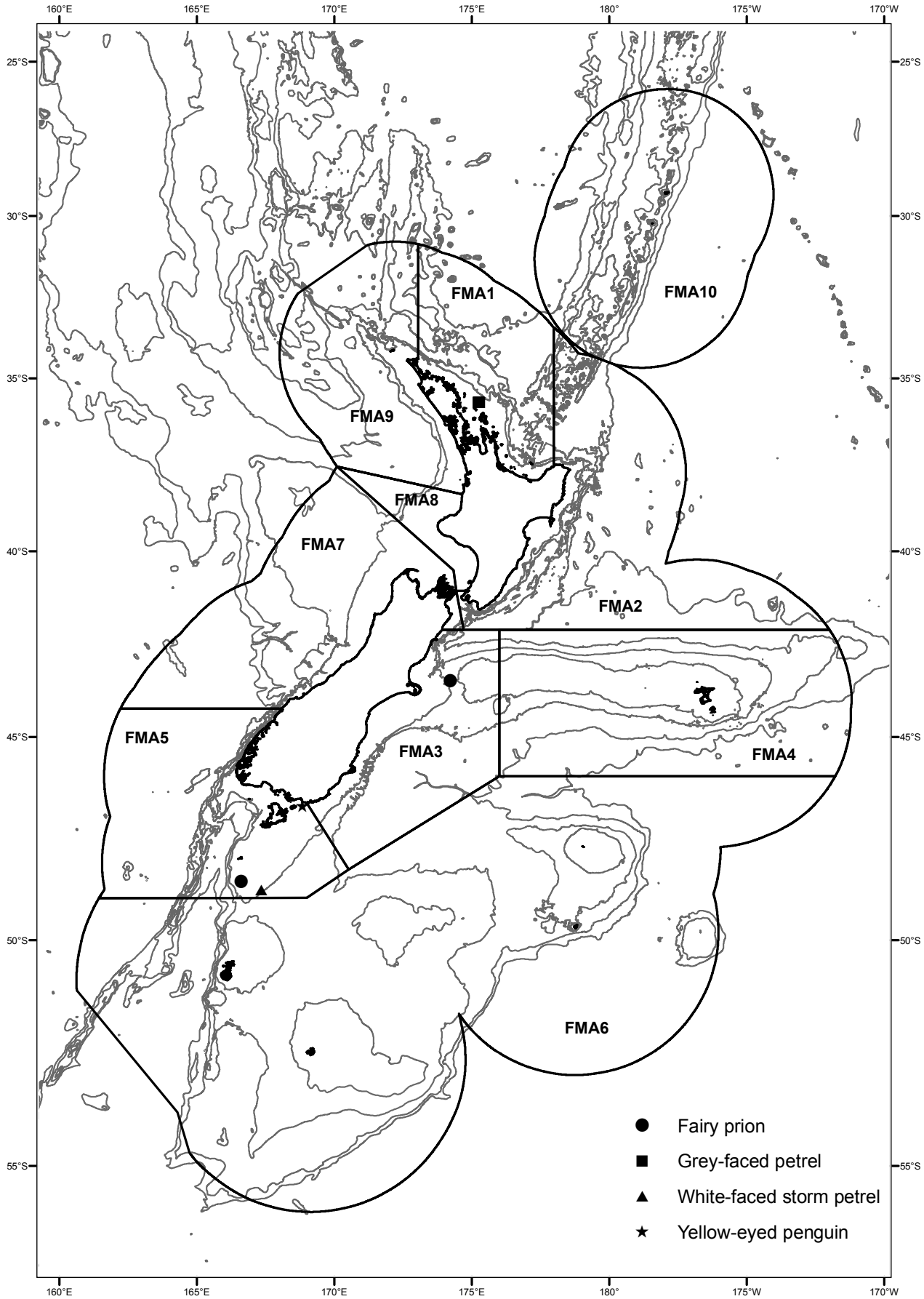

Figure A1.7. Catch locations of fairy prion *Pachyptila turtur*, grey-faced petrel *Pterodroma macroptera gouldi*, white-faced storm petrel *Pelagodroma marina* and yellow-eyed penguin *Megadyptes antipodes* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008.

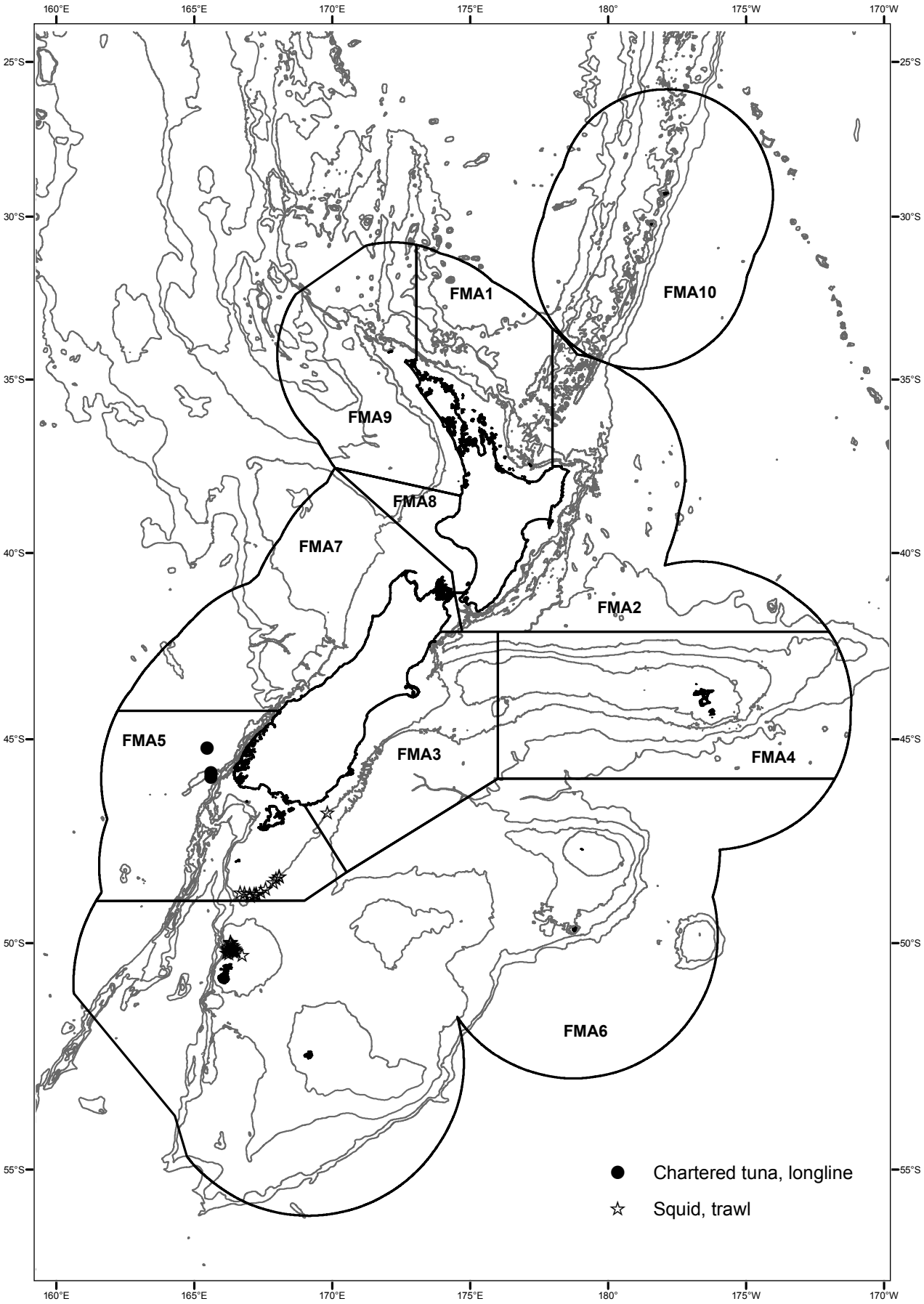

Figure A1.8. Catch locations of white-capped albatross *Thalassarche steadi* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008, by target fishery.

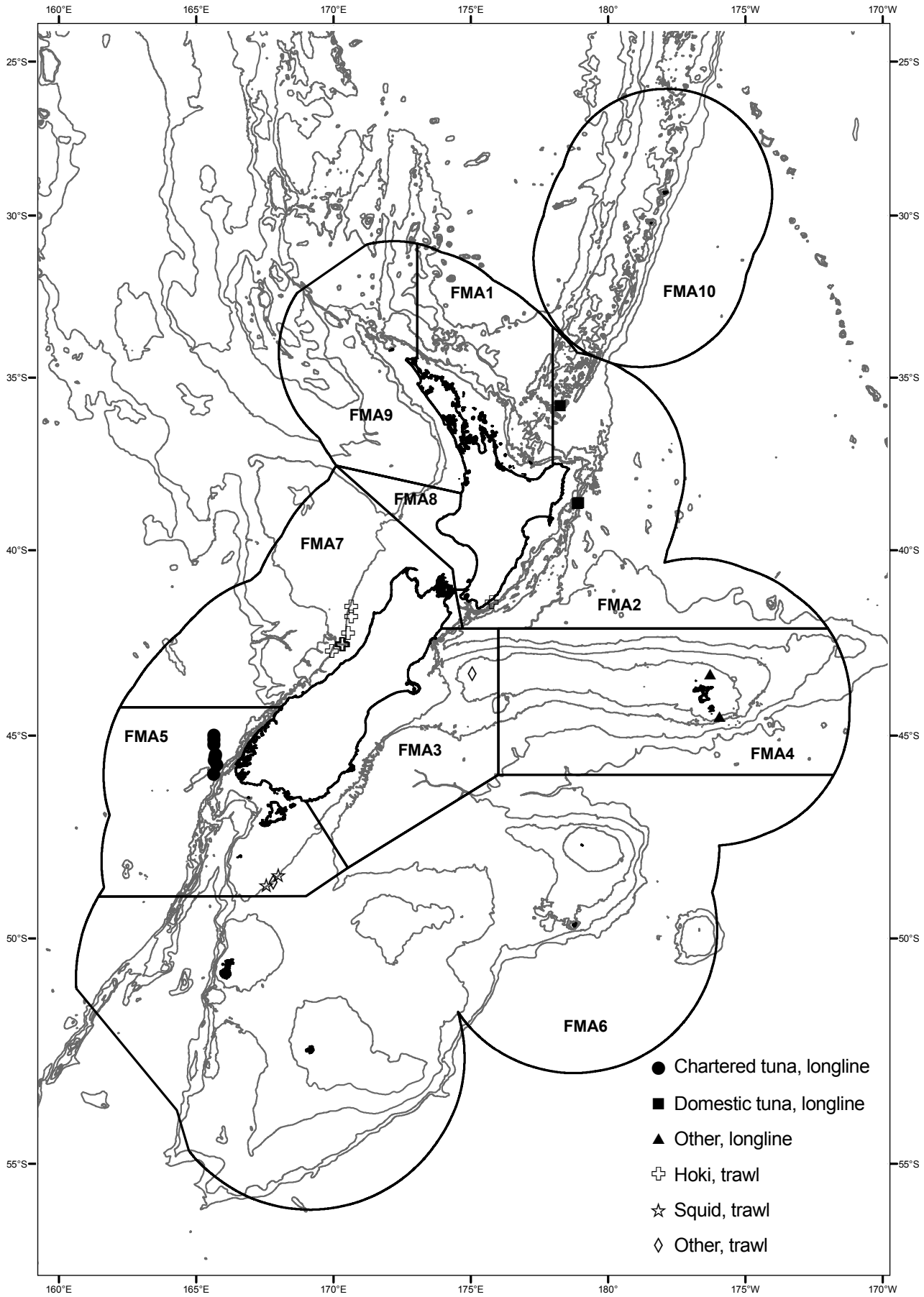

Figure A1.9. Catch locations of Buller's albatross *Thalassarche bulleri bulleri* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008, by target fishery.

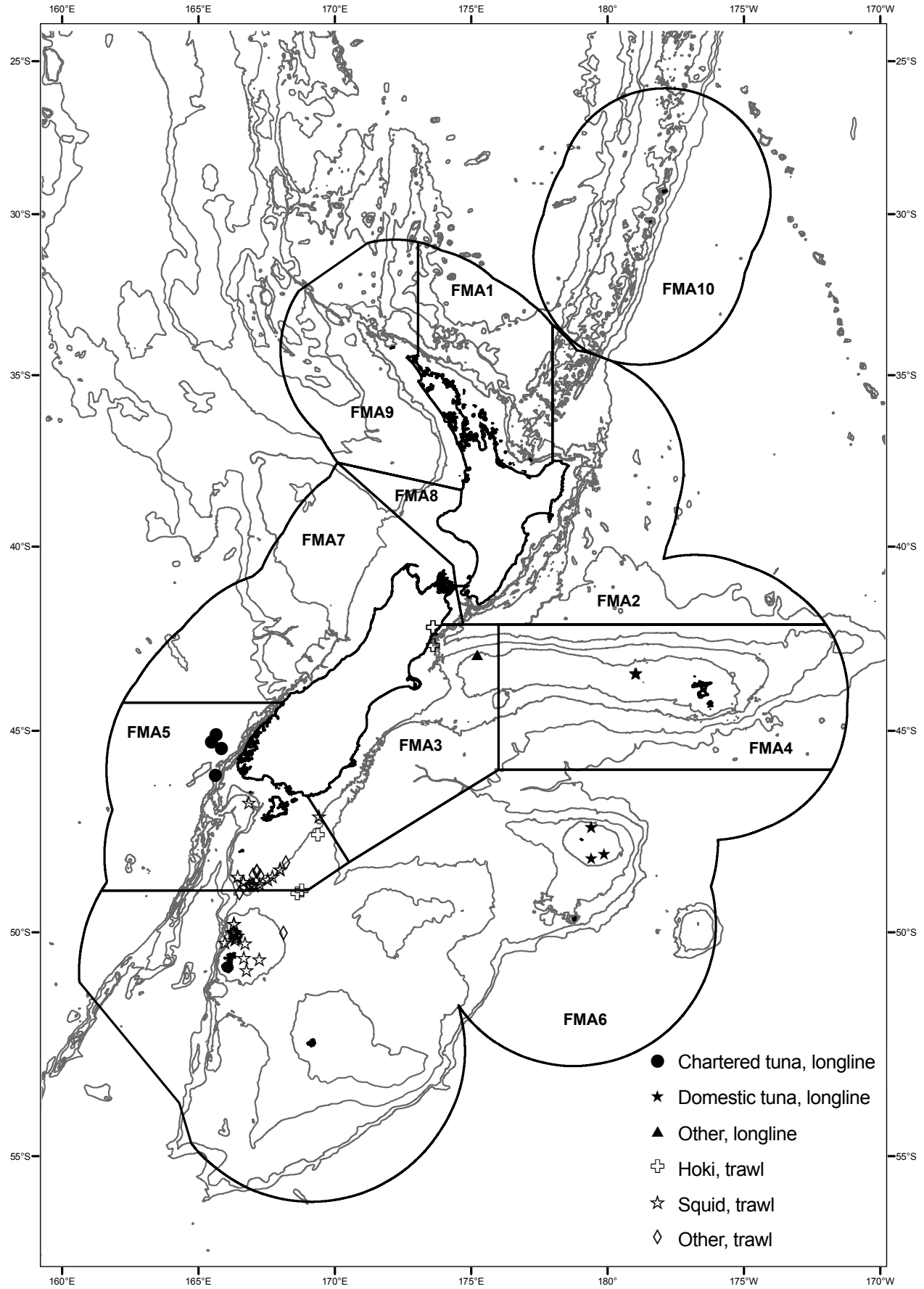

Figure A1.10. Catch locations of white-chinned petrel *Procellaria aequinoctialis* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008, by target fishery.

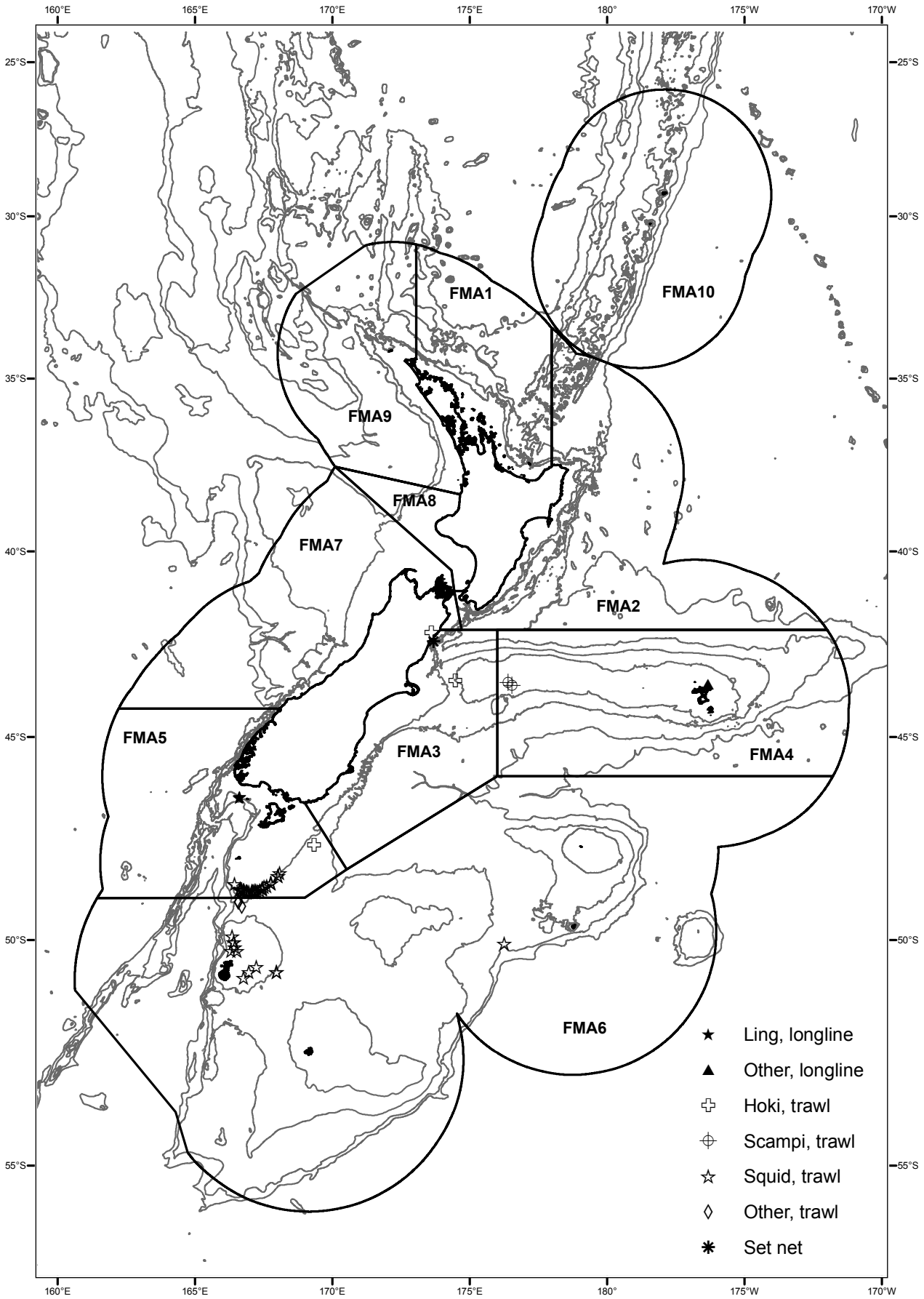

Figure A1.11. Catch locations of sooty shearwater *Puffinus griseus* killed and returned for autopsy during the period 1 October 2007 to 30 September 2008, by target fishery.

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