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

1 October 2005 to 30 September 2006

D.R. Thompson

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1 October 2005 to 30 September 2006

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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. Further, the assessment of the age-class, sex and provenance of captured individuals requires autopsy in the majority of cases. Between 1 October 2005 and 30 September 2006 (the 2005/06 fishing year), a total of 369 seabirds comprising 20 taxa were incidentally killed as bycatch and returned for autopsy by on-board New Zealand government fisheries observers. Birds were returned from longline, trawl and setnet vessels. Seabirds returned during the 2005/06 fishing year were dominated numerically by three species: sooty shearwater *Puffinus griseus*, white-capped albatross *Thalassarche steadi* and white-chinned petrel *Procellaria aequinoctialis*. Birds returned from longline fisheries had injuries consistent with being hooked or entangled in the bill or throat. Birds returned from trawl fisheries were mostly killed through entanglement in the net, with fewer individuals likely killed from a warp interaction. Mean fat scores were generally higher in birds from the 2005/06 fishing year than in previous years. Seabirds returned from the 2005/06 fishing year, and from trawl fisheries in particular, showed clear size-related differences in the likely cause of death, and offal appears to continue to be an attractant for many taxa. Examining the causes of mortality and types of injuries suffered by individual seabirds returned from fisheries is necessary to help reduce future seabird captures in New Zealand fisheries by identifying areas of risk.

Keywords: commercial fishing, seabirds, autopsy, incidental mortality, 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 2005/06 fishing year (1 October 2005 to 30 September 2006), government observers were present on a 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. Observers are instructed to return for autopsy all seabirds caught and killed as incidental bycatch during fishing operations. Because at-sea identifications by observers are sometimes incorrect, post mortems are required to confirm species and gender. Furthermore, post mortem analysis provides information on status, dietary preferences, condition and provenance. Ancillary information (e.g. vessel name, location of capture as latitude and longitude coordinates, date of capture, and additional comments) was also recorded by each observer. All autopsies were performed for the Department of Conservation as part of Conservation Services Programme contract INT2005/03.

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. 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 (Conservation Services Programme 2008). Each specimen was identified to species where possible. Common and scientific names of all species referred to in this report are provided in Appendix 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 December 2008).

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 either breeding adult, adult or juvenile based on a combination of plumage and other morphological characteristics (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 or that were definitely not breeding (based on main feather moult and gonadal evidence); and juveniles were birds with non-adult plumage.

As in previous years, body condition was assessed by assigning a fat score to each individual. Initially, this score was based on the relative amount of subcutaneous fat, but more recently it has also included an assessment of the amount of fat deposited on and around organs and structures within the body cavity (Bartle 2000; Conservation Services Programme 2008). 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, '2' = little fat, '3' = moderate fat, '4' = fat to '5' = very fat (or sufficient fat that internal examination becomes difficult).

For each specimen, feather moult and the condition of the brood patch were recorded, as were the nature of injuries sustained. This information was then combined with observer comments on the autopsy tag to determine the 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 pieces of 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 will be found in the Data Supplement, which is available next to the PDF for this document on the Science Publications page of the DOC website (www.doc.govt. nz > Publications > Science & technical). In some cases, e.g. where a specimen had been damaged by fishing gear and machinery or by sea lice, it was not possible to complete all data fields within the Supplement; therefore, these are reported as 'unknown' in the summary tables presented in this report.

3. Results and discussion

3.1 SPECIES RETURNED

During the 2005/06 fishing year, a total of 369 seabirds were killed as bycatch and returned from 49 separate fishing trips undertaken by 42 different vessels (seven vessels each made two trips from which seabirds were killed and returned). The majority of specimens (363) were identified as belonging to one of 22 distinct species (Table 1). The remaining six specimens could only be identified to genus, as only one or two broken wings were available in each case; these are recorded as 'unknown *Thalassarche* albatross' in Table 1. The locations of seabird captures are shown in Appendix 2.

TABLE 1. SPECIES AND NUMBERS OF SEABIRDS KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2005 AND 30 SEPTEMBER 2006, BY MONTH OF CAPTURE, SEX (M = MALE, F = FEMALE, U = UNKNOWN) AND AGE (BA = BREEDING ADULT, A = 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	J	U		
Antipodean albatross							1							1			1			1	<1
Black petrel	2												1	1		2				2	1
Broad-billed prion										1			1			1				1	<1
Buller's albatross		1	2	4	2	2		1					9	3		11	1			12	3
Campbell albatross					1	1	1						1	2				3		3	1
Chatham albatross										2				1	1	1	1			2	1
Common diving petrel			1								3		2	2		3	1			4	1
Fairy prion		1												1		1				1	<1
Flesh-footed shearwater										8			5	3		8				8	2
Grey petrel						6	1	1					2	6		8				8	2
Grey-backed storm petrel					1										1			1		1	<1
Pacific albatross					1									1		1				1	<1
Pied shag		1											1				1			1	<1
Salvin's albatross	1	1							2	2			1	5		6				6	2
Sooty shearwater		8	34	32	89					2	1		153	13		62	104			166	45
Southern Cape petrel									1		1		2			1	1			2	1
Southern royal albatross			2										2			2				2	1
Spotted shag											2		1	1				2		2	1
Unknown *Thalassarche* albatross		3				2				1					6				6	6	2
Wandering albatross						1								1			1			1	<1
White-capped albatross		38	30	3	5	1				1			42	24	12	64	14			78	21
White-chinned petrel	8	26	15	5	1					2	3		37	15	8	44	11		5	60	16
White-faced storm petrel												1	1			1				1	<1
Total	**11**	**79**	**84**	**44**	**100**	**13**	**3**	**2**	**3**	**19**	**10**	**1**	**261**	**80**	**28**	**216**	**136**	**6**	**11**	**369**	
% Total	**3**	**21**	**23**	**12**	**27**	**3**	**1**	**1**	**1**	**5**	**3**	**<1**	**71**	**22**	**7**	**58**	**37**	**2**	**3**		

Seabirds returned during the 2005/06 fishing year were dominated numerically by three species which, combined, accounted for 82% of all specimens. Sooty shearwater *Puffinus griseus* was the most numerous species returned, accounting for nearly half of all specimens (166 birds, 45% of the total). White-capped albatross *Thalassarche steadi* (78 birds, 21%) and white-chinned petrel *Procellaria aequinoctialis* (60 birds, 16%) were the next most numerous species. Historically, these three have been the species most commonly returned for autopsy (see summaries in Robertson et al. 2004 and Conservation Services Programme 2008) and, together with Buller's albatross *T. bulleri bulleri*, grey petrel *Procellaria cinerea* and Salvin's albatross *T. salvini*, have contributed 86% of all specimens returned for autopsy (Robertson et al. 2004; Conservation Services Programme 2008). This pattern was maintained during the 2005/06 fishing year, with these six species comprising 89% of all birds returned (Table 1). Of the remaining 16 species, 13 were represented by only one or two specimens (Table 1). Spotted shag *Phalacrocorax punctatus* represented a new taxon to be returned and identified.

Only one specimen returned was banded: the single wandering albatross *Diomedea exulans*, band number BS-23270, which was banded as an adult at Kerguelen Island in the southern Indian Ocean in January 2003.

The monthly distribution of returned specimens was clearly not evenly spread across the fishing year, with the majority of seabirds having been killed from February to May (307 specimens, 83% of the total) (Table 1). This reflects an interaction between the timing of seabird breeding and, therefore, presence of birds within New Zealand's EEZ, the timing and location of fishery operations, and observer coverage. This pattern is exemplified by the three most numerous species returned (Fig. 1): approximately 87% of all white-capped albatrosses and 68% of all white-chinned petrels were returned in February and March, and over 50% of all sooty shearwaters were returned in May alone. That so many sooty shearwaters were killed and returned during May was perhaps surprising, and relatively unusual compared with historical returns for this species (Robertson

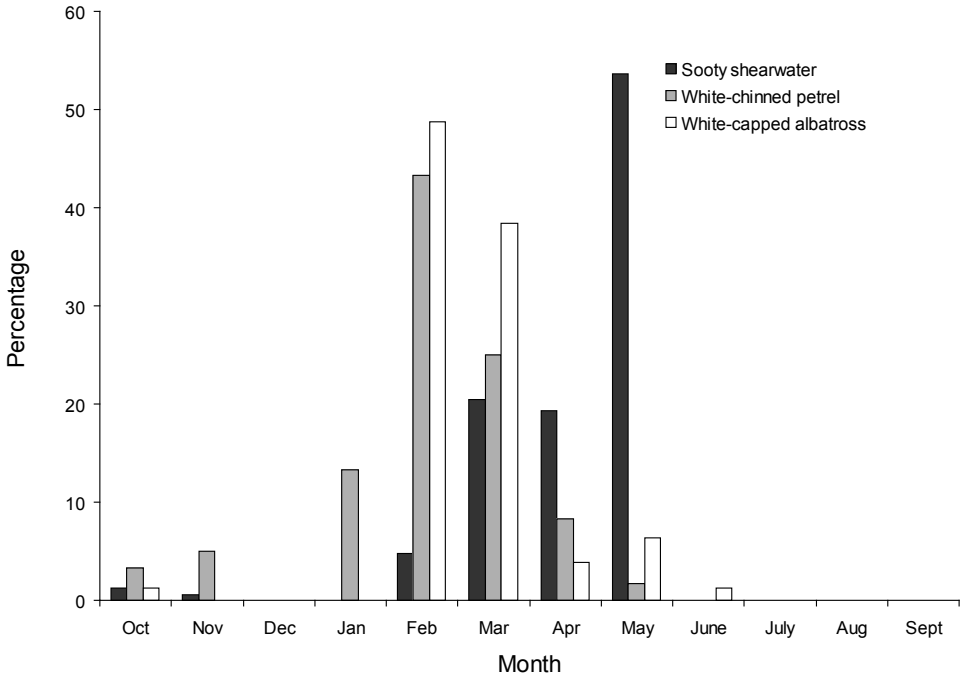

Figure 1. Proportion of sooty shearwaters *Puffinus griseus*, white-chinned petrels *Procellaria aequinoctialis* and white-capped albatrosses *Thalassarche steadi* killed and returned for autopsy between 1 October 2005 and 30 September 2006, by month.

et al. 2004; Conservation Services Programme 2008), as by this time of the year many birds will have migrated to their wintering areas in the north Pacific (Shaffer et al. 2006). However, it is perhaps worth noting that of the 89 sooty shearwaters returned in May, all but two were from just two trips, suggesting that rather than a genuine shift in sooty shearwater capture characteristics, these data emphasise, at least in part, the stochastic nature of seabird capture by commercial fishing operations.

In keeping with previous years' findings, the majority of birds returned were males (71% of all birds and 77% of sexed birds; Table 1). This pattern was particularly the case for sooty shearwaters, where males comprised 92% of individuals returned. Females were more numerous than males for three species (Campbell albatross *Thalassarche impavida*, grey petrel and Salvin's albatross), although sample sizes were small for these (Table 1). There was a similarly strong bias in the age/status of birds returned, with 95% of birds classified as either breeding adult or adult (Table 1). 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. Based on moult and gonadal characteristics, only three adult birds could be described as being definitely non-breeding: one each of Antipodean albatross *Diomedea antipodensis antipodensis*, pied shag *Phalacrocorax varius varius* and white-capped albatross.

3.2 TARGET FISHERIES AND EFFECT OF VESSELS

Longline fisheries accounted for only 45 (12%) of the 369 seabirds returned for autopsy. Within this group, the ling *Genypterus blacodes* longline fishery returned the most specimens (23 birds, 51% of all longline fishery returns; Table 2), although four of these (a single broad-billed prion *Pachyptila vittata*, and three common diving petrels *Pelecanoides urinatrix*) were very likely deck-strikes. Seabirds were also returned from longline boats targeting tuna *Thunnus* spp. (both chartered and domestic vessels), swordfish *Xiphias gladius* and snapper *Pagrus auratus* (Table 2). Trawl activities returned 321 birds (87%), with trawlers targeting squid *Nototodarus* spp.and hoki *Macruronus novaezelandiae* accounting for 280 of these (75% of all birds returned) (Table 2). It should be noted, however, that these totals for trawlers targeting squid and hoki were dominated by a few large capture events (trips): 54 (61%) of the 85 birds returned from boats targeting hoki were from a single trip, and 82 (42%) of the 195 birds returned from boats targeting squid were from two trips. Seabirds were also returned from trawlers targeting scampi *Metanephrops challengeri*, and a group of relatively infrequently targeted species (classified as 'other'), which included barracouta *Thyrsites atun*, jack mackerel *Trachurus* spp., orange roughy *Hoplostethus atlanticus*, silver warehou *Seriolella punctata* and southern blue whiting *Micromesistius australis* (Table 2). The pattern of most trips and vessels returning relatively low numbers of birds, with 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, because seven of the vessels made two observed trips from which birds were returned. It is worth noting that there was no significant relationship between the numbers of birds killed on the two separate trips for

TABLE 2. SPECIES AND NUMBERS OF SEABIRDS KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2005 AND 30 SEPTEMBER 2006, BY TARGET FISHERY.

SPECIES	LONGLINE					TRAWL				SET NET	TOTAL
	CHARTERED TUNA	DOMESTIC TUNA	SWORDFISH	SNAPPER	LING	HOKI	SQUID	SCAMPI	OTHER	RIG	
Antipodean albatross	1										1
Black petrel				2							2
Broad-billed prion					1						1
Buller's albatross	4	1				2	2	1	2		12
Campbell albatross	1	1	1								3
Chatham albatross					2						2
Common diving petrel					3		1				4
Fairy prion									1		1
Flesh-footed shearwater								8			8
Grey petrel		7							1		8
Grey-backed storm petrel						1					1
Pacific albatross		1									1
Pied shag										1	1
Salvin's albatross					1	4	1				6
Sooty shearwater					2	69	85		10		166
Southern cape petrel					1	1					2
Southern royal albatross							2				2
Spotted shag										2	2
Unknown albatross					1	1	3	1			6
Wandering albatross		1									1
White-capped albatross	1		1			4	58		14		78
White-chinned petrel					12	3	43		2		60
White-faced storm petrel									1		1
Total	**7**	**11**	**2**	**2**	**23**	**85**	**195**	**10**	**31**	**3**	**369**
% Total	**2**	**3**	**1**	**1**	**6**	**23**	**52**	**3**	**8**	**1**	

each of these seven vessels; for example, three vessels returned 54, 31 and 22 birds, respectively, from each of their first trips, but only one bird from each of their second trips.

For the 2005/06 fishing year, and excluding deck-strikes, six species were caught exclusively by longline fisheries: Antipodean albatross, black petrel *Procellaria parkinsoni*, Campbell albatross, Chatham albatross *Thalassarche eremita*, Pacific albatross *T. bulleri platei* and wandering albatross (Table 2). In addition, seven of the eight grey petrels returned were captured in the domestic tuna longline fishery (Table 2). Only flesh-footed shearwaters *Puffinus carneipes*, southern royal albatrosses *Diomedea epomophora* and singles of fairy prion *Pachyptila turtur*, grey-backed storm petrel *Oceanites nereis* and white-faced storm petrel *Pelagodroma marina* were captured exclusively in trawl fisheries, although the majority of sooty shearwaters (164 of 166, 99%) and white-capped albatrosses (76 of 78, 97%) were returned from trawl fisheries (Table 2). Buller's albatrosses and white-chinned petrels were returned in reasonable proportions from both longline and trawl fisheries (Table 2). The pied shag and spotted shags were only captured in setnets targeting rig *Mustelus lenticulatus* (Table 2).

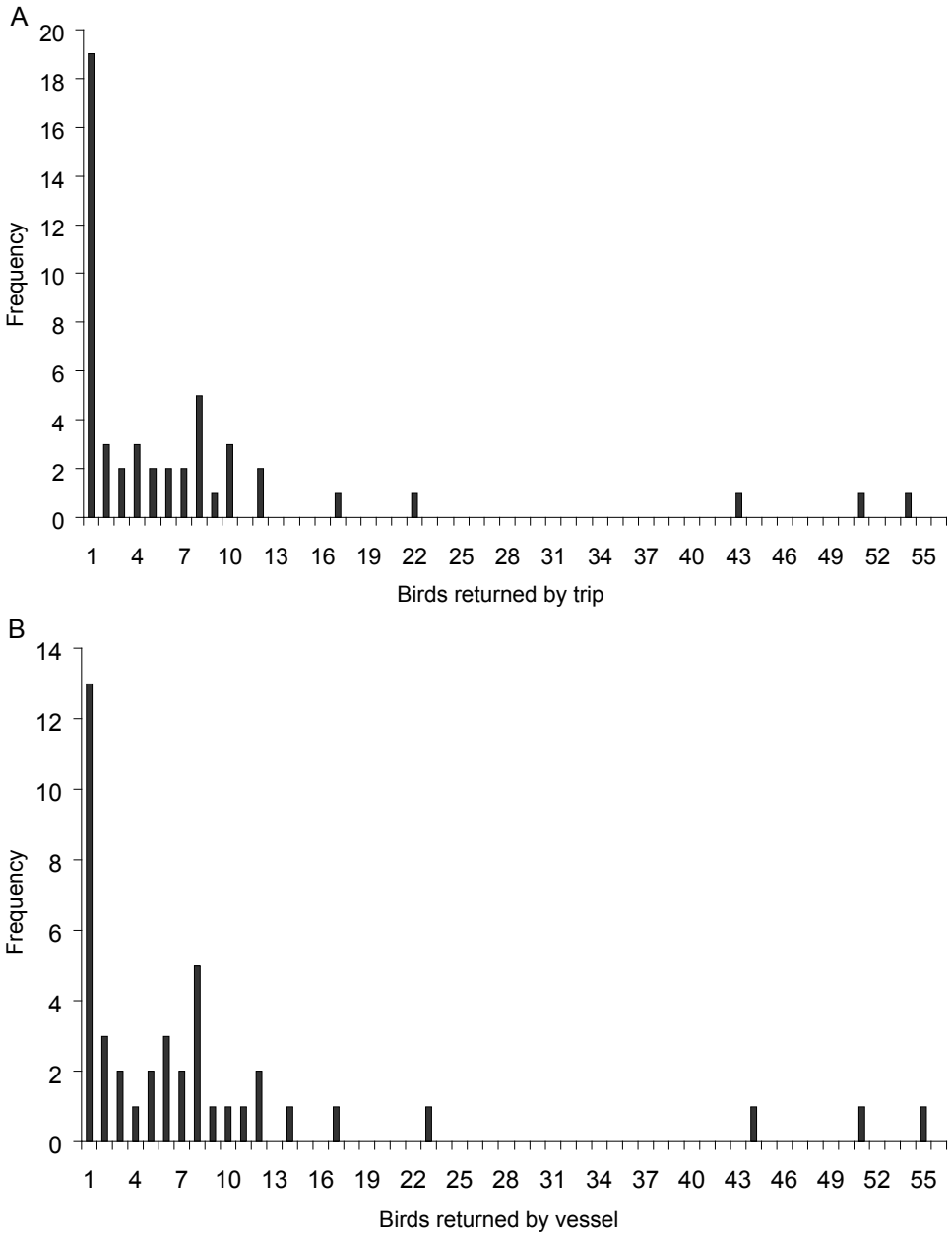

Figure 2. Number of seabirds killed and returned for autopsy from A. each observed trip and B. each observed vessel between 1 October 2005 and 30 September 2006. Trips and vessels that returned no birds are not included.

The relatively low numbers of birds returned from specific longline fisheries precludes any meaningful comparison of whether large (albatross) or small (non-albatross) taxa are particularly vulnerable to this fishing method. However, the proportions presented here for longline fisheries overall (Fig. 3) are in keeping with results from previous fishing years (summaries in Robertson et al. 2004; Conservation Services Programme 2008). Trawl fisheries overall returned 73% small taxa, with the proportion of small birds highest (95%) in the hoki fishery (Fig. 3). In previous fishing years, trawl fisheries overall have returned about equal numbers of large and small taxa (summaries in Robertson et al. 2004; Conservation Services Programme 2008). The skew towards small species in 2005/06 is a result of relatively large numbers of sooty shearwaters being caught and returned from all trawl fisheries, excepting the scampi fishery (Table 2).

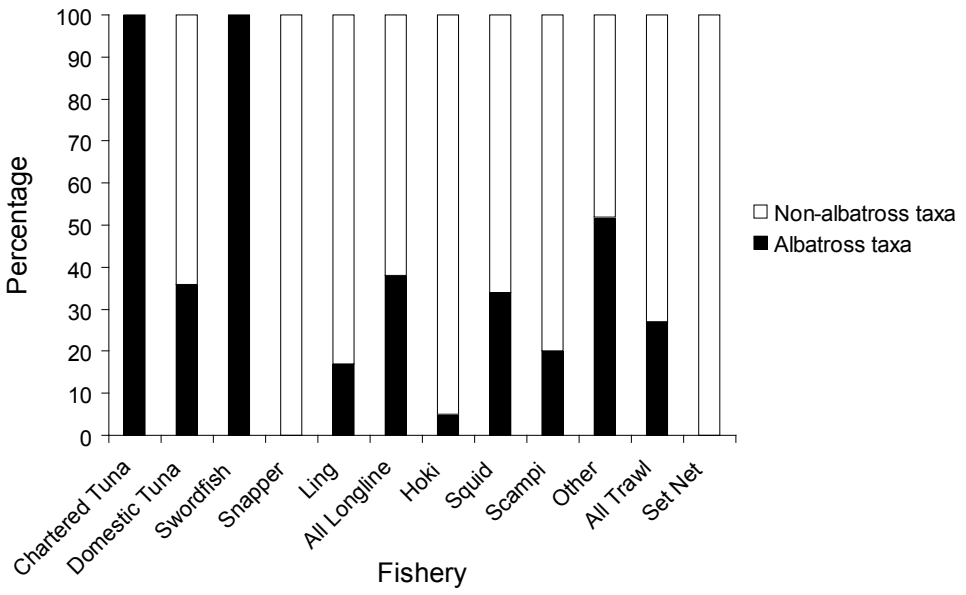

Figure 3. Proportion of albatross and non-albatross taxa killed and returned for autopsy between 1 October 2005 and 30 September 2006, by target fishery.

3.3 INJURIES OF RETURNED BIRDS AND LIKELY CAUSE OF DEATH

Returned birds exhibited diverse injuries. 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 entire organs and/or body parts missing. Often injury classifications were not exclusive, with some birds exhibiting many separate injuries.

Not surprisingly, injuries involving hooks and snoods were recorded exclusively from birds captured in longline fisheries. Of the 45 birds returned from all longline fisheries, 30 (67%) had injuries from hook impalement or snood entanglement (although all but three birds had a hook either impaled or showed injuries consistent with a hook having been removed, e.g. holes in the bill or throat). Of these 30 birds, 57% had hooks in the bill or throat, and 43% were 'foul hooked' in the wing, feet or body. Albatrosses were slightly more likely to be hooked through the bill or throat (47% of 17 birds) than the non-albatross taxa (32% of 28 birds), whereas non-albatross taxa were more often hooked/entangled through the wing (25%) than albatrosses (12%). Other injuries included broken or badly damaged wings (9% of all birds), legs (7%) or other bones/part of the body (2%), and relatively superficial lacerations and abrasions (7%). There was no obvious sign of injury in 16% of all birds returned from longline fisheries.

In contrast to birds returned from longline fisheries, and in keeping with findings from previous fishing years (summaries in Robertson et al. 2004; Conservation Services Programme 2008), birds returned from trawl fisheries exhibited a different set of predominant injuries. For example, of the 321 birds returned from trawl fisheries, 30% had broken or badly damaged wings. Wing injuries were mainly consistent with collision with warps, and included fractures, ripped skin and lacerations at the 'elbow'. They were also often associated with thick, brown grease, as reported previously (Robertson et al. 2004). The proportion of albatrosses with wing injuries (80% of 95 birds) was far greater than that of

non-albatross taxa (8% of 226 birds). Similarly, 59% of albatrosses exhibited grease on the plumage, compared with only 4% of non-albatross taxa. Overall, 47% of birds returned from trawls showed no obvious injury, but only 2% of albatrosses fell into this category compared with 64% of non-albatross taxa. This latter statistic is driven primarily by 117 (70%) of the 166 sooty shearwaters returned showing no injuries, although many were coated in fish scales and 'slime', which are consistent with being caught in the net.

By using information on injuries obtained from autopsy along with the 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 was assigned to each bird (Table 3). 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 43% of all cases and hooked/entangled in the wing in 27% of cases (Table 3). In a further 20% of cases, it was not obvious how death occurred (Table 3). Sample sizes within categories were relatively small, but there was a suggestion that non-albatross taxa were more likely to be hooked/entangled in the wing (Table 3).

Birds returned from trawl fisheries were assigned to one of three likely cause of death categories: warp interaction, net and other (Table 3). Birds that died as a result of warp interaction were not necessarily recovered from the warp itself; some birds that hit a warp (as shown by their injuries) were subsequently recovered from the net. Birds assigned to the 'net' category exhibited none of the injuries typical of interacting with a warp, rarely had brown grease on their wings and often had fish scales on their plumage (indicative of time spent in the net and/or fish pound). The single white-faced storm petrel assigned to the 'other' category was 'caught on [the] Tori line' according to observer comments. For all trawl fisheries combined, there were striking differences in the likely cause of death between albatross and non-albatross taxa. Although only 29% of trawl specimens could be assigned to warp interaction, 88% of these birds were albatrosses, primarily white-capped albatross: of the 78 white-capped albatrosses returned during 2005/06, 65 (83%) were assigned to this category (Table 3). Conversely, 71% of all birds likely died as a result of becoming entangled in the net or from diving into the net itself, and 94% of these were non-albatross taxa, primarily sooty shearwaters and white-chinned petrels: 160 (96%) of the 166 sooty shearwater and 42 (70%) of the 60 white-chinned petrels returned likely died from interactions with the net (Table 3).

All three shags returned showed no obvious sign of injury and died as a result of entanglement in set nets. In addition, eight birds belonging to five taxa were classified as having been killed through deck-strike, based on observer comments. These birds were found dead on board in a variety of locations, but away from nets and lines (e.g. the sooty shearwater and one of the four common diving petrels *Pelecanoides urinatrix* in this category were recovered together from one of the vessel's engine rooms), and were generally in good condition (Table 3).

TABLE 3. LIKELY CAUSE OF DEATH OF SEABIRD SPECIES KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2005 AND 30 SEPTEMBER 2006.

Note: Longline specimens were either hooked or entangled by the snood; '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. 'Other' refers to a single specimen that hit the Tori line deployed behind a trawler.

SPECIES	LONGLINE HOOK/SNOOD					TRAWL			SET-NET	DECK-STRIKE	TOTAL
	BILL/THROAT	WINGS	LEGS/FEET	BODY	NOT OBVIOUS	WARP INTER-ACTION	NET	OTHER			
Antipodean albatross	1										1
Black petrel		1	1								2
Broad-billed prion										1	1
Buller's albatross	4				1	6	1				12
Campbell albatross	1		1		1						3
Chatham albatross		2									2
Common diving petrel										4	4
Fairy prion										1	1
Flesh-footed shearwater							8				8
Grey petrel	7						1				8
Grey-backed storm petrel										1	1
Pacific albatross					1						1
Pied shag									1		1
Salvin's albatross	1					4	1				6
Sooty shearwater		1				4	160			1	166
Southern Cape petrel				1		1					2
Southern royal albatross						2					2
Spotted shag									2		2
Unknown albatross					1	5					6
Wandering albatross	1										1
White-capped albatross					2	65	11				78
White-chinned petrel	2	7		1	2	6	42				60
White-faced storm petrel								1			1
Total	**17**	**11**	**2**	**2**	**8**	**93**	**224**	**1**	**3**	**8**	**369**
% of total longline or trawl	**43**	**27**	**5**	**5**	**20**	**29**	**71**	**<1**			
Albatrosses (%)	**47**	**18**	**50**	**0**	**75**	**88**	**6**	**0**	**0**	**0**	
Others (%)	**53**	**82**	**50**	**100**	**25**	**12**	**94**	**100**	**100**	**100**	

3.4 BODY CONDITION

For the six most numerous species returned historically (Table 4), mean fat scores were generally higher in birds from the 2005/06 fishing year than in previous years, excepting 1996/97 (summaries in Robertson et al. 2004; Conservation Services Programme 2008), suggesting that overall these birds were in slightly better condition during 2005/06.

There are two potential explanations for this result, which are not mutually exclusive. Firstly, it could be that interpretations of the fat score criteria were different between 2005/06 and other years, with birds from 2005/06 being assigned higher fat scores than would have been the case in 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

TABLE 4. 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		3	5	4			12	3.1 ± 0.8
Grey petrel	2		4	1	1		8	2.9 ± 1.4
Salvin's albatross		1	2	2	1		6	3.5 ± 1.0
Sooty shearwater		18	69	57	22		166	3.5 ± 0.9
White-capped albatross		9	22	25	10	12	78	3.5 ± 0.9
White-chinned petrel		7	28	9	8	8	60	3.3 ± 0.9
Total	**2**	**38**	**130**	**98**	**42**	**20**	**330**	

relatively restricted, given that a score of '1' represents 'no fat' and a score of '5' represents 'very fat' (Bartle 2000) or so fat that 'examination of the body cavity becomes difficult' (Conservation Services Programme 2008). There can be little misinterpretation of a score of '1' (i.e. no fat), and birds returning this score were rare during 2005/06, being confined to two of eight grey petrel, or less than 1% of the six taxa for which a score could be determined (Table 4). In previous years, fat scores of '1' were relatively more numerous for all six species, but particularly for sooty shearwater, white-capped albatross and white-chinned petrel (summaries in Robertson et al. 2004; Conservation Services Programme 2008). Unlike previous years, during the 2005/06 fishing year, fat samples were removed and stored from as many specimens as possible for other potential analyses. Only in specimens returning a fat score of '1' were fat samples not removed (because, by definition, there was no fat to sample). Nevertheless, it is possible that during 2005/06, birds scoring '3' would have previously been scored '2', birds scoring '4' as '3' and birds scoring '5' as '4'.

The second explanation for the higher fat scores during 2005/06 is that, in general, birds returned were genuinely in better condition, as measured by the 1–5-point scale fat score, than in previous years. The almost complete absence of birds returning a score of '1' from 2005/06 supports this explanation.

In reality, both of these explanations may partly explain the apparent 'jump' in mean body condition scores. However, linking fat score to the probability of being captured by a fishing boat is fraught with problems. If fat score is a good predictor of the likelihood that a bird will associate with fishing vessels in search of food, then for any given species one would expect a negative relationship between the numbers of birds captured and mean fat score because, under this model, birds with fat scores of 1 or 2 would be more likely to be captured by fishing vessels than birds with fat scores of 4 or 5. There is some evidence for such relationships over the history of the autopsy programme (see data in Conservation Services Programme 2008), but the nature of the relationships is not consistent (grey petrels show a positive trend between mean fat score and number captured). Furthermore, the non-random nature of bird acquisition diminishes the confidence that such relationships are meaningful. For example, for any given species, and for all years of the programme, birds were not always captured from the same place and at the same time of year. Both of these sources of variation (place and time) could influence fat scores and confound any relationship between a species' mean fat score for a fishing year and the number of that species captured.

3.5 STOMACH CONTENTS

In keeping with previous years, stomach (proventriculus) contents were tentatively identified (presence/absence) as falling into one of nine categories, with 'no stomach' making up a tenth category (see Table 5). Ultimately, it is hoped that it will be possible to produce a more quantitative, detailed dietary account for autopsied birds, but to date the identification of many prey remains (particularly of very small cephalopod beaks and small otoliths, which are often eroded) has proved extremely difficult.

For longline fisheries, sample sizes were generally small, but bait was recorded in stomachs of birds returned from all fisheries excepting swordfish and snapper. Empty stomachs comprised 43%–100% of albatross and 26%–50% of non-albatross taxa.

TABLE 5. STOMACH (PROVENTRICULUS) CONTENTS OF ALBATROSSES AND NON-ALBATROSS TAXA KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2005 AND 30 SEPTEMBER 2006, BY TARGET FISHERY AND FOR EACH FISHING METHOD.
Values are percentages of birds within each category.

STOMACH CONTENTS	LONGLINE					TRAWL				SET-NET
	CHARTERED TUNA	DOMESTIC TUNA	SWORDFISH	SNAPPER	LING	HOKI	SQUID	SCAMPI	OTHER	RIG
ALBATROSSES										
Number caught	7	4	2	0	4	11	66	2	16	0
No stomach					50	18	23	50		
Empty	43	100	50			9	32		44	
Natural?			50							
Sludge										
Bait	29				50					
Bait + natural										
Bait + offal										
Offal	28					73	44	50	56	
Offal + natural							1			
Bait + offal + natural										
NON-ALBATROSS TAXA										
Number caught	0	7	0	2	19	74	129	8	15	3
No stomach					11	1	4			
Empty		43		50	26	37	32	38	7	
Natural?		43		50	21	31	18	50	27	100
Sludge					11		1	12		
Bait		14			5					
Bait + natural					21					
Bait + offal										
Offal					5	24	38		53	
Offal + natural						7	7		13	
Bait + Offal + Natural										

For birds returned from trawl fisheries, natural food types were present in only 1% of albatross stomachs, where they were found in association with offal (Table 5). In contrast, 18%–50% of stomachs from non-albatross taxa contained natural food types, with a further 7%–13% containing a mix of natural food and offal (Table 5). Offal alone was present in 44%–73% of albatross stomachs (Table 5) and 24%–53% of stomachs from non-albatross taxa (Table 5). As an attractant to birds, offal would appear to be a significant factor in the majority of trawl fisheries during the 2005/06 fishing year.

3.6 SEABIRD IDENTIFICATION

Table 6 summarises the identification information provided by observers on board fishing vessels and returned on the autopsy tag attached to each specimen. The majority (78%) of seabirds from the 2005/06 fishing year were identified correctly, but 17% of identifications were inaccurate (5% if birds identified 'as

TABLE 6. SUMMARY OF IDENTIFICATIONS RECORDED BY ON-BOARD OBSERVERS AT SEA COMPARED WITH AUTOPSY IDENTIFICATION FOR SEABIRDS KILLED AND RETURNED FROM OBSERVED FISHING BOATS BETWEEN 1 OCTOBER 2005 AND 30 SEPTEMBER 2006.

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	SPECIES CODE DID NOT EXIST	TOTAL
Antipodean albatross		1	(1)						1
Black petrel	2								2
Broad-billed prion							1		1
Buller's albatross	12								12
Campbell albatross		3	(2)						3
Chatham albatross	1	1							2
Common diving petrel		4	(3)						4
Fairy prion					1				1
Flesh-footed shearwater	8								8
Grey petrel	3				5				8
Grey-backed storm petrel		1	(1)						1
Pacific albatross		1	(1)						1
Pied shag	1								1
Salvin's albatross	4	1		1					6
Sooty shearwater	165	1							166
Southern cape petrel		2	(2)						2
Southern royal albatross	2								2
Spotted shag		2	(2)						2
Wandering albatross	1								1
White-capped albatross	33	44	(31)				1		78
White-chinned petrel	53				3		4		60
White-faced storm petrel					1				1
Total	**285**	**61**	**(43)**	**1**	**10**		**6**		**363***
% Total	**78**	**17**		**<1**	**3**		**2**		

* Excludes the six birds identified as 'unknown *Thalassarche* albatross'.

correct spp. group' are excluded from the 'wrong' total). Historically, 64% of birds returned were identified correctly, with 12% of birds returned inaccurately identified (see Conservation Services Programme 2008). Again, the percentage identified inaccurately falls to 5% if those identified to the 'correct spp. group' are removed from the 'wrong' category. Species for which this frequently occurs include Antipodean and Gibson's albatross (identified as 'wandering albatross'), Campbell albatross (identified as 'unidentified black-browed albatross'), southern cape petrel *Daption capense capense* (identified as 'cape petrel') and white-capped albatross (identified as 'shy albatross'). The mis-identification of some species has implications for the reliability of identifications of birds not returned for autopsy but released after capture. Additionally, accurate identifications are required if these data are to be used in estimations of total seabird captures across fisheries and fishery areas.

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 that helped identify, or in many cases defined, the cause of death. Dennis Fairfax and Stephanie Rowe provided the important link through the Department of Conservation to the Observer Programme, and both 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, and Suze offered much-appreciated help and advice during the year. Stephanie Rowe and Amanda Todd (both Department of Conservation) and an anonymous referee made helpful comments that improved an earlier version of this report. This research was funded through the Conservation Services Programme (INT 2005/03), Department of Conservation (Science Investigation No. 3913).

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Appendix 1

COMMON AND SCIENTIFIC NAMES OF ALL SPECIES REFERRED TO IN THIS REPORT

COMMON NAME	SCIENTIFIC NAME
Antipodean albatross	*Diomedea antipodensis antipodensis*
Black petrel	*Procellaria parkinsoni*
Broad-billed prion	*Pachyptila vittata*
Buller's albatross	*Thalassarche bulleri bulleri*
Campbell albatross	*Thalassarche impavida*
Chatham albatross	*Thalassarche eremita*
Common diving petrel	*Pelecanoides urinatrix*
Fairy prion	*Pachyptila turtur*
Flesh-footed shearwater	*Puffinus carneipes*
Grey petrel	*Procellaria cinerea*
Grey-backed storm petrel	*Oceanites nereis*
Pacific albatross	*Thalassarche bulleri platei*
Pied shag	*Phalacrocorax varius varius*
Salvin's albatross	*Thalassarche salvini*
Sooty shearwater	*Puffinus griseus*
Southern cape petrel	*Daption capense capense*
Southern royal albatross	*Diomedea epomophora*
Spotted shag	*Phalacrocorax punctatus*
Wandering albatross	*Diomedea exulans*
White-capped albatross	*Thalassarche steadi*
White-chinned petrel	*Procellaria aequinoctialis*
White-faced storm petrel	*Pelagodroma marina*

Appendix 2

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

On each figure, 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 (Plateau)
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.

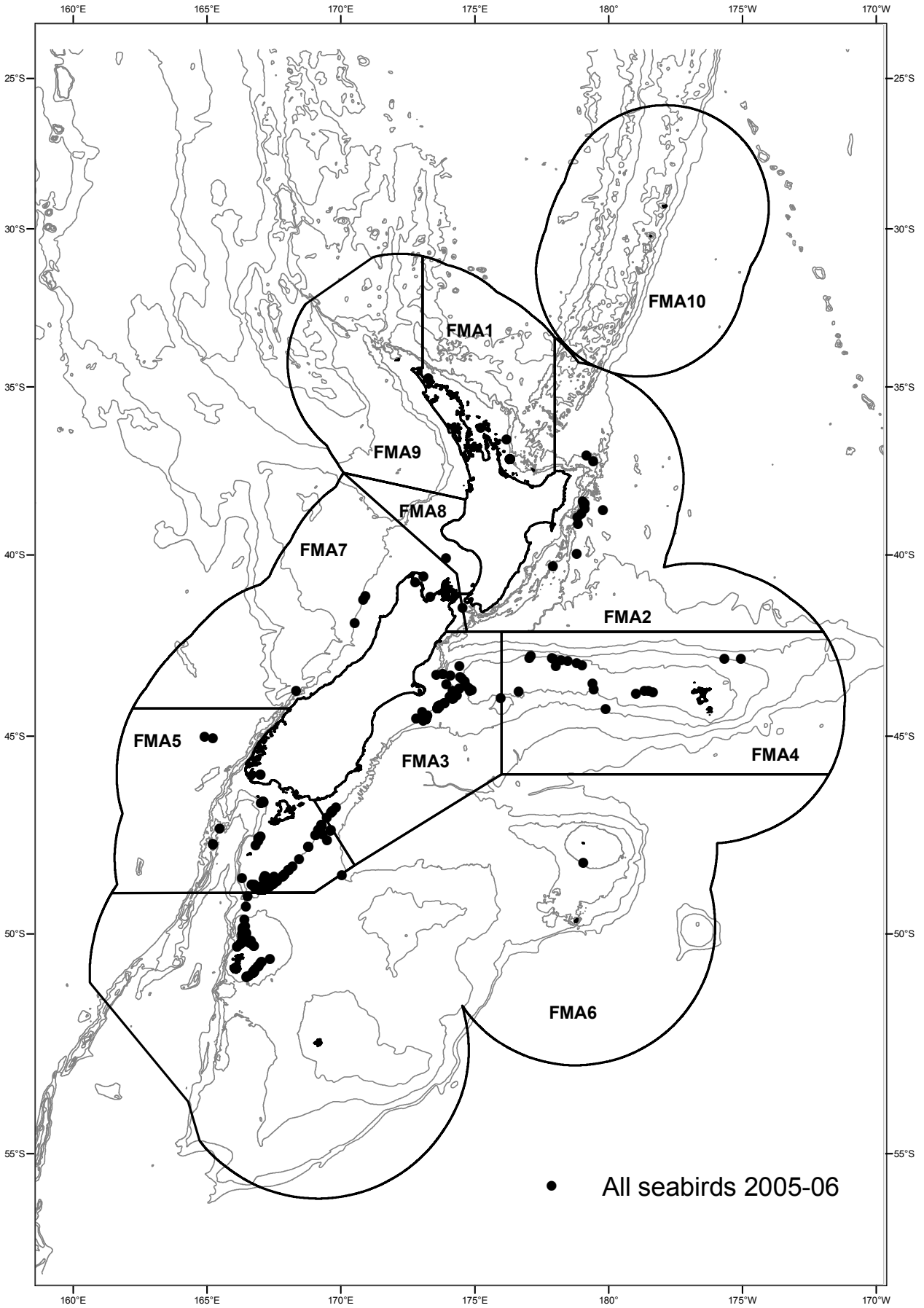

Figure A2.1. Catch locations of all seabirds killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

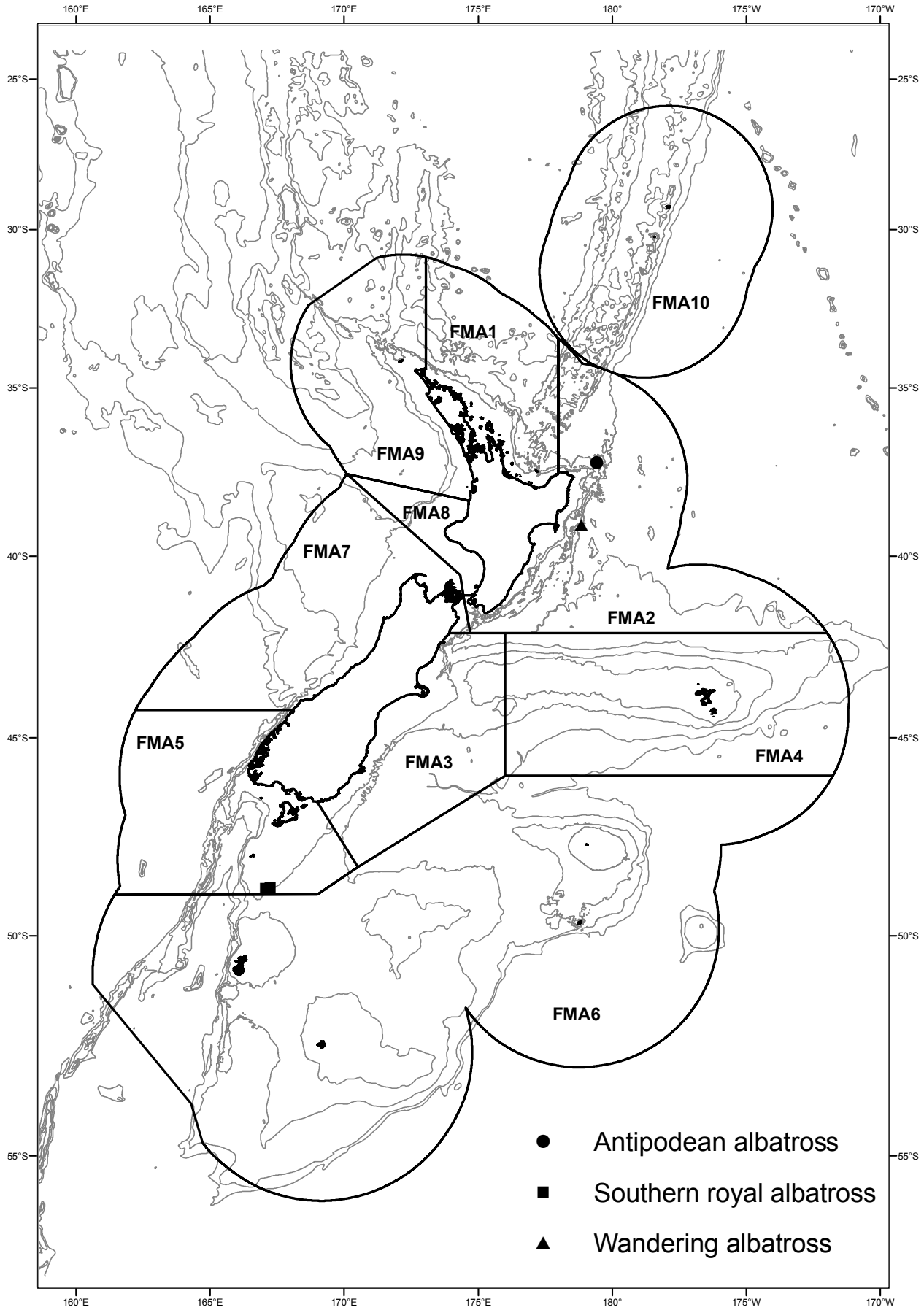

Figure A2.2. Catch locations of Antipodean albatross *Diomedea antipodensis antipodensis*, southern royal albatross *D. epomophora* and wandering albatross *D. exulans* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

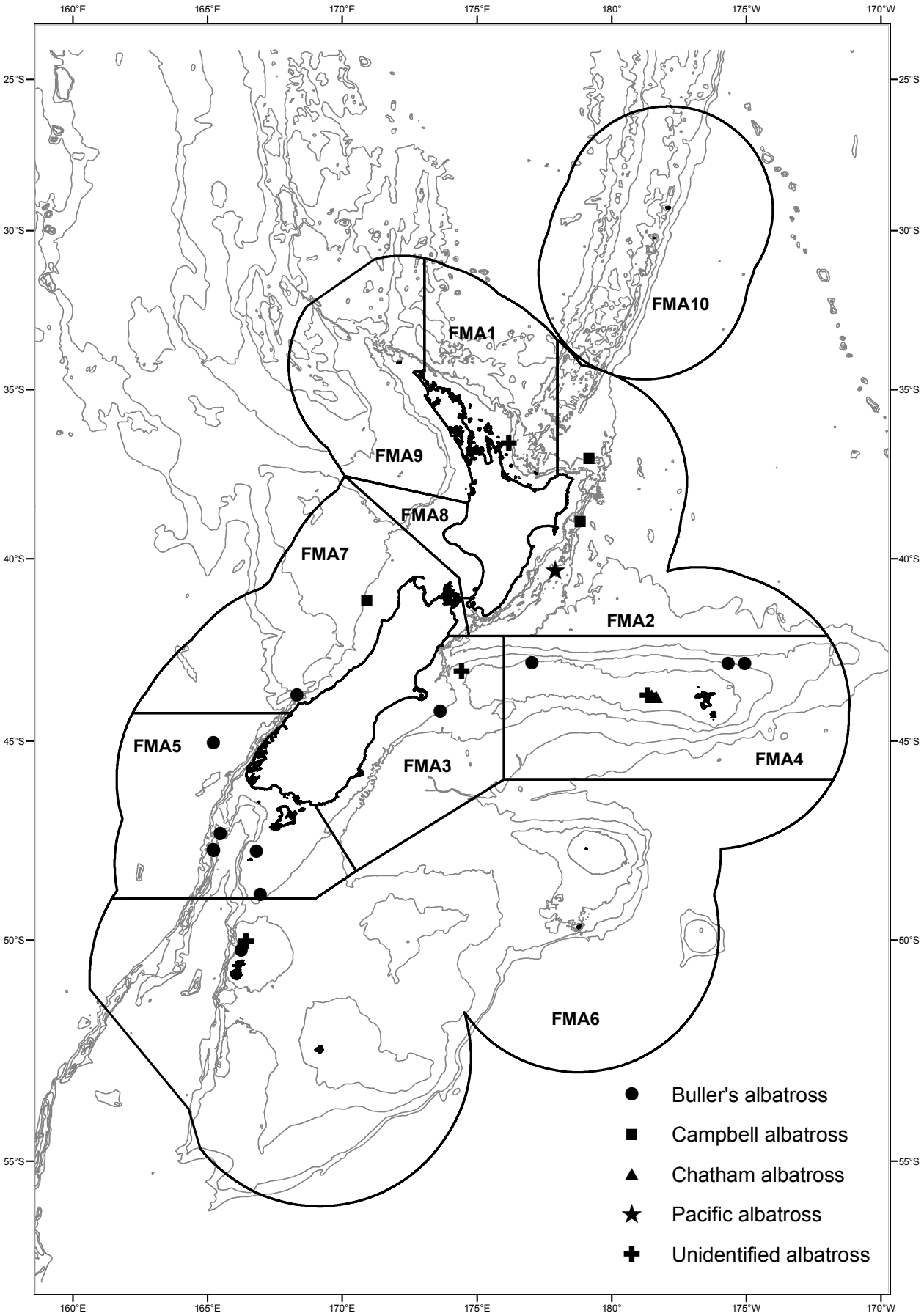

Figure A2.3. Catch locations of Buller's albatross *Thalassarche bulleri bulleri*, Campbell albatross *T. impavida*, Chatham albatross *T. eremita*, Pacific albatross *T. b. platei* and unidentified *Thalassarche* albatross killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

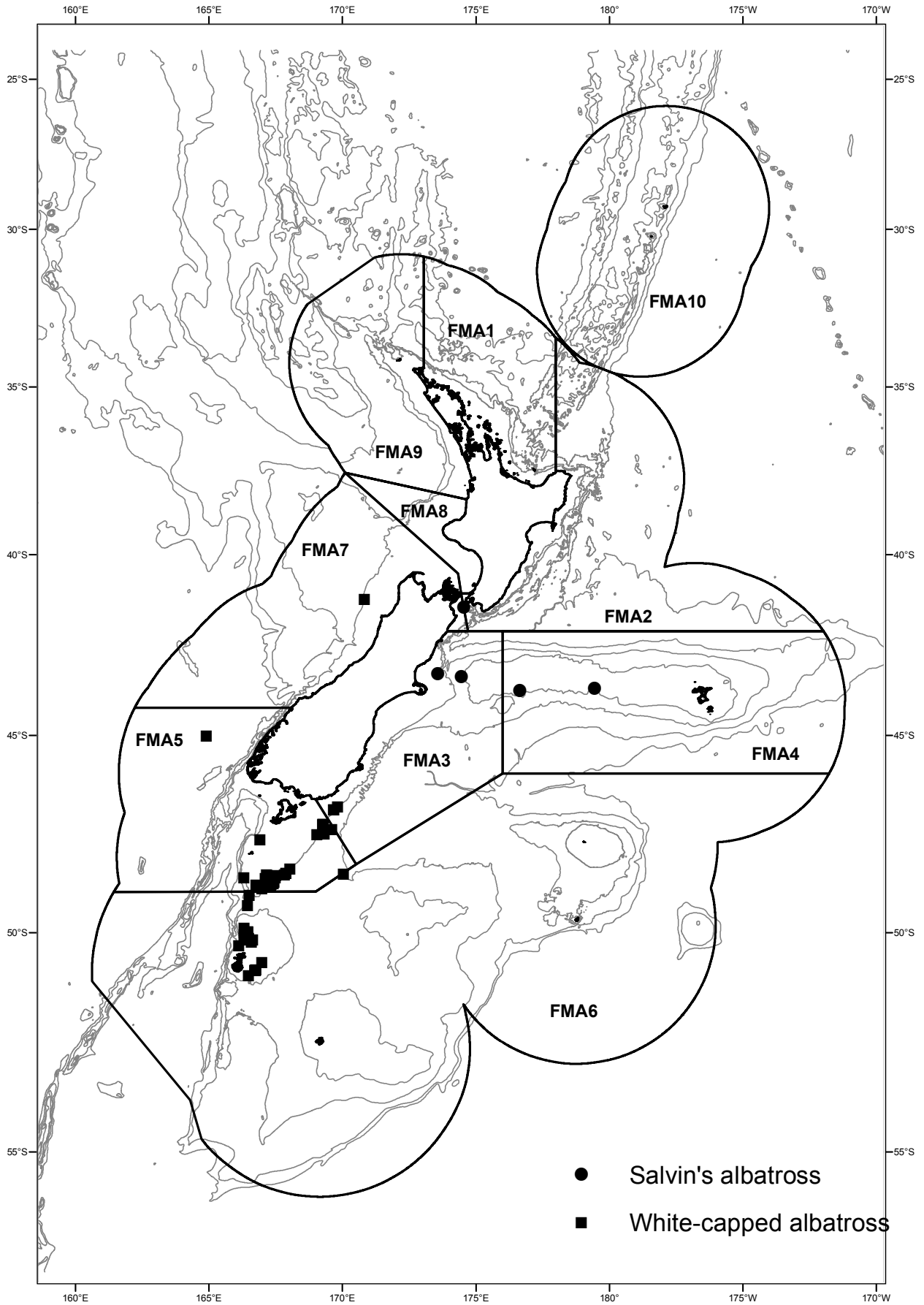

Figure A2.4. Catch locations of Salvin's albatross *Thalassarche salvini* and white-capped albatross *T. steadi* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

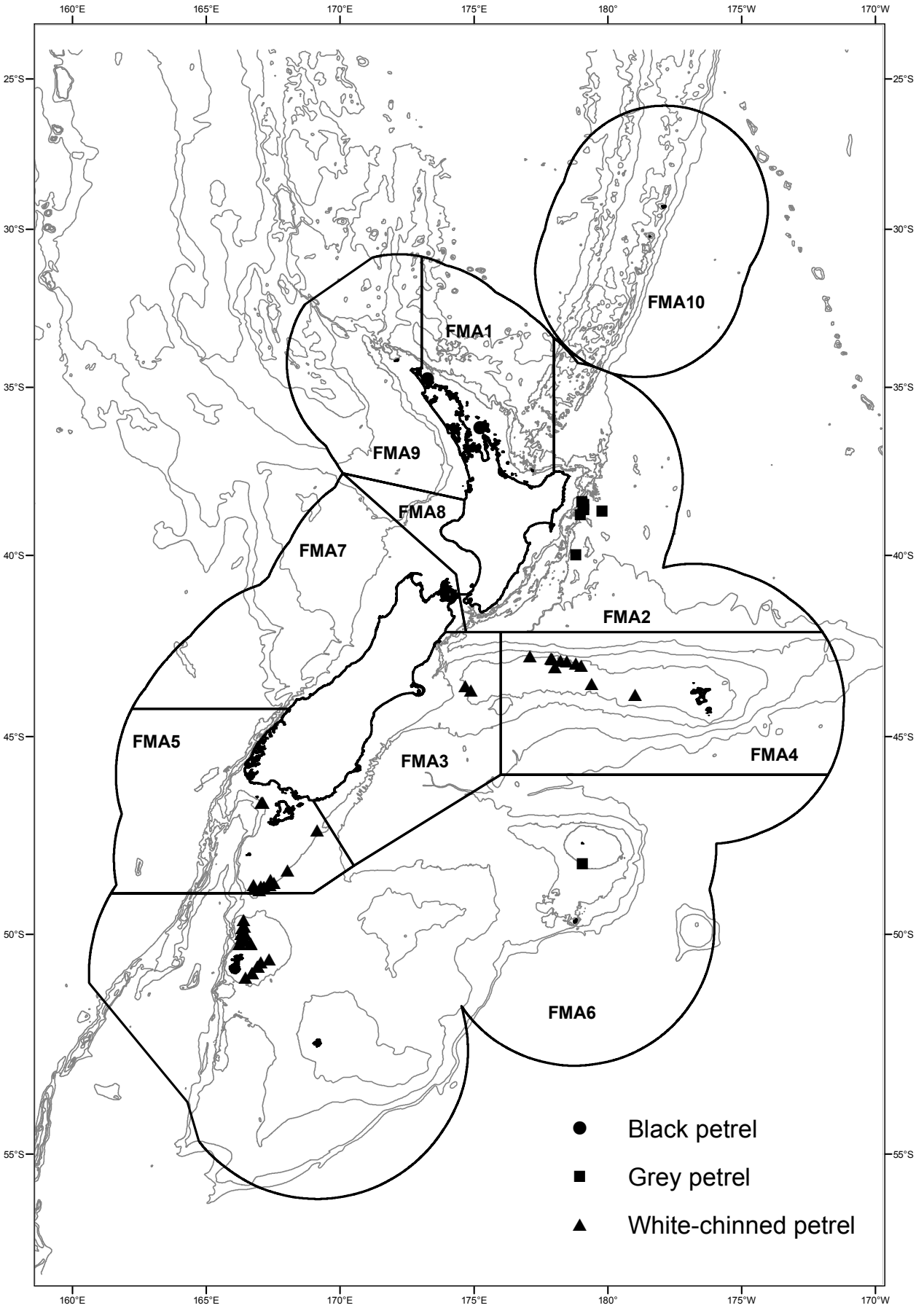

Figure A2.5. Catch locations of black petrel *Procellaria parkinsoni*, grey petrel *P. cinerea* and white-chinned petrel *P. aequinoctialis* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

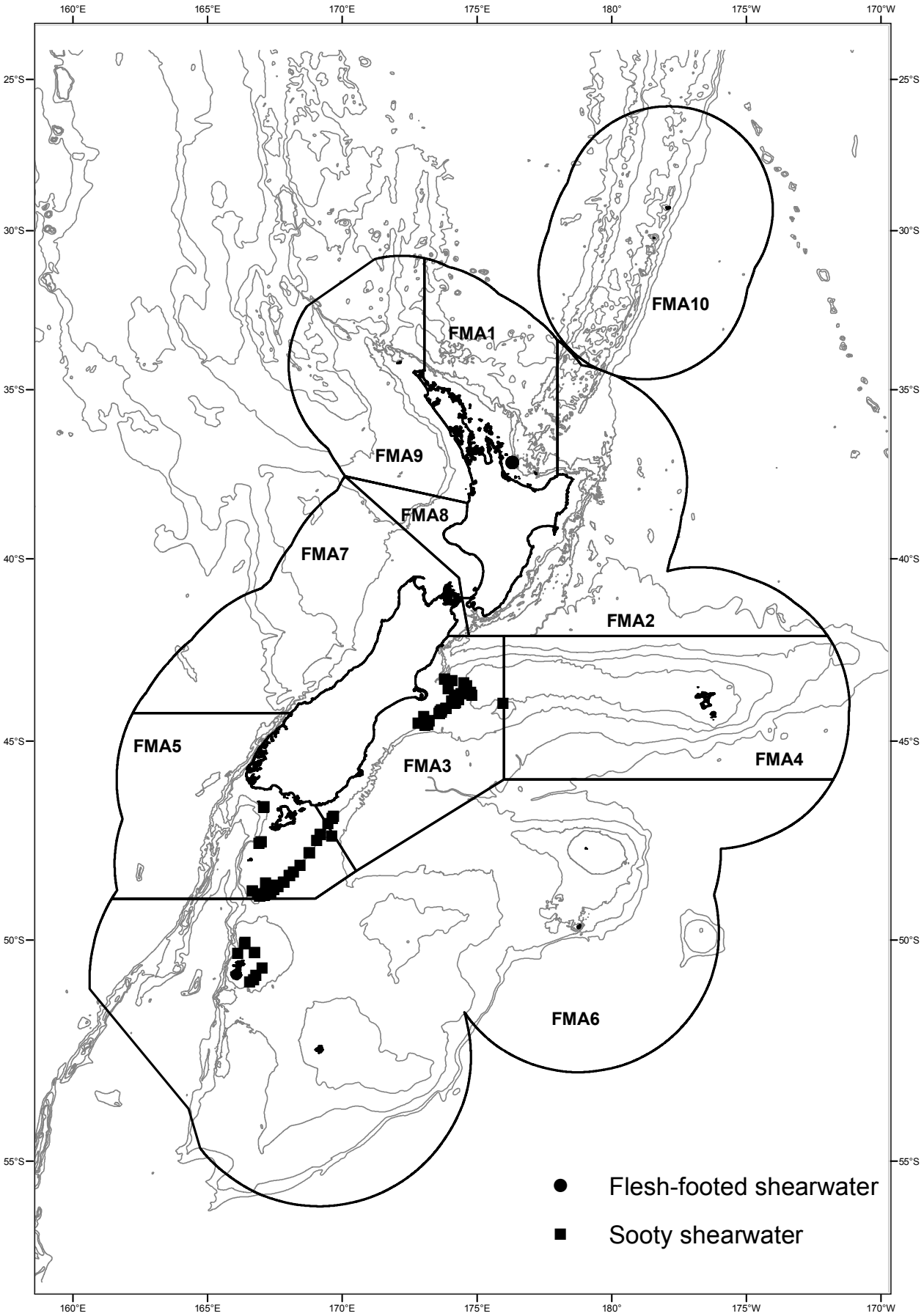

Figure A2.6. Catch locations of flesh-footed shearwater *Puffinus carneipes* and sooty shearwater *P. griseus* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

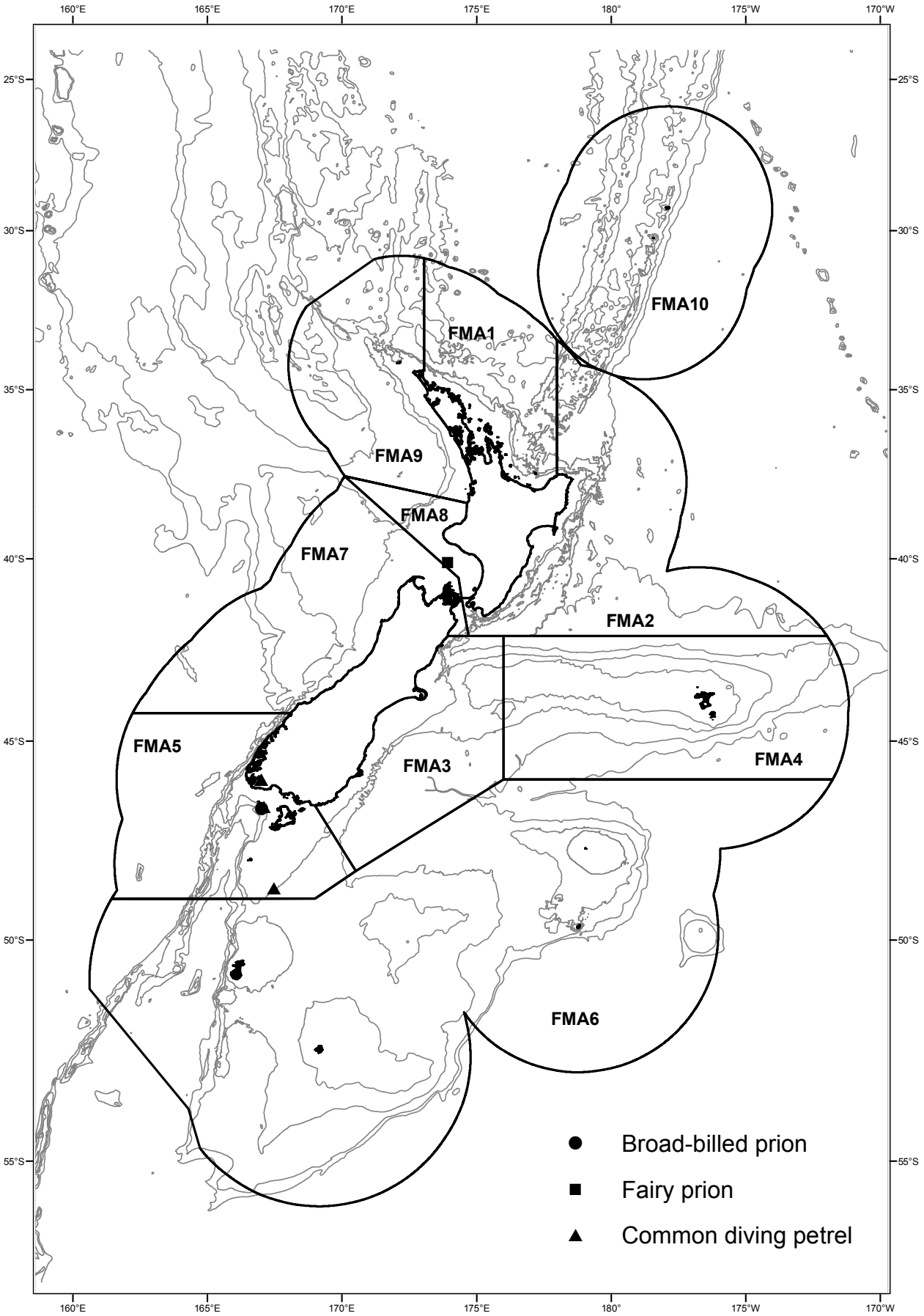

Figure A2.7. Catch locations of broad-billed prion *Pachyptila vittat*a, fairy prion *P. turtur* and common diving petrel *Pelecanoides urinatrix* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

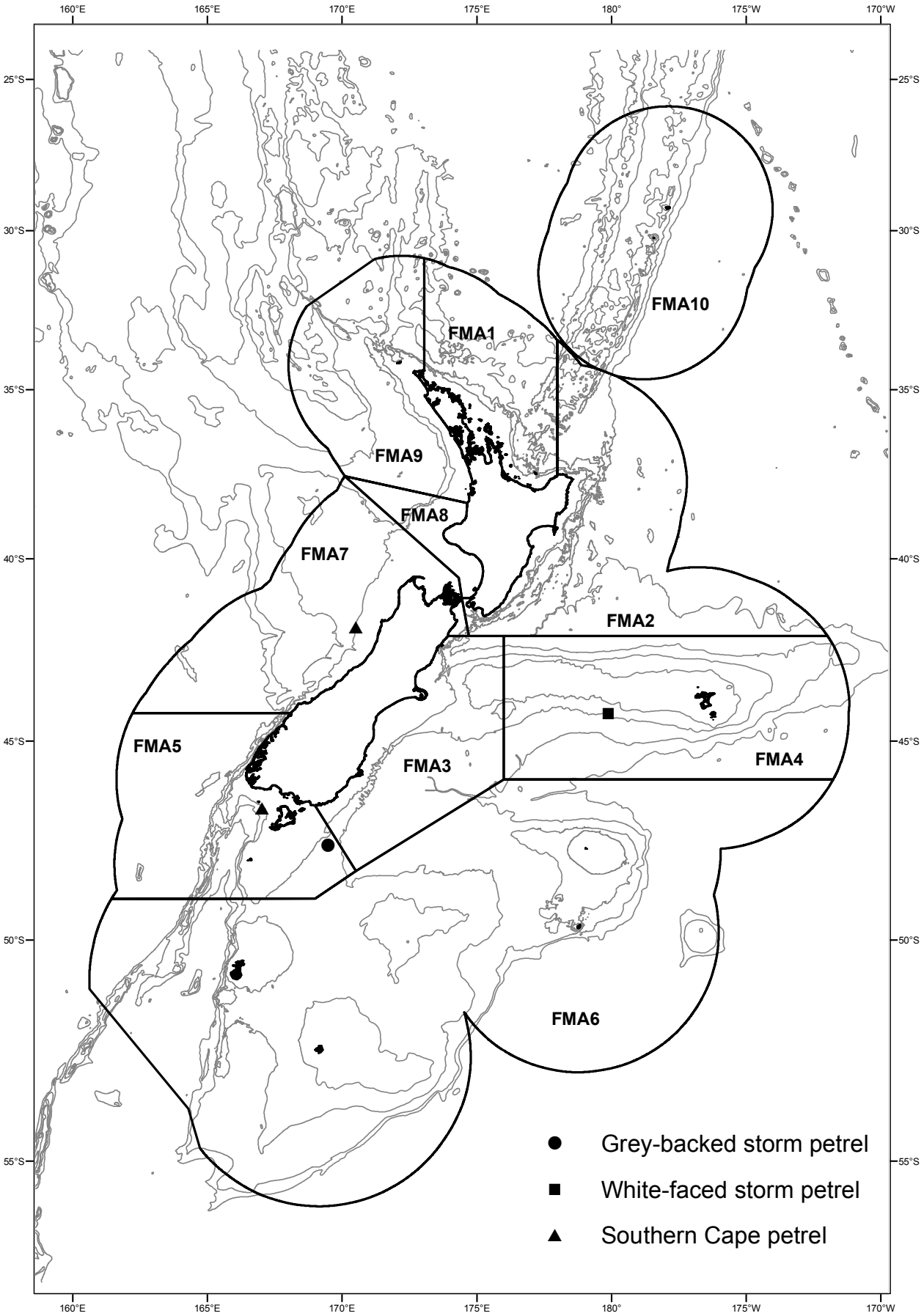

Figure A2.8. Catch locations of grey-backed storm petrel *Oceanites nereis*, white-faced storm petrel *Pelagodroma marina* and southern cape petrel *Daption capense capense* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

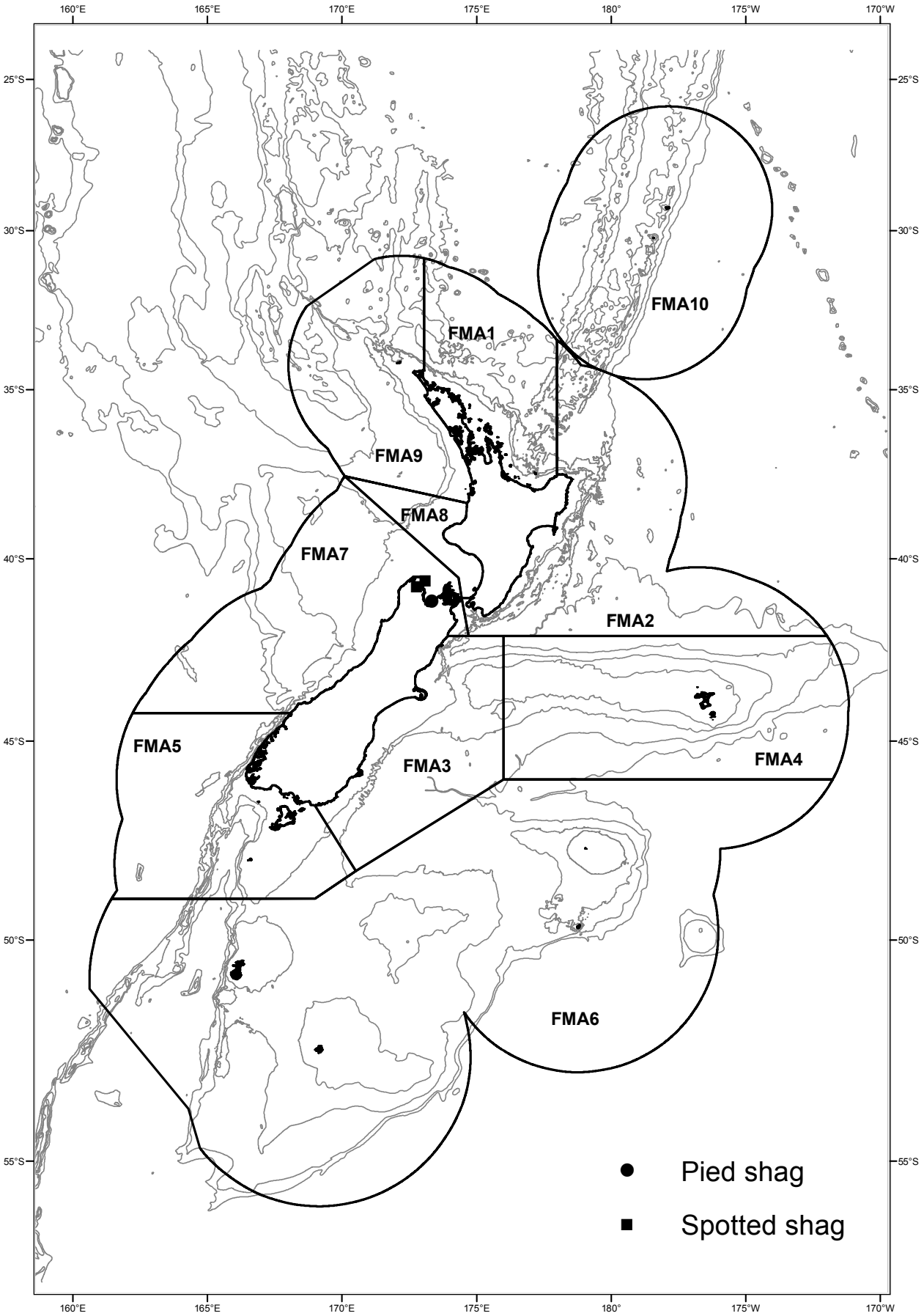

Figure A2.9. Catch locations of pied shag *Phalacrocorax varius varius* and spotted shag *P. punctatus* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006.

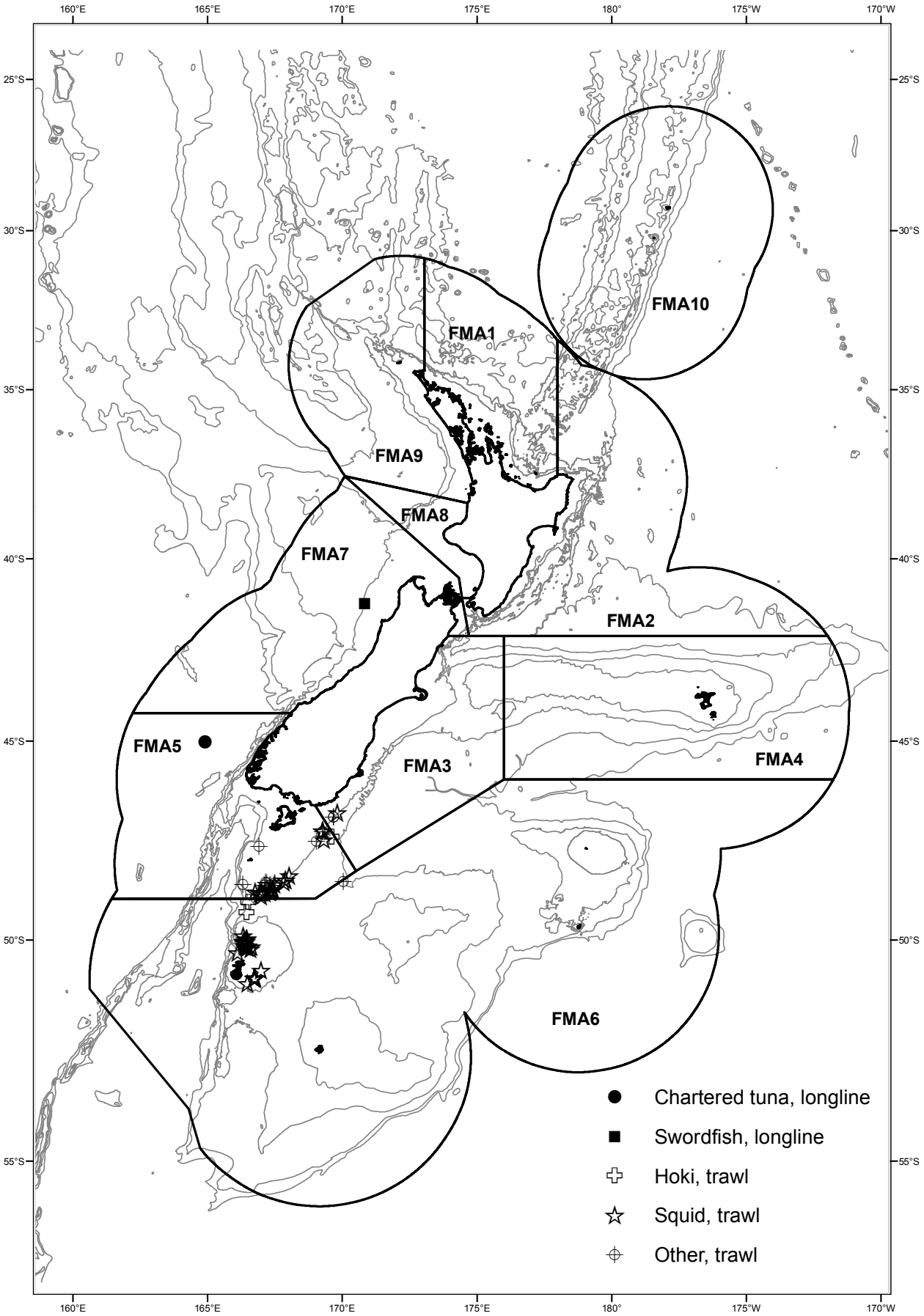

Figure A2.10. Catch locations of white-capped albatross *Thalassarche steadi* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006, by target fishery.

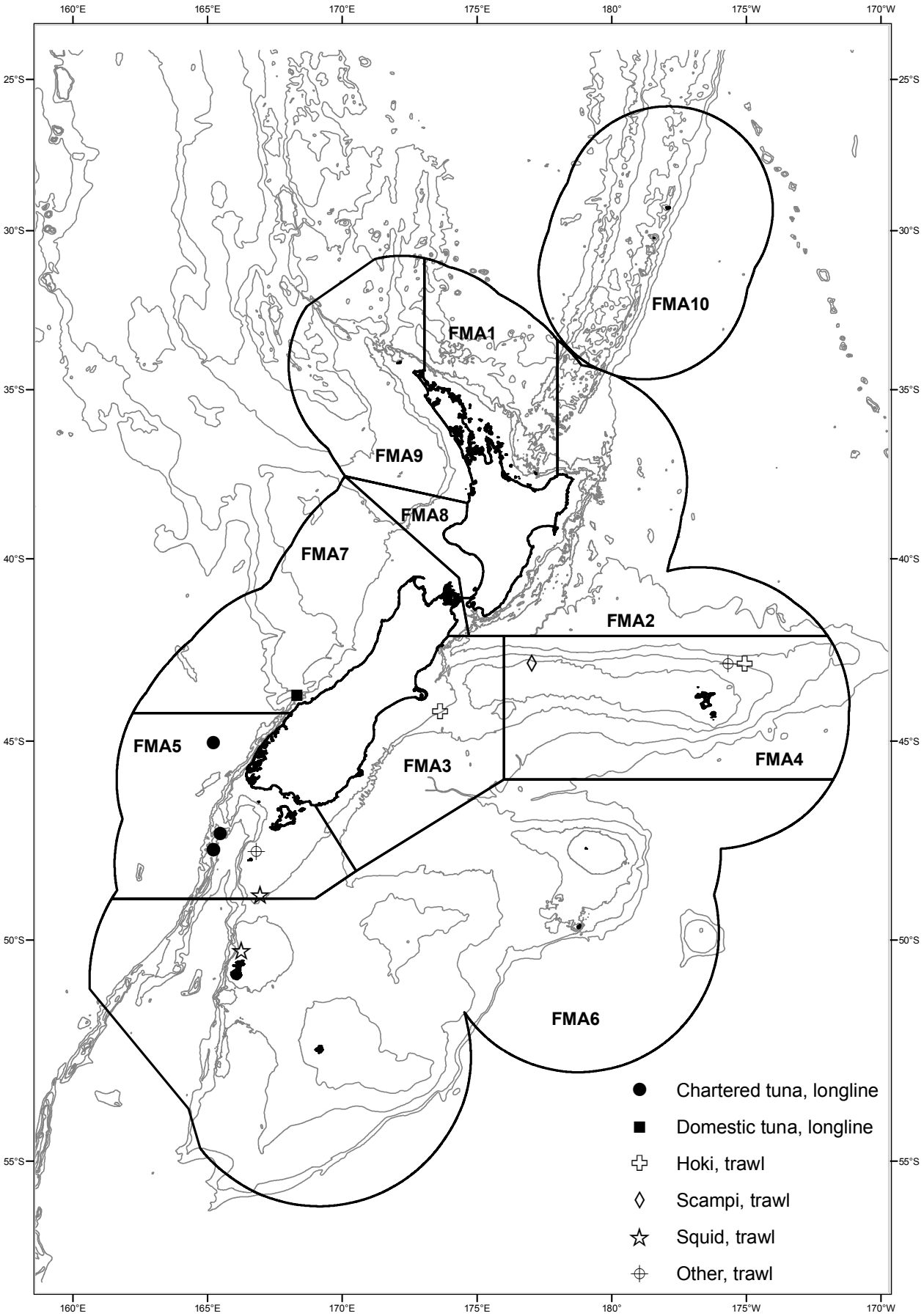

Figure A2.11. Catch locations of Buller's albatross *Thalassarche bulleri bulleri* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006, by target fishery.

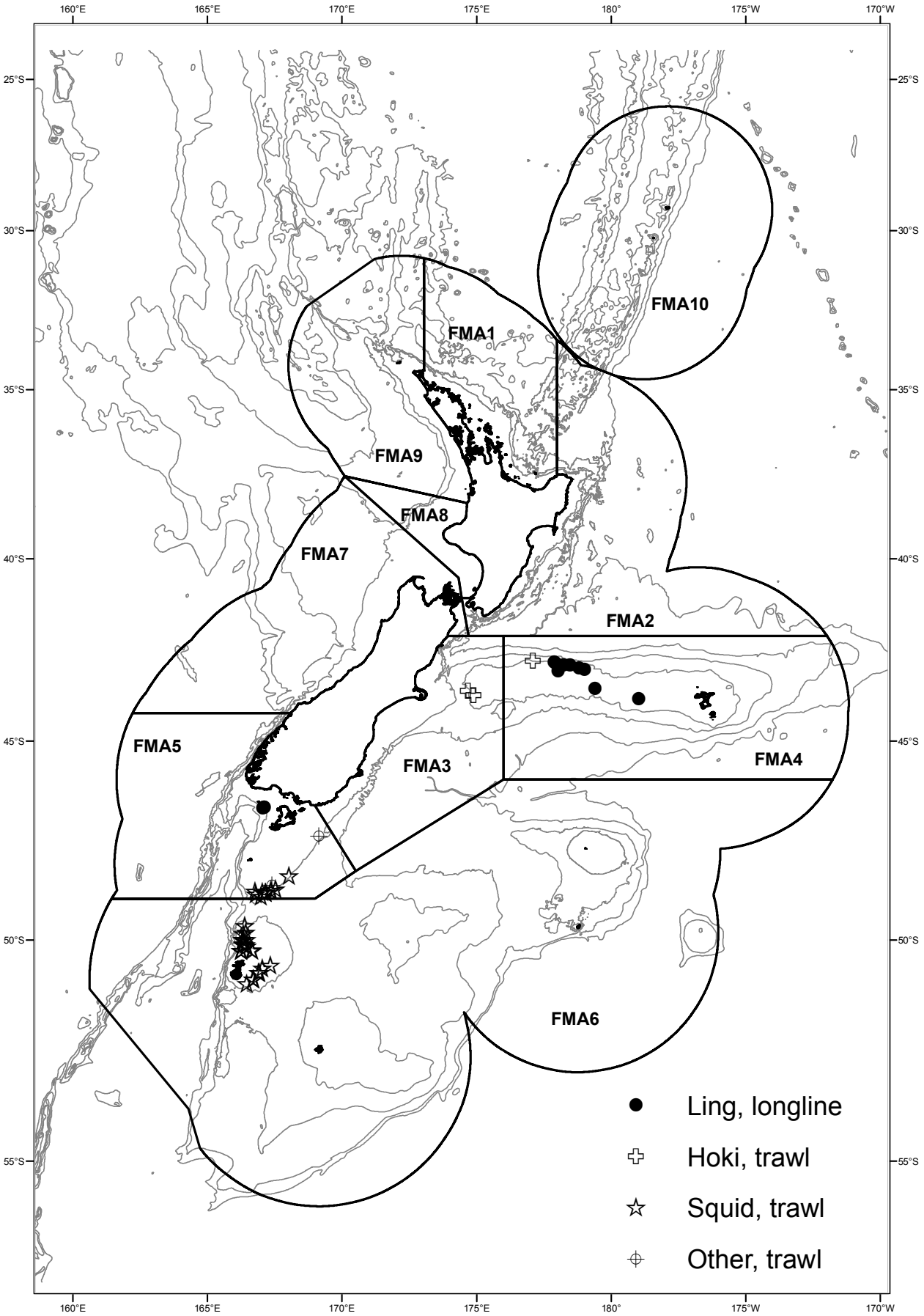

Figure A2.12. Catch locations of white-chinned petrel *Procellaria aequinoctialis* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006, by target fishery.

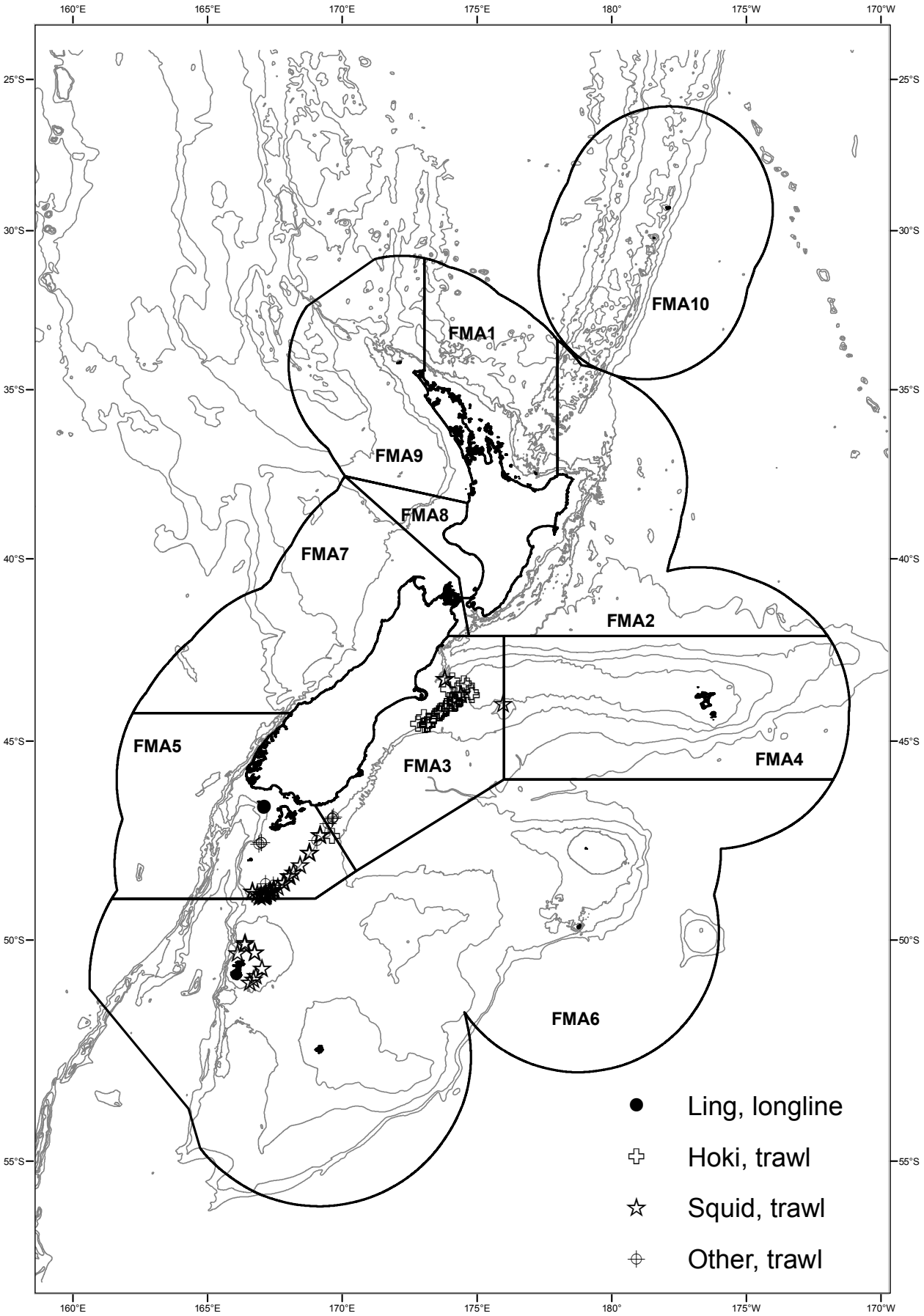

Figure A2.13. Catch locations of sooty shearwater *Puffinus griseus* killed and returned for autopsy during the period 1 October 2005 to 30 September 2006, by target fishery.