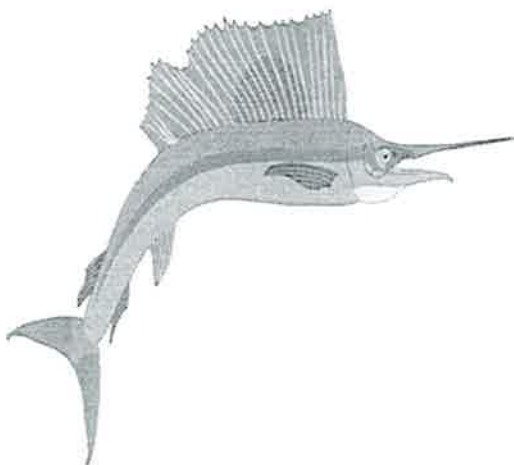


New Zealand billfish and gamefish tagging, 1996–97

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Introduction

In 1975, the New Zealand Ministry of Agriculture & Fisheries implemented a cooperative gamefish tagging programme at the request of angling groups. Historically, recreational fishers had tagged many gamefish, and high recovery rates of tagged fish promised to provide valuable information on growth and movement. Recreational anglers voluntarily reported all tag release and recapture information which was then stored on a database and analysed for fish movement and growth.

The programme became significant in the management of billfish species in 1988, when the Minister of Fisheries restricted access to the Auckland Fishery Management Area for foreign licensed tuna longline vessels and prohibited the retention of any commercially caught billfish, except swordfish, by domestic vessels in northern New Zealand waters. At the time, recreational fishers were encouraged to increase the tagged proportion of all marlin caught to 50% to assist in assessing the distribution of striped marlin (*Tetrapturus audax*) and the interaction with the commercial fishery. The billfish and gamefish tagging programme has provided some means for monitoring recreational catches of billfish, the analysis of CPUE data and other fisheries indicators, and for the collection of biological information on striped marlin and swordfish.

Gamefish tagging yields valuable information on recreational catches. A review of the programme in November 1991 determined that it has the potential to provide data useful for improving management of key recreational gamefish species, such as kingfish (*Seriola lalandi*), mako shark (*Isurus oxyrinchus*), and blue shark (*Prionace glauca*). The objective of tagging these species was to collect and analyse information on growth and movement. The overall results on billfish distribution and movement provide the Ministry of Fisheries with information to gauge the effectiveness of measures to reduce conflict between the recreational gamefish and commercial tuna longline fisheries.

Specifically, the programme objectives for 1996–97 were as follows.

1. To determine the movement of billfish in New Zealand waters by tagging.
2. To determine the potential for interaction between commercial and recreational fisheries for billfish.
3. To determine growth and movement of mako and blue sharks.

This report summarises the results obtained from the tagging programme for July 1996 to June 1997, thus updating the database and maintaining the existing time series of billfish and gamefish tagging data. The project was carried out on contract to the Ministry of Fisheries (project number AKGF01).

Methods

Billfish and gamefish were tagged through the existing cooperative arrangement with recreational and commercial fishers who voluntarily tag and release billfish and gamefish species. This cooperative arrangement with anglers and commercial fishermen formed the basis for the tagging, releasing, and recapturing of tagged gamefish and billfish during 1996–97. The distribution of tags to recreational fishing clubs through the New Zealand Big Game Fishing Council and the tagging methodology have been described by Saul & Holdsworth (1992). A brief outline of the tag type and methodology follows.

As in previous years, a visual implant tag, the gamefish dart tag, was used in 1996–97. A slight improvement to the tag was made to prevent possible damage to information recorded on it. During 1995–96, a number of striped marlin were recaptured with damaged tags from which no release information could be retrieved. These tags appeared to have been broken or bitten off while still attached to the fish. The tag was therefore modified by extending the central core of stainless steel wire the entire length of the tag, thus increasing its strength and resistance to damage.

The New Zealand Big Game Fishing Council distributed over 6000 of the new tags to gamefish clubs and participating anglers before, and during, the billfish season (October–April). Tags were also supplied to commercial fishers by NIWA on an individual boat basis. Participants completed a release card recording relevant information on the release of a tagged fish and submitted it to NIWA through their clubs. All release details were entered into a regional tagging database which is archived on the central NIWA database in Wellington.

The message on the tag informs the angler that a reward will be offered for details of the recapture of the tagged fish. These recapture details are then entered into the relational tagging database and added to the data from previous years.

For each species, tag release and recapture information was summarised in terms of the size and spatial and temporal distribution of tagged fish and fishing sector, commercial or recreational. Size distributions were categorised by 10 cm length intervals. For striped marlin, size at release was generally reported as an estimated fish weight. A length-weight relationship for striped marlin based on data collected in New Zealand (J. Holdsworth, pers comm.) was used to convert estimated weights to length (L):

$$L = e^{0.3302 \ln(\text{weight}) - 0.6486}$$

The spatial distribution of tagged fish was summarised using the Ministry of Fisheries commercial statistical areas (Figure 1). These areas provide sufficient resolution for describing the distribution of releases and recaptures relative to broad areas of the New Zealand coast. Higher resolution plots of the location of released fish of the main species were produced from the information on the release report cards. The temporal distributions of releases and recaptures were categorised by calendar month. Striped marlin releases and recaptures were categorised according to the commercial or recreational methods of capture.

Net movements of billfish, mako sharks, and blue sharks were determined from the release and recapture locations. Movement of billfish in New Zealand waters was considered in terms of the residence period of marlin in the EEZ and its distribution in relation to the commercial tuna longline fleet. The frequency of individual fish moving between statistical areas was tabulated to determine broad patterns in movement of striped marlin, mako shark, and blue shark and a detailed chart of the individual movements of recaptured striped marlin was produced.

The proportion of billfish releases and recaptures made by recreational and commercial fishers was considered to be an indication of the degree of interaction between the two fishing sectors. The spatial and temporal distributions of releases by these two sectors were examined for overlap from which interaction may be inferred.

The size of fish released or recaptured is given in terms of length and weight. Often these sizes are only estimates, especially when the fish is not landed. Length data in this report are based on, in order of preference, measured length, measured weight converted to length, estimated length, and estimated weight converted to length. Mako and blue shark size at release was generally reported by anglers as estimated weight. To convert the estimated weights to lengths, the best available length-weight

relationships for mako and blue shark were used (Nakano *et al.* 1985, Kohler *et al.* 1995). The difference in estimated lengths at release and recapture for individual fish yielded a growth increment which was standardised by the period at liberty to produce a mean daily growth increment. Mean growth increments were plotted against the estimated length at release to determine the feasibility of fitting a suitable growth function.

Results

Striped marlin

Of the 1252 striped marlin tagged and released by commercial and recreational fishers between July 1996 and June 1997 (Table 1), 1226 were released by the recreational fishery (Appendix 1). This is the highest number tagged and released in any one season to date. The estimated total number of marlin caught in the recreational fishery (from gamefish club records) was 1796, so about 68% of all striped marlin caught during the 1996–97 season were tagged and released, as compared to 58% in the 1995–96 season.

A wide range of sizes of striped marlin was tagged and released with an estimated mean length of 234 cm (Figure 2a). A 90 kg marlin is about 231 cm long. The New Zealand Big Game Fishing Council and member clubs encourage the tagging of marlin under 90 kg and do not recognise landed fish under this weight for contests or trophies. The length distribution of released striped marlin indicates that a high proportion of tagged fish were over 90 kg.

Over 60% of tagged striped marlin were released in statistical areas 047 and 048, the areas north and west of North Cape and the Three Kings Islands (Figure 3). Although many releases were made along the east Northland coast, the main concentration of tagging effort occurred in the areas around the Three Kings Islands, Middlesex Bank, and North Cape (Figure 4). This contrasts with the 1995–96 season when most releases were made along the east Northland coast (610) and Bay of Plenty (169). Releases during the 1996–97 year were generally further north than previously observed.

The monthly distribution of releases shows this to be a summer–autumn fishery with relatively few striped marlin being tagged and released in November and December (Figure 5a). The seasonal pattern of releases is broadly similar to that in previous years.

Of the 1252 tagged striped marlin released in 1996–97, 26 were released by commercial fishers (Appendix 2). Most of the fish release locations reported were off East Cape.

The distribution of tagging effort for striped marlin within the recreational fleet was strongly skewed; a few vessels were responsible for a high proportion of the releases. Four vessels (less than 2% of the participating fleet), tagged and released almost 30% of the marlin released, and one accounted for 12% (Table 2). Much of this effort was concentrated around the Three Kings Islands, Middlesex Bank, and North Cape areas, where striped marlin catch rates were high. This pattern of tagging effort in the recreational fishery is different from that of previous years.

The distribution of tagged striped marlin released around New Zealand by recreational and commercial fishers since 1975 is shown in Figure 6. The release location of fish tagged by commercial fishers is available for only 37 fish. There is some overlap in the spatial distribution of fish tagged by commercial and recreational fishers, though the releases by commercial fishers were

mainly off East Cape and east Northland. Tagging effort in the recreational fishery is more concentrated closer inshore off the east coast from Cape Runaway to North Cape, excluding the Hauraki Gulf, and around the Three Kings Islands (*see* Figure 6).

Five tagged striped marlin were recaptured during the 1996–97 season, three by recreational vessels and two by commercial vessels (Tables 3 and 4). No release information was available for a striped marlin recaptured in Fiji by a commercial vessel on 17 January 1997. The second recapture, by a commercial longliner, was made on 30 June 1997 west of the Kermadec Islands: the fish had been tagged by a recreational angler at the Three Kings Islands, had been at liberty for 90 days, and had moved 439 nautical miles. The three marlin recaptured by recreational anglers had also been tagged by recreational anglers. These recaptures were made close to where the fish were released, the Three Kings Islands and Middlesex Banks, so little net movement occurred while at liberty for periods of 40, 41, and 70 days. This may indicate seasonal residency of striped marlin in this area and contrasts with movement patterns indicated for fish recaptured previously where movement has been along the northeast coast of the North Island, from the northeast coast offshore, or to the tropics (Figure 7).

Mako shark

Fewer mako (877) were tagged than in the previous two seasons (*see* Table 1). A broad size range of mako sharks was tagged and released: the mean length was 158 cm (Figure 2b). Almost 70% of all mako sharks released were caught off the east Northland coast (Figure 8), with a few being released in the Three Kings Islands and North Cape areas (Figure 9).

The monthly distribution of releases coincides closely with striped marlin releases (*see* Figure 5) because mako sharks are taken as a bycatch of the recreational marlin fishery. Only three tagged mako sharks were released from commercial vessels (Appendix 2), two in the Bay of Plenty and one near Manukau Harbour on the west coast. This result is similar to that of the 1995–96 season and may reflect the different probability of a mako being caught and tagged by commercial and recreational fisheries, although mako sharks may be legally retained by commercial vessels. The distribution of tagging effort is relatively uniform throughout the recreational fishing fleet with no major skewness towards a particular set of boats (*see* Table 2).

Ten tagged mako sharks were recaptured this season by recreational fishers and 23 by commercial fishers (*see* Tables 3 and 4), mainly off east Northland and Bay of Plenty, with 2 recaptures off the west coast. Fourteen of the commercial recaptures were made outside New Zealand waters, 12 in Fiji, and 2 in Australian waters. This pattern is similar to that of previous years (Table 5), though the number of recaptures from Fiji has increased considerably in the last 2 years. Movements of tagged mako in New Zealand waters appear to be localised around east Northland with some movement to the Bay of Plenty and the west coast.

Seasonal movement of mako may be indicated from apparent patterns in the distance moved by tagged fish relative to their time at liberty (Figure 10). Tagged mako recaptured near the point of release (less than 400 n. miles) appear to be caught during the same time of year after being at liberty for 1 or more years; and in one instance, 11 years later. However, as mako is a bycatch of the target striped marlin fishery, this pattern most likely reflects the strong seasonality in fishing effort, rather than seasonality in their availability caused by movement of tagged fish in and out of New Zealand waters. Large movement of tagged mako do occur, with recaptures taking place about 1000 n. miles from the point of release, mostly in the tropics. No clear seasonal pattern in the timing of these recaptures is apparent.

Blue shark

More blue sharks were tagged and released during 1996–97 than in any other season, a total of 337, more than double the number tagged in the 1995–96 season (*see* Table 1). The size range of tagged blue sharks was broad, with the largest individual estimated to be over 3.0 m and some fish in the 60–70 cm length category (Figure 2c). The mean length of blue sharks tagged and released was 160.6 cm.

About 32% of all tagged blue shark were released in the Wairarapa and Cape Palliser areas, and about 15% were released off east Northland (Figure 11). Many of the blue shark releases (42%) were made off the Otago coast (Figure 12). The season was concentrated with almost 70% being caught in February (*see* Figure 5c).

Nearly all the blue shark were tagged and released by recreational fishers (Appendix 1). The distribution of tagging effort was strongly skewed, with three boats releasing almost 50% of all blue sharks tagged (*see* Table 2). Fishers from one vessel fishing off Dunedin tagged 113 blue sharks.

Four recaptures were made during the season, one by a commercial fisher off Australia (*see* Tables 3 and 4). There have been 16 recaptures in the programme to date, of which 5 have been made outside the EEZ with 1 from Chile (Table 6). These results indicate that blue shark may move well away from New Zealand waters.

Kingfish

There has been a considerable decline in the number of kingfish tagged over the last 2 years, with 377 tagged this season compared to the highest recorded total of 1444 in 1994–95 (*see* Table 1). The kingfish tagged and released this season spanned a wide range of reported lengths, with a mean length of 80.8 cm (Figure 2d).

Kingfish were tagged and released off east Northland, Bay of Plenty, and East Cape (Figure 13). Most releases were made off the Three Kings Islands, Whangaroa Bay, Tutukaka, White Island, and Tolaga Bay (Figure 14), all but one (in the Bay of Plenty) by recreational fishers (Appendices 1 and 2). Two recreational boats were responsible for more than 50% of all kingfish tagged and released (*see* Table 2). Kingfish were tagged throughout the year with effort peaking in February (Figure 5d).

Of the 48 tagged kingfish recaptured during the season, 10 were recaptured by commercial fishers, mostly off East Cape to Wairarapa and east Northland (*see* Table 4). Recaptures by recreational fishers were mostly off east Northland and in the Bay of Plenty (*see* Table 3). The number of recaptures is considerably less than the 72 reported in 1995–96 (Holdsworth & Saul 1998), possibly because of the steep decline in numbers of kingfish tagged and released in the last two seasons, particularly near White Island.

Most (85%) of the tagged kingfish recaptures were made within the fishing statistical area in which they were released, suggesting that large scale movements are uncommon (Table 7), though a few recaptures have been reported from the Wanganella Bank and Australia in the past. The limited movements of recaptured kingfish observed in this season are consistent with previous results (Holdsworth & Saul 1998).

Growth

The length increment data for recaptured mako sharks and blue sharks was evaluated for its potential to derive estimates of average growth. Both the quality and quantity of the data available limited its use. Sizes of fish at release and recapture provided by recreational anglers are usually based on a visual estimate of the weight of the fish at the time of capture. Sometimes the fish may be weighed on recapture, but for obvious reasons very few fish are weighed at both release and recapture, so the precision, and hence quality, of the length increment data is low. Because of the small sample sizes (19 blue sharks and 164 mako sharks) and the poor quality of the data available, it was not possible to reliably estimate growth parameters for blue shark using a tagging data based model (Francis 1988).

The high level of scatter in the mean length increments of recaptured mako sharks (Figure 15a) indicated low precision in some estimates of length at release and recapture. It was assumed that low precision in the estimates of fish size would exaggerate the scatter in growth increments for recaptures made after short periods at liberty, so the distribution of growth increments for recaptures after 6 months or more at liberty was examined. These 92 recaptures had less scatter in the mean daily growth increment relative to the estimated length at release (Figure 15b), but some observations indicated negative growth, the subsample size was small, and no clear pattern in the increments was visible. It was concluded that it is not possible to use the existing data for fitting a growth function for mako shark.

Discussion

The increased percentage of marlin tagged and released (68% compared with 58% in the previous season) and the high proportion of tagged fish over 90 kg indicate a high level of interest and cooperation of anglers in tagging marlin. Although, a record number of striped marlin were tagged this season, the distribution of tagging effort, spatially and within the fleet, suggests that this is attributable to fishing patterns rather than the general availability of marlin along the northeast coast. A high proportion of releases was made by a few vessels in the Three Kings Islands area where effort has recently increased. Landing marlin while fishing in these more remote areas is not logistically feasible, so there is greater incentive to tag fish. In comparison with previous seasons, fewer marlin were tagged and released along the east Northland coast where historically a high proportion of the annual catch is taken. It is unlikely that this is due to a decline in interest in tagging striped marlin and it may therefore reflect lower availability of marlin and reduced fishing effort. This result does illustrate that large numbers of marlin may be tagged during a season when fish availability is not exceptionally high.

The recapture rate of marlin this season was typically low. The annual recapture rate is about 1%, consistent with billfish tagging programmes elsewhere (Squire & Suzuki 1989; Peel *et al.* 1996), and may reflect the characteristics of billfish species. However, for maximum use to be made of the recapture data, effort should be made to improve the quality of release information, particularly by commercial fishers. Greater participation by commercial fishers in this programme would be beneficial, given their level of fishing effort and offshore fishing areas. Potentially important movement information for a striped marlin recapture made this season in Fiji was lost because release information for the fish was unavailable. To maintain the collection of release information, the tag design was improved this season to reduce damage while implanted in the fish at liberty.

Tagged marlin appear to be recaptured after small scale coastal movement, movement to fishing grounds near the edge of the EEZ, or movement to the tropics. These patterns are similar to those inferred from recapture data for mako sharks. The recapture information may indicate seasonal movement of striped marlin between the tropics and New Zealand. Three recaptures this season also suggest that there may be some period of residency for striped marlin in domestic waters.

There appears to be some overlap in the spatial distribution of striped marlin tagged and released by recreational and commercial fishers. Most of the commercial tagging effort is distributed off East Cape, but this may not be representative of the entire fleet as cooperative tagging by all fishers cannot be assumed. Therefore, these results probably do not provide information on the degree of interaction between the two fishing sectors for striped marlin. Direct interactions have been shown to occur with marlin being released by one sector and recaptured by the other, with some movement of tagged fish onto commercial fishing grounds. The degree of this interaction can not be determined because of the low rate of recapture of tagged striped marlin. Given the extent of movements of recaptured marlin, it is likely that the same components of the striped marlin stock may be encountered by the recreational and commercial fishing fleets operating on the east coast of the North Island.

Several factors may combine to increase the amount of information on striped marlin movement and distribution relative to fishing effort obtained from the programme. The high levels of tagging of striped marlin experienced in recent years will increase the effective tagged population. The new, stronger tag will reduce tag damage and loss of release information. Tagging clubs and commercial fishermen will be encouraged to improve the reporting of release and recapture information. The insistence of gamefish clubs that tag release information is provided by their members has resulted in higher levels of data collection than in cooperative tagging studies in other countries (Peel *et al.* 1996). Efforts will be made to encourage anglers who are not members of a gamefishing club to supply release information on tagged gamefish.

Acknowledgments

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Table 1: Numbers of fish tagged and released by species and season (July to June) for each year of the gamefish tagging programme to 30 June 1997 and recapture totals as of 30 June 1997

Season	STM	MAK	BWS	KIN	ALB	BEM	BKM	SWO	YFN	SHA	OSP	Total
1974-75	–	9	1	–	–	–	–	–	–	–	–	10
1975-76	3	17	–	1	–	–	–	–	–	2	–	23
1976-77	2	34	1	1	–	–	–	–	1	–	1	40
1977-78	7	58	–	15	–	–	–	–	–	–	–	80
1978-79	18	152	1	107	1	2	–	–	–	1	4	286
1979-80	17	129	25	22	–	–	–	–	–	3	–	196
1980-81	2	116	7	7	6	–	1	–	–	2	1	142
1981-82	11	185	99	30	14	–	–	–	–	3	3	345
1982-83	6	151	18	56	11	–	–	–	1	4	1	248
1983-84	9	220	15	54	9	–	–	–	5	7	–	319
1984-85	–	98	10	148	–	–	–	–	25	4	1	286
1985-86	2	211	23	323	–	–	–	–	8	1	6	574
1986-87	2	177	12	376	8	–	–	–	7	31	13	626
1987-88	97	505	91	685	40	1	1	6	13	47	44	1 530
1988-89	371	369	122	369	98	1	–	4	63	32	23	1 452
1989-90	366	424	83	427	87	6	4	4	140	30	18	1 589
1990-91	230	419	92	530	40	–	2	5	25	33	24	1 400
1991-92	243	354	128	393	21	5	2	20	39	40	19	1 264
1992-93	387	353	64	692	64	11	1	36	13	24	30	1 675
1993-94	927	667	164	1 097	27	20	2	3	104	19	37	3 067
1994-95	1 206	1 542	176	1 444	5	29	4	10	216	23	60	4 715
1995-96	1 085	1 153	162	638	–	46	6	3	111	29	31	3 264
1996-97	1 252	877	337	377	8	20	5	4	32	35	16	2 963
Unknown date	4	9	1	7	–	–	–	–	1	–	3	25
Total releases	6 247	8 229	1 632	7 799	439	141	28	95	804	370	335	26 119
Total recaptures	29	201	19	781	–	–	1	–	6	26	14	1 077

Species key	ALB	albacore	KIN	kingfish	SWO	broadbill swordfish
	BEM	blue marlin	MAK	mako shark	YFN	yellowfin tuna
	BKM	black marlin	SHA	other shark species	OSP	all other species
	BWS	blue shark	STM	striped marlin		

Table 2 : The distribution of the number of tagged fish released by individual boats in decending order and by species with the cumulative percentage (cum %) of total tagged fish by respective boats

No. fish tagged	No. of boats tagging and releasing									
	Striped marlin		Mako shark		Kingfish		Blue shark		other species	
	n	cum %	n	cum %	n	cum %	n	cum %	n	cum %
145	1	12	-	0	-	0	-	0	-	0
:		:		:		:		:		:
113	-	:	-	:	-	:	1	34	-	:
:		:		:		:		:		:
100	-	:	-	:	2	53	-	:	-	:
:		:		:		:		:		:
88	1	19	-	:	-	:	-	:	-	:
:		:		:		:		:		:
77	1	25	-	:	-	:	-	:	-	:
:		:		:		:		:		:
49	1	29	-	:	-	:	-	:	-	:
48	3	40	-	:	-	:	-	:	-	:
:		:		:		:		:		:
35	1	43	-	:	-	:	-	:	-	:
:		:		:		:		:		:
31	1	45	-	:	-	:	-	:	-	:
:		:		:		:		:		:
26	-	:	-	:	-	:	1	41	-	:
25	1	47	1	3	-	:	-	:	-	:
:		:		:		:		:		:
20	-	:	-	:	1	58	-	:	-	:
19	3	52	1	5	-	:	1	47	-	:
:		:		:		:		:		:
17	1	53	-	:	-	:	-	:	-	:
16	1	55	-	:	-	:	-	:	-	:
:		:		:		:		:		:
14	-	:	1	7	-	:	-	:	-	:
13	3	58	-	:	1	62	1	51	-	:
12	3	61	1	8	1	65	-	:	-	:
11	-	:	-	:	-	:	1	54	-	:
10	3	63	-	:	-	:	-	:	-	:
9	1	64	7	15	1	67	-	:	-	:
8	5	67	6	21	1	69	-	:	-	:
7	6	70	2	22	-	:	2	58	2	12
6	4	72	7	27	1	71	4	65	1	17
5	9	76	16	36	2	74	4	71	-	:
4	7	78	23	46	7	81	3	75	4	30
3	21	83	34	58	1	82	7	81	3	37
2	44	90	7	60	18	92	10	87	11	55
1	122	100	203	83	25	98	44	100	43	91
Vessel unknown	4	100	12	100	7	100	-	100	8	100
Total vessels	243		379		61		79		65	

Table 3 : Numbers of tagged fish recaptured by recreational fishers by species and statistical area

	Statistical area											Total
	002	003	007	008	009	010	012	013	014	047	048	
Striped marlin	-	-	-	-	-	-	-	-	-	-	3	3
Mako shark	2	4	-	-	-	1	1	1	-	-	1	10
Kingfish	2	16	1	1	2	13	2	-	-	1	-	38
Blue shark	1	-	-	-	-	-	1	-	1	-	-	3
Yellowfin tuna	-	-	-	-	1	-	-	-	-	-	-	1
School shark	-	-	-	-	-	-	-	-	-	-	-	-
Total	5	20	1	1	3	14	4	1	1	1	4	55

Table 4 : Numbers of tagged fish recaptured by commercial fishers by species and statistical area

	Statistical area											Total	
	002	003	004	008	011	013	014	041	042	047	999		???
Striped marlin	-	-	-	-	-	-	-	-	-	-	2	-	2
Mako shark	-	2	1	2	2	1	-	1	-	-	14	-	23
Kingfish	3	-	-	-	1	2	3	-	1	-	-	-	10
Blue shark	-	-	-	-	-	-	-	-	-	-	1	-	1
Yellowfin tuna	-	-	-	-	-	-	-	-	-	-	-	-	-
School shark	-	-	-	-	-	-	-	-	-	1	-	1	2
Total	3	2	1	2	3	3	3	1	1	1	17	1	38

??? Denotes fish tagged and released but no statistical area given

999 Denotes fish tagged and released outside of statistical areas

Table 5 : Movement of mako sharks as indicated from statistical areas of release and recapture since 1975

Release area	Recapture area																						Total				
	001	002	003	004	005	008	009	010	011	012	013	014	039	040	041	042	047	048	999	???	AUS	FIJ		MAQ	WAN		
																				2	-	-	8	-	-	22	
002	1	5	3	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	3	1	3	1	2	9	1	-	83
003	1	6	30	1	-	6	4	3	3	1	5	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1	
005	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	5	-	-	16	
008	-	1	1	-	1	1	2	1	1	1	2	-	-	1	-	-	-	-	-	-	-	-	1	-	-	18	
009	-	-	3	-	-	3	5	1	1	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	10	
010	-	1	-	-	1	-	2	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
012	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	
013	-	-	1	-	-	-	-	1	-	-	-	3	-	-	-	-	-	-	-	1	-	-	-	-	-	11	
014	-	-	1	-	-	-	2	1	-	-	3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	5	
041	-	1	-	-	-	-	-	-	1	-	-	1	-	-	-	-	1	-	-	-	-	-	-	-	-	3	
042	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-	-	-	1	
043	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	
046	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	
048	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
???	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Total	2	16	39	2	2	11	15	10	6	2	15	9	2	2	2	2	3	1	9	1	4	24	1	1	181		

AUS, Australia; FIJ, Fiji; MAQ, Marquesas Islands; WAN, Wanganella Bank; ???, area unknown

Table 6 : Movement of blue sharks as indicated from statistical areas of release and recapture since 1975

Release area	Recapture area												Total	
	002	003	010	011	012	013	014	043	999	???	AUS	CHL		FIJ
003	1	1	-	-	-	-	-	-	-	-	1	-	-	3
009	-	-	1	-	-	-	-	-	-	-	-	-	-	1
013	-	-	-	1	-	2	-	-	1	1	1	-	-	6
014	-	-	-	-	-	-	1	-	-	1	-	-	-	2
024	-	-	-	-	1	-	-	-	-	-	1	-	-	2
041	-	-	-	-	-	-	-	1	-	-	-	-	1	2
Total	1	1	1	1	1	2	1	1	1	2	2	1	1	16

AUS, Australia; CHL, Chile; FIJ, Fiji; ???, area unknown

Table 7: Movement of kingfish as indicated from statistical areas of release and recapture since 1975

Release area	Recapture area																			Total	
	002	003	005	006	007	008	009	010	011	012	013	014	039	042	043	047	048	???	AUS		WAN
002	50	11	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	63
003	6	110	3	1	2	2	-	-	-	-	-	1	-	-	-	1	-	4	-	1	131
005	-	3	4	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	8
006	-	1	1	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10
007	-	1	-	5	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17
008	-	1	1	1	-	6	-	-	-	-	1	-	-	-	-	-	-	-	-	-	10
009	-	2	-	-	-	2	37	6	-	-	-	-	-	-	-	-	-	1	2	-	50
010	-	2	2	-	-	3	12	380	2	1	2	-	1	-	-	-	-	-	-	-	405
011	-	-	-	-	-	-	-	1	7	1	1	-	-	1	-	-	-	-	-	-	11
012	-	-	-	-	-	1	1	-	-	2	2	1	-	-	-	-	-	-	-	-	7
013	-	-	-	-	-	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-	4
014	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
043	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	1	-	-	-	-	6
045	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1
047	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	1	-	-	9
048	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2
???	-	-	-	1	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	4
Total	57	131	12	11	19	14	50	389	9	4	9	5	1	1	6	10	1	8	2	1	740

AUS, Australia; WAN, Wanganella Bank; ???, area unknown

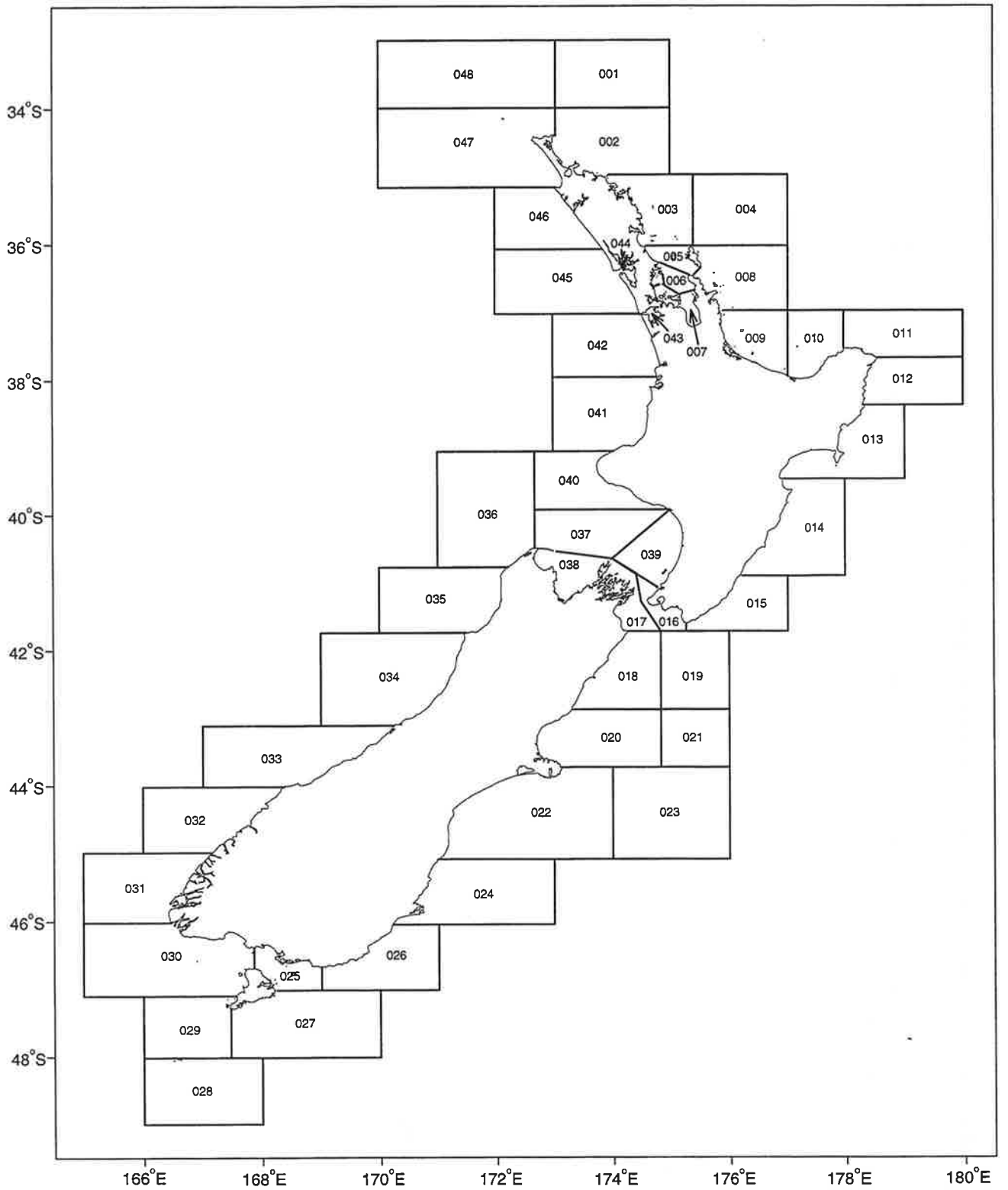


Figure 1: Commercial fisheries statistical reporting areas.

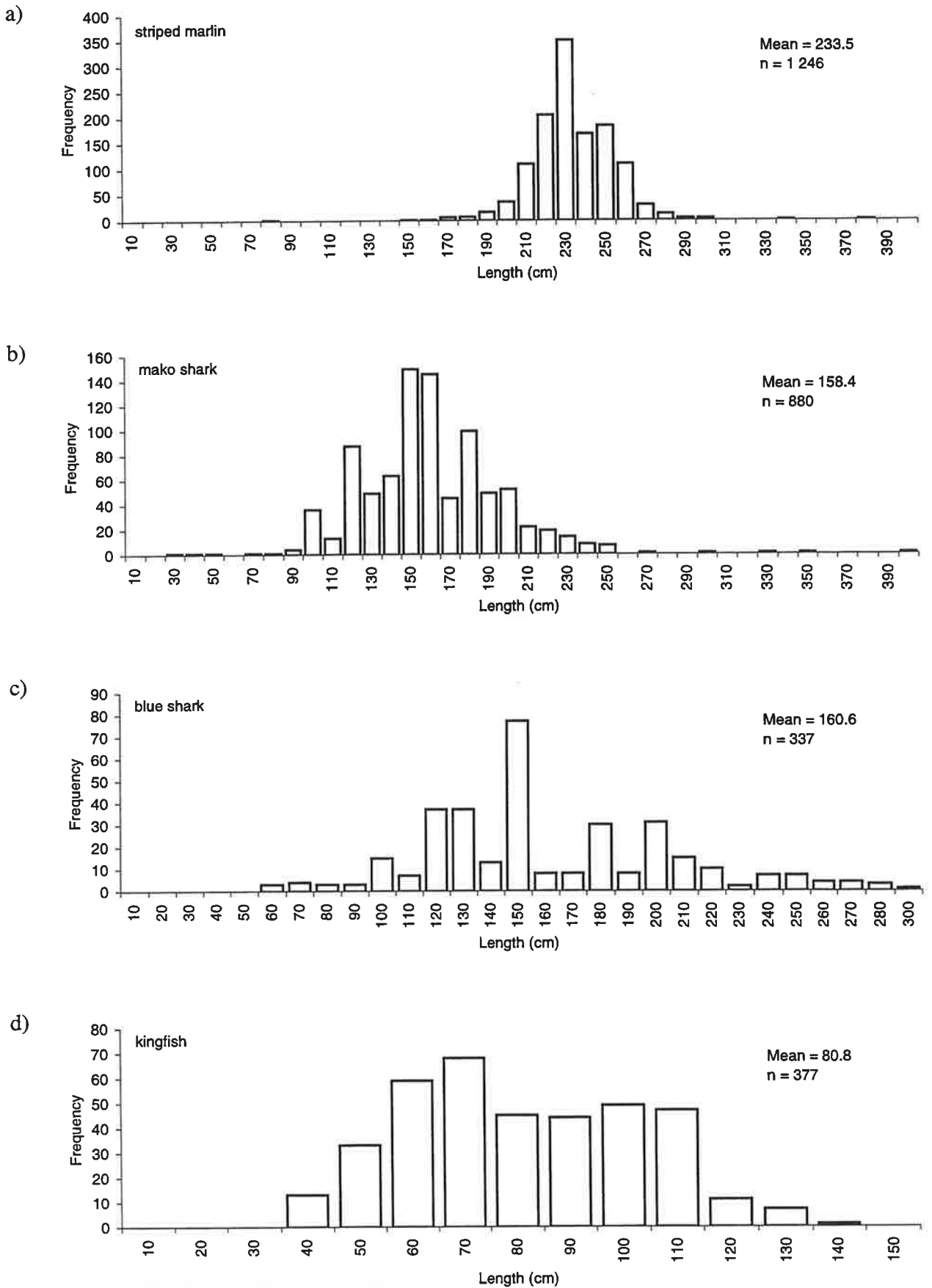


Figure 2 : Length frequency distribution of a) striped marlin, b) mako shark, c) blue shark, and d) kingfish tagged and released during the 1996–97 season.

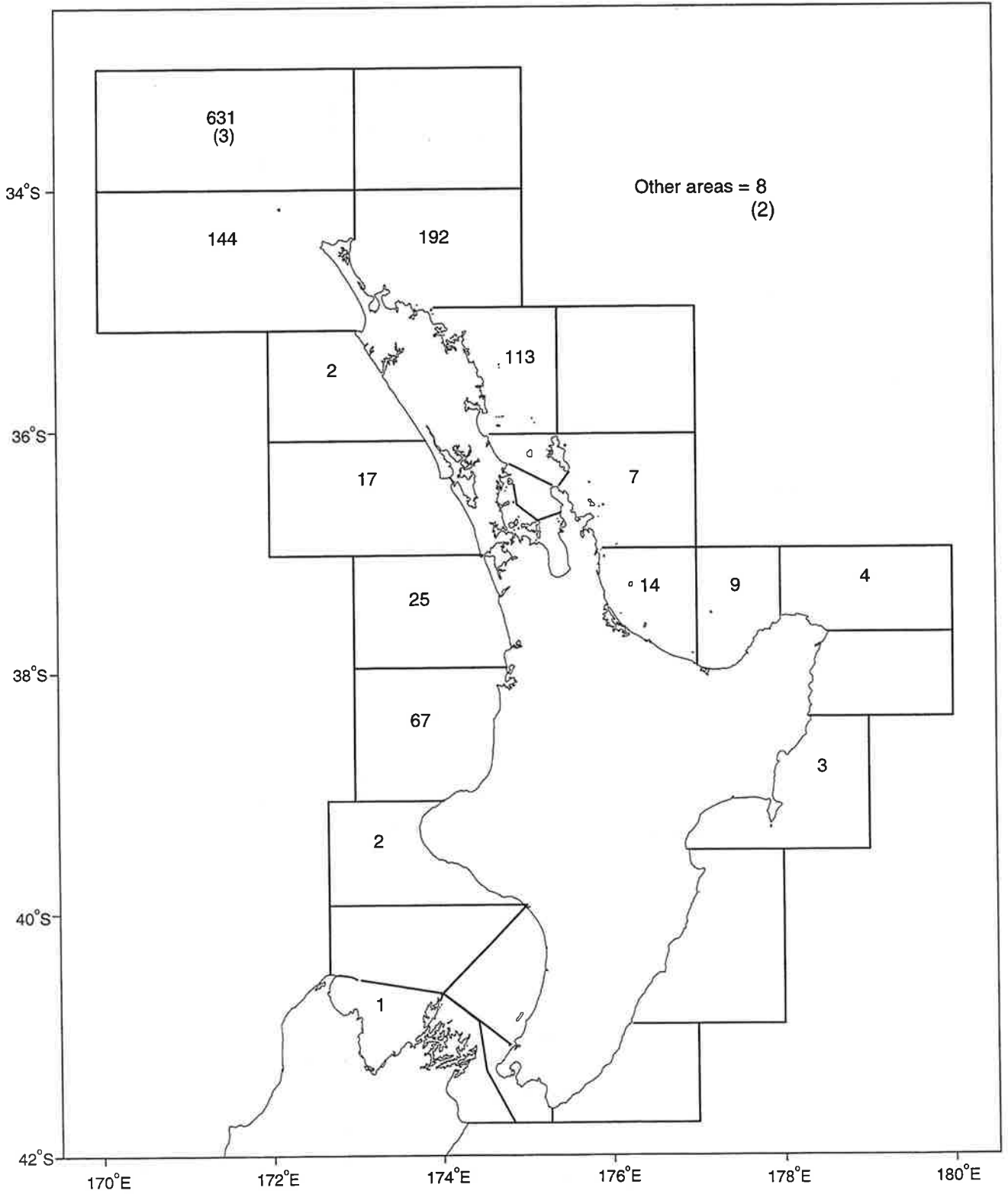


Figure 3: Numbers of striped marlin released and recaptured (in parentheses) by statistical reporting area during the 1996–97 season.

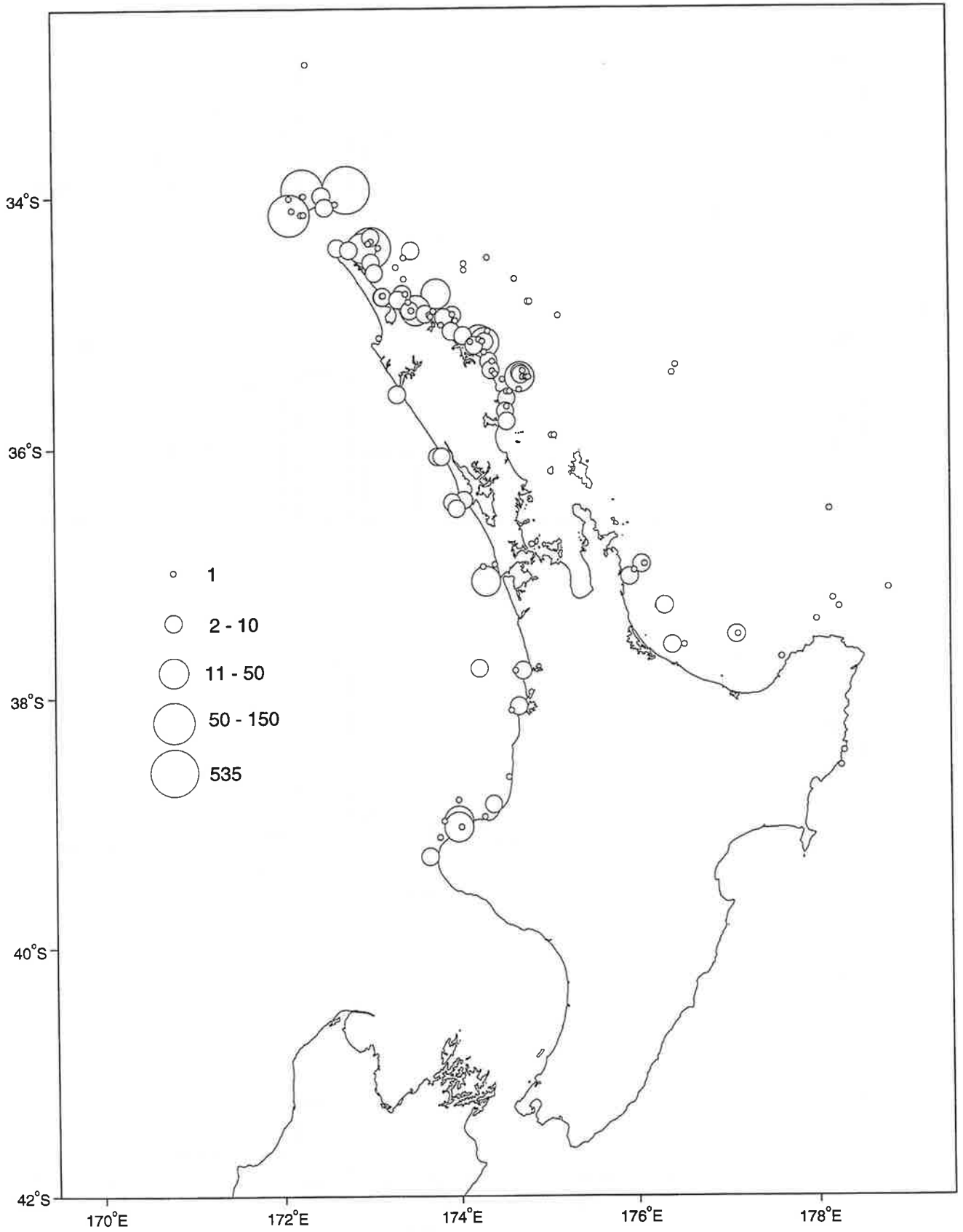


Figure 4: Distribution of striped marlin tagged and released during the 1996–97 season.

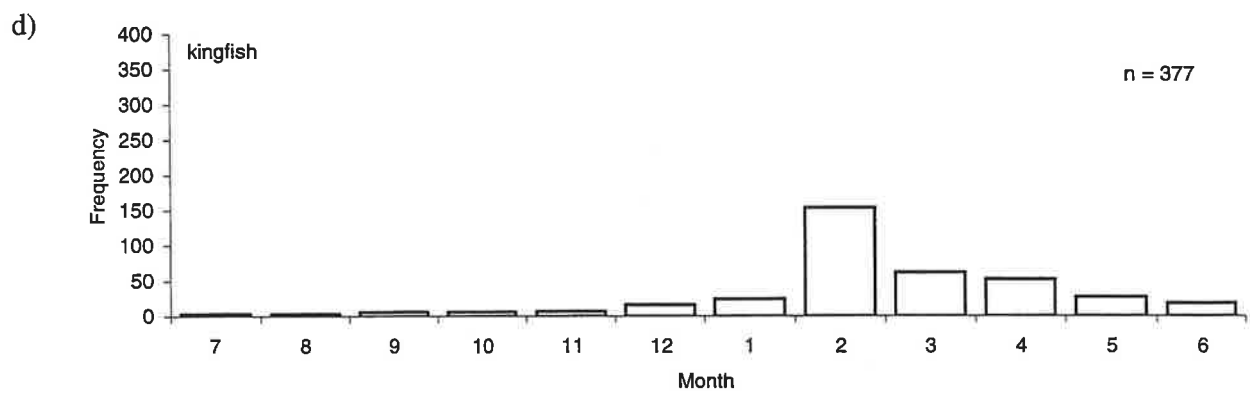
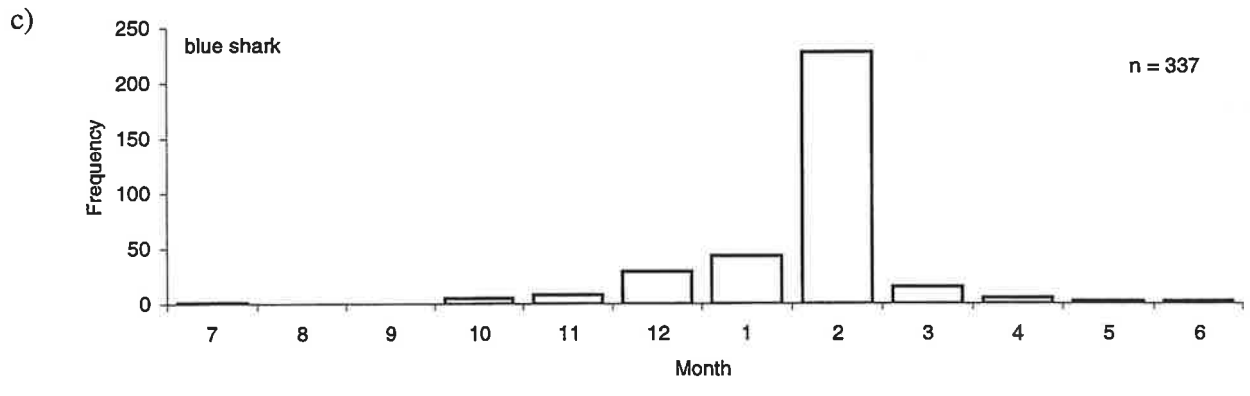
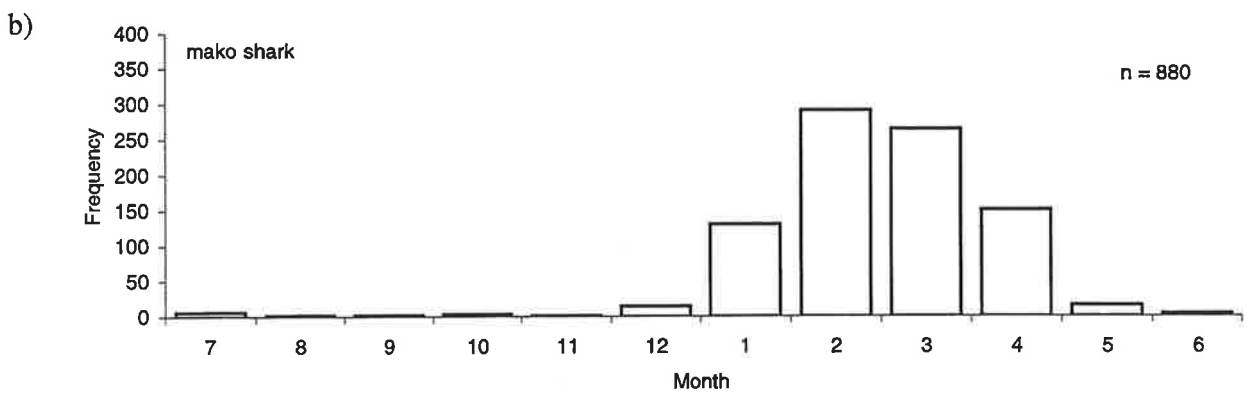
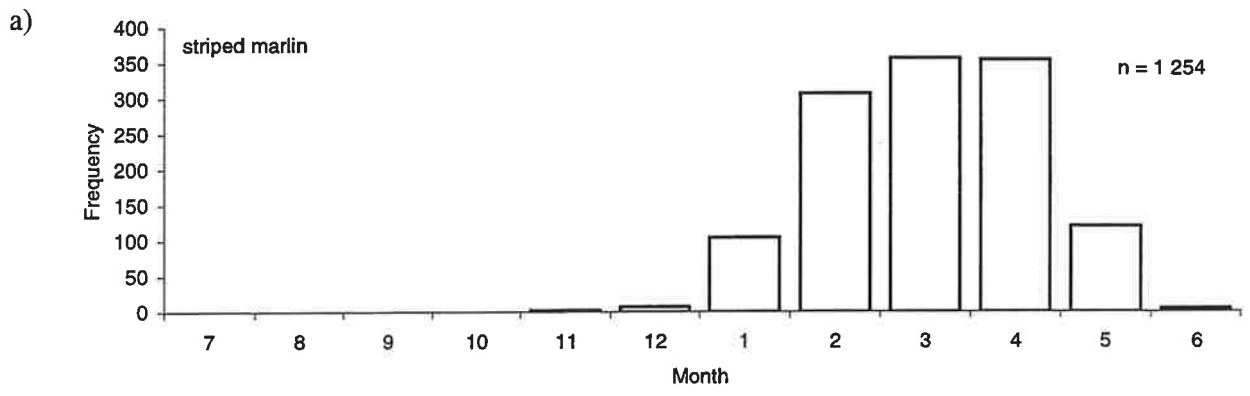


Figure 5 : Distribution of tagged fish release by month during the 1996–97 season for a) striped marlin, b) mako shark, c) blue shark, and d) kingfish.

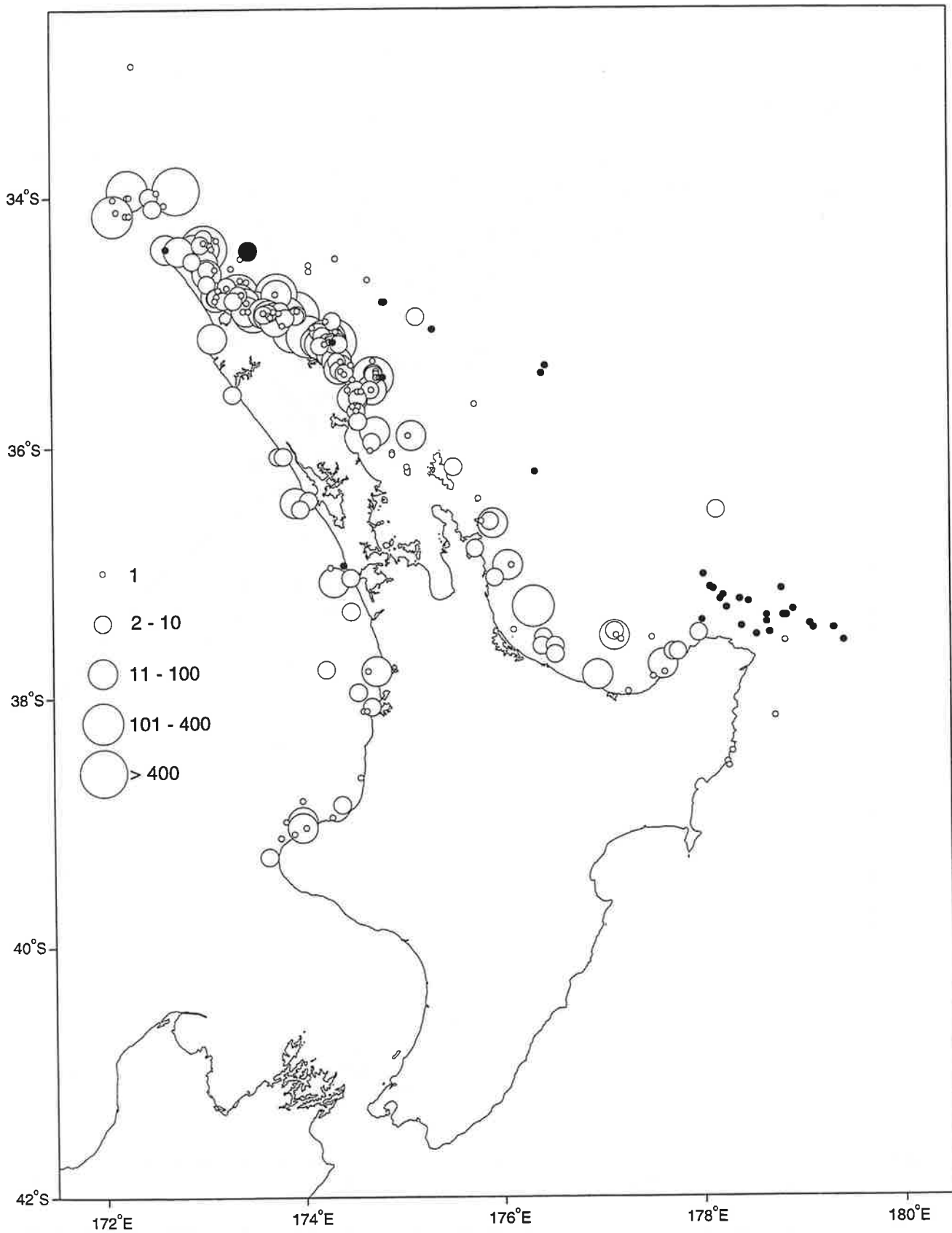


Figure 6: Distribution of striped marlin tagged and released by recreational (open circles, n = 6125) and commercial fishers (solid circles, n = 37) since 1975.

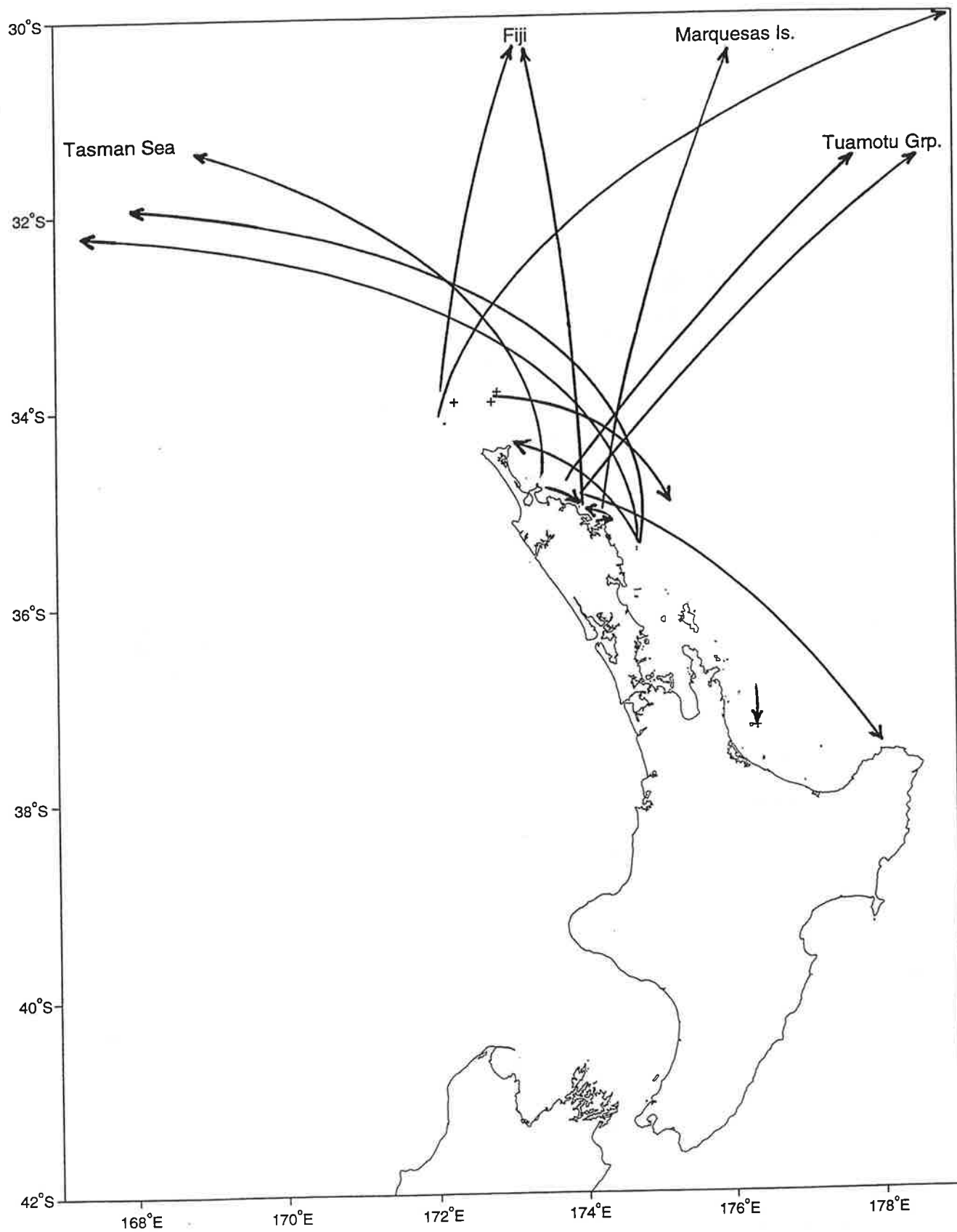


Figure 7: Individual movements of tagged striped marlin recaptured by 30 June 1997 (n = 18). Crosses denote no significant movement from release site.

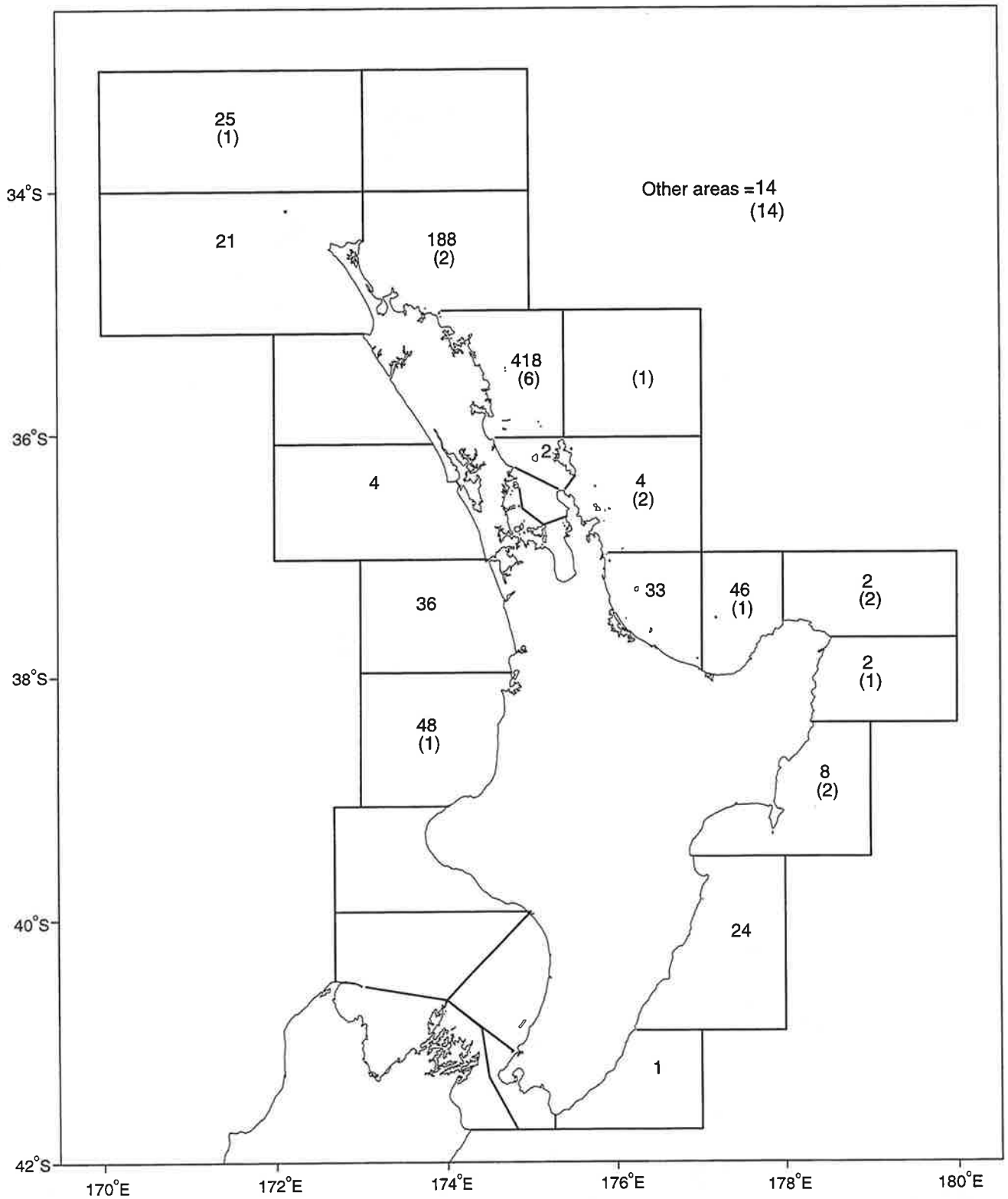


Figure 8: Numbers of mako sharks released and recaptured (in parentheses) by statistical reporting area during the 1996-97 season.

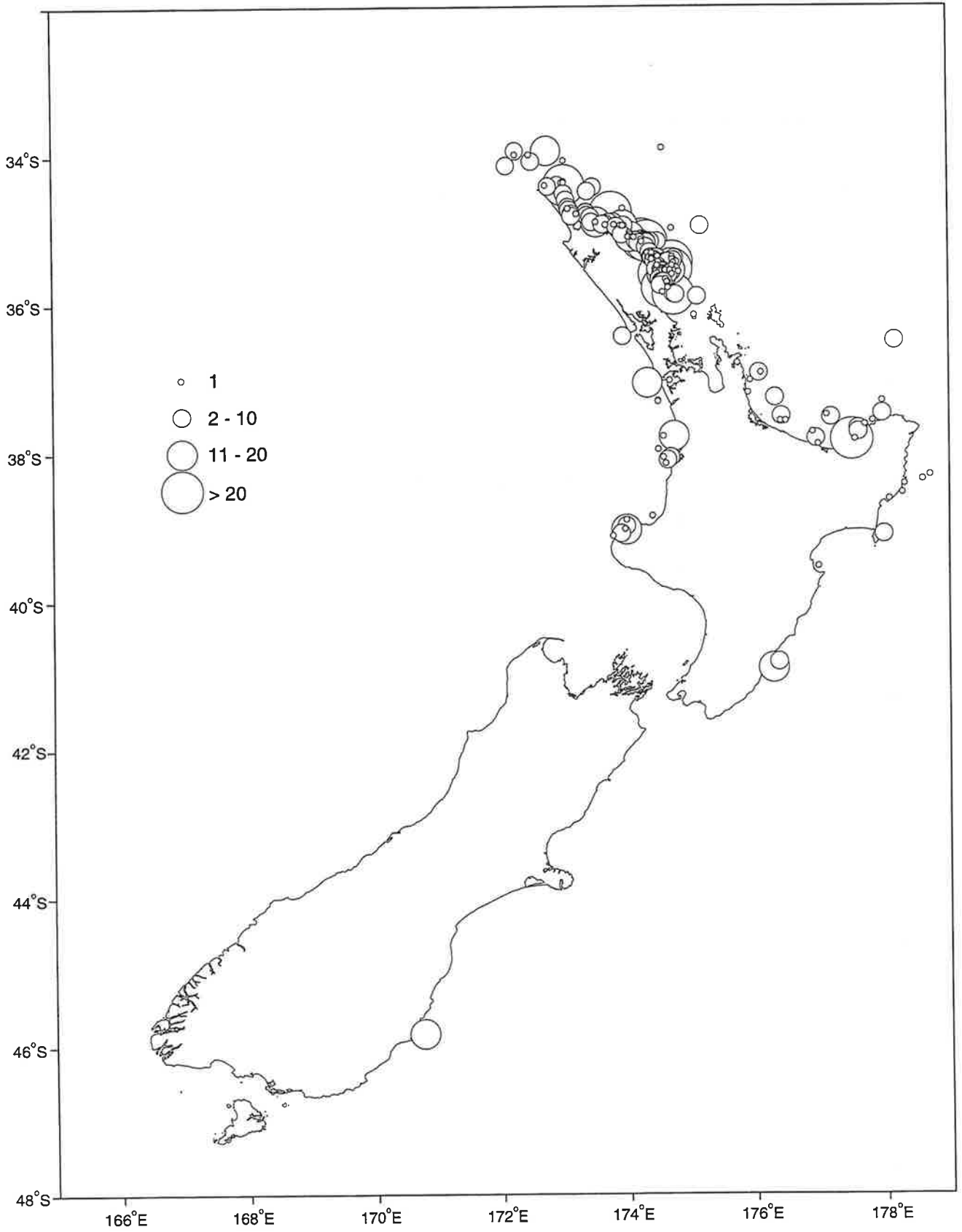


Figure 9: Distribution of mako sharks tagged and released during the 1996-97 season.

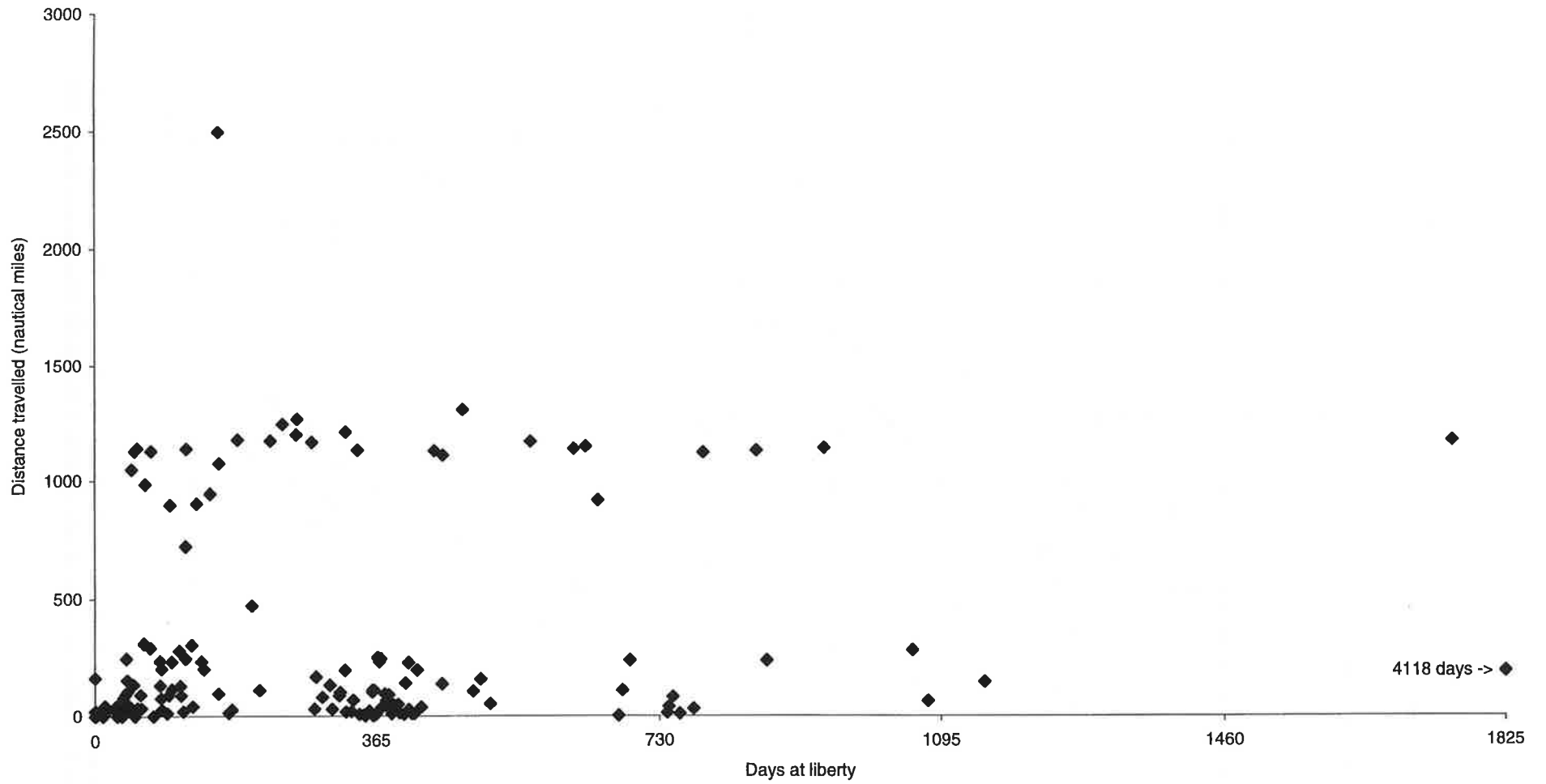


Figure 10 : Distance travelled by recaptured mako sharks relative to the period at liberty.

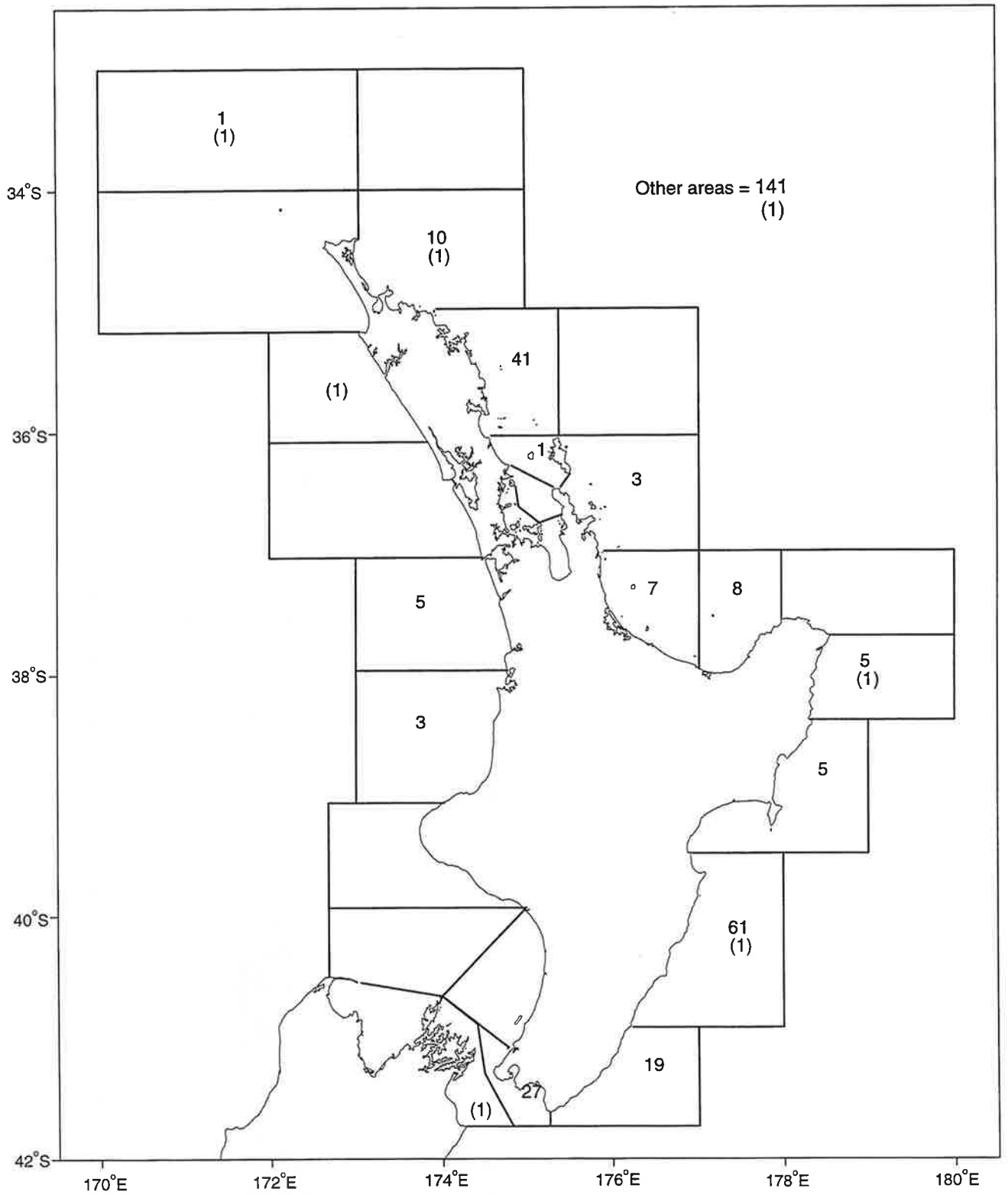


Figure 11: Numbers of blue sharks released and recaptured (in parentheses) by statistical reporting area during the 1996–97 season. Other areas total includes 139 releases from statistical area 024.

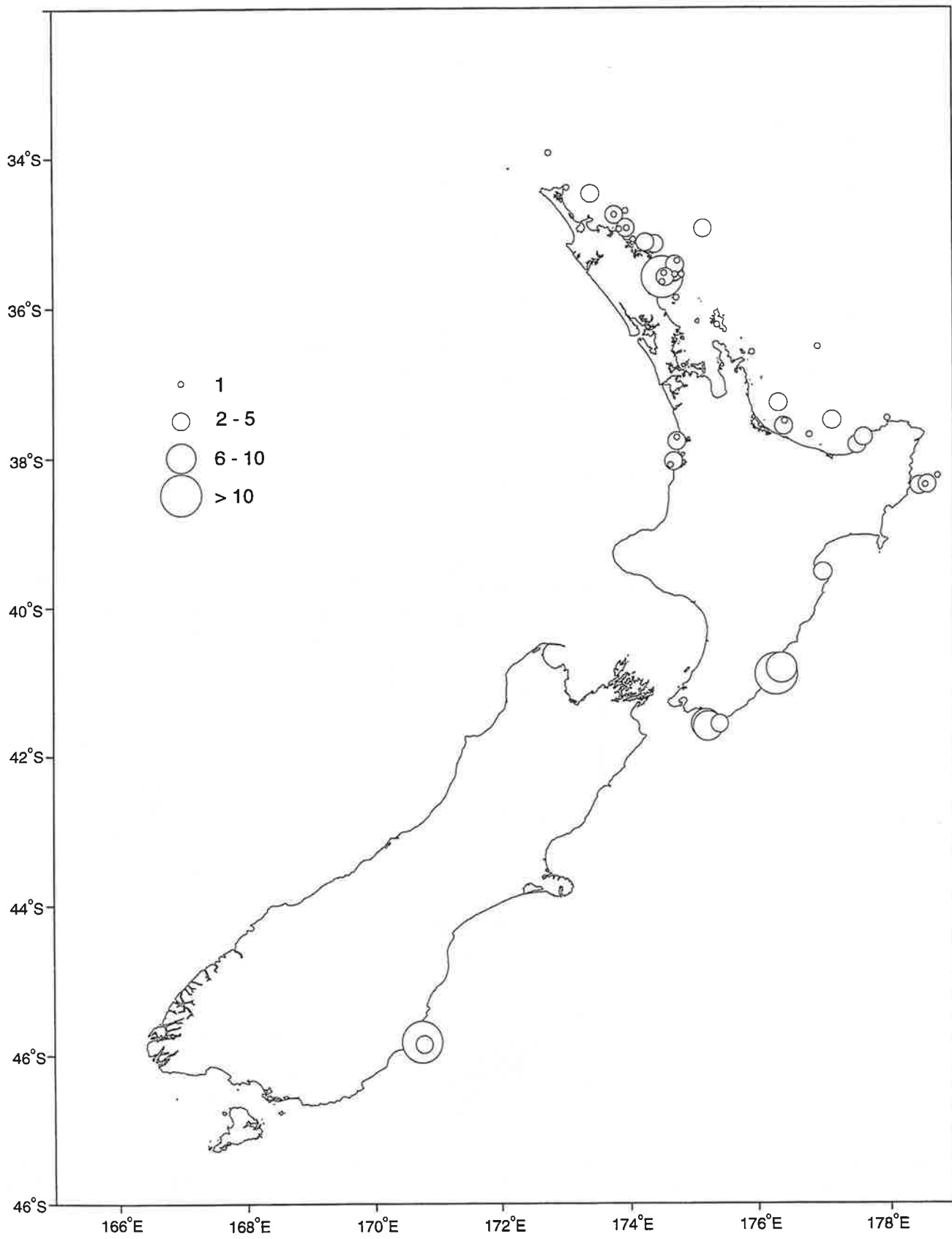


Figure 12: Distribution of blue sharks tagged and released during the 1996-97 season.

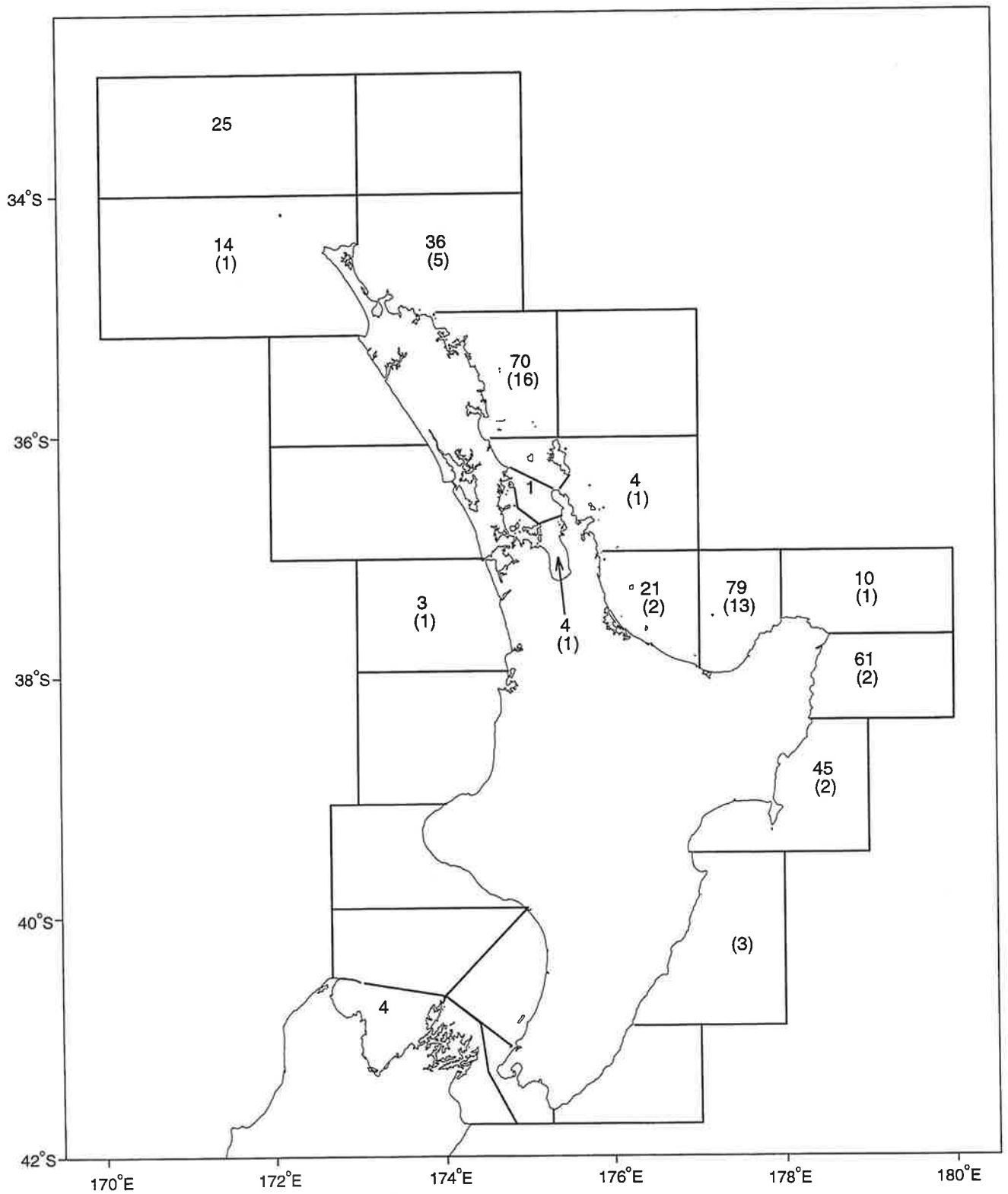


Figure 13: Numbers of kingfish released and recaptured (in parentheses) by statistical reporting area during the 1996-97 season.

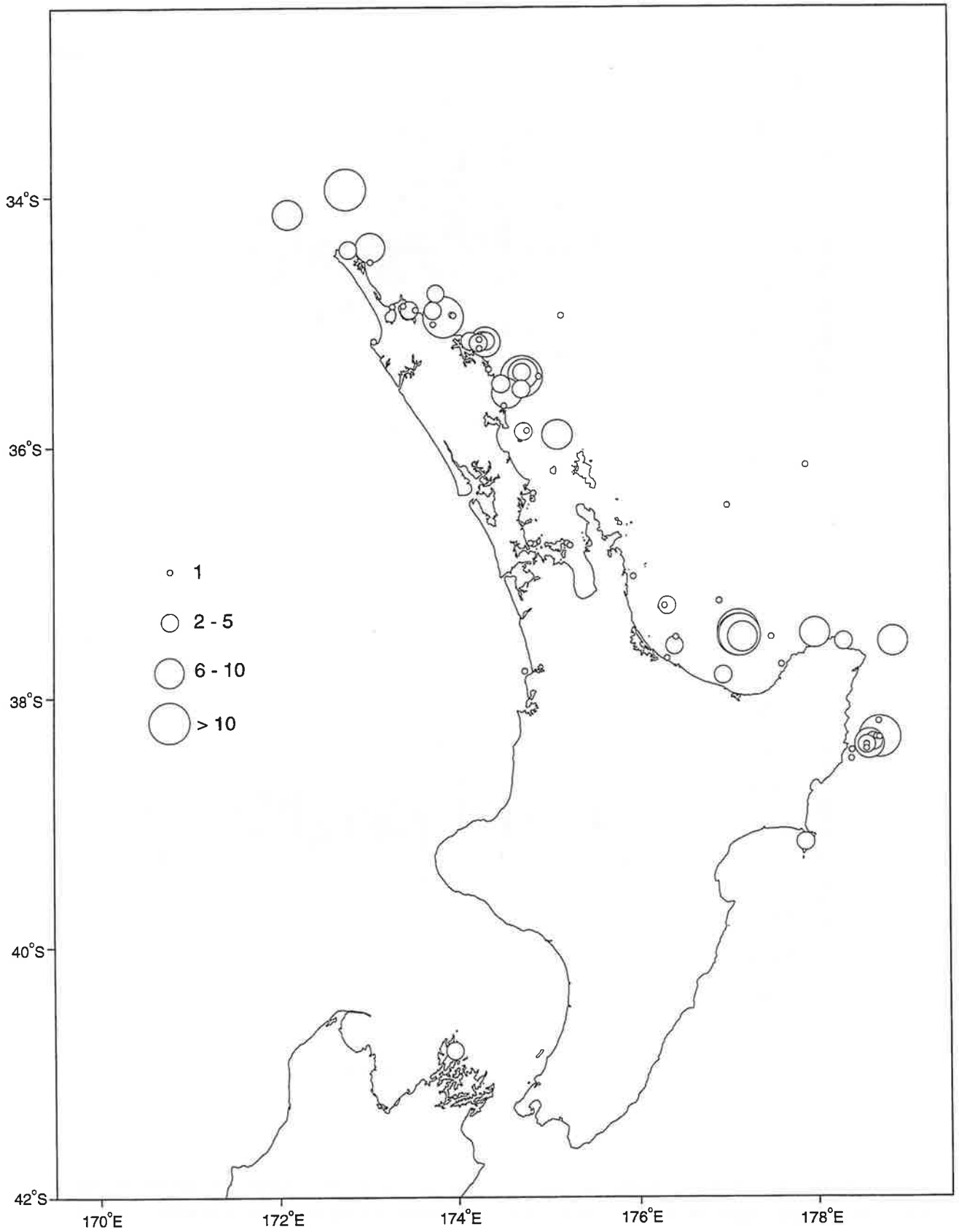


Figure 14: Distribution of kingfish tagged and released during the 1996–97 season.

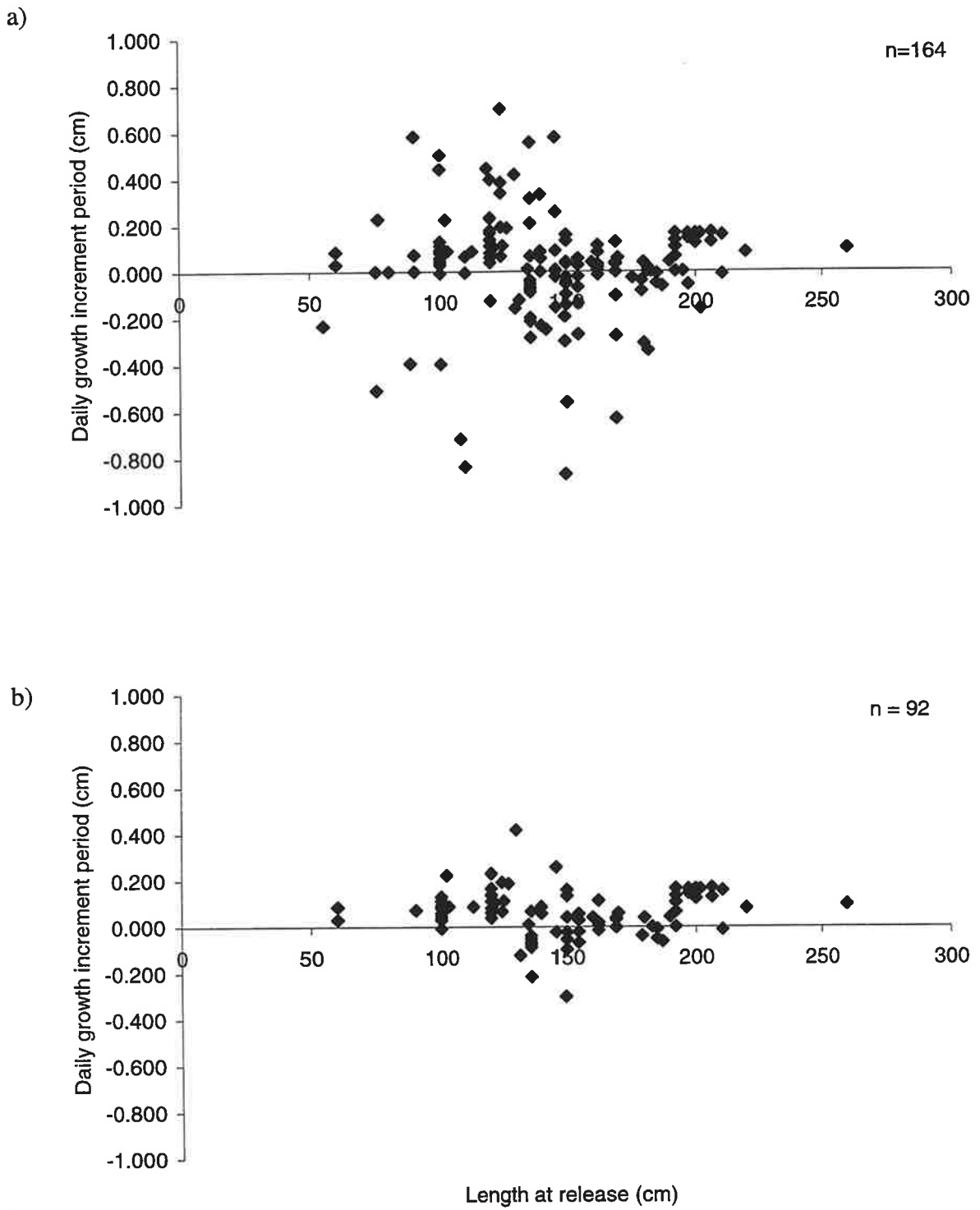


Figure 15 : Plot of mean daily growth increments of recaptured mako sharks relative to length at release for a) all recaptures since 1975, less 7 outliers; and b) recaptures having more than 6 months at liberty.

Appendix 1 : Numbers of fish tagged and released by recreational fishers by species and statistical area in the 1996–97 season

Species	Statistical area																									Total		
	002	003	005	006	007	008	009	010	011	012	013	014	015	016	024	033	038	040	041	042	043	045	046	047	048		999	??
Striped marlin	190	112	–	–	–	7	13	5	1	–	3	–	–	–	–	1	2	67	24	–	17	2	144	631	–	7	1 226	
Mako shark	186	418	2	–	–	4	32	45	2	2	8	24	–	1	14	–	–	–	48	34	1	4	–	21	25	–	3	874
Kingfish	36	70	–	1	4	3	21	79	10	61	45	–	–	–	–	4	–	–	3	–	–	–	14	25	–	–	376	
Blue shark	10	41	1	–	–	1	7	8	–	5	5	60	19	27	139	–	–	–	3	5	–	–	–	–	1	–	2	334
Other shark species	2	12	–	2	7	–	3	2	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	30	
Other species	11	7	–	–	–	1	13	1	–	–	–	–	–	–	–	7	–	–	1	–	–	–	–	3	7	16	–	67
Total	435	660	3	3	11	16	89	140	13	68	61	84	19	28	153	7	5	2	119	67	1	21	2	182	690	16	12	2907

Appendix 2 : Numbers of fish tagged and released by commercial fishers by species and statistical area in the 1996–97 season

Species	Statistical area											Total
	002	003	004	008	009	010	011	042	043	999	??	
Striped marlin	2	1	2	–	1	4	3	1	–	–	12	26
Mako shark	–	–	–	–	1	1	–	1	–	–	–	3
Kingfish	–	–	–	1	–	–	–	–	–	–	–	1
Blue shark	–	–	–	2	–	–	–	–	–	–	–	2
Other shark species	–	–	–	–	–	–	–	–	5	–	–	5
Other species	–	3	–	–	7	–	1	–	–	2	–	13
Total	2	4	2	3	9	5	4	2	5	2	12	50

Appendix 3 : Numbers of fish tagged and released by fishers of unknown origin by species and statistical area in the 1996–97 season

Species	Statistical area			Total
	002	003	014	
Striped marlin	–	–	–	–
Mako shark	2	1	–	3
Kingfish	–	–	–	–
Blue shark	–	–	–	–
Other shark species	–	–	1	1
Other species	–	–	–	–
Total	2	1	1	4

?? Denotes fish tagged and released but no statistical area given

999 Denotes fish tagged and released outside of statistical areas