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EXECUTIVE SUMMARY

Davey, N.K.; Hartill, B.; Cairney, D.G.; Cole, R.G. (2008). Characterisation of the Marlborough Sounds recreational fishery and associated blue cod and snapper harvest estimates.
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This report first describes the results of a characterisation diary survey of recreational fishing in the Marlborough Sounds. A characterisation survey of the Marlborough Sounds was carried out by Bell and associates in 1998 (Bell 2001). That survey identified locations fished, species caught, and methods used, and estimated a catch-per-unit-of-effort (CPUE) for key species. It found that blue cod, snapper and scallops were the key finfish and shellfish targeted by fishers. We compared this 1998 survey to present (2005–06) findings.

In 2005–06 characterisation of the diarists finds Marlborough Sounds' fishers to be mainly New Zealand European males, aged 41–50 years. They fish mainly in the summer months (December to April) using rod and reel from a private boat. Blue cod is still the major recreational species both targeted and caught in the Marlborough Sounds and is targeted mainly with rod and reel from a private boat. Other key species targeted and caught are snapper, scallops, and lobsters. The methods used to target these key species and the locations where they are mainly caught and kept from have not changed greatly between 1998 (Bell 2001) and this survey 7 years later.

The frequency of trips to defined locations indicated that in the 1998 survey, locations with high frequency included Croisilles Harbour, Trio Islands, Kenepuru Sound, and outer Queen Charlotte Sound. In the 2005–06 survey, Kenepuru, Croisilles, and inner Pelorus Sound were visited most frequently by the diarists. The CPUE was estimated for 8 key species from this survey and compared to Bell's (2001) CPUE estimates. The catch rate for snapper was 0.22 fish per hour in 1998 and 0.27 in 2005–06. Catch rate, for blue cod were also similar with 1.37 fish per hour in 1998 and 1.01 in 2005–06.

An aerial overflight approach was also used to estimate recreational harvests in upper QMA 7 between 1 December 2005 and 30 November 2006. Harvests of key species in the Marlborough Sounds were estimated to fulfil the second objective of this programme, and of snapper in Tasman Bay/Golden Bay to meet the third objective. Preliminary analyses of boat ramp interview data suggested that only two species were caught in sufficient quantities to yield reasonable harvest estimates, snapper and blue cod. Large numbers of scallops were landed on occasion, but because our sample design was structured around a 12 month period, and the scallop season is restricted to a 7 month period which falls across summer and winter, we were not able to derive harvest estimates for this species. Further analysis of catch data highlighted the need to further stratify the Marlborough Sounds into two substrata, the Inner and Outer Sounds, primarily because the incidence of snapper catches in the Outer Sounds is far lower than in the Inner Sounds.

We estimated the recreational blue cod harvests to be: 23.8 t in Golden Bay/Tasman Bay, 5.2 t in the Inner Marlborough Sounds, and 111.8 t in the Outer Sounds. When other minor forms of boat-based fishing, such as longlining and set netting, and shore based catches are taken into account, the combined blue cod harvest estimate increases to 148.6 t. For snapper we estimated the harvests to be: 20.7 t in Golden Bay/Tasman Bay, 15.2 t in the Inner Marlborough Sounds, and 4.5 t in the Outer Sounds. Once all forms of fishing are considered, the combined harvest estimate increases to 42.6 t.

These estimates describe most, but not all, of the recreational harvest from BCO 7 and SNA 7. Harvests from areas on the west coast of the South Island and on the east coast from Cloudy Bay to the Clarence River are not assessed, but are not thought to be substantial. The estimates presented here are discussed in relation to those derived previously via telephone/diary surveys, which are not considered as reliable.

Bell, J.D. (2001). Results from the Marlborough Sounds recreational fishing survey 1998. Final Research Report for the Ministry of Fisheries Project REC9807. J.D. Bell & Associates, Dunedin. 73 p.

1. INTRODUCTION

The Marlborough Sounds support a highly valued recreational fishery for blue cod, snapper, scallops, and other species. Blue cod is the major recreational fishery in the sounds, but fishery-independent cod potting surveys indicate that the blue cod population in the Marlborough Sounds appears to have roughly halved between 1995–96 and 2001 (Blackwell 1997, 1998, 2002). The blue cod fishery and other recreational fisheries are under increasing pressure as recreational fishing effort increases and gear technology improves. To address some of these concerns, the recreational bag limit was reduced from 20 blue cod to 12 in 1992–93 and further to 3 fish in 2003.

A diary survey was used to characterise the Marlborough Sounds recreational fishery in 1998 (Bell 2001). Diaries were collected from 297 diarists for one year, providing information on areas fished, species caught, methods used, and estimating catch per unit effort. In this programme we repeated the 1998 characterisation study to determine the nature and extent of the recreational fishery in the Marlborough Sounds between December 2005 and November 2006. The 1998 and 2005–06 surveys are compared to examine changes in target species, species caught, and locations fished that may have occurred in response to the reduction in the recreational daily bag limit for blue cod.

The results of this and other similar telephone/diary surveys have raised concerns about the accuracy of producing harvest estimates using this methodology (Bradford 1998, 2000). Much of their unreliability appears to stem from the indirect methods and associated bias used to estimate fishing effort and catch. In this programme, we also used a more direct approach to estimate the recreational harvest of key species, the aerial overflight method (Hartill et al. 2006). Harvests of blue cod and snapper are estimated for both Tasman Bay/Golden Bay and the Marlborough Sounds and are compared with existing telephone /diary estimates.

Objective

To characterise the recreational fishery in the Marlborough Sounds and estimate the recreational harvest of key species.

Specific objectives

1. To determine the areas fished and catch per unit effort for the recreational fishery in the Marlborough Sounds from 1 October 2005 to 30 September 2006.

2. To estimate the recreational harvest of key species in the Marlborough Sounds.

3. To estimate the recreational harvest of snapper in SNA 7 (Marlborough Sounds, Tasman and Golden Bays).

2. CHARACTERISATION OF THE MARLBOROUGH SOUNDS RECREATIONAL FISHERY

2.1 Study area

The spatial definition of the fishery follows that used previously by Bell (2001), which encompasses the waters between (and including) Croisilles Harbour and Port Underwood, as well as the waters of the outer sounds and surrounding D'Urville Island (Figure 1).

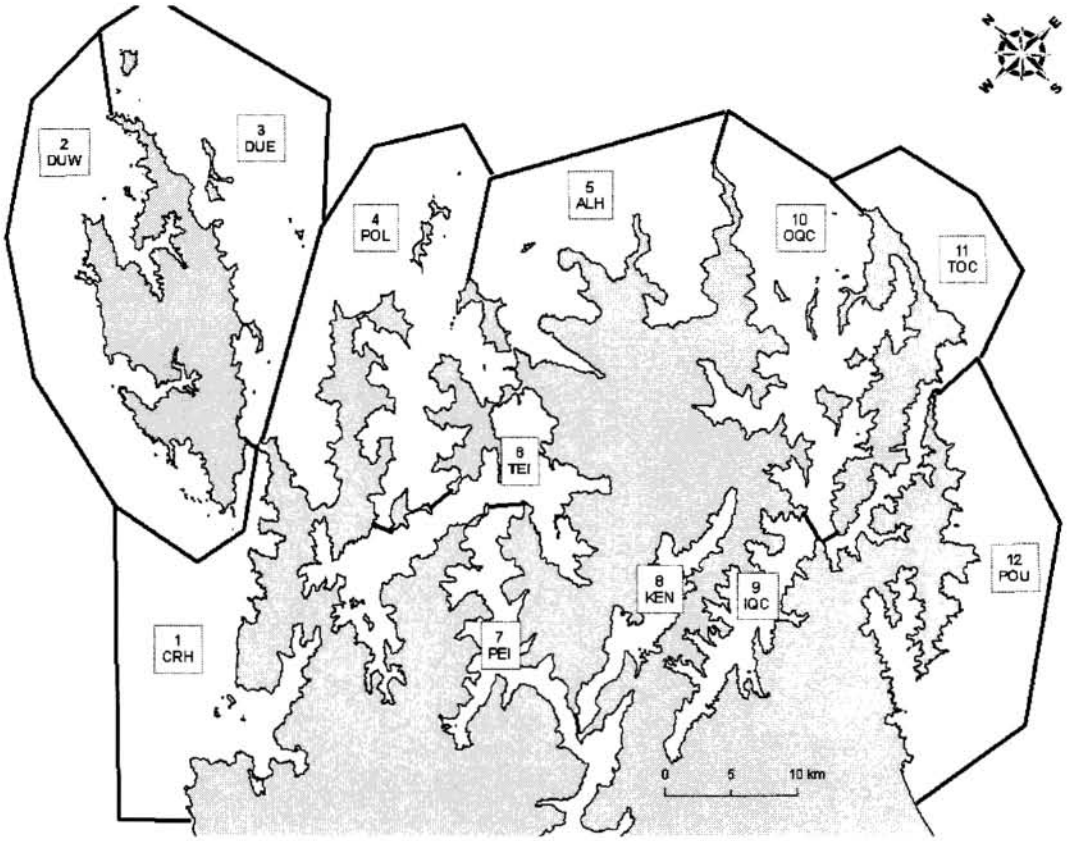


Figure 1: Marlborough Sounds, South Island, New Zealand showing the survey location from Croisilles Harbour to Port Underwood. The 12 zones were defined for use during this diary survey and associated ramp and aerial survey (Obj 2). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood

2.2 Diarist recruitment

The recreational fishery in the Marlborough sounds was characterised on the basis of diarist data, in a manner similar to that used in the 1998 diary survey (Bell 2001). We attempted to recruit 200 diarists in October 2005, two months before the survey was due to start. People who fish in the Marlborough Sounds were identified and asked to keep a diary of their fishing activities for the next 12 months (December 2005–November 2006). Diarists were recruited by contacting local fishing and diving clubs (Dawnbreakers, Nelson Underwater Club, local Marlborough Sounds fishing and boating clubs), contacting fishing/diving shops in Wellington, Picton, Nelson, Blenheim and Kaikoura and using various forms of media publicity. Fishers at local boat ramps who were being interviewed as a part of an aerial overflight survey were also asked by ramp interviewers to take part in the diary survey.

The diarists first completed a demographic survey (Appendix 1). Respondents were then asked to complete pre-printed diaries on which they were to record information regarding each fishing trip undertaken (Appendix 2). The information to be recorded for each fishing trip was:

- The date of the trip
- The location(s) fished (to be marked on a map provided as part of the diary page)
- The number of hours spent fishing
- The fishing method used
- The number of each species of fish they caught and kept
- The target species for the trip

A trip was defined as one fisher, using one fishing method, in one area, on one day. When a method was changed, or fishers moved to a new location, the diarist was asked to fill out another trip record. There was no limit to the number of trip records a fisher could fill out in a day or during a three month period.

Trip records were requested every three months, with diarists being sent a reminder letter and/or phone call to encourage this. Returned trip records were checked, and any queries followed up with a phone call to the fisher. Any data that did not make sense or could not be sorted out with the fisher were removed from the survey. Fishers that did not fish in any three month period were still encouraged to send back one trip record indicating they did not fish in this period. An incentive to encourage fishers to return their trip records was offered. Each time fishers returned three months of trip records on time they were put in a draw to win fishing equipment. A draw was made at the completion of the survey.

Data summaries and map summaries similar to those of Bell (2001) were then produced and compared with the 1998 survey.

2.3 Diarist demographics

This section summarises the diary participants' demographics and their personal fishing habits before starting the diary survey.

Number of fishing trips

All diarists were considered active fishers, having done at least 1–5 days fishing during the 12 months before beginning the survey (Table 1). Fifty-four percent of the diarists had fished 16 or more days in the past 12 months.

Table 1: How many days fishing have you done over the last 12 months? (N = 125 diarists).

No. of fishing days	Frequency	Percentage
0	0	0
1 – 5	14	11.1
5 – 15	44	35.7
16 – 30	43	34.1
31+	24	19.1

Fishing methods

The numbers of fishing trips by diarists in the 12 months before the survey, using the following methods, are shown in Table 2. The most frequently used fishing method by the 125 diarists was rod or handline from a private boat. Dredging was the second most frequently used method, whereas shore fishing with a longline, diving off a charter boat, and potting were not common.

Table 2: What methods had the diary participants used during the 12 months before the survey beginning? Diarists could tick as many boxes as required therefore the percentages are greater than 100%.

Method	Frequency	Percentage of trips
Rod or handline – private boat	122	98
Rod or handline – charter boat	15	12
Longline – private boat	22	18
Shore fishing – rod or handline	37	30
Shore fishing with a longline	0	0
Diving – private boat	41	33
Diving – charter	3	2
Diving – shore	10	8
Dredge	78	62
Set netting and gill netting	32	26
Hand gathering	41	33
Potting	8	6
Spearing	21	17

Number of fishers on a trip

Diarists recorded how many people they usually went fishing with (Table 3). Results show 60% of the diary participants went fishing with two or three other people. Less than 1% went alone.

Table 3: How many people do the diary participants usually go fishing with? N = 125

No. of people	Frequency	Percentage
0 (alone)	1	1
1	11	10
2	39	31
3	37	29
4	24	19
5	4	3
6	0	0
varies	9	7

Age, sex and ethnicity

Thirty-four percent of the diarists were aged 41–50, followed by 28% aged 51–60 (Table 4). Eighty-one percent of the diarists were male (Table 5) and 97% were European New Zealanders (Table 6) with only 3% (the four remaining diarists) identifying as New Zealand Maori.

Table 4: What age group are the diary participants? N = 125

Age	Frequency	Percentage
<14	0	0
15-20	2	2
21-30	5	4
31-40	24	19
41-50	43	34
51-60	35	29
61-70	16	13
71+	0	0

Table 5: What gender are the diary participants? N = 125

	Frequency	Percentage
Male	101	81
Female	24	19

Table 6: What ethnicity are the diary participants? N = 125

Ethnicity	Frequency	Percentage
NZ European	121	97
NZ Maori	4	3
Pacific	0	0
Other	0	0

2.4 Coverage of diarist data

One-hundred and forty-five fishers initially agreed to take part in the diary survey. At the end of the survey only 125 fishers had returned all 12 months of data so the other 20 original participants were removed from the survey. A total of 2148 fishing trips were returned, which recorded 6715 hours of fishing (Table 7). The survey was split up into four quarters according to seasons. Summer (quarter 1) was December, January, February; autumn (quarter 2) was March, April, May; winter (quarter 3) was June, July, August and spring (quarter 4) was September, October, November. The first quarter (December – February) included the highest number of trips (983) and the third quarter (June – August) included the least trips (404) (Table 7). The average hours spent fishing per quarter ranged from 2.9 hours in summer (quarter 1) to 3.6 hours in autumn (quarter 2) (Table 7).

Table 7: The number of trips made per quarter and the number of hours spent fishing on a trip (the time the gear was in the water actively fishing).

Sector of survey	No. trips	Total hours	Average hours
Quarter 1 (Dec 05 – Feb 06)	983	2 791	2.9
Quarter 2 (Mar 06 – May 06)	467	1 554	3.6
Quarter 3 (June 06 – Aug 06)	404	1 125	3.2
Quarter 4 (Sept 06 – Nov 06)	436	1 246	3.2
Overall (12 months)	2 148	6 716	3.1

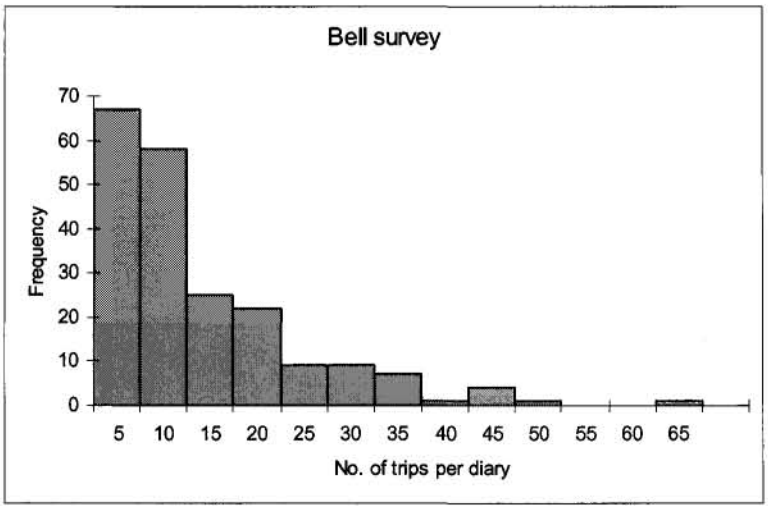
Twenty-eight percent of the trip returns were returned as 'not fishing' (Table 8). The number of diarists 'not fishing' was the highest in the last two quarters, with 39% in each quarter. Only 10% of fishers did not fish in the first quarter (December to February).

Table 8: The number of 'no fishing' returns – those that returned a trip report for a 3 month period saying they hadn't been fishing. Marlborough Sounds, NZ (December 2005-November 2006)

Sector of survey	Not fishing/possible returns	Percentage
Quarter 1 (Dec 05 – Feb 06)	13/125	10.0
Quarter 2 (Mar 06 – May 06)	31/125	25.0
Quarter 3 (June 06 – Aug 06)	49/125	39.0
Quarter 4 (Sept 06 – Nov 06)	49/125	39.0
Overall (12 months)	142/500	28.0

2.4.1 Bell (2001) vs 2005–06 distribution of number of trips per diarist.

The distribution of number of trips per diarist in the Bell survey (2001) and this survey was compared to see how similar the diarists' fishing habits were and hence how valid our comparative survey was. Figure 2 shows the overall distribution of number of trips per diarist. Bell's survey had a greater number of diarists (295 diarists, 2407 trips) but they partook in a smaller average number of fishing trips over the study period compared to this survey (125 diarists, 2148 trips).



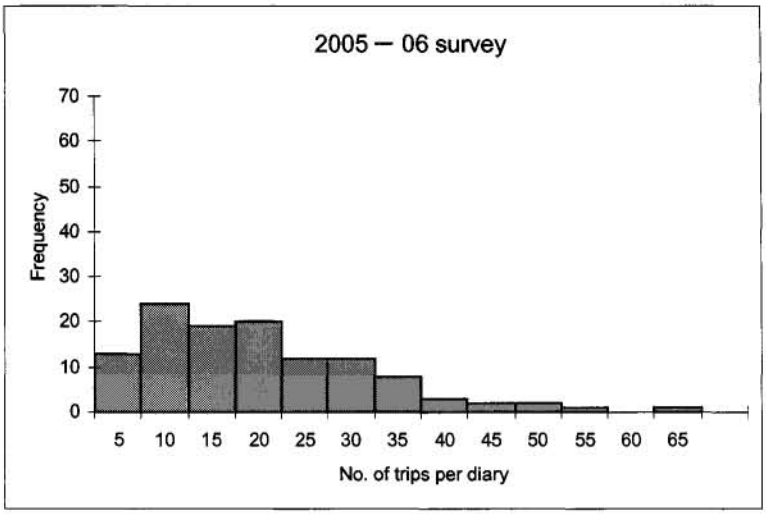


Figure 2: Comparison between the number of trips per diarist for both surveys (Bell 2001 and this survey.

The range of the two surveys was similar (1 – 61 trips (Bell 2001) vs 2 – 63 (this survey) (Table 9). However, the mean and median number of trips per fishers was much lower for Bell (2001) (Table 9).

Table 9: Summary statistics showing the number of trips made per diarist during the two surveys (Bell 2001) and this survey.

	Bell	Davey
Mean	11.79	18.36
Median	9	16
Std. dev	10.32	12.02
Std. error	0.72	1.11
Minimum	1	2
Maximum	61	63
Sum	2406	2148

2.5 Fishery characterisation

2.5.1 Seasonality of fishing effort

The highest percentages of fishing trips were made during December, January, and February (Table 10). April had the next highest percentage of trips with 9% occurring. The least trips were made during June (3.5%).

Table 10: Months during which trips were made over the 12 month survey period.

Month	Quarter	No. of fishing trips	Percentage of fishing trips
Dec – 05	1	339	15.8
Jan – 05	1	356	16.6
Feb – 06	1	275	12.8
Mar – 06	2	129	6.0
Apr – 06	2	193	9.0
May – 06	2	114	5.3
Jun – 06	3	74	3.5
Jul – 06	3	144	6.7
Aug – 06	3	137	6.4
Sep – 06	4	131	6.1
Oct – 06	4	126	5.9
Nov – 06	4	130	6.1
Total		2148	100

2.5.2 Fishing methods used by diarists

Most fishing trips by the diarists in the Marlborough Sounds used rod or handline from a private boat (60.8%) (Table 11). Diving from a private boat was the next most frequently used method (12.1%) followed by dredging (8.8%) and set netting (7.8%). Drag-netting and beach seining were not used by the diarists over this period.

Table 11: What fishing methods were used during the 12 month survey period? (n = 2148 trips).

Method	Frequency of trips	Percentage of trips
1. Rod or handline (bait/jigs/poppers/trolling)	1 306	60.8
2. Rod or handline from a charter boat	14	0.7
3. Longline fishing from a privately owned boat	48	2.2
4. Shore fishing with rod or hand line	76	3.5
5. Shore fishing with a longline (kon-tiki or kite)	4	0.2
6. Diving from a privately owned boat	261	12.2
7. Diving from a charter boat	3	0.1
8. Diving from shore	3	0.1
9. Dredging	189	8.8
10. Set netting/gill netting	168	7.8
11. Drag netting/beach seining	0	0
12. Hand gathering	20	0.9
13. Potting	6	0.3
14. Spearing	40	1.9
15. Other (snorkelling)	10	0.4

The average length of time (effort) spent fishing using each of the fishing methods is given in Table 12. Set netting had the highest mean fishing effort (9.6), followed by longline fishing, spearing and potting. Effort is determined as the time the actual gear was fishing. Diving from the shore and hand gathering had the shortest effort per fishing trip.

Table 12: Effort (hours) spent fishing the various methods over the survey period Marlborough Sounds. (n = 2148 trips).

Method	N (number of trips)	Hours fishing (mean)	Hours fishing (SD)	Hours fishing (SE)
1. Rod or handline from private boat (bait/jigs/poppers/trolling)	1306	2.98	2.25	0.06
2. Rod or handline from a charter boat	14	2.02	1.36	0.36
3. Longline fishing from a privately owned boat	48	3.8	2.27	0.33
4. Shore fishing with rod or handline	76	3.34	3.33	0.38
5. Shore fishing with a longline (kon-tiki or kite)	4	1.75	0.5	0.25
6. Diving from a privately owned boat	261	1.14	1.01	0.06
7. Diving from a charter boat	3	1.67	1.15	0.67
8. Diving from shore	3	1	0.5	0.29
9. Dredging	189	1.19	0.84	0.06
10. Set netting/gill netting	168	9.59	6.47	0.5
11. Drag netting/beach seining	-	-	-	-
12. Hand gathering	20	0.71	0.39	0.09
13. Potting	6	3.58	4.19	1.71
14. Spearing	40	3.85	1.71	0.27
15. Other (snorkelling)	10	1.61	0.82	0.27

2.5.3 Species targeted by diarists

Each fishing trip recorded a target species, even if nothing was actually caught. For some trips, fishers recorded a general target (i.e, nothing specific), and for some trips the fishers recorded more than one target species. Overall, for the entire survey, the species most frequently targeted was blue cod (41.9%). This was followed by snapper, scallops, lobster, and flounder (Table 13).

Table 13: What fish or shellfish were targeted during the fishing trips? (n = 2148). It is possible to target more than one species during a trip; therefore the sum of percentages is greater than 100%. Target species recorded in less than 1% of the fishing trips have been omitted from the table.

Species targeted	Frequency	Percentage
Blue cod	900	41.9
Snapper	591	27.5
Scallops	332	15.5
Lobster	156	7.3
Flounder	122	5.7
Hapuku	120	5.6
Kahawai	101	4.7
Tarakihi	92	4.3
Blue moki	68	3.2
General target	57	2.7
Butterfish	54	2.5
Gurnard	45	2.1
Kingfish	45	2.1
Sea perch	40	1.9
Mussels	23	1.1

The target species varied between quarters. The five top target species for each quarter are given in Table 14. Blue cod was the main target regardless of the season, but scallops became the second most targeted species in the third and fourth quarters. Scallops were in the top five targeted species in quarters 1, 3, and 4. Snapper was a common target in the first and second quarter. Lobster was in the top five target species in quarters 1, 2, and 4 but not in quarter 3 (winter).

Table 14: What were the top five fish targeted each quarter?

Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Species targeted	Frequency	Species targeted	Frequency	Species targeted	Frequency	Species targeted	Frequency
Blue cod	365	Blue cod	208	Blue cod	189	Blue cod	140
Snapper	318	Snapper	157	Scallops	71	Scallops	104
Scallops	157	Flounder	90	Snapper	32	Snapper	87
Lobster	83	Lobster	36	Hapuku	32	Flounder	25
Kahawai	57	Hapuku	27	Flounder	27	Lobster	20

2.5.4 Species caught by diarists

A total of 54 species, including finfish, sharks, rays, lobster, shellfish, kina, and octopus were caught and kept over the 12 month survey period (Table 15). The most commonly caught fish species was blue cod with a total of 2642 individuals kept, followed by snapper, of which 731 individuals were kept. The most caught and kept shellfish/other species was scallops (18 835).

Table 15: What species were caught during fishing trips (n (trips) = 2148).

Species caught and kept	Frequency	Species caught and kept	Frequency
Blue cod	2 642	Scorpionfish	4
Snapper	731	Conger eel	3
Lobster	572	Warehou	3
Sea perch	551	Skate	3
Flounder	539	Banded wrasse	2
Kahawai	441	Thresher shark	2
Spotty	302	John Dory	2
Tarakihi	280	Sole	2
Hapuku	184	Trumpeter	2
Blue moki	155		
Barracouta	140	Marblefish	1
Gurnard	138	Seven gill shark	1
Yellow-eyed mullet	125	Butterfly perch	1
Spiny dogfish	120	Rock cod	1
Butterfish	97	Sweep	1
Jack mackerel	85	Eagle ray	1
Red cod	60		
Maori chief	41		
Trevally	32		
Grey-boy shark	16	Scallops	18 835
Rig	15	Mussel	1 145
Scarlet wrasse	13	Oyster	141
Leather jacket	13	Cockle	114
Shark-general	13	Kina	101
Piper	12	Paua *(H. iris)*	62
Herring	12	Pipi	23
Kingfish	11	Tuatua	6
Stargazer	8	Octopus	1
Stingray	6	Paua *(H. australis)*	1

The species caught and kept varied depending on the season (Table 16). Blue cod was the main catch at all times of the year with sea perch, flounder, snapper, and lobster also being popular. Scallops and mussels (green or blue not distinguished) were the main shellfish taken, but this also was seasonal.

Table 16: Number of each species caught per quarter.

Species caught (Quarter 1)		Species caught (Quarter 2)		Species caught (Quarter 3)		Species caught (Quarter 4)	
Blue cod	1 044	Blue cod	620	Blue cod	581	Blue cod	407
Snapper	374	Snapper	248	Sea perch	138	Flounder	135
Lobster	286	Flounder	198	Flounder	104	Sea perch	112
Kahawai	235	Lobster	158	Tarakihi	75	Kahawai	80
Sea perch	193	Sea perch	109	Hapuku	66	Lobster	76
Spotty	187	Kahawai	90	Lobster	52	Snapper	63
Flounder	102	Tarakihi	84	Snapper	46	Tarakihi	59
Barracouta	85	Spotty	73	Kahawai	36	Hapuku	37
Yellow-eyed mullet	75	Blue moki	57	Butterfish	20	Spotty	32
Gurnard	65	Spiny dogfish	52	Gurnard	19	Butterfish	29
Tarakihi	62	Barracouta	47	Spiny dogfish	15	Spiny dogfish	28
Blue moki	61	Gurnard	43	Maori chief	15	Yellow-eyed mullet	23
Jack mackerel	47	Hapuku	37	Blue moki	14	Blue moki	20
Hapuku	44	Butterfish	32	Red cod	11	Jack mackerel	17
Spiny dogfish	25	Yellow-eyed mullet	27	Spotty	10	Gurnard	11
Butterfish	16	Jack mackerel	21	Trevally	10	Maori chief	9
Trevally	14	Red cod	19	Barracouta	7	Red cod	7
Grey shark	10	Maori chief	14	Red moki	7	Piper /Garfish	5
Red cod	11	Trevally	8	Scarlet wrasse	6	Barracouta	4
Piper	7	Red moki	8	Sole	4	Grey shark	4
Herring	7	Leather jacket	6	Leather jacket	3	Stingray	4
Kingfish	6	Kingfish	5	Rig	3	Scarlet wrasse	3
Rig	6	Rig	5	Herring	2	Banded wrasse	2
Tuatua	6	Herring	3	Stargazer	2	Rig	1
Stargazer	5	Skate	3	Warehou	2	Stargazer	1
Leather jacket	4	Grey shark	2	Stingray	1	Sole	1
Scarlet wrasse	3	Conger eel	2	Butterfly perch	1	Trumpeter	1
Scorpionfish	3	Stingray	2	Sweep	1	Eagle ray	1
Maori chief	3	Scarlet wrasse	1	Salmon	1		
Sand shark	3	Scorpionfish	1				
Thresher shark	2	John dory	1				
Conger eel	1	Shark	1				
Marblefish	1	Seven gill shark	1				
John dory	1	Warehou	1				
Spiker shark	1	Rock cod	1				
Shark	1						
Sole	1						
(shellfish/other)		**(shellfish/other)**		**(shellfish/other)**		**(shellfish/other)**	
Scallops	8 376	Mussel	508	Scallops	4 187	Scallops	6272
Mussel	387	Oyster	45	Mussels	250	Kina	10
Cockle	134	Paua *(H. iris)*	10	Cockle	80	Oyster	6
Kina	81	Kina	10	Oyster	71		
Paua *(H. iris)*	52	Octopus	1				
Pipi	23						
Oyster	19						
Paua *(H. australis)*	1						

2.5.5 Catch by fishing method

The major target species (blue cod, snapper, lobster, and scallops), the methods used to catch them, and the numbers caught with each method given in Table 17. Blue cod and snapper were targeted mainly by rod and reel from a private boat. Lobsters were targeted predominantly by diving from a private boat. Scallops were targeted by either dredging or diving from a private boat.

Table 17: The number of trips and total catches of the main target species using the various methods.

Frequency (number of trips) capturing the main target species by different methods

	Method														
	Rod or handline private boat	Rod or handline charter boat	Long line private boat	Shore fishing rod or handline	Shore fishing with longline	Diving private boat	Diving charter boat	Diving shore	Dredging	Setnetting gill netting	Drag netting beach seining	Hand gathering	Potting	Spearing	Other
Species															
Blue cod	817	6	13	8	1	6	0	0	0	2	0	2	0	26	0
Snapper	267	5	27	22	1	1	0	0	0	14	0	1	0	0	0
Lobster	0	1	0	0	0	124	3	0	0	0	0	0	5	3	2
Scallops	0	0	0	0	0	137	1	2	188	0	0	0	0	0	0

Total catches (number of individuals taken) of the main target species by different methods

	Method														
	Rod or handline private boat	Rod or handline charter boat	Long line private boat	Shore fishing rod or handline	Shore fishing with longline	Diving private boat	Diving charter boat	Diving shore	Dredging	Setnetting gill netting	Drag netting beach seining	Hand gathering	Potting	Spearing	Other
Species															
Blue cod	2 480	18	36	15	1	17	0	0	0	4	5	0	63	0	0
Snapper	612	12	40	33	3	1	0	0	0	24	1	0	0	0	0
Lobster	0	6	0	0	0	523	10	0	0	0	0	24	6	3	0
Scallops	0	0	0	0	0	10 352	50	57	8 376	0	0	0	0	0	0

2.5.6 Locations fished

Frequency and effort

The frequency of trips to each location and number of hours spent fishing (effort) are tabulated below (Table 18). Appendix 5a shows trip frequencies in relation to location. Outer Queen Charlotte (OQC) is the location where the most fishing trips were made by our diarists (14.3%) followed closely by Croisilles Harbour (CRH) (14.0%). The average duration of a fishing trip was the greatest at Inner Pelorus (PEI) and Kenepuru Sound (KEN) (5.9 and 5.65 h). The shortest average duration of a trip was to Inner Queen Charlotte (IQC) (1.35 h) (Appendix 5b).

Table 18: Frequency of fishing trips to locations and the average duration of fishing effort in each location. CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.

Location	Frequency of trips	% of fishing trips to location	Average duration of trips (h)	SD (duration)	SE (duration)
CRH	301	14	2.1	1.9	0.11
DUW	140	6.5	2.4	2.1	0.18
DUE	105	4.9	2.8	1.8	0.18
POL	192	8.9	2.3	1.7	0.12
ALH	72	3.4	2	1.4	0.16
TEI	138	6.4	2.9	1.9	0.17
PEI	235	10.9	5.9	5.4	0.35
KEN	271	12.7	5.7	5.1	0.31
IQC	158	7.4	1.4	0.9	0.08
OQC	307	14.3	2.3	1.6	0.09
TOC	133	6.2	2.5	1.9	0.16
POU	96	4.5	3	2.9	0.3

Fishing Methods

The number of trips to each location, using each of the 15 methods is given in Table 19.

Table 19: Frequency of each method used in each of the survey locations. CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.

Method	Rod or handline private boat	Rod or handline charter boat	Long line private boat	Shore fishing-rod or handline	Shore fishing with longlining	Diving-private boat	Diving-charter boat	Diving-shore	Setnetting/gill netting	Drag netting /beach seining	Hand gathering	Potting	Spearing flats/flounder	Other	Total
CRH	130	6	14	2	0	55	2	0	85	5	0	0	2	0	301
DUW	101	1	2	0	0	23	0	0	0	3	0	0	10	0	140
DUE	78	0	3	2	0	4	0	0	0	4	0	0	14	0	105
POL	125	1	6	0	0	12	0	0	45	0	0	0	2	1	192
ALH	51	0	1	0	0	14	0	0	0	5	0	0	1	0	72
TEI	111	2	16	1	0	1	0	0	1	3	2	0	1	0	138
PEI	108	1	0	15	3	0	0	0	17	88	2	0	0	1	235
KEN	188	0	1	52	1	0	0	0	0	27	2	0	0	0	271
IQC	54	0	1	2	0	77	0	1	17	0	6	0	0	0	158
OQC	226	0	2	1	0	39	0	0	22	4	2	1	5	5	307
TOC	92	1	2	0	0	17	1	1	2	13	1	0	2	1	133
POU	42	2	0	1	0	20	0	1	0	15	5	5	3	2	96
Total	1 306	14	48	76	4	262	3	3	189	167	20	6	40	10	2 148

Rod and line fishing from a private boat was the most frequently used method at all locations except Inner Queen Charlotte (IQC) where diving from a privately owned boat was more common. Dredging occurred at 8 of the 12 locations, with Croisilles Harbour (CRH) having the greatest number of dredging trips. Set netting occurred at 10 of the locations with Inner Pelorus (PEI) having the greatest number of set netting trips. Shore fishing was not common with our diarists, but of the 80 trips that did use this method, 53 were in Kenepuru Sound (KEN). Diving from a private boat occurred at 9 locations with varying frequencies. However, Tennyson Inlet (TEI), inner Pelorus (PEI), and Kenepuru (KEN) had no trips using this method. Spearing mainly took place at D'Urville West (DUW) and D'Urville East (DUE).

The frequency of the fishing methods at each location during each quarter is given in Appendix 3 and mapped in Appendix 5c. The most used method during each quarter at locations DUW, DUE, POL, TEI, ALH, OQC, TOC, and POU was consistently rod or line fishing from a private boat. At CRH dredging was also frequently used, particularly in the third and fourth quarters. Set netting was extensively used at PEI during the third and fourth quarters. At location IQC, diving from a private boat was the most popular fishing method in quarters 1 and 4 (summer and spring), whereas rod and line fishing from a private boat was dominant in the other two quarters.

Target species

The species targeted in each location are shown in Table 20. Thirty-six target species (including 'any fish') were fished for during the survey period. Blue cod was the main target finfish species at eight locations whereas snapper was the major target species at Kenepuru Sound (KEN) and inner Pelorus (PEI). The two major target species at each location are shown on Appendix 5d (see Appendix 4 for data). The number of different species targeted in a location ranged from 12 at IQC to 20 at TOC (Tory Channel). More fishing trips at Croisilles (CRH) and Inner Queen Charlotte (IQC) targeted scallops than blue cod. Flounder was a notably frequent target species at Inner Pelorus Sound (PEI), proving more popular than blue cod. Hapuku was the second most targeted species at DUE (D'Urville East).

Table 20: Target species at each location in the Marlborough Sounds (December 2005-November 2006). It is possible to target more than one species per fishing trip, therefore n = 2784 trips. CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.

	CRH	DUW	DUE	POL	ALH	TEI	PEI	KEN	IQC	OQC	TOC	POU
Any fish	1	0	4	2	1	1	2	0	12	27	5	0
Blue cod	109	93	70	114	45	89	34	2	34	194	85	31
Gurnard	18	0	3	2	3	5	0	0	2	9	2	1
Lobster	39	23	4	9	13	0	0	0	1	27	18	22
Snapper	76	34	17	25	4	63	119	231	11	4	1	6
Kahawai	11	2	4	7	4	7	4	28	5	18	7	4
Scallops	118	0	1	49	1	1	17	0	94	46	4	1
Tarakihi	6	14	8	6	7	0	0	0	0	18	17	16
Kingfish	4	14	14	5	1	2	1	2	1	1	0	0
Barracouta	1	1	1	0	0	1	0	0	1	1	6	0
Scarlet wrasse	0	0	0	1	0	0	0	0	0	0	0	0
Blue moki	8	5	12	6	9	1	0	0	0	7	9	11
Jack mackerel	0	0	0	0	0	1	0	2	0	0	0	0
Spotty	1	0	0	0	0	0	0	1	0	7	5	0
Sea perch	1	2	2	8	2	0	0	0	0	18	5	2
Hapuku	0	17	35	8	10	2	2	0	0	18	14	14
Greyshark	0	0	1	0	0	1	0	0	0	0	0	0
Flounder	2	0	0	0	0	2	84	25	0	2	0	7
Yellow eyed mullet	1	0	0	0	0	0	2	2	2	0	0	0
Leatherjacket	0	0	0	0	0	0	1	0	0	0	1	0
Butterfish	2	3	9	3	4	1	0	0	0	8	7	17
Blackfoot paua	0	0	0	1	0	0	0	0	0	4	1	3
Mussels	0	0	0	0	0	1	0	3	3	7	1	8
Trevally	0	0	0	0	0	0	0	3	0	0	0	0
Kina	0	0	0	1	0	0	0	1	0	0	2	0
Rig	0	1	0	0	0	0	0	0	0	0	1	6
Oyster	1	0	0	0	0	1	2	0	0	0	0	4
Conger eel	0	1	0	0	0	0	0	0	0	0	0	0
Maori chief	0	0	0	0	0	0	0	0	0	0	2	0
Pipi	0	0	0	0	0	0	0	2	0	0	0	1
Cockle	0	0	0	0	0	0	0	2	2	0	0	0
Tuatua	0	0	0	0	0	0	0	2	0	0	0	1
Stargazer	0	0	0	0	0	0	0	0	0	1	0	0
Red cod	1	0	0	0	0	0	0	0	0	0	0	0
Sole	1	0	0	0	0	0	3	0	0	0	0	0
Salmon	0	0	0	0	0	0	1	0	0	0	0	0
No. species targeted	19	13	15	16	13	16	13	14	12	19	20	18

Species caught

The number of species caught in each location is given in Table 21.

Table 21: The number of each species caught and kept at each location over the 12 month survey period.

Species list	CRH	DUW	DUE	POL	ALH	TEI	PEI	KEN	IQC	OQC	TOC	POU
Banded wrasse	0	0	0	0	0	0	0	0	0	0	0	2
Barracouta	19	31	13	8	5	15	15	7	1	15	11	0
Blue cod	315	292	228	414	137	240	84	1	35	557	244	95
Blue moki	12	12	29	8	13	0	0	0	0	18	45	18
Butterfish	1	6	26	2	2	0	0	0	0	15	9	36
Butterfly perch	0	0	0	0	0	0	0	0	1	0	0	0
Cockle	0	0	0	0	0	0	0	34	80	0	0	0
Conger eel	0	1	0	0	1	0	1	0	0	0	0	0
Eagle ray	0	0	0	0	0	0	0	1	0	0	0	0
Flounder	5	0	0	0	0	0	331	185	0	1	0	17
Greyboy	0	1	2	5	3	1	1	0	0	2	1	0
Gurnard	21	4	11	0	13	22	1	1	5	54	6	0
Hapuku	0	34	40	0	26	3	0	0	0	30	13	38
Herring	0	0	0	0	0	0	9	1	2	0	0	0
Jack mackerel	3	0	0	1	0	21	6	54	0	0	0	0
John dory	1	0	0	1	0	0	0	0	0	0	0	0
Kahawai	25	10	7	47	8	30	77	96	7	70	25	39
Kina	0	20	0	6	5	0	0	1	8	0	60	1
Kingfish	0	4	1	0	0	2	0	1	0	3	0	0
Leatherjacket	4	7	0	0	0	0	0	0	0	0	2	0
Lobster	134	111	11	15	40	5	0	0	0	99	76	81
Maori chief	0	14	0	1	5	0	0	0	0	6	15	0
Marblefish	0	0	0	0	0	0	0	0	0	0	1	0
Mussel	0	0	0	0	0	50	0	85	300	338	20	352
Octopus	0	0	0	0	0	0	0	0	0	1	0	0
Oyster	11	0	0	0	0	15	45	0	0	0	0	70
Paua (blackfoot)	0	0	0	1	0	0	0	0	0	30	3	28
Paua (yellowfoot)	0	0	0	0	0	0	0	0	0	0	0	1
Piper	0	0	0	0	0	0	4	8	0	0	0	0
Pipi	0	0	0	0	0	0	0	23	0	0	0	0
Red cod	2	3	0	2	0	0	1	0	0	5	0	0
Rig	2	4	1	0	1	0	1	1	0	0	3	2
Rock cod	1	0	0	0	0	0	0	0	0	0	0	0
Scallops	6 325	0	0	2 172	50	6	584	0	6 317	3 263	68	50
Scarlet wrasse	0	0	0	3	0	0	0	0	0	3	5	2
Scorpion fish	0	0	1	1	0	2	0	0	0	0	0	0
Sea perch	19	108	56	33	24	7	1	0	1	195	88	19
Sevengill shark	0	0	0	0	0	0	0	1	0	0	0	0
Shark	0	0	3	0	0	0	1	1	0	2	6	0
Skate	0	0	0	0	0	0	0	0	0	0	0	3
Snapper	137	61	9	22	0	77	121	277	5	8	0	14
Sole	2	0	0	0	0	0	0	0	0	0	0	0
Spiny dogfish	10	17	7	3	2	20	15	6	0	21	0	19
Spotty	5	4	1	15	0	70	35	133	10	22	7	0
Stargazer	0	0	0	0	2	0	3	1	0	2	0	0
Stingray	0	0	0	0	0	0	1	5	0	0	0	0
Sweep	1	0	0	0	0	0	0	0	0	0	0	0
Tarakihi	19	42	16	4	12	0	1	0	0	70	70	46
Thresher	1	0	0	0	0	0	0	1	0	0	0	0
Trevally	0	11	0	0	0	0	2	10	1	8	0	0

Trumpeter	0	0	0	0	0	0	0	0	0	1	1	0
Tuatua	0	0	0	0	0	0	0	6	0	0	0	0
Warehou	0	0	0	0	0	0	0	0	0	0	3	0
Yellow-eyed mullet	12	0	0	0	0	7	24	72	8	1	0	1

Blue cod was the most frequently caught and kept finfish species at all locations except KEN and PEI where snapper was more frequent. Lobster was caught in the highest numbers in CRH, followed by DUW, then OQC. Shellfish of note were scallops, which were caught and kept in large quantities at CRH and IQC followed by KEN and PEI. Mussels were also a frequent catch species at IQC, OQC, and POU and cockles were caught at IQC and KEN only. Flounder, while mainly absent from most locations, were frequently caught at KEN and PEI, with 185 and 331 respectively taken from those locations. Appendices 5e to 5m show the total catch of the key species in each location.

Catch per unit effort

The catch per unit effort for species targeted is given in Table 22. Lobsters, blue cod, and scallops were caught in numbers greater than 1 per hour but all other species were caught at rates of less than 1 per hour of effort.

Table 22: Catch per unit effort (CPUE) for the main target species.

Key species	No. trips targeting the species	Total no. hours spent targeting species	Total number of species caught when targeted	No. of that species caught per hour when targeted
Blue cod	900	2 398	2 427	1.01
Lobster	156	257	560	2.18
Snapper	591	2 494	685	0.27
Kahawai	101	334	225	0.67
Flounder	122	1 376	522	0.38
Hapuku	120	413	179	0.43
Tarakihi	92	289	165	0.57
Scallops	332	371	18 780	50.65

2.6 Representativeness of diarist data

The methodology of obtaining data from diarists is known to have problems (Bradford 1998, 2000). The selection of fishers was not random. We were targeting active, possibly experienced, fishers. The approach was considered pragmatic and was the same as in 1998 (Bell 2001) and see Section 2.4.1. Also, despite extensive attempts to get 200 diarists we did not reach our target number before the start of the survey. More advertising and more hours spent on the boat ramp or telephone have eventually achieved our aim, but this was beyond the resources of the project. Furthermore, the hours of fishing logged were high and comparable with those of Bell (2001). Also problematic to this survey was diarists' inability to follow instructions and provide good data. A phone call, a letter, and two pages of instructions were sent to each diarist before the survey start. Additionally, every 3 months a letter was sent highlighting problem areas. Despite this, many diarists continued to record the catch of all occupants on the boat, confuse species target with catch, record many trips on one record, and forget to record fishing location. This was an ongoing source of uncertainty with the data. Again, sorting through these problems was both time-consuming and resource-intensive, and the gains were questionable.

2.7 Comparison with Bell's survey

Bell's (2001) survey identified locations fished, species caught, and methods used, and estimated a CPUE for key species. It found that blue cod, snapper, and scallops were the key finfish and shellfish targeted by fishers. We now compare this 1998 survey to present (2005–06) findings.

2.7.1 Demographics

The demographic composition (age, sex, and ethnicity) of the diarists in the 2005–06 survey was similar to that in the Bell (2001) survey with males of New Zealand European descent in the 41–50 age bracket being the highest percentage of volunteers to take part. This may not be a direct reflection of the fishing population in the Marlborough Sounds due to the methodology of recruitment potentially having bias. However, the composition of diarists and methods of recruiting the volunteers was similar to Bell (2001).

The 2005–06 diary participants were more likely to fish in groups of 2 and 3. This was in contrast to Bell's (2001) survey where the participants more commonly answered that the number of people they fished with 'varied'. This response, however, may have had more to do with how the question was asked. The 2005–06 survey asked this question over the phone whereas the Bell (2001) survey handed out a written questionnaire, allowing the participants to view the questions longer.

The most common fishing methods used by participants in the prior questionnaire were the same for both surveys (1998 and 2005–06). Rod and line from a private boat was the most frequent method, followed by diving from a private boat. Also frequent in both questionnaires was rod and line from shore and hand gathering.

2.7.2 Trip returns

In 2005–06, 125 diarists completed 12 months of fishing trip records. A total of 2148 fishing trips were returned, which described 6715.5 hours of fishing. This compared to Bell's survey (2001) where 297 diarists returned 2407 fishing trips, describing a total of 6467 hours fishing. So, despite the 2005–06 survey having fewer participants, both surveys described a similar number of fishing hours from the Marlborough Sounds during the respective study periods.

In 2005–06, the most fishing hours and trips were recorded in the summer months (December, January, and February), probably due to this being the most favourable fishing weather/holiday time. Also, this was the start of the survey and enthusiasm from the fishers was high. This was a similar scenario to the Bell (2001) survey. Fishing effort per month saw December–April being the most popular months for fishing for both surveys. This is a general phenomenon of recreational fishing throughout the country (Hartill et al. 2006).

The frequency of diarists (2005–06) not going fishing (i.e, returning a 'Not fishing' trip report) was highest in June to November, again typical of fishing behaviour and probably reflecting the weather in the Marlborough Sounds. Overall 28% of fishing returns were not fishing. Bell's survey did not discuss 'not fishing' trip returns hence this aspect is not comparable.

2.7.3 Fishing methods

Sixty-one percent of the described fishing trips in 2005–06 survey used rod or handline from a private boat, followed by 12% which used diving from a private boat. Bell's survey (2001) had a similar trend with 70% of the trips describing rod or handline followed by 10% diving from a private boat. Other

popular fishing methods in both surveys were dredging and set netting. Other methods made up less than 10% of the overall composition.

Of interest in both surveys was the 'effort' spent fishing by the various methods. The method with the highest average effort in both surveys was set netting. The average effort for set netting in 1998 (Bell 2001) was 5.8 h and in 2005–06 it was 9.59 h. The other methods in 2005–06 with more than 3 h average effort were shore fishing, potting, and spearing. Set netting, potting, and shore fishing are all methods where the fishing gear is often set and fishers go elsewhere (either to fish another method or partake in another activity) while the gear fishes alone. The average effort for rod or handline from a private boat remained consistent between the Bell (2001) and 2005–06 survey at 2.8 h and 2.9 h respectively.

2.7.4 Target species

The target species was of particular interest to this survey due to the change to the blue cod bag limit in 2003. We were interested to know if fishers were now targeting different species.

Overall it appears that despite the bag limit changes, fishers in the Marlborough Sounds are still just as likely to target blue cod by preference. Blue cod were the most popular target fish on 42% of trips in 2005–06 and 52% of the trips in 1998 (Bell 2001). This was followed by snapper which was targeted on 27% of trips (2005–06) and 36% in 1998. Scallops were a more frequent target species in the Marlborough Sounds in 2005–06 (15.5%) compared to 1998 (6%). The other species were targeted in similar amounts during both surveys.

The target species changed slightly depending on the time of year. Blue cod remained consistently the main target but scallops were the second most targeted species in the third and fourth quarters. As scallops have a defined season (July-February) they were not targeted in quarter 2. Bell's (2001) survey did not look in detail at the target species per season.

2.7.5 Species caught

The main fish species caught during both surveys was blue cod. Bell's (2001) survey recorded that fishers caught 4866 blue cod over a year whereas the 2005–06 survey recorded 2642 blue cod caught. This is likely to be due to the higher blue cod bag limit in 1998, as both surveys were describing a similar number of fishing trips. Scallop numbers taken were much higher in 2005–06 compared to 1998. In the 2005–06 survey 18 835 scallops were taken by 125 diarists over a year. In 1998 (Bell 2001) only 6578 scallops were taken by the 357 diarists. The composition of fish species caught in the Marlborough Sounds was diverse in both surveys with the 2005–06 survey describing 46 species and Bell (2001) describing 23 species (we are unsure if this list is abridged).

2.7.6 Locations fished

Bell (2001) split the Marlborough Sounds into 35 regions, but as we were doing an additional aerial/ramp component our survey split the location into only 12 regions. However, the surveys are still comparable.

The frequency of trips to the locations indicated that in 1998 locations with high frequency included Croisilles Harbour, Trio Islands, Kenepuru Sound, and outer Queen Charlotte Sound. In the 2005–06 survey, Kenepuru, Croisilles, and inner Pelorus Sound were visited most frequently by our diarists to fish. Both Kenepuru and Croisilles are easily accessible by vehicle and don't require long distances to travel to find fishing grounds.

The average duration of fishing trips to the locations in 2005–06 ranged from 1.35 h in inner Queen Charlotte (IQC) to 5.9 h in inner Pelorus Sound (PEI). Bell (2001) found inner Mahau Sound to be the area with the longest duration of a fishing trip. Inner Mahau Sound is actually part of the PEI location in the our survey. The use of set nets at PEI/Keneperu/Mahau is responsible for extending duration of a fishing trip here. Both surveys found IQC to be the location with the shortest average duration of a fishing trip.

In 2005–06 rod and reel from a private boat was the most frequently used method at all locations except IQC, where diving from a privately owned boat proved more frequent. With two exceptions, Bell (2001) also found that rod and reel from a private boat was also the most popular at all locations. The exceptions were the two Port Underwood sites, where diving from a private boat was more frequently used, and inner Tawhitinui Reach where set netting was the most frequently used method. Dredging was the most frequent method in Croisilles in both the 2005–06 survey and in the 1998 survey. Diving from a private boat (second most frequent method in 2005–06) appeared to occur in most locations throughout the Marlborough Sounds (KEN and PEI excluded) as it did in the 1998 survey which found this method occurred at 24 of the 34 locations. Overall, the methodology used in the various locations in the Marlborough Sounds to catch a range of fish and shellfish has not changed greatly between 1998 and 2005–06.

Bell (2001) found that the major target species for the Marlborough Sounds was blue cod. This was the primary target at 25 of 35 locations. Blue cod was also the major target species for the 2005–06 survey. Snapper was the major target at locations KEN and PEI during both surveys. Bell (2001) found lobster was the major target species at Port Underwood, whereas the 2005–06 survey found blue cod was targeted by 20% of the fishing trips there and lobster only slightly less at 14.2% of trips. Also of note was that the second most targeted species in 2005–06 at DUE was hapuku with 18.9% of fishing trips. In 1998 (Bell 2001) hapuku was targeted by 60.3% of trips; however, our location boundaries were slightly different from his. Flounder were intensely targeted at inner Pelorus (PEI), with 31% of trips targeting this species in 2005–06.

The locations where the main species were caught were comparable between the surveys. Blue cod was the most commonly targeted and caught species in 1998 and in 2005–06. The 2005–06 survey found that locations outer Queen Charlotte, outer Pelorus, and Croisilles Harbour had the highest take of blue cod. This is similar to Bell (2001) who found outer Queen Charlotte, Croisilles Harbour, and D'Urville Island to have the highest blue cod take.

Snapper was consistently taken in the highest numbers from Kenepuru Sound during both surveys. Kahawai was also taken from similar locations during both survey years with the major areas being inner Pelorus (Nydia Bay in 1998) and Kenepuru Sound. Sea perch was mainly taken from D'Urville east and outer Queen Charlotte in 1998 whereas in 2005–06 it was taken from D'Urville west and outer Queen Charlotte. Note that the boundaries of these locations are slightly different between the surveys.

Despite being taken in much higher numbers in 2005–06 than in 1998 (Bell 2001), the locations where scallops were taken from have remained fairly constant. Bell found the main scalloping grounds in 1998 were Croisilles Harbour, outer and inner Pelorus and the inner Queen Charlotte. In 2005–06 the main locations for scalloping were also Croisilles Harbour and inner Queen Charlotte.

The catch per unit effort (CPUE) was estimated for eight key species from this survey. When compared to Bell's (2001) CPUE estimates it seems that the number of species being caught per hour has not changed greatly for any of the species. The catch rate for snapper was 0.22 fish per hour in 1998 and 0.27 in 2005–06. Catch rate for blue cod also was similar with 1.37 fish per hour in 1998 and 1.01 in 2005–06. Even scallops remained comparable with 40.11 scallops per hour in 1998 and 50.65 in 2005–06. It should be noted, however, that the catch record is only for volunteer diarists and not for the general fishing population of the Marlborough Sounds. It is likely that diarists are more active and

perhaps better, fishers than the average Marlborough Sounds fisher, so the overall catch rates may be biased high.

In summary, characterisation of the diarists describes Marlborough Sounds' fishers as mainly New Zealand European males, aged 41–50 years. They fish mainly in the summer (December to April) using rod and reel from a private boat. Blue cod is still the major recreational species both targeted and caught in the Marlborough Sounds and this fish is targeted mainly with rod and reel from a private boat. Other key species targeted and caught are snapper, scallops, and lobsters. The methods used to target these key species and the locations where they are mainly caught and kept from have not changed greatly between 1998 (Bell 2001) and this survey 7 years later. Despite the reduction in the bag limit for blue cod, most fishers still target this species primarily; however, the number caught and kept has reduced in line with the legal requirements. There has been a large increase in the number of scallops taken by the diarists between the surveys. Overall there were three times more scalloping trips by the 2005–06 diarists and three times more scallops taken than in 1998. The scallops are still being taken from similar locations, and the CPUE has not changed greatly. Fishers are still putting in the same amount of effort per species for approximately the same amount of return.

3. BLUE COD AND SNAPPER HARVEST ESTIMATES

3.1 Fisheries assessed

The second and third objectives of this programme were to estimate the recreational harvests of key species in the Marlborough Sounds, and of snapper in SNA 7 (Marlborough Sounds, Tasman Bay and Golden Bay). Blue cod was the most commonly caught species in all areas except the inner Marlborough Sounds, where snapper, spotties, and many other species were landed in low numbers (Figure 3). The results for the Marlborough Sounds areas broadly reflect those reported by diarists (see Table 15). Consequently, harvest estimates were generated for blue cod and snapper. An assessment of the scallop harvest was not considered feasible as the open season mainly occurred during winter when little sampling was scheduled.

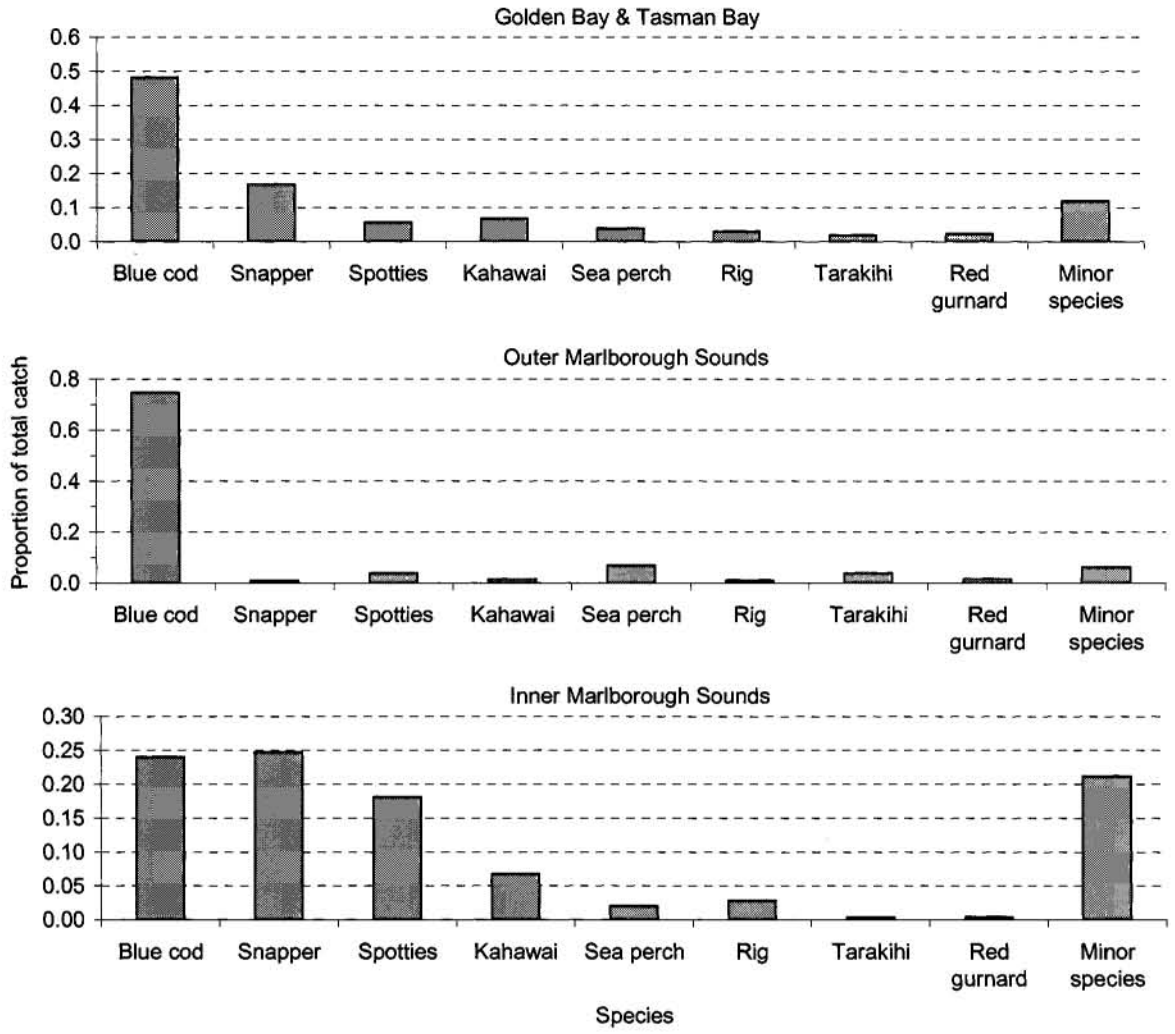


Figure 3: Proportion that each species contributes to the total number of finfish encountered by boat ramp interviewers from Golden bay, Tasman Bay, and the inner and outer Marlborough Sounds.

3.2 Aerial-access methodology overview

The methods used to estimate area specific harvest estimates for blue cod and snapper followed those of Hartill et al. (2006) as follows.

Daily harvest estimates, collected according to a randomised, temporally stratified design, were weighted together appropriately to give either seasonal or annual harvest estimates. Each daily harvest estimate was derived from an estimate of the level of instantaneous fishing effort at a given time of day, which was then used to scale up diurnal profiles of effort and related harvest.

Daily estimates of the level of instantaneous fishing effort were derived from counts of recreational fishing boats made by an observer flying at 500 feet. On the same day, fishers were interviewed at key boat ramps between approximately dawn and dusk, and these data were used to generate diurnal profiles of relative fishing effort (boats or people fishing) and harvest (weight or number of fish). The ratio of the number of boats fishing (i.e, fishing parties) as observed from the air at a given time, relative to the number of interviewed fishing parties claiming to be fishing at that time, was used to scale up the profiles mentioned above. These scaled profiles were integrated (i.e, the area under the "curve" was summed) and the resulting daily estimates of effort and harvest were weighted together to produce larger scale temporal harvest estimates based on the original random stratified sample design.

The analytical approach used is discussed throughout the next few sections to provide a framework for the survey results. A more succinct description of the analytical approach is given in appendix 1 of Hartill et al. (2006), which includes mathematical formulae.

3.3 Temporal stratification

The highly variable nature of recreational fishing effort was accommodated in a stratified sampling design based on fisher behaviour relative to the conventional working week (weekend/public holiday vs midweek day-types) and season (summer – 1 December 2005 to 30 April vs winter – 1 May 2006 to 30 November 2006). Fishing effort is generally higher and more variable (in an absolute sense) during the summer when catch rates are higher, daylight hours peak, and weather conditions are generally more favourable for recreational fishing. Most sampling effort was therefore allocated to this seasonal stratum (Table 23).

Table 23: Aerial-access sample design for both the summer (1 December 2004 to 30 April 2005) and winter (1 May to 30 November 2005) seasons.

Season	Temporal strata	No. of days in strata	Days flown	Sampling intensity
Summer	Midweek days	99	8	0.10
	Weekends/holidays	52	16	0.26
Winter	Midweek days	150	5	0.03
	Weekends/holidays	64	11	0.19

The number of days flown in each stratum were loosely based on the design used previously in QMA 1 (Hartill et al. 2006) in which the seasonal split of sampling effort was based on a parametric optimisation of midweek and weekend fishing effort estimates, collected during summer flights over the Hauraki Gulf in 1994.

3.4 Spatial stratification

Although instantaneous counts provide unbiased estimates of fishing effort (Pierce & Bindman 1994), the time taken to census the entire Marlborough Sounds/Tasman Bay/Golden Bay area in a single flight would necessitate a progressive count methodology, which has inherent biases that are difficult to overcome reliably (Hoenig et al. 1993). We therefore spatially stratified the survey area into smaller areas which are readily defined by local landmarks apparent from 500 ft (Figure 1). Counts of vessels within each of these sub-areas can be treated as instantaneous counts, as the time taken for an aircraft to traverse any of these was less than 30 minutes.

Mid-day counts of recreational fishing vessels were made by an observer in a fixed-wing aircraft at an altitude of 500 ft, which is the minimum altitude permissible under civil aviation regulations. Each flight was about 4.5 hours long, and covered the inner and outer Marlborough Sounds, Croisilles Harbour in the west, Port Underwood in the east, and the waters around D'Urville Island. Golden and Tasman Bay were also included in this flight as part of Objective 3.

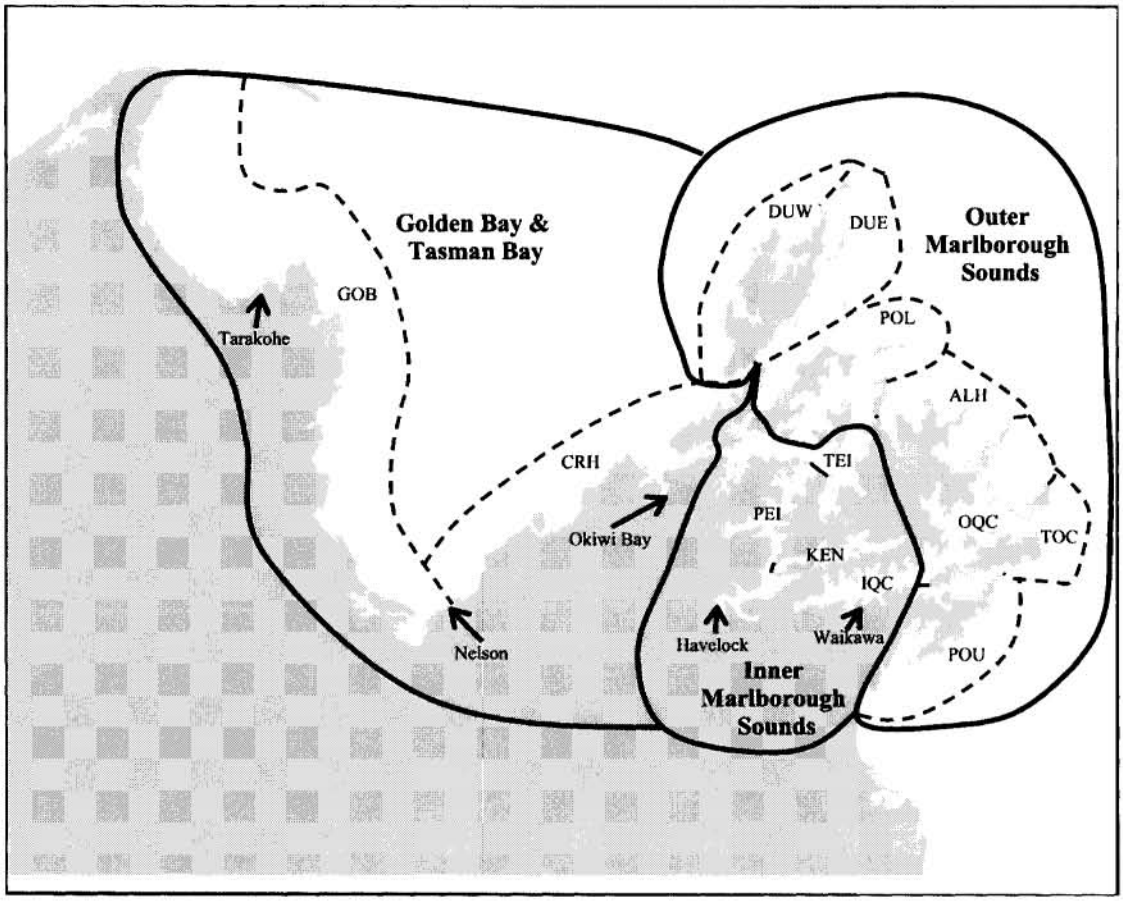


Figure 4: Spatial stratifications used for the three regions assessed: Golden/Tasman Bay, the Inner Marlborough Sounds and the Outer Marlborough Sounds. Areas of water defined by solid lines are those for which harvest estimates were calculated. Dashed lines and three letter codes denote smaller sub-areas which were commonly used by aerial observers and boat ramp interviewers. Place names with arrows denote the locations of surveyed ramps

Spatial strata were combined into three larger zones for analysis; Golden Bay/Tasman Bay, the Inner Marlborough Sounds, and the Outer Marlborough Sounds. The selection of spatial strata groupings was determined by species catch compositions (see Figure 4) and geographical proximity. Initially, the inner and outer Marlborough Sounds strata were combined into a singe analytical zone, but a review of the boat ramp data highlighted marked differences in snapper catch rates between inner and outer strata, and these were ultimately treated as two separate zones.

3.5 Aerial overflights – estimating instantaneous fishing effort

On each randomly predetermined survey day, flights over the study area began at about 9.30 am, weather permitting. Flights followed roughly the same route each time, based upon the need to cover the survey area as efficiently as possible.

The aerial observer used standard laminated maps to record the approximate positions of all boats thought to be involved in stationary recreational fishing activity, and noted the time at which their plane passed from one area to another. Pilots acted as secondary observers, counting all boats on their side of the plane. This necessitated clear communication between the two parties, as to who was counting which boats in which areas, with overall responsibility resting with the primary observer. Route navigation was left to the pilot, although intervention by the observer was sometimes necessary when they felt that the area was not being covered to their satisfaction, or when the pilot was not

affording the observer the best possible view of most of the boats. The same observer was used on all flights.

Boats were classified as trailer boats (T, usually with outboards and of trailerable size), launches (L), yachts (Y), charter boats (C, usually based on the number of visible fishers and the general appearance of the boat), or kayaks (K). Boats which were underway were ignored, as were stationary boats obviously involved in non-line fishing activity, such as swimming or picnicking close inshore. The observer and pilots were instructed to count boats as fishing when there was any doubt. Daily environmental conditions were also recorded by each observer.

Very few fishers appeared to fish from yachts and kayaks, although the former are more likely to employ trolling methods to catch pelagic species such as kahawai, because of their suitable cruising speed. Counts of charter boats used here are probably underestimates, as only boats with at least six to eight fishers which appeared to be equipped for large numbers of fishers, were so classified by airborne observers. Charter boats with fewer occupants would have been classified as either trailer boats or launches.

In Golden Bay/Tasman Bay about 90% of the vessels counted by the aerial observer were trailer boats (Table 24). In the Inner Marlborough Sounds about 80% of the vessels were trailer boats, with launches accounting for most of the remainder.

In the Outer Marlborough Sounds, the percentage of boats considered to be trailer boats was much lower (about 60%) with launches being far more common. The lower incidence of trailer boats in the outer Sounds has implications for the accuracy of harvest estimates for this area, as the catch data used in the analysis are derived solely from trailer boats returning to boat ramps. For analytical purposes it is assumed that the catch of launch-based fishers is the same as that caught by those fishing from trailer boats. If this is not the case, however, the resultant bias could be appreciable given the relative size of the launch fleet. Many of the vessels fishing in the outer sounds may originate from the Wellington area, and would not have been encountered by boat ramp interviewers.

Table 24: Proportions of vessel types counted by aerial observers in each analytical zone by season and day type.

		Summer		Winter	
		Weekend	Midweek	Weekend	Midweek
Golden Bay & Tasman Bay	Trailer boat	460	70	159	16
	Yacht	9	2	5	0
	Launch	44	2	13	3
	Charter boat	0	0	0	0
	Kayak	2	3	0	0
Outer Marlborough Sounds	Trailer boat	586	161	238	43
	Yacht	26	8	7	1
	Launch	305	54	96	36
	Charter boat	24	10	15	7
	Kayak	1	0	0	1
Inner Marlborough Sounds	Trailer boat	320	62	105	22
	Yacht	10	1	2	1
	Launch	79	6	16	7
	Charter boat	3	0	1	1
	Kayak	2	0	0	0

For the most part, only trailer boats return to boat ramps, and we therefore used information on the relative number of fishers in other types of boats to re-scale aerial counts of non-trailer borne vessel types. The data used for this transformation of launch, yacht, charter boat, and kayak counts were those collected during an on the water survey of boat type occupancy, as part of a series of eight on-the-water surveys conducted in the Hauraki Gulf in 2003–04 (Hartill et al. 2006). These results suggested that average occupancy rates were: trailer boats, 2.5 fishers; launches, 2.9 fishers; yachts, 2.6 fishers; charter boats, 10.4 fishers; kayaks, 1.6 fishers. All charter boat counts, for example, were multiplied by 10.4/2.5, to account for the higher occupancy of this vessel type relative to that encountered at boat ramps, i.e, trailer boats. In doing this we assumed that vessel type has no influence on either catch rate or fishing duration.

Consistent patterns were evident in the spatial and temporal distribution of fishing vessels counted by aerial observers. Fishing effort was generally highest in the summer months, and, within a season, higher on weekends and public holidays (Figure 5). On most days, over half of the fishing effort observed took place in the Outer Marlborough Sounds, much of it distant from surveyed boat ramps. About 25% of the recreational vessels observed from the air were in Golden Bay/Tasman Bay, but the spatial concentration of boats was highest in the Inner Marlborough Sounds, where about 20% of the fishing effort took place. Fishing effort was highly variable from day to day, within any temporal/spatial stratum, and this is thought to be largely due to local weather conditions (as suggested by Watson & Hartill (2005)).

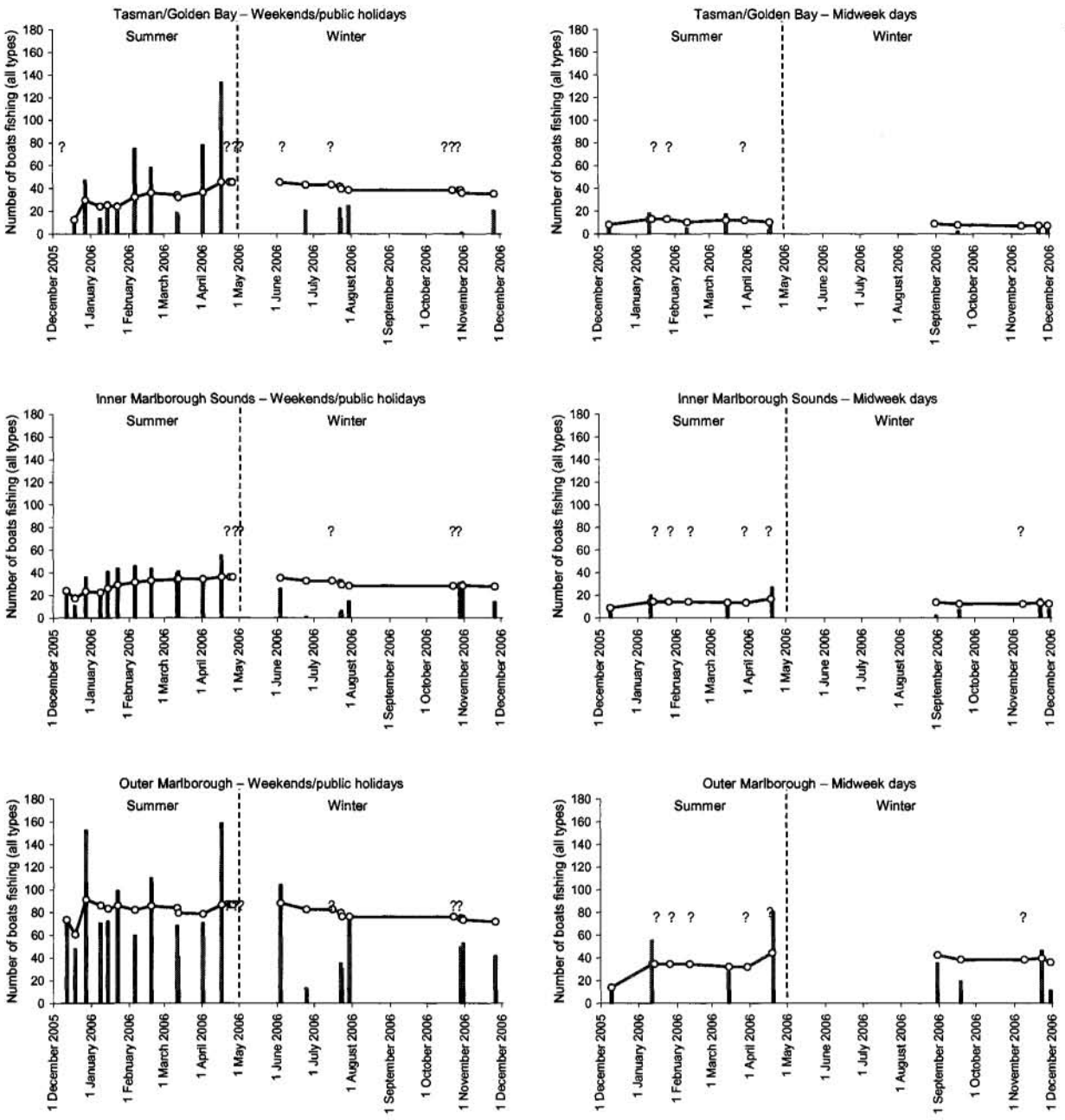


Figure 5: Counts of recreational fishing boats (all vessel types combined, shown as bars) made by airborne observers on late morning flights during weekends/public holidays (top panel) and midweek days (bottom panel) by analytical zone. Running averages are given for each season, denoted by open circles. Question marks indicate days on which low cloud prevented aerial counts of recreational fishing vessels.

Flights were cancelled on 12 of the randomly preselected days due to low cloud (signified by "?" in Figure 5). Estimates of the number of boats fishing at midday are required for all survey days, however, as cancellations were weather dependent, and not random. The estimated numbers of boats that would have been counted from the air on these days were, therefore, based on the relationship between aerial counts and numbers of boats which were fishing at the time of the overflight which returned to surveyed ramps on those days (Figure 6).

Initial regressions of flight counts of vessels against counts from boat ramps indicated that the inclusion of data from public holidays resulted in very poor levels of correlation. This is probably because public

holidays are usually associated with long weekends, when many fishers go away on overnight trips, and do not return to a ramp after a day's fishing. Cancelled flights did not fall on public holidays, however, and predicted flight counts were derived from regressions which did not include data from public holidays.

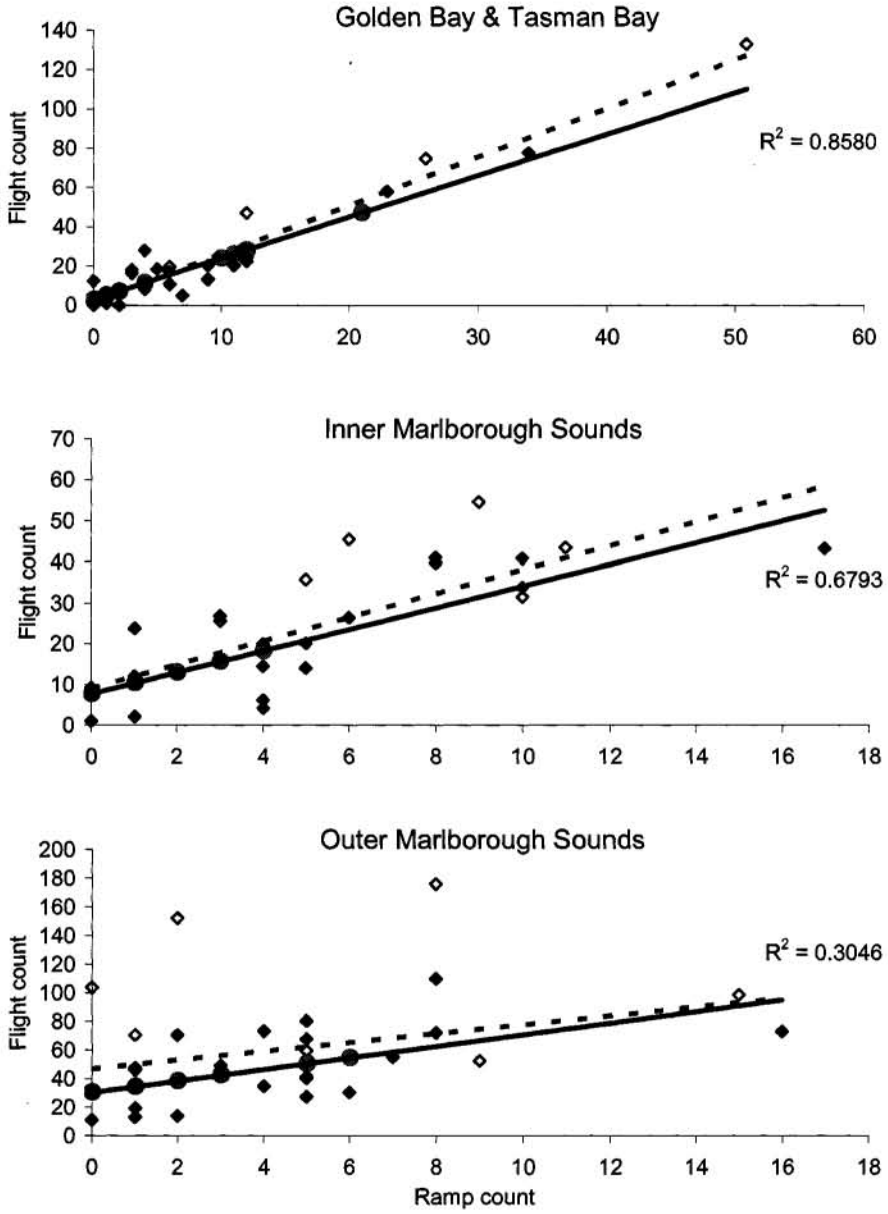


Figure 6: Relationships between daily counts of the number of boats observed from the air and those estimated from boat ramp data at the time at which the aerial flight took place. These relationships were used to predict the number of vessels that would have been counted on those days when flights were cancelled due to low cloud. Dashed lines are associated with regressions based on all available data (open and solid symbols), whereas solid lines denote regressions based on non-public holiday days (solid symbols). These later regressions were used to predict boat counts on unflown days, which are denoted by large solid circles.

3.6 Boat ramp interviews – estimation of diurnal fishing profiles

The analytical approach used to estimate harvest tonnages follows that of Hartill et al. (2006). In this approach we use boat ramp interview data to create profiles of how the intensity of fishing effort (and

associated catch) changes during each of the days sampled. These profiles, however, are based on a subsample of the daily fisher population, as we conducted interviews only at some of the ramps used. It is, therefore, necessary to scale up our profiles by instantaneous counts of all fishing vessels, which are made from the air, at a given time of day. Because of this, boat ramp interviews must take place on the same days that aerial overflights take place, to ensure that the daily profiles are scaled up by concurrently collected aerial estimates of total effort.

The original sampling design was closely adhered to at most boat ramps, with only one or two sessions missed at a few ramps due to staffing issues (which were not weather related, Table 25). The timing of each day's 13 hour survey period varied with the time of year, given the timing of dawn and dusk, but always ended at dusk (very few fishers return to boat ramps in the early morning, before the first interviewer would normally arrive).

Table 25: Summary statistics, by region, by boat ramp, of the number of days surveyed, total hours of interviewing, numbers of parties and fishers interviewed, and numbers of blue cod and snapper landed at these boat ramps during interview sessions.

Ramp	Season	Days worked	Hours worked	Parties interviewed	Fishers interviewed	Blue cod landed	Snapper landed
Havelock	Summer	24	321	358	1 018	357	545
Havelock	Winter	16	194	90	284	146	17
Waikawa	Summer	23	307	211	718	587	1
Waikawa	Winter	16	194	112	335	224	1
Tarakohe	Summer	22	291	245	915	197	340
Tarakohe	Winter	16	194	177	647	49	15
Nelson	Summer	24	320	386	1 164	156	749
Nelson	Winter	16	194	92	273	43	30
Okiwi Bay	Summer	24	325	516	1 994	1 983	498
Okiwi Bay	Winter	16	194	254	1 016	992	69
Marlborough Sounds		40	1 016	771	2 355	1 314	564
Golden/Tasman Bay		40	1 516	1 670	6 009	3 420	1 701
Total		40	2 531	2 441	8 364	4 734	2 265

Interviews of recreational fishers followed the format of those undertaken in all previous boat ramp surveys conducted by MAF Fisheries and NIWA, ensuring that data were collected in a consistent and rigorously tested manner. Data collected as part of these interviews can be used to determine where fishing took place, at what time, which methods were used, and which fish were caught by each fisher, for any given combination of method, area, and time. In most cases the interviewer was able to measure the catch, but when this was not possible, a count or estimate of the number of fish of each species was made and the nature of that count recorded. From these data it is possible to estimate average catch rates (or harvest rates when fish were landed) in terms of the number of fish, and the weight of fish (via length weight relationships).

Interviewers were instructed to note the time at which each boat returned to the ramp, and classify them as: interviewed, interviewed but not fishing, refused but fishing, refused (activity unknown), or, not interviewed. From these data it is possible to establish how many boats approached the ramp over any period, and to estimate how many had been fishing, given the proportion of those who had been

spoken to that claimed to have been fishing. At busy times of day, the interviewer may have been unable to interview all fishing parties approaching the ramp. In such instances, the interviewer was instructed to select boats at random.

Profiles of fishing effort and catch (relative to the time of overflight) were generated by combining interview data collected from those fishers fishing in each area, on each survey day. Each survey day was divided up into 15 minute bins, and effort profiles were generated by counting up the number of fishers (or boats) who reported fishing activity within each 15 minute period. The shape of an effort profile will be distorted when the interviewer noted that a boat returned to the ramp, but was unable to interview the occupants to determine whether, and for how long, the party had been fishing. When there was no information available for an uninterviewed boat, we adopted the expedient of assuming that the behaviour and any catch on board the following boat reflected that of the uninterviewed boat. In our analysis, therefore, data for uninterviewed boats were generated from that of subsequent interviewed boats. This should not introduce any bias in terms of the number, or nature, of boats fishing (or otherwise) if the boats were originally selected at random.

Catch profiles were also generated by apportioning each fisher's catch (numbers and weight of fish) across the period fished, and summing these apportioned values within each 15 minute bin. Daily fishing, or harvest estimates, were derived by summing up the area underneath a profile, and scaling up this number by the ratio of the aerial count by the number of interviewed boats which claimed to be fishing in that area at the time of the overflight.

Although interview rates at "all day ramps" mostly resulted in sufficient data to yield meaningful diurnal profiles of fishing effort for most areas, this was not always the case. Usually this was because very little fishing activity took place in some weather conditions, and concomitantly, few fishers were encountered on ramps on these days. Insufficient data were more common for weekdays, when less fishing took place. The criteria for deciding whether or not meaningful profiles of fishing effort and catch rates could be derived are given in Table 26.

Table 26: Criteria used to determine whether a day's boat ramp interview data should be used to generate a daily profile of fishing effort in a given area.

1) Ignore a day's data if boat ramp interviewers did not encounter any fishers who had fished in a given area.

2) Ignore all boat ramp interview data on those days when the number of boats observed from the air in a given area was 30 or more times greater than the number of boats interviewed at boat ramps which reported fishing activity at the time of the overflight.

3) Ignore interview data on those days when aerial counts suggested that one or more boats fished a given area, but none of the fishers encountered by boat ramp interviewers reported any fishing activity in that area at the time of the overflight.

Often, more than one of these criteria applied. Combinations of days and areas where these criteria were met, and profiles were subsequently generated from boat ramp interview data, are given in Table 27. For most combinations of temporal and spatial strata, profiles were generated for most, if not all, of the survey days. There were insufficient data to create viable profiles for most of the winter/midweek survey days, however, which is unfortunate given the limited number of days surveyed. Two of the days randomly preselected as winter weekend days fell on public holidays (Queen's Birthday and Marlborough Anniversary Day), and hence were reallocated to the winter weekend/public holiday strata.

On days when there were insufficient interview data to build meaningful profiles, profiles were still required to describe changes in catch and effort throughout the day. These were derived by averaging the profiles from those days when there were enough data for profiling purposes, from the same seasonal/day type/area stratum. For most of the days when average profiles were required, their use

would have created very little bias in the final harvest estimate, as aerial counts suggest that very little catch was taken on these days, regardless.

Table 27: Days where there were sufficient boat ramp data available in a given area to satisfy the criteria given in Table 25. Data meeting these criteria were used to generate diurnal profiles of fishing effort and catch, which were scaled by aerial counts of fishing boats.

Season	Day type	Date	Tasman Bay/ Golden Bay	Inner Marlborough Sounds	Outer Marlborough Sounds
Summer	Weekend/ Public holiday	11/12/05	Y	Y	–
		18/12/05	–	Y	–
		27/12/05	Y	Y	Y
		08/01/06	Y	Y	–
		14/01/06	Y	Y	Y
		22/01/06	Y	Y	Y
		05/02/06	Y	Y	Y
		18/02/06	Y	Y	Y
		11/03/06	Y	Y	Y
		12/03/06	Y	Y	Y
		01/04/06	Y	Y	Y
		16/04/06	Y	Y	Y
		23/04/06	–	Y	Y
		25/04/06	–	Y	Y
		29/04/06	Y	Y	–
	Weekday	09/12/05	Y	–	–
		11/01/06	Y	Y	Y
		13/01/06	Y	Y	Y
		25/01/06	–	–	Y
		10/02/06	Y	Y	Y
		14/03/06	Y	Y	Y
		29/03/06	Y	Y	–
		18/04/06	–	Y	–
		19/04/06	Y	Y	Y
Winter	Weekend/ Public holiday	03/06/06	Y	Y	Y
		24/06/06	Y	–	Y
		15/07/06	Y	Y	Y
		22/07/06	Y	Y	Y
		23/07/06	Y	Y	Y
		29/07/06	Y	Y	Y
		22/10/06	Y	–	–
		28/10/06	Y	Y	Y
		29/10/06	–	–	–
		30/10/06	Y	Y	Y
		25/11/06	Y	Y	Y
	Weekday	30/08/06	Y	Y	–
		18/09/06	–	–	–
		08/11/06	–	–	–
		22/11/06	Y	–	Y
		29/11/06	Y	–	–

3.7 Blue cod and snapper harvest estimates

Area specific harvest estimates were generated for each species, for each survey day, by summing up the area under each species' catch profile. Daily harvest estimates were then generated by combining all spatial estimates calculated for a given day. These daily harvest estimates were averaged and weighted up on the basis of the number of days occurring in each seasonal/day-type stratum, which were combined to give annual regional harvest estimates.

Stratum specific variance estimates were generated by a bootstrapping procedure. Survey days from each seasonal/day-type/area stratum were selected with replacement. In turn, data from fishing parties interviewed on that day were selected with replacement, and were used to construct profiles of fishing effort, catch, and catch rate. Each bootstrapped profile was then scaled up by the aerial count on the associated day. When there were insufficient interview data for profiling on the selected day, profile data were selected at random from one of the stratum days which meet the criteria given in Table 26. Bootstraps were performed 1000 times, from which mean, median, and 5% and 95% percentile profiles were generated.

The aerial overflight methodology does not account for vessel-based harvests resulting from trolling, longlining, and set netting effort. We used region-specific boat ramp interview data on the number of blue cod and snapper landed by these methods to estimate appropriate scalars, which were then applied to overflight estimates. Only a small proportion of blue cod (Table 28) and snapper (Table 29) are taken by these methods. Other recreational harvests, which were not directly considered in our survey, were those associated with shore-based fishing methods such as surf casting, beach seining, and kite fishing. We used regional data on the method specific catch of blue cod and snapper from the 2000 telephone diary survey (Boyd et al. 2004) to estimate appropriate scalars to account for shore-based harvests (Tables 28 and 29). Only a small proportion of the catch of these species appears to be taken from the shore. Variances associated with both the indirectly assessed boat-based and shore-based telephone diary scalars were estimated by bootstrapping the underlying data sources 1000 times, and then applying these bootstrap scalars to the 1000 bootstrap estimates generated from the overflight survey (Appendices 6 and 7).

When all sources of harvest are taken into account, including that taken from the shore and by other miscellaneous boat based methods, we estimate that 148.6 t of blue cod and 42.6 t of snapper was landed by recreational fishers in 2005–06 (Tables 28 and 29). The c.v.s associated with these estimates were 0.16 and 0.17 respectively, which probably don't fully reflect the true level of variance that may be expected, given the diverse and complex nature of these fisheries.

Estimates for the Outer Marlborough Sounds are possibly less reliable than those derived for other fisheries, because of the nature of fishing effort in this area. Launch-based fishers account for a much greater proportion of the fishers in this area, yet very few of these fishers return to surveyed ramps. Further, many of the trailer boats observed from the air would have originated from baches and farms, and, on good days, from Wellington. We therefore made the implicit assumption that the fishers we encountered at surveyed ramps provided a representative sample of those fishers fishing from other boat types in other areas. This assumption may not hold true, but there is no cost-effective way of overcoming this deficiency, because of the dispersed and distant nature of this unassessed fishing component. All available ramps in the Marlborough Sounds were included in our survey. Our estimates will describe most, but not all, of the recreational harvest from BCO 7 and SNA 7. Harvests from areas on the west coast of the South Island and, on the east coast, from Cloudy Bay to the Clarence River are not assessed, but are not thought to be substantial.

Previous harvest estimates derived from national telephone diary surveys have ranged from 239 t (1996; Bradford (1998) to 288–335 t (1999–2000; Boyd & Reilly (2002), 2000–01; Boyd et al. (2004) for blue cod and 177 t (1996) to 125–134 t (1999–2000 and 2000–01) for snapper. Comparisons of our overflight estimates with previous telephone diary estimates should be made with caution for two reasons. Firstly, levels of recreational catch and effort can potentially change over time in response to stock status and economic and environmental conditions. Secondly, the telephone/diary estimates are not considered

reliable, and are inconsistent with each other. The 1999–2000 and 2000–01 surveys overcame a soft refusal bias associated with the 1996 survey, which theoretically should have resulted in a roughly threefold increase in harvest estimates (yet this was not the case for either of these two species). For snapper, dividing the 1999–2000 and 2000–01 harvest estimates by three gives an estimate similar to that derived from our aerial overflight survey, conducted five years later, but this is probably coincidental.

Much uncertainty currently surrounds recreational harvest estimates, and they should all be used with some caution. The aerial overflight estimates should be more accurate, however, as they are mainly based on direct observations of catch and effort, and are not subject to the range of unquantifiable biases which indirect estimation methods, such as telephone/diary surveys, are prone to.

Table 28: Estimates of the 2004–05 recreational harvest of blue cod in the three regions of BCO 7 (Tasman Bay/Golden Bay, Inner Marlborough Sounds, and Outer Marlborough Sounds) for each stratum in summer (1 December 2005 to 30 April 2006) and winter (1 May 2006 to 30 November 2006) with associated bootstrap statistics. Estimates from all three areas are combined and scaled to account for harvests by vessel based fishing methods which were not estimated by the overflight approach, harvests by shore based fishers.

Aerial overflight estimates

Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
Golden Bay & Tasman Bay	Summer	Weekend/PH	57	0.181	0.164	0.161	0.075	0.266	
		Midweek	94	0.049	0.046	0.045	0.014	0.091	
	Winter	Weekend/PH	63	0.121	0.131	0.128	0.070	0.197	
		Midweek	151	0.008	0.009	0.008	0.003	0.019	
		2005–06 harvest		23.8	23.4	23.2	15.8	31.3	0.20
Inner Sounds	Summer	Weekend/PH	52	0.009	0.009	0.009	0.004	0.015	
		Midweek	99	0.003	0.003	0.002	0.000	0.007	
	Winter	Weekend/PH	63	0.024	0.023	0.021	0.004	0.048	
		Midweek	151	0.019	0.021	0.021	0.009	0.036	
		2005–06 harvest		5.2	5.5	5.4	3.1	8.1	0.28
Outer Sounds	Summer	Weekend/PH	52	0.859	0.896	0.835	0.514	1.440	
		Midweek	99	0.337	0.374	0.356	0.212	0.613	
	Winter	Weekend/PH	63	0.324	0.336	0.330	0.226	0.471	
		Midweek	151	0.071	0.078	0.078	0.030	0.129	
		2005–06 harvest		111.8	119.2	115.7	88.2	158.9	0.20

Combined aerial overflight estimates scaled to account for other sources of effort

Area	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
All areas combined 2005–06 harvest	140.9	148.1	145.0	116.0	187.3	0.16
Scaled to account for 2.2 % of catch by unassessed vessel based methods[1]	144.0	151.3	148.2	118.6	191.4	0.16
Scaled to account for 3.4 % of catch[2] by shore based methods	148.6	156.2	153.	122.4	197.6	0.16

1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for the BCO 7 in 2000.

Table 29: Estimates of the 2004–05 recreational harvest of snapper in the three regions of SNA 7 (Tasman Bay/Golden Bay, Inner Marlborough Sounds, and Outer Marlborough Sounds) for each stratum in summer (1 December 2005 to 30 April 2006) and winter (1 May 2006 to 30 November 2006) with associated bootstrap statistics. Estimates from all three areas are combined and scaled to account for harvests by vessel based fishing methods which were not estimated by the overflight approach, harvests by shore based fishers.

Aerial overflight estimates

Area	Season	Day-type	Number of days	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
Golden Bay & Tasman Bay	Summer	Weekend/PH	57	0.186	0.163	0.163	0.101	0.231	
		Midweek	94	0.100	0.090	0.080	0.020	0.189	
	Winter	Weekend/PH	63	0.009	0.009	0.008	0.002	0.021	
		Midweek	151	0.001	0.002	0.000	0.000	0.003	
		2005–06 harvest		20.7	18.4	17.9	10.7	28.0	0.30
Inner Sounds	Summer	Weekend/PH	52	0.131	0.138	0.135	0.085	0.198	
		Midweek	99	0.070	0.073	0.071	0.038	0.114	
	Winter	Weekend/PH	63	0.011	0.010	0.009	0.001	0.023	
		Midweek	151	0.003	0.004	0.002	0.000	0.010	
		2005–06 harvest		15.2	15.8	15.7	11.1	21.0	0.20
Outer Sounds	Summer	Weekend/PH	52	0.025	0.018	0.016	0.005	0.036	
		Midweek	99	0.024	0.014	0.012	0.002	0.031	
	Winter	Weekend/PH	63	0.013	0.013	0.010	0.000	0.032	
		Midweek	151	0.000	0.000	0.000	0.000	0.000	
		2005–06 harvest		4.5	3.1	3.0	1.3	5.2	0.38

Combined aerial overflight estimates scaled to account for other sources of effort

Area	Estimate	Mean of bootstraps	Median of bootstraps	5th percentile	95th percentile	c.v.
All areas combined 2005–06 harvest	40.4	37.3	36.9	27.6	48.2	0.17
Scaled to account for 5.3 % of catch by unassessed vessel based methods1	41.3	38.1	37.7	28.2	49.3	0.17
Scaled to account for 8.9 % of catch2 by shore based methods	42.6	39.4	38.9	29.1	50.9	0.17

1 - Derived from concurrent boat ramp interview data.

2 - Derived from telephone diary survey data collected for the SNA 7 in 2000.

4. CONCLUSIONS

- The diary survey characterisation study describes Marlborough Sounds' fishers as mainly NZ European males, aged 41–50 years. They fish mainly in the summer (December to April) using rod and reel from a private boat.

- Blue cod is still the major recreational species both targeted and caught in the Marlborough Sounds and this fish is targeted mainly with rod and reel from a private boat. Other key species targeted and caught are snapper, scallops, and lobsters.

- The frequency of trips to defined locations indicated that in the 1998 (Bell 2001) survey, locations with high frequency included Croisilles Harbour, Trio Islands, Kenepuru Sound, and outer Queen Charlotte Sound. In the 2005–06 survey, Kenepuru, Croisilles, and Inner Pelorus Sound were visited most frequently by the diarists.

- The CPUE was estimated for eight key species from this survey and compared to Bell's (2001) CPUE estimates. The catch rate for snapper was 0.22 fish per hour in 1998 and 0.27 in 2005–06. Catch rate for blue cod also were similar with 1.37 fish per hour in 1998 and 1.01 in 2005–06.

- Aerial overflights were used to estimate recreational harvests of blue cod and snapper in Golden Bay/Tasman Bay, Inner Marlborough Sounds, and the Outer Marlborough Sounds between 1 December 2005 and 30 November 2006. The annual harvest estimates obtained from this survey were 140.9 t for blue cod and 40.4 for snapper.

- The aerial overflights assessed only harvests by fishers fishing from stationary vessels. We indirectly assessed other sources of harvest by applying relative scalars to allow for fishing from moving vessels, or vessels deploying longlines (via concurrent boat ramp data) and fishing from the shore (telephone diary data).

- When all these harvest sources are combined, the 2005–06 recreational harvest estimates for the area assessed increased to 148.6 t for blue cod and 42.6 for snapper.

- The harvest estimates for the Outer Marlborough Sounds may not be as accurate as those for other areas, as a large proportion of the fishers in this area fish from launches and other vessels which are not readily encountered during aerial overflight surveys.

5. ACKNOWLEDGMENTS

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Appendix 1: Questionnaire given to diary participants before starting the survey. This was administered either in person or over the telephone.

MARLBOROUGH SOUNDS RECREATIONAL FISHING SURVEY-DIARISTS

In the last 12 months, how many times have you personally gone saltwater fishing, diving or shellfish gathering in or around the Marlborough Sounds (Croisilles Harbour to Port Underwood) ?

☐ Never ☐ 1-5 times ☐ 6-15 times ☐ 16-30 times ☐ 31 or more ☐ Don't know

When you go fishing, diving or shellfish gathering around the Marlborough Sounds, how many people do you usually go with?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ varies ☐ Don't know

In the last 12 months which fishing methods have you used?

☐ Rod or handline from a private boat (jigs, bait, poppers, trolling etc)
☐ Rod, handline or longline fishing from a charter boat
☐ Longline fishing from a private boat
☐ Shore fishing with a rod or handline
☐ Shore fishing with a longline (kon-tiki or kite)
☐ Diving from a private boat
☐ Diving from a charter boat
☐ Diving from the shore
☐ Dredging
☐ Set netting/beach seining
☐ Hand gathering
☐ Potting
☐ Spearing
☐ Other

Which sex?
☐ Male ☐ Female

Which age group?
☐ under 14 yrs ☐ 15-20 yrs ☐ 21-30 yrs ☐ 31-40 yrs ☐ 41-50 yrs ☐ 51-60 yrs
☐ 61-70 yrs ☐ 71 yrs or older

Which ethnic group do you identify with?

☐ European/NZ Pakeha ☐ NZ Maori ☐ Pacific groups ☐ Other

Appendix 1 continued: Questionnaire given to diary participants before starting the survey. This was administered either in person or over the telephone.

NIWA is carrying out a year long (Dec 05-Dec 06) study on saltwater recreational fishing in and around the Marlborough Sounds. We need people to keep a diary recording when and where they went fishing and what they caught. Would you be prepared to keep one of these fishing diaries? It is to be filled out each time you go fishing. It does not matter whether you go out 1 or 100 times or whether you caught nothing or 50 fish.

Name:

Address:

Phone numbers:

Diary number:

Appendix 2: Example of the diary pages 2-4. Page four was repeated 40 times and was able to be torn out and sent back in a self addressed envelope.

Welcome

Thank you for participating in the 2005/2006 recreational fishing survey in and around the Marlborough Sounds region (Croisilles to Port Underwood). This information will provide us with a characterisation study of the fishery. A previous diary survey in 1999 will be compared to this study so we can look at changes in targeting of finfish species that may have occurred in response to the reduction in the recreational daily bag limit for blue cod.

General information

1. Please fill in a page of the diary each time you go fishing or gather shellfish in or around the greater Marlborough Sounds area (see map on diary pages).
2. Record your individual catch and fishing effort. **Do not** record the catch and effort of anyone else (even if they are on the same boat).
3. Please keep the diary from the 1st December 2005 until 1st December 2006 (unless told otherwise).
4. It is important to fill out the diary for every trip, **even if you catch nothing.**
5. Only record one trip on each page. If you fished at more than one site please treat each site as a separate trip and fill out a trip record for each site.
6. Fill out a trip record for each different fishing method that you use and each different site you fish at. (eg. three dive sites will require three trip reports or if you put out a set net, then go handlining you will require two trip reports).
7. If you are a commercial fisher, please do not include any trips where you caught fish or shellfish to sell.
8. Please send in your trip records every three months. We will send a letter or ring you asking you to send in a trip record for that period.
9. Please send in a trip record even if you didn't go fishing. Just write 'didn't go fishing' across a blank sheet and indicate what three month period you mean.. It is just as important to us that to know what times of the year people don't go fishing.
10. Any queries about the survey and diary, or if you need extra pages please don't hesitate to call Niki or Anna or write to NIWA Nelson, PO Box 893, Nelson.

EVERY 3-monthly return that we receive, whether it be blank (indicating you didn't go fishing) or detailing many trips, will go into a draw to win fishing equipment!

Appendix 2 continued: Example of the diary pages 2-4. Page four was repeated 40 times and was able to be torn out and sent back in a self addressed envelope.

NIWA Contacts

Niki Davey (Project leader)
03 545 7736 (office)
027 233 5336 (a/h)

Anna Bradley
03 545 7742 (office)

Filling in a trip record

1. Diary number-please make sure this is written on all the pages.
2. Date of trip-day/month/year
3. Hours spent fishing, diving, gathering shellfish. Please record to the nearest half hour you spent fishing. Do not include travel time or resting time. Also record the length of time the net, long line, pot was in the water.
4. Fishing method: Options
    1) Rod or handline from private boat (bait, jogs, poppers, trolling)
    2) Rod or handline from a charter boat
    3) Longline fishing from a privately owned boat
    4) Shore fishing with a rod or handline
    5) Shore fishing with a longline (eg Kon-tiki or kite)
    6) Diving from a privately owned boat
    7) Diving from a charter boat
    8) Diving from shore
    9) Dredging
    10) Set netting/gill netting
    11) Drag netting/beach seining
    12) Hand gathering
    13) Potting
    14) Spearing (flounder or other flats)
    15) Other (please specify)
5. Species targeted: Please list all the species of fish and shellfish you set out to catch. Please be as specific as possible. e.g. Red or Blue cod?
6. Species caught: Please record all species of fish and shellfish that you caught and killed. Also include any fish discarded dead or that you used as bait. Do not include any fish that you returned to the water alive. Please be specific when naming the species caught.
7. Number of species caught: Please record <u>only</u> your own catch (including those dead fish discarded or used as bait). However, if the catch was the result of a group effort (netting or dredging), please divide the catch evenly among the people involved, even if in reality some people received more than others, and record your share.
8. Remember to use a separate trip record page to record each trip you make. Make sure different fishing methods and different sites are on separate trip reports.
9. Please include any comments you may have on the trip report or include a separate sheet.

Appendix 2 continued: Example of the diary pages 2-4. Page four was repeated 40 times and was able to be torn out and sent back in a self addressed envelope.

TRIP RECORD

Diary Number: ____

Please use a separate trip record for each trip.

Date of Trip: ____/____/____

Hours spent fishing, diving, gathering etc: ____

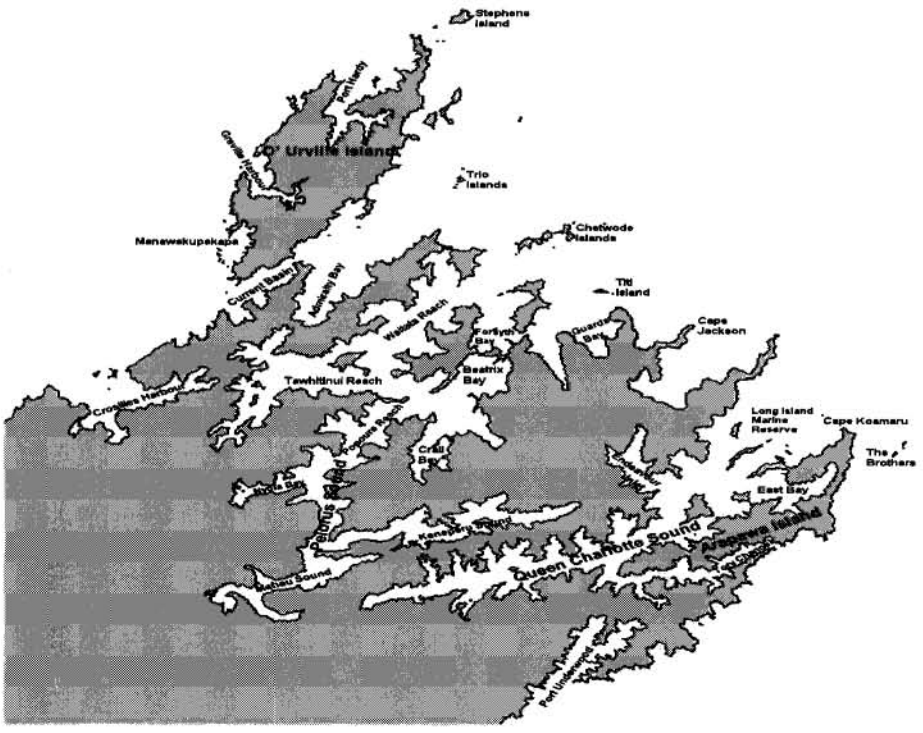
Site Fished: *On the map below please mark with an **'X'** (as accurately as possible) the site you tried to catch fish at during this trip. If you fished at more than one site, please use a separate trip record for each site. If you have trolled or dredged over a large area please shade that whole area of the map.*

General site description: ____

Type of fishing method: ____

If you used more than one fishing method on a trip, please treat each method as a separate trip and fill in a trip record for each method.

Species targeted:	Species caught:	No. caught and killed:



Appendix 3: Fishing methods used at the 12 locations in the Marlborough Sounds (2005–06). This is split into various quarters (1–4). Method 1=rod or handline; 2=rod or handline from charter boat; 3=longline fishing from private boat; 4=shore fishing with rod or handline; 5=shore fishing with a longline (kon-tiki or kite); 6=diving from a private boat; 7=diving from a charter boat; 8=diving from shore; 9=dredging; 10=set or gill netting; 11=drag netting / beach seining; 12=hand gathering; 13=potting; 14=spearing; 15=other (snorkelling).

Quarter	Method	CRH	DUW	DUE	POL	TEI	PEI	KEN	ALH	OQC	IQC	TOC	POU
1	1	63	39	34	49	52	61	111	23	72	22	36	12
	2	6	1	0	1	2	1	0	0	0	0	1	2
	3	11	2	2	4	11	0	0	1	1	1	1	0
	4	1	0	0	0	1	6	25	0	1	2	0	1
	5	0	0	0	1	0	3	1	0	0	0	0	0
	6	35	12	3	4	0	0	0	9	14	39	6	8
	7	2	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	1	1	1
	9	38	0	0	25	0	9	1	0	7	4	2	0
	10	2	1	0	0	2	31	0	3	1	0	8	7
	11	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	2	0	2	0	1	1	1	2
	13	0	0	0	0	0	0	0	0	1	0	0	0
	14	0	5	2	0	1	0	0	0	2	0	1	2
	15	0	0	0	1	0	0	0	0	3	0	1	2
2	1	36	28	17	17	31	25	38	9	55	15	34	3
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	2	0	1	1	1	0	1	0	0	0	0	0
	4	0	0	1	0	0	4	12	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	6	10	0	1	1	0	0	3	4	0	7	3
	7	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0
	10	2	1	4	0	1	22	11	2	1	0	3	3
	11	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	2	0	0	1	3	0	0
	13	0	0	0	0	0	0	0	0	0	0	0	0
	14	2	2	4	0	0	0	0	0	2	0	1	1
	15	0	0	0	0	0	0	0	0	2	0	0	0
3	1	18	23	16	33	8	10	5	6	59	14	14	15
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	1	0	0	0	0	0	0	0	0	0	1	0
	4	1	0	0	0	0	1	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	8	0	1	1	0	0	0	2	9	13	1	4
	7	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0
	9	22	0	0	5	0	5	0	0	3	9	0	0
	10	1	1	0	0	0	16	8	0	1	0	2	1
	11	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	2	0	3
	13	0	0	0	0	0	0	0	0	0	0	0	5
	14	0	3	3	0	0	0	0	1	0	0	0	0
	15	0	0	0	0	0	0	0	0	0	0	0	0
4	1	13	11	11	24	19	13	35	13	40	4	8	12

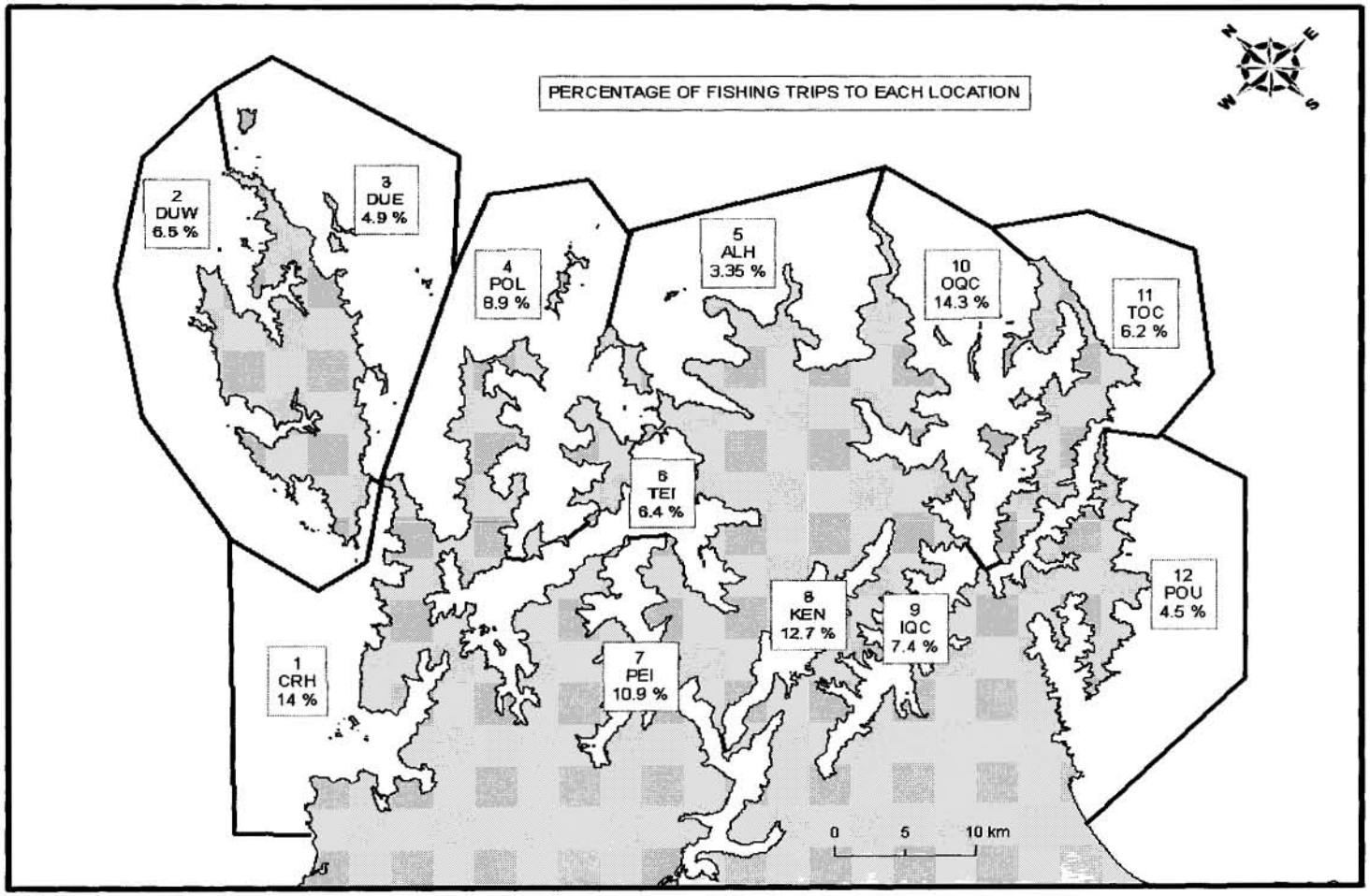
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	1	4	0	0	0	1	0	0	0
	4	0	0	1	0	0	4	15	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	6	1	0	6	0	0	0	0	12	24	3	5
	7	0	0	0	0	0	0	0	0	0	0	1	0
	8	0	0	0	0	0	0	0	0	0	0	0	0
	9	25	0	0	15	1	2	0	0	12	4	0	0
	10	0	0	0	0	0	20	8	0	1	0	0	4
	11	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	0
	13	0	0	0	0	0	0	0	0	0	0	0	0
	14	0	0	5	2	0	0	0	0	1	0	0	0
	15	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 4: Target species at the 12 locations in the Marlborough Sounds (2005–06). Percentages are shown and the main target is shown in bold and the second target species is shown in *italics*.

	ALH	CRH	DUE	DUW	IQC	KEN	OQC	PEI	POL	POU	TEI	TOC
Any fish	1.0	0.2	2.2	0.0	7.1	0.0	6.5	0.7	0.8	0.0	0.6	2.6
Blue Cod	**43.3**	*27.2*	**37.8**	**44.3**	*20.2*	0.7	**46.5**	12.5	**46.2**	**20.0**	**49.7**	**44.0**
Gurnard	2.9	4.5	1.6	0.0	1.2	0.0	2.2	0.0	0.8	0.6	2.8	1.0
Crayfish	*12.5*	9.7	2.2	11.0	0.6	0.0	6.5	0.0	3.6	*14.2*	0.0	*9.3*
Snapper	3.8	19.0	9.2	*16.2*	6.5	**75.5**	1.0	**43.8**	10.1	3.9	*35.2*	0.5
Kahawai	3.8	2.7	2.2	1.0	3.0	9.2	4.3	1.5	2.8	2.6	3.9	3.6
Scallops	1.0	**29.4**	0.5	0.0	**56.0**	0.0	*11.0*	6.3	*19.8*	0.6	0.6	2.1
Tarakihi	6.7	1.5	4.3	6.7	0.0	0.0	4.3	0.0	2.4	10.3	0.0	8.8
Kingfish	1.0	1.0	7.6	6.7	0.6	0.7	0.2	0.4	2.0	0.0	1.1	0.0
Barracouta	0.0	0.2	0.5	0.5	0.6	0.0	0.2	0.0	0.0	0.0	0.6	3.1
Scarlet wra	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0
Bluemoki	8.7	2.0	6.5	2.4	0.0	0.0	1.7	0.0	2.4	7.1	0.6	4.7
Jack mack	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.6	0.0
Spotty	0.0	0.2	0.0	0.0	0.0	0.3	1.7	0.0	0.0	0.0	0.0	2.6
Sea perch	1.9	0.2	1.1	1.0	0.0	0.0	4.3	0.0	3.2	1.3	0.0	2.6
Hapuku	9.6	0.0	*18.9*	8.1	0.0	0.0	4.3	0.7	3.2	9.0	1.1	7.3
Greyshark	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0
Flounder	0.0	0.5	0.0	0.0	0.0	*8.2*	0.5	*30.9*	0.0	4.5	1.1	0.0
YEM	0.0	0.2	0.0	0.0	1.2	0.7	0.0	0.7	0.0	0.0	0.0	0.0
Leatherjacl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.5
Butterfish	3.8	0.5	4.9	1.4	0.0	0.0	1.9	0.0	1.2	11.0	0.6	3.6
Blackfoot p	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.4	1.9	0.0	0.5
Mussels	0.0	0.0	0.0	0.0	1.8	1.0	1.7	0.0	0.0	5.2	0.6	0.5
Trevally	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Kina	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.4	0.0	0.0	1.0
Rig	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.5
Oyster	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.7	0.0	2.6	0.6	0.0
Conger eel	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maori chief	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Pipi	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.6	0.0	0.0
Cockle	0.0	0.0	0.0	0.0	1.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Tuatua	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.6	0.0	0.0
Stargazer	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Red cod	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sole	0.0	0.2	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0
Salmon	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0

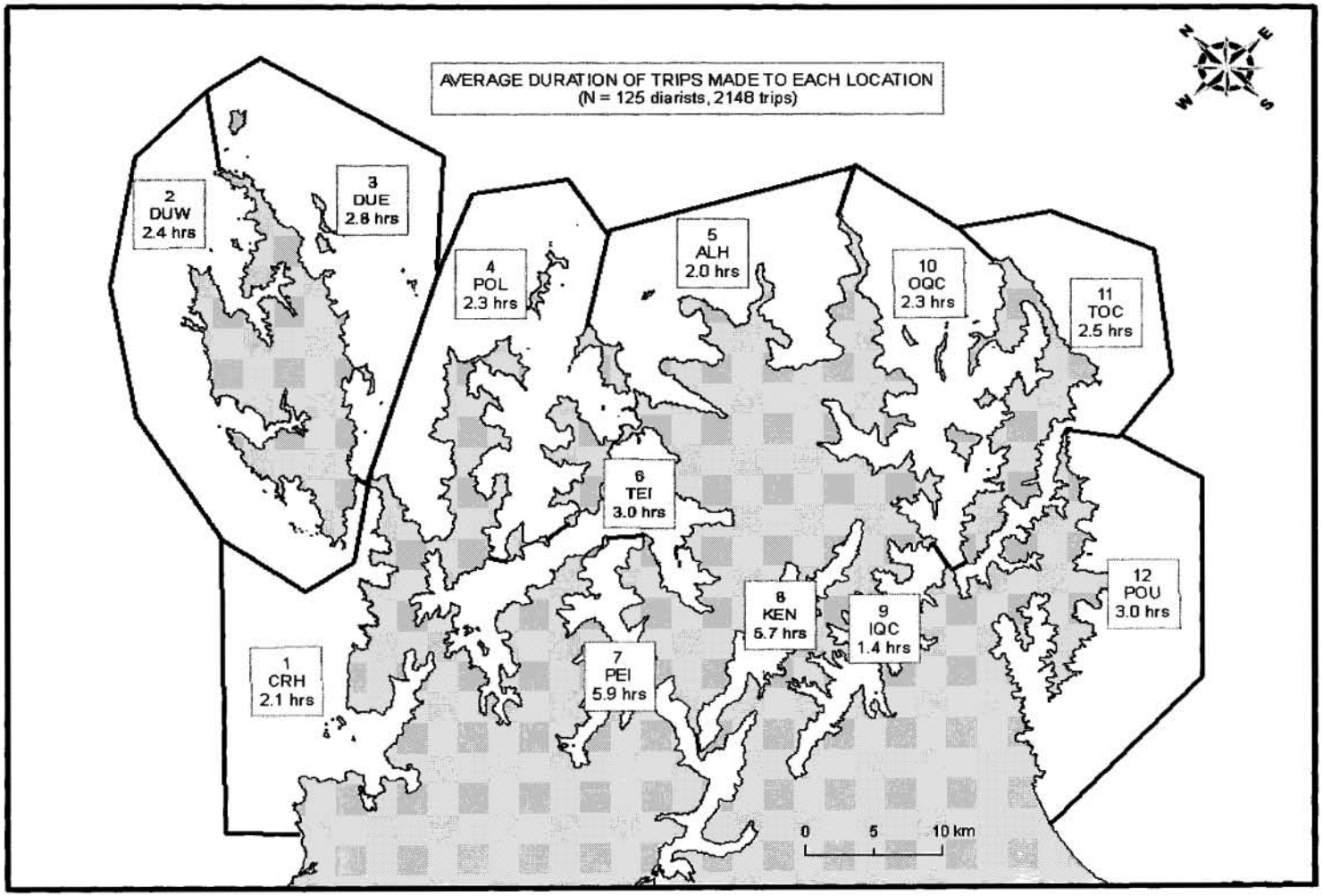
Appendix 5: Maps of results from recreational diaries

Appendix 5a: Percentage of fishing trips to each location made by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005–November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



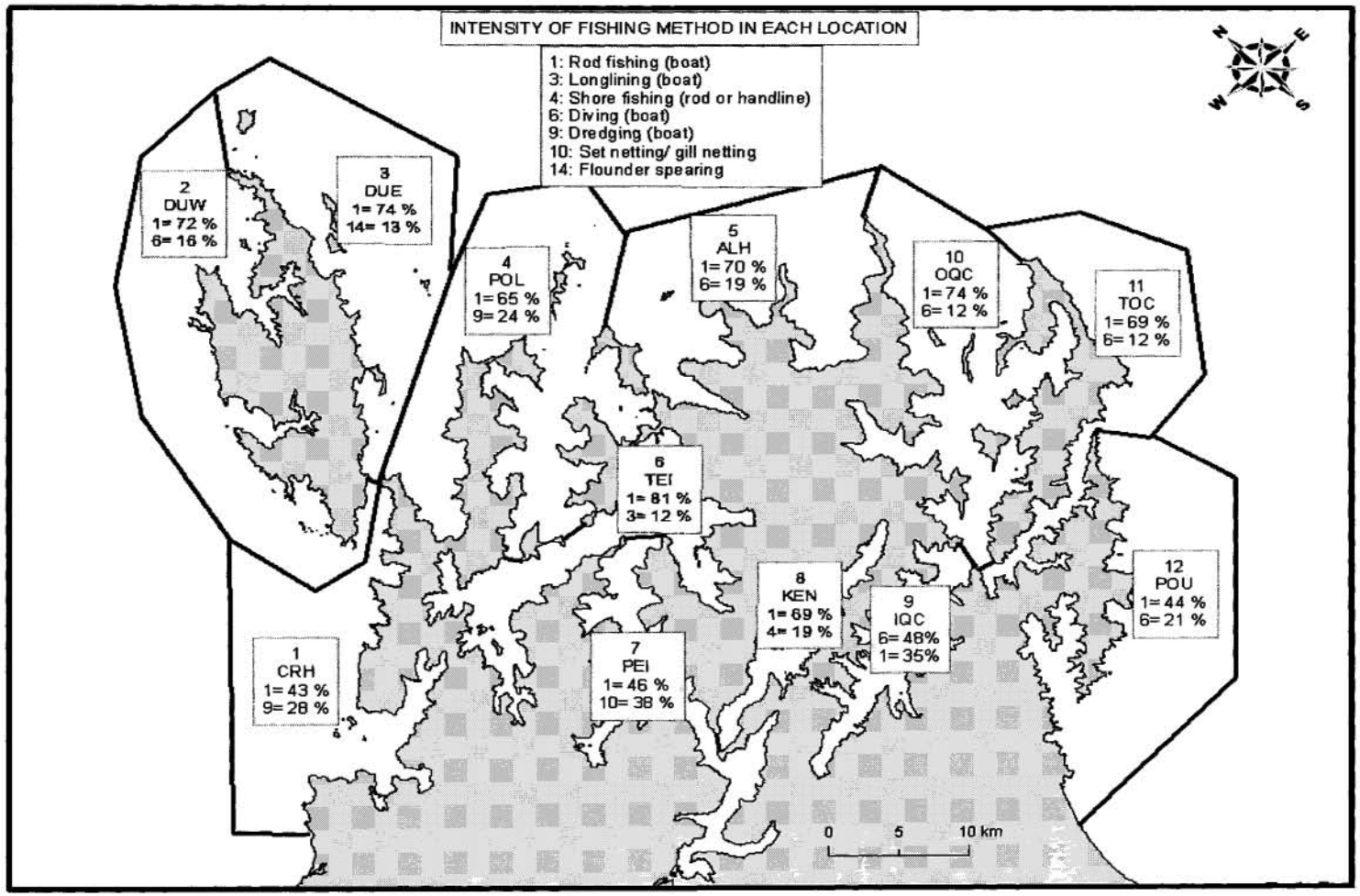
Appendix 5: continued:

Appendix 5b: Average duration of fishing trips to each location made by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



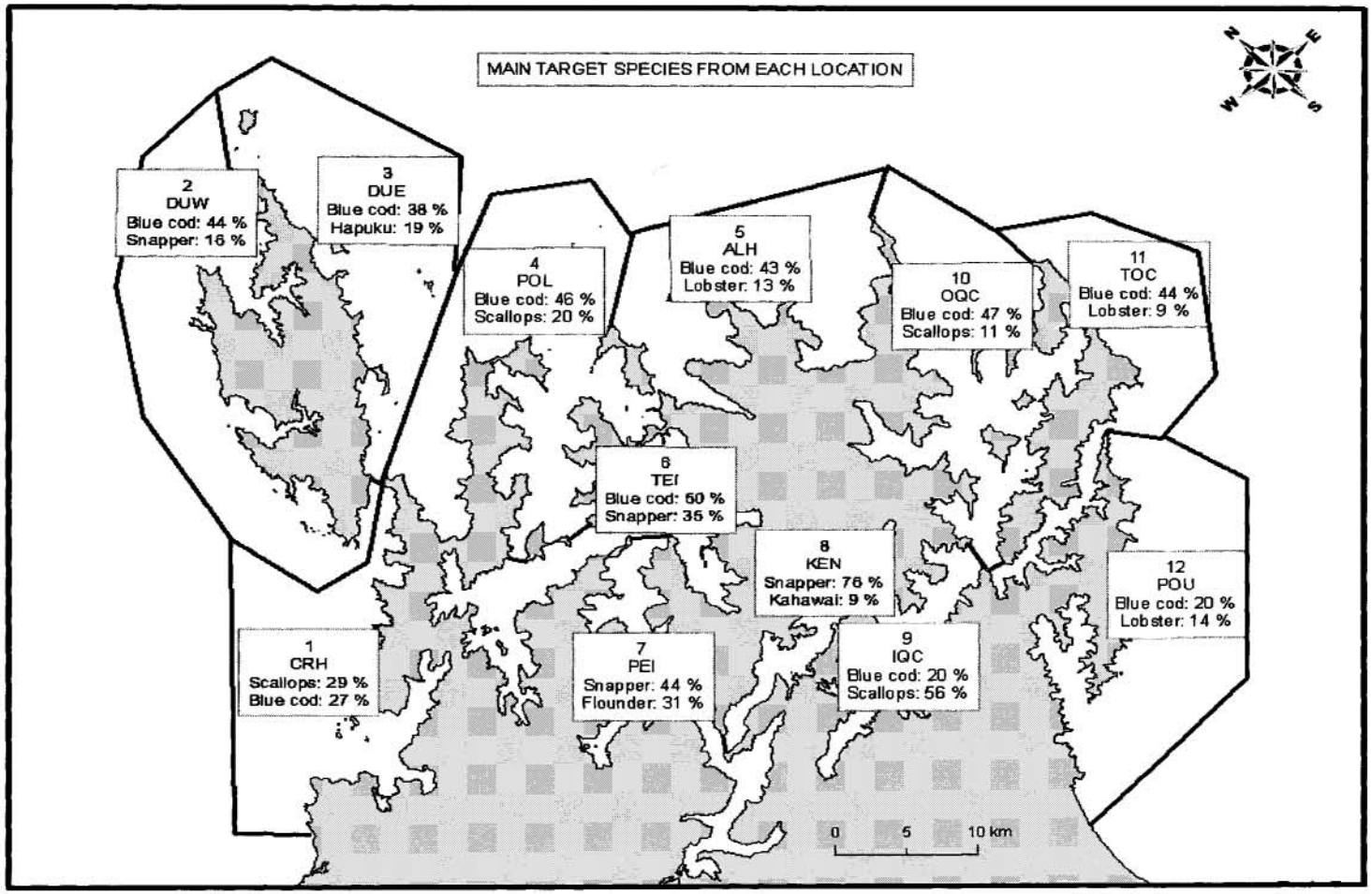
Appendix 5: continued:

Appendix 5c: Intensity of fishing method at each location. The two main methods used at each location are shown. Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



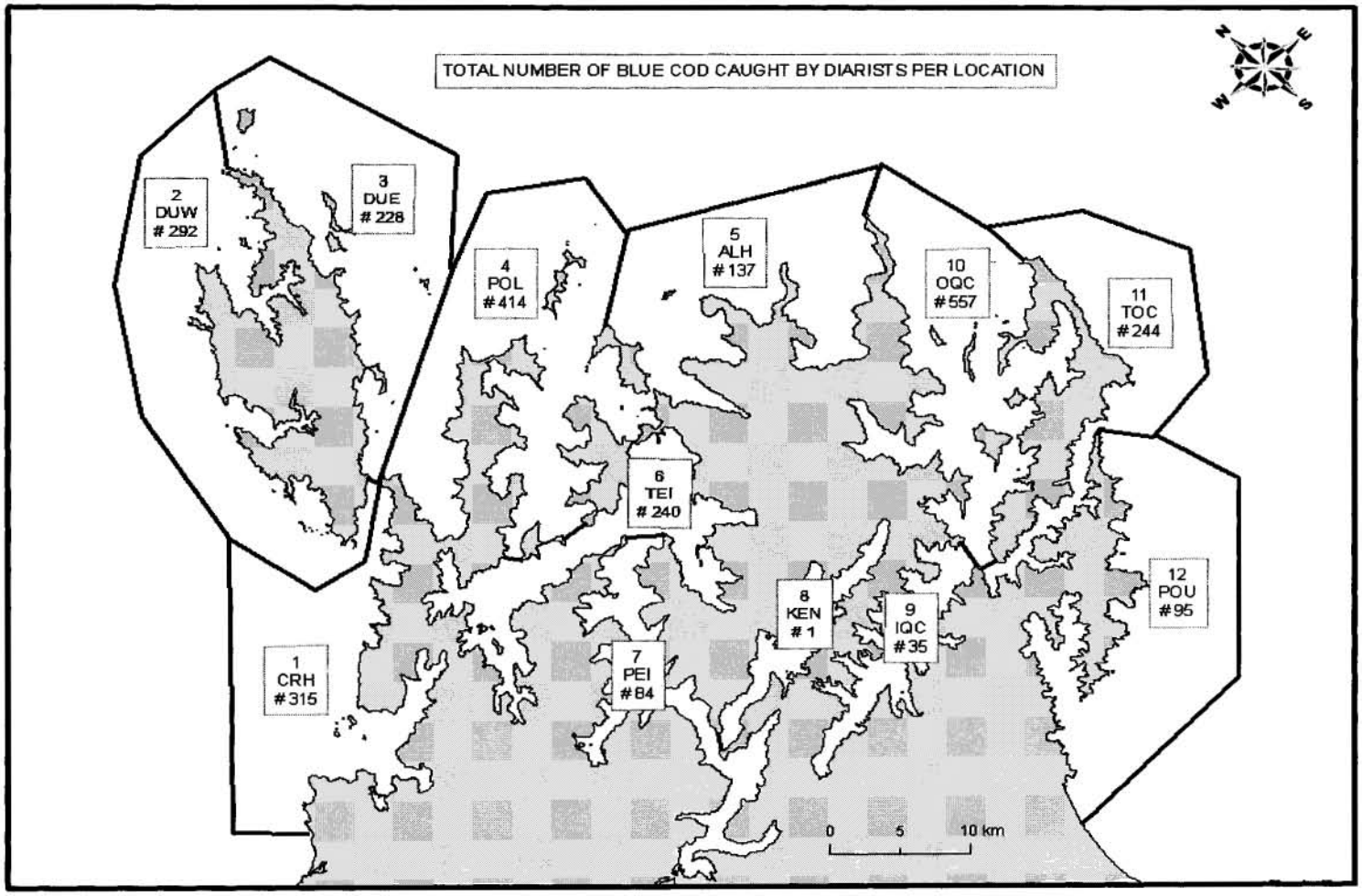
Appendix 5: continued:

Appendix 5d: Major target species in each location. Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



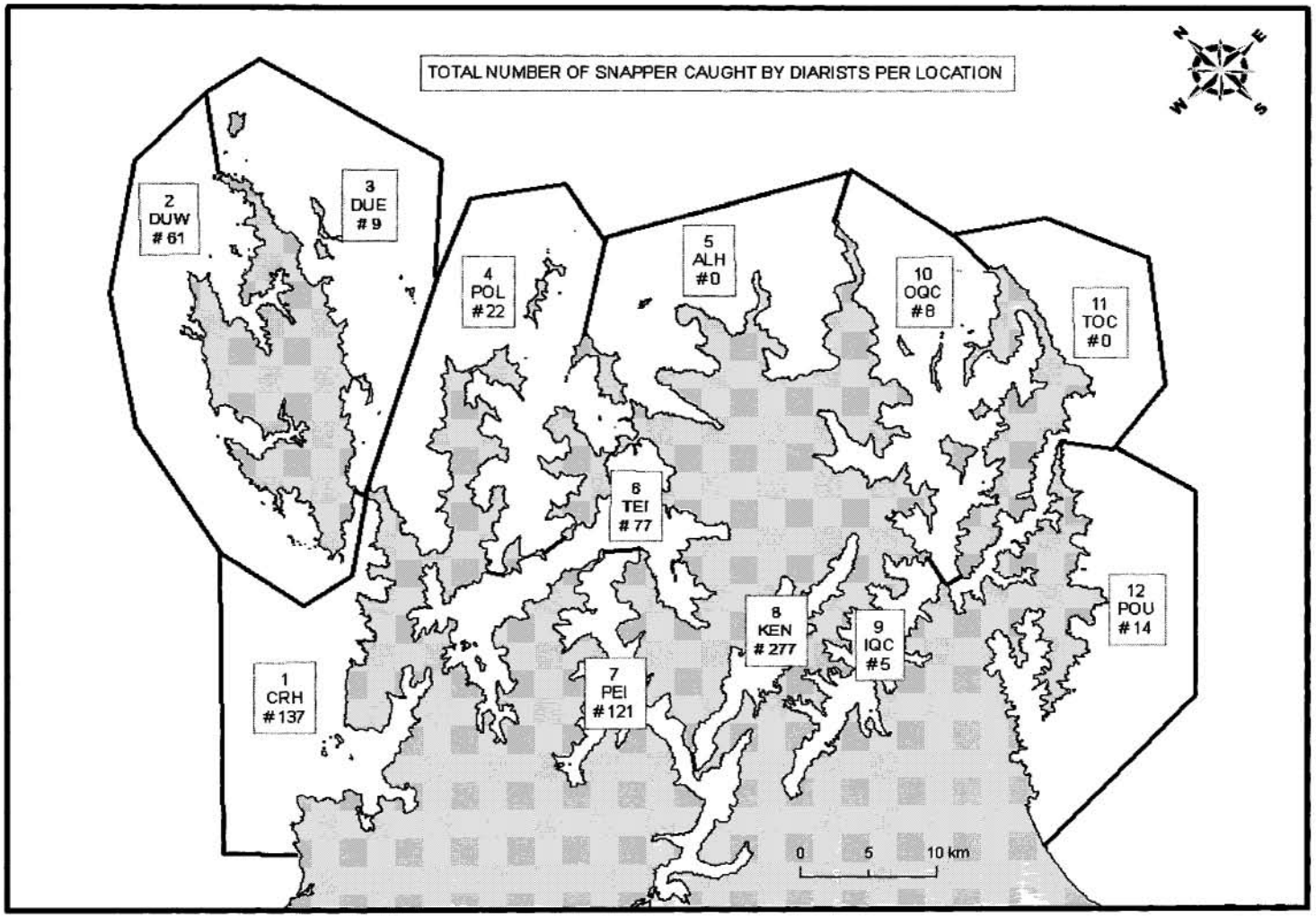
Appendix 5: continued:

Appendix 5e: Total number of blue cod caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



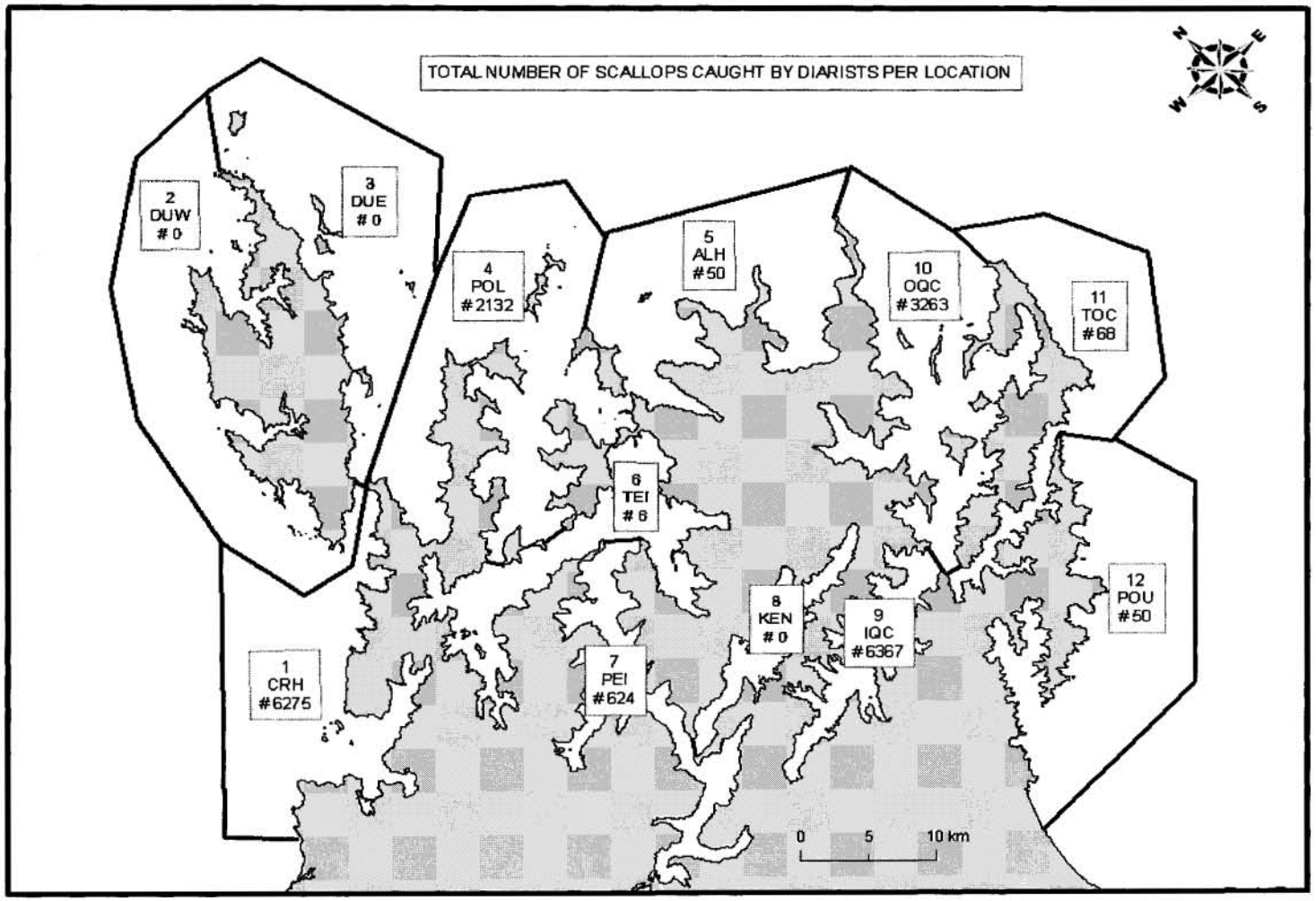
Appendix 5: continued:

Appendix 5f: Total number of snapper caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



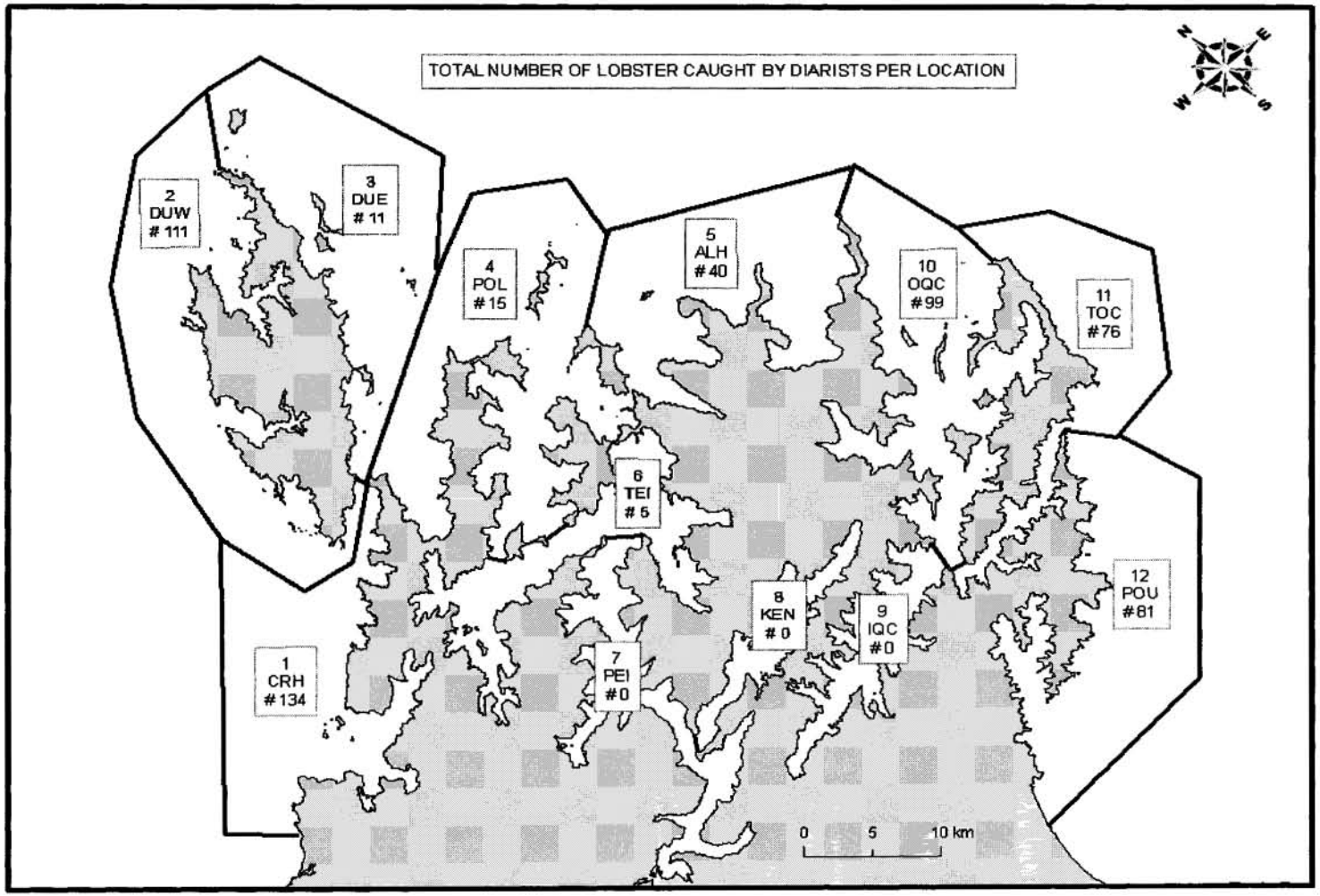
Appendix 5: continued:

Appendix 5g: Total number of scallops caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



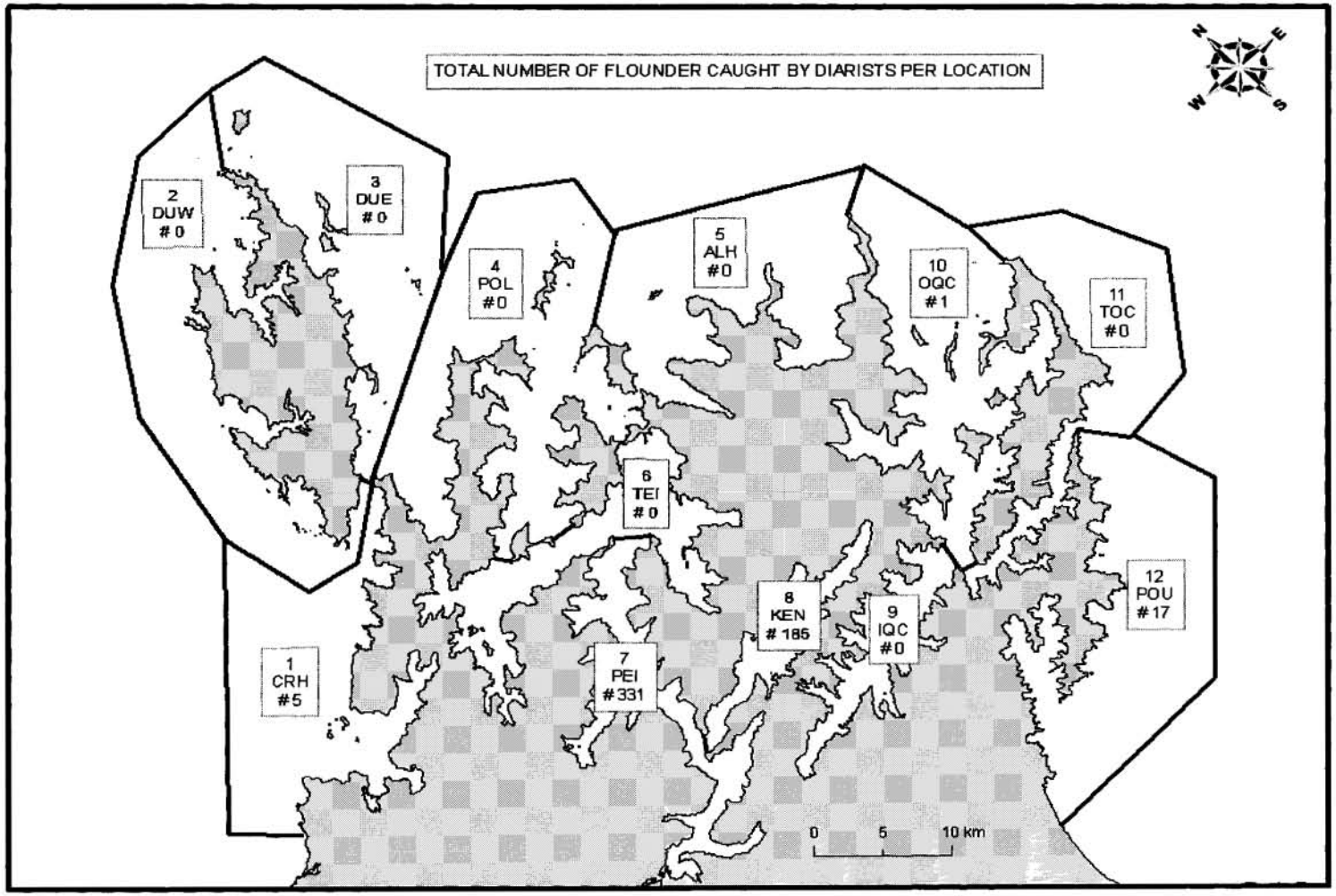
Appendix 5: continued:

Appendix 5h: Total number of lobster caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



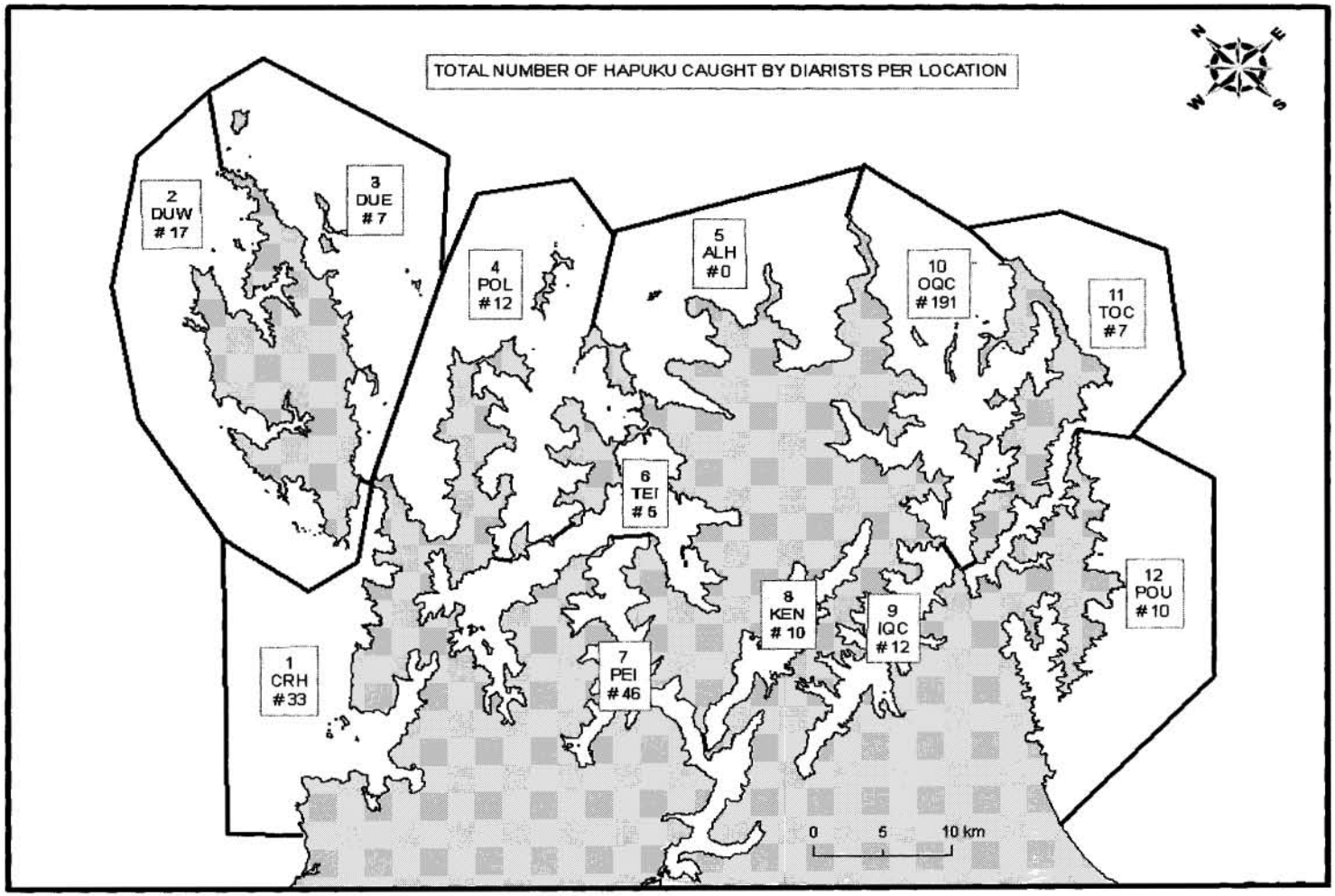
Appendix 5: continued:

Appendix 5i: Total number of flounder caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



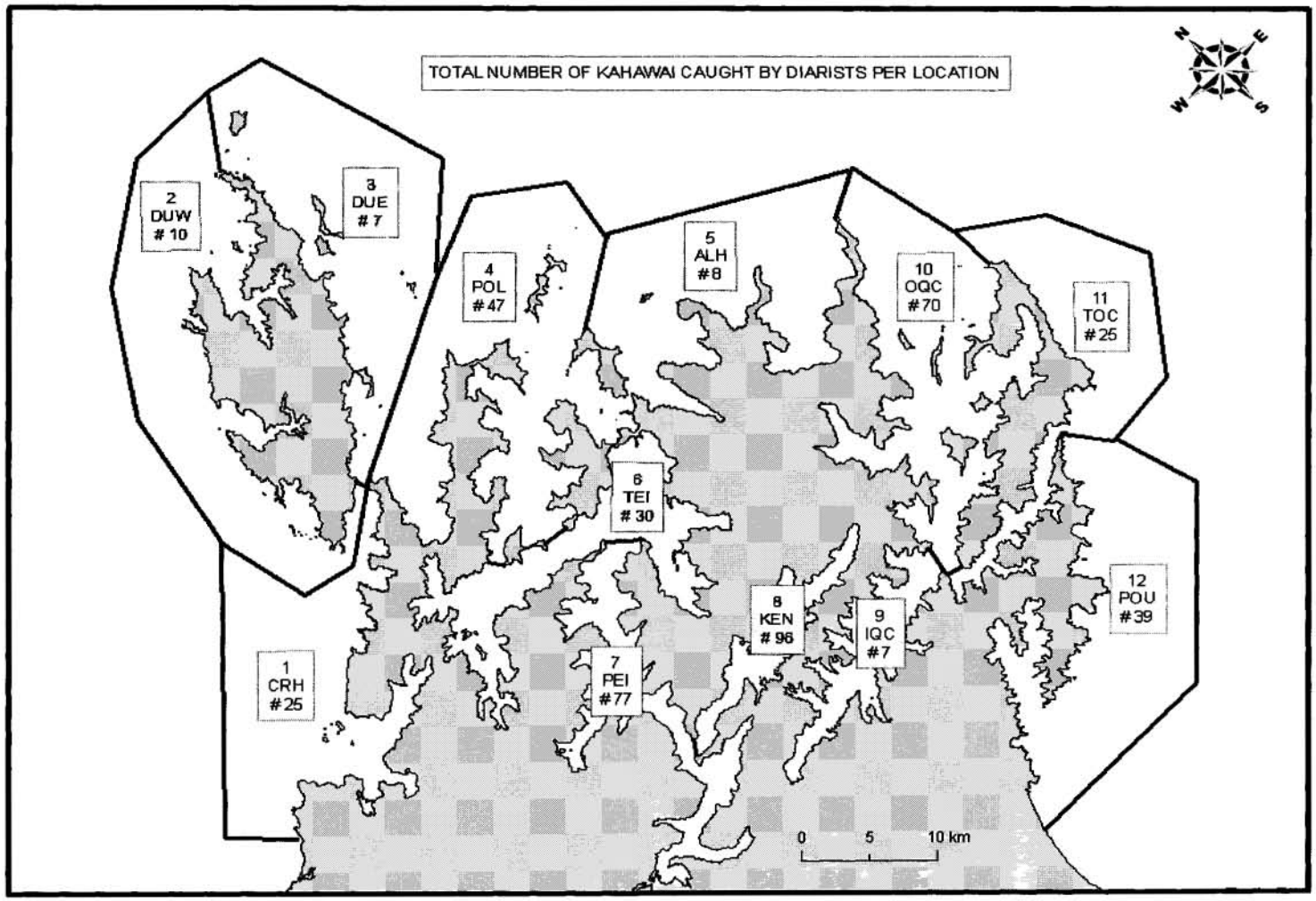
Appendix 5: continued:

Appendix 5j: Total number of hapuku caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



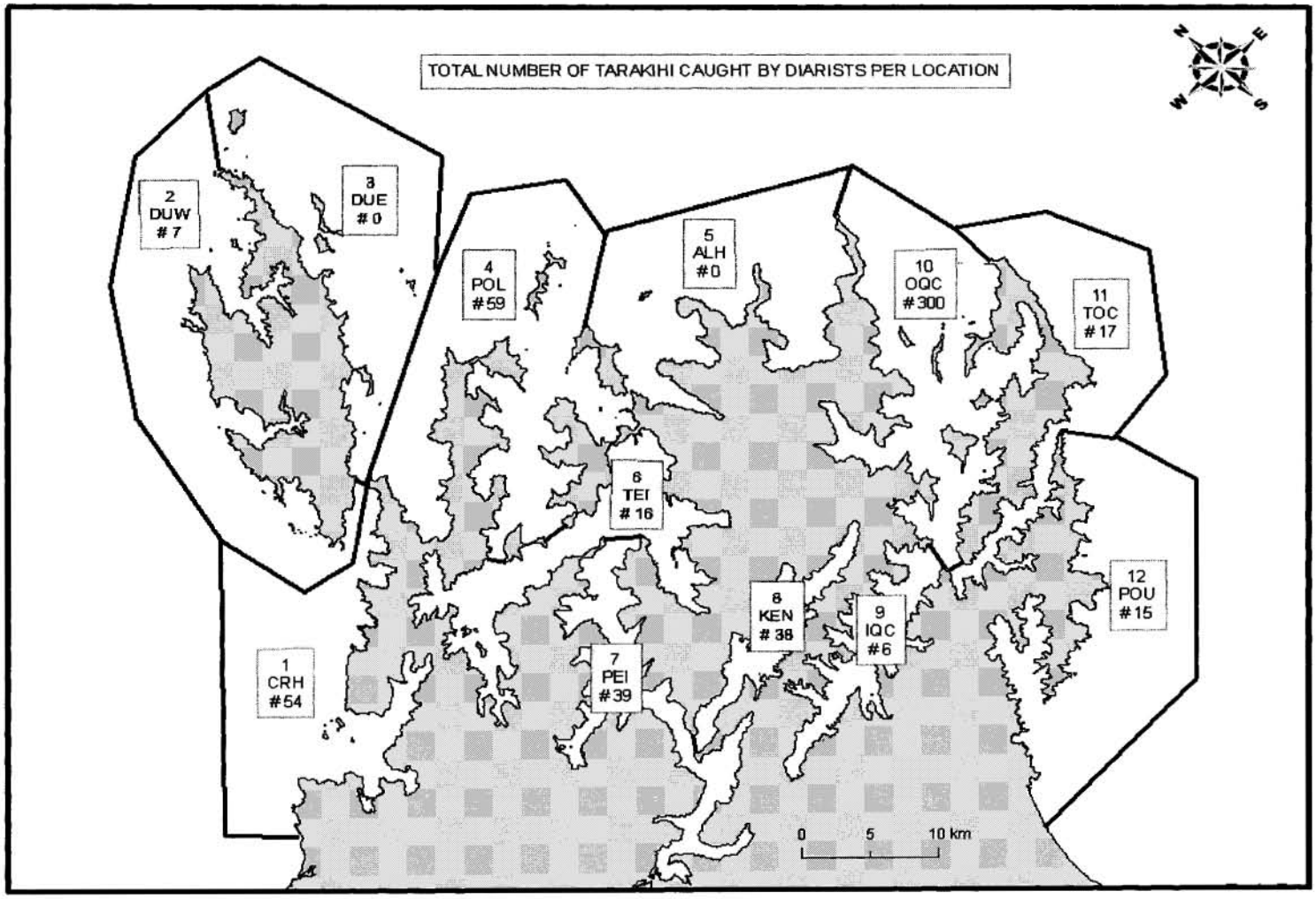
Appendix 5: continued:

Appendix 5k: Total number of kahawai caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.



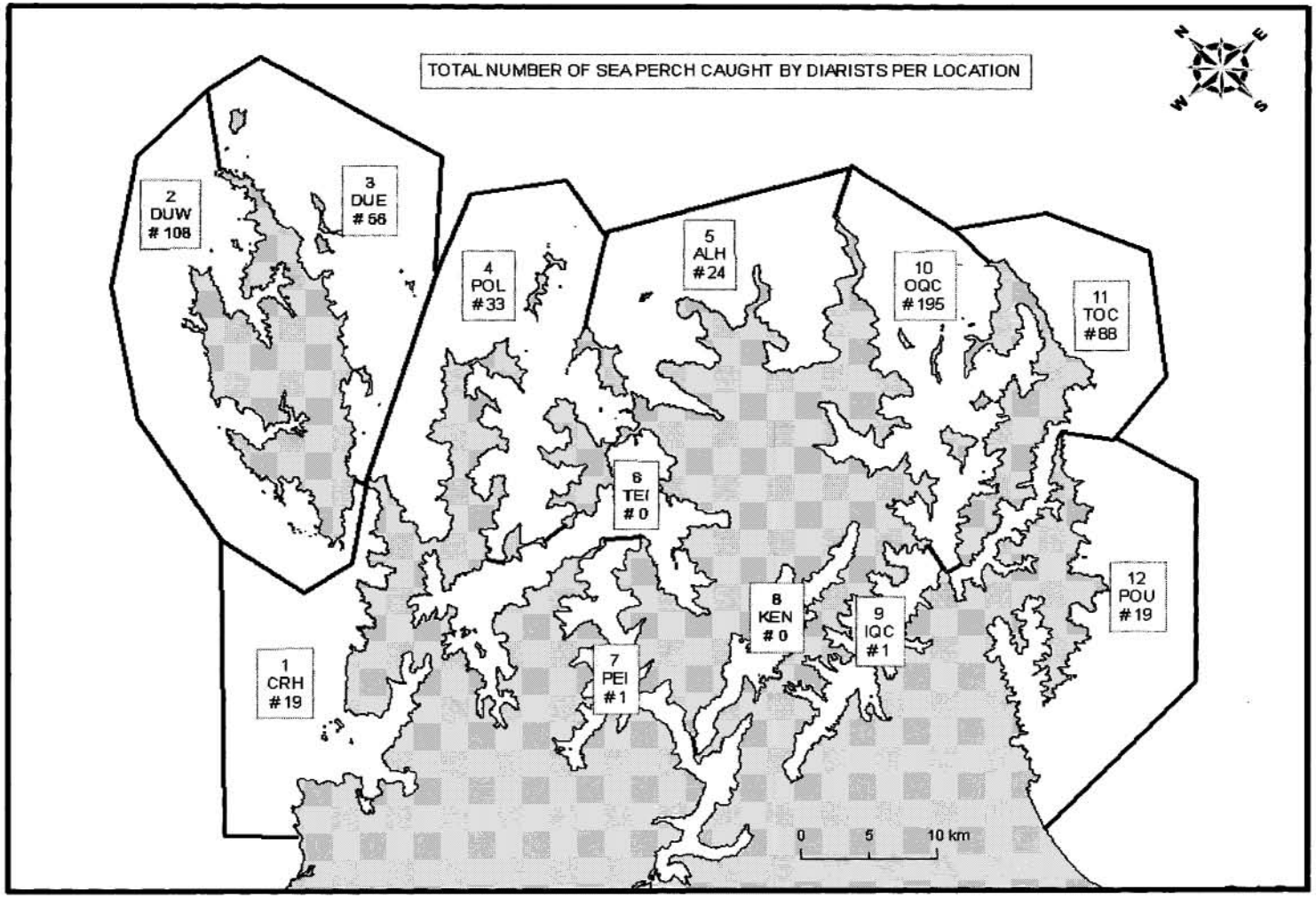
Appendix 5: continued:

Appendix 5l: Total number of tarakihi caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.

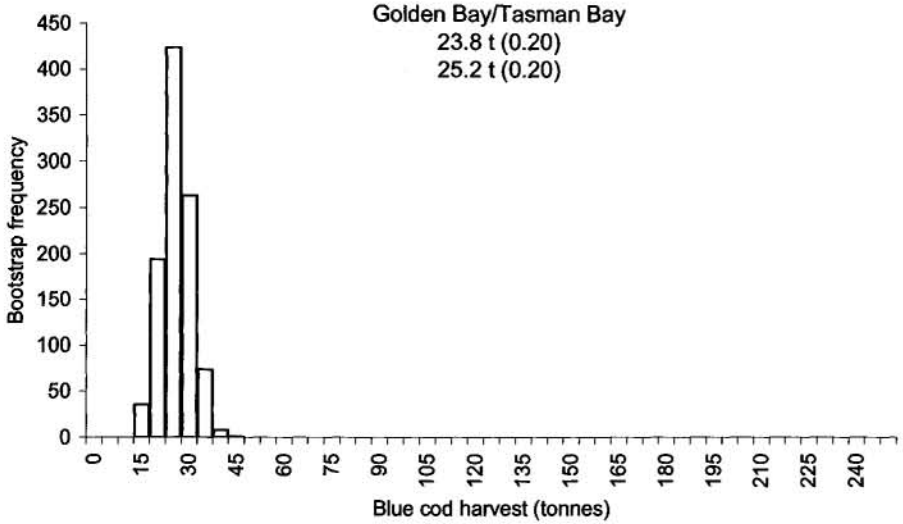


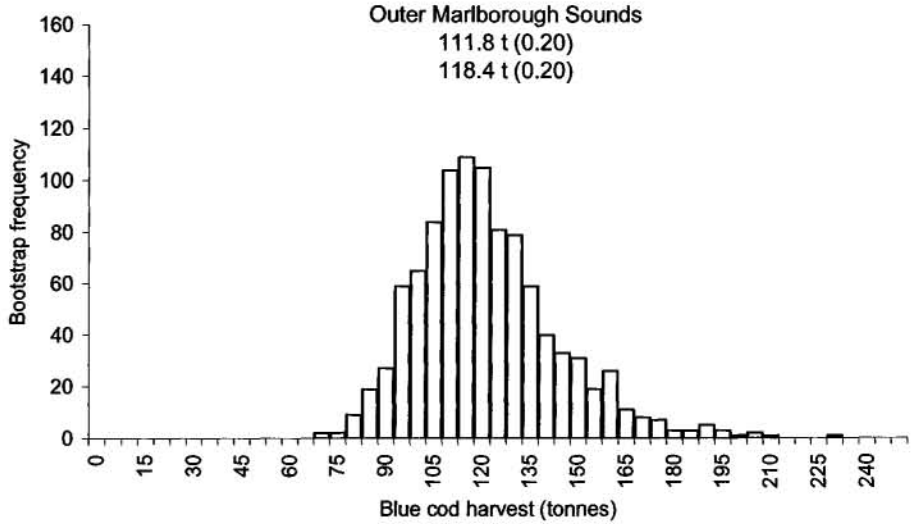
Appendix 5: continued:

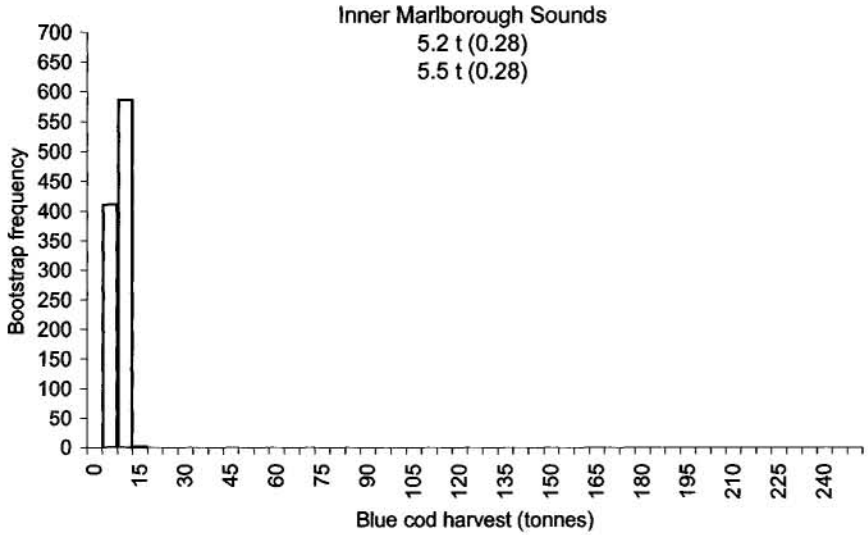
Appendix 5m: Total number of sea perch caught by diarists over the 12 month period (n = 125 diarists). Marlborough Sounds, NZ (December 2005-November 2006). CRH, Croisilles Harbour; DUW, D'Urville Island West; DUE, D'Urville Island East; POL, Port Ligar; ALH, Alligator Head; TEI, Tennyson Inlet; PEI, Pelorus Inner; KEN, Kenepuru Sound; IQC, Inner Queen Charlotte; OQC, Outer Queen Charlotte; TOC, Tory Channel; POU, Port Underwood.

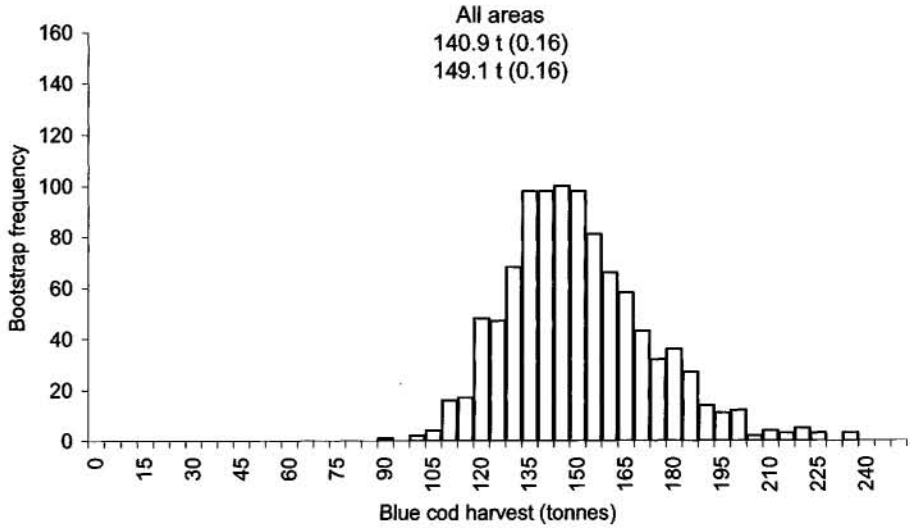


Appendix 6: Distribution of bootstrapped blue cod harvest estimates for Golden Bay/Tasman Bay, the Inner Marlborough Sounds, the Outer Marlborough Sounds, and for all areas combined. For each area assessed the overflight estimate (and c.v. in brackets) is given followed by estimates which are scaled to account for other forms of recreational harvest (and the associated c.v.).









Appendix 7: Distribution of bootstrapped snapper harvest estimates for Golden Bay/Tasman Bay, the Inner Marlborough Sounds, the Outer Marlborough Sounds, and for all areas combined. For each area assessed the overflight estimate (and c.v. in brackets) is given followed by estimates which are scaled to account for other forms of recreational harvest (and the associated c.v.).