Census of the Snares crested penguin (*Eudyptes robustus)* breeding population

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Abstract
In October 2000, a baseline census of Snares crested penguins (*Eudyptes robustus)* on the main Snares Island revealed 23,683 breeding pairs. Combined with estimates for Broughton Island and the Western chain, the world breeding population of Snares crested penguins is estimated at 28,800 pairs. Previous population estimates of 23,000 pairs (Johns & Miskelly 1986) have been based on counts of chicks and although not directly comparable, indicate the population is not declining. One hundred and twelve active penguin colonies were located in this census; the position of each was fixed using a handheld GPS. Each colony was counted, mapped, measured, and the cover and border vegetation recorded to assist long term monitoring of the population. Four colonies were closely monitored to measure change in nest numbers over the census period.

Introduction
A census of the endemic Snares crested penguin (*Eudyptes robustus)* was conducted in October 2000. Snares crested penguins are classified as a "local endemic", a category "C" species in the Department of Conservation *Conservation management strategy Subantarctic Island 1998* (Doole, P. 1998). While the Snares crested penguin is not considered to be at risk, populations of other crested penguins in the sub-antarctic have declined and baseline monitoring is needed to determine future management.

The Snares crested penguin is only known to breed on 4 islands in the Snares group 48°S 166°E (Main, Broughton and the Western chain islands of Rima and Toru). The total breeding population in 1985/86 was estimated as 23,250 pairs based on counts of chicks and a 73% breeding success per pair (Johns & Miskelly 1986). Counts of chicks were also conducted in 68/69, 82/83, 83/84 and 86/87 seasons. Unfortunately reproductive success was not measured in these seasons so the breeding population is unknown for these data (Tennyson 1987).

Historic photographs have been used to document a 94% decline in rockhopper penguin (*Eudyptes chrysocome)* at Campbell Island since the early 1940's. Sea temperature increases have been suggested as the most likely cause of these declines (Cunningham & Moors 1994). At Antipodes Island declines in the mixed erect-crested (*Eudyptes sclateri)* and rockhopper penguin colonies are apparent from photographs taken in the 1920's, 50's and 70's. Elsewhere in the NZ subantarctic crested penguin numbers have declined (Tennyson & Taylor 1995).

No historical photographic record exists for Snares crested penguin colonies. Unlike the rockhopper and erect-crested penguin which nest in open coastal sites, Snares crested penguins tend to breed in small dense colonies under *Olearia* or *Brachyglottis* forest. Colony location and size are also dynamic, changing as the forest breaks down under heavy penguin habitation.

Snares crested penguins return to the breeding grounds in mid-August and as with other *Eudyptes* species, a small "A" egg is laid followed by a larger "B" egg at an interval of 4.34 ± 0.28 days. Egg laying commences on 19 September on the Main Island, with the median lay date for the first egg being 28 September (Warham 1974). 95.6% of pairs present at this time lay at least one egg (Miskelly 1986). Pairs remain at the nest sharing incubation duties for 5 to16 days before the female takes the first long incubation shift while the male goes to sea to feed.

Alan Tennyson (National Museum of New Zealand Te Papa) and Dave Houston (Department of Conservation, Oamaru) were landed on the main Snares Island on 4 October 2000 by the NZ Navy frigate HMNZS *Te Mana*. Gus McAllister (contract worker) and Jacinda Amey (Department of Conservation, National Kakapo Team) joined the expedition on 9 October also compliments of *Te Mana*. The expedition was based at the station cove huts for the census duration.

The *Southern Express* picked expedition members up on 24 October 2000, bad weather prevented the planned day census of Broughton Island, and the team returned to Bluff that day.

Aims
To establish a methodology for and to undertake a baseline census of the Snares crested penguin breeding population.

To map the location of colonies.

To measure and record the vegetation covering and bordering colonies ,so change in colony size and location can be measured over time.

Method

Timing
We conducted the census from 6 to 23 October 2000 to coincide with the end of the egg laying period when the maximum number of pairs attempting to breed would be present. Throughout this time we intensively monitored 4 colonies (1 large and 1 small from 2 landing sites) to interpret changes at the colonies over the census period.

Monitoring sites
Large colonies “A3” and “N16” and small colonies “AO” and “N114h” were monitored for rates of nest loss and gain over the census period. These sites were monitored daily from when established until 9 October then every 3 days thereafter. Adult incubation patterns and behavior were also noted to indicate the timing of the breeding cycle.

This census was of breeding pairs, counts were of nests with one or two eggs, “egg nests” (EN) and “empty nests” (MTN) visible nest bowls with or without penguin(s) in attendance. Nests were recorded as “abandoned” when the nest bowl was still visible but no penguins were in attendance or “gone” when no nest bowl was visible even if penguin/s were still in attendance.

We monitored a large and a small colony from 2 separate landing sites to allow for variation between landing sites. Miskelly (Johns & Miskelly 1986) showed the incidence of empty nests and late egg laying was substantially higher around the periphery of a colony. Therefore different rates of empty nests (MT) to egg nests (EN) would be expected in small and large colonies due to this edge effect. At colony “AO” and “N114h” all nests were monitored, at the large colony sites (“A3” and “N16”) a representative sample of 100 birds from a discrete area were sampled.

Colonies “N16” and “A3” were divided into smaller areas using raddle paint marks on the ground and on sticks. In colony “A3” old marking pegs from previous studies were used to divide the colony up. The nest locations in each block were mapped and numbered to assist in re-finding the individual nests throughout the study.

Census

Locating colonies
Alan Tennyson’s knowledge from counting penguin chicks during the 1985/86 and 1986/87 expeditions was invaluable in locating penguin colonies. We also used colony maps from the 1985/86 expedition reports, followed penguin tracks up from the landing site and grid searched when traversing new areas to locate colonies.

Counting colonies
Each colony larger than 100 nests was divided into small easy to count area’s. Lines were painted with raddle paint and/or stringlines laid on the ground through the colony to mark divisions. Two methods of counting were used “tally” and “paint” depending on the vegetation cover and difficulty of the block.

The majority of blocks were “tally” counted, two people would visually count nests, registering each nest with an egg and each nest without an egg on separate sheep tally counters. Both counts were recorded on the colony sheet and if within 5%, the average would become the total count. When tally’s varied by more than

5% either a third counter or both original counters would “tally” the block again until a consensus within 5% was reached.

When “paint” counting, every nest was visited, a small paint mark placed at the nest and a tally put on the sheep counter. We tested the reliability of this census by walking 10% sampling transects through the counted area, checking all nests within 2m of the transect for paint marks. The “paint” count total was then adjusted for nests not painted or those painted twice. “Paint” counts were considered an “absolute” count and were used where agreement could not be reached through “tally” counting and in blocks where vision was obscured by vegetation.

For the first three days of the census we counted “penguin nests”, a nest being defined as - an obvious nest mound with or without eggs or birds. From 9 October for the remainder of the census a count of “egg nests” (EN) and “empty nests” (MTN) nests was made. An “egg nest is defined “where egg/s are seen or a bird or bird pair was in an incubating position, opposed to an empty nest (MTN) being “an obvious nest mound with or without birds”.

This division was made because a bird incubating an egg was obviously breeding, whereas an MTN may belong to birds not capable of breeding –old, infertile or young birds prospecting for a nest and mate. In some cases MTN will be early failed breeders still present in the colony. Early observer counts were often not within 5%, this was largely due to counter variation in interpreting what constituted an MTN and was easier to confer when EN and MTN were considered separately.

In calculating the final census figure the average percentage of nests with eggs is applied to blocks counted before 9 October.

Bad weather prevented the planned visit to Broughton Island. Chick counts on Broughton Island in 1983/84 (John 1984) and 1984/85 (Miskelly1984) were 20% of the main Snares island count. This 20% figure is used to estimate the number of breeding pairs on Broughton Island.

Snares crested penguins also breed on Rima and Toru Islands of the Western chain (Miskelly 1984). The most recent estimates of breeding numbers for Rima Island are150 breeding pairs from a count of chicks (Miskelly 1984) and on Toru 231 breeding pairs from a direct count of nests (Clark 1996). These data are used to calculate total breeding population in October 2000.

Colony names

The 1985/86 and 1986/87 census reports were used to help locate penguin colonies during the census. As many of these colonies still exist; the numbering system is workable and there are historic records, we continued with the 1986/87 numbering system. Colonies are numbered sequentially when found and are grouped by the catchment and landing site the colony is accessed from. Catchments are denoted by a letter prefix in the colony name as shown in table 1.

Table 1: Colony prefix

Prefix	Location/ catchment
A	Station point, including mouth of penguin creek
C	Penguin creek, both branches and intervening area, but excluding sinkhole flat (penguin creek birds use station cove landing site).
N	North Promontory-sinkhole flat,
H	Hoho point, between mouths of Muttonbird and Hoho creeks
M	Muttonbird creek, upper reaches
S	South Promontory (south of senecio creek)
B	Broughton Island

Where historical names could be read on tags or the colony location and description fitted, old colony names were assigned. Where colonies appeared to have merged the two old names were hyphenated e.g. H79/80. Where a large colony was divided into lobes, the main colony name is retained and a letter suffix added e.g. “N114h”, should these colonies join again the suffix can be dropped.

In 1987 the highest number assigned to a colony was N142. New colonies in 2000 were numbered sequentially from 143 and prefixed by the catchment letter.

We defined a colony as “an area the penguins treat as one nesting area, where birds move between or hang around between areas, but not including penguin paths or through traffic”. This definition fitted better than an

arbitrary distance e.g. 20m, as some colonies were quite close together but still distinct, others were separated by a physical barrier e.g. rock outcrop or wet area but were essentially one colony.

Mapping
A GPS location was obtained from the centre of each colony using a handheld "Garmin 12" Global positioning system. The latitude and longitude were recorded in degrees and decimal minutes using Geodetic Datum 1949 setting. Each colony location was saved as a waypoint and the amount of error per position recorded on the data sheet (appendix I).

A sketch map of colony shape and vegetation cover was drawn at each colony. The longest and widest points of the colony were measured using a 50m fiberglass tape to provide a scale for the drawing.

In colonies where good satellite coverage allowed, the perimeter of the colony was mapped (±3m) using the GPS "track" function. "Waypoints" and "tracks" were gathered in the Geodetic 49 datum and later converted to WGS84 to be consistent with the Snares 2000 map. Data was downloaded from the GPS units and converted using "GPS Trackmaker" software (http://www.gpstm.com).

Cover and Border descriptions
Snares penguin colonies are sited on bare rock, in open areas surrounded by tussock grass or under a canopy of *Olearia lyallii, Brachyglottis stewartiae* or *Hebe elliptica.* Penguins have a marked effect on vegetation, the trees in a well-established colony are usually dead or dying (Warham 1972). The colonies move gradually, with established breeders returning to sites used previously but new pairs establishing nests beneath fresh canopy on the periphery of the colony.

To quantify the amount and type of cover in each colony, we scored the percentage cover given a bird's-eye view, categories were *Olearia lyallii*, *Brachyglottis stewartiae*, *Hebe elliptica* and open. These categories were further divided into dead and alive, the alive vegetation usually indicated recent colonization and the dead a longer period of colonization.

Border vegetation was scored on percentage of colony circumference. Categories were Grass, *Hebe*, *Olearia*, *Brachyglottis*, rock, water, and other.

By recording border and cover vegetation and mapping the colony shape we hope that colony movement and change over time can be quantified.

Effort
The start and finish time of a colony count was recorded to give some indication of the time required to do a repeat census. 3-4 people counted most blocks and times allow for the GPS, mapping, border and cover descriptions but not for travel to and from the colony.

Results

Monitoring sites
The small monitoring sites "AO" and "N114h" had 19 and 38 egg nests respectively when established, the large colonies contained 100 nests with "N16" having 99 EN and "A3" 93 EN. The small monitoring sites "AO" and "N114h" had no change in the number of egg nests (EN) over the duration of the census. While very little change occurred in egg nest numbers in colonies "A3" and "N16".

In colony "A3" two EN were gained and two lost over the census period, in colony "N16" three of the 99 EN failed over the census period. Nest numbers were unchanged in the small colonies "AO" and "N114h". Therefore 99.5% percent of nests had been laid in when the census commenced on 6 October and an average of 1.3% of nests were lost over the census period.

Monitoring colony nests were mapped using grid pegs, paint lines on branches and bare ground as features. It was difficult to mark individual nests due to mud and nest movement, some nests moved as much as 500mm as penguins jockeyed for spacing from their neighbors. The maps were used to follow the progress of individual nests, recording incubating adult and nest contents.

October 6 is the census date that all census data is corrected to. By averaging the percent difference for all 4 monitoring colonies each day a daily correction factor (Mean EN%) is calculated for 6 October (table 2). The

correction factor is applied to all colonies counted on that day, to give a corrected census figure for 6 October 2000 (table – census data).

Table 2: Monitoring colony results and correction factor calculations

	"AO"				"A3"				"N16"				"N114h"				Mean EN%
	%EN	EN	MTN	TOT	%EN	EN	MTN	TOT	%EN	EN	MTN	TOT	%EN	EN	MTN	TOT	
MTN ratio	0.0				0.0				0.0				0.1			Mean	0.03
6-Oct		19	0	19		93	4	97		99	1	100		38	3	41	
7-Oct	100.0	19	0	19	101.1	94	3	97	100.0	99	2	101	100.0	38	3	41	100.27
8-Oct	100.0	19	1	20	101.1	94	4	98	99.0	98	3	101	100.0	38	3	41	100.02
9-Oct	100.0	19	2	21	101.1	94	4	98	99.0	98	3	101	100.0	38	3	41	100.02
10-Oct																	100.02
11-Oct																	100.29
12-Oct	100.0	19	3	22	102.2	95	5	100	99.0	98	3	101	100.0	38	3	41	100.29
13-Oct																	100.29
14-Oct																	99.76
15-Oct	100.0	19	2	21	101.1	94	6	100	98.0	97	4	101	100.0	38	3	41	99.76
16-Oct																	99.76
17-Oct																	99.51
18-Oct	100.0	19	2	21	101.1	94	5	99	97.0	96	3	99	100.0	38	3	41	99.51
19-Oct																	99.51
20-Oct																	99.51
21-Oct																	99.24
22-Oct	100.0	19	2	21	100.0	93	2	95	97.0	96	3	99	100.0	38	3	41	99.24
23-Oct																	99.24

Although the corrected census data lies within the 5% margin of error, the level of nest loss and gain should be monitored in future counts.

There was a high level of variability in the number of empty nests (MTN) at the monitoring sites. These represented failed EN, nests formed and not laid in and in one case a very late EN. Due to the small numbers involved and the high variability between days, a ratio of MTN to EN nests has been used to calculate a daily correction factor for blocks counted after 6 October.

Although MTN numbers were not an important factor for this census, with little change being observed over time. Extreme weather events or other environmental factors may raise the number of MTN in some years and they may be an indicative factor of breeding and population health. Without monitoring these nests it is difficult to understand their significance.

Over the four colonies monitored an additional 8 nests were built during the census period. Only one of these produced an egg, this was still being incubated when monitoring ceased on 22 October. The other 7 nests lasted an average 7.3 days (SD=4.0, range 3-14) days before disappearing, one each lasted 14, 10 and 9 days, and 2 each for 6 and 3 days.

There were six MTN when the monitoring colonies were set up, these lasted an average of 10.3 days (SD 2.1, range 9-14). Two eggs were lost from one nest on 5 October, this nest was still attended on 22 October.

Census

The census of breeding pairs of Snares crested penguins commenced on 6 October and was completed on 23 October 2000. A total of 112 active colonies containing 23,659 nests with eggs were counted, when corrected to 6 October 2000 this equates to 23,683 breeding pairs.

2206 empty nests (MTN) were counted over the course of the census, but when the average ratio of empty nests for October 6 (0.03MTN:1EN) is applied, (table 2, "mean MTN ratio") MTN on 6 October number only 783 nests.

The weather prevented the planned census of Broughton Island. Assuming Broughton Island breeding success is similar to that of the main Snares Island and that the chick counts in 1983/84 and 1984/85 seasons were representative, it is reasonable to assume that the breeding population on Broughton Island is 20% (Tennyson 1987) of the main Snares Island population. A reasonable estimate for Broughton Island is therefore 4737 breeding pairs.

The most recent figure for penguin numbers on The Western chain are 231 breeding pairs on Toru (a direct count, Clark 1996) and 150 breeding pairs on Rima (based on chick estimates Miskelly 1984).

The world population of Snares crested penguins is an estimated 28,800 breeding pairs.

Table 3: Total number of breeding pairs Snares Crested Penguins 2000.

Location	Breeding pairs	Empty nests
Main Island	23,683	783
Broughton Island	4,737	157
Rima	150	
Toru	231	
TOTAL	**28,800**	**940**

Penguin colonies ranged in size from 0 EN at "M150" (this colony contained 24 MTN) to colony N114g with1351 EN. The average colony size was 211 (SD 224) with 95% of the colonies containing less than 500 EN and 62% of colonies having less than 200 EN. Direct colony counts and counts adjusted to 6 October are presented in table 4.

In calculating the final census figure the average percentage of nests with eggs is applied to blocks counted before 9 October.

Table 4: Direct and corrected colony counts of Snares crested penguins 2000.

Colony	Date	Start time	No. people	Effort	Nests			Corrected nest counts (day = 6/10/00)		
				(h:mm)	Egg	MT	Total	Egg	MT	Total
A0	4/10/00	17:00	2	0:30	19	0	19	19	0	19
"N114h"	6/10/00	15:00	2	0:30	38	3	41	38	3	41
"N16"	7/10/00	13:37	2	1:16	244	23	266	243	8	251
N20	7/10/00	15:25	2	1:20	188	18	205	187	6	194
N114l	8/10/00	15:30	2	1:00	161	15	176	161	5	167
N17	8/10/00	16:15	2	0:50	97	9	106	97	3	100
C136	9/10/00	15:05	4	2:20	110	13	123	110	4	114
C117	9/10/00	15:40	4	4:40	360	34	393	360	12	372
C110	9/10/00	17:55	4	3:00	470	44	512	469	15	485
C112	10/10/00	12:10	4	2:08	151	27	178	151	5	156
A1a	10/10/00	13:00	2	0:10	23	5	28	23	1	24
A1b	10/10/00	13:20	4	2:00	191	32	223	191	6	197
H74	10/10/00	16:30	4	3:20	375	38	413	375	12	387
H75	10/10/00	17:30	4	1:00	66	7	73	66	2	68
H78	10/10/00	17:40	2	0:30	13	3	16	13	0	13
A4	11/10/00	09:45	4	2:32	222	19	241	221	7	229
A5	11/10/00	10:30	4	4:20	446	50	496	445	15	459
H76/H113	11/10/00	14:25	4	3:40	452	35	487	451	15	466
H132	11/10/00	15:36	4	0:28	12	1	13	12	0	12
H77	11/10/00	15:47	4	0:24	68	6	74	68	2	70
H69/H133	11/10/00	16:00	4	3:40	329	34	363	328	11	339

H71b	11/10/00	17:10	4	1:40	118	15	133	118	4	122
H71a	11/10/00	17:37	4	2:32	249	37	286	248	8	256
“A3”	12/10/00	09:30	4	14:00	1246	139	1385	1242	41	1283
N22	12/10/00	16:30	4	1:40	233	13	246	232	8	240
N21	12/10/00	16:55	4	0:40	27	11	38	27	1	28
N143	12/10/00	17:30	4	1:00	87	8	95	87	3	90
N23b	12/10/00	18:00	4	2:40	388	28	416	387	13	400
N144	13/10/00	11:35	4	3:04	426	48	474	425	14	439
N10	13/10/00	12:32	4	3:12	489	40	529	488	16	504
N23a	13/10/00	14:15	4	6:40	960	60	1020	957	32	989
N11b	13/10/00	16:30	4	3:04	448	57	505	447	15	461
N11d	13/10/00	17:16	2	0:18	33	3	36	33	1	34
N11a	13/10/00	17:25	1	0:18	105	14	119	105	3	108
N14	13/10/00	17:45	4	1:08	367	34	401	366	12	378
N114g	13/10/00		4	12:12	1312	106	1418	1308	43	1351
M149	14/10/00	09:55	1	0:18	119	9	128	119	4	123
M115	14/10/00	11:00	4	1:20	136	8	144	136	5	141
M62	14/10/00	11:27	4	2:52	419	42	461	420	14	434
M60	14/10/00	12:14	4	1:44	171	32	203	171	6	177
M64	14/10/00	13:47	4	3:12	510	61	571	511	17	528
M140	14/10/00	14:35	4	1:20	179	11	190	179	6	185
M150	14/10/00	15:10	4	0:44		24	24	0	0	0
M65	14/10/00	15:20	4	0:48	97	13	110	97	3	100
M59	14/10/00	15:37	4	1:40	152	19	171	152	5	157
M51	14/10/00	16:05	4	1:40	141	15	156	141	5	146
M53	14/10/00	18:00	4	1:08	131	16	147	131	4	136
M52	14/10/00	18:20	4	2:00	348	40	388	349	12	360
M50	14/10/00		4	2:04	169	16	185	169	6	175
N15	15/10/00	14:38	2	1:54	437	26	463	438	14	452
N146	15/10/00	15:37	2	2:34	351	25	376	352	12	363
N141	15/10/00	17:36	4	1:12	119	4	123	119	4	123
N28	15/10/00	19:05	4	1:00	76	10	86	76	3	79
N31	15/10/00	19:25	4	0:32	25	3	28	25	1	26
S81	16/10/00	10:10	4	1:00	43	5	48	43	1	45
S85	16/10/00	10:30	4	0:28	50	8	58	50	2	52
S84	16/10/00	10:43	4	0:48	140	13	153	140	5	145
S83	16/10/00	11:05	4	1:00	97	4	101	97	3	100
S82	16/10/00	11:23	4	0:28	60	7	67	60	2	62
S86	16/10/00	11:50	4	0:56	133	6	139	133	4	138
S88	16/10/00	12:17	4	0:40	77	8	85	77	3	80
S108	16/10/00	13:25	4	2:48	419	31	450	420	14	434
S105	16/10/00	14:16	4	0:28	135	13	148	135	4	140
S106	16/10/00	14:34	4	0:32	61	19	80	61	2	63
S104	16/10/00	14:44	4	0:24	45	4	49	45	1	47
S102	16/10/00	15:12	4	0:44	126	19	145	126	4	130
S130	16/10/00	16:30	4	0:24	18	6	24	18	1	19
S99	16/10/00	16:43	4	1:08	206	13	219	206	7	213
S98	16/10/00	17:01	4	1:28	304	29	333	305	10	315
S103	16/10/00	17:35	4	1:32	223	15	238	224	7	231
S101e	17/10/00	10:45	3	1:06	221	30	251	222	7	229
S101f	17/10/00	11:13	3	0:24	30	5	35	30	1	31
S100	17/10/00	12:02	3	0:21	96	12	108	96	3	100

S90	17/10/00	12:18	3	0:27	109	5	114	110	4	113
S91	17/10/00	12:28	3	1:21	352	11	363	354	12	365
S92	17/10/00	13:05	3	1:03	256	25	281	257	8	266
H120	17/10/00	17:25	3	0:57	194	14	208	195	6	201
N145	18/10/00	09:40	1	2:30	829	82	911	833	28	861
N32	18/10/00	13:27	3	2:03	290	20	310	291	10	301
N26	18/10/00	14:32	3	2:09	256	16	272	257	8	266
N25	18/10/00	15:25	3	2:15	241	46	287	242	8	250
A6	18/10/00	18:00	3	0:30	85	3	88	85	3	88
A7d	18/10/00	18:14	3	0:27	71	4	75	71	2	74
A139	18/10/00	18:27	3	0:54	305	6	311	306	10	317
A7f	18/10/00	18:58	3	0:57	169	8	177	170	6	175
C49	19/10/00	10:37	3	0:57	111	17	128	112	4	115
C48	19/10/00	10:37	3	0:12	37	0	37	37	1	38
C39	19/10/00	11:10	3	0:18	38	3	41	38	1	39
C38	19/10/00	11:17	3	0:21	122	10	132	123	4	127
C116	19/10/00	12:15	3	0:45	129	4	133	130	4	134
C40	19/10/00	12:30	3	0:15	26	2	28	26	1	27
C134	19/10/00	13:23	3	0:18	45	6	51	45	1	47
C135	19/10/00	13:36	3	0:39	120	4	124	121	4	125
C37	19/10/00	13:53	3	0:30	137	12	149	138	5	142
C36	19/10/00	14:06	3	0:21	119	12	131	120	4	124
C35	19/10/00	14:31	3	0:24	70	3	73	70	2	73
C119	19/10/00	14:44	3	0:15	42	6	48	42	1	44
C41	19/10/00	14:59	3	0:51	236	13	249	237	8	245
C34	19/10/00	15:20	3	0:36	141	13	154	142	5	146
H73	19/10/00	17:05	3	2:45	478	28	506	480	16	496
H66/131/72	19/10/00	18:15	3	3:06	597	31	628	600	20	620
A147	20/10/00	11:32	3	0:30	16	9	25	16	1	17
A7e	20/10/00	11:47	2	0:12	18	3	21	18	1	19
A148	20/10/00	11:58	3	0:36	49	2	51	49	2	51
N151	22/10/00	07:32	3	1:45	461	11	472	465	15	480
N152	22/10/00	08:20	3	0:21	117	4	121	118	4	122
C47	23/10/00	15:31	2	0:12	1	3	4	1	0	1
C43	10/10/10	09:15	4	2:00	54	8	62	54	2	56
C111	10/10/10	10:10	4	1:20	140	23	163	140	5	145
C44	10/10/10	10:55	2	0:40	33	9	42	33	1	34
C45	10/10/10	11:00	4	4:20	371	55	426	371	12	383
H79/80	10/10/10	18:00	4	2:40	207	26	233	207	7	214
TOTAL				180:09	23659	2206	25861	23683	783	24466

Colony names

Ten of the colonies did not fit the historic names or location descriptions from the 1984-87 Snares island expedition reports and were assigned new names prefixed by the catchment and numbered from 143 to 152.

Seventeen colonies recorded in 1987 could not be located in this census so were presumed extinct. Three colonies were the amalgamation of 2 historic colonies into one (H79/80, H69/133 and H76/H113) and one colony was the joining of three historic colonies (H66/131/72).

In 7 historic colonies lobes had separated to become individual colonies, these retained the colony prefix and number but were suffixed by letter. In 1987 colonies “A3”, A5, S130, N10 and S99 were suffixed as “a” and “b” these colonies have rejoined to become single colonies.

Colonies A7, S101 and N114 were each in 3-6 distinct colonies in 1987. In this census these colonies were still in parts, these were assigned a new suffix because we could not determine their 1987 colony locations. GPS location and colony field maps should keep suffixed colonies identifiable in the future.

In some colonies (e.g. S99) a letter suffix is recorded on the field sheet to help divide the block into workable pieces, unless this suffix is recorded in the colony name it is considered to be only one colony (in two parts).

Mapping

A GPS position from the approximate centre of each colony was recorded; fixes were averaged until in most cases they were within ± 10.m. Where satellite reception was good the periphery of the colony was walked using the track function to map the colony shape. These data were downloaded onto a laptop each evening and mapped using the "trackmaker" software to give an accurate map of colony location. Refer to figures 2 – 5.

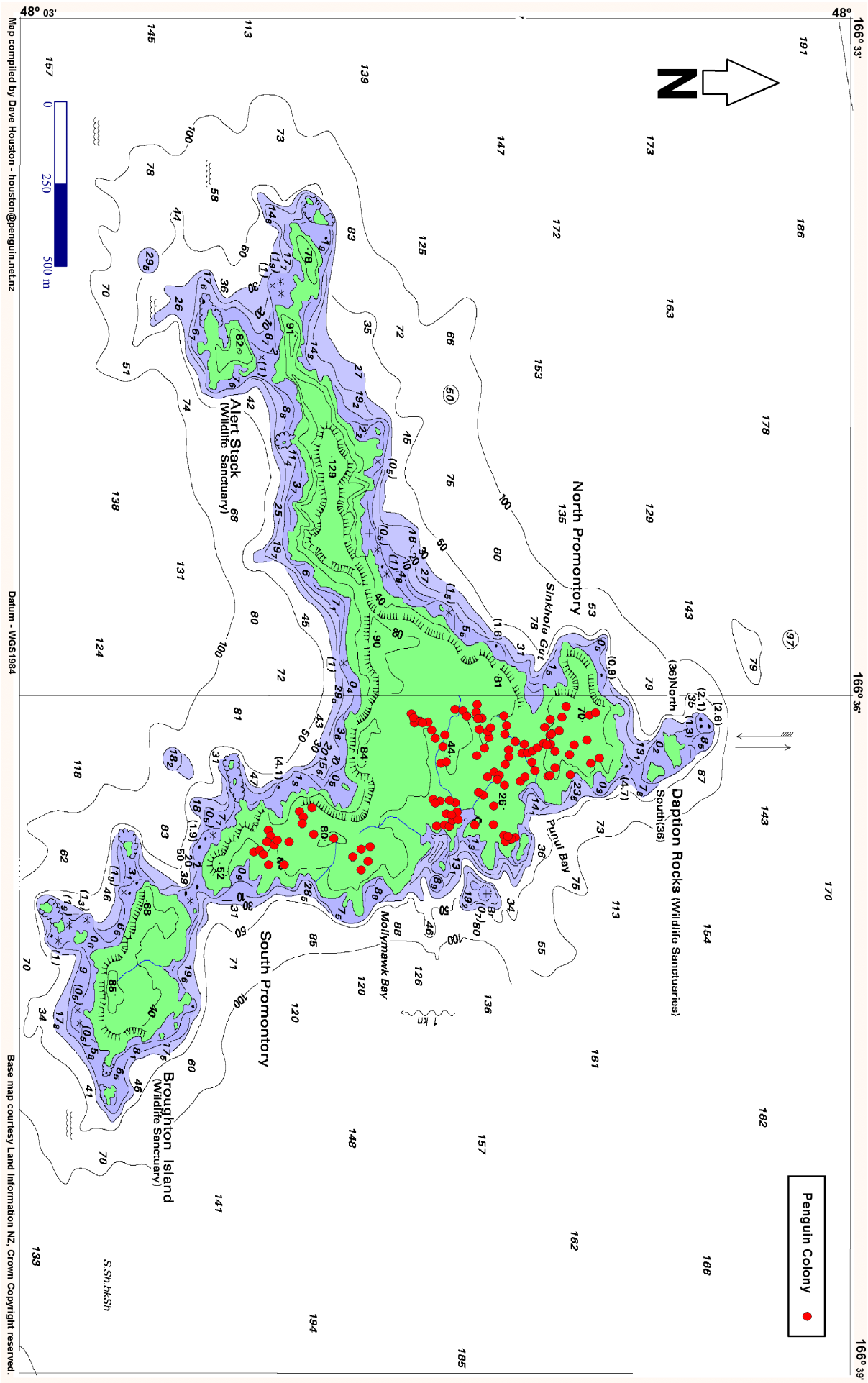

Figure 2: Map of colony locations

At all colonies a sketch map of the colony shape was drawn and the length and width of the colony measured and recorded. This was done in an effort to quantify colony change over time and aid in refinding colonies in future. Table 4 gives the GPS co-ordinates for all colonies counted in 2000 and figure 2 is a map of colony locations.

Field sheets containing the sketch maps are held on file at Department of Conservation Southland.

Effort

The time spent counting each colony was recorded (refer to table 3); this amounted to 53 hours for 3-4 people or 181 person hours and included the mapping, GPSing, counting and colony descriptions but not the travel time to and between colonies.

The census was conducted from 6 October and the last block counted on 23 October (18 days), the team was usually away from the hut for 9-11 hrs/day. Although from 20 - 23 October only a few missed colonies were counted the rest of the time being spent searching for colonies and updating notes. Two half days were lost to bad weather.

Three days were spent establishing and mapping the monitoring colonies. It generally took 2 people half a day to check the four monitoring colonies, there were 7-8 checks of each monitoring colony throughout the census.

Given the small changes within the monitoring colonies over this time, the intensity of checks could be reduced to half in future census.

There should be savings in time in future census as a robust methodology has now been developed. GPS locations should also speed up the process of locating and determining colony names although time should still be put into searching for new colonies.

Border and Cover

On average 68 percent of a penguin colony was under cover and 32% in the open. The main cover was live *Olearia* forest (43%) and equal percentages of dead *Olearia* (6%), live *Brachyglottis*, live *Hebe* and dead *Hebe*.

At 15 small (less than 140 egg nests)colonies the entire colony was under *Olearia* forest. Only 23 colonies had no *Olearia* cover at all. In a few places (particularly south Promontory) *Brachyglottis* was the predominant canopy species although it only occurred in 12 colonies, Making up 100% of the cover in 3 colonies and averaged 63% of cover in the colonies it occurred in. Dead *Brachyglottis* only occurred in one colony.

Hebe was the worst type of cover to attempt counting penguins in, generally a “paint” count was necessary as visibility was restricted by twiggy stems. Most *Hebe* was waist to chest high and in many instances crawling on hands and knees was the only way to count all the nests. The *Hebe* appeared to colonise wetter open sites that had previously been abandoned by earlier penguins, it appeared to be easily killed by renewed penguin activity.

Olearia was the most common plant bordering colonies, on average making up 61% of the border vegetation and recorded as border vegetation in 75% of the colonies. *Hebe* was the next most common border plant being present in 37% of colonies, with an average border of 17%. Rock made up some of the boundary in 29% of the colonies, averaging 9%.

Discussion

The world breeding population of Snares crested penguins is an estimated 28,800 pairs. Previous population estimates of 23,000 pairs (Johns & Miskelly 1986) have been based on counts of chicks and although not directly comparable, indicate the population has not declined since the 1985/86 count. Chick counts from 1968/69, 82/83, 83/84 and 86/87 indicate similar numbers but as reproductive success was not measured these data are not conclusive.

Weather prevented landing and a census of Broughton Island, this population was estimated as 20% of the main island population. While there is no reason to suspect any change in this proportion, a census of this significant part of the population must be a priority in future census effort. Colonies at the Western chain are smaller and therefore changes to these populations have a less significant effect on the total population so are a lesser priority for future census. The logistics of counting this population are complicated by the difficulty of landings on the Western Chain and that the breeding cycle is 6 weeks (Miskelly 1984) later than penguins on the Broughton and the Main Island.

This census has created a baseline figure and robust methodology to work from. Regular future census are imperative for this species which is found only at the Snares islands. Early detection of change is essential if active management of threats is to be possible.

Declines in rockhopper penguins on Campbell island have been attributed to sea temperature warming causing changes in the penguin's food supply (Cunningham and Moors 1994), it is possible the crested penguin declines at Antipodes island have a similar origin.

Snares penguins are known to feed mostly on crustaceans, especially euphausiids, some cephalopods and (rarely) fish (HANZAB 1990), but where these occur and how changes in sea temperature might effect them is unknown.

Fishing bycatch/competition, geological exploration, visitation, pollution (oil, fuel, ballast water) and introduced predators are all factors effecting other marine species and that could threaten this local, endemic (Doole 1998). Monitoring the population is essential to detect negative impacts on the population.

Future census should be over a similar time period, this census coincided with the end of the egglaying period (99.5% of nests had been laid in by October 6) when the maximum number of breeding pairs are in the colony. By 16 October locating and counting penguin colonies became more difficult, 80% of male penguins had departed for sea leaving the female bird incubating. The colonies became very quiet and it was possible to pass close without hearing the colony. Single females were easily scared from the nest leaving eggs vulnerable and making counting more difficult. Provided representative colonies are monitored, the census could commence 1 week earlier.
We corrected census figures to 6 October, the number of nests lost and gained over the census was negligible, monitoring is important for calibrating successive counts although the frequency of future monitoring could be reduced.

We invisage that with the aid of GPS positions and a 5 yearly frequency of census, future counts should not take as long to conduct. After several complete census it may be possible to establish a representative sample of the population to monitor for change. Given the dynamic nature of Snares penguin colonies several years of whole census should be conducted first.

Recommendation

A census of the Snares penguin population should be repeated every five years at the same time of year to monitor population trends over time. In future population counts could be reduced to a representative sample of the population. Given the dynamic nature of the colonies a whole island census should be conducted for the next two counts, before considering a part island count. Future census should repeat the methodology used during this study.

Priority should be given to a census of the Broughton Island population to measure the proportion of penguins that inhabit Broughton Island and determine if 20% is a realistic figure for this census.

A census of the Western chain penguin population is recommended, the 6 week delay in the breeding cycle of these birds may indicate different foraging patterns and therefore a different susceptibility to environmental changes. Some form of aerial photography survey may be possible on these treeless islands.

Acknowledgements
Thanks must go to Jeremy Carroll who initiated and organised this study, but was unable to participate due to other work priorities, thank you for the opportunity to visit this magnificent island. We also thank the Royal New Zealand Navy for transport aboard the frigate *HMNZS Te Mana* and her crew for the genuine hospitality we were afforded. The final acknowledgement must go to the penguins who were not too difficult to find *as* 'Where there's mud there's penguins!".

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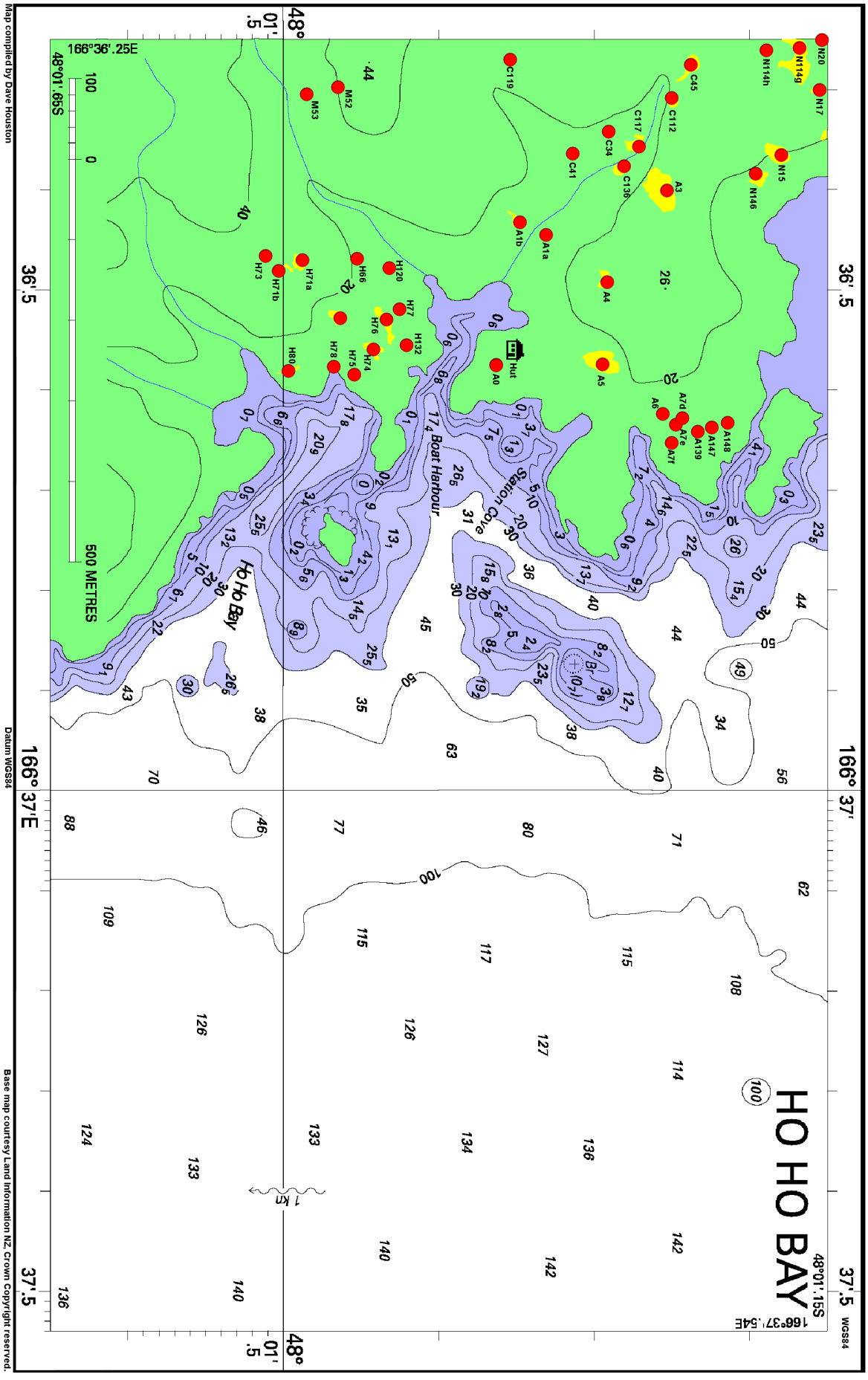

Figure 3. Hoho bay

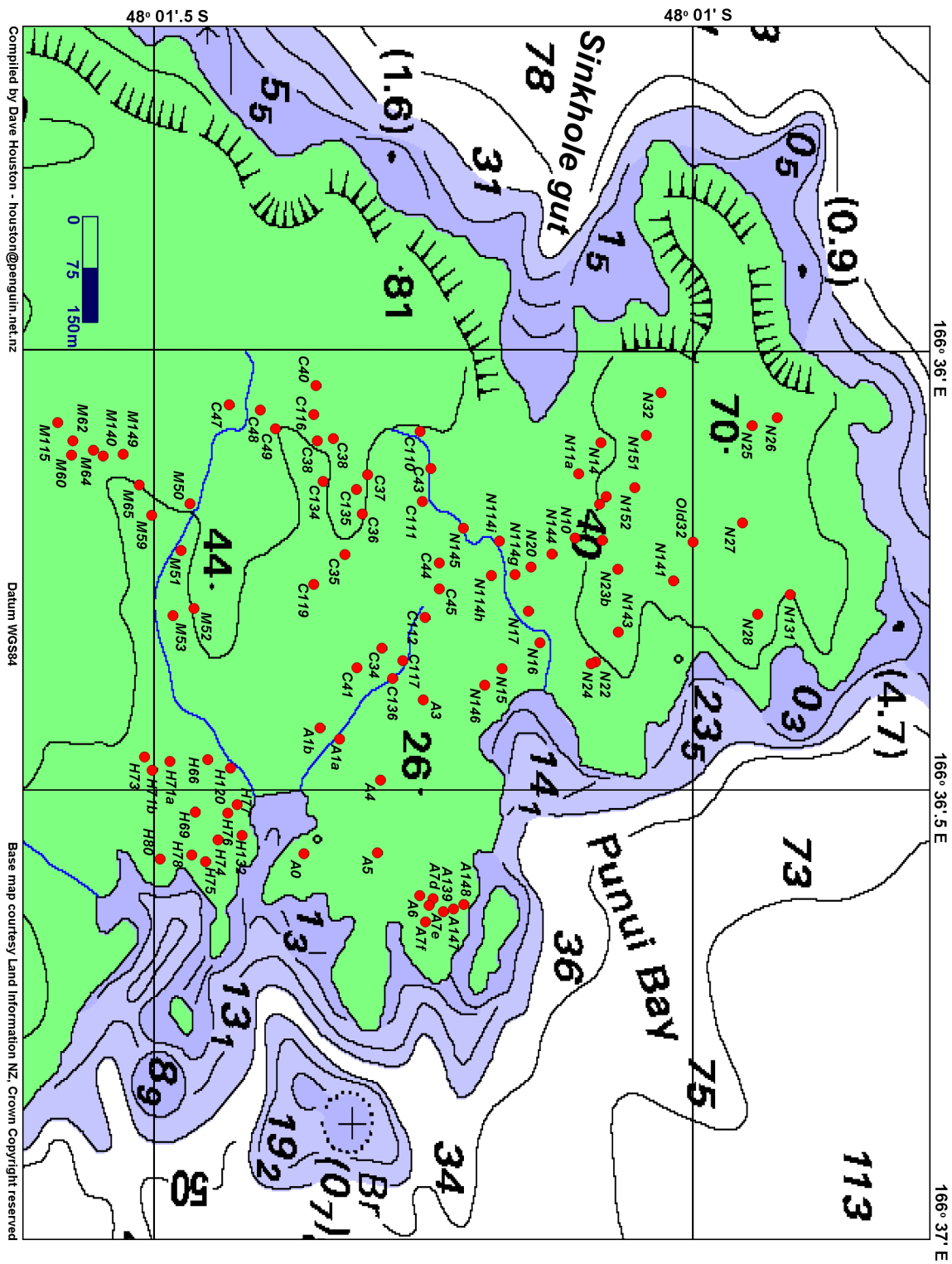

Figure 4. North Prom

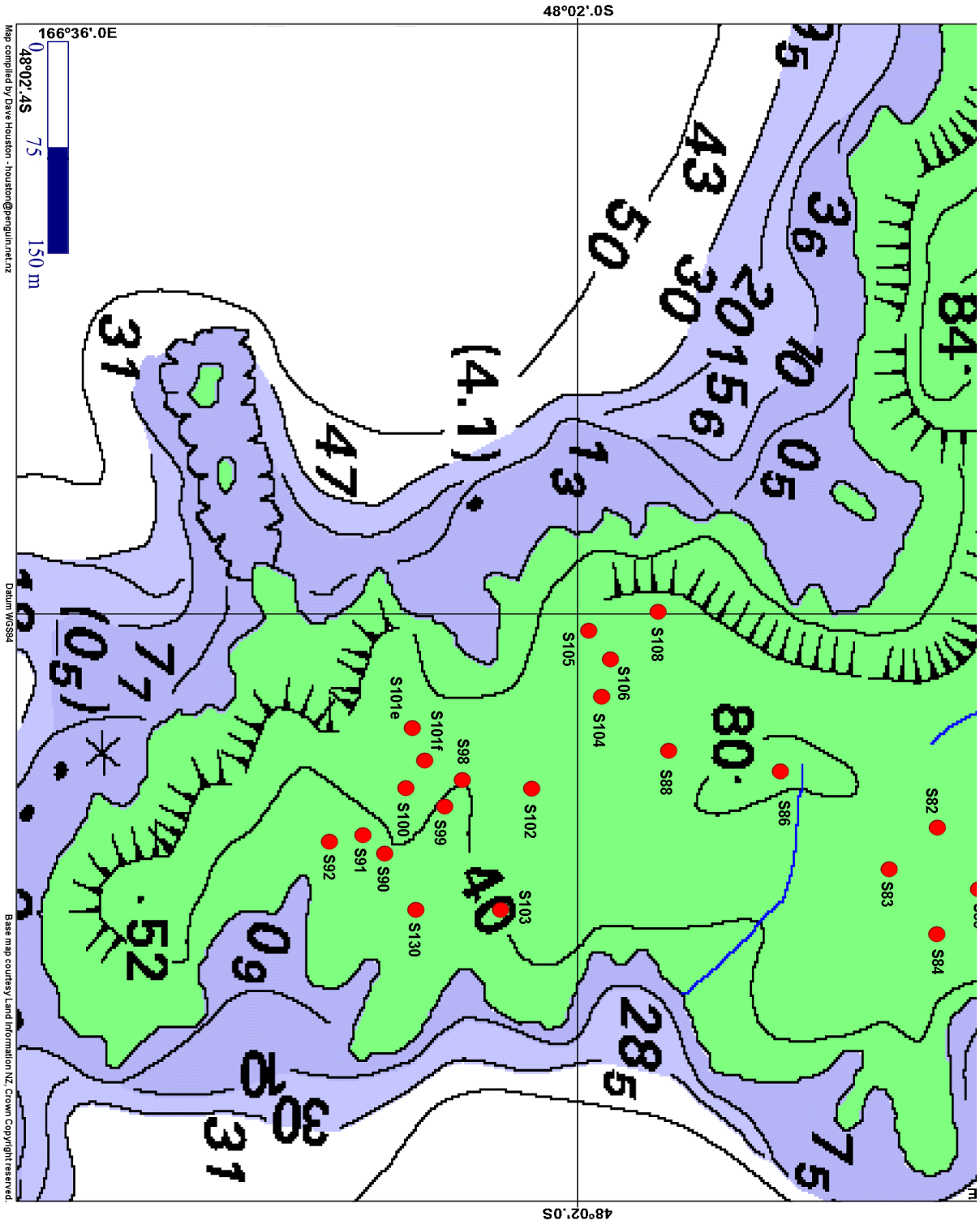

Figure 5. South Prom

Appendix I. Snares crested penguin census form

Snares crested penguin census

Colony: **Date:**

Start time: **Finish time:**

deg min deg min

Latitude: S **Longitude:** E ± m

	Live Olearia	Dead Olearia	Live Senecio	Live Hebe	Dead Hebe	Open
% colony under cover:						

Border: %	Grass	Hebe	Olearia	Senecio	Rock/mat	Water	Other

Comments:

Observer	Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Total
Total								

Appendix II. GPS positions of Snares crested penguin colonies 2000.

Colony	Latitude		Longitude		GPS Satellites	
	WGS84		WGS84			
	Deg	Min	Deg	Min	EPE	Track
A0	48	1.454	166	36.575		Yes
A139	48	1.235	166	36.642	6.2	No
A147	48	1.226	166	36.639	4.5	No
A148	48	1.216	166	36.634	3.8	No
A1a	48	1.421	166	36.445	4.4	No
A1b	48	1.438	166	36.432	4.0	Yes
A3	48	1.349	166	36.399	3.7	Yes
A4	48	1.383	166	36.492	5.1	Yes
A5	48	1.385	166	36.574	5.1	Yes
A6	48	1.257	166	36.625	5.4	No
A7d	48	1.245	166	36.628	5.8	No
A7e	48	1.248	166	36.634	5.2	No
A7f	48	1.252	166	36.654	5.2	No
C110	48	1.347	166	36.096		
C111	48	1.344	166	36.175	4.4	Yes
C112	48	1.341	166	36.307	4.4	Yes
C116	48	1.355	166	36.078	5.2	No
C117	48	1.362	166	36.355		
C119	48	1.355	166	36.271	5.4	No
C134	48	1.346	166	36.155	8.0	No
C135	48	1.316	166	36.163	4.9	No
C136	48	1.371	166	36.376		
C34	48	1.292	166	36.343	4.8	No
C35	48	1.326	166	36.237	5.4	No
C36	48	1.311	166	36.191	5.2	No
C37	48	1.306	166	36.146	7.4	No
C38	48	1.337	166	36.105	5.0	No
C39	48	1.352	166	36.108	9.0	No
C40	48	1.353	166	36.045	10.4	No
C41	48	1.315	166	36.365	5.8	No
C43	48	1.336	166	36.138	4.4	No
C44	48	1.329	166	36.245	4.8	No
C45	48	1.328	166	36.275	4.4	Yes
C47	48	1.523	166	36.066	16.0	No
C48	48	1.404	166	36.073	6.9	No
C49	48	1.391	166	36.094	8.4	No
H120	48	1.434	166	36.479	7.5	No
H132	48	1.511	166	36.554	6.0	No
H66/131/72	48	1.453	166	36.470	5.4	No
H69/H133	48	1.554	166	36.527	5.0	Yes
H71a	48	1.578	166	36.470	6.5	Yes
H71b	48	1.594	166	36.480	7.9	Yes
H73	48	1.512	166	36.467	5.1	No
H74	48	1.533	166	36.559	7.2	Yes
H75	48	1.545	166	36.580	10.6	No
H76/H113	48	1.525	166	36.529	4.7	Yes
H77	48	1.516	166	36.519	6.2	Yes
H78	48	1.558	166	36.576	6.6	No

H79/80	48	1.587	166	36.587	4.8	Yes
M115	48	1.592	166	36.087	8.0	No
M140	48	1.550	166	36.125	5.3	No
M149	48	1.498	166	36.262	8.4	No
M150	48	1.532	166	36.123	5.6	No
M50	48	1.470	166	36.180	7.2	No
M51	48	1.478	166	36.231	6.8	No
M52	48	1.466	166	36.298	4.7	No
M53	48	1.486	166	36.306	5.8	No
M59	48	1.505	166	36.192	5.6	No
M60	48	1.579	166	36.124	5.5	No
M62	48	1.578	166	36.105	5.1	No
M64	48	1.558	166	36.119	5.0	No
M65	48	1.517	166	36.157	5.9	No
N10	48	1.113	166	36.218	3.7	Yes
N114g	48	1.169	166	36.259	6.2	Yes
N114h	48	1.280	166	36.260		Yes
N114i	48	1.273	166	36.220		Yes
N11a	48	1.110	166	36.146	7.1	Yes
N11b	48	1.091	166	36.181	5.1	Yes
N11d	48	1.085	166	36.173	7.5	Yes
N14	48	1.089	166	36.110	5.2	Yes
N141	48	1.022	166	36.267	7.3	No
N143	48	1.163	166	36.327	6.6	No
N144	48	1.134	166	36.237	3.6	Yes
N145	48	1.217	166	36.207	3.8	No
N146	48	1.197	166	36.385	6.1	No
N15	48	1.181	166	36.366	4.1	No
N151	48	1.047	166	36.101	4.1	No
N152	48	1.058	166	36.161	5.4	No
N16	48	1.226	166	36.337		Yes
N17	48	1.246	166	36.300		Yes
N20	48	1.244	166	36.249		
N21	48	1.175	166	36.359	5.6	No
N22	48	1.175	166	36.359	7.2	No
N23a	48	1.088	166	30.221	5.0	Yes
N23b	48	1.162	166	36.251	4.3	Yes
N25	48	0.950	166	36.091	5.4	No
N26	48	0.926	166	36.082	4.8	No
N28	48	0.944	166	36.305	4.1	No
N31	48	0.913	166	36.582	5.6	No
N32	48	1.033	166	36.052	4.3	No
S100	48	2.111	166	36.652	7.2	No
S101e	48	2.107	166	36.601	9.4	No
S101f	48	2.099	166	36.629	9.5	No
S102	48	2.031	166	36.652	4.5	No
S103	48	2.050	166	36.755	5.3	No
S104	48	1.985	166	36.574	5.4	No
S105	48	1.994	166	36.518	5.7	No
S106	48	1.980	166	36:543	5.5	No
S108	48	1.950	166	36.502	4.5	No
S130	48	2.104	166	36.755	7.2	No
S81	48	1.739	166	36.675	9.3	No
S82	48	1.772	166	36.686	9.5	No
S83	48	1.802	166	36.721	8.3	No

S84	48	1.773	166	36.777	3.6	No
S85	48	1.746	166	36.738	8.9	No
S86	48	1.871	166	36.639	8.0	No
S88	48	1.943	166	36.619	6.0	No
S90	48	2.124	166	36.707	3.4	No
S91	48	2.138	166	36.692	4.0	No
S92	48	2.159	166	36.698	5.2	No
S98	48	2.074	166	36.645	7.5	No
S99	48	2.086	166	36.668	7.3	No

Appendix III. Border and cover vegetation Snares penguin colonies

Colony	Cover						Border vegetation							
	Olearia		Brachyglottis		Hebe		Open	Grass	Hebe	Olearia	Brach	Rock	Water	Other
	Live	Dead	Live	Dead	Live	Dead								
A0	0%	0%	0%	0%	0%	0%	100%	50%	50%	0%	0%	0%	0%	0%
A139	0%	30%	0%	0%	0%	60%	10%	5%	30%	20%	0%	45%	0%	0%
A147	0%	0%	0%	0%	80%	10%	10%	10%	90%	0%	0%	0%	0%	0%
A148	5%	10%	0%	0%	0%	0%	85%	10%	40%	40%	0%	10%	0%	0%
A1a	90%	10%	0%	0%	0%	0%	0%	0%	5%	95%	0%	0%	0%	0%
A1b	50%	5%	0%	0%	5%	0%	40%	0%	5%	95%	0%	0%	0%	0%
A3	15%	5%	0%	0%	0%	0%	80%	0%	0%	100%	0%	0%	0%	0%
A4	20%	5%	0%	0%	0%	0%	75%	5%	0%	95%	0%	0%	0%	0%
A5	25%	10%	0%	0%	0%	0%	65%	5%	0%	95%	0%	0%	0%	0%
A6	95%	0%	0%	0%	0%	0%	5%	0%	5%	95%	0%	0%	0%	0%
A7d	30%	0%	0%	0%	70%	0%	0%	0%	90%	10%	0%	0%	0%	0%
A7e	0%	0%	0%	0%	100%	0%	0%	0%	100%	0%	0%	0%	0%	0%
A7f	20%	0%	0%	0%	80%	0%	0%	0%	85%	10%	0%	5%	0%	0%
C110	70%	0%	0%	0%	0%	0%	30%	0%	10%	90%	0%	0%	0%	0%
C111	40%	10%	0%	0%	0%	0%	50%	20%	0%	80%	0%	0%	0%	0%
C112	80%	5%	0%	0%	0%	0%	15%	15%	0%	80%	0%	0%	0%	5%
C116	20%	0%	0%	0%	0%	0%	80%	50%	0%	50%	0%	0%	0%	0%
C117	55%	15%	0%	0%	0%	0%	30%	5%	0%	95%	0%	0%	0%	0%
C119	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
C134	70%	20%	0%	0%	0%	0%	10%	10%	0%	90%	0%	0%	0%	0%
C135	100%	0%	0%	0%	0%	0%	0%	0%	0%	50%	0%	0%	0%	50%
C136	85%	5%	0%	0%	0%	0%	10%	0%	0%	100%	0%	0%	0%	0%
C34	40%	10%	0%	0%	0%	0%	50%	0%	0%	100%	0%	0%	0%	0%
C35	45%	0%	0%	0%	0%	0%	55%	5%	0%	95%	0%	0%	0%	0%
C36	85%	0%	0%	0%	0%	0%	15%	0%	0%	100%	0%	0%	0%	0%
C37	90%	5%	0%	0%	0%	0%	5%	0%	0%	80%	0%	0%	20%	0%
C38	85%	0%	0%	0%	0%	0%	15%	0%	0%	100%	0%	0%	0%	0%
C39	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
C40	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%
C41	15%	5%	0%	0%	0%	0%	80%	25%	0%	65%	5%	5%	0%	0%
C43	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
C44	90%	5%	0%	0%	0%	0%	5%	0%	0%	100%	0%	0%	0%	0%
C45	40%	20%	0%	0%	0%	0%	40%	15%	0%	85%	0%	0%	0%	0%
C47	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
C48	80%	0%	0%	0%	0%	0%	20%	0%	0%	100%	0%	0%	0%	0%
C49	95%	0%	0%	0%	0%	0%	5%	5%	0%	95%	0%	0%	0%	0%
H120	35%	10%	10%	0%	0%	0%	45%	0%	80%	10%	10%	0%	0%	0%
H132	0%	0%	100%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
H66/131/72	20%	10%	0%	0%	0%	0%	70%	15%	5%	80%	0%	0%	0%	0%
H69/H133	0%	0%	70%	0%	0%	0%	30%	10%	0%	0%	90%	0%	0%	0%
H71a	35%	15%	40%	0%	0%	0%	10%	0%	0%	60%	40%	0%	0%	0%
H71b	5%	0%	90%	0%	0%	0%	5%	0%	0%	0%	100%	0%	0%	0%
H73	0%	0%	70%	5%	0%	0%	25%	5%	0%	0%	95%	0%	0%	0%
H74	0%	5%	60%	0%	0%	0%	35%	0%	0%	0%	100%	0%	0%	0%
H75	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	85%	15%	0%	0%
H76/H113	0%	0%	45%	0%	0%	0%	55%	15%	0%	10%	65%	10%	0%	0%
H77	70%	0%	0%	0%	0%	0%	30%	0%	0%	90%	10%	0%	0%	0%
H78	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	75%	25%	0%	0%

H79/80	0%	0%	70%	0%	0%	0%	30%	0%	0%	0%	100%	0%	0%	0%
M115	90%	0%	0%	0%	0%	0%	10%	0%	0%	100%	0%	0%	0%	0%
M140	95%	0%	0%	0%	0%	0%	5%	0%	0%	100%	0%	0%	0%	0%
M149	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
M150	40%	0%	0%	0%	0%	0%	60%	10%	0%	90%	0%	0%	0%	0%
M50	60%	5%	0%	0%	0%	0%	35%	10%	0%	90%	0%	0%	0%	0%
M51	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
M52	40%	5%	0%	0%	0%	0%	55%	0%	0%	100%	0%	0%	0%	0%
M53	95%	0%	0%	0%	0%	0%	5%	0%	0%	60%	0%	40%	0%	0%
M59	95%	0%	0%	0%	0%	0%	5%	0%	0%	100%	0%	0%	0%	0%
M60	50%	5%	0%	0%	0%	0%	45%	5%	0%	95%	0%	0%	0%	0%
M62	35%	5%	0%	0%	0%	0%	60%	5%	0%	95%	0%	0%	0%	0%
M64	30%	10%	0%	0%	0%	0%	60%	5%	0%	95%	0%	0%	0%	0%
M65	75%	10%	0%	0%	0%	0%	15%	0%	0%	100%	0%	0%	0%	0%
N10	5%	0%	0%	0%	0%	60%	35%	0%	65%	0%	0%	35%	0%	0%
N114g	0%	0%	0%	0%	5%	85%	10%	0%	35%	0%	0%	65%	0%	0%
N114h	0%	0%	0%	0%	0%	0%	100%	25%	5%	0%	0%	70%	0%	0%
N114i	0%	0%	0%	0%	0%	5%	95%	5%	30%	0%	0%	60%	5%	0%
N11a	0%	0%	0%	0%	40%	40%	20%	0%	100%	0%	0%	0%	0%	0%
N11b	0%	0%	0%	0%	10%	85%	5%	0%	100%	0%	0%	0%	0%	0%
N11d	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
N14	0%	0%	0%	0%	15%	35%	50%	0%	70%	0%	0%	30%	0%	0%
N141	40%	20%	0%	0%	0%	0%	40%	0%	0%	40%	0%	60%	0%	0%
N143	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
N144	0%	50%	0%	0%	0%	50%	0%	10%	50%	40%	0%	0%	0%	0%
N145	0%	5%	0%	0%	5%	90%	0%	0%	90%	10%	0%	0%	0%	0%
N146	10%	75%	0%	0%	0%	0%	15%	0%	15%	85%	0%	0%	0%	0%
N15	10%	0%	0%	0%	0%	0%	90%	10%	10%	50%	0%	30%	0%	0%
N151	5%	15%	0%	0%	5%	10%	65%	10%	50%	40%	0%	0%	0%	0%
N152	20%	80%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
N16	10%	0%	0%	0%	0%	0%	90%	5%	0%	40%	0%	55%	0%	0%
N17	5%	65%	0%	0%	0%	30%	0%	0%	70%	5%	0%	25%	0%	0%
N20	2%	0%	0%	0%	2%	0%	96%	0%	20%	40%	0%	40%	0%	0%
N21	75%	10%	0%	0%	0%	0%	15%	0%	0%	70%	0%	30%	0%	0%
N22	20%	5%	0%	0%	0%	0%	75%	0%	10%	80%	0%	10%	0%	0%
N23a	15%	20%	0%	0%	0%	0%	65%	15%	0%	85%	0%	0%	0%	0%
N23b	35%	10%	0%	0%	0%	0%	55%	0%	5%	75%	0%	20%	0%	0%
N25	30%	5%	0%	0%	40%	25%	0%	0%	70%	30%	0%	0%	0%	0%
N26	5%	60%	0%	0%	5%	30%	0%	0%	15%	80%	0%	5%	0%	0%
N28	70%	0%	0%	0%	0%	0%	30%	0%	0%	50%	0%	50%	0%	0%
N31	95%	0%	0%	0%	0%	0%	5%	10%	0%	90%	0%	0%	0%	0%
N32	30%	25%	0%	0%	0%	0%	45%	5%	5%	55%	0%	25%	0%	10%
S100	5%	0%	0%	0%	10%	0%	85%	5%	15%	80%	0%	0%	0%	0%
S101e	0%	0%	0%	0%	20%	20%	60%	5%	35%	0%	0%	60%	0%	0%
S101f	0%	0%	0%	0%	50%	15%	35%	0%	65%	0%	0%	35%	0%	0%
S102	80%	10%	0%	0%	0%	0%	10%	0%	0%	100%	0%	0%	0%	0%
S103	25%	0%	0%	0%	5%	0%	70%	0%	60%	40%	0%	0%	0%	0%
S104	40%	5%	0%	0%	0%	0%	55%	10%	0%	90%	0%	0%	0%	0%
S105	70%	0%	0%	0%	0%	0%	30%	0%	0%	90%	0%	10%	0%	0%
S106	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
S108	50%	0%	5%	0%	0%	0%	45%	0%	0%	100%	0%	0%	0%	0%
S130	0%	0%	0%	0%	90%	10%	0%	0%	100%	0%	0%	0%	0%	0%
S81	80%	20%	0%	0%	0%	0%	0%	0%	0%	95%	0%	5%	0%	0%
S82	80%	0%	0%	0%	0%	0%	20%	0%	0%	90%	0%	0%	0%	10%
S83	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%

S84	90%	10%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
S85	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
S86	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
S88	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	0%
S90	0%	0%	0%	0%	5%	0%	95%	0%	80%	0%	0%	20%	0%	0%
S91	0%	0%	0%	0%	0%	0%	100%	0%	10%	0%	0%	90%	0%	0%
S92	0%	0%	0%	0%	10%	5%	85%	0%	80%	0%	0%	20%	0%	0%
S98	15%	5%	0%	0%	0%	0%	80%	5%	15%	80%	0%	0%	0%	0%
S99	10%	5%	0%	0%	5%	0%	80%	0%	55%	40%	0%	5%	0%	0%
TOTAL	43%	7%	7%	0%	6%	6%	31%	5%	17%	61%	7%	9%	0%	1%