Quantifying abundance of Hector's dolphins between Farewell Spit and Milford Sound

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ABSTRACT

This report summarises results of an aerial line-transect survey to quantify Hector's dolphin abundance in the coastal area off the South Island West Coast between Farewell Spit and Milford Sound in December 2000 and early January 2001. The primary set of transect lines was placed at 45° to the coast, extending out to 4 nautical miles (n.m.) offshore. Lines were spaced apart at 2 or 4 n.m. intervals in three strata based on existing distribution data. Within strata, sighting effort was uniform. A secondary set of offshore lines ran 4–10 n.m. offshore, and were spaced approximately 30 n.m. apart. Two independent teams of two observers were used in order to estimate perception bias. In addition, dive times were recorded from a helicopter to estimate the proportion of time that dolphin groups are visible at the water surface and 'available' to be counted. A total of 142 separate sightings were made in 1355 km of trackline. Greatest dolphin densities were observed between 41° and 42° S, and between 43° and 43° 31´S. No sightings were made on the transects 4–10 n.m. offshore. Fifty Hector's dolphin groups observed from the helicopter (161 dive/surface cycles) were visible, on average, for about half the time (availability = 46.3%; CV 4.2%). Data from the two independent observer teams suggest that 96.2% (CV 2.3%) of dolphin groups at the surface on the trackline are seen. Correcting abundance estimates for perception bias and availability results in an estimated population of 5388 Hector's dolphins (CV = 20.6%) off the South Island West Coast. The total population estimate for South Island Hector's dolphins is 7270 (CV = 16.2%).

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1. Introduction

As part of an effort to provide updated, robust data on the population size of Hector's dolphin, four line-transect surveys have now been conducted. The first took place in January and February 1998, covering the area between Motunau and Timaru (Dawson et al. 2000). In the 1998/99 summer, a further survey extended this coverage from Timaru to Long Point, 12 n.m. (22 km) west of Te Waewae Bay (DuFresne et al. 2001). In the 1999/2000 summer, the region from Motunau to Farewell Spit was covered (Clement et al. 2001), completing the coverage of the South Island's north, east and south coasts. This report provides a population abundance estimate for the South Island West Coast.

The only previous quantitative population estimate for Hector's dolphins is from a strip-transect survey conducted in 1984/85 (Dawson & Slooten 1988). In addition to being too old to be useful in management, newer, line-transect methodology provides more robust data. The discovery of genetically different sub-populations of Hector's dolphins (Pichler et al. 1998; Pichler & Baker 2000) and results of recent modelling of extinction risk (Martien et al. 1999) highlight the need for updated, fine-grained information on the distribution and abundance of Hector's dolphins.

The three previous line-transect surveys of Hector's dolphin have been conducted from a specially adapted 15 m catamaran. Our standard practice on this vessel is to steam transect lines down-swell in order to reduce pitching. This practice improves observers' ability to make sightings and measure distances to them. On the West Coast, steaming lines down-swell would result in running most lines from SW to NE, which would force observers to look into morning glare. For this reason we adapted our methods to a six-seat, twin-engine, high-wing aircraft. Aerial surveys, while they see a much smaller proportion of the population (which must be assessed in a separate set of trials, as for boat surveys), have the virtue of not requiring any correction for responsive movement (see DuFresne et al. 2001), and allowing a large area to be covered comprehensively within a short window of good weather. The purpose of this report is to describe survey methods and results from an aerial survey of the South Island West Coast.

2. Methods

2.1 SURVEY PLATFORM AND EFFORT

The survey was carried out using a Partenavia P-68, a six-seat, twin-engine, high-wing aircraft. Prior to the survey, the aircraft was modified by replacing the flat rear windows with bubble-windows to allow the rear observers to see directly underneath the plane. The aircraft and pilot were hired from the Canterbury Aero Club.

The aircraft was flown at an altitude of 500 feet at an airspeed of 100 knots. The transect lines were navigated using a Garmin GPS12XL Global Positioning System (GPS) with a Cetrek 343 Chartplotter GPS as map-referenced backup. The direction in which the transect lines were flown was decided in the field according to the glare at that time. All survey work was completed in sea states of Beaufort 3 or less. Glare was scored on a scale of 0 to 4 (0 = no glare). Survey work was discontinued if bubble-window observers were not confident they could see all sightings close to the trackline.

2.2 DESIGN

Design principles followed our previous surveys. The coast was first divided into nine sections of relatively straight coastline. Within these sections, transects were placed at 45° to the baseline. The coastal start point of one transect within each section was chosen randomly, with the rest of the transect lines spaced evenly at 2 or 4 n.m. (see Table 1). Transect spacing was decided on the basis of existing data on dolphin abundance (Dawson & Slooten 1988) and reports of recent sightings. The survey was designed to achieve an abundance estimate with a coefficient of variation (CV) of 30%.

The study area was measured independently by two people (3× each) using a digital planimeter from current high-resolution marine charts.

2.3 OBSERVER TEAM AND PROTOCOL

The survey team consisted of four observers (two on each side of the aircraft) and the pilot. On the first few flights a fifth person assisted with navigation, but this was later found to be unnecessary. Due to all-up weight restrictions, carrying a fifth person reduced fuel allowance and therefore flight time. Flights were typically 2–4 hours. Observers swapped positions diagonally between

TABLE 1. STRATA, EFFORT AND AREA.

STRATUM	TRANSECT SPACING (n.m.)	AREA (km^2)	EFFORT (km)	SIGHTINGS
(1) Northern low density (Kahurangi Pt to Farewell Spit, to 4 n.m. offshore)	4	683.2	94.7	1
(2) Mid-coast high density (Kahurangi Pt to Jackson's Bay to 4 n.m. offshore)	2	3894.9	1017.7	140
(3) Southern low density (Jackson's Bay to Milford Sound to 4 n.m. offshore)	4	937.0	114.3	1
(4) Offshore low density (4 n.m. to 10 n.m. offshore)	30	Not calc.	128.4	0

flights (i.e. the observer in the front right position on the first flight would be in the rear left position on the next flight).

While flying transect lines the rear observers focused their attention on and near the trackline, while the front observers focused their attention at the steepest angle that the flat-windows would allow (60° from horizontal). This resulted in an overlapping field of vision between 40° and 60° (Fig. 1). An overlapping field of vision was required so that observers' effectiveness could be tested against each other and hence the proportion of Hector's dolphin groups missed could be calculated. Observers wore headphones in order to receive instructions from the survey leader, but did not communicate when 'on effort'. Wearing headphones in the noisy environment of the aircraft, and the layout within the aircraft itself, ensured that observers gained no visual or acoustic cues from each other. Information about sightings was shared only after observers had gone 'off effort'.

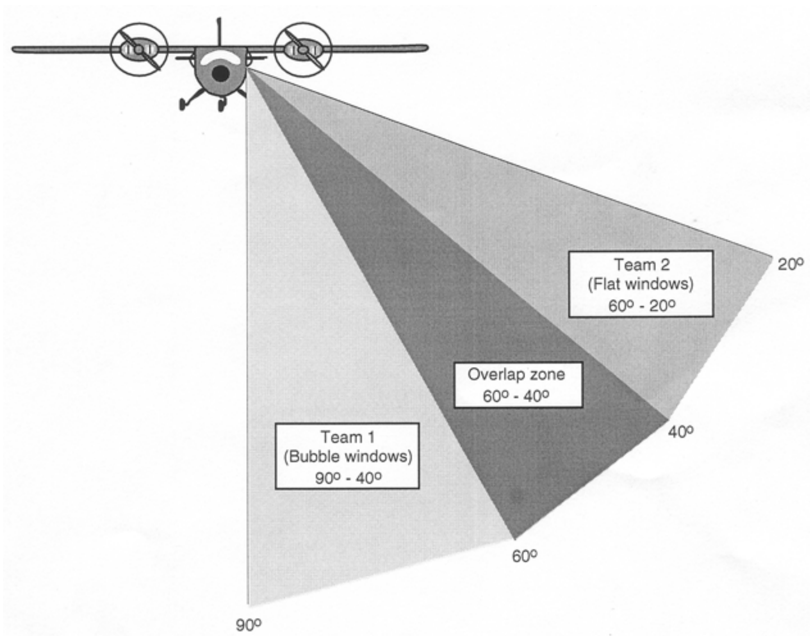

Figure 1. Angles of view from the survey aircraft.

When a group of Hector's dolphins was sighted, the observer measured the downward angle to the group perpendicular to the aircraft's track using a hand-held inclinometer (Suunto PC5/36D PC13). Sighting details were dictated into personal dictaphones (one for each observer, and one carried as backup), with time of sighting noted (to the second) from digital clocks (one for each observer) that were synchronised with GPS time at the start of each flight. These clocks were attached by Velcro to the window ledge so that the observers could see the time without taking their eyes off the sighting; time of sighting was used to locate positions of sightings on transects. A GPS-linked Hewlett Packard 200LX palmtop computer with custom-written software was used to record starts and ends of transect lines, details of effort (via recording a GPS fix every 20 sec) and sighting conditions (recorded by the survey leader at the start of each transect, and whenever they changed). Data were downloaded at the end of each day and during refuelling stops. Each observer was responsible for transcribing and checking their own sighting data at the end of each day.

The survey was conducted in 'passing mode' (Buckland et al. 1993). Hector's dolphins are highly visible from the air, and their typically small group sizes made it easy to count animals. In a few cases when we observed large groups (10+), we broke off effort, circled in order to resolve uncertainty, then rejoined the trackline and resumed effort.

Data from the palmtop computer were downloaded onto a Macintosh laptop computer at the end of each day and backed up.

To familiarise the pilot and observers with survey protocols, we conducted four training flights on which we made 83 sightings on 26 transects. These data were used for training only, and are not analysed here.

2.4 ESTIMATING THE FRACTION MISSED

No aerial survey of cetaceans can be expected to count all the animals present (Marsh & Sinclair 1989). Some will be underwater at the time the aircraft passes overhead, and hence not available to the survey method. Additionally, not all the sightings that are available to observers will be recorded, due to glare, fatigue or inattention. These two factors are respectively referred to as availability bias and perception bias (Marsh & Sinclair 1989). Both are combined in $g(0)$, the probability of recording a sighting on the trackline.

Quantifying the proportion of time dolphin groups spend at the surface is a standard way to correct for availability bias (e.g. Barlow et al. 1988). Between 20 December 2000 and 7 January 2001, we spent a total of 5 days observing dolphin groups from a Robinson R22 two-seat helicopter, in the area between Karamea and 21 n.m. south-west of Westport. Flights were conducted at 60–80 knots, at an altitude of 500 ft. On finding dolphins, the pilot circled so that the observer could record dive and surfacing times, which were measured using a custom-written program running on an HP 200LX palmtop computer interfaced with a Garmin GPS12XL GPS. Dictaphones and stopwatches were used as backup. To help the pilot and observer retain a visual reference, a Rhodamine dye 'bomb'[1] was dropped near the dolphin group. To prevent preponderance of one or a few groups' data in the database, we ensured that no group was observed for more than ten dive/surface cycles.

The proportion of time spent at the surface was calculated for each group of dolphins by dividing the total amount of time the group was visible at the surface into the total amount of observation time. Each observation period consisted of a sequence of times at which the dolphins became visible as they surfaced and disappeared out of sight as they dived.

Perception bias was assessed via double counts made by independent observer teams (see below).

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[1]Dye bombs comprised a tablespoon of Rhodamine dye in a paper cup two-thirds filled with sand. An additional (empty) paper cup was taped upside down to the other with paper-based masking tape. On impact the two cups broke apart, releasing the sand/dye mix into the water.

2.5 DATA ANALYSIS

2.5.1 Abundance estimation

Within each stratum, Hector's dolphin abundance (*N*) was estimated as:

$$N = A\ n\ s / \{2\ L\ ESW\ g(0)\} \qquad (1)$$

where *A* is the size of the study area, *n* is the number of groups seen, *s* is the expected group size, *L* the length of transect line surveyed, *ESW* the effective half strip width, and *g*(0) the probability of seeing a group directly on the transect line.

Plots of group size against latitude showed no geographic trends in group size or locations with especially large or small groups. Also, there was no significant relationship between group size and perpendicular distance (linear regression; $p = 0.39$: as an additional check of this we ran Distance with the 'size bias' option checked; this changed only the second decimal point of the group size estimate). Therefore expected group size was estimated as a simple mean of observed group size. To eliminate the possibility of twice including a sighting seen by both front (flat-window) and rear (bubble-window) observers, we used all bubble-window sightings from 90° (directly under the aircraft) to 59°, and flat-window sightings less than or equal to 58°.

Perpendicular distances were right-truncated (as recommended by Buckland et al. 1993) at 330 m, leaving 136 sightings for estimating *ESW* and cluster size. Using the program Distance 3.5 (release 5; Thomas et al. 1998) five models were fitted to the distance data (Hazard/Cosine, Hazard/Simple polynomial, Half-normal/Hermite, Uniform/Cosine, Half-normal/Cosine) in order to estimate *ESW*. Akaike's Information Criterion (AIC, Akaike 1973) was used to select among models. Goodness of fit was evaluated with six manually specified cutpoints. Group size and *ESW* were estimated globally, with encounter rate and density estimated by stratum.

2.5.2 Estimating availability bias

The proportion of time visible at the surface was calculated by adding all the time periods that the dolphins were visible at the water surface and therefore available to be counted, and dividing this total this total into the total observation time. To avoid bias in estimating proportion of time any particular group spent at the surface, we ensured that the numbers of dive and surface intervals available for that group were equal. We chose to use a simple mean of the estimates for each group. Weighting the analysis by the number of dive/surface cycles seen for each group changed the overall estimate of availability bias very little (< 1%) and produced an unrealistically small CV (< 1%). This availability correction will lead to slightly optimistic (biased high) population estimates, as it assumes the observers have only a split second to spot each dolphin group (very small field of view and very fast plane speed). Because observers look down and forward, an observer views each section of water for several seconds.

2.5.3 Estimating perception bias

The flat-window and bubble-window observers had a zone of overlap from 40° to 60° in which duplicate sightings could be made (Fig. 1). In this zone, we have data on how many sightings were seen by one observer, but not the other. These data were used to estimate the probability of observers seeing dolphin groups that were at the water surface, using a maximum likelihood method developed by Manly et al. (1996). This method corrects for perception bias by fitting a logistic curve to data from independent observers, recorded using a double-counting protocol. Variables that influence detection probability include observer position, group size and distance from the trackline. A series of five models were fitted using maximum likelihood (Manly et al. 1996). These varied from a simple model in which detection probability was the same for front and rear seat observers and not affected by either distance from the trackline or group size (Model 1), to the most complex model in which probability of detection is different for the two observer positions and depends on both distance from the trackline and group size (Model 5). The relative fit of the models was based on AIC values. The best fitting model was Model 4, in which the probability function for sighting a group depends on observer position and distance from the trackline, and depends on dolphin group size in the same way for front- and rear-seat observers.

Bootstrapping was used to estimate a mean and standard error for perception bias. One thousand replicate data sets were generated by bootstrapping from the original data set. Each data set was analysed using Model 4 (Manly et al. 1996). This resulted in 1000 estimates for sighting probability on the trackline (from the rear seat, with the bubble-window). The mean of these is our estimate of perception bias. The standard error was computed as the standard deviation of the bootstrapped estimates.

The coefficient of variation (CV) for the abundance estimate was calculated from the coefficients of variation of each variable element in Equation 1:

$$\mathrm{CV}(N) = \sqrt{\{\mathrm{CV}^2(n) + \mathrm{CV}^2(s) + \mathrm{CV}^2(ESW) + \mathrm{CV}^2[g(0)]\}} \qquad (2)$$

The CV(n) was estimated empirically as recommended by Buckland et al. (1993):

$$\mathrm{CV}(n) = \sqrt{\{\mathrm{var}(n)/n^2\}} \qquad (3)$$

where: $$\mathrm{var}(n) = L \sum l_i(n_i/l_i - n/L)^2/(k - 1) \qquad (4)$$

where l_i is the length of transect line i, n_i is the number of sightings on transect i, and k is the total number of transect lines.

CV(s) was estimated from the standard error of the mean group size. CV(ESW) was estimated via Distance's bootstrapping option (999 bootstrap replicates). This process incorporates uncertainty in model fitting and model selection. The CV[g(0)] was estimated as the standard deviation of bootstrap estimates of perception bias at the mean group size found in the survey, and from the standard error of the mean proportion of time each group spend at the surface.

Calculations of abundance, combining estimates of availability and perecption bias, were performed within Distance via its 'multiplier' option, which requires input of the value and its standard error.

The CV of the combined stratum estimates (and of the total population) was calculated via:

$$SE(total) = \sqrt{\{SE^2(N_1) + SE^2(N_2) + SE^2(N_3)\}} \quad (5)$$

and $$CV(total) = SE(total)/N(total). \quad (6)$$

Log-normal confidence intervals of abundance (Buckland et al. 1993, p. 118) were calculated from Distance's bootstrap estimates of the standard error of abundance.

3. Results

On the Farewell Spit–Milford Sound line-transect survey, we flew 122 transect lines (Figs 2–4) making a total of 207 sightings. After removing duplicate sightings and those that were data-deficient (e.g. angle not measured), 142 sightings remained (three of these are not shown on Figs 2–4 because, although we know which transect they were recorded on, exact time was not recorded, and hence we do not know the exact location on the transect line). No sightings were made on any of the transects in the offshore zone (effort = 128.4 km). Effort in the 0–4 n.m. inshore zone was 1226.7 km of trackline (Table 1).

As expected, the greatest numbers of sightings were made around and north of Westport, and in the area south of Hokitika around Okarito to Heretaniwha Point (Figs 2–4). These were also high-density areas in the 1985 boat survey (Dawson & Slooten 1988).

From the helicopter we observed 161 complete surface/dive cycles, from 50 groups ranging in size from 1 to7 individuals (mean = 3.36, CV = 5.5%). When foraging, Hector's dolphins tend to undertake long dives of 1 to 1.5 minutes, then swim close to the surface, breathing 5–7 times, then go on another long dive (Slooten & Dawson 1994). From the air, dolphins were almost always continuously visible during the period between dives (see Barlow et al. 1988 for similar result from harbour porpoise). Only in extremely turbid water (e.g. river mouths) did dolphins occasionally disappear from view between breaths. Availability, or proportion of time dolphin groups were visible, ranged from 0.80

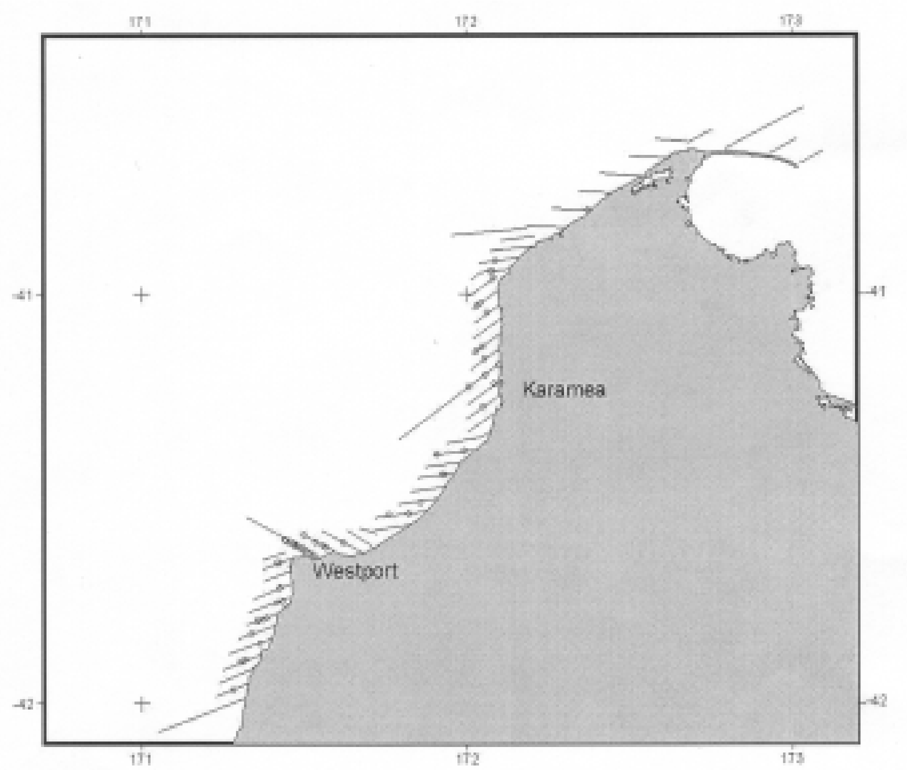

Figure 2. Transect lines and sightings, Karamea, Westport.

 (Paragraph above Results corrected, May 2002)

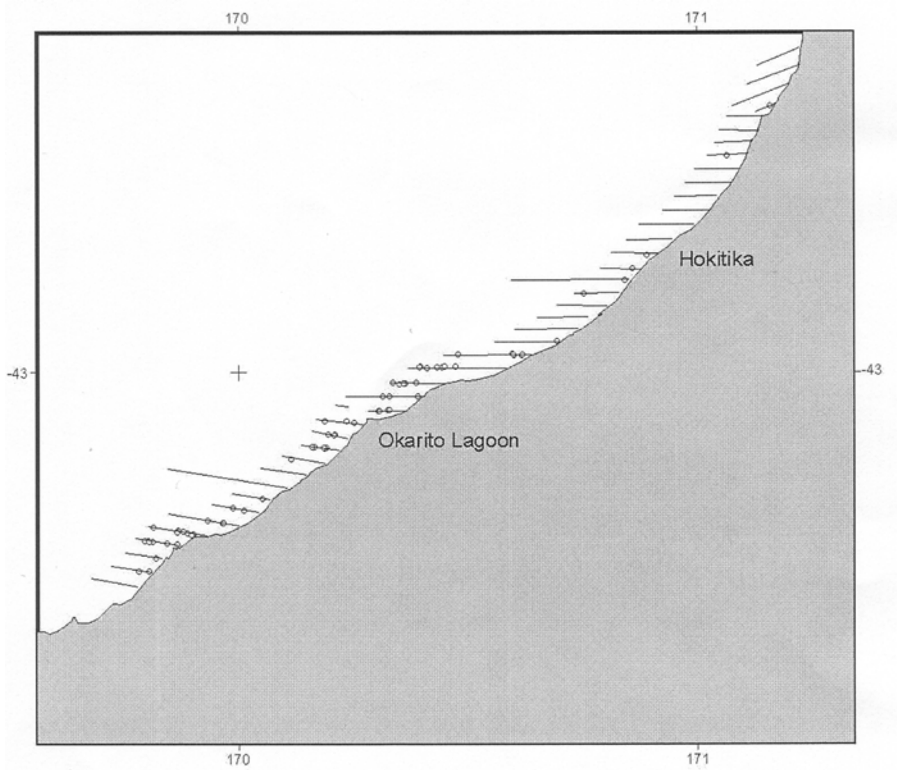

Figure 3. Transect lines and sightings, Hokitika, Okarito Lagoon.

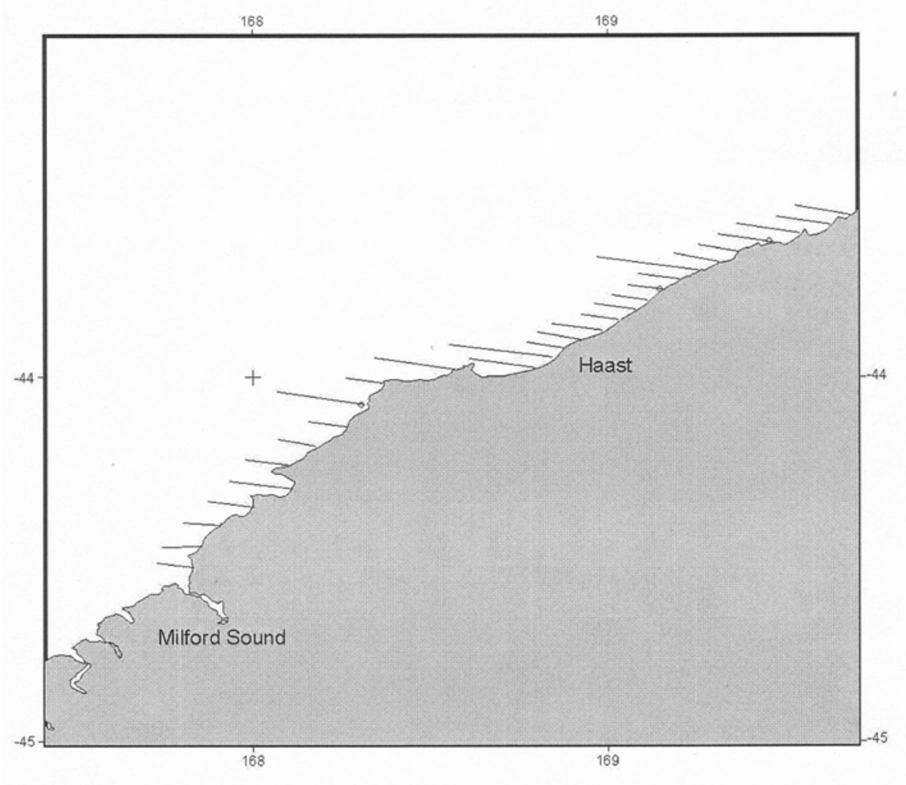

Figure 4. Transect lines and sightings, Haast, Milford Sound.

for groups that were 'surface active' to 0.19 for groups that were 'long-diving' (see Slooten 1994, for behavioural definitions). Mean proportion of time visible from the air was 46.3% (CV = 4.2%; Table 2).

Perception bias, the probability of the observers seeing dolphins that were on the trackline at the water surface, and therefore available to be sighted, was estimated using the double-count data from the two observer teams.

TABLE 2. PARAMETERS ESTIMATED ACROSS STRATA.

PARAMETER	POINT ESTIMATE	CV (%)
Effective strip width, *ESW* (m)	240.5	5.98
Group size	2.184	5.64
Availability bias	0.463	4.23
Visability bias	0.962	2.26

Seventy-seven sightings were made in the overlap zone seen by both observers. Sighting probability on the trackline was estimated at 96.2% (CV = 2.26%).

After truncation, 136 sightings were available to model the detection function, comfortably exceeding the rule of thumb of Buckland et al. (1993) that 60–80 sightings are needed for robust estimation of effective strip width. A Hazard/Cosine model proved to be the best fit, based on AICs (Fig. 5). Because only one sighting is available for each of strata 1 and 3, density and abundance estimates are highly imprecise (CVs > 90%; Table 3). This is of little consequence, as the

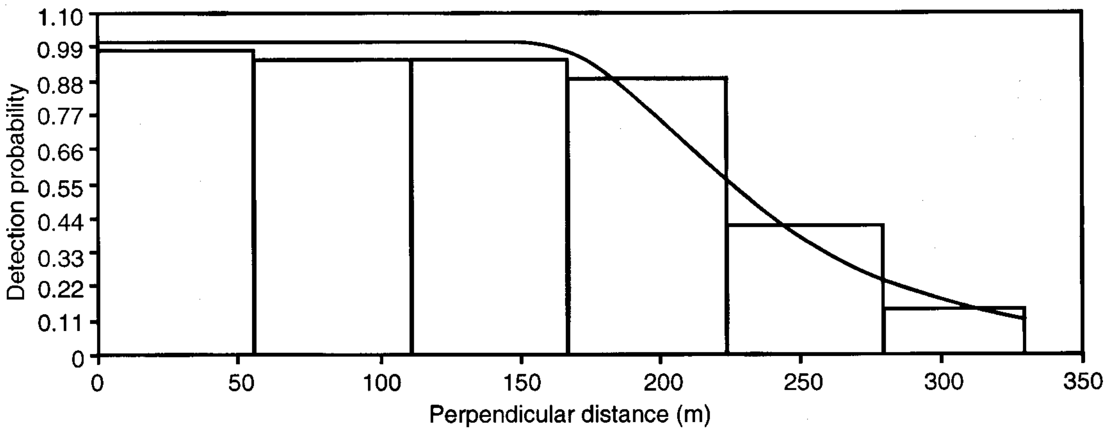

Figure 5. Detection function fitted to the distance data (n = 136 sightings).

TABLE 3. ESTIMATES WITHIN STRATA, CORRECTED FOR AVAILABILITY AND PERCEPTION BIAS.

	POINT ESTIMATE	CV (%)	LOWER 95%CI (bootstrap)	UPPER 95%CI (bootstrap)
Stratum 1. Farewell spit–Kahurangi Pt				
Number of sightings (after truncation @ 330 m)	1			
Dolphins/km^2	0.108	97.43	0	0.358
Abundance	74	97.92	0	244
Stratum 2. Kahurangi Pt–Jacksons Bay				
Number of sightings (after truncation @ 330 m)	134			
Dolphins/km^2	1.343	21.07	0.887	1.970
Abundance	5230	21.08	3454	7672
Stratum 3. Jacksons Bay–Milford Sound				
Number of sightings (after truncation @ 330 m)	1			
Dolphins/km^2	0.089	104.87	0	0.312
Abundance	84	104.49	0	292

data show that abundance in these areas is low. Stratum 2, however, with 134 sightings, produced highly precise density and abundance estimates (CV c. 20%; Table 3). In each case variance in encounter rate was by far the largest contributor to variance in density estimates (Table 4). This indicates that gains in precision would be better attained by more survey effort and optimised design than by putting more effort into estimating perception or availability biases, for example. Combining the estimates from each stratum results in an estimate of 5388 (CV = 20.6%) Hector's dolphins on the South Island West Coast (Table 5).

TABLE 4. PERCENTAGE CONTRIBUTION OF PARAMETERS TO ESTIMATE OF VARIANCE IN DENSITY.

	STRATUM 1	STRATUM 2	STRATUM 3
Effective strip width	0.4	8.3	0.2
Encounter rate	99.0	78.9	99.4
Cluster size	0.4	7.4	0.2
g(0)	0.1	1.2	0.0
Availability	0.2	4.2	0.1

TABLE 5. ESTIMATES OF TOTAL ABUNDANCE OF HECTOR'S DOLPHIN, SOUTH ISLAND, NEW ZEALAND.

	ABUNDANCE	CV (%)	LOWER 95%CI (log-normal)	UPPER 95%CI (log-normal)
West Coast	5388	20.6	3613	8034
North, east and south coasts[1]	1882	21.3	1246	2843
Total SI population	7270	16.2	5303	9966

[1]From Clement et al. 2001

4. Discussion

This survey demonstrated that aerial line-transect techniques can work well for Hector's dolphins. In part this is because the animals are highly detectable from the air, the light grey of the body standing out obviously against a green or blue background. That aerial surveys do not cause responsive movement is an advantage, but the speed with which aircraft move makes it even more necessary to estimate availability bias than for boat surveys. The single greatest advantage demonstrated on this survey is the ability to cover large areas in a short period of good weather. Hence in areas where good sighting conditions occur only in short time 'windows', we believe aerial surveys are favoured. In our view aerial surveys are not suitable for high-resolution surveys of complex coastlines, for example harbours, sounds and fiords, where transects would be short and finely spaced. There are also some limitations in areas where human residents may object to noise (e.g. Akaroa Harbour), in places where aerial traffic is already heavy (e.g. Milford Sound), and where civil aviation regulations prohibit low-altitude flight.

Estimation of distances from survey aircraft is easier and more accurate than from vessel surveys, for three reasons: (1) only one angle (vertical) is estimated at the time the sighting passes 90° (on ship surveys both vertical and horizontal angles must be estimated); (2) the steep angles to the sightings make for more favourable geometry for calculating perpendicular distances; and (3) inclinometers are much easier to use than reticle-equipped binoculars used on ship surveys.

The best way to assess sighting probability is via double counts made directly on the trackline. Given that the aircraft we used had no belly window and had bubble-windows only in the rear seats, the best alternative was to use the method of Manly et al. (1996) for modelling sighting probability from data gathered in the zone of overlap between the front- and rear-seat observers (40°–60°). This method is less direct, but in our case has few other disadvantages because the detection function is almost flat over the range of sighting distances that 40°–60° angles represent (88–182 m). Our estimate of sighting probability is high, but this is not surprising considering how easily detectable Hector's dolphins are from the air. This estimate of perception bias applies only to our survey, as it is dependent on who the observers were, the aircraft layout, and the windows we used. The correction for it is small, as bubble-window observers concentrated their sighting effort on the trackline. Likewise our estimate of availability bias is from a 110 km stretch of coast in the vicinity of Westport, and may not apply to Hector's dolphins on other coasts.

The abundance estimate for the West Coast (Table 5) is precise by the standards of good quality line-transect aerial surveys (e.g. Forney et al. 1994). Improvement is certainly possible, however. The contribution of the various parameters to the estimate of variance in density (Table 4) provides useful guidance for future aerial surveys for Hector's dolphin. Since variance in encounter rate is the most important contributor to total variance, every step should be taken to minimise this. The current survey was as well-designed as the existing information allowed. It shows, however, that a two-phase survey, in which an initial set of flights to quantify distribution are used to set up strata and allocate effort in a subsequent set of 45° transects, might improve accuracy and precision. If this is considered, the initial-phase surveys should be alongshore, perhaps down the coast at 0.5 n.m. offshore, and back further offshore, perhaps at 1–2 n.m. This design would be likely to see the most dolphins, and maximise efficiency (it would **not** be a good design for the second phase as it is too sensitive to changes in offshore distribution). It would allow coverage of the West Coast from Farewell Spit to Milford Sound (c. 375 n.m.) in less than eight hours of flying. Stratification based on these data should allow for a buffer zone of 30 km or so north and south of the high-density areas to ensure that dolphin movement (Bräger et al. submitted for publication) does not render stratification inappropriate. This is needed because, if a stratum division was placed close to a cluster of high density, that cluster might move out of the stratum before the second phase of the survey was complete. Additionally, to minimise change in distribution between the survey phases, the second phase should immediately follow the first phase.

The line-transect estimate presented here is larger than the previous estimate (Dawson & Slooten 1988) which was from a strip-transect survey conducted from a 4 m inflatable boat. Large differences between old and recent surveys were not evident on the east coast, where recent surveys have employed line-transect methods from a 15 m catamaran (Dawson et al. 2000; DuFresne et al. 2001; Clement et al. 2001). In part the difference could arise from ocean swell having a much greater effect on dolphin sightability from the small inflatable on the West Coast than on the east coast, where swells are typically much smaller. Additionally, line-transect methods are intrinsically superior to strip-transect methods, because the strip width is empirically estimated by the sighting data. Bräger and Schneider (1998) report dolphin sightings from the West Coast of the South Island, made between 1995 and 1997. Their surveys were not designed to estimate abundance, but like ours indicate that the West Coast is a stronghold for Hector's dolphins.

South Island Hector's dolphin was recently classified as endangered (lUCN 2000). The new total abundance estimate (7270, CV = 16.2%, Table 5) will not change that status. It is likely that one of the currently applied criteria for endangered status is no longer appropriate (population fewer than 2500 mature individuals). However, the first lUCN criterion still applies (observed, estimated, inferred, projected or suspected population decline of 50% or greater over a 10 year or three generation period; e.g. see Martien et al. 1999).

5. Acknowledgements

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