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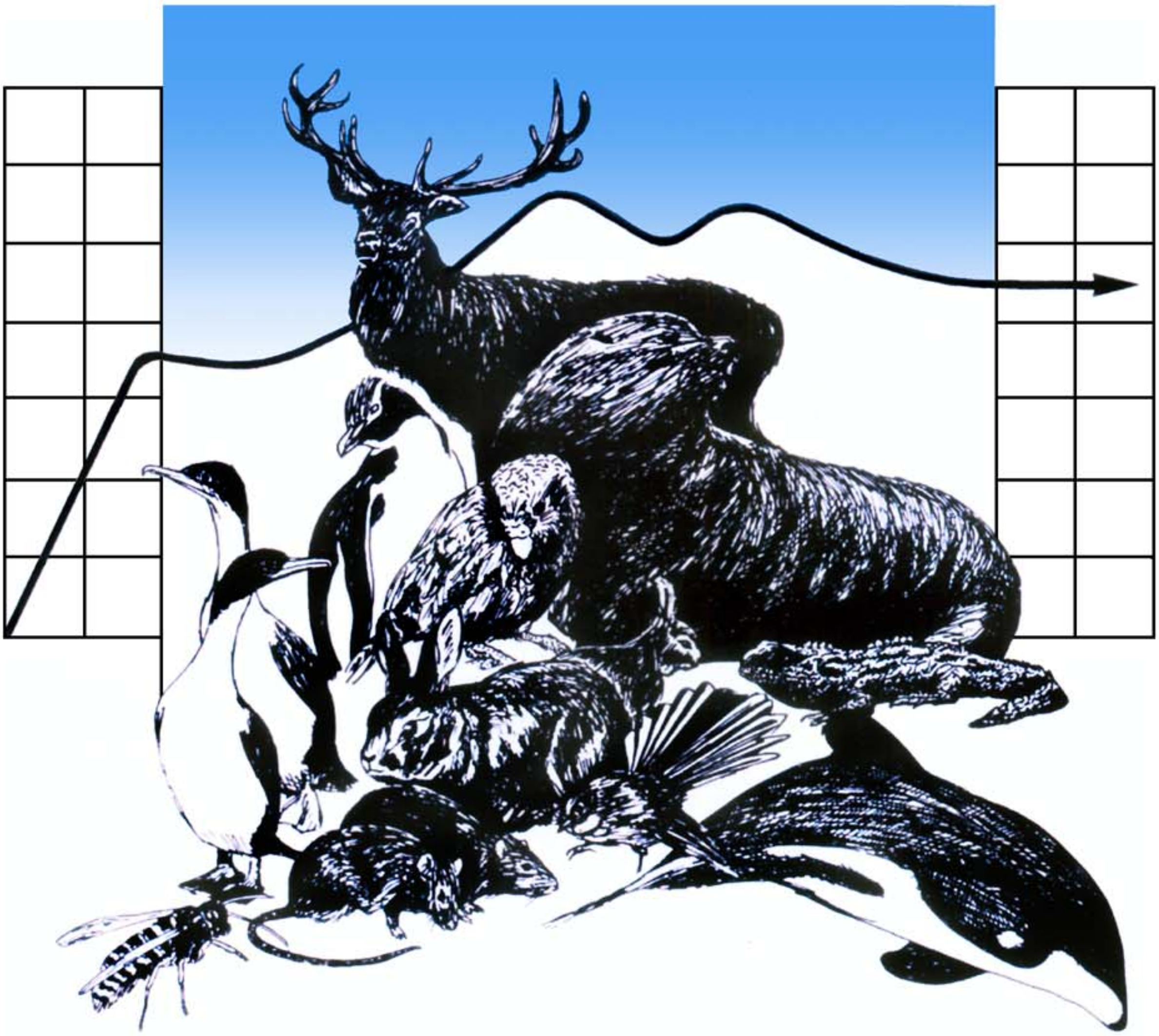

WILDLIFE MANAGEMENT

Abundance of Banded Dotterels (*Charadrius bicinctus*) in the Upper Ahuriri River – A comparison of methods

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Abstract

Braided rivers are an uncommon geological feature globally but are a characteristic feature on the eastern side of the Southern Alps in New Zealand. Braided rivers provide a breeding ground for a number of endemic bird species including Banded Dotterels (*Charadrius bicinctus*). In the past walk through river surveys have been conducted whereby the observer counts all birds that are seen. This method results in a minimum population size for each species counted, however, it does not provide any indication of the precision of the estimate and does not account for animals present in the system but not detected. Distance sampling can provide direct estimates of bird density that are not confounded by detectability and it has the potential to be applied in the braided river environment. The aim of this study was to trial distance sampling on Banded Dotterels in the braided Ahuriri River and to compare the estimates of density and abundance with those obtained from the conventional walk through method.

Keywords Banded Dotterels, *Charadrius bicinctus*, braided rivers, survey, Ahuriri

Introduction

Braided rivers are not a common phenomena world wide. They are found in temperate piedmont and mountain-valley areas, primarily containing young eroding mountains (e.g. Alaska, Canada, New Zealand, the Himalayas, and Japanese Alps) (Tockner *et al.*, 2005) Conditions which promote braided channel formation include (i) an abundant supply of sediment, (ii) rapid and frequent variations in water discharge, and (iii) erodable banks of non-cohesive material (Church and Jones, 1992). Braided rivers consist of multiple channels with bars and islands which are dynamic in nature and disturbance regimes (i.e. flooding) are an important factor in controlling community structure and ecosystem function (Van der Nat *et al.*, 2003).

In New Zealand braided rivers are a prominent feature on the eastern side of the Southern Alps and many plants and animals are adapted to living on these riverbeds (DOC, 1993) Six endemic birds; Banded Dotterel (*Charadrius bicinctus*), Black-billed Gull (*Larus bulleri*), Black-fronted Tern (*Sterna albostriata*), Kaki (*Himantopus novaezealandiae*), South Island Pied Oyster Catcher (*Haematopus finschi*) and Wrybill (*Anarhynchus frontalis*) breed primarily in braided river habitats (Maloney *et al*, 1997). These birds and other plant and animal species are coming under increasing pressure due to changes to their habitat through human-altered flow regimes, invasions of introduced weeds, recreational activities disturbing birds as well as predation by introduced mammals (Balneaves, 1989; Ligon *et al*, 1995; Sanders and Maloney, 2002; Murphy *et al.*, 2004).

Surveys have been conducted to measure bird density and diversity in the braided riverbeds in the Upper Waitaki Basin (Maloney *et al.*, 1997; Maloney, 1999). From these surveys a minimum population size for each species can be established and this data has been analysed and compared between consecutive years (Maloney *et al.*, 1997; Maloney, 1999). However, this index of abundance does not have any measures of precision and does not account for the individuals that are present in the system but not detected. It relies upon the assumption that the number of animals detected represents a constant proportion of actual numbers present across space and time (Thompson, 2002). Actual population size remains unknown and for some of the more threatened species such as the wrybill this could have implications for knowing the effectiveness of any conservation measures that are being employed.

Distance sampling may potentially be a viable alternative to the conventional survey method in the braided rivers. When applied properly it provides direct estimates of bird density that are not confounded by detectability (Buckland *et al.*, 2001, Rosenstock *et al.*, 2002). Distance sampling is based on a detection function, denoted as $g(x)$, which is the probability of detecting an object given that it is at distance x from the line (Buckland *et al.*, 2001). This detection function compensates for the fact that detectability decreases the further the object is from the line. Distance sampling relies on four key assumptions: (1) all animals on the line are detected, (2) animals are detected prior to evasive movement, (3) Distances are estimated or measured accurately and (4) sightings are independent (Buckland *et al.*, 2001, Rosenstock *et al.*, 2002). Distance sampling offers a rigorous approach to obtaining valid density estimates as long as these assumptions are met.

Initially distance sampling was going to be carried out simultaneously on Banded Dotterels, South Island Pied Oystercatcher (SIPO) and Wrybills but due to small numbers of SIPO and Wrybills in the sampling area there would not be enough time to do enough transects to get the number of detections required for a robust analysis so only distance sampling on Banded Dotterels was carried out. Therefore, the objective of this research was to act as pilot study, using Banded Dotterels as an example, to assess whether there is the potential to use distance sampling to obtain more precise and robust estimates of density and abundance of bird species in braided rivers. I will also compare the minimum population sizes and density estimates from past surveys of the same section of river with the estimates calculated from this study.

Methods

Study Area

The Ahuriri River is a braided river that flows for 77.2 kilometres through the southernmost part of the Upper Waitaki Basin and discharges into Lake Benmore. The sampling area was a section of river (E2240218 N5661180 to E2239127 N561176 NZ Map Grid) in the Upper Ahuriri River of approximately 10km in length and covering an area of 290 hectares (ha), outlined by the bold lines in Figure 1. This area coincides with the sectioning up of the Ahuriri River used for previous river surveys (see Maloney *et al.*, 1997). This section of river is characterized by stony braids that had limited vegetation except for the braids that were adjacent to the farmland and where grass had encroached onto the riverbed. The gorge region (25 ha) of this section of river (Fig. 1) was not sampled for distance analysis because of the absence of the braids that characterize the rest of the sampling area and which therefore did not support the habitat requirements of banded dotterels. Therefore, the area used in the analysis of the data was 265 ha.

Data collection

Distance sampling

Due to the dynamic nature of the braids in the river it was not possible to place pre-determined transects on a map for the observer to follow. The procedure that was followed was that the observer would start at the middle of a braid look down into the distance and get a landmark in line with the middle of the end of the braid and use that as a reference point for the line that was to be followed. Global Positioning System (GPS) was used to plot the start and finish points for each transect so that length (km) could be calculated. Distance sampling was carried out over two days with transects being conducted on the braids that had not been sampled on the first day.

The perpendicular distance of the banded dotterel from the line was classified into one of 5 grouped intervals (0-5m, 5-10m, 10-15m, 15-25m, 25m+). The collection of grouped data allows a relaxation in the assumption that distances are measured exactly, instead, the assumption is made that only that an object is counted in the correct distance interval (Buckland *et al.*, 2001). To satisfy this assumption the observer underwent a day of training to practice being able to accurately estimate distances from the line.

Survey protocol and the observer's search behaviour were designed to ensure a detection probability of 1 on the line and to detect animals prior to a response movement. The observer spent the majority of the time searching forward and near the line, moving at a sufficient pace (about 3 km h^{-1}) to ensure that animals were not counted multiple times which would lead to density being over estimated (Buckland *et al.*, 2001).

River survey

The survey method is similar to that of Maloney *et al.* (1997). The observer walked downstream at a constant pace (about 3 km h^{-1}) and where possible tried to stay walking through the middle of unvegetated gravel banks and islands and near the water to try and increase the likelihood of observing the cryptic Wrybill. Birds were recorded only when they moved upstream of the observer. If birds moved downstream of the observer or left the sampling area they were recorded and if by the end of the survey the number of birds of one species seen flying downstream was greater than the total of that species recorded for the survey then the difference between them would be added to the total. Data was recorded instantly on a tally sheet. Passerines were not included in this survey.

Surveys of the river section were repeated until the cumulative variance of surveys began to stabilize for banded dotterels, Wrybills, black fronted terns and south island pied oyster catcher. Seven surveys were conducted over a 3 week period on fine, clear days.

Data analysis

Distance sampling

The program DISTANCE (Laake *et al.*, 1993) was used to calculate the detection probability function that best fits the perpendicular distance data and to estimate the density and abundance of banded dotterels with 95% confidence intervals.

The best fitting detection function was selected by the lowest Akaike Information Criterion (AIC) and with the best precision (% coefficient of variation).

The AIC identifies the model that best fits the data with the minimum number of parameters (Buckland *et al.*, 2003).

River survey

The minimum population size estimates for each species were defined as the highest single total count of each species over all the surveys (Maloney *et al.*, 1997). Minimum densities were calculated by dividing the minimum population estimate by the area of the survey.

Results

With all detections (n = 99) included in the analysis the goodness-of-fit (GOF) test was significant which indicated that the fit of the model was significantly different to that of the data. When detections beyond 25m were omitted (n = 91) the precision of the estimate for density and abundance improved and the GOF test was not significant so detections beyond 25m were discarded to improve the analysis.

The best fit for the detection probability function calculated with the programme DISTANCE is shown in Figure 2. The estimated values calculated for banded dotterel density (birds/ha) and abundance were 3.31 and 876 respectively with corresponding 95% confidence intervals (Table 1). The minimum population density and size for banded dotterels derived from the conventional river survey data was 0.4 and 106 respectively (Table 2).

From the river survey data there is quite a bit of variation in the minimum population size between the survey years for different species (Fig. 3). In 1992 and 2005 there were no Black Billed Gulls present in the sampling area and no Kaki were seen in the 2005 river survey (Table 3). Banded dotterels remain the most abundant of the endemic wading birds in this area across all of the surveys (Fig. 3). There appears to be a rather dramatic decrease in the minimum population size and density estimates for the SIPO between the 1994 and 2005 surveys (Fig. 3 and Table 2).

Discussion

Nesting home range sizes of Banded Dotterels measured in the Rakaia and Ashley Rivers averaged 1.5 and 1.0 ha respectively (Hughey, 1998) so the density estimate produced by DISTANCE of 3.31 birds ha^{-1} seems reasonable based on these figures. The estimate of abundance (876 birds) from the distance analysis was derived from the density estimate and the size of the total sampling area. There is a considerable difference between this value and the minimum population size estimate of 106 birds from the conventional river survey. Although the observer is likely to have missed a number of birds it is unlikely that they failed to detect over 700 birds within the sampling area. A possible explanation could be that the total sampling area may have been slightly over estimated, hence inflating the abundance estimate. However, this is unlikely to be significant enough to considerably reduce the abundance estimate. A more feasible explanation is that the density estimate is too high.

As previously mentioned the assumptions of distance sampling must be met to obtain a reliable estimate of density and the resulting abundance. Although every effort was made to detect birds prior to evasive movement it is possible that this assumption did not hold. Due to their territorial nature during the breeding season Banded Dotterels are attracted to the observer. If the birds are not detected at their initial location and are infact detected once they have moved closer to the observer then this can positively bias the density estimate. One way to resolve this issue would be to have two observers walking the line transect with each person focusing on just one side of the line increasing the likelihood of detecting the bird before it moves. The assumption that all individuals must be independent was also compromised in this study due to field work being carried out during the breeding season which runs from July-January (Robertson and Heather, 1999). Banded Dotterels pairs remain together until the chicks have fledged so, therefore, the sightings were not independent events. It would have been better, if circumstances had permitted, to have carried out the distance sampling after the breeding season but before the birds move to the coasts of the North and South Islands or migrate to Australia for winter (Robertson and Heather, 1999). If these changes were incorporated into a future study then there can be more confidence in the density and abundance estimates.

Although distance sampling was only carried out over a relatively small section of river and for only one species of bird in this study it has the potential to be expanded to entire river lengths and multiple species. The sampling of entire river lengths would mean that there would be an adequate number of detections to support a robust analysis of a range of different species. If field work was to be carried out in January, this would avoid the breeding season of Banded Dotterels, Wrybills and SIPO but not the black-fronted terns and black billed gulls which continue until February (Robertson and Heather, 1999) and they nest in colonies. However, these colonies can be analysed in DISTANCE as clusters and each colony would be one observation with cluster size also being recorded (Buckland *et al.*, 2001).

The comparison of the 1994 and 2005 conventional river surveys show that there have been increases in both wrybill and black fronted tern minimum population sizes. However, for the black fronted terns the minimum population size in 2005 is still lower than that in 1993. There has also been a drop in the minimum population size of SIPO in this section of river by a dramatic 31% between 1994 and 2005. The benefits of obtaining reliable estimates of density and abundance through the use of distance sampling would be invaluable to be able to more intensely monitor the population trends throughout the Upper Waitaki Basin to aid and improve the conservation of the avian fauna on braided riverbeds.

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Figure 1. Map of the Upper Ahuriri River, South Canterbury with the sampling area outlined by the bold line. The shaded area is the gorge region of the river that did not have any transects in it.

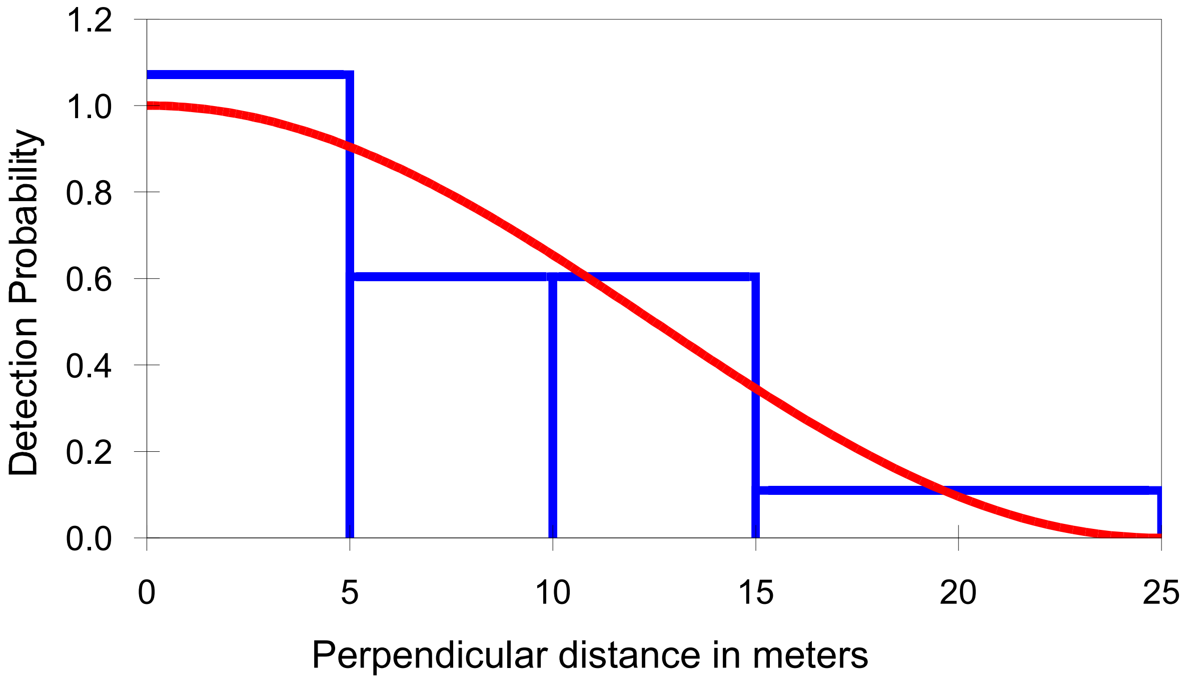

Figure 2. Histogram of perpendicular distance data and best fit of detection probability function for Banded Dotterels detected on line transects in the Upper Ahuriri River. Graphs plotted with the programme DISTANCE. Uniform-cosine function to fit data truncated at 25m. χ^2 = 2.85, p = 0.24.

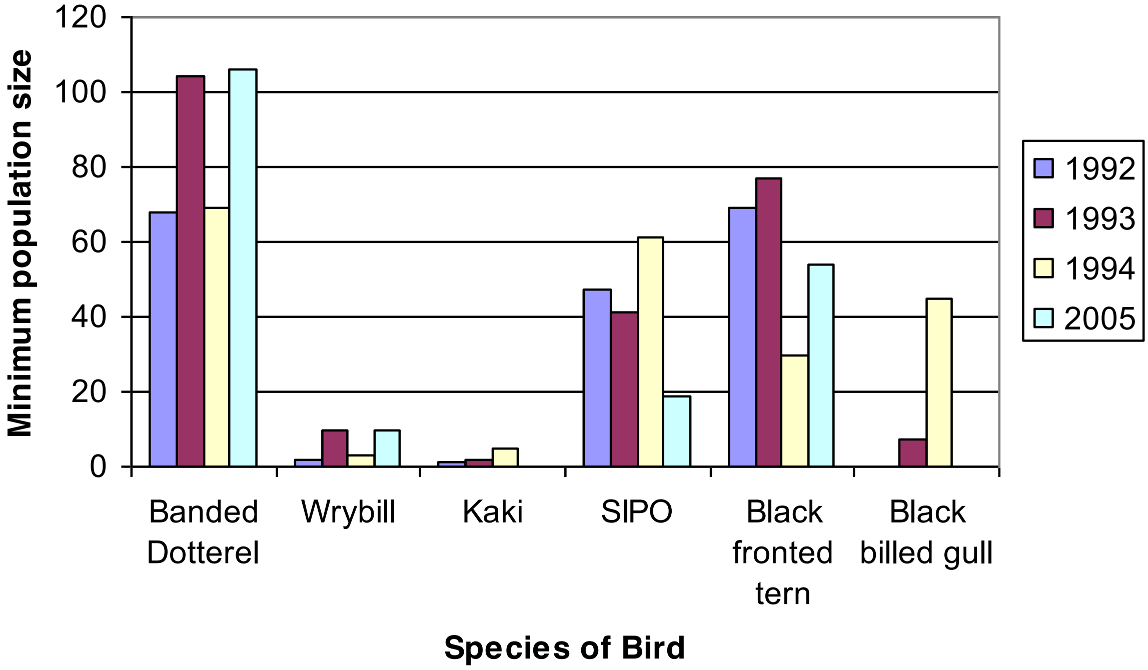

Figure 3. Bar graph showing the minimum population sizes for surveys carried out in 1992, 1993, 1994 and 2005.

Table 1. Banded dotterel density and abundance estimates derived from line transects in the Upper Ahuriri River.

Uniform-cosine model	Estimate	% Coefficient of Variation	95% Confidence Interval
Density (D) birds/ha	3.31	16.03	2.40 – 4.55
Abundance (N)	876	16.03	567 - 1300

Table 2. Estimated mean densities (number of birds ha^{-1}) of six endemic wetland birds for the years surveyed in 1992, 1993, 1994 and 2005.

SPECIES	1992	1993	1994	2005
Banded Dotterel	0.257	0.392	0.260	0.400
Wrybill	0.008	0.038	0.011	0.038
SIPO	0.177	0.155	0.230	0.072
Black fronted tern	0.260	0.291	0.113	0.204
Black billed gull	0	0.026	0.170	0
Kaki	0.004	0.008	0.019	0

Table 3. Presence (+)/absence (-) of 22 Wetland birds recorded during surveys of the Ahuriri River, Upper Waitaki Basin, 1992-1994 and 2005.

SPECIES	1992	1993	1994	2005
Banded Dotterel	+	+	+	+
Wrybill	+	+	+	+
Black Stilt	+	+	+	_
Hybrid Stilt	_	+	+	_
Pied Stilt	+	+	+	+
SIPO	+	+	+	+
Black Fronted Tern	+	+	+	+
Black Backed Gull	+	+	+	+
Black Bill Gull	_	+	+	_
Caspian Tern	_	_	_	_
Black Shag	+	_	+	+
Little Shag	_	_	_	_
Grey Duck	+	+	+	+
Mallard Duck	+	+	+	+
Paradise Shelduck	+	+	+	+
Canada Goose	+	+	+	+
Spurwing Plover	+	+	+	+
W.F. Heron	_	_	+	+
Harrier	+	+	_	+
Black Swan	+	+	+	_
Magpie	_	+	_	+
Grey Teal	_	_	+	_
Number of species present	15	17	18	15