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The effects of a settling-down period on estimates of bird species richness and occurrence from point counts in the Alps

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Capsule The effect of a settling-down period on estimates of species richness, and on the presence of 12 species, was considered on point counts along altitudinal transects in the Alps. For the individual species, Water Pipit was the only species which showed evidence that a settling-down period increased detectability. Species richness was higher when a point count was preceded by a settling period. A settling-down period may therefore confer some slight advantage in surveying birds in alpine habitats.

Point counts are commonly used to survey birds across a range of habitats (e.g. urban, Melles *et al*. 2003; agricultural, Verhulst *et al*. 2004; forest, Caprio *et al*. 2009) as they provide a relatively simple and rapid method of sampling (Bibby *et al*. 1992, Rosenstock *et al*. 2002). Often, a 'settling-down period' is used, whereby the observer remains inactive at the point for a relatively short time prior to the onset of the survey proper (e.g. Paquet *et al*. 2006, Shahabuddin & Kumar 2007, Bonthoux & Balent 2012), the expectation being that detectability will initially be low, but will increase after the birds have 'settled-down' following the initial disturbance caused by the observer's arrival (Bibby *et al*. 2000), hence decreasing the probability of false absences being recorded. Whilst there is some evidence that detection can be lower in a settling-down period (Galbraith *et al*. 2011), there is also evidence that its inclusion may underestimate abundance (Lee & Marsden 2008). Furthermore, other studies have indicated that shorter count durations may be the most appropriate for estimating local population size and for modelling bird distributions, either with (Bonthoux & Balent 2012) or without (Cimprich 2009) a settling-down period.

Here, we aim to determine whether a settling-down period (henceforth SDP) is necessary for point count surveys aimed at estimating the distribution of alpine birds along altitudinal transects, in terms of detecting individual species and estimating species richness. The transects crossed a gradient of marked habitat structure, from closed forest to almost vegetation-free high mountains (further details in Chamberlain *et al*. 2013). This poses a problem for choice of methods because point counts are typically recommended for forested habitats, and line transects for open habitats (Bibby *et al*. 2000). Nevertheless, it is necessary to adopt consistent methods across the altitudinal gradient. We opted for point counts with a SDP.

For presence/absence data, where double-counting the same individuals is not an issue, it could be argued that the longer the better for determining species richness. However, including the SDP will decrease the number of points that are able to be surveyed within a given time period, hence there are implications for sample size and, potentially, costs (Lee & Marsden 2008). This is particularly important for birds, when a restricted survey period (i.e. in the morning) is usually recommended. Furthermore, in alpine environments, access may be difficult and time-consuming - even reaching the first, lowest altitude point on some of the transects studied here necessitated a hike of over an hour. Minimising the number of non-detections whilst maximising efficiency of data collection is therefore the choice of the surveyor attempting to estimate the distributions of alpine birds.

If habitat structure influenced bird behaviour, then we might have expected this to affect the probability of detection of birds in the SDP – open habitat species may be more likely to detect the observer from a greater distance, and they may also be more likely to perceive the observer as a threat, as the bird community is dominated by ground-nesters (pers. obs.). Furthermore, detectability is likely to vary according to habitat structure. The influence of broadly defined habitat structure on the effect of SDP was assessed for species richness by considering the interaction with woody vegetation cover (trees and shrubs). Whilst the effects of SDP on bird richness and abundance estimates have been considered in forests (Lee & Marsden 2008), we are unaware of any studies that have considered possible differential effects across a marked gradient of habitat structure.

A total of 137 points were surveyed once along 19 altitudinal transects (1725m to 3048m asl) in the western Italian Alps in 2011 or 2012, between 1 May and 19 July. The average number of points per transect was 7.2 ± 0.8 (range 2 to 14, $n = 19$). All counts took place between 1 hour after sunrise and 1300 hrs. Transects were spaced at least 1km apart. Suitable points (i.e. those lacking obvious sources of human disturbance or factors compromising detectability) were spaced a minimum of 200m apart. At each point, standard point count methodology was followed (Bibby *et al*. 2000) within a fixed radius of 100m, and distances were estimated with the help of a laser range finder. Each point was subject to three consecutive five minute survey periods, where period 1 is analogous to SDP for a 10-minute point count. For period 1 and period 2, the presence of each species detected was recorded, not including birds in flight (unless in song flight). For period 3, a species was recorded if it had not been detected in period 2. Visual estimates were made of simple habitat variables within 100m radius, including the percentage cover of canopy and shrubs, recorded in period 1 following Bibby *et al*. (2000). The goal was to determine whether SDP affected the probability of detection of individual species, and the species richness recorded, for a 10-minute point count. For individual species, this was assessed by comparing probability of presence or species richness between two survey types -period 1 and period 2 combined (i.e. simulating a 10-minute point count without SDP), and period 2 and period 3 combined (i.e. simulating a 10-minute point count with SDP).

For individual species, the analyses were based on a null hypothesis that the probability of detection was random with respect to survey type, and therefore no difference was expected between a 10-minute point count with (period 2 + period 3) or without (period 1 + period 2) SDP. The difference in the probability of detecting a species between survey types was estimated using a mixed binomial logistic regression model. Point identity was included as a random effect to maintain the paired structure in the data. The strength of the magnitude of the estimates between survey types was described using the z statistic. As potentially the same individuals could be counted in both survey types (period 2 was common to both, hence violating assumptions of independence), P values were estimated from randomization tests rather than conventional statistical tests. For each species, the data were randomly re-allocated to the different points and visits (i.e. resampled without replacement), and a z value was derived from a further model. This was repeated 99 times to give a distribution of z values from randomly selected data sets. The probability of the observed result arising by chance was then the proportion of the entire sample (99 randomly generated and one observed) of z values equal to or exceeding that observed. Note that this was a two-tailed test, i.e. the sign of z was not considered, only the magnitude. Note also that the probabilities were the likelihoods of detection in a given period where the species was present (i.e. double-zeros were not included), as we wanted to know whether a given species was more likely to be detected on a point count with or without SDP where that species occurs. Only the commoner species (occurrence on at least 10% of all points) were considered for this analysis.

For species richness, when comparing point counts with and without SDP, the species richness in period 2 was common to both, so the comparison effectively becomes the number of species recorded in the settling period but not in period 2, against the number of species recorded in period 3 but not in period 2. This measure of species richness, which we refer to as additional species richness, was analysed assuming Poisson errors, with point as a random factor, in relation to survey type, habitat cover (sum of canopy and shrub cover), and the interaction between survey type and cover. All analyses were run using the glmer command from the lme4 package using R version 15.3 (R Development Corporation 2012). Means and parameter estimates are presented ± se.

For the majority of species considered, there was no difference in the probability of detection between survey types (Table 1). Water Pipit *Anthus spinoletta* was the only species to show a significant difference, the probability of detection being 16% higher when SDP was used. There was, however, a general trend towards higher probabilities of occurrence when SDP was included, which was shown in 8 of the twelve species considered.

A total of 41 species were recorded, although overall mean species richness per point was low (3.67 ± 0.21, n = 137). There was a higher overall mean species richness in points with (3.36 ± 0.20, n = 137) than without (2.91 ± 0.19, n = 137) SDP. The mean additional species in period 1 (0.47 ± 0.06, n = 137) was lower than that in period 3 (0.93 ± 0.10, n = 137), i.e. more species were added when there was SDP. This difference was significant (z = 3.6, P < 0.001). There was also a significant positive effect of cover on additional species richness (parameter estimate = 0.013 ± 0.003, z = 3.7, P < 0.001), showing it was greater in well vegetated points, but no significant interaction between survey type and cover (z = 1.5, P = 0.13).

The conclusion of the study is therefore that SDP may have some beneficial effect when using point counts in relatively high (>1700m) alpine habitat. There was no evidence that habitat cover influenced the effect of survey type on species richness, i.e. there was no interaction (note we did not consider effects of cover on individual species because the majority of species considered show specific habitat requirements and are restricted in distribution to a single cover type, e.g. forest, scrub or grassland species). Our results therefore suggest that including SDP as recommended by Bibby *et al*. (2000), i.e. that includes a period for recording habitat, has some advantages for estimating species richness. However, our results may also have arisen because habitat recording was concurrent with the SDP, which may have been expected to lead to a reduced ability of the observer to detect birds. We feel that this is unlikely to be the case because the habitat data collected were simple and quick to estimate. Furthermore, in the majority of cases, detection of species presence was aural rather than visual (only 5% of records of presence were based solely on visual detection, and 85% of all presences were individuals in song). We consider song in particular to be highly detectable, and its detection unlikely to be affected by the observer undertaking other simple concurrent tasks. Nevertheless, we cannot completely rule out this effect.

Further potential biases may have arisen due to confounding effects of time of day and season. All transects were carried out in sequence from the lowest to the highest point, therefore points surveyed later in the day were necessarily at higher altitude, and indeed there was a significant correlation between altitude at a point and hours since sunrise ($r_{133} = 0.49$, $P < 0.001$, $n = 135$ due to two missing values). Similarly, higher altitude areas were surveyed later in the season (altitude vs number of days since 1st April, $r_{133} = 0.60$, $P < 0.001$), simply because access to higher altitudes is restricted until late June in most years due to snow cover. For individual species, this seems unlikely to have affected the outcome of the analyses, given that it was a paired comparison, so these factors are effectively controlled. Nonetheless, such effects may have reduced the overall detection rate, and therefore the sample size, for higher altitude species. Furthermore, seasonal and temporal biases may have contributed to the effects of cover on species richness, although a similar decline in species richness with increasing altitude has previously been reported for birds at the altitudes considered here (Viterbi *et al*. 2013).

It should be stressed that these findings only apply to the habitats in question, one of the features of which is a generally low species richness (11 species was the maximum recorded in any one point) and low density of individual species (e.g. the highest occurrence rate was for Chaffinch, which was 34%). Also, only presence/absence data were considered – the impact on abundance estimates may have been different, e.g. Lee & Marsden (2008) found inclusion of SDP underestimated species abundance in a tropical forest. Habitat structure may also have been an influence on the difference between the two studies – although our transects covered a marked gradient of habitat structure (from forest to alpine grassland), the larch forest that we surveyed is still probably fairly open (especially in the understorey) compared to tropical forest, and subsequently detectability may be generally higher. Therefore, although there appears to be a slight advantage in using SDP to assess species richness in our study area, we acknowledge that such effects may be context-specific.

In summary, there is evidence for a significant beneficial effect of SDP for Water Pipit and for species richness. Whether the gain in detection rate for Water Pipit (16%) and in species richness (*c*. 0.5 species) is enough to offset the additional point counts that could be undertaken if SDP is not included must depend on the individual goals of a given study. However, there are two additional points worth making. First, Water Pipit seems likely to be one of the most sensitive species to potential future environmental change in the Alps (Chamberlain *et al*. 2013) and therefore it may be considered a priority species. Second, several species showed a trend towards higher detection rates with SDP, although these were not significant. To some extent this may have been due to relatively low sample sizes. This study is small-scale, and used a sub-sample of a much larger dataset (Chamberlain *et al*. 2013) to address the effect of SDP. A larger more detailed study, designed specifically to address as far as possible potential biases in the transect approach, would be needed to draw firmer conclusions on the effects of SDP in a wider suite of species.

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Table 1. Estimated probability of occurrence of individual species detected in point counts with (SDP) and without (No SDP) a settling-down period, derived from binomial logistic regression.

Species	SDP	No SDP	*P*	*n*
Skylark *Alauda arvensis*	0.96 (0.78 – 0.99)	0.81 (0.63 – 0.92)	0.28	27
Tree Pipit *Anthus trivialis*	0.95 (0.71 – 0.99)	0.95 (0.71 – 0.99)	1.00	19
Water Pipit *Anthus spinoletta*	0.95 (0.83 – 0.99)	0.79 (0.64 – 0.89)	0.05	42
Wren *Troglodytes troglodytes*	0.87 (0.67 – 0.96)	0.96 (0.75 – 0.99)	0.44	23
Dunnock *Prunella modularis*	0.79 (0.59 – 0.91)	0.79 (0.59 – 0.91)	1.00	24
Black Redstart *Phoenicurus ochruros*	0.86 (0.69 – 0.95)	0.69 (0.50 – 0.83)	0.20	29
Wheatear *Oenanthe oenanthe*	0.94 (0.80 – 0.97)	0.80 (0.64 – 0.90)	0.17	35
Lesser Whitethroat *Sylvia curruca*	0.87 (0.60 – 0.97)	0.73 (0.47 – 0.90)	0.60	15
Chiffchaff *Phylloscopus collybita*	0.95 (0.73 – 0.99)	0.95 (0.73 – 0.99)	1.00	21
Coal Tit *Periparus ater*	0.92 (0.73 – 0.98)	0.76 (0.56 – 0.89)	0.23	25
Willow Tit *Poecile montana*	0.94 (0.79 – 0.99)	0.79 (0.63 – 0.90)	0.16	34
Chaffinch *Fringilla coelebs*	0.98 (0.86 – 0.99)	0.89 (0.77 – 0.96)	0.18	47

Only points where the species occurred were considered (*n* = number of points where a species was present). 95% confidence limits are shown in parentheses. Only species with overall occurrence rates of at least 10% (from the total sample of 137 points) were analysed. P values were derived from randomization tests (see text for further details).