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Brief report

Abundance of crossbills, Siskins and cone-crops

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We present a more complete and definitive analysis than hitherto of the long runs of data on crossbill abundance and cone-crops in Finland and in Scotland. The abundance of Common Crossbills *Loxia curvirostra* in Finland was correlated with the abundance of cones of Norway Spruce *Picea abies*, the main food of this small-billed species, but not with the cone-crop of Scots Pine *Pinus sylvestris*. In Scotland, where the habitat was native Scots pinewood and the breeding crossbills are now known to be Scottish and Parrot, *scotica* and *pytyopsittacus*, their abundance was correlated with the cone-crop of Scots Pine, the main food of these larger-billed species.

1.Introduction

Reinikainen (1937) in Finland and Nethersole-Thompson (1975) in Scotland reported that the abundance of crossbills (*Loxia* spp.) was associated with that of their coniferous seed food. Thies (1996) showed a similar pattern for crossbills in a mixed-species plantation in Germany, but it included a high proportion of exotic conifers and crossbill abundance was heavily influenced by irruptive movements. Papers by Formosov (1960) and Förschler *et al*. (2006) also mentioned associations between crossbills and seed-food, but lacked the above authors' quantitative data on both. It is therefore worth making fuller use of the long runs of data produced by the two remarkable pioneering ornithologists in Finland and Scotland.

Reinikainen (1937) reported the annual numbers of Common Crossbills (*Loxia curvirostra*) that he saw during his spring transects on skis, and his scores for cone abundance. D. Nethersole-Thompson (1975; for brevity called DNT below) published annual scores for the abundance of crossbills, Siskins (*Carduelis spinus*), and the cone-crop of Scots Pine (*Pinus sylvestris*).

Summers (1999) analysed the data on crossbills in Finland and Scotland, and McGhie (2002) on Siskins in Scotland. Both found statistically significant associations between changes in the abundance of birds and food. However, both analyses contained errors, including one that was in DNT's book. A fresh analysis is therefore justified.

2. Material and methods

The new analysis incorporates each annual datapoint rather than lumping them as in the above

Table 1. Spearman correlation coefficients between scores for bird abundance or clutches and Scots Pine cone-crops. Place: 1 = Upper Spey, 2 = Abernethy, 3 = Rothiemurchus, 4 = Ardgay, Sutherland. Abundance: A = crossbill, B = Siskin, C = cone-crop, D = crossbill mean clutch, and E = cone-crop in previous year.

Years	Place	Compare	n years	r_s	P
1924–74	1^	A and C	41	0.617	<0.0001
1934–42	2	A and C	9	0.627	0.067
1934–42	2	C and D	9	0.698	0.038
1934–42	2	B and C	9	0.672	0.051
1934–42	2	A and B	9	0.773	0.019
1934–42	2	C and E	39	–0.336	0.037
1946–68	3	A and C	15	0.579	0.025
1946–68	3	B and C	14	0.651	0.014
1946–68	3	A and B	14	0.600	0.025
1962–74	4#	A and C	14	0.699	0.007

^ Includes Abernethy, Rothiemurchus and other woods in Strathspey and Badenoch of upper Speyside, Inverness-shire. # Cone-crop estimated by DNT in a 60-ha wood far smaller than others in the Table.
DNT wrote that crossbills laid eggs earlier in years of bumper cone-crop. At Abernethy, annual dates of the earliest full clutch found were negatively associated with the score for the cone-crop, though not significantly, in crossbills (n = 8, r_s = –0.396), and Siskins (n = 7, r_s = –0.386). The 1934–42 data referred to Abernethy and 1946–68 data to Rothiemurchus, so McGhie's lumping of both was invalid. He included a 1942–46 Siskin case of decrease or no change, but this was invalid because DNT had given no data for 1943–45; there were three other such invalid cases.

analyses (which lumped them into categories such as high or low, and increase or decrease, with no change being lumped in the decrease category). We used DNT's crossbill rank of fair in 1973 (as corrected by him in the copy of the book that he sent to AW), his five scores for crossbill numbers (very low, low, fair, high, and peak, ranked by us as 1 to 5 respectively), and his three scores for Scots Pine cone-crops (low or poor, fair, and bumper, ranked by us as 1 to 3). The pine score rested on the Abernethy foresters' field observations and also the yield of seed from cones dried in a kiln at Abernethy. Hence, in Nethersole-Thompson & Watson (1974) and in DNT, the term 'seed yield' was sometimes used rather than cone-crop. For simplicity below, we use cone-crop, but DNT's qualification about seed should be borne in mind.

Because numbers in consecutive years may not be fully independent, it is preferable to use proportionate change in number from one year to the next for interval data that are based on precise measurements such as exact numbers of birds, cones or seeds. However, here the data are ordinal, based on scores or ranks. A change of +1 from score 1 up to 2 may not be of the same magnitude as a change of +1 from 4 up to 5. Hence we used individual scores, not change in score. Consequently, because successive scores are not statistically independent, the probability values below are merely indicative.

3. Results

The analyses confirmed Reinikainen's (1937) suggestions. The number of crossbills seen on his transects was correlated with his scores for the abundance of cones of Norway Spruce (*Abies picea*), whose seeds are the birds' main food (n = 7, r_s = 0.826, P = 0.028). It was not significantly associated (r_s = 0. 321) with scores for the abundance of Scots Pine cones.

Our analyses of the Scottish data showed that the abundance of crossbills and of Siskins was correlated with annual scores for the Scots Pine cone-crop (Table 1). Turning to clutch size, we tested DNT's idea that crossbills lay bigger clutches in years of large crop. The annual mean clutch size was correlated positively with the score for the crop (Table 1, Fig. 1).

DNT suggested that a poor cone-crop tended to come a year after a good one, and vice versa. Our analysis showed that scores for the current year's and previous year's crop were correlated negatively (Table 1), thus confirming his idea. Such short fluctuations in food fit the short fluctuations

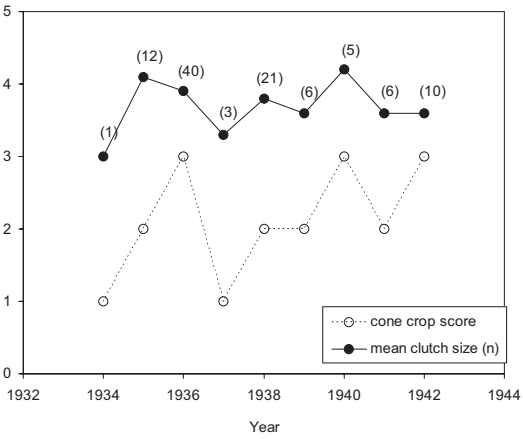

Fig. 1. Annual mean clutch size of crossbills (upper) compared with annual scores for cone-crop of Scots pine at Abernethy (lower).

in the abundance of the two species of seed-eating birds.

4. Discussion

Our analysis of data from both studies showed crossbill numbers to be correlated with cone-crop, but this involved Norway Spruce in Finland and Scots Pine in Scotland. This difference is associated with different crossbills, small-billed *curvirostra* in Finland as against the larger-billed birds studied by DNT in native pinewood, where it is now known that both *scotica* and *pytyopsittacus* are breeding (Marquiss & Rae 2002, Summers *et al*. 2002).

Within the Scottish area, Scots Pine was the main species, comprising 72% of the area of coniferous woodland, so only 28% were non-native conifers (Dunlop 1994). The close correlation between crossbills and conifer seed in Germany, [$n = 15$, $r_s = 0.932$, $p < 0.001$; our analysis from data in Thies (1996)] involved small-billed *curvirostra* and mixed native and exotic conifers, predominantly Norway Spruce and Japanese Larch *Larix leptolepis*.

Käpylintujen, vihervarpusen ja käpysadon runsaus

Teimme aiempia tutkimuksia täydellisemmän analyysin suomalaisille ja skotlantilaisille käpylintuja käpysatoaikasarjoille. Suomalaisten pikkukäpylintujen (*Loxia curvirostra*) runsaus korreloi kuusenkäpyjen (*Pidea abies*) runsauden kanssa – lajin pääravintoa – muttei männynkäpyjen (*Pinus sylvestris*) kanssa. Skotlannissa, missä tutkimus koski kotoperäisiä männiköitä ja missä pesivät käpylinnut ovat joko skotlannin- tai isokäpylintuja (*L. scotica* ja *L. pytyopsittacus*), käpylinturunsaus korreloi nimenomaan männynkäpyjen runsauden kanssa; männynkävyt muodostavat näiden isompinokkaisten käpylintujen pääravinnon.

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