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Brief report

Numerical responses by crossbills *Loxia* spp. to annual fluctuations in cone crops

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Accounts of the abundance or change in abundance of crossbills *Loxia* spp. often allude to the size of the cone crop, the seeds of which form the food supply of the birds (Newton 1972, Benkman 1987, Petty et al. 1995). However, the associations between changes in crossbill numbers and the size of the cone crops usually refer to short runs of data or, when long runs are available, they have not been statistically analysed.

One of the earliest studies of crossbills and their food supply was carried out by Reinikainen (1937) in Finland. He skied a set route of 120 km in March for 11 years, counting pairs of Common Crossbills *Loxia curvirostra* and assessing the Norway Spruce *Picea abies* and Scots Pine *Pinus sylvestris* cone crops on a six-point scale. Common Crossbills tend to specialise on spruce cones rather than pine (Lack 1944). Graphs of the time series for crossbill numbers and the spruce cone crop, but not that of the pine, showed coincident peaks and troughs (Reinikainen 1937).

Nethersole-Thompson (1975) assessed the abundance of Scottish Crossbills *Loxia scotica* in upper Speyside, Scotland, on a six-point scale, from "very low" to "peak" numbers. These crossbills have larger bills than Common Crossbills and feed mostly on pine cones (Nethersole-Thompson 1975). Simultaneously, two foresters assessed the Scots Pine cone crop on a four-point scale, from "poor" to "bumper". Spruces are uncommon in Speyside and their cone crops were not assessed. The study took place between 1924 to 1974; data for both birds and cone crops were obtained for 41 years.

Christen (1995) analysed counts of Common Crossbills in the Jura Mountains, Switzerland. The maximum number recorded in each 5-day period was summed for each three-month period from 1980 to 1993. During this period, there were four mast years of Norway Spruce: 1985, 1988, 1991 and 1993.

For each of the sets of data, I attempted to split the bird and cone data into two groups so that there were as many observations in the high abundance categories as the low ones. Two types of contingency tables were then constructed. In the first, each year was classified on two dimensions: high or low crossbill numbers, and good or poor cone crops. In the second, each pair of years was classified as: increase or decrease in numbers of crossbills, and increase or decrease in the abundance of cones. If there was no change in abundance, the data were lumped with the "decrease" category. Interactions between crossbills and cone crops were tested for by using Fisher's exact test (two-tail).

In the data from Finland, the number of Common Crossbills was positively associated with the size of the Norway Spruce cone crop (Table 1), but not with the size of the Scots Pine cone crop (Table 2). In the Scottish data, there was a positive association between the abundance of Scottish Crossbills and the Scots Pine cone crop (Table 3). There was no association between the abundance of Common Crossbills and the mast years of Norway Spruce in Switzerland (Table 4).

Even stronger positive associations were found between the change in the number of crossbills and the change in the size of the cone crops (Tables 1 and 3). The weaker association between numbers of birds and cone crops might have arisen from inaccuracies in assessing abundances, or from a lag in the time taken for crossbills to respond to changes in the food supply. Clearly, if a cone crop increased, the absolute number of birds

Table 1. Associations between the numbers or change in the number of pairs of Common Crossbills and the abundance or change in abundance of Norway Spruce cones in different years in Finland; e.g., 28 = 1928. Data from Reinikainen (1937).

Cone crop categories	Crossbill numbers	
	0–5	15–40
0–1	28, 31, 33, 35, 36	30
2–5		27, 29, 32, 34, 37

Fisher's Exact Test P = 0.015

Change in cone crop	Change in crossbill numbers	
	Decrease	Increase
Decrease	27–28, 29–30, 30–31, 32–33, 34–35, 35–36	
Increase		28–29, 31–32, 33–34, 36–37

Fisher's Exact Test P = 0.005

Table 2. Associations between the numbers or change in the number of pairs of Common Crossbills and the abundance or change in abundance of Scots Pine cones in different years in Finland; e.g., 31 = 1931. Data from Reinikainen (1937).

Cone crop categories	Crossbill numbers	
	0–5	15–40
1–2	31, 33, 36	30, 32, 34, 37
2.5–4.5	28, 35	27, 29

Fisher's Exact Test P = 1.0

Change in cone crop	Change in crossbill numbers	
	Decrease	Increase
Decrease	27–28, 29–30, 35–36	31–32, 33–34
Increase	30–31, 32–33, 34–35	28–29, 36–37

Fisher's Exact Test P = 1.0

Table 3. Associations between the abundance or change in abundance of Scottish Crossbills and abundance or change in abundance of Scots Pine cones in different years in Scotland; e.g., 34 = 1934. Data from Nethersole-Thompson (1975, p. 242).

Cone crop	Crossbill abundance	
	Very low–fair	Fairly high–peak
Poor–fair	34, 37, 39, 41, 47, 48, 50, 51, 53, 54, 55, 57, 59, 61, 64, 65, 66, 67, 69, 70, 73, 74	35, 38, 46, 58, 72
Good–bumper	40, 45, 60, 68, 71	24, 29, 33, 36, 42, 49, 52, 56, 63

Fisher's Exact Test P = 0.006

Change in cone crop	Change in crossbill abundance	
	Decrease or same	Increase
Decrease or same	33–34, 36–37, 38–39, 40–41, 46–47, 49–50, 52–53, 54–55, 56–57, 58–59, 60–61, 63–64, 64–65, 66–67, 68–69, 72–73	45–46, 71–72
Increase	39–40, 65–66, 70–71, 73–74	34–35, 35–36, 37–38, 41–42, 47–48, 48–49, 50–51, 51–52, 53–54,55–56, 57–58, 59–60, 67–68, 69–70

Fisher's Exact Test P < 0.001

that could respond to it will depend on the size of the pool of searching birds and the state of the cone crop elsewhere. On the other hand, birds should be more immediately responsive to a declining food supply by emigrating in search of better cone crops elsewhere.

These analyses confirm earlier interpretations of these data sets by Reinikainen (1937) and Nethersole-Thompson (1975). I also confirm the findings of Christen (1995) who found no clear relationship between Common Crossbill numbers and seed production of Norway Spruce in Switzerland. Perhaps crossbill populations in central Europe are more influenced by immigrants from northern Europe, rather than local populations. Christen (1995) noted that there was in invasion in 1990 and highest numbers were counted in the following year which was a mast year.

The results serve to highlight how changes in numbers may be more sensitive indicators of a response to changes in food supply than absolute numbers. This may be particularly true when data are combined across many years, during which the effect of other influences on population size, such as climate, predation and overall population size, is unknown and varying.

Table 4. Associations between the numbers or change in the numbers of Common Crossbills and the abundance or change in abundance of Norway Spruce cones in different years in Switzerland; e.g., 80 = 1980. Data from Christen (1995).

Cone crop categories	Crossbill numbers	
	0–40	over 40
non-mast	81, 82 ,84, 86, 87, 89, 92	80, 83, 90
mast	85, 88, 93	91

Fisher's Exact Test P = 1.0.

Change in cone crop	Change in crossbill numbers	
	Decrease	Increase
Decrease or same	80–81, 81–82, 83–84 86–87, 88–89, 91–92	82–83, 85–86, 89–90
Increase	84–85, 92–93	87–88, 90–91

Fisher's Exact Test P = 1.0.

Selostus: **Käpylintujen runsaudenvaihtelut suhteessa käpysadon vaihteluihin**

Kirjoittaja analysoi käpylintujen runsaudessa havaittua vaihtelua suhteessa käpysadon vaihteluihin kolmessa julkaistussa pitkässä havaintosarjassa: Reinikaisen (1937) 11 vuoden aineistossa pikkukäpylinnusta Suomessa, Nethersole-Thompsonin (1975) 41 vuoden aineistossa Skotlannin käpylinnusta ja Christenin (1995) 14 vuoden aineistossa pikkukäpylinnusta Sveitsissä. Sekä Suomen että Skotlannin aineistossa käpylintujen runsauden vaihtelu on selkeässä yhteydessä pääravintopuun (Suomessa kuusi, Skotlannissa mänty) käpysadossa havaittuun vaihteluun. Käpylintuja esiintyi aineistoissa runsaammin hyvinä kuin huonoina käpyvuosina. Vielä selkeämpi yhteys oli käpylintujen runsauden muutoksissa suhteessa käpysadon muutoksiin (Taulukot 1–3). Sveitsin aineistossa ei havaittu yhteyttä käpylintujen runsauden ja käpysadon suuruuden välillä, mikä saattaa johtua siitä, että Keski-Euroopan käpylintukantojen muutoksiin vaikuttaa enemmän käpylintujen immigraatio Pohjois-Euroopasta kuin vaihtelut paikallisessa kuusen käpysadossa. Kirjoittaja toteaa, että runsauden muutoksen suunta on selkeämpi ilmentäjä ravintovarojen muutoksista kuin absoluuttiset runsausarvot.

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References

Benkman, C. W. 1987: Food profitability and the foraging ecology of crossbills. — Ecol. Monog. 57: 251–267.
Christen, W. 1995: The occurrence of Common Crossbills Loxia curvirostra north of Solothurn (Switzerland) 1980–1993. — Orn. Beobacher 92: 82–85.
Lack, D. 1944: Correlations between beak and food in the Crossbill, Loxia curvirostra Linnaeus. — Ibis 86: 552–553.
Nethersole-Thompson, D. 1975: Pine Crossbills. — Poyser, Berkhamsted.
Newton, I. 1972: Finches. — Collins, London.
Petty, S. J., Patterson, I. J., Anderson, D. I. K., Little, B. & Davison, M. 1995: Numbers, breeding performance, and diet of the Sparrowhawk Accipiter nisus and Merlin Falco columbarius in relation to cone crops and seed-eating finches. — For. Ecol. Manage. 79: 133–

146.
Reinikainen, A. 1937: The irregular migrations of the Crossbill, *Loxia c. curvirostra*, and their relation to the cone-crop of the conifers. — Ornis Fennica 14: 55–64.