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Effects of the acid rain syndrome on bird populations (Harz Mountains, Lower Saxony, FR Germany)* Auswirkungen des Saure-Regen-Syndroms auf Vogelbestände (Harz, Niedersachsen, Bundesrepublik Deutschland)

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The unmistakable signs of forest death spreading over wide, esp. the more populated and industrial areas of Europe arose deep scientific, public and finally political concern. Special first-aid programs have been started although not tested in stopping the continuous rise in tree damaging. In Germany, the Federal Government launched the programme "Rettet den Wald" in 1983 focusing (a) on jurisdictional national + international actions, (b) forestal measures as damage monitoring and prevention (mainly insect pest control and soil chalking), (c) finally research (Bundesminister des Innern 1985).

Contrary to the economic concern in forest death, responsibility for the ecological impact is, whenever, only a minor part of research and administrative activities. The Federal State of Lower Saxony (with Göttingen University, School of Forestry as one, new-founded center of inventories of other organisms than trees and potential pest animals (e.g. beetles as Ipidae, mammals as Rodentia or Cervidae) (see special issue of "Wald und Umwelt" 1982, Niedersächsischer Minister für Ernährung, Landwirtschaft und Forsten 1987). The changes and losses of ecosystems and afflictions with their numerous plant and animal species by forest death are - at least in this country - no theme of systematic research.

In 1972, I carried out a systematic bird census of the Harz Mountains, an impressive woodland block of palaeozoic origin and higher elevations (400-1000 m N above sea level) amidst hillside and even plain country. The census inventory (OELKE 1977, 1981), long done before we had foreseen the outcome of air pollution, forms now a basis for detecting changes in bird populations. Using birds as environmental monitors, insights might be won into further components of the woodland ecosystems.

For lack of any official backing (time, finances), the monitoring project had to be restricted to areas exemplaric in forest damage and identical with, at least closely related to 1972 study plots. A systematic, more widespread and differentiated inventory, thus a 1972 copy has still to be done.

*) Vortrag 10th Int. Conference Bird Census Work and Atlas Studies, Helsinki, 24.-28.8.1987

Materials, methods

The study plots (Table 1) fall into the altitudinally highest and most severely damages spruce (*Picea abies*)-stands of the Harz Mountains (no. G in Fig. 1 a + b). The plot numbers correspond with the 1972 numbering (Fig. 2). New plots (routes) have been attributed the präfix 1987 (as 1987-1 contd.).

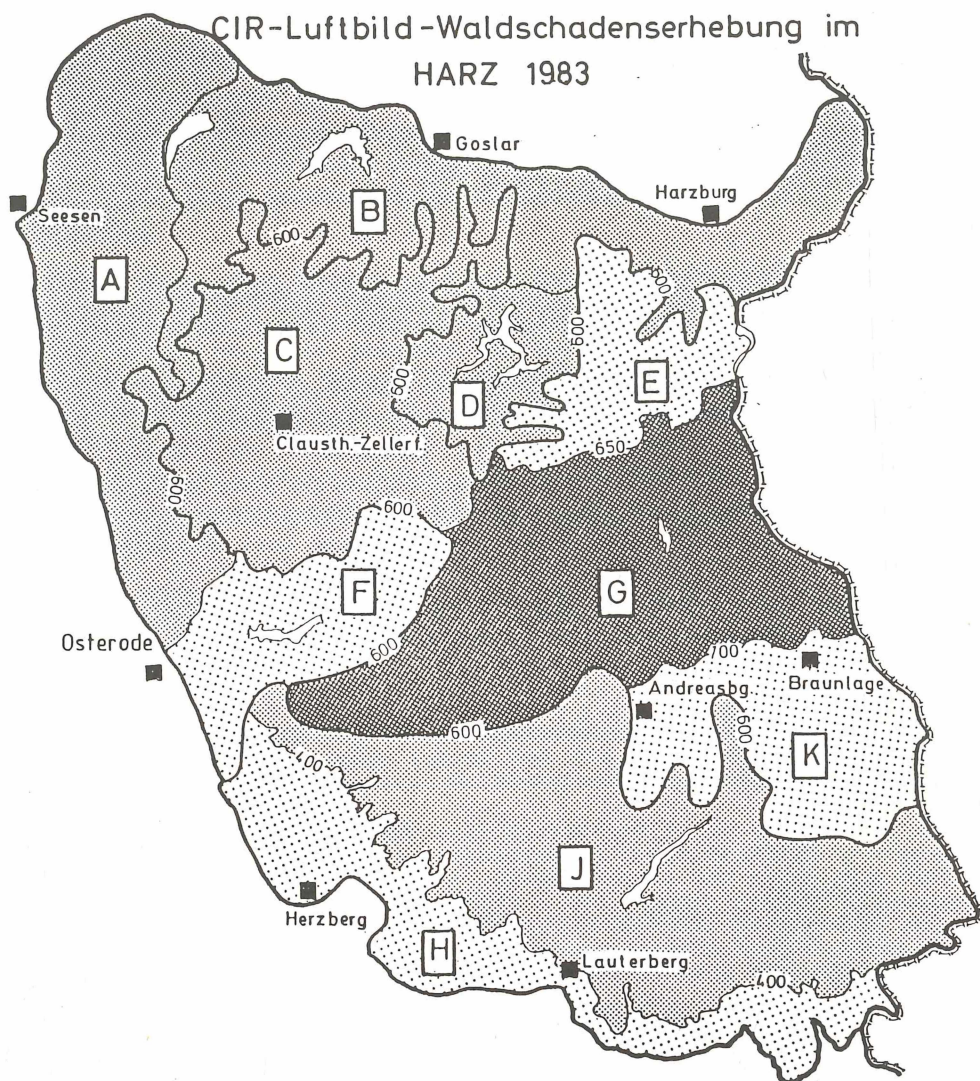


Fig. 1a. Colour-infrared (CIR) aerial survey of forest damages in the Harz 1983. - Infrarot-Luftbilderfassung der Waldschäden im Harz 1983.

CIR-Luftbild-Waldschadenserhebung im HARZ 1985

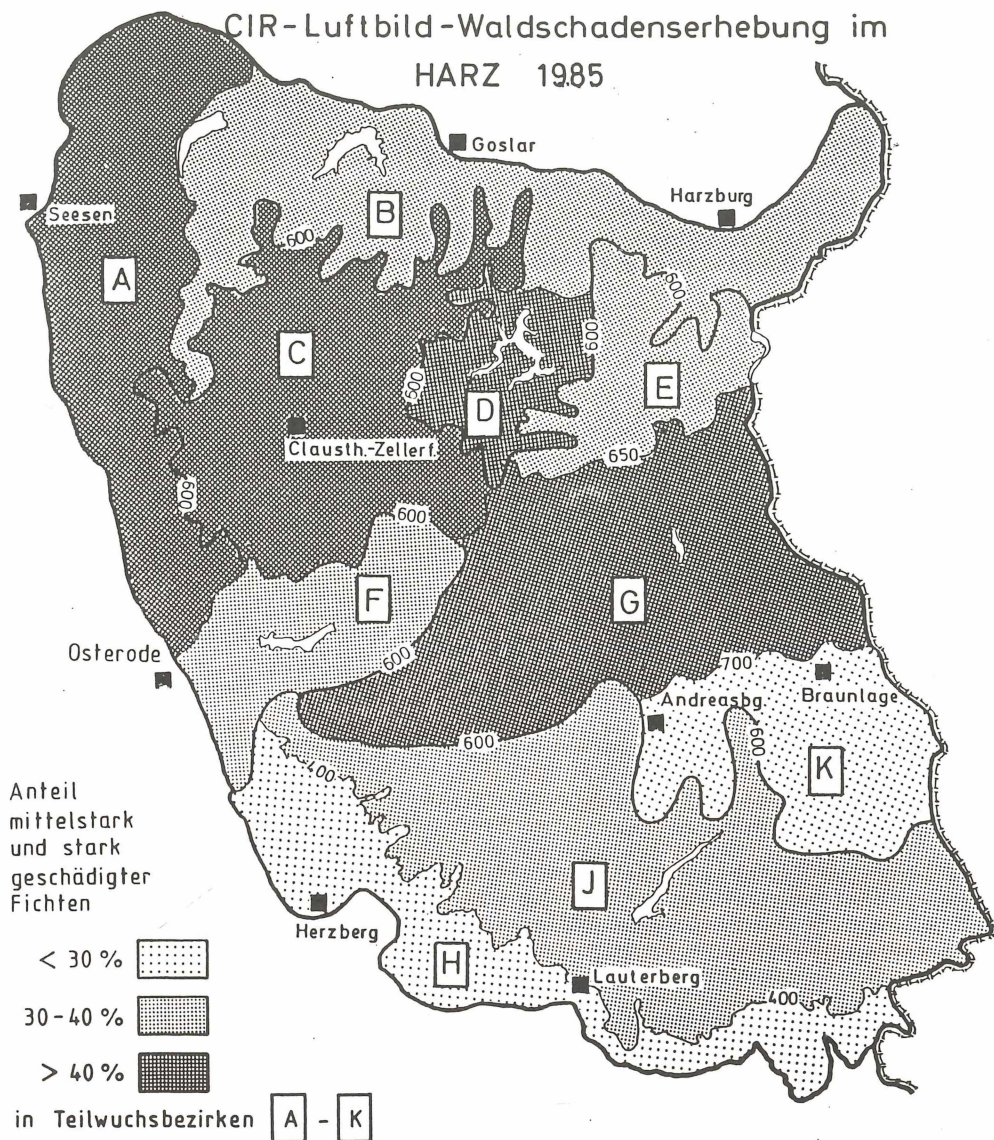


Fig. 1b. Dito in 1985. - 3 categories of proportions of intermediate and severe spruce damages in forestal = infraregional stands (no. A-K). Figures by kind permission of Nieders. Forstliche Versuchsanstalt Göttingen. - Desgl. 1985. 3 Kategorien intermediärer und starker Fichtenschäden in Forstbeständen (Nr. A-K). Unterlagen mit frdl. Genehmigung der Nieders. Forstl. Versuchsanstalt Göttingen.

Table 1. Liste der Probeflächen/-routen der Harzvogel-Erfassung 1986, 1987.
List of study plots/routes of the Harz Mountains bird survey 1986, 1987.
For site of plots see Fig. 2. - Zur Lage der Probeflächen vgl. Abb. 2.

No.	Name, Lage name, location	Größe size (ha)	Höhenlage elevation (m above sea)	Exposition exposition	Böschung cline (°)	Baumalter tree age (years)	Deckungsgrad	
							Bäume cover of trees	Sträucher shrubs
14	Vodberg, Abt. 136 A, FA Riefensbeek	21,4	800-840	W	2-12	140	< 15	< 1
16+21	Bruchbergkamm, Stieglitz- eck-Skikreuz Altenau (appr. 75 m on both sides of forest trail)	50,0	860-910	WSW	1-5	105-185	< 30	< 20
17	Brockenfeld, Abt. 210, 211, 217-219, FA Oderhaus (Kaiserweg-Dreieckiger Pfahl)	25,0	870-895	SW-SE	1-3	120-130	60-80	< 5
18	Wurmberg, Abt. 104-106	25,0	880-910	S-SE	20-40	160	60-70	-
19	Wurmberg, Abt. 105-108, FA Braunlage	20,3	900-970	WNW	3-12	160	5-75	-
9	Hahnenkleeklippen, Abt. 71, 73, FA Oderhaus	11,3	570-740	W	13-35(90)	110-210	30	0-10
1987-1	Forstweg (Auf dem Acker, Stieglitzack-Hanskühnen- burg - Seilerklippe) subplots over appr. 7,9 km	70	756-827	W-SW	1-5	105-185	< 50	0-5
1987-2	Ackerstraße (Stieglitzack- Hanskühnenburg), subplots over appr. 6,8 km	63	743-806	SW	1-5	75-185	70-80	< 5
1987-3	Odertal (Rinderstall - Hahnenkleeklippen)	25	495-540	S	1-3	150	70-90	0-15

Remarks: Abt. = Abteilung (compartment), FA = Forstamt (forest district office)

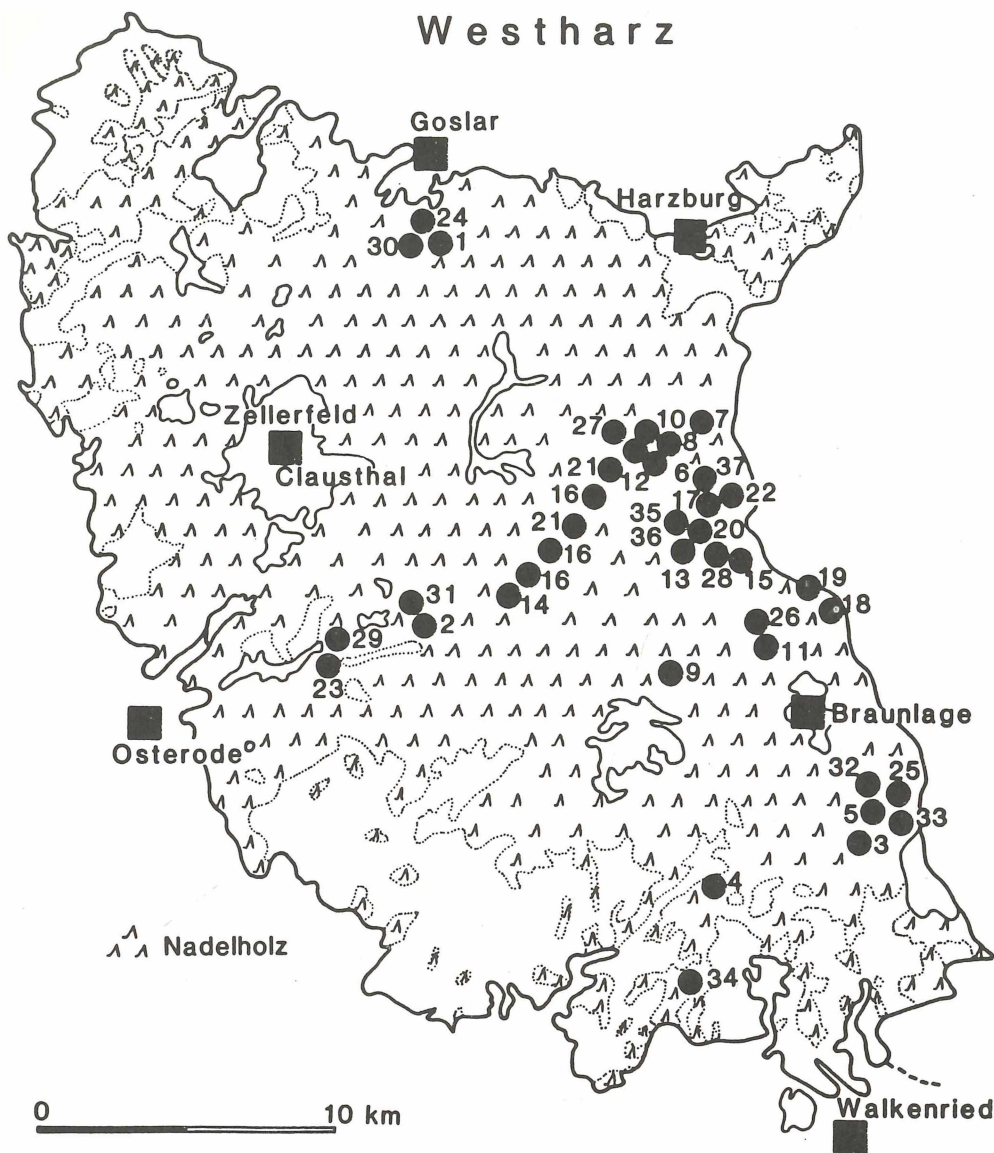


Fig. 2. List of study plots in the Westharz (after OELKE 1981). -
 Liste der Probeflächen des Westharzes (nach OELKE 1981).

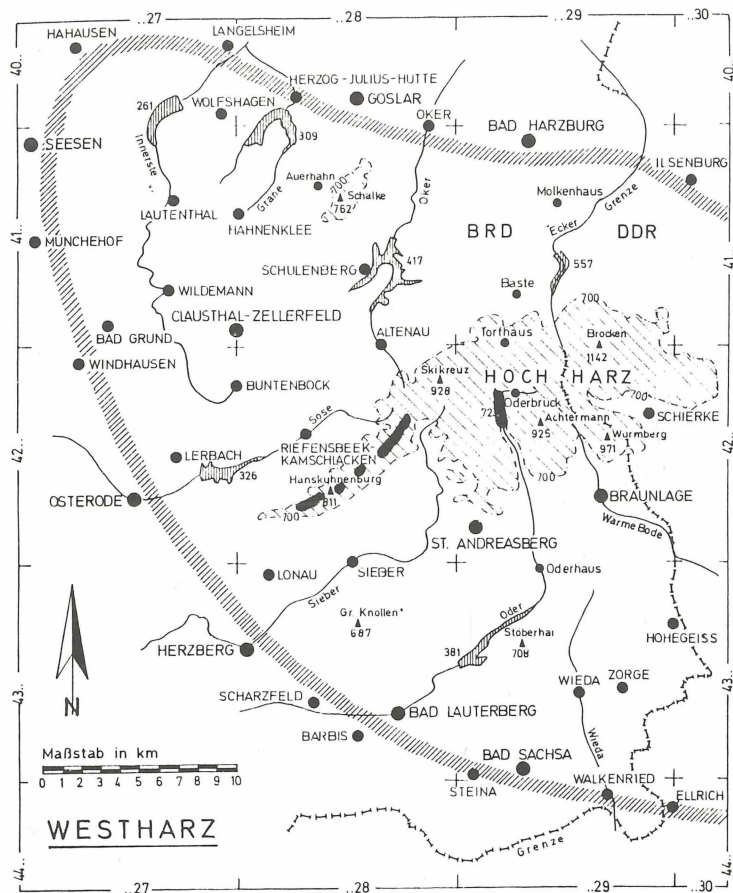


Fig. 2 a. Study plots new in 1986, 1987 (black lines). –
Neue Probeflächen 1986, 1987 (schwarze Balken).

Following the instructions of the IBCB and the recommendations for stop counts (OELKE 1980, 1983), the surveys have been carried out both during excursions and a bird census seminar by student groups of the Zoological Institute, University of Göttingen (10., 11., 31.5., 14.6. 1986, full-day seminar 9.-13.6.1987, basis camp Wolfenbütteler Hütte, Braunlage-Königskrug). We tried to compensate the disadvantage of only 1-2 surveys per plot by 3 or even more observers who worked the route simultaneously and independently. The surveys were timed to fit into the maximum of breeding bird activities of the higher mountain elevations (normally June-early July). Night controls have not been done. An extremely cold and snowy winter with snow layers in the Harz until May and snow rests even in June preceded the breeding season 1987. The survey as well as the breeding period fell into the unusual cold, rainy summer 1987. For meteorological parameters of the Harz Mountains see OELKE (1981).

Table 2. Wichtigste sichtbare Veränderungen der Forststrukturen zwischen 1972 und 1987. - Main visible changes in forest structure between 1972 and 1987.

Probefläche Nr. Plot no.	Baumschicht, Deckungsgrad tree cover (in %)		Wichtigste äußere Veränderungen Main physiognomic changes
	1972	1987	
14	60-80	< 15	no intact spruces, trees removed except some dead stems; new plantation (appr. 5-year-seedlings) dying off; 'battlefield' appearance; insect pest control (pheromone trapping)
16+21	30-80	< 30	no intact spruces, larger areas felled, numerous dead trees, attempts for replantations, but now stopped, conspicuous storm damages ('battlefield'), underground stone and block material opened at many places
17	80-95	60-80	damages, but still closed forest, a few dead trees, insect pest control
18	90	60-70	damaged, but still closed forest, tree stands around the mountain top (skiing and resting area) removed
19	75	5-75	western parts felled, dead zone progressing to central and eastern parts of the plateau; all spruces damaged; insect pest control
9	50	30	majority of spruces dead, but not removed (cliffs!), some deciduous trees (upper limit of beeches and acorns)
1987-1	60-80	< 50	western slopes, esp. around cliff and top areas (see Hanskühnenburg) nearly treeless, see also no. 16+21
1987-2	60-80	50-70	damaged, but still uniform mature stands due to the E-SE slopes in the lee of the prevailing westerly winds
1987-3	80-100	70-90	no conspicuous damage detectable from the ground; stands in a narrow, N-S directed valley 200 m below the surrounding plateaus

Remarks

The former highly variable and luxurious lichen cover in tree canopy and on stems (so 1972) has completely disappeared. With the exception of *Sphagnum* species, even mosses grow less abundantly.

Acknowledgements

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Altenau, FOR KÜHL, FA Sieber, FD GREMSE, FA Braunlage, FD WACHTER, Nds. Forstplanungsamt Wolfenbüttel). Dr. G. HARTMANN, Nds. Forstliche Versuchsanstalt Göttingen, made available recent results of aerial forest surveys. Permits of entering all forest roads normally closed to public access were issued by the Bezirksregierung Braunschweig (Forstverwaltung). H. BLOCK, Mrs. and Mr. BOLLNER finally cared for accommodation in the Wolfenbütteler Hütte, Königskrug, just at the center of the study areas.

Results

1. Exponated mature spruce stands and their status 1972, 1987

The Wurmberg stands (see no. 18, 19 in Table 1, Fig. 2)

The isolated Wurmberg, highest part of the Westharz and southern edge of the granite massif Brocken (1142 m above sea level, 4.5 km N) surpasses the highland plateaus (Hochharz) for 200-400 m. Forest damages well correspond with marked decrease in bird populations (Table 3).

Table 3. Anzahl der Arten und Brutpaare auf den Wurmberg-Probeflächen 1972 und 1987. - Bird species and pair numbers of the Wurmberg study plots 1972 and 1987.

Arten species	Wurmberg			
	Plateau plateau (plot 19)	Südhänge southern slopes (plot 18)		
	Anzahl territorialer number of territorial males	Männchen (= Brutpaare) (= breeding pairs)		
	1972	1987	1972	1987
<i>Columba palumbus</i>	1	1	v	-
<i>Dryocopus martius</i>	-	-	f	-
<i>Anthus trivialis</i>	0.5	4.5 ¹⁾	2.5	2
<i>Motacilla alba</i>	-	-	-	1
<i>Garrulus glandarius</i>	v	1	1	-
<i>Troglodytes troglodytes</i>	1	-	-	-
<i>Prunella modularis</i>	1	-	0.5	-
<i>Regulus regulus</i>	8	2	3.5	-
<i>R. ignicapillus</i>	1	-	3.5	-
<i>Ficedula hypoleuca</i>	1	-	1	-
<i>Phoenicurus phoenicurus</i>	-	1 ²⁾	-	1
<i>P. ochrurus</i>	-	1	-	1
<i>Erithacus rubecula</i>	7	-	2.5	-
<i>Turdus torquata</i>	-	1 ²⁾	-	-
<i>T. philomelos</i>	1	-	f	-
<i>Parus ater</i>	2	1	3	-
<i>P. cristatus</i>	2	-	1	-
<i>P. major</i>	-	1	1	- ³⁾
<i>Certhia familiaris</i>	0.5	-	f	-
<i>Fringilla coelebs</i>	26	11 ^{x)}	10	7
number of territorial males	52	24.5 ^{xx)}	29.5	12 ^{xx)}
number of species	13	10	11	5

remarks

v = visitor, f = feeding guest, ¹⁾1986 even 8 ♂, ²⁾1986 3 ♂, ³⁾1986 0.5

x) $p < 0.05$, xx) $p < 0.01$ (χ^2 , df 1)

The Acker-Bruchberg stands (see no. 14, 16 + 21 in Table 1)

The appr. 12 km Acker-Bruchberg ridge rises 200-500 m above surrounding mountain country within a distance of 3-4 km. The NE-SW direction of the ridge acts as a weather barriere. Impacts of forest death characterize esp. the western (windward) slopes as to be seen from the bird populations of the devastated plot 14. Patches of wet stands and leeward, more closed spruce woods counterbalance the decrease in plot 16 + 21 (Table 4).

Habitat change and therefore changes in bird species composition and abundance are reflected by the 1987 gain and loss of breeding species compared with 1972:

Table 4. Anzahl der Arten und Brutpaare auf den Acker-Bruchberg-Probe-flächen 1972 und 1987. - Bird species and pair numbers of the Acker-Bruchberg plots 1972 and 1987.

Arten species	Hochfläche plateau (plot 14) Anzahl territorialer Männchen (= Brutpaare) number of territorial males (= breeding pairs)		Bergrücken ridge (plot 16+21) Anzahl territorialer Männchen (= Brutpaare) number of territorial males (= breeding pairs)	
	1972	1987	1972	1987
<i>Columba palumbus</i>	-	1-2	-	1
<i>Cuculus canorus</i>	-	1	1	> 1
<i>Anthus trivialis</i>	8.5	5	25	30
<i>A. pratensis</i>	1.5	-	3	1
<i>A. spinoletta</i>	0.5	-	2	-
<i>Motacilla alba</i>	0.5	-	-	-
<i>Garrulus glandarius</i>	-	-	f	v
<i>Troglodytes trogl.</i>	-	-	3	2
<i>Prunella modularis</i>	5	1	6	5
<i>Sylvia atricapilla</i>	-	-	v(1?)	-
<i>Phylloscopus trochilus</i>	3	7	3	13 ^x
<i>Regulus regulus</i>	7	-xx)	17	2 ^{xxx}
<i>R. ignicapillus</i>	-	-	-	1
<i>Phoenicurus ph.</i>	1	0.5	5	9
<i>P. ochrurus</i>	-	1	-	2
<i>Erithacus rubecula</i>	6	-x)	25	-xxx)
<i>Turdus merula</i>	1.5	-	7	1 ^x
<i>T. viscivorus</i>	-	-	1	2
<i>T. philomelos</i>	0.5	-	8	1 ^x
<i>Parus ater</i>	2	-	7	9
<i>P. cristatus</i>	2	-	3	-
<i>P. major</i>	1	-	6	8
<i>Certhia familiaris</i>	-	-	2	-
<i>Loxia curvirostra</i>	-	-	1(f)	v
<i>Fringilla coelebs</i>	16.5	9	57	49
number of territorial males	56.5	25.5-26.5 ^{xxx)}	182-183	137 ^{x)}
number of species	15	8	19-20	17

x) $p < 0.05$, xx) $p < 0.01$, xxx) $p < 0.001$ (χ^2 , df 1)

Probefläche	Artengewinn (no.) 1987 species gain (+)	Artenverlust (no.) loss (-)
plot 19	5	8
plot 18	3	9
plot 14	3	10
plot 16 + 21	2	3-4
	13	30-31
$\bar{x}$	3.2	7.7

The species loss explains the reduction in bird density of appr. 37.5 %:

Probefläche	Brutpaare breeding pairs 1972	1987
plot 19	52	24.5
plot 18	29.5	12
plot 14	56.5	25.5-26.5
plot 16 + 21	182-183	137
	320-321	199-200

A number of species, esp. insectivorous birds of the peripheral canopy is most heavily affected by tree damage:

Art/species	Brutpaare breeding pairs 1972	1987	Rückgang um den Faktor reduction by factor
<i>Erithacus rubecula</i>	40.5	0	40.5x
<i>Turdus philomelos</i>	9.5	1	9.5x
<i>Regulus regulus</i>	35.5	4	8.9x
<i>Turdus merula</i>	8.5	1	8.5x
<i>Parus cristatus</i>	8	0	8x
<i>Anthus pratensis</i>	4.5	1	4.5x
<i>Regulus ignicapillus</i>	4.5	1	4.5x
<i>Anthus spinoletta</i>	2.5	0	2.5
<i>Certhia familiaris</i>	2.5	0	2.5

The small, isolated Water Pipit population (1972 less than 10 breeding pairs) seems to be wiped out.

There are, however, a few species being favoured by the woodland destruction (habitat change). From 1972 to 1978, the breeding population of *Phoenicurus phoenicurus* (1.5:16 pairs), *P. ochruros* (0:5 pairs), *Phylloscopus trochilus* (6:20 pairs), *Columba palumbus* (1:3-4 pairs) rose conspicuously.

The Ring Ouzel (*Turdus torquatus alpestris*) was recorded for the first time (1 nest record with feeding adults 1986, 1 feeding pair 1987 on study plot 19). In relation to the rather small Harz population around the Brocken massif with less than 20 assumed breeding pairs, an alpine-like, timberline high elevation habitat might explain the occurrence of this rare species.

In regard to the small, statistically unreliable numbers, the remaining 11 out of 25 species (44 %) seem to be stable although Chaffinches (*Fringilla coelebs*) decreased considerably in absolute numbers (109,5 : 76 pairs).

The reduced number of *Prunella modularis* (12.5 : 6 pairs), *Troglodytes troglodytes* (4:2 pairs) and the absence of *Ficedula hypoleuca* (2 pairs 1972) might fall into the realm of normal fluctuations, but influenced the status of reduced plot populations.

2. Non environmentally exponents mature spruce forests and their status 1972, 1987

Spruce stands at the Brockenfeld moor (plot 17 in Table 1)

The central moorland "Brockenfeld" (study plot 22, Table 2.2 in OELKE 1981) was closed 1987 for public access as a nature reserve. Fringes with wet mature woodland could be surveyed along a hiking route at the south- and east edge. They coincide with the 1972 study plot no. 17, but include, too, an appr. 50 m wide opposite southern stripe. Birds of this stripe have been omitted from the calculation.

Species number and pair density fell down in 1987 for 33.3 resp. 30 %. The decline is due to the absence of 7 species and no gain of new species. The decrease in pair density occurred once more in canopy species (see *Prunella modularis*, *Regulus regulus*, *Erithacus rubecula*, *Parus cristatus*, *Loxia curvirostra*, *Carduelis spinus*). With the possible exception of *Phylloscopus collybita*, *Parus ater*, the losses are not compensated (see Table 5).

Table 5. Vogeldichten in nassen Fichtenbeständen des Brockenfeld-Moores 1972 und 1987 (Probefläche 17). - Bird densities in wet spruce stands along the Brockenfeld moor 1972 and 1987 (plot 17).

Arten species	Anzahl territorialer Männchen (= Brutpaare) number of territorial males (= breeding pairs)	
	1972	1987
<i>Columba palumbus</i>	2	1
<i>Cuculus canorus</i>	1	1
<i>Anthus trivialis</i>	11	6
<i>Lanius collurio</i>	1	-
<i>Garrulus glandarius</i>	1	-
<i>Prunella modularis</i>	9	2 ^x)
<i>Sylvia atricapilla</i>	1	1
<i>Phylloscopus trochilus</i>	4	5
<i>P. collybita</i>	1	4 ^x)
<i>Regulus regulus</i>	10	3 ^x)
<i>R. ignicapillus</i>	1	1
<i>Erithacus rubecula</i>	9	-xx)
<i>Turdus merula</i>	2	2
<i>T. philomelos</i>	2	2
<i>Parus ater</i>	2	6
<i>P. cristatus</i>	1	-
<i>P. major</i>	2	1
<i>Loxia curvirostra</i>	2	-
<i>Pyrrhula pyrrhula</i>	1	-
<i>Carduelis spinus</i>	1	-
<i>Fringilla coelebs</i>	19	23
number of territorial males	83	58 ^x)
number of species	21	14

x) $p < 0.05$, xx) $p < 0.01$ (χ^2 , df 1)

Wooded cliffs (Hahnenkleeklippen, plot 9 in Table 1)

The lower altitude and leeward position of the study area result in a more or less balanced bird population *in toto* (Table 6). Compared to 1972, species gain and loss are balanced (5 : 4). The slight decrease in pair numbers (13 %) must be regarded as part of the normal fluctuation. In accordance with oxponated stands (Table 3-4), the reduced pair number in Robin, Goldcrest, Crested Tit and even Chaffinch seem to be typical for wider regions of the Harz Mountains in 1987. The increase in Tree Pipit and Willow Warbler is probably favoured by a greater proportion of openings with dead trees (for details see Table 2).

Table 6. Vogeldichten der bewaldeten Hahnenkleeklippen 1972 und 1987. - Bird densities of wooded cliffs (Hahnenkleeklippen) 1972 and 1987.

Arten species	Anzahl territorialer Männchen (= Brutpaare) number of territorial males (= breeding pairs)	
	1972	1987
<i>Cuculus canorus</i>	-	0.5
<i>Anthus trivialis</i>	-	6x)
<i>Prunella modularis</i>	2	4
<i>Sylvia atricapilla</i>	1	3
<i>Phylloscopus trochilus</i>	v	5x)
<i>P. collybita</i>	1.5	1
<i>P. sibilatrix</i>	3	-
<i>Regulus regulus</i>	6	1 (x)
<i>R. ignicapillus</i>	0.5	-
<i>Phoenicurus ochruros</i>	3	2
<i>Erithacus rubecula</i>	6	-x)
<i>Turdus merula</i>	1.5	-
<i>T. philomelos</i>	0.5	1
<i>Parus ater</i>	1	1
<i>P. cristatus</i>	1	-
<i>P. major</i>	-	1
<i>Sitta europaea</i>	f	1
<i>Fringilla coelebs</i>	18.5	13
number of territorial males	45.5	39.5
number of species	13	13

Remarks: v = visitor, f = feeding guest

x) $p < 0.05$ (χ^2 , df 1)

3. Mature spruce at the top (windward) and slopes (lee) of the mountain ridge "Auf dem Acker" (plot 1987-1, 1987-2)

The differences in the bird populations settling on study plots of similar size are striking (Table 7). This may be shown by the high proportion of so-called clearing (open-area-)species on the ridge (see *Anthus trivialis*, *A. pratensis*, *Anas platyrhynchos*) and the high(er) diversity 'behind' the ridge: $H' = 1.63$ (ridge) and $H' = 2.6$ (leeward slopes). A number of species absent on the 1972-1987 plot series (Table 3-6), is again present (e.g. *Troglodytes troglodytes*, *Regulus regulus*, *Erithacus rubecula*, *Carduelis spinus*) indicating that the populations have not been totally wiped

out but repelled from unsuitable habitats of the higher elevations. Species of open areas have, however, intruded into woodland gaps of the more protected leeward stands.

Examples: *Locustella naevia*. The presence of the Green Woodpecker, normally a species of deciduous forests in lower elevations (< 600 m) (SKIBA 1983), is striking.

Table 7. Brutvogel-Erfassung auf der Luv- und Leeseite des Ackermassivs 1987. - Breeding bird survey at the top (windward) and leeward slopes of the mountain ridge "Auf dem Acker", 1987.

Arten species	Höhenkamm (Luv) ridge 70 ha		Hänge (Lee) slopes 63 ha	
	n	%	n	%
<i>Anas platyrhynchos</i>	1	0.8	-	-
<i>Columba palumbus</i>	f	-	10	5.9
<i>Picus viridis</i>	-	-	0.5?	0.3
<i>Cuculus canorus</i>	3	2.3	3	1.8
<i>Anthus trivialis</i>	43	32.8	15	8.9
<i>A. pratensis</i>	11	8.4	-	-
<i>Garrulus glandarius</i>	f	-	1.5	0.9
<i>Troglodytes troglodytes</i>	-	-	3.5	2.1
<i>Prunella modularis</i>	2	1.5	9	5.3
<i>Locustella naevia</i>	-	-	1	0.6
<i>Sylvia atricapilla</i>	-	-	2	1.2
<i>Phylloscopus trochilus</i>	13	9.9	14.5	8.6
<i>P. collybita</i>	-	-	11	6.5
<i>Regulus regulus</i>	-	-	12	7.1
<i>R. ignicapillus</i>	-	-	4	2.4
<i>Phoenicurus phoenicurus</i>	3	2.3	1	0.6
<i>Erithacus rubecula</i>	-	-	5.5	3.3
<i>Turdus merula</i>	3	2.3	8.5	5.0
<i>T. viscivorus</i>	2	1.5	0.5	0.3
<i>T. philomelos</i>	-	-	6	3.6
<i>P. ater</i>	1	0.8	9	5.0
<i>P. major</i>	-	-	4.5	2.7
<i>Carduelis spinus</i>	-	-	1	0.6
<i>Fringilla coelebs</i>	49	37.4	46	27.2
number of territorial males (n)	131		169	
number of species	11		22	

Remarks: f = feeding guest, in plot "slopes" *Loxia curvirostra*

4. Mature spruce stands in the Oder valley (plot 1987-3)

The presence of specialized canopy species as the *Regulus* species, Blackcap, of hole breeders as Great Spotted Woodpecker, Pied Flycatcher, Treecreeper should be explained by lesser spruce damage resp. the more normal situation of lower elevation spruce stands in these parts of the Harz Mountains (Table 8). For comparison with 1972 surveys in the 400-600 m altitudinal zones see discussion.

Table 8. Brutvogel-Erfassung im Odertal 1987 (25 ha). -
Breeding bird survey in the Oder valley 1987 (25 ha).

Arten/species	n	%
<i>Dendrocopus major</i>	1	1.4
<i>Motacilla cinerea</i>	2	2.8
<i>Garrulus glandarius</i>	f	-
<i>Troglodytes troglodytes</i>	4.5	6.2
<i>Prunella modularis</i>	1	1.4
<i>Sylvia atricapilla</i>	4	5.6
<i>Phylloscopus collybita</i>	6	8.3
<i>Regulus regulus</i>	3	4.2
<i>R. ignicapillus</i>	5	6.9
<i>Ficedula hypoleuca</i>	1	1.4
<i>Turdus merula</i>	3	4.2
<i>T. viscivorus</i>	0.5	0.7
<i>T. philomelos</i>	2	2.8
<i>P. ater</i>	6	8.3
<i>Certhia familiaris</i>	2	2.8
<i>Carduelis spinus</i>	1	1.4
<i>Fringilla coelebs</i>	30	41.7
number of territorial males	72	
number of species	16	

Remarks: f = feeding guest, additionally in the neighbourwood
Buteo buteo, *Columba palumbus*, *Cinclus cinclus*, *Erithacus rubecula*,
Phylloscopus trochilus, *Pyrrhula pyrrhula*.

5. Changes in population densities and structures (all plots compiled)

There are practical no study plots which have not changed in pair and/or species density (Table 9 + 10). Compared to 1972, the pair densities have been most severely affected whereas species densities fell down in a less dramatic way. The lower elevation plots are lesser hampered than areas around the mountain tops and here at the windward sides.

The reduced densities resp. the poorer community diversities are also reflected by the rise of the dominance index. Following MacNAUGHTON & WOLF (1970), abundance (pairs/10 ha) of the 2 dominant breeding species has been related to the total plot abundance. A rise in the dominance indices (Table 11) coincides with more unbalanced species structures.

The surveys revealed 31 (potential) breeding species in 1972, 23 species in 1987 based on plots studies in both years. 10 species (*Lanius collurio*, *Anthus spinoletta*, *Erithacus rubecula*, *Ficedula hypoleuca*, *Phylloscopus sibilatrix*, *Parus cristatus*, *Certhia familiaris*, *Loxia curvirostra*, *Pyrrhula pyrrhula*, *Carduelis spinus*) were recorded only in 1972, 2 species (*Turdus torquatus*, *Sitta europaea*) only in 1987. In relation to densities and/or dominance (Table 12), 8-10 species decreased (including *Anthus spinoletta*, *Certhia familiaris*) whereas 8-9 species (including *Turdus torquatus*) increased. Therefore the mere species calculation (present-non present) is getting more complicated when taking into account the pair numbers of influent/recedent species. These ones are so small (less than 5 pairs in a total of appr. 449.5 in 1972 resp. 298 in 1987) that personal, albeit biological interpretation must be used. Species in brackets (see above) are examples of these considerations.

Table 9. Abundanz (Brutpaare/10 ha) in Harz-Probeflächen 1972 und 1987. - Population abundance (pairs/10 ha) of Harz study plots 1972 and 1987.

Probefläche plot no.	Größe size (ha)	1972	1987	% of 1972
19	20.3	25.6	12.1	47.3
18	25	11.8	4.8	40.7
14	21.4	26.4	12.1	45.8
16+21	50	36.5	27.4	75.1
17	25	33.2	23.2	69.9
9	11.3	40.3	35.0	86.8
1987-1	70	(36.5) ¹⁾	18.7	(51.2)
1987-2	63	(26.9) ²⁾	26.8	(± 100)
1987-3	25	(33.1) ³⁾	28.8	(87.0)

1) corresponding in habitat type and structure with plot 16+21, therefore 1972 abundance transferred to plot 1987-1.

2)3) adopted from Table 10, elevations 800-900 resp. 500-600 m, in OELKE 1981.

Table 10. Artendichte (Arten/10 ha) der Harz-Probeflächen 1972 und 1987. - Species density (species/10 ha) of Harz study plots 1972 and 1987.

Probefläche plot no.	Größe size (ha)	1972	1987	% of 1972
19	20.3	6.4	4.9	76.6
18	25	4.4	2.0	45.4
14	21.4	7.0	3.7	52.9
16+21	50	3.9	3.6	92.3
17	25	8.4	5.6	66.7
9	11.3	11.5	11.5	100
1987-1	70	(3.9) ¹⁾	1.6	(41.0)
1987-2	63	(5.2) ²⁾	3.5	(67.3)
1987-3	25	(11.2) ³⁾	6.4	(57.1)

1)2)3) see footnotes in Table 9

Table 11. Shannon-Weaver Diversitätsindex (H') und MacNaughton Dominanzindex (IDo) für die Harz-Probeflächen 1972 und 1987. - Shannon-Weaver diversity index (H') and MacNaughton dominance index (IDo) of Harz study plots 1972 and 1987.

plot	H'		IDo	
	1972	1987	1972	1987
19	1.7	1.8	65.2	52.8
18	2.1	1.2	45.8	75.0
14	2.2	1.7	44.3	62.0
16+21	2.3	2.0	44.9	57.2
17	2.5	2.1	36.1	50.0
9	2.0	2.1	53.8	48
1987-1	(2.4) ²⁾	1.6	(44.9)	(70)
1987-2	(2.4) ²⁾	2.6	(22.6)	(36.2)
1987-3	(2.7) ³⁾	2.1	(21.3)	(50)

2)3) see footnotes in Table 9

DISCUSSION

When - without doubt - habitat selection and thus distribution of birds is most significantly related to vegetation height and percent canopy cover (CODY 1985, p. 33), habitat changes - in the scale of the recent environmental impacts - must strongly change bird populations as top consumers of ecosystems. The physiognomic and - by food chains - physiological influence of the parameters plant height and canopy cover is shown in Figure 3. Decrease of tree canopy cover is more or less identical, too, with decrease of overall tree height by sorting out the higher trees because of storms, insect damage, lumbering.

To be true, the top rank of species diversity in mature woodlands can never be compensated by any succession either natural or man-made (see agricultural areas, OELKE 1985). Loss or absence of woodland and therefore time-dependent successions and/or even geographically stable intermediate habitats (see savanne, steppe, parkland) have ever fallen into the array of bird faunas of the temperate zone. Therefore a number of species (specialists) will always try to fill left ecological niches. The Harz Mountains woodland or better the rests of them are no exceptions of this rule. In spite of the dramatic loss by both high canopy and ground cover species (Table 12), their replacement by *Phyl-*

Table 12. Auffällige artenspezifische Variationen der Paardichte und Dominanz zwischen 1972 und 1987. - Alle Probeflächen (153 ha) zusammengenommen. Die 1987 neu aufgenommenen Flächen sind hier ausgelassen. - Conspicuous species-specific variations in pair density and dominance between 1972 and 1987. - All plots (153 ha) compiled. The 1987 new elected plots are omitted.

decrease - Abnahme species - Arten	pairs/10 ha		dominance (%)	
	1972	1987	1972	1987
<i>Fringilla coelebs</i>	9.6	7.3 ^x)	increase!	
<i>Erithacus rubecula</i>	3.6	0 ^{xxx})	12.3	0
<i>Regulus regulus</i>	3.4	0.5 ^{xxx})	11.5	2.7
<i>Prunella modularis</i>	1.5	0.8 ^x)	5.2	4.0
<i>Turdus merula</i>	0.8	0.2 ^x)	2.7	1.0
<i>T. philomelos</i>	0.8	0.3 ^x)	2.7	1.3
<i>Parus cristatus</i>	0.6	0 ^{xx})	2.2	0
<i>Regulus ignicapillus</i>	0.4	0.1	1.3	0.7
increase - Zunahme				
<i>Fringilla coelebs</i>	[decrease]		32.7	37.6
<i>Anthus trivialis</i>	3.1	3.5	10.6	17.9
<i>Phylloscopus trochilus</i>	0.6	2.0 ^{xx})	2.2	10.1
<i>Phoenicurus phoen.</i>	0.4	0.8	1.3	3.9
<i>P. ochruros</i>	0.2	0.5	0.7	2.3
<i>Phylloscopus collybita</i>	0.2	0.3	0.6	1.7
<i>Parus ater</i>	1.1	1.1	3.8	5.7
<i>P. major</i>	0.7	0.7	2.4	3.7

Remarks: For statistical analysis (χ^2 , df 1) the pair numbers were used.
^x) $p < 0.05$, ^{xx}) $p < 0.01$, ^{xxx}) $p < 0.001$.

No conspicuous variations in: *Columba palumbus*, *Cuculus canorus* (increase ?), *Anthus pratensis*, *Motacilla alba*, *Lanius collurio*, *Garrulus glandarius*, *Cinclus cinclus*, *Troglodytes troglodytes*, *Sylvia atricapilla*, *Phylloscopus collybita*, *P. sibilatrix* (decrease?), *Ficedula hypoleuca*, *Turdus viscivorus*, *Parus ater*, *P. major*, *Sitta europaea*, *Certhia familiaris* (decrease?), *Pyrrhula pyrrhula*, *Carduelis spinus*, *Loxia curvirostra* (decrease?).

Ioscopus trochilus, *Phoenicurus phoenicurus* or *Anthus trivialis* is still in accordance with the normal species composition of light, widened-up, sparse woods and openings. Higher altitudes simultaneously regulate the species composition and density. The relatively high density of the Redstart is one example. Another example might be the Ring Ouzel colonizing *Vaccinium myrtillus* type spruce forests near the timber line which is now depressed from former 1100 to 900 m in the Harz. Similarly surprising, new colonisation of uncommon, so-called rare species could be shown in fire devastated pine forests (for details DIERSCHKE & OELKE 1979). The appearance of specialists of the open woodland and grasslands is certainly caused by emigrating surplus-individuals of outside populations. The origin of the new settlers is unknown. Any marked populations are lacking. Any recoveries of marked specimens are non existent. The presence of the rather conspicuous Ring Ouzel cannot really be traced back to any neighbouring Harz population (SKIBA 1983) or adequate habitat tracking of far-distant populations as indicated by the alpine form of this thrush. The problem of origin of the colonisers must be analysed in all future studies in so far as official concern will enable the necessary funding of such research.

TREE COVER

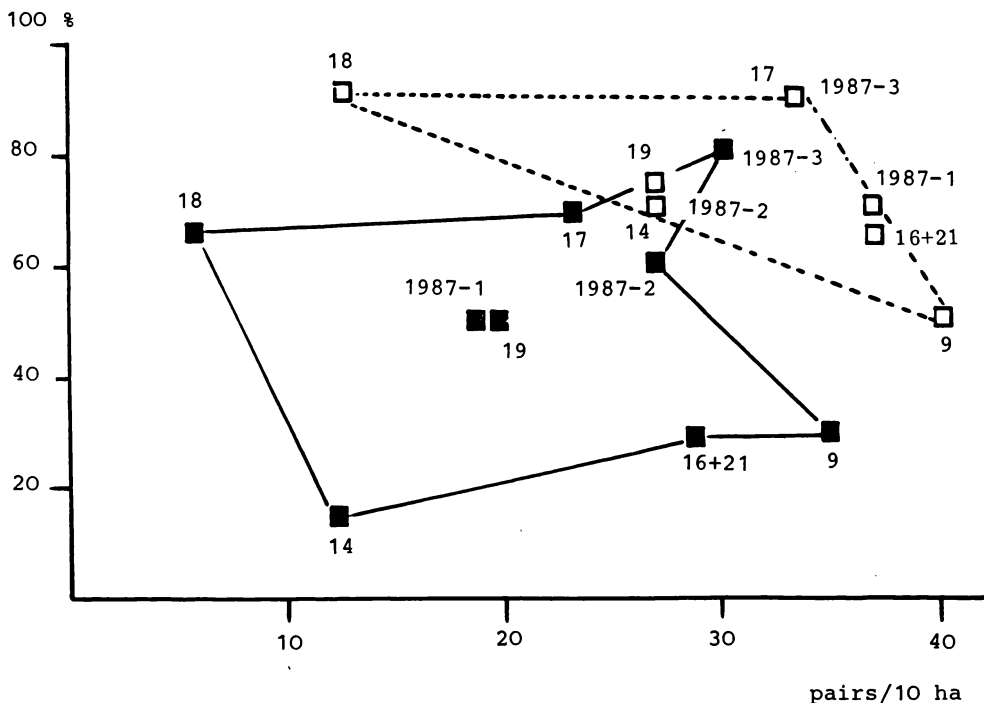


Fig. 3. Correlation canopy cover (in %) and pair density in the Harz Mountains (plots 1972 and 1987). □ = 1972. ■ = 1987. - Korrelation Baumschicht-Deckungsgrad (in %) und Paardichte für die Harz-Probeflächen 1972 und 1987.

The loss of species and population by forest death might be interpreted both from the distributional and the conservational aspect. Although a complete recent survey of the bird populations of the Harz Mountains has not been done and important species (owls, birds of prey) have not included, feeding and breeding conditions have been greatly disturbed in the foraging guilds of foliage and ground gleaners. The disappearance of the *Regulus* species, the absence of Siskins, the reduction of Crossbills could be expected because of the onset of visible tree damages in the high canopy. The alarming reduction in thrushes (Blackbird, Song Thrush), especially the wiping-out of the once dominant Robin, the lack of Crested Tits and bark drillers and gleaners (woodpeckers, Treecreeper) should be connected with intrigue disturbances and damages even in the lower vegetational layers and the vertebrates living in these horizons. Once more the lack of ecological raw data is blocking any further explanations.

From the ornithological point-of-view, however, species as *Regulus regulus*, *Erithacus rubecula*, Thrushes, Wren (in lower elevations) resp. Willow Warblers, Tree Pipits should be monitored on a wider scale. They might act as monitoring parameters of forest ecosystem damages at least in Central Europe.

The Harz forest impact is locally and now regionally threatening bird species (Table 12) which are normally regarded as no endangered species. With the exception of the Rock Pipit, they are still no red-data list species (HECKENROTH 1985). On the contrary, the endangered species (red-data list Lower Saxony) Green Woodpecker (Table 7), Meadow Pipit, Redstart, Ring Ouzel seem to be favoured by the forest destruction. Skylarks (*Alauda arvensis*) which settled in 1972 on moorland outside study plot 16+21 might be ranked as endangered for wider parts of agricultural Central Europe (OELKE 1985), but were still widespread in 1987 on meadows in 700 m altitude (around St. Andreasberg). Neglecting losses or even regional extirpation of otherwise abundant species will rapidly change when the bird decrease is spreading into woodlands of geographically wider, distinct units. A country-wide impact especially in the richer avifaunas of the lower elevations will rapidly grip the rarer and thus endangered species. The Harz bird losses are unmistakable alarm signals for the situation of all animals in the ecosystems. Nowhere any stop of forest death - in reality of plant death - can be reckognized.

Monitoring studies of bird populations of (visibly) damages forests are too few to overlook the present situation on a wider scale. The censuses of STASNY & BEJCEK (1985) and KOLBE (1984) draw attention to similar developments in the Harz Mountains (GFR), the Erzgebirge (GDR) and the Ore Mountains, northwestern Bohemia, Czechoslovakia, at altitudes between 680-870 m. Both reduction of overall and individual species density are now to be observed in spruce stands all over Central Europe. The withdrawal of *Regulus* species, thrushes (*T. merula*, *T. philomelos*), Crested Tit or Robin seem to be general phenomena. Surprisingly, the gain of new species, Czechoslovakia *Lanius collurio*, *Saxicola rubetra*, *Anthus pratensis*, *Alauda arvensis*, especially Fringillidae (*Carduelis cannabina*, *C. flammea*, *C. chloris*), *Emberiza citrinella*, in the Erzgebirge *Alauda arvensis*, *Anthus pratensis*, *Saxicola rubetra*, *Oenanthe oenanthe*, *Phoenicurus phoenicurus*, *Emberiza citrinella*, express similarity in species replacements over wide parts of Europe.

Which trend - reforestation (at the moment unrealistic) or extra and progressive clearing and in connection with these habitat types poorer open areas-avifaunas and peripheral, suboptimal northern low total densities (OELKE 1980b) - will prevail, depends on decisions outside the range of scientific conclusions and possibilities.

Summary

Based on breeding bird surveys on mostly the same, but severely impacted study plots, the bird populations of spruce (*Picea abies*) stands in the high elevations of the Harz Mountains, FGR, are compared with the survey years 1972 (before) and 1987 (at the present peak of forest death).

The common but altitudinally dependent decline of overall and special single species densities is conspicuous. A number of both canopy and ground gleaning species has already been totally excluded (e.g. *Erithacus rubecula*, *Parus cristatus*) or drastically reduced (e.g. the *Regulus* species, *Turdus merula*, *T. philomelos*, *Prunella modularis*) thus changing community composition and species dominance. These species can be regarded as monitors of spruce forest damage.

The underlying habitat changes on a way to disappearing woodlands still fit into the habitat selection key factors of surplus open area species populations. Species losses are counterbalanced up to a certain degree, e.g. by *Anthus trivialis*, *Phoenicurus*, *Phylloscopus* species. The depression of the timber line from appr. 1100 to 900, now 700 m might explain the unexpected breeding of *Turdus t. torquatus* in 1986 and 1987.

The changes and overall reductions of bird populations are more or less identic in the higher elevations of Central European woodlands, mostly spruce forests, as revealed by comparison of the (few) available studies in literature.

Zusammenfassung

Auf der Basis von Brutvogelerfassungen zumeist auf denselben, jetzt aber schwer geschädigten Probeflächen sind die Vogelpopulationen von Fichtenforsten (*Picea abies*) in den Hochlagen des Harzes (Bundesrepublik) für die Jahre 1972 und 1987 verglichen worden, d.h. vor und während des Einbruchs des Saure-Regen-Syndroms.

Auffällig ist der allgemeine, jedoch höhenlagenabhängige Rückgang der Vogelbestände und insbesondere einzelner Arten. Eine Reihe von Arten der Wipfelregion und der Bodenschicht ist bereits mehr oder weniger verschwunden, z.B. Rotkehlchen, Haubenmeise, oder zumindest drastisch reduziert, z.B. die Goldhähnchen-Arten, Amsel, Singdrossel, Heckenbraunelle. Damit sind die Zusammensetzung der Vogelgesellschaften und die Häufigkeitsverhältnisse (Dominanz) der Arten verändert. Diese Arten können somit als Monitor-Spezies der Fichtenforst-Waldschäden betrachtet werden.

Habitatveränderungen von geschlossenem Waldland zu größeren, offenen Freilandflächen fördern allerdings das Auftreten anderer, hier speziell angepasster Arten, wie Baumpieper, Rotschwänze, Laubsänger (Fitis, Zilpzalp). Das Absinken der Baumgrenze von einst etwa 1100 auf jetzt fast 700 m Höhe könnte das unerwartete Brüten der Alpen-Ringdrossel 1986, 1987 erklären.

Die Veränderungen und allgemeinen Rückgänge von Vogelpopulationen sind offenbar identisch in den Hochlagen der mitteleuropäischen Wald-, speziell Fichtenbiom-Gebiete. Das ergibt ein Vergleich mit den (relativ wenigen) Literaturhinweisen.

Literature

B u n d e s m i n i s t e r d e s I n n e r n (1985): Aktionsprogramm Rettet den Wald. Umweltbrief 32, 40 S. Bonn. - C o d y , M.L. (1985): Habitat selection in birds. 558 S. Academic Press. London. - D i e r s c h k e , F., & H. O e l k e (1979): Die Vogelbestände verbrannter niedersächsischer Kiefernforsten 1976 - ein Jahr nach der Waldbrandkatastrophe 1975. Vogelwelt 100: 26-44. - H e c k e n r o t h , H. (1985): Atlas der Brutvögel Niedersachsens 1980 und des Landes Bremen mit Ergänzungen aus den Jahren 1976-1979. Naturschutz u. Landschaftspflege in Niedersachsen, H. 14, 428 S. Hannover. - K o l b e , U. (1984): Zur Situation der Brutvogelfauna des oberen Osterzgebirges. Falke 31: 421-426. - Landesanstalt für Ökologie, Landschaftsentwicklung und Forstplanung Nordrhein-Westfalen (1982): Immissionsbelastungen von Waldökosystemen. Wald und Umwelt (Sonderheft), 57 S. Recklinghausen. - Niedersächsischer Minister für Ernährung, Landwirtschaft und Forsten (1987): Waldschäden - Herausforderung an alle. 30 S. Hannover. - M a c N a u g h t o n , S.J., & L.L. Wolf (1970): Dominance and the niche in ecological systems. Science 167: 131-139. - O e l k e , H. (1977): Vogelsiedlungsdichten und ornitho-ökologische Differenzierungen der Laubwälder und Laubholzanlagen des Westharzes. In: Vegetation und Fauna (Hrsg. R. Tüxen), Ber. Int. Symp. Ver. Vegetationskunde (Rinteln), 12.-15.4.1976, S. 353-396. Vaduz. - O e l k e , H. (1980a): Siedlungsdichte. In: Praktische Vogelkunde (Hrsg. P. Berthold, E. Bezzel, G. Thielcke), S. 34-45. Greven. - O e l k e , H. (1980b): The bird structure of the European spruce forest biome - as regarded from breeding bird censuses. In: Bird Census Work and Nature Conservation (ed. H. Oelke), p. 201-209. Göttingen. - O e l k e , H. (1981): Quantitative Vogelbestandsuntersuchungen der Fichtenwaldgesellschaften des Westharzes (Niedersachsen, Bundesrepublik Deutschland). Ber. naturhist. Ges. Hannover 124, S. 219-278. Hannover. - O e l k e , H. (1985): Vogelbestände einer niedersächsischen Agrarlandschaft 1961 und 1985. Vogelwelt 106: 246-255. - O e l k e , H., J.K. G e h r t , S. L i n k e r s d ö r f e r , J. T ö n n i e ß e n u. B. W o l f f (1983): Vogelerfassungen im niedersächsischen Küstengebiet. Beitr. Naturk. Niedersachsens 36: 121-140. - S k i b a , R. (1983): Die Tierwelt des Harzes. 140 S. 3. Aufl. Clausthal-Zellerfeld. - S t a s t - n y , K., & V. B e j c e k (1985): Bird communities of spruce forests affected by industrial emissions in the Krusne Hory (Ore Mountains). In: Bird Census and Atlas Studies (ed. K. Taylor, R.J. Fuller & P.C. Lack), p. 243-253. BTO. Tring.

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