Birdlife in intensively used rural and urban environments

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Intensive use of the environment under the conditions of industrial society in the second half of the 20th century reduces the diversity of resources in both urban and rural areas. This results in decreased numbers of bird species and an increase of new species favoured by man-made environments. Within the last 150 years the loss of species per district in Central Europe is about 10 %; the ratio of extinct/declining to immigrating/increasing species is about 2:1. The losses are unevenly distributed among different ecological and/or systematic groups. Nonpasserine land birds show the strongest decrease. In comparison to areas in their immediate vicinity, intensively used plots show very low species numbers and very high numerical dominance of the most abundant species. Small islands formed by natural habitats are influenced by their surroundings, which indicates that local bird associations cannot be protected against the impact from outside, if the habitat island is too small. The seasonal distribution of birds is also strongly affected by modern methods of land use and the growth of urban areas. Detailed studies, however, are very scarce. The most successful colonizers of intensively used environments mostly belong to the following groups: granivorous and/or having a variable diet; medium-sized omnivorous; sedentary or partial migrant. Some species which seem to be well adapted to a changed environment cannot reach the rate of reproduction necessary for maintaining a stable population (e.g. Curlew, Lapwing; in cities also Great Tit). Their continued presence in such habitats depends on immigration of a surplus from optimal habitats. The only means of preserving a richer birdlife in intensively used areas is the maintenance of a network of natural or seminatural habitats.

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Introduction

Studies of birdlife are much more popular under natural conditions than in man-made environments, evidently because birdlife is rather poor in urban areas and near industrial plants or in heavily exploited fields and monocultural plantations. But in many parts of Europe man-made environments now cover vast and increasing areas, and research in our immediate surroundings has become indispensable for habitat management and bird conservation. Many ornithological studies have described the temporal and spatial distribution of birds in more or less intensively used environments but synthetic approaches have so far been tried only for small areas or single aspects (Bezzel 1982). To understand the problems of survival in man-made environments detailed long-term studies are badly needed, especially on population dynamics and on etho-ecological aspects. The rate of habitat changes, however, has been accelerating to such a degree that we have only vague ideas on the present state of birdlife in man-made environments.

The following review of birdlife in intensively used environments concerns Central Europe. Similar developments can be found in many other temperate zone regions with a dense or rapidly growing human population demanding a high standard of living.

Recent environmental changes

As a result of the intensive use of the environment many original (= natural) habitats have disappeared or been reduced to small islands. New types of habitats have also been created, for example the agricultural environment providing human food and the urban environment containing human habitations. The industrial revolutions of the 19th century and the last few decades have drastically changed the man-influenced environment; the urban environment has become an urban-industrial system. In modern man-made systems the input of solar energy has been largely replaced by fossil fuel, electric power, and at present, by nuclear energy. Intensively used environments contain a few dominant plant species introduced and/or cultivated by man and such products of technology as urban residential quarters, industrial areas, traffic routes and power lines (e.g. Tischler 1980, Odum & Reichholf 1980, Bezzel 1982).

The last 100 years have seen an overall loss of diversity of habitats, plants and animals. As far as birds are concerned, the situation may be characterized as follows (see Bauer & Thielcke 1982):

1) Loss of natural habitats because of growing human settlement and increase of cities, towns and villages;
2) loss of natural habitats because of growing industrial zones and industrial exploitation of natural resources;
3) increasing density of traffic routes, cutting areas into more or less isolated pieces and islands, occupation of natural habitats by airports, railway, highways, etc.;
4) drastic manipulation of water courses, for example destruction of nearly all natural river beds and lake shores, construction of reservoirs and dams, intensive use of lakes and ponds (e.g. fish culture, sport, industrial reservoirs) and lowering of the groundwater level;
5) drainage of moorland, bogs, marshes and moist

meadows, mechanical exploitation of meadows, conversion of meadows into fields (often maize), use of large uniform engine-adapted fields, increasing intensity of exploitation of the soil, destruction of hedgerows and small woods, decrease of extensive methods of land use as a result of the technical revolution in modern agriculture;
6) increasing intensity of forestry, resulting in spruce plantations instead of mixed woodland, modern roads constructed through forests for harvesting engines, afforestation of heathland and meadows.

The intense exploitation of the environment needs increased inputs of energy and material. Artificial fertilizers are becoming a more and more serious source of pollution of soil and water, and even today irresponsible use of pesticides is acting against diversity. Furthermore, the impact on the water and air of the output of industrial society has become the most serious problem for life on earth. Small natural or seminatural habitats cannot be protected against this impact. Even in nature reserves, birdlife is threatened by a farther hazard. As urban areas do not contain enough recreation facilities, millions of holidaymakers in thousands of vehicles fall like locusts over the few places with rich plant and animal life. Tourism, outdoor sports and other holiday activities are at present one of the most urgent problems of nature conservation. Well-planned habitat protection (e.g. Blab 1984) seems to be useless if there is no official or political help for managing recreation activities in densely settled areas and protecting small natural sites, at least during the breeding season. Finally, man has introduced and/or domesticated animals. The biomass of domestic animals today outnumbers that of wild mammals. Species used for hunting have been released (e.g. Pheasant *Phasianus colchicus*, Fallow Deer, Mouflon) or are kept at too high densities like the Roe Deer and Red Deer. Escapes from captivity have become established in the wild (e.g. Canada Goose *Branta canadensis* and some other waterfowl, Muskrat, Coon).

Historical aspects of birdlife

It is very likely that birdlife has changed more within the last 100 years than during the preceding 500 years; the former period has been monitored by ornithologists, too. The dynamics of natural factors (variation of climate and weather, successions of living communities, etc.) are overshadowed more and more by the activities of the growing human population and are nowadays often reduced to secondary importance. Within the last 100 years many bird species have become scarse and/or regionally extinct (e.g., Bittern *Botaurus stellaris*, White Stork, *Ciconia ciconia*, Osprey *Pandion haliaetus*, Peregrine *Falco peregrinus*, Black Grouse *Tetrao tetrix*, Capercaillie, *T. urogallus*, Great Bustard *Otis tarda*, Lesser Grey Shrike *Lanius minor*, Woodchat Shrike *L. senator*); a few have disappeared as breeding species from the whole of Central Europe (e.g. Stone Curlew *Burhinus oedicnemus*, Lammergeyer *Gypaetus barbatus*, Griffon Vulture *Gyps fulvus*). Others have colonized new areas, immigrated from abroad, or considerably increased in certain regions (e.g. Pochard *Aythya ferina*, Tufted Duck *A. fuligula*, Collared Dove *Streptopelia decaocto*, Woodpigeon *Columba palumbus*, Fieldfare *Turdus pilaris*, Blackbird *T. merula*, Serin *Serinus serinus*). Many species were favoured by the early stages of

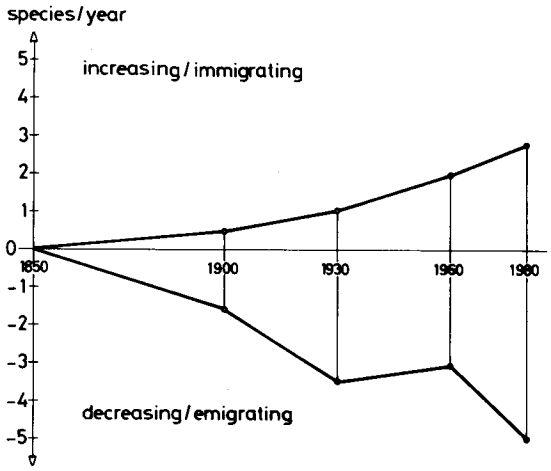

Fig. 1. Breeding species/year with negative or positive trend in Central Europe (data from Bezzel 1982).

land use, but further development caused decrease or emigration; some of those species are now severely threatened (especially meadow birds such as the Corncrake *Crex crex* and Curlew *Numenius arquata*, but also the Partridge *Perdix perdix* and some passerines). Some species lost their habitats at the beginning of modern land use and have now adapted to artificial habitats and re-established their populations (e.g. Little Ringed Plover *Charadrius dubius*). In all these cases man has played an important role.

An analysis of the faunistic literature reveals that since about 1850 in Central Europe the ratio of decreasing/extinct to increasing/immigrated species per area has been about 2:1. Within the last 100–150 years the loss of species has been about 10 % per district. At the same time the turnover rate in the fauna composition has increased remarkably (Fig. 1). During the last few decades the number of species per year with a positive trend has been 6-fold the value before 1900, whereas at the same time the number of species with a negative trend has grown 3-fold. The interruption of the increase in the latter value between 1930 and 1960 is due to World War II, which stopped the development of intensive land use. So a period of recovery for some species could be observed till the beginning of the 1950s. Today we have to expect high dynamics in the bird associations living in intensively used environments. According to a detailed analysis, the increase of the turnover shown in Fig. 1 is not seriously biased by the increasing numbers of birdwatchers (Bezzel 1982).

"A purely statistical approach that acts as if all species were the same is bound to leave unexplained residue" (Mayr 1983). This residue can be reduced if we look at the fate of ecological and/or systematic groups. The examples in Fig. 2 show different situations in three main groups of birds in the present avifauna. The greatest change seems to have taken

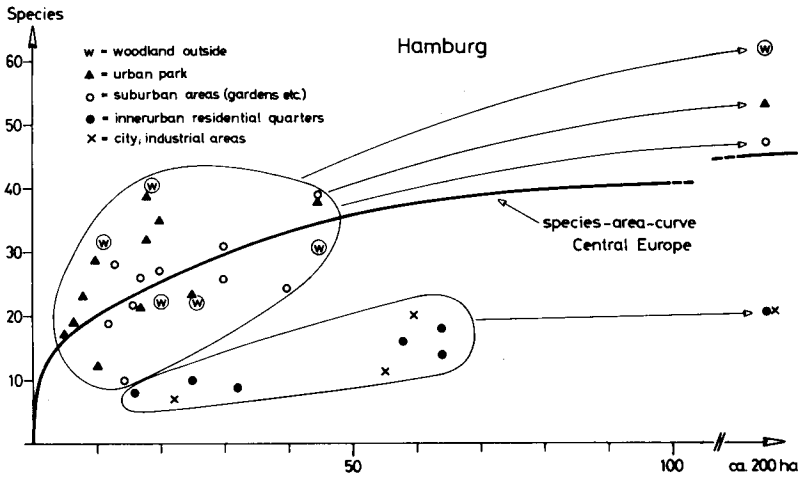

Fig. 2. Number of breeding species of the present avifauna in two areas of W Germany. W = Water birds (Podicipedidae, Ardeidae, Anatidae, Rallidae without *Crex*, Haematopodidae, Recurvirostridae, Laridae); L = Land birds, nonpasserines (incl. most Charadriidae, Scolopacidae); P = Passerines (data from Mulsow 1980, Orn. Arb.gem. Bodensee 1983).

place in water birds. This is due to drainage and destruction of natural zonations around lakes and along rivers, to recreation activities, eutrophication, excessive feeding during winter (e.g. Mallard *Anas platyrhynchos*, Coot *Fulica atra*, gulls) or released species (e.g. Mute Swan *Cygnus olor*) and probably to recent habitat management and preservation (e.g. creation of artificial wetlands, reserves). The rather heterogeneous group of nonpasserine land birds shows the highest loss and a relatively great number of decreasing species. Various factors are responsible for this. A simple overall conclusion is that most non-passerines need larger areas of suitable, not intensively used habitat than small passerines. Some of them, as most birds of prey, have suffered from heavy persecution. Some of the passerines were favoured by the early development of human land use (e.g. Starling *Sturnus vulgaris*, Yellowhammer *Emberiza citrinella*, Skylark *Alauda arvensis*, Tree Sparrow *Passer montanus* and House Sparrow *P. domesticus*). Up to now, wooded areas have provided a habitat for large populations, but the impact of pollution on the forests will probably change the situation. Considerable losses can soon be expected in the insect-eating species and/or long-distance migrants as well. Each species has its own history, but in intensively used environments the overall trend in nearly all groups or guilds is towards loss of species and often higher turnover rates within bird associations. The developments concern both breeding habitats and resting places for migrants.

Species richness and abundance

Normally intensively used environments today are characterized by low numbers of species. This is especially obvious in urban areas (Fig. 3). Here only parks and gardens — mostly more or less small islands among houses, streets, and industrial and commercial areas — keep the numbers of breeding species which can be expected from their area (Banse & Bezzel 1984). The number of breeding species increases from town centres to suburban areas or sur-

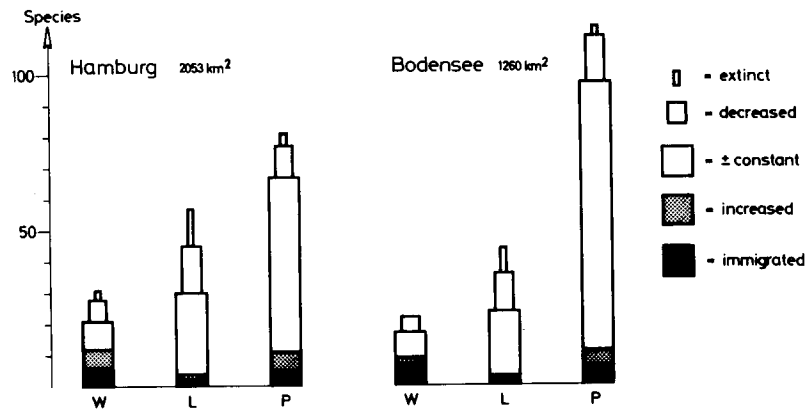

Fig. 3. Species number/area of Hamburg (data after Mulsow 1980; species-area-curve Central Europe after Banse & Bezzel 1984).

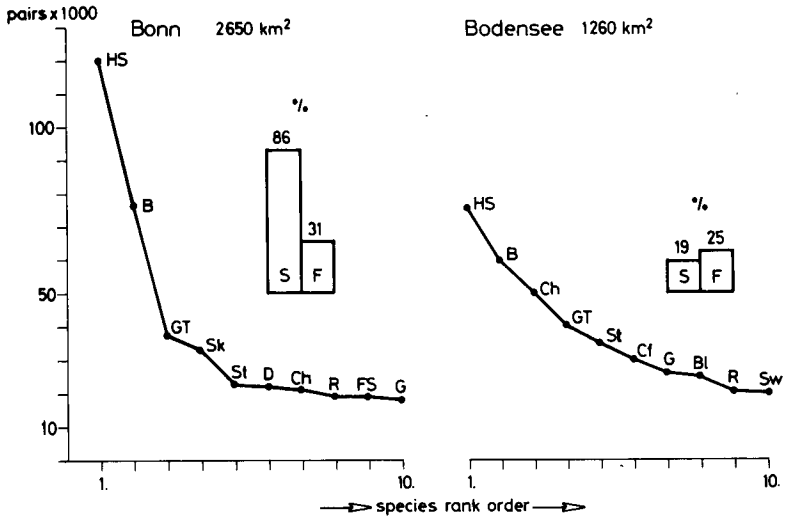

Fig. 4. The most abundant bird species of two areas in W Germany. Histogram: percentages of grid units with cities, villages, etc. (S) or forest (F). Hs = House Sparrow *Passer domesticus*, B = Blackbird *Turdus merula*, GT = Great Tit *Parus major*, Sk = Skylark *Alauda arvensis*, St = Starling *Sturnus vulgaris*, D = Dunnock *Prunella modularis*, Ch = Chaffinch *Fringilla coelebs*, R = Robin *Erithacus rubecula*, Fs = Tree Sparrow *Passer montanus*, G = Greenfinch *Carduelis chloris*, Sw = Swallow *Hirundo rustica*, Bl = Blackcap *Sylvia atricapilla*, Cf = Chiffchaff *Phylloscopus collybita*, (data from Orn. Arb.gem. Bodensee 1983, Rheinwald et al. 1984).

roundings, as in large woodland areas, for example, some species can be found which never or seldom breed even in large urban parks (some birds of prey, Woodcock *Scolopax rusticola*, Nightjar *Caprimulgus europaeus*, Black Woodpecker *Dryocopus martius* etc.). Similar results are found in rural areas. Parallel with the decrease of species number, there is an increase of species which find few suitable nesting sites and therefore only settle in very low abundance (Bezzel 1983b), and some very abundant species can be expected. This means that the two components of diversity measured in the Shannon-Wiener function decrease: species number and evenness, or equitability of allotment of individuals among species. This can be roughly explained by the loss of diversity of habitat structure and/or food resources.

If urban areas cover much of the area investigated, the numerical dominance of the most common bird species is higher than in less intensively used areas. This can be found even in larger sections of the landscape with a mixed set of habitat types (Fig. 4). In contrast to intensively used rural and urban areas with reduced structural diversity and/or a high amount of human disturbance, semi-natural parts mostly show higher species numbers and higher evenness regardless of the habitat type (Bezzel 1982). But if such habitats form small isolated islands, the structure of the bird association will change according to the development in the larger surrounding areas. The two small city parks in Fig. 5 show the characteristic trend: the abundance of a few dominant species increases strongly, so that the total abundance increases as well, but rarer species disappear (further examples Bezzel 1979).

Intensive use of the environment also strongly influences the seasonal oscillation of bird populations and associations. This has been studied very insufficiently so far. Under natural conditions abundance and number of species, and therefore diversity and evenness as well, are influenced mainly by the climate (or weather) and seasonal changes in the kind and amount of food (Bezzel 1982, 1983a, Busche 1983). In urban environments, however, there is also enough food during winter, at least for many multivorous or omnivorous species. Futhermore the urban climate has a higher annual mean temperature than the surrounding areas. In winter the difference between urban and rural areas even in maritime parts of Central Europe, can amount to 10°C. This enables insectivorous species as well to stay longer or even during the whole winter. Higher winter temperatures keep the water open and therefore the "urbanization" of water birds has become a well-known phenomenon in most cities. The number of species involved has increased considerably within the last few decades. Now up to ten water bird species can be observed at inner urban feeding-stations.

Systematic investigations by Mulsow (1980) in Hamburg show clearly that the coefficients of variation between the months of the year are much lower in urban areas than outside for all the parameters describing bird associations, as number of individuals, number of species, diversity or evenness (Bezzel 1982). In rural areas, however, modern techniques of harvesting fields surely cause a food shortage during the summer months, especially in areas with large monocultures. So it is likely that not only the conditions in winter have deteriorated, but that the limiting factor for many species is the scarcity of food in late summer and autumn. The seasonal distribution of birds in a rural environment needs to be thoroughly studied because many problems of the survival of bird populations could then be better un-

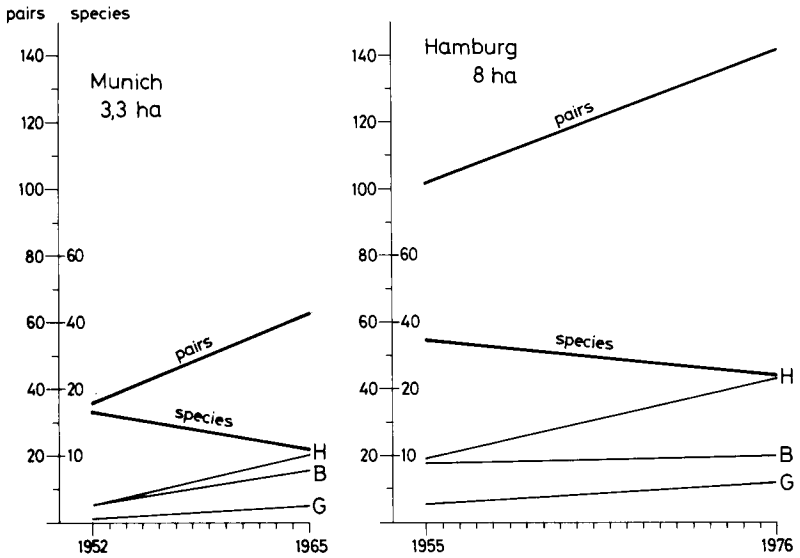

Fig. 5. Trends in the association of breeding birds in two small city parks. H = House Sparrow, B = Blackbird, G = Greenfinch (data from Bezzel et al. 1966, Mulsow 1980).

derstood (see below). In winter, birdlife is concentrated around human settlements, and species which live there all the year round are favoured. Therefore the most common winter birds partially belong to the same species which are abundant in summer. The number of wintering individuals may be about as high as in summer.

Successful colonists

In addition to the most abundant species in Fig. 4, the group of successful colonists can be considered to include a number of species which are not as abundant as the most common passerines but have achieved a wide distribution and sometimes colonized new habitat types, like the Carrion Crow *Corvus corone*, Magpie *Pica pica*, Collared Dove, Wood Pigeon. The ecological niche of each of the species is different, but roughly they belong to at least one of the following groups: granivorous or/and variable diet according to the season; medium-sized omnivorous; sedentary or partial migrant. The Passeridae and some Fringillidae, Turdidae, Corvidae and Columbidae represent successful breeders in intensively used environments. The Yellowhammer and Skylark have been very successful in rural environments so far, but recent counts seem to indicate a decline, as in the Starling and some other common species. Among purely insectivorous species and therefore long-distance migrants, the Swallow *Hirundo rustica* and House Martin *Delichon urbica* have successfully colonized intensively used rural areas and the Swift *Apus apus* even urban environments. They were favoured by nesting possibilities in human settlements and by their high mobility, which enables them to exploit huge aerial feeding ranges. However, local decreases during the last few years may indicate bad times for these species, at least in the most intensively used areas.

For water birds the breeding space in most inland areas is limited. Furthermore, breeding on suitable sites is often prevented by disturbance from sports and recreational activities (e.g. sport fishing, hunting; Reichholf 1973, 1975). Regular winter feeding in and around many cities, eutrophication and water reservoirs suitable as wintering grounds have favoured some water birds so that they can nowadays be counted among the most successful colonizers of intensively used environments. The Mallard and Moorhen *Gallinula chloropus* (in the lowlands) are widespread as breeding birds; the Black-headed Gull *Larus ridibundus*, Tufted Duck and Pochard are among the most numerous winter birds in cities and artificial wetlands today.

We must be cautious, however, in deducing the situation of a species from local population trends. Sometimes adaptation seems to have evolved when a species colonizes new habitat types. In some areas Curlews have colonized fields, but detailed studies proved that this evident change in habitat is only the result of high site fidelity (Ortstreue). The pairs returning from their winter quarters try to breed in their old territory, even if it has meanwhile changed into a maize field! The reproduction success in such a habitat is nearly zero, because the few chickens hatched die from starvation. But the birds try it again next year and so on in their long individual lifetime.

Breeding "populations" with no offspring could be observed over several years (Kipp 1982). Even in moist meadows, which seem to be optimal breeding sites in cultivated areas today, the reproduction rate is lower than 0.6 fledged young/pair. The rate necessary to maintain a population is about 0.8 fledged young/pair. So it is likely that many local inland populations of the Curlew can only survive by immigration of surplus birds from optimal areas, e.g. from coastal meadows (see also Ranftl 1982).

Likewise in the Lapwing *Vanellus vanellus*, which seems to be the most successful of the meadow birds, the reproduction rate of 0.96 necessary for maintaining a stable population is not achieved at all on intensively used meadows and fields, and the surplus of coastal populations evidently fills the losses of many inland breeding populations (Matter 1982). Even the Great Tit *Parus major* has very low breeding success in city parks, so that populations in inner urban areas cannot survive without immigration from suburban areas (Schmidt & Steinbach 1983).

Are many bird populations in intensively used environments indebted to immigration for their survival? Anyway, the maintenance of sparingly used habitats and reserves, even small ones forming a network, will be the only means of preserving birds in modern intensively used rural and urban environments.

Selostus: **Maaseutu- ja kaupunkiympäristöjen linnusto**

Nykyaikaisten teollisuusyhteiskuntien tehokas ympäristönkäyttö köyhdyttää sekä kaupunki- että maanviljelysalueiden ympäristövaroja. Seurauksena on linnuston laadullinen köyhtyminen ja muutamien harvojen, kulttuuriympäristöihin hyvin sopeutuneiden lajien runsastuminen. Viimeisten 150 vuoden aikana on Keski-Euroopassa noin 10 % lajeista hävinnyt, ja hävinneiden/taantuvien lajien suhde uusiin ja runsastuviin lajeihin on 2:1 (kuva 1). Menetykset ovat kohdistuneet epätasaisesti eri ekologisiin ja systemaattisiin ryhmiin (kuva 2). Maalla elävät ei-varpuslinnut ovat vähentyneet eniten. Verrattuna lähialueisiinsa tehokkaasti hyödynnetyillä alueilla on hyvin vähän lajeja (kuva 3) ja runsaimpien lajien osuus kokonaisparimäärästä on hyvin suuri (kuva 4). Pienet, luonnontilaiset ympäristösaarekkeet eivät tällaisilla alueilla pysty säilyttämään alkuperäistä linnustoaan (kuva 5). Tehokkaasti hyödynnetyissä kulttuuriympäristöissä menestyvät parhaiten siemensyöjät, keskikokoiset, kaikkiruokaiset lajit sekä paikkalinnut ja osittaismuuttajat. Joidenkin, kulttuuriympäristöihin näennäisesti hyvin sopeutuneiden lajien (esim. kuovi, töyhtöhyyppä) poikastuotto ei riitä ylläpitämään vakaata kantaa ja kannat säilyvätkin vain muualta tulevan täydennyksen varassa. Ainoa tapa turvata monipuolinen linnusto ihmisen tehokkaasti hyödyntämillä alueilla on riittävä luonnontilaisempien ympäristöjen säilyttäminen kulttuuriympäristöjen lomassa.

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