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LIMITATIONS OF ESTIMATING BIRD POPULATIONS BECAUSE OF VEGETATION STRUCTURE AND COMPOSITION

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ABSTRACT.—The mapping method is difficult to use in many habitats. Moreover, there are no alternative census methods or means to calculate errors which can correct for difficulties in the census. Problems are most apparent in or near human population centers where an increasing number of vegetation types are unavailable for census work, for reasons of nature protection and possible economic damage.

Central European (German) bird censuses show (1) A standard mapping of wetlands with the use of the IBCC recommendations results in sharp, long lasting changes to fragile vegetation and significant disturbance of bird communities. (2) Changes in agriculture, as demonstrated by monocultures and increased sizes of farm fields, place large areas of the landscape out of reach. (3) Mosaic-like landscapes with distinct horizontal and vertical plant diversities can be censused with the mapping method providing individual error calculations are made for the "out-of-bond" subplots of the study area.

The IBCC bird census recommendations (Oelke 1974a) on the mapping method are the only internationally standardized census method. Among the recommendations suggested are the need for the position of the observer and that of the bird to be known as exactly as possible. When no topographic or physiognomic features are available, a grid should be established with points marked in 100 m intervals in open areas and in 50 m intervals where the vegetation is closed.

Unfortunately these recommendations cannot be followed in a number of vegetation types or in areas which are densely settled or used by people. This imposes limits to the estimation of bird numbers which must be taken into consideration when planning research.

PROBLEMS WITH VEGETATION

For many types of vegetation, difficulties are imposed by the nature of the habitat or by their economic value (Table 1). The large size and economic value of many critical vegetational types—in the sense of being sensitive to disturbance or of such limited extent as to be considered "endangered"—prevents calibration. A calibrating of the mapping method by nest search, line transects, point counts or best, color-banded populations is still possible. Many endangered habitats which show the vegetation criteria in Table 1 (1a–1c, partly 2c) are excluded for reasons of nature protection. Many nature reserves of the Federal Republic of Germany cannot be used for bird mapping. Examples are coastal boglands, natural inland lakes (such as Dümmer, Steinhuder Meer), seabird sanctuaries including peripheral dunes and marshes in Northwest Germany, and many unique plant communities (e.g., grasslands with orchids). Besides severe restrictions on access, the nature protection agencies have changed their attitude to research. They operate on the principle that protection of nature must be guaranteed, with research a secondary consideration (Erz et al. 1979). There are other administrative restrictions in the Federal Republic. All proposals to conduct research in nature reserves must be presented to authorized nature protection associations for consultation (§29 Act of Nature Conservation "Bundesnaturschutzgesetz" of 20 December 1976, or the adequate acts of the federal states of GFR). The associations include groups with diverse attitudes to nature. They include ornithological and bird watcher societies (e.g., Deutscher Bund für Vogelschutz), nature protection societies, historic-folkloristic groups (e.g., Heimatvereine), and the hunters' associations. This guarantees that approval for research will be delayed if not refused.

Thus the census of birds by mapping or other methods is not solely the decision of the research worker or the scientific institute.

SELECTED EXAMPLES

In a number of cases the vegetation structure is not compatible with hitherto applied bird census techniques. Form and range of these discrepancies will be evaluated by selected examples.

EFFECTS ON VEGETATION BY BIRD MAPPING

In the course of a breeding bird census (1961) and the monthly mapping (1960–1962) of a 13.1 ha bog (Wendesser Moor, county of Peine, Lower Saxony, Federal Republic of Germany), I censused an area 300 m in length by 30–60 m in width (Oelke 1963). The numerous, 28 main and 40 additional multi-hour visits, created 20 to 30 cm wide trails with a total length of approximately 1500 m throughout the inner part of the bog. Access to the outer parts of the bog were blocked by fences. The trails affected a zone of *Salix cinerea* with open areas of *Eriophorum*

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TABLE 1
VEGETATION TYPES WHERE IT IS DIFFICULT OR IMPOSSIBLE TO USE THE MAPPING METHOD

Vegetation type/habitat	Common difficulties
1. Complex structures	
a. Climax woods (± natural woods) with uniform high plant cover in all strata, esp. deciduous woods, their successions (thicket types), man-made communities (e.g., mediterranean macchies)	Optical barriers; lacking or too wide-spaced roads/trails; unavoidable habitat manipulation when improving the census efficiency; too small study plots; disturbance or change of the bird community
b. Shore vegetation (e.g., reed beds, *Carices* communities, floating plant communities)	As 1a; additional danger of opening the study plots for human access; in some cases not to be entered (deep mud banks)
c. Habitats with a high horizontal plant species diversity (floristic island types), e.g., moors, dry grasslands with rare or endemic plant species	No immediate disturbance of avifauna, but sometimes irreparable damages to rare vegetation
d. Mosaic-like, cultural landscapes, esp. gardens	Visibility markedly reduced because of property lines (walls, hedges, fences), often disturbed by traffic or other noise
2. Uniform structures	
a. Monocultures and their successions in forestry (esp. thickets, 15–30 year-old coniferous forests)	As 1a; effects on birds not known because of low species and pair densities
b. High growing agricultural monocultures (e.g., banana, surgarcane, corn plantations)	Visibility reduced; little possibility of establishing smaller study plots; risk of economic damage
c. Low growing vegetation (e.g., *Carex* reeds, meadows, pastures, grain, sugar-beet, potato, oil seed, vegetable, flower fields)	Insufficient or—in the case of larger areas—lacking control routes; no additional census methods possible (e.g., nest searching); risk of economic damage
d. Water areas with uniform floating, or underwater vegetation (e.g., fish farms)	Visits only possible at the edges; study plots cannot be entered

angustifolium, Comarum palustre, Juncus conglomeratus and the dominant *Carex rostrata*. Even a stand of *Phragmites communis* was affected. The vegetation along the trails did not recover until 1968. The last traces of the trails within the rather uniform 50–75 cm high swamp disappeared in 1970. Mammals such as *Lepus europaeus, Ondatra zibethica, Vulpes vulpes, Capreolus capreolus,* as well as people used the trails for access and intensified the disturbance.

The impact on the vegetation had an adverse effect on the avifauna. The loss of plant cover reduced protection of breeding sites and split the uniform stand into patches (Table 2). The population decline of non-passerines shown in Table 2 is related to the disturbance but the decline of passerine species might be a normal fluctuation in population size.

The impact on the birds shown in Table 2 could be minimized by restricting observations to the periphery of the plot, by stopping all forms of nest search, and using blinds for studies of breeding or rare species. This means an increase in observation time.

PROBLEMS WITH MAPPING CAUSED BY AGRICULTURE

Most Central European sites are agricultural or urban. Forests and wetlands continue to decrease in area; the percentage cover of these habitats in the German Federal Republic (248,601 km²) are: forests (28.7%), agricultural areas (53.0%), settlements (6.6%), traffic areas (4.7%), and water areas (1.8%). Although agricultural areas are the most extensive they have been neglected in bird censuses compared with woodlands. The proportion of woodland to agricultural areas studied by bird censuses (mapping) is 11:1 (numerically approximately 1000:100; Oelke 1974b, corrected for 1980 data).

Most bird watchers and ornithologists avoid agricultural areas because of the low species and pair densities. Compared with forest (450–500 breeding pairs, 40–60 species per km² on the average) the corresponding agricultural densities are lower (30–40 territorial males, 3–10 species per km²) (Oelke 1963). Beside the small number of birds, it is difficult to inspect agricultural areas.

TABLE 2
EFFECTS OF INTENSIVE MAPPING (1960–1962) ON SPECIES NUMBER AND PAIR DENSITY IN THE SWAMP WENDESSER MOOR[a]

Species	Pairs/territorial birds 1961	1962	Difference (%)
Little Grebe (*Podiceps ruficollis*)	1	1	—
Mallard (*Anas platyrhynchos*)	9	5	(−) 44.4
Gargany (*Anas querquedula*)	2	2	—
Teal (*Anas crecca*)	1	1?	?
Shoveler (*Anas clypeata*)	1	—	(−)100
Ferruginous Duck (*Aythya nyroca*)	1[b]	—	(−)100
Pheasant (*Phasianus colchicus*)	1	—	(−)100
Water Rail (*Rallus aquaticus*)	1	—	(−)100
Spotted Crake (*Porzana porzana*)	1	—	(−)100
Moorhen (*Gallinula chloropus*)	2	1–2	(−?)50
Coot (*Fulica atra*)	8	5	(−) 37.5
Lapwing (*Vanellus vanellus*)	2	—	(−)100
Snipe (*Gallinago gallinago*)	1	1	—
Tree Pipit (*Anthus trivialis*)	2	—	(−)100
Sedge Warbler (*Acrocephalus schoenobaenus*)	2	1?	(−) 50
Marsh Warbler (*A. palustris*)	1	—	(−)100
Reed Warbler (*A. scirpaeus*)	1	—	(−)100
Whitethroat (*Sylvia communis*)	1	—	(−)100
Willow Warbler (*Phylloscopus trochilus*)	1	—	(−)100
Blackbird (*Turdus merula*)	—	1	(+)100
Yellowhammer (*Emberiza citrinella*)	1	1	—
Reed Bunting (*E. schoeniclus*)	7	7–8	—
Magpie (*Pica pica*)	1	—	(−)100
Pairs/territorial birds	48	24–28	(−)42–50
Species	22	11	(−)50

[a] Weather conditions in 1960–62: relatively cold and rainy summer periods with more or less constant, 30–50 cm high water levels.
[b] Female illegally killed by hunters (Oelke 1962).

Agriculture in Europe is changing and the trend is towards larger and more uniform areas of production. In the Federal Republic, the average farm size rose from 8 ha (1960) to 18 ha (1975) and in the Democratic Republic of Germany, it increased from 280 ha to 1170 ha (Schultzke et al. 1979). The best German agricultural areas have field sizes of 100–300(–700) × 50–150 m in the loess belt of Hildesheim-Braunschweig-Hannover, Federal Republic, but blocks of 1000–1300(–1700) × 1500–2000(–3000) m occur in the loess belt of Halberstadt-Magdeburg, Democratic Republic.

The disadvantages of agricultural areas for bird census and especially for mapping procedures are many. It might be possible to observe from an average of 100–200 m distance those fields separated by field roads at intervals of 200–400 m. At times shorter distances are possible because of ditches, water lines, border rows, grassland strips, and along fields characterized by smaller strip sizes ("towel-like-fields"). Even this kind of observation is impossible on the state farm blocks. Regular traverse

TABLE 3
HABITAT TYPES AND AREA IN A MOSAIC-LIKE LANDSCAPE (FUHSE VALLEY, NW EDGE OF THE CITY OF PEINE, LOWER SAXONY, FEDERAL REPUBLIC OF GERMANY). CALCULATIONS (SMOOTHED) FOR 1980

Habitat	Visible complexes (number)	Total size (ha)
Alder swamp	7 (2 large plots)	38.4
Fuhse River	1	4.0
Old river beds (left after canalization)	10	3.3
Phragmititea reed	3	47.5
Meadows (unused by cattle)	1	80.0
Pastures (used by cattle)	4	14.5
Abandoned mining dump	1	4.4
Roads, trails[a]	37	6.1
	64	198.2

[a] Total length: approximately 20.2 km, including 0.5 km tar pavement, 2.7 km with compressed stone layer (1 km railway dam), 9.95 km grass roads, and 7.05 km small trails.

FIGURE 1. Aerial view of the mosaic-like landscape (Fuhse Valley, NW edge of the city of Peine, Lower Saxony, Federal Republic of Germany), April 6, April 15, 1980. By kind permission of Niedersächsisches Landesverwaltungsamt (Landesvermessung), no. 28/80/1708. For type and area of habitats see Table 3. Dark line = 500 m.

TABLE 4
LENGTH OF ROADS/TRAILS AND EDGE LINES IN THE DIFFERENT HABITATS OF THE STUDY AREA IN THE PEINE RIVER VALLEY (SEE TABLE 3)

Habitat	Length of roads, trails (m)	Edge lines (m)	Edge lines / Habitat size
Alder swamp	4000	10,500	273
River	2100	4200	1050
Old river beds	1550	6650	2015
Reeds	3550	14,750	310
Meadows	8450	15,700	196
Pastures	1550	5500	379

of a field is impossible because of crop damage. The time is near that no kind of mapping will be allowed on fields. Only transect methods along the rare rights-of-way through fields offer a solution. This will reduce detectability of birds and censuses will be less reliable. There will be zones within a field where vegetation will conceal some species. Quiet species are the main problem in these habitats.

RELIABILITY OF CENSUSES IN A MOSAIC-LIKE LANDSCAPE

While some habitats make censuses of any sort difficult, other habitats, including most mature woodlands of the boreal zone, tundra, steppe, and savannah habitats, are ideal for censusing because there are no "real" restrictions imposed by the vegetation. Greater difficulties arise in the mosaic-like landscapes which are typical around population centers of Europe. These landscapes are distinguished by diverse regional or local features. A variety of horizontal and vertical structures, vegetational elements, plots, human use, and ownership patterns are typical. This variety prevents the location of representative census plots. The best method might be to census a whole landscape and differentiate structural elements by summarizing similiar elements (participation method, after Puchstein 1966).

I should like to draw attention to the problems of a bird census that I started in 1960 on the river plain northwest of the city of Peine (50,000 inhabitants, situated between Hannover-Braunschweig, Lower Saxony, German Federal Republic). Size, habitats, length of access routes and edge lines are summarized in Tables 3 and 4. Although the landscape seems to be well developed, in the midst of suburbs encircling the river plain (Fig. 1), special protection of vegetation had to be observed: (a) securing the reed beds against a network of trails from the ever present number of walking people; (b) no entering of wetlands containing stands of rare plant species (*Carex* species); (c) keeping out of the meadows before mowing (i.e., between May–June); and (d) keeping out of alder swamps to protect particular plant associations (*Urtica urens* stands)—and for the safety of the observer against mud more than 6 m in depth.

These restrictions excluded access to the higher and lower parts of the different habitats (Table 5). When all visits carried out between 1960–1980 are considered, about 25% of the alder swamp and 30% of the reed beds had not been entered. This affected census results. In particular, errors in the estimation of density of rarer species are expected (Table 6).

The evaluation of bird densities in landscapes with many different types of vegetation has to allow for the many local or regional peculiarities. Botanical restrictions are only one feature with implications for bird censuses. Equally great restrictions may be imposed by the presence of certain species of animals. Endangered fauna of national or international significance may require a safety zone within neighbouring habitats which then cannot be censused. Ex-

TABLE 5
VISIBLE AND ENTERED PARTS OF MAPPED STUDY PLOTS (MOSAIC-LIKE LANDSCAPE IN THE PEINE RIVER VALLEY) IN RELATION TO ACOUSTICALLY CONTROLLED PARTS (AUDITORY BELT APPR. 50 M)

Habitat	Distance of visibility[a] (m)	Visible areas (% ha)[b]		Entered area (% ha)		Auditory area[c] (% ha)
		In theory	In reality	1960–1979	1980	
Alder swamp	15 (10–25)	50.8	31.2	2.6	0.8	52.1–100
River	50	100	100	—	—	100
Old river beds	2 (1–5)	100	9.4	18.2	3.0	100
Reeds	2 (1–5)	62.1	2.2	1.1	0.2	37.4–74.8
Meadows	50	98.1	52.8	0.6	0.1	52.8–100
Pastures	50	100	100	1.4	0.0	53.4–100

[a] Related to 50% visibility of a 1 × 1 m white cardboard during summer (May–August).
[b] Related to observations from all present edge lines (in theory) compared to present road and trail length (in reality).
[c] Related to auditory belts of 50 m (left numbers)–100 m (right numbers).

TABLE 6

NUMBER OF BIRD SPECIES WITH REDUCED VISIBILITY IN A 1975 MAPPING CENSUS (TABLE 5). MOSAIC-LIKE LANDSCAPE IN THE PEINE RIVER VALLEY, LOWER SAXONY. METHOD: INTERNATIONAL RECOMMENDATIONS OF THE IBCC (OELKE 1974A)

Habitat	Species	Pairs territorial birds	Critical[a] species	% of all pairs/terr. birds
Alder swamp (38.4 ha)	33	270	18	80.7
Reeds + old river beds (50.1 ha)	28	239	20	92.3
Meadows + pastures (94.5 ha)	8	9	—	—

[a] See text for explanation.

amples in the Federal Republic are: heronries of the Grey Heron (*Ardea cinerea*), breeding habitats of Bittern (*Botaurus stellaris*), Greylag Goose (*Anser anser*), White-tailed Eagle (*Haliaeetus albicilla*), Black Grouse (*Lyrurus tetrix*), Crane (*Grus grus*), and Golden Plover (*Pluvialis apricaria*); of specific beetles (*Dytiscus lapponicus, Carabus clathratus, Brephos parthenias*); other insects, especially butterflies; and such mammals as *Equus caballus* ssp., *Cervus elaphus, Bison bonasus,* and *Phoca vitulina.*

CONCLUSIONS

Vegetation limits the census of birds and especially the use of mapping techniques in many ways. The difficulties for an observer getting orientated in complex habitats and respecting the safety of vegetation and animals are only one side of the problem. There are problems not only between people, vegetation, and birds, but between birds and vegetation themselves. Bird species which have a wide area of habitat selection in Central Europe, e.g., Chaffinch (*Fringilla coelebs*), European Robin (*Erithacus rubecula*), Blackbird (*Turdus merula*), and Blackcap (*Sylvia atricapilla*), have different distribution patterns and densities in different parts of their range (Oelke 1980). The type of vegetation and the geographic site influence the species-specific detectability and will therefore affect density estimates.