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The Decline of a Black Grouse Population in a fragmented Moor Landscape (*)(1)

by

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SUMMARY

The objective of the reintroduction project «Wurzacher Ried» (1978 - 1993) was to establish a stable black grouse (*Tetrao tetrix*) population after extinction of the autochthonous population in 1978 in the scattered moorlands of the western part of Allgäu in Upper Swabia (South-Germany).

Losses and changes in habitats as potential causes of extinction were quantified in ten peat bogs on the basis of historical maps and aerial photos. The diet (162 faecal samples from July 1988 – Dec. 1991) together with the bird's habitat acceptance of released and radio tracked black grouses were analysed to estimate the carrying capacity on the basis of food and habitat resources. No ethological, morphological and parasitic particularities have to be noticed in the released black grouses.

The early peat exploitation in the 19th century was getting more intensive since the early 20th century. Litter meadows were meliorated and now used as pastures. The drained and peat cutted areas developed into heath and dwarf shrub heath. In the middle of the 20th century draining and peat cutting were abandoned thus pristine rain bog areas could be preserved to a large extent. Approximately 1200 hectares of the study area (total 3600 hectares) are optimal habitats for black grouse. The patchy distribution of the moorlands in the landscape, and the habitat resources in the peat bogs are comparable to the time period of the highest density of black grouse. The decline in the larger bogs proved not to be due to changes and losses of habitats in contrast to the small bogs. The main cause of the extinction, and the failure of reintroduction is probably the impact of predators from the surrounding areas into the habitat islands, as a consequence of edge effects, and the increasing of predator density.

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Introduction

In Germany the black grouse *(Tetrao tetrix* L.) is an extremely endangered species (NOWAK *et al.* 1994). The current occurrences of black grouse in Central Europe are mainly limited to moorland and heath areas of the Netherlands and northern lowlands in Germany as well as to the moorlands and ridge areas of the low mountain ranges and the upper forest boundary of the Alps. The decline observed for Central European populations is mainly caused by habitat changes and losses (DOENECKE & NIETHAMMER 1970, BRÜLL 1977, NIEWOLD & NIJLAND 1979, MÜLLER 1980, HECKENROTH 1980, ZIESEMER 1980, DEGN 1980, HÖLZINGER 1980, 1987, CLEMENS 1990, MEYERHOFER 1995, BROZIO & BROZIO 2000). Furthermore, hunting (HÖLZINGER 1987), unfavourable climatic conditions (SCHRÖDER *et al.* 1982, LONEUX *et al.* 2000), human disturbances and predation (HÖLZINGER 1980, MÜLLER 2000) were discussed to be causes of the decrease.

Black grouses in the prealpine moorlands were common during the first part of 20th century. The autochthonous black grouse population in Baden-Wuerttemberg (South Germany) was getting extinct by end of the 1970th (HÖLZINGER 1987). The causes of decrease, mentioned by HÖLZINGER (1987) (changes and losses of habitats, hunting and disturbances), explain only partially the decrease of the black grouse in Baden-Wuerttemberg. Substantial questions are still left (AMMERMANN 1998). *E.g.*: what prevented the population from spreading after renunciation of hunting since 1954, and after stopping the peat cutting in the 1950th and 1960th although natural succession has shaped particularly larger suitable habitats in the upper swabian moorlands ? The fact that the population could not survive in the larger, not drained areas of mountain pine raised bogs in Wurzacher Ried and Gruendlen Ried still is not given a reason for.

Connected with a reintroduction project by the hunting association of Baden-Wuerttemberg it was expected that the black grouse would be re-settled in upper swabian moorlands., starting from the Wurzacher Ried. The documentation of historical occurrence and hunting of the former black grouse population in Upper Swabia as well as parameters like habitat use, migration and diet of the released population, food and habitat supply, habitat changes and losses were recorded scientifically. Furthermore, studies about small mammal`s and evertebrata`s fauna were carried out as well as studies with focus on influence of predators like carrion crow (*Corvus corone corone*), red fox (*Vulpes vulpes*) and goshawk (*Accipiter gentilis*) regarding to the edge effect in several moorlands in the western part of Allgäu (HÖVEL *et al.*1994).

Objectives and Questions

The study is to evaluate:

- to what extent the decrease and extinction of autochthonous black grouse population in Upper Swabia is caused by habitat changes and losses,
- which habitats were still appropriate as black grouse´s biotopes in the moorlands of the western part of Allgäu in the 1990th and whether such habitats inclusive food are available,
- whether released black grouses are able to survive in the wilderness and
- chances of preservation of black grouses in Upper Swabia .

The habitat changes and losses by human utilisation, afforestations, peat cutting and natural succession of vegetation were pointed out and quantified in several moorlands in the western part of Allgäu in Upper Swabia within the last 40 years, even the last 100 years in Wurzacher Ried.

Due to the high variability of individual black grouse biotopes it is difficult to get an complete impression of the range of fitting ones (BEICHLE 1987). Standardised analysis of habitats for a comprehensive evaluation of black grouse habitats are usually not available. Most investigations deal with confined parameters like specific habitat qualities (vegetation structure by tree layer, BEICHLE 1987; heights and densities of the vegetation structure, GLÄNZER 1980), selected phaenological phases of the birds (brood and rearing, BERNARD 1981; brood, WEGGE *et al.* 1982) or certain seasons (summer, BRITTAS *et al.* 1990; winter, HJELJORD *et al.* 1995). Mapping habitat types or general habitat descriptions (*e.g.* LINDEMANN 1952, HAAS 1965, NIEWOLD & NIJLAND 1987, MÜLLER 1988, BAINES 1989 a. o.) only were prevalent.

For the present investigation a habitat analysis was prepared, which considered the habitat use of released and radio-tagged black grouses in the Wurzacher Ried as well as habitat requirements of the black grouses for different biotopes. The offer of food and structure was evaluated in rather small homogeneous vegetation units (after PFADENHAUER *et al.* 1990). Moreover, the area of optimal habitats was quantified.

The diet of the black grouse in Wurzacher Ried was determined by faecal analysis all year and served as basis for the evaluation of food supply. In comparison with the investigations from Switzerland (PAULI 1980) analysis of nutrient and mineral contents should reveal the nutrition situation of the black grouse in Wurzacher Ried in winter and spring.

WIPPER (1983) had discussed an increase by parasites within the habitats as potential stock-limiting factors in consequence of habitat changes (e.g. draining). An effect of parasitic infections on the population fluctuations

of Red Grouses was proved by HUDSON (1984). Many authors emphasize that acute parasites disease can emerge under stress (catching, releasing) and other unfavorable factors like bad weather-conditions or food changes (BOCH & SUPPERER 1983, ASCHENBRENNER 1987, IPPEN *et al.* 1987). It was analyzed which influence endoparasite infections and physical constitution exert on the released black grouse population and how these factors did influence the release success. (Detailed results see HÖVEL *et al.* (1994) and STRAUß (1996)).

Study Area

The study area included nine moorlands of the morainic landscape of the alpine foothills in the western part of Allgäu in Upper Swabia, Baden-Wuerttemberg (**Fig. 1**). Shaped by the ice ages this region developed with a more or less hilly relief.

The average amount of precipitation is between 1000 and 1500 mm p.a.. The average yearly air temperature comes to 6-8°C (GÖTTLICH 1971). Up to the middle of the 20th century agriculture in the western part of Allgäu was more important than today. The agriculture was replaced by intensive grassland farming. Today, the forests are predominantly small (< 200 hectare), whereby spruce prevails in forests (GÖTTLICH 1968, 1971). The share of forests in this region varies between 21% and 43 % (source: FORSTAMT TUEBINGEN, 1986).

The moorlands are between 650 - 750 m. They are surrounded by up to 100 m higher morainic hills. Conditional on the geomorphology the mires are embedded island-like in the valleys of the western part of Allgäu.

The upper swabian moorlands are ombrotrophic peat bogs surrounded by fens. In the last 100 years these moorlands have been changed by human use in different respect and with distinct intensity: draining, peat cutting and melioration on peat bogs as well as turning to intensive farming on pastures and afforestation on fens (**Fig. 2**).

Besides the peat cutting by hand in the last centuries an intensive industrial peat mining took place after 1900. The exploited areas were left afterwards to a natural succession, therefore, biotopes of various development and succession stages resulted today (transition mires, birch and pine woods with heather and dwarf shrubs). The peat mining was stopped mainly in the 1960th. In some moorlands the small-scaled of former rural utilisation created a variety of habitats which exceeds the initial state by far (PFADENHAUER & KRÜGER 1991). Today, the Wurzacher Ried and the Gruendlen Ried indicate still wide lagg sites with mountain pine and dwarf shrubs as well as large open bog plains with *sphagnum*-complexes only, typical for these moorlands. Larger pristine fen areas are preserved only in the Wurzacher Ried and Taufach Fetzach Moos in different stages. The predominant proportion of fens is intensively used as pastureland today.

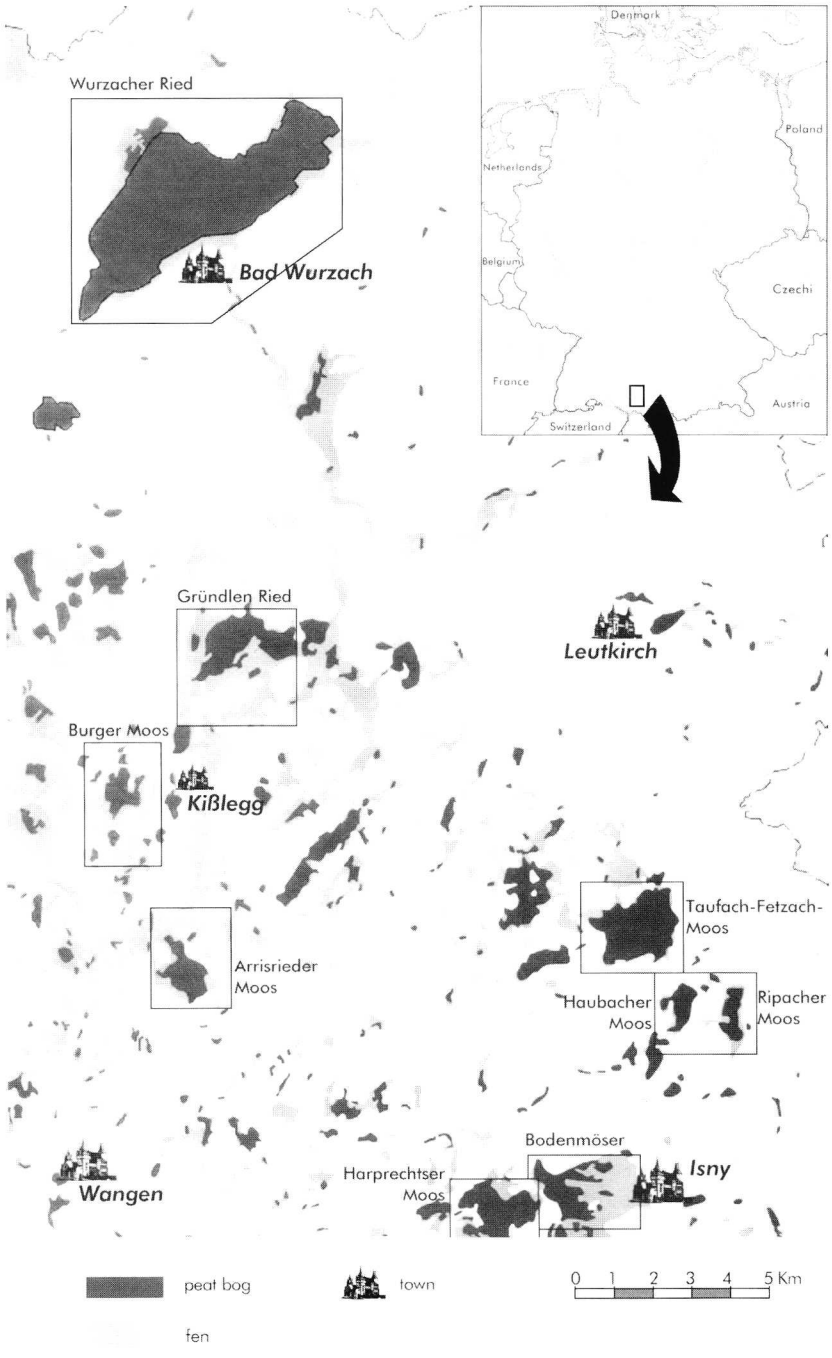

Fig. 1 Map of the study areas in western part of Allgäu in Upper Swabia, South Germany. *Carte des zones d'étude, dans la partie occidentale de l'Allgäu en Souabe, Sud de l'Allemagne.*

Apart from the main study area Wurzacher Ried (1769 hectare), habitat investigations were carried out on eight further moorlands with an area of approximately 1985 hectare (altogether 3754 hectare) (**Tab. 1, Fig. 1**). The Wurzacher Ried is still the largest intact Central European peat bog. The distances between the moorlands amount to 1-10 km. Most of the moorlands are protected now. The next black grouse populations in the northern region of the Alps is about 50 km away from the Wurzacher Ried.

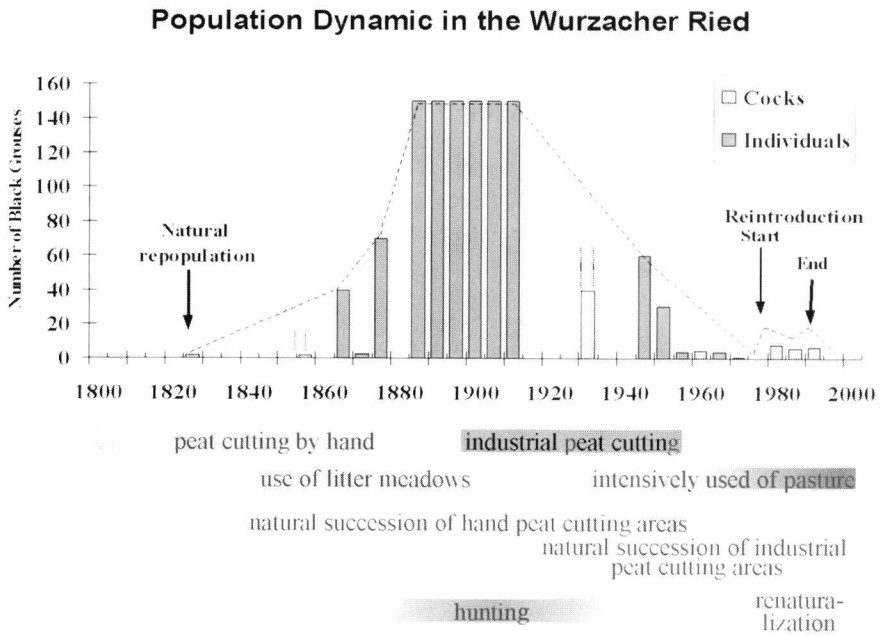

Fig. 2 Development of the human utilization and population of Black Grouse in Wurzacher Ried from 1800 – 2000.
Développement de l'utilisation humaine et de la population de tétras lyres dans le marais de Wurzach de 1800 à 2000.

Tab. 1 Dimensions of the study areas.
Taille des zones d'étude

Wurzacher Ried	**1,769 ha**
Gruendlen Ried	545 ha
Burger Moos	214 ha
Arrisrieder Moos	205 ha
Taufach-Fetzach Moos	243 ha
Rimpach Moos	70 ha
Haubach Moos	131 ha
Harprechtser Moos	229 ha
Bodenmoeser	398 ha

Methods

Parasitological analysis

For the analysis of caecum – and colon feces (approx. in each case 4 g) on parasites oocysts and eggs the flotation method with $ZnCl_2$/NaCl was used. The oocysts and eggs were counted in the analysis drop under the microscope (V = 100x) (BOCH & SUPPERER 1983). The classification of the infestation degree was made by specification of the «Tieraerztlichen Untersuchungsanstalt Aulendorf» and the «Tieraerztliche Hochschule Hannover».

Food analysis

The qualitative composition of the black grouse diet was determined on the basis of recognizable, cellular and morphologic features by epidermis, cuticulars, seed bowls, fruit walls as well as parts of arthropods from weekly collected faecal samples. Their remnants are not destroyed by any time during the stomach-intestine-passage (STEWARD 1967, ZETTEL 1974 a/b, WESTOBY 1976, MARTI 1982). Assuming the plants were divided into particles equal in size by the bird's beak and grinding by stomach stones, we then can approximately conclude from the relative frequency of plant particles to food quantity (by volume or weight percentage) (BEICHLE 1985). The quantitative food composition determined on the basis of 50 randomly food particles from an faecal sample (pin-point-method) that reflected a representative cross section of the food remainders contained in the faecal sample (CHAMRAD & BOX 1964, BEICHLE 1985). The values were verified by feeding experiments in spring and autumn with four black grouse in captive.

Vegetation mapping, habitat analysis and habitat assessment

On the basis of black-and-white aerial photographs of 1954 (scale approx. 1: 12000) and 1986 (orthophotos; scale 1: 10000) regarding the use forms and biotope types classified and square an area of the moorlands. The vegetation of the moorlands were mapped 1991 and 1992 in spring and summer after BRAUN-BLANQUET (1964), modified by PFADENHAUER *et al.* (1990) for a vegetation type mapping on ecologically homogeneous vegetation units. These units were evaluated and quantified by their food supply and habitat structure for black grouses.

History of Anthropogenic Utilization and the Development of the Black Grouse Population

Characterization of Pristine Peat Bogs in Upper Swabia

The growth of the peat bogs started mainly 7000 years ago (GÖTTLICH 1968, 1971, SCHWINEKÖPER *et al.* 1991). The pristine rain bogs are marked by a central open bog plain without bushes and trees. Beside peat mosses typical species are *Carex limosa* and *Rhynchospora alba*. This area merges into a *Sphagnum magellanicum* and *Eriophorum spec.* dominated peat bog. The lagg sites of the bogs are more or less entirely covered with mountain pine (*Pinus mugo*) and several dwarf-shrubs (*Vaccinium oxycoccus, V. myrtillus, V. uliginosum* and *Calluna vulgaris*).

The bogs are surrounded by smaller or larger fens and transition mires at the boundary to mineral soil.

History of Human Use and Habitat Development

From the Middle Age until the end of 1800 the moorlands were mainly diminished at the lagg sites by hand peat cutting for production of fuel peat.

In the 19th century agricultural production strongly expanded as a consequence of the industrialization and increase of the human population, primarily in the cities **(Fig.2)**. Fens and wet meadows were drained and used as pastures and litter meadows – the latter were only cut once in autumn. Both the hand peat cutting and the draining of the moorlands were intensified. As a consequence of continuing intensive drainage, dry-adapted vegetation types were promoted, so that dwarf shrub heathland and bog forest could expand into the moorland center.

In the beginning of the 19th century the industrial peat mining has started with deep draining channels and first peat cutting machines up to the moorland centers. However, larger moorlands were still drained in patches only. A succession to heath and dwarf shrub heathland followed the drained and plot-wise exploited hand peat-cuttings. Furthermore, the hand and machine peat cuttings developed into different stages of moorlands and regenerated peat bogs with *Shagnum spec.*, *Calluna vulgaris*, dwarf-shrubs and mountain pine.

Starting from 1950 the peat cutting was gradually abandoned. After the peat exploitation the cuttings and drained bogs were neither afforested nor converted into farmland or pasture. Only the litter meadows in the surrounding

of the bog were usually afforested or changed into frequently used grassland in that time.
Since 1970´s most moorlands were protected as nature conservation areas.

Development of the Black Grouse Population

Around 1820 a natural re-population took place in the Wurzacher Ried **(Fig. 2)**. At that time the black grouse were common as insular populations in the low mountain ranges and moor low lands of South Germany with the adjacent alpine region. Thus, the resettlement probably got started from one of the neighboring moorlands.

The extensive human utilization of the lagg sites has clearly promoted the development of the black grouse population that achieved its maximum at the end of the 19th century. Between 1910 and 1920 the black grouse even appeared at all moorland parts, inclusive the small ones.

Beginning in 1920 the population decreased again, and finally disappeared in the smaller patches first *e.g.* Burger Moos, Arrisrieder Moos.

Around 1960, at the end of peat cutting, black grouses still occurred in the larger moorlands like Wurzacher Ried, Gruendlen Ried, Taufach Fetzach Moos, Harprechtser Moos. The populations became extinct in these moorlands in the 1970´s, although no more human utilization was carried out and a large portion of natural moorland and dwarf shrubs habitats were available. Hunting has been stopped in 1954. In Wurzacher Ried the last autochthonous cock was observed in1977 (SCHNEIDER 1981).

Results

Release and Survival of the Black Grouse

Between 1978 and 1992 altogether 448 black grouses were released in the moorland habitats. For adaptation the birds remained up to three weeks in aviaries. Until spring of 1985 a population of 20 - 25 individuals could be established. In the spring of the following years only some 10 black grouses were observed in the Wurzacher Ried. During the research project from 1988 to 1992 192 black grouses were released and 91 were marked with a transmitter (HÖVEL *et al.* 1994). In the autumn and winter 39 cocks and 31 hens were recaptured for a check-up of health status and replacement of transmitter.

From October (time of releasing) till March (mating season) the released population decreased by 75 %. Between 1988 - 1992 in each year 3 - 6 cooks

were observed in the mating season. The survival rate of the 91 (41cocks and 50 hens) radio-tagged black grouse proved to be meanly 165 days (range 1 - 1511 days (at the end of the project). Several birds became two or three years old. Typically, most losses occurred during the first two weeks after release. After this period the mortality rate rapidly decreased.

Health Status and Parasitic Infection

The body mass of the released cocks and hens increased significantly with longer duration of survival in the wilderness from autumn to winter ($p<0.05$).

The evidences of elder individuals, mating, broods and the examined morphological and parasitological parameters did not show any sign of an insufficient constitution of the released black grouses. The high mortality of the animals was obviously not caused by insufficient adaptation or health status.

The parasitic infection of *Coccidia spec.* and *Capillaria spec.* was examined in 125 cecum feces and 118 colon feces by counting the oocysts and worm eggs. A proportion of infested black grouses (inclusive of low-grade infestation) of 86 % respectively 63 % was diagnosed in the released population. *Ascaridia spec.* and *Trichostrongylus spec.* was found in few samples only. The infestation of the birds is highest shortly after releasing and decreased significantly with duration of survival outside **(Fig. 3)**. The parasitic infection did not cause a higher mortality rate. Approximately half of the birds survived middle- and high-loaded infections of *Coccidia spec.* or *Capillaria spec.* **(Fig. 4)**. These two parasitosis were the main diseases of the black grouse. We assume these diseases are a consequence of the short period in which the birds were kept in aviaries before release. Since the cages were designed as naturally as possible perfectly hygienic conditions can not be achieved, thus infections by parasites are likely.

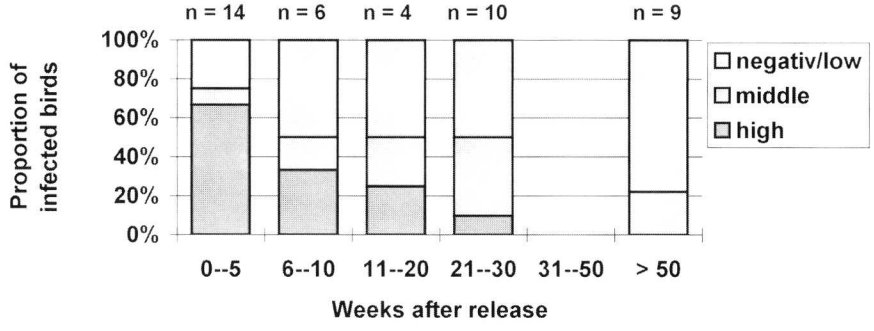

Fig. 3 Parasitic infections of *Coccidia spec.* and *Capillaria spec.* after release diagnosed by oocysts and worm eggs from cecum feces (n = individuals).
Infections après réintroduction dues à des du genre Coccidia et du genre Capillaria; diagnostic sur base d'oocystes et d'oeufs de vers dans les fèces (n=nombre d'individus)

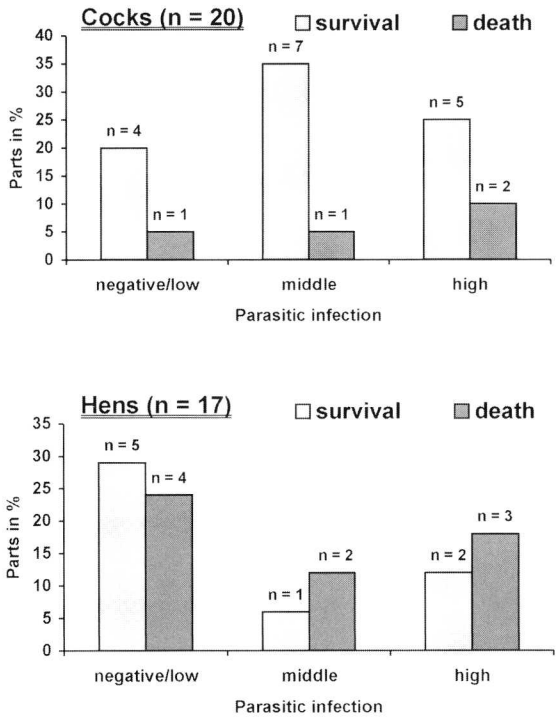

Fig. 4 Parasitic infections of *Coccidia spec.* and *Capillaria spec* vs death and survival of radio-tagged cocks and hens (Survival: survive two weeks after diagnosis; Death: die within two weeks after diagnosis).
Parasitisme par Coccidia sp. et Capillania sp. par rapport à la mort ou la survie de coqs et poules suivis par radio-pistage. Survie : survie 2 semaines après diagnostic ; Mort : mort dans les 2 semaines après diagnostic

Food Analysis

In order to estimate the food supply for the black grouse in the moorlands, the diet of the black grouses was determined qualitatively and quantitatively by means of fecal analysis. Above that, nutrient and mineral content of the most important forage plants from the Wurzacher Ried was checked.

From July 1988 – Dec. 1991 altogether 162 weekly collected fecal samples were collected and examined **(Fig. 5)**. The fecal analysis values were standardized through feeding experiments in spring and autumn with four captured black grouses because some food plants as *Calluna vulgaris* (leaves) were overrated while others underestimated like *Vaccinum spec.* (berries) (STRAUß 1996).

Grains held a share of 17% in the food. The grains were only offered during the winter months for catching the birds again and as an initial support after getting the birds released. In winter, mainly *Pinus mugo* needles were eaten and rarely birch catkins. The leaves of *Calluna vulgaris*, *Vaccinium oxy-*

coccus and in winter young shoots of *V. myrtillus* came to a proportion of 13 %. Berries of *V. oxycoccus* were identified most frequently (32 %) in the fecal samples **(Fig. 6)**.

An unexpected high berry proportion in the feces did we find during the summer months. Probably the huge supply of *V. oxycoccus* berries over the whole year is responsible for that. *E.g.* in April 45 berries/m² were still counted at some plots. Already by July new berries were ripening with a harvest up to 500 berries/m².

An optimal forage was available for the black grouse population over the whole year, particularly in raised bogs with mountain pine and dwarf shrubs. For that reason the black grouse did not have to leave these central areas at all and food shortage could not be the cause for the population's decline.

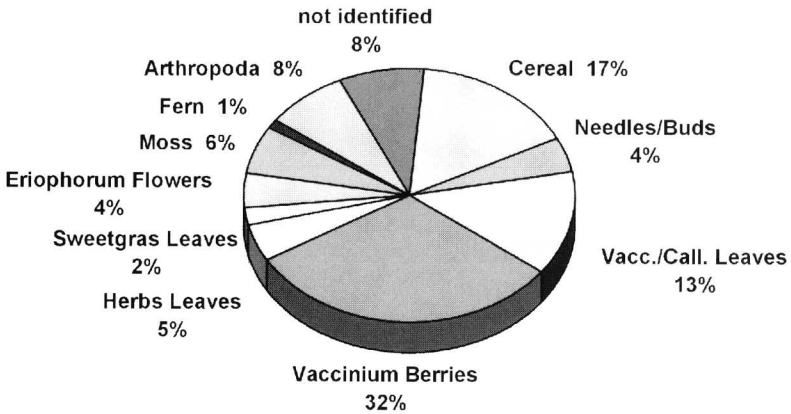

Fig. 5 Diet of the Black Grouse in the Wurzacher Ried from July 1988 – Dezember 1991 analyzed by 162 samples of feces.
Régime alimentaire du tétras lyre dans le marais de Wurzach de juillet 1988 à décembre 1991, analyse de 162 échantillons de crottes.

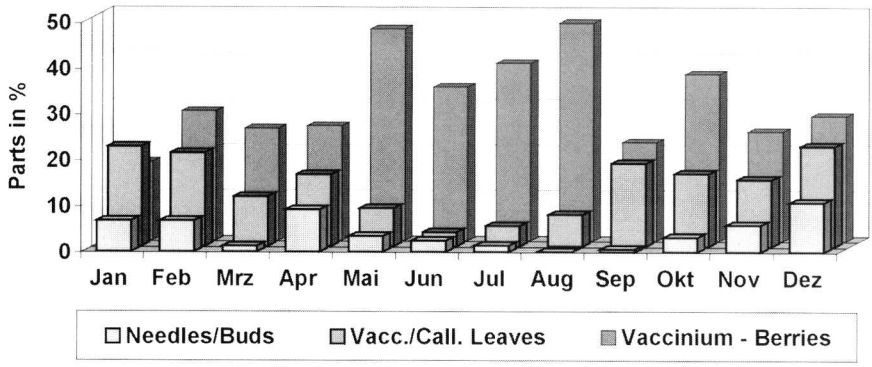

Fig. 6 Seasonable proportions of needles and buds, *Vaccinium spec.* and *Calluna vulgaris* leaves and *Vaccinium spec.* berries in the diet of Black Grouse in Wurzacher Ried between 1988 – 1991.
Proportions saisonnières d'aiguilles et de bourgeons, de feuilles de Vaccinium spec. et de Calluna vulgaris et de baies de Vaccinium spec. dans le régime alimentaire du tétras lyre dans le marais de Wurzach.

Evaluation of Habitats

The optimal habitat structure for black grouses was classified on the basis of data from literature in order to consider the large ecological potential of this specie on the evaluation of the biotopes. A grid habitat analysis with the localizations of the radio-tagged black grouses showed that the population used only 25 % of this optimal habitats since the population (nearly ten birds) was rather small. For this reason, the evaluation of habitats could not exclusively be based on localizations of the released black grouses.

The habitat changes and losses were estimated by aerial photos between 1954 and 1986 for the Wurzacher Ried and further eight moorlands. For historical comparison the studies of SCHWINEKÖPER *et al.* (1991) and BAUER, C. (in HÖVEL *et al.* 1994) were consulted.

In nine moorlands on an area of 3597 hectares the vegetation was recorded. Homogeneous structures were defined on aerial photos. The coverage of the most important food plants as well as the structure of these plant communities was documented.

For evaluation of the habitats an index was determined in combination of structure and food supply.

In the Wurzacher Ried 600 - 750 hectare of areas with high food supply and optimal habitat structure were recorded in each relevant season. The neighboring Gruendlen Ried indicated optimal environments of all its 150 hectares. Despite its small size other moorlands may serve as links between greater ones («step-stone habitats») **(Fig. 7)**.

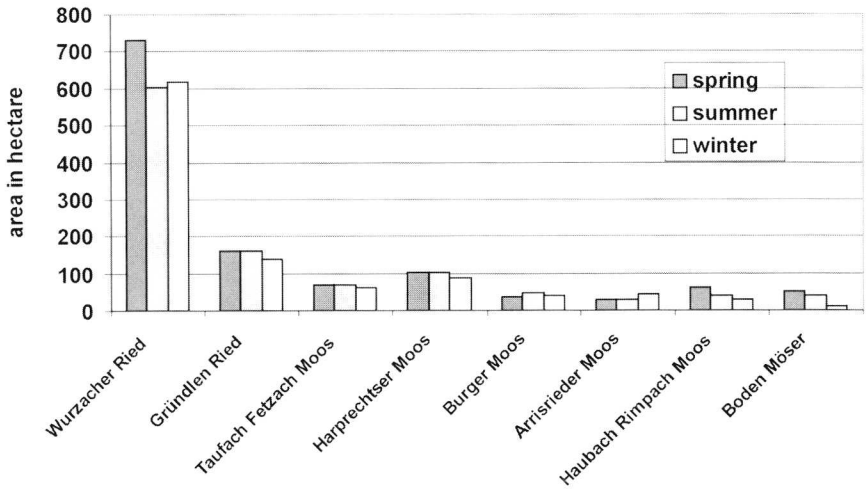

Fig. 7 Area of optimal habitats in the investigated moorlands.
Etendue des habitats optimaux dans les tourbières de Haute Souabe.

Habitat Changes of the Wurzacher Ried

The habitat changes and area losses were investigated *ad exemplum* at the Wurzacher Ried. The pristine situation in former time and 1986 had been taken into account **(Fig. 8.1– 8.4)**.

The center of the historical rain bog seemed not to be attractive for the black grouse. Only the lagg sites of the moorlands with dwarf shrubs and heather offered proper habitats. The transition moorlands and fens were suitable in parts only. Roughly only half of the pristine moorlands (approx. 850 hectare) proved to have been fitting living spaces **(Fig. 8.1)**.

Around 1850 **(Fig. 8.2)** the situation is characterized by the beginning of peat cutting by hand at lagg sites. A majority of the raised bog areas, *e.g.* the central open bog plain, were not an acceptable environment. Only as lek sites the central open bog plain possessed optimal conditions. Those areas were the lagg sites, hand peat cuttings, litter meadows and extensively used pastures. They altogether covered nearly 60% or 1000 hectares of the study area.

The habitat types of the Wurzacher Ried at 1954 were classified on the basis of aerial photographs **(Fig. 8.3)**. Optimal black grouse habitats were all non-drained raised bogs, the lagg sites and the rewetted peat cuttings, however, large sections of the industrial peat cutting areas and dense raised bog forests made settling impossible. Due to the draining no open bog plains were available any more. About 60 % or 1000 hectares were evaluated as suitable habitats as 100 years ago. In this time 50 till 70 black grouses still occurred in the Wurzacher Ried. The intensive peat cutting came to an end in the 1950th.

Between 1954 and 1986 no more areas were subjected to melioration and exploitation. The increase of natural afforestation at some areas at the lagg sites and some old peat cutting areas led to habitat losses. However, the most drained and exploited areas developed into dwarf shrub heatherland or regenerated to different moorland types. These areas underwent a process that finally led to well-accepted black grouse territories **(Fig. 8.4)**.

The investigation demonstrates that the proportions of sub-optimal and optimal habitats remained quite constant during this period. The habitat's vegetation cover and composition changed but substantial habitat losses could not be detected.

In particular, this refers to the period from 1954 to 1986 in which the habitat in every respect (size, equipment) became gradually suitable. Nevertheless, the black grouse became extinct. In these decades changes of the vegetation in the raised bogs caused by eutrophication and drying out of the peat body influenced the black grouse habitats rather positive.

More than anything else the agriculture in the surrounding of the island-like embedded bogs as well as the fens have changed strongly in the last 100 years, however, this biotopes are not the essential habitats of the black grouse.

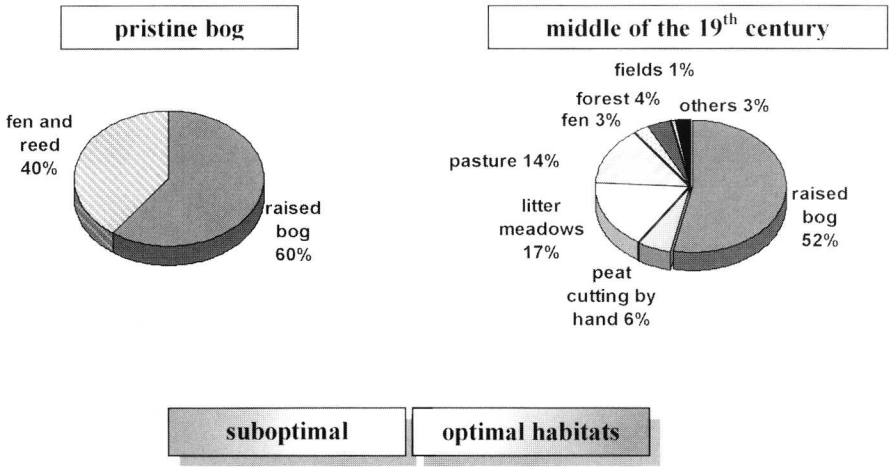

Fig. 8.1 and 8.2 Habitat types of the pristine Wurzacher Ried and in the middle of the 19th century based on historical notes.
Types d'habitat du marais de Wurzach à l'état initial, et au milieu du 19è siècle d'après des notes historiques

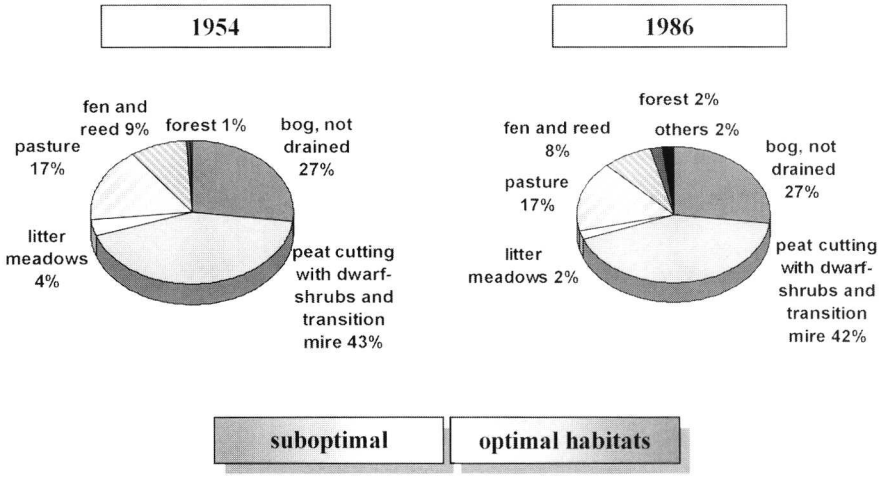

Fig. 8.3 and 8.4 Habitat types of the Wurzacher Ried in 1954 and 1986 based on aerial photos.
Types d'habitat du marais Wurzach en 1954 et en 1986 d'après des photos aériennes.

Conclusion

The unfavorable changes and area losses of black grouse habitats caused by peat cutting since the beginning of the 20th century probably initiated the decrease of the bird's population. For the extinction after 1950, however, there is still no sufficient explanation. Total losses of habitats, like those in the moorlands of North Germany (DOENECKE & NIETHAMMER 1970, CLEMENS 1990, STRAUß *et al.* 1995), did not take place in the moorlands in the western part of Allgäu.

Hundred years ago over 150 cocks lived in the Wurzacher Ried possessing approximately the same habitat range as today. In other large moorlands with a comparable development like the Wurzacher Ried the populations survived until the end of the 1970's. The black grouse populations in these moorlands became extinct despite of the clearly favorable development of its habitats, and although black grouse is able to colonize new habitats quickly (MÜLLER 1980, SCHERZINGER 1988, KLAUS *et al.* 1990). Particularly, the peripheral moor areas as well as the agriculture land in the surroundings have changed.

Of course population dynamic factors like isolation and migration influence the process of extinction too, but it is questionable that the extinction was caused by these factors only. The main cause of the black grouse's extinction in South Germany can be explained by the strong modification of the surroundings and in the following by its impact on these habitat islands by intensification of agriculture. Further investigations in this project supply evidences for the strong influence of predators (foxes, carrion crows) to the black grouse population (DICK 1995, AMMERMANN 1998). Nowadays, many authors supposed the predation as a substantial cause of the decrease of several species both in cultivated and non-cultivated landscape, *e.g.* brown hare (*Lepus europaeus*) or grey partridge (*Perdix perdix*). (*e.g.* MÜLLER 1996, TAPPER *et al.* 1996, AMMERMANN 1998, GORETZKI *et al.* 1999). The steep increase of predators we face nowadays in the cultivated scenery since the last 50 years is well known (GUTHÖRL & KALCHREUTER 1995). This high predator density caused a strong edge-effect influence on these habitat islands (ANGELSTAM 1986). If the habitat islands do not have sufficient size and uninfluenced core zones (more than 3000 hectare (WILCOVE 1985)) - which is true for most of the German protected areas - the edge effect of predation could lead to consequences for the prey population.

Apparently, the long-term survival of such endangered populations can be ensured only by sufficient large habitats or by reduction of the predation pressure to these habitat islands.

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ZUSAMMENFASSUNG : Der Rückgang des Birkhuhns in einer fragmentierten Moorlandschaft.

In dem Birkhuhn-Wiedereinbürgerungsprojekt «Wurzacher Ried» (1978-1993) sollte nach dem Erlöschen der autochthonen Birkhuhn-Population Ende der 70er Jahre in den verstreut liegenden oberschwäbischen Mooren (Süddeutschland) durch Auswilderung wieder eine stabile Birkhuhnpopulation begründet werden.

Biotopverluste und -veränderungen als potentielle Rückgangsursachen der letzten 100 Jahren wurden an Hand historischer Karten und Luftbilder der letzten Jahrzehnte in mehreren dieser Moore qualifiziert und quantifiziert. Mit Hilfe des Nahrungsspektrums (Analyse von 162 Kotproben, Juli 1988 - Dezember 1991) und der Habitatnutzung ausgewilderter, telemetrierter Birkhühner wurde das Habitatangebot in diesen Mooren bewertet und die Biotopkapazitäten für eine Metapopulation quantifiziert. Die ausgewilderten Birkhühner waren morphophysiologisch wie auch parasitologisch nicht auffällig.

Die anfängliche Moornutzung (Brenntorfgewinnung) im 18. und 19. Jahrhundert wurde Anfang des 20. Jahrhunderts intensiviert. An den Moorrändern wurden die Streuwiesen durch Entwässerungen in intensiv nutzbares Grünland umgewandelt. Mitte des 20. Jahrhunderts wurden die Entwässerungen und Abtorfungen nach und nach eingestellt, so daß größere ursprüngliche Hochmoorflächen erhalten sind. Die entwässerten und abgetorften Flächen sukzedierten zu Heiden und Zwergstrauchheiden. Aktuell sind ca. 1200 ha (Gesamtuntersuchungsfläche: 3597 ha) als optimale Birkwildhabitate zu bewerten. Die räumliche Verteilung der einzelnen Moore sowie das Habitatangebot in den Mooren ist vergleichbar mit dem zu Zeiten höchster Populationsdichte. Im Gegensatz zu den kleineren Mooren ist der Rückgang des Birkwildes in den größeren Mooren nicht auf die Biotopverluste zurückzuführen. Entscheidend verändert hat sich das Umland der Moore, so daß der Prädationseinfluß auf diese Biotopinseln und deren Populationen als der entscheidende Faktor für das Aussterben und Scheitern der Wiederansiedlung angesehen werden muß.

RESUME : Le déclin d'une population de Tétras lyre dans un paysage de lande morcelé

L'objectif du projet de réintroduction «Wurzacher Ried» (1978-1993) était d'installer une population stable de Tétras lyre (*Tetrao tetrix*) après l'extinction de la population autochtone en 1978 dans les landes morcelées de «l'Oberschwaben» en Allemagne méridionale.

Pertes et transformations des habitats et causes potentielles de cette extinction ont été quantifiées dans dix tourbières sur base de cartes anciennes et de photos aériennes. On a analysé le régime alimentaire (162 échantillons de fientes de juillet 1988 à Décembre 1991) et l'utilisation de l'habitat de tétras lâchés sur le site et suivis par radio télémétrie afin d'estimer les capacités d'accueil du milieu quant aux qualités et abondance de nourriture et ressources de l'habitat. On n'a noté aucune particularité comportementale ni parasitaire chez les oiseaux introduits.

L'exploitation ancienne de la tourbe au début du 19ème siècle avait été intensifiée au début du 20ème. Les prairies productrices de litières entourant les tourbières pluviales furent transformées en prairies intensivement pâturées. Les aires drainées et les tourbières exploitées se transformèrent en bruyères et landes à bruyères et buissons bas. Au milieu du 20ème siècle, drainage et extraction de la tourbe devinrent intermittents, de telle sorte que la plupart des tourbières encore intactes purent être préservées. 1200 ha approximativement sur les 3600 ha de l'aire étudiée sont constitués d'habitats de valeur optimale pour le tétras lyre. La répartition en mosaïque des landes dans le paysage et les ressources que fournissent les tourbières sont comparables à celles qui prévalaient à l'époque de la plus haute densité des tétras. Le déclin de ces derniers dans les tourbières plus étendues n'est pas attribuable à la perte d'habitats, contrairement à ce qui se passe dans le cas des tourbières de faible étendue. La cause principale de l'extinction et de l'échec de la réintroduction est vraisemblablement l'impact dans les habitats insularisés de prédateurs en provenance des aires voisines, et dont la densité aurait augmenté à la faveur de l'effet frontière.