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Biodiversity Management by Water Buffalos in Restored Wetlands

Biodiversitätsmanagement mit Wasserbüffeln in renaturierten Feuchtgebieten

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Abstract

The use of water buffalos for landscape maintenance started ten years ago in Germany. Now, more than 2,100 buffalos are kept by about 90 breeders, and first results concerning their usefulness for landscape management are available. Buffalos are mainly used on particularly wet sites which cannot be grazed by cattle or other domestic animals. Although grazing of wetlands, river banks and water bodies is still controversial, early results from literature and our own research clearly indicate the beneficial impact of moderate grazing on such sites for birds, amphibians, vegetation and insects. This paper presents a short literature review and the first results of the BUBALUS project at Brandenburg University of Technology (BTU) and general experience from other projects.

Keywords: *Grazing behaviour, wallowing, dung, food webs, vegetation structure*

Zusammenfassung

Seit etwa zehn Jahren gibt es in Deutschland den verstärkten Trend, Wasserbüffel zu halten. Inzwischen gibt es mehr als 2.100 Wasserbüffel bei mehr als 90 Haltern. Erste Ergebnisse ihrer Eignung als Landschaftspfleger in Feuchtgebieten sind nun verfügbar. Die Büffel werden überwiegend auf besonders nassen Standorten eingesetzt, die für die Haltung von Rindern oder anderen Haustieren nicht geeignet sind. Obwohl die Beweidung von Nassstandorten, Ufern und Gewässern noch immer umstritten ist, zeigen die verfügbaren Ergebnisse den Nutzen für Vögel, Amphibien, Insekten und Vegetation.

Dieser Artikel gibt eine kurze Übersicht zu relevanter Literatur sowie erste Ergebnisse des BUBALUS Projektes der Brandenburgischen Technischen Universität Cottbus (BTU) sowie generelle Erfahrungen aus anderen Projekten.

Schlüsselwörter: Fraßverhalten, Suhlen, Dung, Nahrungsnetze, Vegetationstruktur

1 Introduction

Over the last two decades, a concept of holistic biodiversity conservation has developed that aims to restore degraded ecosystems (see Bunzel-Drüke et al. 2008 for a review). In a natural system, processes such as flooding (Gerken 2006), fire and grazing (Schley & Leytem 2004) create structures and micro-habitats for many endangered species. Fires and floods have been and continue to be suppressed, and grazing is the only natural process which can be simulated without conflicting with other socioeconomic interests (Bunzel-Drüke et al. 2008, Overmaars 2001, Gerken & Görner 1999). Traditionally, herbivores such as sheep and goats were used for grazing in heath lands or dry grasslands. It was only in the late 1980s and 1990s that management of wetlands such as floodplains or bogs through the use of horses and cattle became more common (Bunzel-Drüke et al. 2008), and it was only very recently that, for the first time in the history of German biodiversity conservation, horses and cattle have been allowed to graze year-round in a deciduous forest complex (Gerken et al. 2008).

However, woodland pasturing is still strictly forbidden in most parts of Germany and has been since about 1850. Current research results will not change this easily (Gerken et al. 2008). Although not explicitly forbidden, grazing of wet sites or water bodies is viewed extremely critically and avoided. Despite traditional views, grazing in some wet sites along has been studied (Barth et al. 2000, Kazoglou & Papanastasis 2001, Krüger 2006, Gerken et al. 2008, Krawczynski et al. 2008). Results show that grazing at such sites is beneficial for biodiversity conservation. Under wet conditions, however, grazing with traditional herbivores such as sheep, goats, horses and even cattle might not be possible and can even lead to catastrophic results for the animals (Petermamm et al. 2008). There has been a successful attempt to use moose (*Alces alces*) in wetlands to reduce shrubs and trees (Burkhart 2006). But as moose are browsers, unwanted succession of grasses could not be prevented, and handling as well as fencing of moose is not always easy.

During the last 10 years, several projects have begun to use water buffalos (*Bubalus bubalis*) in wetlands. Water buffalos are domesticated animals which can be handled more easily than moose, they are grazers or at least mixed feeders, and no special fencing is needed. Nevertheless, grazing with water buffalos has often been rejected in Central Europe because the animals are perceived as tropical and exotic (Krawczynski et al. 2008).

2 Literature review

2.1 Why grazing of wetlands and reed beds?

Over the last three decades, special focus has been given to conservation and expansion of reed beds (Mook & van der Toorn 1982, van der Toorn & Mook 1982, Ostendorp 1989, Kühl & Neuhaus 1993). Different laws and regulations in all federal states of Germany declare reed beds to be "*especially protected habitats*" (§ 30 BNatSchG). This was mainly due to the assumption that reed beds (similar to beech forests) represent natural vegetation in Central Europe and that protec-

tion of birds such as the marsh harrier (*Circus aeruginosus*) and great bittern (*Botaurus stellaris*) required vast monotonous reed beds. Despite reed bed protection, populations of wetland species including the great bittern (*Botaurus stellaris*), little bittern (*Ixobrychus minutus*), little egret (*Egretta garzetta*) and all species of crake (*Fulica* spp.) except Coot (*Fulica atra*) have declined (Bauer et al. 2005).

Some reed bed birds including the harriers and bittern are nidicolous birds. The nestlings stay in the nest and are fed by the adults who hunt outside the dense reed bed. Crakes, on the other hand, are nidifugous birds. The nestlings leave the nest and look for food in the reed beds. Although reed beds as we know them today are a suitable breeding habitat, they are not a proper feeding habitat for the nestlings. The nestlings are carnivorous and need a larger supply of insects, spiders and mollusks. In monotonous reed stands, diversity of structure and availability of proper food are rather low. Water rails (*Rallus aquaticus*) need enough space to move through vegetation (Bauer et al. 2005). For spotted crake, "*optimal population densities were found in the reed beds after fire*" (Bauer et al. 2005). Krüger (1999, 2006) stresses the importance of open, shallow waters for fishing birds such as herons and muddy sites free of vegetation as feeding habitat for snipes.

Obviously, reed beds in natural landscapes would have a richer structure, otherwise the mentioned birds could not have evolved. Large herbivores including horses, European bison (*Bison bonasus*), aurochs (*Bos primigenius*) and red deer (*Cervus elaphus*) would have grazed in reed beds and created gaps and path systems. In addition to the large herbivores which would structure reed beds by grazing in natural ecosystems, there are a number of insects that also feed on reed and therefore can potentially structure the beds, including lepidopterans such as *Archanara geminipuncta* (Todeskino et al. 1994), flies such as *Lipara lucens* or leaf mining flies of the family *Agromyzidae* and midges such as *Giradiella inclusa* (Tscharntke 1988). It seems, however, that the influence of insects alone is not enough to maintain the reed habitat for the mentioned birds. The complex influence of vertebrate herbivores, insects, water table and competition among *Phragmites*, *Typha* and *Schoenoplectus* should be studied in the future.

Thus, even for the bittern and little egret, it is not sufficient to simply protect reed beds. For conservation of these species, Bauer et al. (2005) have suggested cutting parts of the reed regularly and creating richly structured reed beds. Little egrets can only be helped by preventing reed beds from covering all shallow waters. It has therefore become apparent that monotonous reed beds have to be structured to offer all reed breeding birds with suitable breeding and feeding habitats.

In January and February 2009, two small areas of the reed stands at Herter See in Lower Saxony (Germany) were blown up with dynamite to create pools for amphibians and birds (Anonymous 2009). It is doubtful whether maintaining wetlands with explosives is sustainable or desirable. On the other hand, grazing with livestock in low densities has proved beneficial for birds breeding in reed beds (Gulickx et al. 2007, Kazoglou et al. 2004, Andres & Reisinger 2001). Bauer et al. (2005) have suggested abandonment of grazing as one reason for the local extinction of common spoonbill (*Platalea leucorodia*). Bremer et al. (1999) offer an aerial image of a colony of *Platalea leucorodia*. The breeding sites are in a grazed patch within a dense reed bed. Wallows of wild boar (*Sus scrofa*) have provided sufficient habitat for water rails (Bauer et al. 2005). Wallows of water buffalos should do the same.

2.2 What are water buffalos?

Water buffalos are only distant relatives of cattle (Fig. 1). Their evolutionary lines separated about 5 million years ago. Therefore cattle and buffalos cannot interbreed as is the case with cattle/bison/yak (for more explicit information see Alexiev 1998 and Krawczynski et al. 2008).

Water buffalos are not only adapted to warm climates. Palaeontological research, especially in China, has shown that water buffalos and Przewalski's horses lived together in northeast China during the last glaciation in cold steppe climate (Tong 2007). Nevertheless, and despite their thick winter fur, buffalos should be given shelter in the form of thickets, reed beds or artificial shelters as is done for cattle.

2.3 Why water buffalos?

In flood plains and similar wetland habitats, cattle and horses can be kept without major problems. In fens, bogs or marsh lands, however, cattle and horses often reach their ecological limits. For example, the Weserumlauftal bei Bodenfelde nature reserve is within the floodplain of the Weser River, and large parts of it are a peat bog. Heck cattle and Exmoor ponies avoid these parts, allowing a succession of dominant plants including *Alnus glutinosa*, *Salix cinerea* and *Carex acutiformis* to form large stands, while less competitive species such as *Menyanthes trifoliata* and *Carex lasiocarpa* have declined or vanished (Gerken et al. 2008). In a marsh land in northwest Germany, 18 Heck cattle were lost in a conservation project in the winter of 2008 because the cattle drowned, became stuck in mud pools or starved as they tried to live on rush (*Juncus* sp.), which were the only plants available in winter (Petermamm et al. 2008). The digestion system of cattle is not adapted to digest rush (Krawczynski et al. 2008) and the animals died despite stomachs full of the plant (Petermamm et al. 2008).

Target conservation species include wading birds, and so the areas should be grazed to provide the structure these birds require, but cattle and horses cannot do the job. Water buffalos are adapted to such conditions and are able to live on rush in winter (Krawczynski et al. 2008). They are well adapted to Central European winters and will grow a thick fur in year-round grazing systems (Krawczynski et al. 2008, Hering et al. 2009).

Although water buffalos generally have no problems with mud and irrigation ditches, in the BUBALUS project, two buffalo cows suffering from infections and fever died in an irrigation ditch in one year. Although they had never had problems with the ditch before and used it for wallowing, they were weakened so much by disease that they were unable to leave the ditch. Two buffalo cows met a similar fate last winter in Saxony-Anhalt (Bley, pers. comment). These cases underline that only healthy buffalos have no problems with muddy terrain. Care should be taken to check the animals' conditions regularly as buffalos suffering from a fever will use any available water to lose body heat. Buffalos which separate themselves from the herd should raise suspicion.

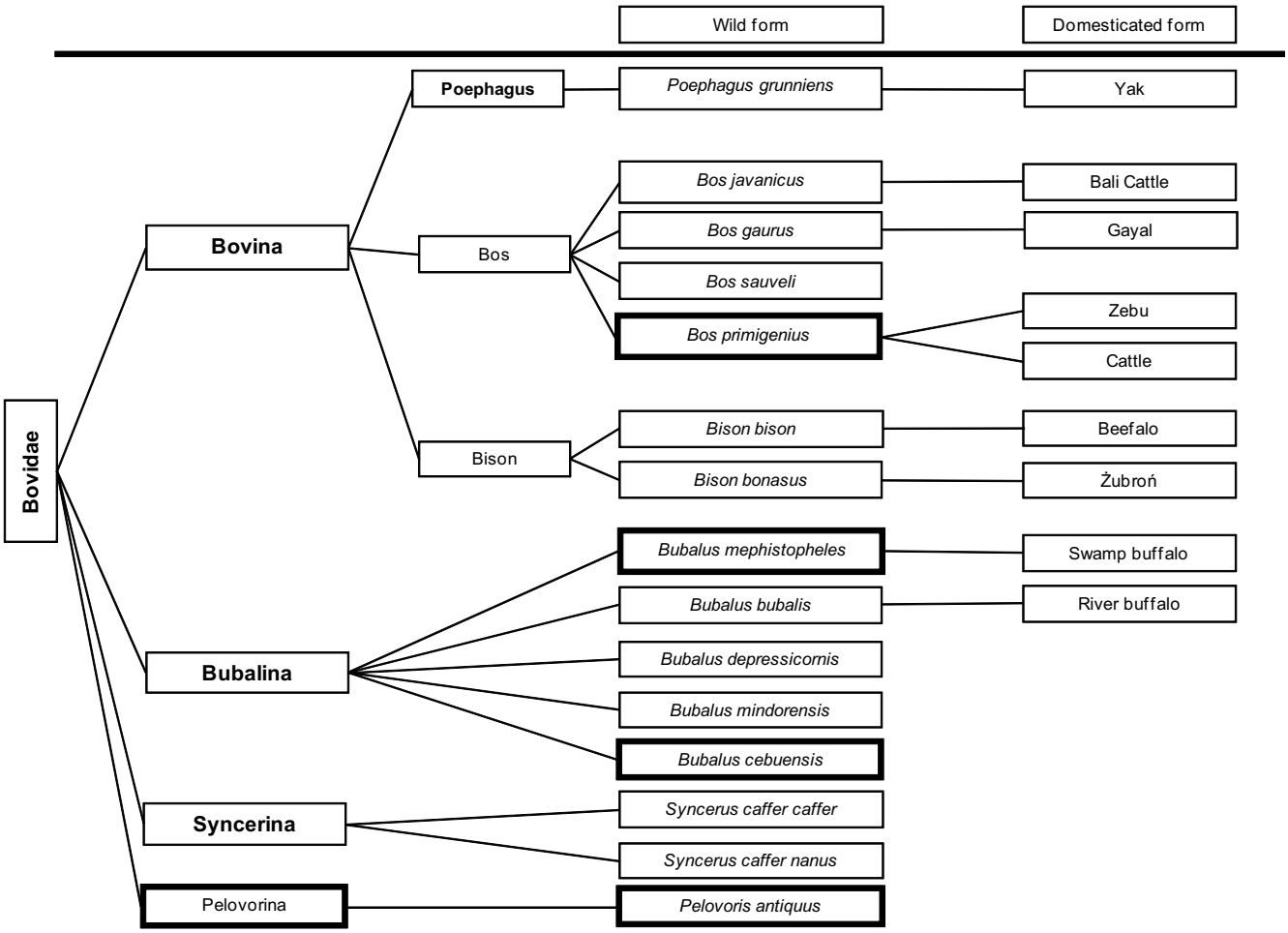

Fig. 1: Relationship between water buffalos and other Bovidae. Heavy black boxes indicate extinct species.

Abb. 1: *Verwandtschaft von Büffeln und anderen Boviden. Die fetten Kästchen markieren ausgestorbene Arten.*

3 Materials and Methods

The area for the BUBALUS project is near the river Spree about 10 km north of the city of Cottbus near the village Dissen (Brandenburg, Germany). Grazing by buffalos started in July 2008. Five buffalo cows and two Konik horses were released into a 7 ha pasture. By summer 2009, two young bulls (Heck cattle) and a stallion (Konik) were also brought to pasture. As the buffalo cows had been in calf when bought, the herd increased to ten buffalos. In total, the study site was grazed by 2.0 livestock units per hectar in summer 2009, which was not optimal. In December 2009 the number of animals was reduced to six (three Koniks and three young female buffalos). In addition to the pasture itself, the animals have access to 0.5 ha of woodland which had been an allée with oaks and alders. The allée has been neglected in the past and a number of young trees, especially *Alnus glutinosa*, now cover its edge and small areas of the meadow. The shrub layer in the allée consists mainly of *Sambucus nigra*. All trees and shrubs higher then 1.30 m (standard height for tree inventory) were inventoried and examined for traces of use by buffalos.

In winter, about one-third of the pasture is covered by water, mainly the southwest part. The existing pools are potential reproduction habitats for several amphibians (see below). However, drought in spring 2008 and spring 2009 led to the pools drying up in May and April, respectively. To ensure a water supply for the animals, a watering hole was dug: the bank was removed from the irrigation ditch “Grenzgraben” on the east side of the meadow to allow the animals to drink there (Fig. 2).

Vegetation consisted of typical plant communities for barren wet pastures. Three species of rush (*Juncus conglomeratus*, *J. effuses*, *J. inflexus*) covered about half of the area. Drier parts contained large amounts of *Cirsium arvense*. The pools were totally covered by *Glyceria fluitans*.

4 Results

4.1 Buffalo wallows

The reason water buffalos go wallowing is that they have problems withstanding high temperatures. This is due to their skin which is about six times as thick as that of cattle with about one-sixth as many sweat glands (Sambraus & Spannl-Flor 2005). If no water is available, they seek the shade of trees, but they prefer wallowing. When no permanent pools are around, they use temporary pools after rain to wallow. Through their wallowing, they deepen the pools and create sites where water will be available longer than in surrounding untouched pools. Our original five buffalos dug four wallows in three months (27, 50, 90 and 152 m^2 in size). By August 2009, the buffalo herd had increased to ten animals, and one more wallow were created.

The wallows are free of larger vegetation and offer habitat for smaller plant species such as *Myosurus minimus* or *Triglochin palustre*. We expect species adapted to flood plains and temporary water bodies such as tadpole shrimp (*Triops cancriformis*) to appear in the wallows. Mallards (*Anas platyrhynchos*) visit the wallows and might act as dispersal agents for plants and other organisms. After one year of buffalo grazing, *Ranunculus peltatus* appeared in one of the less often frequented pools. At the regularly used wallows, *Rorippa palustris* appeared in large numbers when the wallows fell dry.

Before the buffalos began grazing in spring 2008, no tadpoles were found in any of the pools. Although a number of amphibian species (common newt [*Triturus vulgaris*], red bellied toad [*Bombina bombina*], common toad [*Bufo bufo*], common frog [*Rana temporaria*] and edible frog [*Rana* kl. *esculenta*]) were found in the pools, there was no apparent reproduction. In 2009, however, there were tadpoles found in one of the less frequently used wallows. Red bellied toads use the wallows more frequently than other amphibians. Unfortunately, due to the dry April of 2009, the pools all fell dry by the end of that month. Only the most intensively used wallow kept water for a few more days. The drying pools and wallows no longer provided reproduction habitats for amphibians, but the deep hoof prints offered moist daytime conditions. All amphibian species living on the meadow except *Triturus vulgaris* have been found using the hoof prints as daytime shelter. It is known however that *T. vulgaris* also uses hoof prints (Gerken et al. 2008). We have observed the same for yellow bellied toad (*Bombina variegata*) in hoof prints of domestic cows and natterjack toad (*Bufo calamitata*) in hoof prints of red deer.

4.2 Buffalo dung and food webs

From Australia it is known that introduction of exotic animals can cause severe ecological problems because their droppings may not decompose. This affected breeding of cattle and water buffalos. Adapted dung beetles from Europe and Africa had to be introduced to Australia to solve the problem (Low 2001). In Europe, buffalos have been part of the fauna for probably the last million years (Krawczynski 2010). Early research indicates that buffalo dung in Central Europe is decomposed by the same species of micro flora (e. g., *Coprobia granulata*, *Ascobolus furfuraceus*, *Sporormiella minima*, *Pilobolus kleinii*) and dung beetles (e. g., *Geotrupes vernalis*, *Sphaeridium scarabaeoides*) as cattle dung. Song birds including red backed shrike (*Lanius cullurio*), meadow pipit (*Anthus pratensis*), whinchat (*Saxicola rubetra*) and yellow wagtail (*Motacilla flava*) breed and hunt on the buffalo pasture. The occurrence of dung beetles and flies from early spring into late November makes the buffalo pasture an ideal feeding habitat for insectivorous birds and bats. Starlings (*Sturnus vulgaris*) not only use insects which are roused by grazing buffalos but also ride on the buffalos and hunt for horse flies.

White storks (*Ciconia ciconia*) have frequently been using the buffalo pasture as feeding habitat. They not only hunt for amphibians and small mammals but also for large insects such as *Stethophyma grossum*. Black storks (*Ciconia nigra*) and grey herons (*Ardea cinerea*) also patrol the wallows (Fig. 3). Even a white tailed eagle (*Haliaeetus albicilla*) was captured by an automatic camera sitting next to a wallow. Red kites (*Milvus milvus*) and marsh harriers use the pasture as hunting habitat.

4.3 Buffalos and vegetation structure

Buffalos are able to digest plants which cattle cannot, e. g. rush, sedges and alder (*Alnus glutinosa*). It is sometimes explicitly stated that buffalos do NOT eat these plants (Sambraus & Spannl-Flor 2005). Indeed, buffalos prefer to feed on more tasty plants but have to take in more rough forage than cattle. We observed in year-round grazing systems that buffalos tend to feed on sedges in autumn and rush in winter, but they will feed on alder leaves whenever these are available. To get at the canopy of young alder trees which are already out of reach, buffalos push the young trees over and feed on the leaves while holding the tree down with their weight. They share this habit with cattle and European bison. For a list of plants eaten or avoided by buffalos see Krawczynski et al. (2008). New observations indicate that *Schoenoplectus tabaernimontani* is avoided by buffalos and that shrub like *Salix cinerea* and *S. aurita* are preferred over tree like *S. fragilis*.

Buffalos appear to have a unique comfort behavior. They not only rub their 600–1,000 kg bodies against large trees but they also brush their heads and horns against younger trees and bushes. First results from the BUBALUS project indicate that *Alnus glutinosa*, *Sambucus nigra* and *Viburnum opulus* are strongly preferred for brushing. Only initial theories are available to explain that behavior, and more research is needed. However, by reducing the shrub layer and understory in woods as well as reducing *Alnus glutinosa* succession in meadows, the buffalos offer a more suitable micro climate for xylobiont species such as *Protaetia lugubris* or *Osmoderma eremita*. Moreover, the newly available sunny, dead twigs and branches are breeding habitats for beetles such as *Clytis arietus*. *C. arietus* was observed mating in spring 2009 in large numbers on twigs and bushes after the buffalos had killed these plants off.

By suppressing the dominant rush, sedges and reeds, buffalos make way for smaller, less competitive plants such as *Isolepis setacea*, *Carex demissa* or the green algae *Botrydium granulatum*. In temporary pools dominated by *Glyceria fluitans*, the buffalos reduced the cover, and species such as *Ranunculus peltatus* appeared. Before grazing, the *G. fluitans* cover was about 95 to 100 %.

4.4 Influence on woody species

Buffalos use the woody species in three ways: browsing, rubbing and brushing. There is no evidence that the buffalos strip bark as horses or cattle do. For rubbing, older trees are chosen which will stand the weight of an adult buffalo. As there was no visible damage to trees from rubbing, only browsing and brushing were studied in detail.

When buffalos browse on trees, they use their tongue to strip off the leaves. If leaves are out of reach (~ higher then 1.80 m), the animals run the young trees over, pushing them under their bellies. Similarly to bison and cattle, buffalos are able to browse the canopy of trees up to 6 m of height. Younger trees or shrubs are preferred for brushing. Browsing has been observed on the following species of trees and shrubs: *Salix cinerea* (50.0 % of all specimens), *Alnus glutinosa* (33.2 %), *Salix fragilis* (28.6 %), *Quercus robur* (26.7 %), *Fraxinus excelsior* (15.0 %). *Sambucus nigra* and *Viburnum opulus* did not appear to have been browsed in spring and summer. By late autumn, however, young *S. nigra* had obviously been browsed, but we were not able to tell which of the

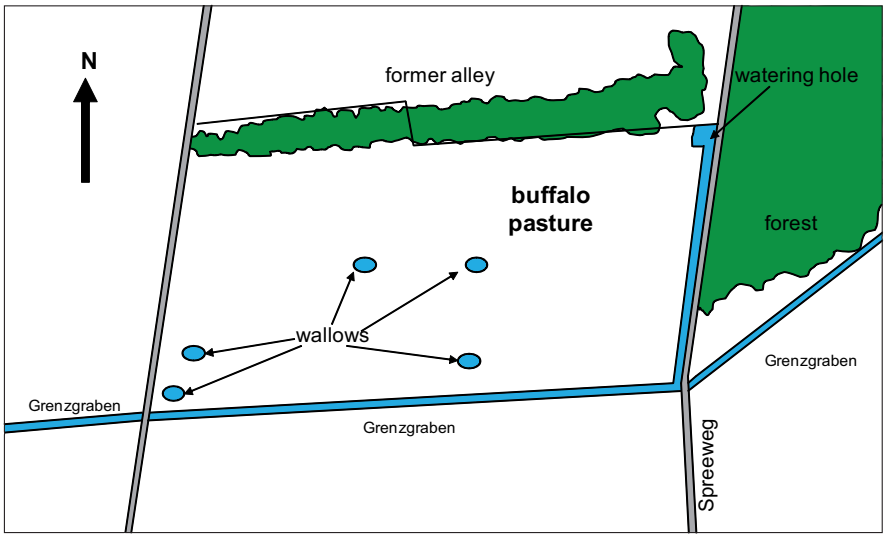

Fig. 2: Schematic map of the buffalo pasture (7.5 ha).

Abb. 2: *Schematische Karte der Büffelwiese (7,5 ha).*

three herbivore species had done so. Our observations in woodland pastures in Lower Saxony and Thuringia showed that Heck cattle and horses do browse *S. nigra*.

Brushing is done only with the heads and the horns. The following species of wood were heavily used for brushing: *Viburnum opulus* (100 % of specimens), *Sambucus nigra* (93.5 %), *Alnus glutinosa* (79.4 %) and *Salix cinerea* (66.7 %). Less frequently used were *Quercus robur* (45.0 %), *Salix fragilis* (42.9 %) and *Fraxinus excelsior* (25.0 %). *Sorbus aucuparia* was not brushed at all.

5 Conclusions

Water buffalos can occupy their evolutionary niche in Central Europe. They are well-adapted to semi-open landscapes consisting of a mosaic of water bodies, marginal vegetation, wet meadows, and woods. Similar to other European herbivores, their use in low densities can be beneficial for biodiversity conservation. Birds, amphibians and insects in particular will benefit from buffalo impact on vegetation structure and species composition. However, many questions still remain unanswered as scientific research has only just begun.

Acknowledgements

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Fig. 3: A black stork (*Ciconia nigra*) patrols a buffalo wallow. Photo taken by an automatic camera.

Abb. 3: *Ein Schwarzstorch (*Ciconia nigra*) patrouilliert entlang einer Büffelsuhle. Die Aufnahme entstand mit einer Fotofalle.*

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