

Konik polski horses as a mean of biodiversity maintenance in post-agricultural and forest areas: an overview of Polish experiences

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(Accepted October 12, 2017)

Traditional agricultural measures are still necessary for maintenance of endangered endogenous species of plants and animals in ecologically valuable habitats. Poland is one of the countries of the highest biodiversity of agricultural lands in Europe, however, the intensification of agriculture and farming resulted with regular decrease of valuable wildlife species. Abandonment of agricultural use of traditionally pastoral areas induced the encroachment of species that reduce local biodiversity.

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To counteract this undesirable process, several organisations re-introduce Konik polski horses into wastelands.

The aim of this overview is to share the experiences of institutions which used Konik polski horses as a mean for biodiversity restoration in post-agricultural and forest areas, including expected effects, their implementation and main problems encountered. The aims, positive and negative effects are presented and discussed.

KEY WORDS: biodiversity / bird protection / environmental heterogeneity /
Konik polski horses / traditional agriculture

In view of changing agricultural landscape in Europe in a relatively short time of past one hundred years, rapid and often dramatic changes in environment have occurred. In Poland, the number of main farm animals changed from 22 heads/100ha in 1913 to 46 heads/100ha for pork, from 18 heads in 1913 to 0.3 heads/100 ha in 2007 for sheep and from 14 heads in 1913 to 1 head/100 ha in 2007 for horses. For cattle, the numbers remained the same (35 heads/100 ha both in 1913 and 2007) [Gorzelać 2010]. With these changes, the number of grazing animals dropped dramatically, and the structure of land use modified from extensive to intensive agricultural production. One hundred years ago (1913) grasslands (meadows and pastures) comprised 16.8%, forests 23.9% and wastelands 11.0% of total country area, while in 2007 grasslands comprised 10.5%, forests 29.5% and wastelands 18.7% of total country area [Gorzelać 2010]. Decrease in economic profit from exploitation of low-producing or hardly accessible wet meadows, previously scythed, had led to increase of the wastelands areas and wild shrubs encroachment. In consequence, the biodiversity of these lands, both in botanic composition and in variety of animal species, especially birds, abruptly dropped. Now, such areas are mostly qualified as biologically valuable and considered for preservation in NATURA 2000 program. However, traditional agricultural measures are still necessary for maintenance of endangered endogenous species of plants and animals.

Therefore, in order to limit succession of undesirable vegetation, several organizations and private persons reintroduced farm animals of local breeds into the wastelands. More specifically, Konik polski horses, the breed under genetic conservation breeding program, has been considered as most suitable for reintroduction for landscape maintenance. Present review, focused on Konik horses, introduces the background, aims and results of such activities, as well as problems encountered by these organizations. This is not the presentation of hard scientific results due to different durations of Konik maintenance in given locations and the lack of primary studies (inventory) of local flora and fauna before the release of Koniks. We trust however that the information from present review would be helpful for some considering such activity in their regions.

Short history of Konik polski horse breed and its potential in landscape shaping

In Poland, only Konik polski horses were maintained in year-round free-roaming semi-feral conditions for more than 60 years. Koniks history is related to East European ‘tarpan’ (*Equus caballus gmelini* Ant. forma *silvatica*, Vet.) horses [Lister *et al.* 1998]. It was considered originally wild form of domestic horse by some equine scientists [Antonius 1933, Vetulani 1933], while others [Czapski 1874, Skorkowski 1934] claimed that tarpans were de-domesticated feral horses.

The last wild tarpan died in the 18th century in count Zamojski’s wildlife sanctuary, Poland. However, there is some evidence that Tarpans were crossbred with local primitive domestic horses [Jeziernski and Jaworski 2008]. In the early XX century, the reconstruction of the tarpan-like horse was initiated by Polish researchers. Horses characterized by mouse colour, primitive type of body conformation, black back stripe and ‘zebra’ leg stripes, were purchased from farmers living in close proximity to, at those times non-existent wildlife sanctuary [Jeziernski and Jaworski 2008]. Those individuals gave raise to Konik polski horse breed maintained, apart from traditional stable breeding system, in experimental free-roaming forest conditions, that Konik horses coped with exceptionally well. At present, the main centre of Konik breeding in Poland at Popielno Research Station (53.7508381, 21.6279047000) offers the Koniks 1620ha of forest and meadow land that allows natural social, foraging, reproductive and comfort behaviour for more than 10 generations of horses. Overgrowth of the population is controlled by offspring removal – only some young individuals are left in forest reserve as next generation, every few years.

The success of forest breeding of Konik horses and their exceptionable adaptability to local harsh environment due to high soundness, fertility, resourcefulness, feed indiscrimination and general resistance was the reason of introducing semi-feral herds of Koniks in other forest and meadow habitats in Poland.

Main problems in environment maintenance and endangerments to biodiversity

Poland is one of the countries of the highest biodiversity of agricultural lands in Europe [European Environment Agency, HNV Farming Project, Final Report, 2004], however, the intensification of agriculture and farming results with regular decrease of valuable wildlife species [Tryjanowski *et al.* 2011, Rosin *et al.* 2016]. The five habitats presented in this paper, situated mainly in North East of Poland, differ with their geomorphological, floral and faunal diversity so the aims, reasons and effects of Koniks introduction as well as the problems encountered are presented in relation to each keeping location. Nevertheless, two groups of habitats endangered by undesirable plant succession were submitted to Koniks’ grazing intervention: post-agricultural and forest areas. The re-introduction of horses, as a large farm herbivore, into the lands with biodiversity endangerments, were led with full respect to NATURA 2000, Ramsar

Convention, Wild Bird (Council Directive 79/409/EEC) and Conservation of natural habitats (Council Directive 92/43/EEC) EU directives. In this chapter, we present the overview of geo-biological characteristics of locations chosen for introduction of horses for biodiversity maintenance, main problems for each location and most endangered species. The description of herds at each location (year of starting the project, number of animals, herd social structure) is also given.

Post-agricultural lands – Narew and Narewka river valleys

The Upper Narew Valley is a NATURA 2000 site located in north-eastern Poland in proximity to Białowieża Primeval Forest while Narewka river valley is located within Białowieża Primeval Forest. The introduction and maintenance of horses were funded by EU Commission and by National Fund for Environmental Protection and Water Management “Protection of the Lesser Spotted Eagle in selected Natura 2000 sites” LIFE08 NAT/PL/000510 project, “Active protection of Black grouse (*Lyrurus tetrix*) in special protection area Natura 2000” POIS.05.01.00-00-328/10-00 and “Active protection of great snipe *Gallinago media* in Dolina Górnej Narwi Natura 2000 site” LIFE11 NAT/PL/436. The horses are kept in two locations (52.918196, 23.485626 and 52.694753, 23.867397). The mean temperature in this region in January is -5°C , in July 17°C and mean annual temperature about 7°C . For between 110 to 138 days the temperature is below 0°C and for 80-100 days there is snow cover. Average annual precipitation is 550 mm [Górniak 2000].

Botanical changes in Narew and Narewka river valleys are related to the decline of agricultural use of valley lands, decrease in submersions caused by annual spring thaw flood and in lowering of ground waters level. These changes provoked favourable conditions for reed, willow thickets, alder forests and swamps expansion. Previously dominant *Glyceria maxima* (*Glycerietum maximae*), Red canary grass (*Phalaridetum arundinaceae*) and valuable habitats like fresh meadows, wet meadows or dry xeric sand calcareous grassland were successively replaced by expansive *Caricetum elatae* and *C. gracilis typicum*. Introduction of Koniks was aimed at limiting these unfavorable processes and at restoration of proper conditions of habitats of wading and waterfowl.

In the past, large farm animals provided the optimal habitat for the waders by maintenance of short grass by grazing and trampling the ground during pasturing. Due to discontinuance of pasturing in meadows on marshlands of Narew and Narewka river valleys a 39% decrease in number of highly valued wading and water bird species like Northern lapwings (*Vanellus vanellus*) and Common Snipes (*Gallinago gallinago*) has been observed during last ca 20 years [Pugacewicz 2012]. Also, the birds are endangered by the predation by feralised American mink (*Neovison vison*) [Pugacewicz 2012] and red foxes (*Vulpes vulpes*), since their population recently abruptly increased due to anti-rabies prevention.

The most endangered species are Northern lapwing, Black-tailed godwit (*Limosa limosa*), Redshank (*Tringa tetanus*), Common snipe, Great snipe (*Gallinago media*) and Eurasian curlew (*Numenius arquata*). Abrupt increase in number of passerines

(Passeriformes) by 86% reflects deep environmental transformation into thickets and *Convolvuletalia sepium* communities [Pugacewicz 2012].

Seven (four mares, one stallion and two foals) Konik horses were introduced in 2010 into location of total area of 30 ha (Narew river valley). In 2017 the population consisted of 27 horses. In 2015, three geldings were released in another location of 3.5 ha of total area (Narewka river valley).

The horses are dewormed twice a year. They are not submitted to hoof trimming since they have an access to solid surfaces enabling appropriate wearing of hoof corn. The offspring is being weaned by removal from natal herd and sold.

Post-agricultural lands – Błota Rakutowskie (Rakutowskie peatbogs)

Rakutowskie peatbogs is a Natura 2000 nature protection area, localised in central Poland (52.48076280000001, 19.264697100000035). The mean temperature in January is -1°C, in July is 18°C and mean annual temperature of about 8°C. In this region 31.4 days are of temperature below 0°C and 56-60 days with snow cover. Average annual precipitation is 525mm. Rakutowskie peatbogs, of about 4438 ha of total area, have a form of basin, restricted by dune and moraine heights, containing in its centre Rakutowskie kettle lake. Its floral habitats are mainly fen mires, riparian and alder swamp forests as well as reed and sedge meadows. In the past, most of area was meliorated (drained) and used for harvesting hay and as pastures.

Like in other sites, increasing forestation of lands previously extensively used endangered avian biodiversity. Especially, selective grazing by large farm animals is necessary factor for nest building by *Charadiiformes* thus the cessation of pasturing resulted in dramatic decrease in breeding pairs of Lapwings, Black-tailed godwits and Curlews by 86-100% [Gromadzki *et al.* 1994, Sidło *et al.* 2004, Brauze *et al.* 2014].

The aim of introduction of Konik horses into Błota Rakutowskie area was the reconstruction of extensive agricultural use of meadow habitats. In order to introduce horses, 15ha of wasteland, including 10ha of grassland, was purchased and fenced. Existing undesirable trees and bushes were removed with the root system and meadow habitats were reconstructed.

The introduction and maintenance of Koniks was funded by the National Fund for Environmental Protection and Water Management, Poland, project POIS.05.01.00-00-362/12-00 “Protection of birds in NATURA 2000 reserves and areas in kujawsko-pomorskie voivodship”. In 2015 one stallion and five mares were released into the area of 15 ha. They are rotationally pastured from November to June on a drier pasture and from July to October on a pasture where water stagnates until July. Due to scarcity of trees in pastures the horses are provided with open wooden shelters. Supplementary feeding of the horses is restricted to solely harsh winters while hoof trimming and deworming takes place twice a year. The weanlings are successively sold.

Post-agricultural lands – Biebrza National Park

Biebrza National Park is the largest of Polish National Parks (592 km²) under the protection of the Ramsar Convention. It is localised in North East of Poland (53.632088, 22.772174). Mean temperature in January reaches -4°C, in July 17°C, whereas mean annual temperature oscillates around 7°C. There are about 50 days of temperature below 0°C, and 80 days with snow cover. Average annual precipitation is 600 mm. Similarly, to other wetland habitats, invasive overgrowing was the main cause of gradual loss of valuable fitocenoses. Like in other locations, the aim of reintroduction of large grazing farm animal was the prevention of this process. Selective grazing, trampling and seed transportation by horses was assumed to enhance desirable plant diversity.

Wetlands are exceptional environment for rare and endangered animal species, especially birds, but also protected invertebrates, amphibians and reptiles. Extensive pasturing of Koniks was assumed to have beneficial effects on invertebrates' (butterflies, bumblebees, molluscs) and vertebrates' diversity. Apart from environment and feeding enrichment for *Charadiiformes*, enhancement of nesting of *Clanga* species was expected.

The introduction and maintenance of Koniks was funded by own funds of the Biebrza National Park, governmental agri-environmental subsidies, and two projects co-financed by National Fund for Environmental Protection and Water Management (Poland): 432/2004/Wn50/OP-re/D „Conservation breeding of Konik polski horses in Biebrza National Park” and 69/2017/Wn-10/OP-WK/ D “Modernisation of the Centre of Konik polski conservation breeding in Biebrza National Park”. Twelve (nine mares, one stallion and two geldings) Konik horses were introduced in 2004 into location of total area of 210 ha. At present (2017) one stallion and 11 mares with foals at foot are kept at the centre. All weanlings are being sold when one-year-old.

The horses are dewormed once a year. They are not submitted to hoof trimming. The offspring is being weaned by capturing and separation with natal herd.

Post-agricultural lands – Oświn lake reserve

Oświn lake reserve (54.2958934, 21.6682938), a wildlife sanctuary of 1618 ha, contains within its boundaries shallow eutrophic Oświn lake, with several small islands and marsh shore thickly vegetated with reeds and thickets. In this region, long transitory periods between basal seasons (winter and summer) are characteristic. Mean temperature in January fall down to -2°C, in July attains 17°C and the mean annual temperature reaches 7°C. There are about 26 days of temperature below 0°C, and snow cover stays for 72 days. Average annual precipitation is 600 mm.

The islands and shores are partly covered by alder, elm and ash forests as well as Galio-Carpinetum oak-hornbeam forest. The lake is surrounded by hilly moraine heights vegetated with grass which were previously used as pastures, successively abandoned. The major problem in this location is quick outgrowing of the pastures

with Hawthorn (*Crataegus monogyna*) which succession entailed the loss of highly valued plant species, especially from the *Orchidaceae* family. The introduction of Konik was aimed at retardation of Hawthorn succession and at the maintenance of the mosaic character of plant communities.

In the Oświn lake reserve the introduction of large grazers, apart from landscape maintenance enhancing bird migration and nesting, was also aimed at the creation of beneficial environment for coprophagic invertebrates specifically related to open spaces herbivores since, after cessation of pasturing, the variability of coprophages was highly reduced and restricted only to the forest herbivores.

The introduction and maintenance of Koniks in 1990 was funded by a private person. In 2008 part of the horses was sold to different Konik breeders, and another part was purchased by Borki Forest District. The breeding is continued from its own funds. The structure of population ranged from one to three herds with offspring. At present (2017) one herd with one stallion and 15 mares with foals uses 1200ha of land.

The horses are not dewormed and no problems with helminthiasis was ever noted. They are not submitted to hoof trimming since they sufficiently wear the hoof corn off. The offspring is being weaned annually by separation with the natal herd and is successively sold, mainly to other free-roaming studs as an exchange of genetic material.

Forest environment – Strzałowo forest district

Thermophilous oak forests (*Quercetalia pubescenti-petraeae* forests) are biologically the richest forest communities in Poland. Thanks to their formation on calcareous, argillaceous-arenaceous soils with high content of calcium carbonate they provide excellent conditions for Oaks (*Quercus spp.*) and other plants such as Multiflowered buttercup (*Ranunculus polyanthemus*), White cinquefoil (*Potentilla alba*), Kashubian vetch (*Vicia cassubica*), Blue lungwort (*Pulmonaria angustifolia*) and many other plant species that are endangered and protected.

These habitats have anthropogenic character and had been formed in shine forests where, historically, farm animals such as cattle, horses, sheep, pigs, goats and geese were pastured. By browsing understory overgrowth, the animals reduced overshadowing and, by feeding with forest undergrowth beneficially contributed to alkaline pH of forest soils. After the II World War the pasturing in public forests was banned and from this moment thermophilous oak forests have been successively vanishing and replaced by oak-hornbeam forests (*Carpinion betuli*) and mixed oak-pine (*Pinus silvestris*) forests.

In 2012, the inventory of plants in Strzałowo forest district (53.7763026, 21.44166919999998) has shown that in this area thermophilous oak forests were probably historically frequent. Thus, the project of re-introducing horses in Strzałowo forest district was aimed at reconstruction of this almost extinct habitat which protection is considered as priority by Habitats Directive 92/43/EWG. In Strzałowo forest district

mean temperature in January is -9°C , in July 21°C , mean annual temperature is about 6°C and there is 650 mm of mean annual precipitation.

The introduction and maintenance of Koniks during the project was funded by the Strzałowo Forest District own budget. The horses are lent by a local breeder for the pasturing season covering project periods, and are under veterinary and farrier care provided by the owner. First experiment with horse grazing for reconstruction of thermophilous oak forests started in 2013 on the area of 1ha. In next two years, area available for horses has been enlarged to 6ha and to 12ha in 2016. Before introduction of horses the Hazel (*Corylus spp*) and Hornbeam groves were removed. Ten to 15 horses (geldings and mares with foals at foot), were rotationally pastured in 1ha fenced areas for about 10 days. The horses were daily provided with fresh water and salt block available *ad libitum*.

Effects of introduction of Konik horses into the environment

The effects of introducing horses were considered by their owners as mainly positive. It should be noted however that plant composition and animal diversity in these locations need more detailed analysis. In this chapter, we present main observations provided by the owners of horses.

Narew and Narewka rivers' valleys

Positive effects. During the project period intensive feeding by Yellowhammers (*Emberiza citrinella*) and increased number of nesting pairs of Eastern yellow wagtail (*Motacilla flava*), Meadow pipit (*Anthus pratensis*) and Redshanks were observed in the monitored area. In the first pasturing season two nesting pairs of Lapwings and territories of four male Snipes were noted in previously unpopulated areas. Koniks successfully suppressed reed and willow succession.

Negative effects and main problems. Negative effects of introducing horses into Narew and Narewka river valleys are restricted to decline of Corn crakes (*Crex crex*) which prefer higher vegetation for refuges and nesting. In view of recent increase of corn crane population due to implementation of agri-environmental subsidies [Kotowska and Żmihorski 2015], its protection in areas with rarely mowed meadows is considered to be sufficient. No other negative effects of Koniks grazing on biodiversity in Narew and Narewka river valleys environment have been noted.

During 8 years of the project some health problems occurred, namely one stallion's, two neonates' and one 9 months old foal's deaths from unknown reasons were recorded. Also, one mare died from helminthiasis. Another problem was related to the lameness of one mare, caused with deep puncture of the hoof. The veterinary treatment was effective in complete recovery of the mare. Other incidents were related to innate blindness in one gelding and aggressive encounter involving kicking the two years old colt by a mare.

Since the reproduction is restricted to only 15 mares, there is no problem of sale of weanlings in this site.

Rakutowskie peatbogs

Positive effects. Although the timeframe of the Project is not a long one, desired effects already can be observed. In both pastures, the Koniks willingly feed with reeds, alder and willow outgrowths which confirms the usefulness of Koniks for limiting the succession of invasive plant species. In the first pasturing season (2016) eight pairs of Lapwings, four pairs of Redshank and presumably one pair of Black-tailed godwit were observed in pastured lands, in contrary to no nesting birds in the adjacent, mowed only areas. In the next season (2017), observed were nine nesting pairs of Lapwings and five pairs of Redshank. It is suggested that pasturing contributes to greater food resource diversity for birds and better hiding places availability in plant patches omitted by horses that play anti-predator functions. Moreover, the pastures are resting and feeding refuges for migrating birds such as little Ringed plover (*Charadrius dubius*), spotted redshanks (*Tringa erythropus*), Ruffs (*Philomachus pugnax*), Wood sandpipers (*Tringa glareola*), Northern shovelers (*Anas clypeata*), Garganeys (*Anas querquedula*), Eurasian teals (*Anas crecca*), Taiga bean geese (*Anser fabalis*), Greylag geese (*Anser anser*) and Common cranes (*Grus grus*).

Another added value of Koniks reintroduction is growing interest in the horse-environment interaction in tourists and local people, which may contribute to the increase of ecologic awareness and pro-nature attitude of visitors and local society.

Negative effects and main problems. No negative effects of introduction of Koniks into Rakutowskie peatbogs were actually observed. However, some problems with reproduction occurred in two mares. In the first case the foal was rejected by dam, but fortunately it was accepted after one week of human-assisted nursing. In the second case the mare and the foal were died due to complications during foaling. In the restricted area of 15ha divided into two smaller pastures, frequent monitoring of horses, winter feeding and shelter cleaning is an additional workload as compared with larger sanctuaries. Moreover, the horses should be manageable enough to be led between available pastures, so, in smaller areas of free-keeping conditions, some handling of animals is necessary.

At the start, the project was financed by the National Fund for Environmental Protection and Water Management. At present the funding from **agri-environmental subsidies totally covers the costs of keeping the horses.**

Biebrza National Park

Positive effects. Before introducing the horses into protected area some risks related to grazing were suspected. Most concerns raised were complete eradication of some highly palatable meadow plant species on the one hand and monoculture of unpalatable plants area formation on the other, due to selective feeding by horses, greensward ripping and eutrophication related to the redundancy of dung.

Personal observations by one of the authors (A.T.) contradict predicted suspicions. There is no danger neither for detrimental changes in plant compositions nor in over fertilisation of lands with such a low number of animals. In contrary, it turned out that dung depositions were beneficial for Purple moor-grass (*Molinia caerulea*) and other plants increasing the biodiversity in the grazed areas. This is crucial for providing microhabitats for small birds and invertebrates (Chodkiewicz and Stypiński, 2011).

According to the latter authors, the horses grazing in the Biebrza valley most frequently choose grass-like sedge (*Carex panacea*), Large yellow sedge (*Carex flava*), Purple moor-grass (*Molinia caerulea*) and Velvety bentgrass (*Agrostis canina*). Nipping dominant plant species by horses is beneficial for rare and protected plants like Marsh gentian (*Gentiana pneumonanthe*) and Early marsh-orchid (*Dactylorhiza incarnata*). The horses omitted ligneous (Marsh cinquefoil *Comarum palustre*, Rosemary-leaved willow *Salix rosmarinifolia*, Bugleweed *Lycopus europeus*), poisonous (Greater creeping spearwort *Ranunculus flammula*, Marsh-marigold *Caltha palustris*) and aromatic plants (Water mint *Mentha aquatica*).

The observations confirm the usefulness of pasturing the horses for elimination of young sprouts of trees and bushes, however, in the vegetation season, it is probably related rather to trampling than to eating the groves. Another author's (J.L.) observations indicate that contribution of Koniks to elimination of some tree species like the birch, alder and willow varieties is limited and without annual mowing of meadows preventing the succession of these plant would not be possible.

Negative effects and main problems. Observations indicate that low density of animals per available area, typical to natural herd requirements and allowing food resources also in winter season, does not assure complete protection from undesirable plants' succession processes. Moreover, the horses accessing the whole area of the enclosure omit some sites which are more at risk of intensive growth of invasive species. In this situation continuous pasturing and mowing the overgrowths once per two years are most efficient methods for maintaining ecological balance in protected areas.

Some problems with hoof corn overgrowth were suspected before releasing the horses into wet marshland. However, as in other locations with access to hard surfaces, the horses wear sufficiently the hoof corn by using sand paths within their enclosure.

A minor problem encountered by owners in this site is related to reduction of the demand for all male individuals and both sexes of Konik horses with white markings and other not typical coat or body features, that unable the horse to enter the studbook as a reproduction stock. Since only the broodmares are granted with the subsidy from conservation breeding program, the untypical fillies and colts are hardly saleable.

Oświn lake reserve

Positive effects. The activity of Koniks was successful in preventing unrestrained succession of meadows by bushes, however, complete control of vegetation overgrowth is not possible with only pasturing horses in the present number. Moreover, hawthorn

is highly resistant to browsing by horses. However, the enrichment of diversity of coprophagic invertebrates and plant communities have been noted as compared to the areas not grazed by Koniks.

Negative effects and main problems. No negative effects of Konik horses upon the environment and local fauna and flora was observed. Also, no severe health or welfare problems, except for intensive tick invasions in the summer season, were noted.

Forest environment – Strzałowo forest district

Positive effects. The effects of grazing by horses were assessed by phytosociological releaves. In the grazed areas qualitative and quantitative diversity of plants characteristic to thermophilous oak forests, like Peach-leaved bellflower *Campanula persicifolia*, St. John's-wort *Hypericum montanum*, Cowslip *Primula veris*, Wild basil *Clinopodium vulgare*, and Hedgenettle *Betonica officinalis*, gradually increases. Interestingly, the number of sprouts of the Norfolk ever-lasting pea (*Lathyrus heterophyllum*), after one pasturing event, increased from 85 to 142.

In a pasturing experiment in the habitat of protected *Thesium ebracteatum* after autumn grazing the number of sprouts increased from 1500 to 2500. In the same habitat summer grazing resulted in further increase in sprouts by 500 and after summer grazing this species repeated the blossoming. First observations indicate that in thermophilous oak forests restoration the most optimal season of pasturing is late autumn (after first frosts) when the horses feed with Eagle fern (*Pteridium aquilinum*) and Nettle (*Urtica spp.*).

Negative effects and main problems. No problems to horses have been observed during the pasturing season. Only minor negative effects like sporadic presence of Creeping thistle (*Cirsium arvense*), Dandelion (*Taraxacum officinale*) and Wheatgrass (*Agropyron caninum*) were observed in the grazed areas. To be eradicated, these plants have to be destroyed before the blossom.

Discussion

Presented overview confirms that the idea of introducing horses into wastelands and forest habitats was generally purposeful. The ability to cope with local wildlife in different natural environments without provoking any harm to highly valued plant species was confirmed by all persons that introduced them into wastelands for plant and animal biodiversity maintenance.

As expected, grazing increased observed plant, invertebrate and bird biodiversity and all programs of free-roaming year-round maintenance of Konik polski herds are continued, even after main sources of funding have expired. Keeping of Konik horses

in such extensive environments revealed to be not too expensive in terms of feeding and veterinary expenses. The authors of the present work who are also the caretakers of the described herds, agree on high usefulness of this breed as a mean of landscape shaping and maintenance.

However, to keep the feeding resource in a state sufficient for its self-restoration and availability to horses also in the winter periods, as well as for assuring biodiversity of invertebrates [Boschi and Baur 2006] and plants [Dorrrough *et al.* 2004], appropriate stocking density should be foreseen. Unfortunately, without additional agricultural measures like mowing, the encroachment of invasive plant species wouldn't be possible. Although Koniks were successful in reduction of some unwanted species like *Calamagrostis epigejos*, insufficient reduction of undesirable shrub species was reported for management of Belgian coastal dunes [Cosyns *et al.* 2000] and in the Biebrza valley [Borkowski, 2002]. For extinction of bushes and other dicotyledonous species cattle was suggested to be more efficient [Menard *et al.* 2002], however horse grazing was considered better than cattle grazing since horses removed more vegetation per unit body weight than cattle and used more productive plant communities and plant species (especially graminoids, Menard *et al.* 2002). Horses graze closer to the ground and maintain a mosaic of patches of short and tall grass which contribute to species richness and heterogeneity of habitats [Marion *et al.* 2010]. It should be however noted, that traditional use of wet meadows including both scything and pasturing of all species of domestic farm animals was best assuring high biodiversity in agricultural landscape.

Abandonment and eutrophication are major threats to traditional pastoral landscapes and their wildlife in Europe [Bokdam and Gleichman 2000]. As pointed out by Fahrig *et al.* [2011] general biodiversity depends mainly on its protection in human-controlled landscapes. Since the number and variety of feeding and nesting birds is a measure of heterogeneity in agricultural landscapes, bird protection by assuring appropriate conditions similar to traditional agricultural farmsteads are highly effective in biodiversity enhancement [Rosin *et al.* 2016]. Year-round Konik horse grazing was beneficial for typical plants, orchids and rare bird communities in Germany [Köhler *et al.* 2016]. No negative effects, like latrine formation, excessive soil trampling or eutrophication were observed.

Little information about the impact of horse grazing in forest areas is available. The horses generally prefer open spaces [Jaworski 2003] and use forest for refuges from insect harassment [Górecka and Jezierski 2007]. They also forage in forest areas. In review by Smugała and Pikuła [2015] negative effects to forest were reported (browsing sprouts of valuable tree species, especially in nurseries), while no such effects have been observed in Popielno Research Station for 60 years of Koniks' keeping in the forest habitat (Jaworski, unpublished data). Cautious management of grazing by rotational pasturing in fenced areas or fencing valuable plant species and nurseries is recommended for controlling damages made by horses in forests.

The appropriate stocking rate is crucial for land management and animal welfare. In all the presented locations the mean stocking rate was 0.32 head/ha (0.01-0.8 head/

ha). The offspring is being removed annually, at some locations the horses are gelded or only-mare herds are maintained. The stocking rate was optimal for biodiversity maintenance and welfare of horses. Seasonal decrease in body condition are minor problems and relates mainly to older animals and lactating mares. Good health, body and hoof condition and high reproduction rate reflect perfect adaptation of horses of this breed to harsh conditions and, under minimum human surveillance, they could be considered an excellent mean of landscape protection.

It can be concluded that Konik horses are right candidates for landscape shaping and biodiversity assurance in wastelands. Additionally, with their potential for use in recreational riding and driving they are still associated with traditional use of farm animals and have an unquestionable role in maintenance of agricultural traditions in local culture.

***Acknowledgements.** This work was inspired by the International Conference „Konik polski horses in nature protection”, 22nd – 24th June, 2016, Białowieża, Poland. The Authors thank the Polish Society for Birds Protection and Białowieża National Park for the opportunity to present their studies and share experience related to Konik horses used for biodiversity protection.*

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