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THE IMPACT OF THE EUROPEAN BEAVER (*CASTOR FIBER*) ON THE ENVIRONMENT AND ECONOMY

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Abstract. The aim of this study was to illustrate the influence of the European beaver (*Castor fiber*) on the natural environment and economy using the data on the size and type of damages inflicted by these rodents within the boundaries of the Kuyavian-Pomeranian Voivodship over the years 2005–2013. The population of beaver in this area is estimated around 5 thousand. The most common damages include tree girdles, grassland flooding, arable crop damages, damages to dikes and fish pond embankments.

Key words: arable land, beaver, damage, dikes, embankments of fish ponds, grassland, tree girdles

INTRODUCTION

By the body size, the European beaver is the largest rodent in Poland. With a weight ranging from 18 to 30 kg, a beaver's body can measure 105–135 cm in length, including 20–26 cm tail. The beaver is very well adapted both to terrestrial and aquatic habitats. The small head and elongated body help the mammal to swim. Eyes, ears and nostrils are located on top of the head, all nearly on the same level, which allows the animal to watch the surrounding even if nearly entirely submerged. While underwater, beavers close their ears and nostrils, whereas the eye is protected by the third, transparent eyelid. Beaver's toes of hind feet are webbed, whereas the front paws are small and prehensile. The upper lip, which

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is split in two, is another adaptation to water life. Also the tail, flat and broad, covered by tiny scales on 2/3 of its length, serves the swimmer as propultion and steering; on the ground it is also useful as the body support of a tree-chewing beaver. The tail is also the body's main thermal regulator and fat store [Reichholf 1996, Zalewski 2011].

These herbivorous mammals feed on nearly all plants that are available, including aquatic species and those growing on the shore. Most often, the animals forage within a distance of 20 m from the bank. The diet consists of more than 200 lakeside plants, as well as 100 tree species. In spring, summer and early fall beavers forage mainly on abundant herbaceous vegetation located near their ponds. Later during the year, their diet will shift to shrubs and deciduous trees. Beavers actually do not eat wood, but young shoots, twigs, leaves, bark, or phloem. They prefer aspen, willow, hazel, birch and other deciduous trees [Fabijański 2000, Stichmann and Kretzschmar 2006, Czech 2007, Fustec and Cormier 2007, Berthelsen 2012].

The fact that the European beaver is spreading in great numbers stirs controversy. Due to a destructive impact on the surrounding that beavers occupy, their presence has many opponents in the local community. Definitely, most anxious are farmers, who are forced to bear the loss resulting from beavers' activity, such as fruit tree-chewing or foraging on the crops. On the other hand, there are many people who support the case of beavers. The positive ecological influence of beavers' populations should be kept in mind. Biodiversity scientists and forest ecologists are those among beaver's supporters, since the rodent is their great ally in the natural habitat restiutution [Andersen and Rosemond 2007, Czarnecka 2010].

The aim of the present study was to show the impact of the European beaver (*Castor fiber*) on both the ecosystem and the economy based on the data on the size and type of beaver-caused damages in the Kuyavian-Pomeranian region of Poland.

MATERIAL AND METHODS

The study investigated into the number and type of damages caused by beavers in the Kuyavian-Pomeranian Voivodship, Poland, over the years 2005–2013. It is based on the data collected from surveys by the Regional Directorate of Environmental Protection in Bydgoszcz carried out during the same period. Data regarding damages came from the forest district offices in the Kuyavian-Pomeranian Voivodship. In order to determine the total number of beavers, we used a factor of 3.7 beavers per site.

The presence of beavers in a particular area, the place of occurrence, as well as the number and distribution of beaver sites were determined by direct field obse-

rvation. Beavers are very difficult to be watched in the wild, as they are extremely vigilant and skittish, and what is more, they lead a nocturnal life. Therefore, in practice, beavers are detected in the particular area by the signs they leave, namely the structures they build (dams, lodges, and burrows with their ventilation duct openings), or characteristic beaver feeding marks (girdled or felled trees).

In order to see the tendencies in the studied traits (i.e. damages) over the examined period of time, we calculated trends using linear regression according to the following formula [Zając 1988]:

$$y_t = a_t + b$$

where: a_t – slope of regression line, representing the annual rate of increment of the given trait, t – time expressed as consequitive years, b – initial level of the trait.

RESULTS AND DISCUSSION

Population status and distribution of beavers in Poland

After the Second World War, scarce populations of beavers remained in Poland and were found only on the rivers Pasłęka and Czarna Hańcza and its tributaries. However, in 1975 foresters and hunters succeeded in their efforts to implement the program entitled "Active protection of the European beaver in Poland". In order to support the natural expansion and migration of the species, the process aimed to systematically relocate individual beavers to new sites was started. Within two years from the commencenment of the program, beaver populations reached 1000 individuals living in 254 families. After that, about 1400 beavers from Masuria and the area of Suwałki were reintroduced in other places and new local populations occurred in the regions of Kujawy, Middle and Western Pomerania, Greater Poland, Lublin, Lower Silesian Forests, the Bieszczady Mountains, Subcarpatia and Mazovia. A survey conducted in 1982 perorted 1800 individuals living in a total of 456 families. Another survey carried out in 1994 revealed 1796 sites occupied by beavers. Based on this information, some authors estimated the national population of beaver at the level of 7400 individuals living on 2000 sites. In 1996–1997, 28 sites occupied by 112 beavers were found in the Wda Landscape Park alone [Tobolski 2003, Taras 2012].

Currently, beavers inhabit virtually all flowing and stagnant water bodies across Poland, approx. 54% of rivers, 29% of lakes, and 17% of drainage ditches [Janiszewski et al. 2009]. The only areas free of beavers are in the higher parts of the mountains. Poland's beaver population is currently estimated at a level of 25–60 thousand individuals. In the Tuchola Forest, the average density of the be-

aver population is approx. 1.13 indiv./100 ha [Janiszewski and Janiszewska 2006, Janiszewski et al. 2007 Janiszewski et al. 2009].

Based on data provided by the Regional Directorate for Environmental Protection in Bydgoszcz, a 12% increase in beaver population, i.e. from 3000 to 4800 beavers, was recorded in the Kuyavian-Pomeranian region in the years 2009–2010. According to some Internet sources, beaver population in the Suwalki region during this period was much larger, 6235 individuals living in 1685 families. It is associated with the presence of geat lakes in the area, i.e. Lake Śniardwy or Lake Nidzkie. The landscape of the Kuyavian-Pomeranian region is also rich in water bodies, although they are not as large as those in Masuria. The average density of beaver population in the Kuyavian-Pomeranian region is 3.06 individuals per km^2; for comparison, this ratio in the Pomeranian province is 4.3 individuals per km^2. The European beaver population in Poland is estimated at approx. 60 thousand individuals [Aszyk and Kistowski 2002, Taras 2012].

Beaver damages

One of the most characteristic signs of beaver presence in a particular area are the structures they build: dams, lodges, dens and channels to transport wood [Rurek 2009]. Active beaver habitats are also accompanied by felled trees and beaver girdles (Photos 1 and 2).

Phot. 1. A tree felled by bavers (phot. B. Durawa)

Fot. 1. Ścięte drzewo przez bobry (fot. B. Durawa)

Trees are brought down in order to reach the thinnest twigs, as well as to acquire building material. The diameter of felled trees ranges from a few centimeters to up to 1 meter. Beavers need usually one night to fell a tree of 10–20 cm in diameter. If the tree is thicker, beavers need several nights to chew it through and, for this purpose, they come back to the tree every night. The rate at which a tree can be felled depends not only on its diameter, but also on the species, position in relation to the bank, the motivation of the animal, and the conditions it has to work in [Rurek 2009].

Phot. 2. Characteristic beavers girdles (phot. B. Durawa)

Fot. 2. Charakterystyczne zgryzy bobrowe (fot. B. Durawa)

The bites are represented by 5–8 mm wide gouge-shape grooves cut in the wood (Photo 2). Tree girdles are accompanied by scattered wood chips, several centimeters in length. By the bites, an expert examiner can determine the age of the beaver that left the mark. An adult's bites are 8 mm wide, whereas younger beavers leave narrower bites [Czech 2010].

Data published by the Regional Directorate for Environmental Protection in Bydgoszcz show that in the period 2005–2013 the number of damages caused by beavers in the Kuyavian-Pomeranian region was 190; of these most were reported in 2010 (15% of all complaints) and 2011 (17%), while the fewest reports in 2005–2006 (3 and 4% of complaints, Chart 1). The amount of a compensation for the damages caused by beavers ranged from approx. PLN 8000 to PLN 15,000, depending on the year.

Beavers' engineering activity has a significant impact on the ecosystem and the economy. The most common alterations are land flooding due to the construction of dams. Beavers also clog culverts, girdle fruit and garden trees, and also

forage on crops (mainly corn, carrots and beets) on a field nearby [Czech 2010]. Forestry and hydrology also suffer severe damages, such as forest flooding, dyke damaging, tree felling, compromising levees by digging barrows in them, and clogging drainage ditches. Occasionally, beavers damage trees used for the forest management, for example poles of watch towers, or monumental trees [Czech 2010].

On 190 beaver reported damages, 80 were girdled trees, which accounted for 42% of all reported loss accounts. Damages in the form of grassland flooding accounted for 27% of cases (51 complaints), 20% of cases (38 complaints) were damages to crops on arable land, and 11% (or 20 complaints) were damaged of dykes and embankments of fish ponds (Chart 2).

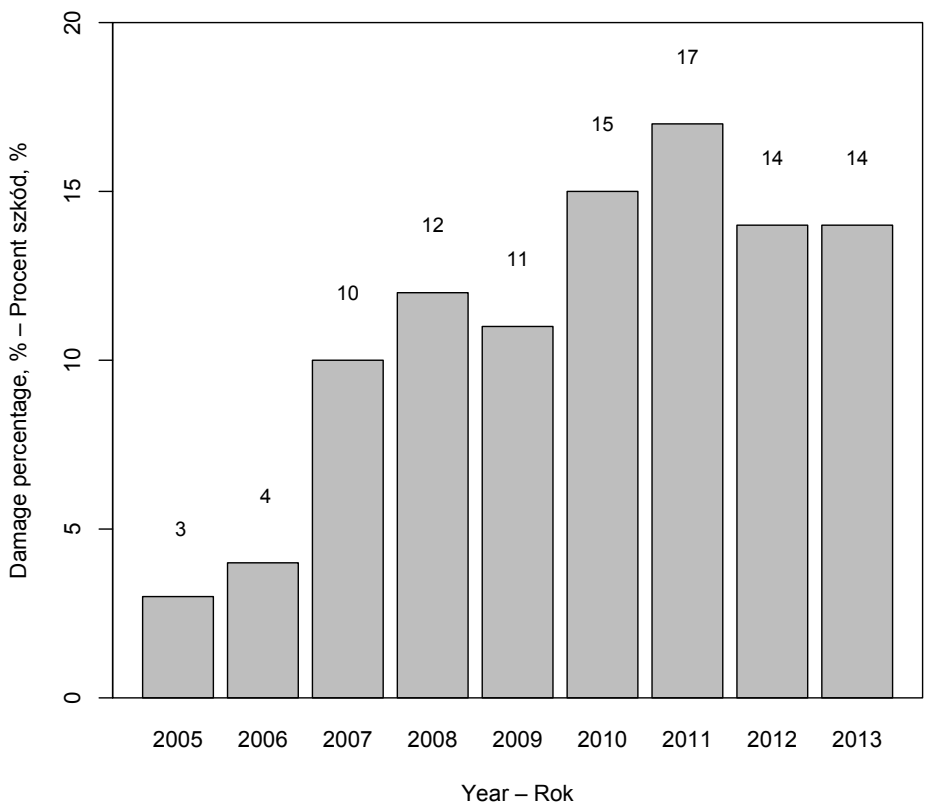

Chart 1. The percentage share of damages caused by beavers in the years 2005–2013 in the Kuyavian-Pomeranian Voivodship

Wykres 1. Procentowy udział wyrządzanych szkód przez bobry w latach 2005–2013 na terenie województwa kujawsko-pomorskiego

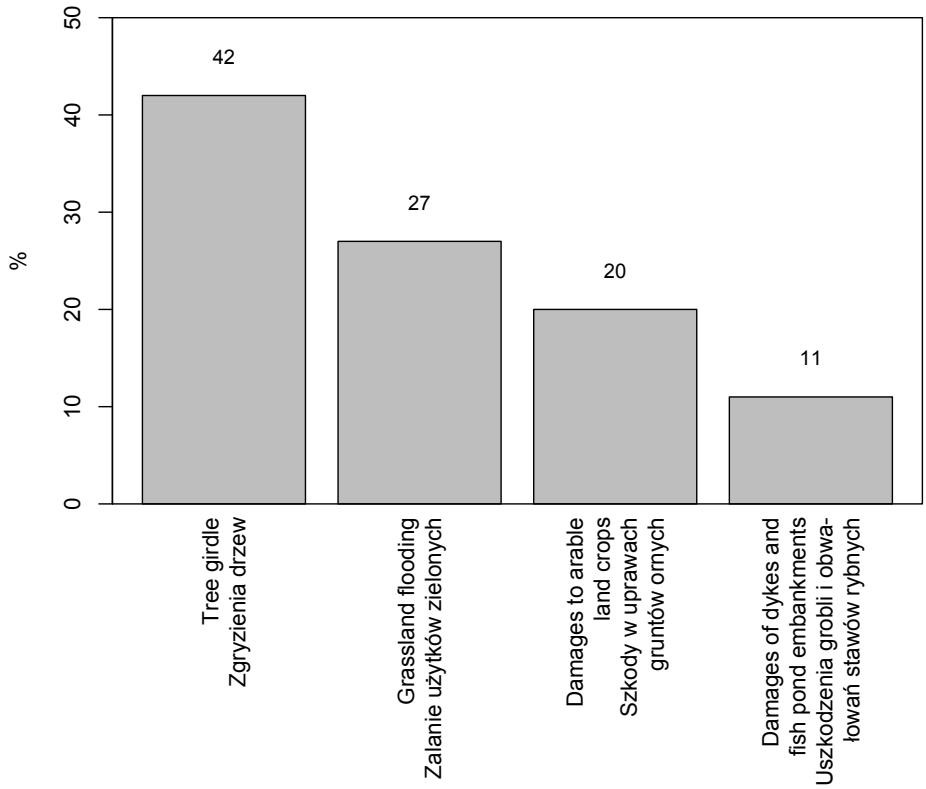

Chart 2. The percentage individual share of damages caused by European beavers in the Kuyavian-Pomeranian Voivodship

Wykres 2. Procentowy udział poszczególnych rodzajów szkód wyrządzonych przez bobry europejskie w województwie kujawsko-pomorskim

As shown in Chart 3, girdled trees in the forests of the Kuyavian-Pomeranian region represented 46–50% of damages inflicted over the years 2005–2009. From 2010 on, a marked decrease in the incidence of the damage can be noted. Grassland flooding most often occurred in 2007, 2008, and 2011 (respectively, the damages represented 32 and 31%). The highest number of beaver damages to arable land crops was recorded in 2010 (31%) and 2013 (30%), the lowest number in 2007 (5%). Damages of dykes and fish ponds embankments represented 7 to 17% of all damages caused by beavers (Chart 3).

Temporal trends for girdled trees and damages of dykes and fish ponds embankments by beavers were falling, which means that these damages decreased by approx. 2% and approx. 1% per year on average (Chart 3). In contrast, grassland

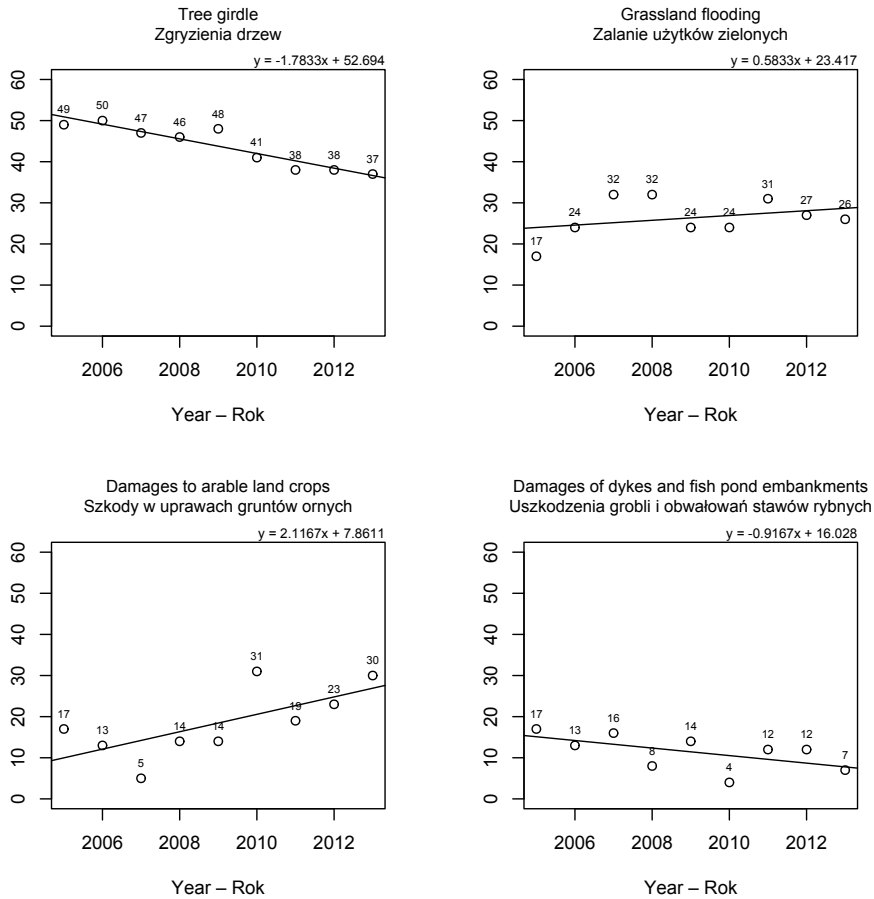

Chart 3. Trend lines in types of the damage caused by the European beaver in the years 2005–2013 in the Kuyavian-Pomeranian Voivodship

Wykres 3. Linia trendu rodzajów szkód wyrządzonych przez bobra europejskiego na przestrzeni lat 2005–2013 w województwie kujawsko-pomorskim

flooding showed an upward trend, approx. 0.6% per year. Similarly, flooding of arable land and meadows showed an upward trend, 2% a year on average (Chart 3).

According to information by the Forest Research Institute [Borowski 2011], the damages in the Kuyavian-Pomeranian region caused by girdles and felling of trees extended on an area of 301–400 ha, and the flooding of forests (although without filed complaints) covered 22–100 ha. The lack of complaints may be due to the fact that this area is not very large in relation to the damage caused by beavers across the country. An inventory by State Forests in Olsztyn in 2009 revealed that

flooded areas occupied 3116 ha of forests and 374 ha of grasslands [Borowski 2011].

In conclusion, one should also emphasize the positive effects that beavers bring to the ecosystem, which is mainly enhanced water retention and enriched biodiversity. Through their retention activity, beavers collect several million qubic meters of water in the form of marches across the entire country's area. Stabilization of groundwater reduces soil erosion and increases the deposition of mineral and organic matter. Due to physical and chemical changes to pollution, beaver ponds clean the dammed water like a kind of a natural "wastewater treatment plant". Mixing water with sirred sediments activates biochemical processes [Czech 2010]. Changing water chemical composition significantly affects the animals and plants living in the water bodies. New species of phyto- and zooplankton appear. Slowing down the water current has a positive effect on aquatic invertebrates, including stoneflies, mayflies and crustaceans, which provide food for fish. As a result of tree felling and elevated water level, the species composition of riparian vegetation changes as well. Shrubs begin to dominate [Czech 2007].

Beaver dams are the most characteristic result of their engineering activities. Dams impound water and in this way clean the flowing water. This leads to rehabilitation of the habitat where beavers live, the process by which the environment returns to its original, natural state. By digging channels and dens, beavers alter the shape and the character of the shoreline. Water that enters the channels slows down, becoming deep in some places and shallow in others. Branches and twigs of some trees, for example willow, which are discarded by beavers, take root and grow to form thickets which stabilize the bank. The waterside ecotone – the area between the water and compact vegetation – expands, which is of great importance for many species of birds; resulting islets and growing abundance of invertebrates and insects create good nesting conditions. Therefore it can be concluded that beavers not only increase retention of water and enhance biodiversity, but also alter the riparian morphology [Andersen and Rosemond 2007].

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WPŁYW BOBRA EUROPEJSKIEGO (*CASTOR FIBER*) NA ŚRODOWISKO NATURALNE I GOSPODARKĘ CZŁOWIEKA

Streszczenie. Celem pracy było przedstawienie wpływu bobra europejskiego (*Castor fiber*) na środowisko naturalne i gospodarkę człowieka na podstawie danych dotyczących wielkości i rodzajów szkód wyrządzonych przez te gryzonie w województwie kujawsko-pomorskim na przestrzeni lat 2005–2013. Populację bobrów na terenie województwa kujawsko-pomorskiego szacuje się obecnie na ok. 5 tys. osobników. Najczęściej wyrządzane szkody przez bobry to: zgryzienia drzew, zalanie użytków zielonych, szkody wyrządzone w uprawach na gruntach ornych, uszkodzenia grobli i obwałowań stawów rybnych.

Słowa kluczowe: bobry, groble, grunty orne, obwałowania stawów rybnych, szkody, użytki zielone, zgryzienia drzew

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