Assessing the efficiency of using passive hair traps as a method for non-invasive sampling from European beavers (Castor fiber L.)

Authors: Sobkowiak, Marta, Kochan, Joanna I., and Kruszyński, Wojciech

Source: Journal of Vertebrate Biology, 71(21053)

Published By: Institute of Vertebrate Biology, Czech Academy of Sciences

URL: https://doi.org/10.25225/jvb.21053

Journal of Vertebrate Biology

Open Access

J. Vertebr. Biol. 2022, 71: 21053

DOI: 10.25225/jvb.21053

RESEARCH PAPER

Assessing the efficiency of using passive hair traps as a method for non-invasive sampling from European beavers (*Castor fiber* L.)

Marta SOBKOWIAK, Joanna I. KOCHAN* and Wojciech KRUSZYŃSKI

Wrocław University of Environmental and Life Science, Department of Genetic, Wrocław, Poland;
e-mail: sobkowiak@poczta.onet.pl, joanna.kochan@upwr.edu.pl, wojciech.kruszynski@upwr.edu.pl

Received 13 July 2021; Accepted 6 September 2021; Published online 9 December 2021

Abstract. Using passive hair traps to obtain genetic material from wild mammals is an effective form of testing the abundance of animal populations. Based on genetic analysis of collected hair, it is possible to estimate the number and sex of individuals present in a given area. The aim of this study was to confirm the success of the method of collecting hair from beavers in a non-invasive way, as well as to determine the effectiveness of using passive hair traps as sampling tools that can be applied in different regions. The study was carried out in the area of Stobrawa Landscape Park (southwestern Poland) between December 2017 and May 2018. For 17 control days, 12 samples were obtained, which gave the result of 0.7 samples per control day. This study shows that the proposed method, due to its simplicity and efficiency, could be a cost-effective way of collecting hair from free-ranging beavers without the need for capturing individuals.

Key words: *Castor* sp., genetic monitoring, hair collecting, DNA

Introduction

Population size is one of the basic attributes of populations, but it is often difficult to estimate. Reliable population size estimation is essential for understanding the demography and conservation status of a population, especially if the species under investigation is rare or cryptic, or may be required in the context of pest control (Macdonald et al. 1998, Frantz et al. 2004).

The Eurasian beaver (*Castor fiber*), a keystone species, has been reintroduced over much of its former range following near-extinction. Evidence has repeatedly shown that beavers can provide important riparian biotic and abiotic ecosystem services. Their capacity to modify their environment can cause conflict, especially in intensively-used agricultural landscapes (Campbell-Palmer et al. 2016). Eurasian beavers originally inhabited rivers and lakes in most countries of Europe and North Asia until the Middle Ages. Due to excessive hunting, however, their populations have dramatically decreased (Nolet & Rosell 1998). Since the 1900s, when Eurasian beavers were nearly extinct, they have since shown recovery (up to ~ 1.5 million) throughout much of their former range as a result of protected natural recolonization along with active reintroductions (Halley et al. 2020). In Poland, beavers were formerly close to extinction, but currently their population is estimated at over 100,000 animals (Central Statistical Office 2016). The observed increase was triggered by the introduction of the Active Beaver Protection Plan (Żurowski

* *Corresponding Author*

1979). As a species, the beaver is protected by Polish and international law. Restoration of the beaver population was so effective that the species' status was changed from full to partial protection (Giżejewski & Goździewski 2016).

The recovery of the Eurasian beaver throughout western and central Europe is considered a major conservation success (Frosch 2014). In parts of Europe, beavers have returned to heavily-populated and intensively-managed river catchments, leading to human-beaver conflict and management issues. Beavers inhabit various habitats, which include agricultural and urban landscapes (Campbell-Palmer et al. 2016, Auster et al. 2019). Beavers live in family units, typically made up of an adult breeding pair with offspring from the current and previous years; such a unit ranges, on average, from two to seven individuals in total (Wilsson 1971). Due to the continued expansion of the beaver population (Batbold et al. 2016), places in which these animals exist should be constantly monitored, and the number of individual families should be systematically examined.

Most rodent species are difficult to observe due to their biological characteristics, strong anthropogenic pressure over time, and/or destruction of habitat. As a result, they inhabit remote areas, shift their activity to dusk or night hours, or live underground. Studying rare and elusive species inhabiting patchy environments is always a challenge for researchers. The data collected about their behaviour and activity is often indirect (mainly tracks and other signs of animal presence), and can be subjectively interpreted (Cutler & Swann 1999). Direct methods that relay on counts of the animals themselves (e.g. capture-mark-recapture, radio-tracking, spotlight, counts) are generally inadequate because of cost, staffing and permission requirements, are not readily applied to all habitats, and cannot easily be used by volunteers (Sadlier et al. 2004). Consequently, only limited areas can be surveyed with limited personnel. Therefore, the study of such animals using non-invasive genetic tools appears to be well-suited for this purpose.

The European beaver is an example of such a hard-to-access species. Finding beaver habitation is not difficult due to their visible and characteristic building activity. However, direct counting of individuals living in dens or lodges may be difficult, especially because of their secretive lifestyle and nocturnal activity.

Recently, glue or barbed-wire hair traps have been used to remotely pluck hair from terrestrial animals such as brown bears (*Ursus arctos*) (Woods et al. 1999), European badgers (*Meles meles*) (Frantz et al. 2004, Scheppers et al. 2007, Balestrieri et al. 2010), European wildcats (*Felis silvestris*) (Anile et al. 2012), martens (*Martes Americana*) (Mowat & Paetkau 2002) and Eurasian lynx (*Lynx lynx*) (Davoli et al. 2013), as well as from beavers and river otters (*Lontra canadensis*) (e.g. Depue & Ben-David 2007, Herr & Schley 2009). These findings showed that hair traps, when constructed according to the specific characteristics of the studied species, are an excellent alternative to invasive DNA sampling methods. According to studies on other species, DNA from a single guard hair may be sufficient to carry out genetic analyses, such as microsatellite-based genotyping (Scheppers et al. 2007). Moreover, DNA samples may be used as a material to determine species, sex and the genetic structure of the population, as well as the genealogy of specific individuals (Woods et al. 1999). Hair traps can also provide material required for stable isotope analysis (Magioli et al. 2018).

We were interested in learning whether the modified field methods presented by Herr & Schley (2009) were effective for beavers in Poland. We studied different passive hair trap constructions illustrated by Balestrieri et al. (2010) and Scheppers et al. (2007).

Hair traps used by Herr & Schley (2009) consisted of ordinary, two-stranded barbed wire with four-point barbs, with 15 cm between barbs, with the wire was attached to the stems of woody vegetation. Balestrieri et al. (2010) and Scheppers et al. (2007) constructed traps that consisted of two iron rods (5-6 mm in diameter and 70-80 cm long), supporting a single strand of barbed wire with four prongs per set of barbs and 10 cm spacing between barbs; these traps were placed about 20 cm above ground level.

In this study, we report the results of a trial of using passive hair traps as a tool for non-invasive and cost-effective hair sampling, for later genetic analysis of material obtained from European beavers coloniing the area of Stobrawa Landscape Park (southwestern Poland).

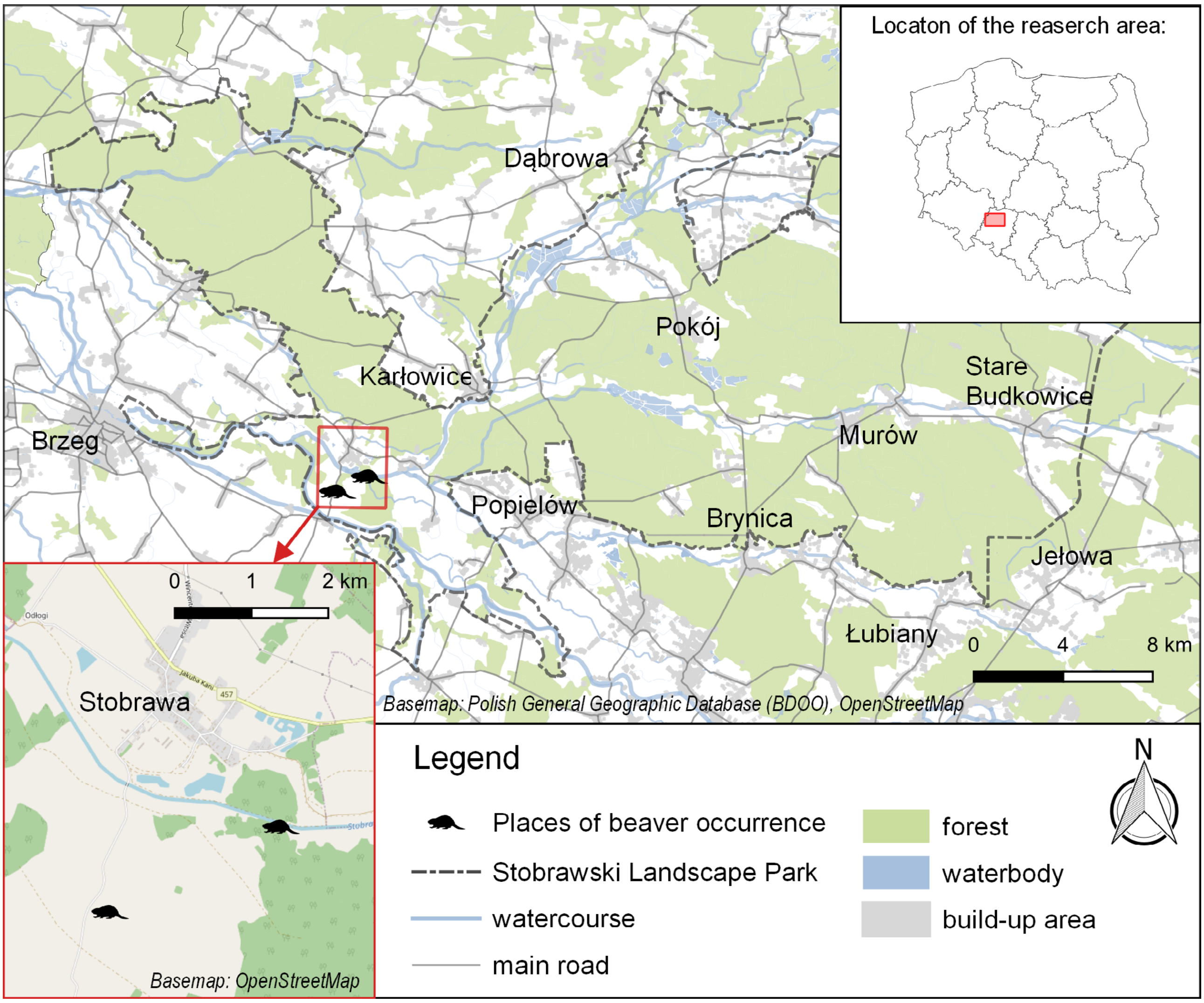

Fig. 1. A passive hair trap suspended on a wooden stem, near the River Stobrawa (photo Marta Sobkowiak).

Material and Methods

Study area

The study was carried out in the Stobrawa Landscape Park (SLP), located in southwestern Poland (50°51′ N, 17°44′ E) (Fig. 1). Between December 2017 and May 2018 (ten separate trips), we set up hair traps at two sites located near the village of Stobrawa, where beaver activity (lodges, dens, tree bites) were readily observable. SLP is the largest park in the Opole Voivodeship (527 km^2), known for its wealth of aquatic environments and a dense river network. It covers a large part of the Odra Valley with a complex of Stobrawsko-Turawskie forests. SLP is a typical lowland park, mainly with wetlands and pine monoculture (*Pinus sylvestris* L.) cover (forest cover up to 80%). Current vegetation within the study area has been shaped by human activity and is still subject to forest management. The region is inhabited by people, with the average population density reaching 20 people per km^2. The local climate is the mildest in all the Opole Voivodeship and in Poland at large. The mean annual temperature is 8.5 °C. The amplitude of mean temperatures from the hottest to the coldest months is approximately 19.5-20 °C. This is one of the lowest-altitude regions in the Opole Voivodeship. Mean annual precipitation is about 620 mm in the western and 680 mm in the eastern part. As much as 400-420 mm of the average annual rainfall falls during the warm period of April-September, while during the cool period (October-March) rainfall amounts to about 200-260 mm. Snow cover lasts for 50-60 days. The length of the vegetation season is the longest in Poland, lasting for about 240 days in the Odra Valley, and for 230 days in the eastern part of the area (Badora et al. 2003).

Field sampling

Traps were set at two beaver sites. The first site was on the bank of the River Stobrawa

(50°50′24.4″ N, 17°38′32.6″ E), and the second near a small pond adjacent to a cornfield (50°50′01.7″ N, 17°37′20.6″ E).

The traps were constructed using two-stranded barbed wire with a diameter of 1.7 mm, with groups of four barbs every 10 cm. The wire was cut to an appropriate length depending on where it was set. Two methods of attaching traps were used, depending on the situation. In the first the wire was attached to shrubs or trees at the trap site, as in Herr & Schley (2009). In the absence of suitable vegetation, another method was used; the wire was fixed to metal frames or stakes; as in Scheppers et al. (2007) and Balestrieri et al. (2010), 1-2 m from the water's edge. The trap was set about 20 cm above ground level, at such a height that only hairs were sampled. The barbed wire was sufficiently flexible so as to avoid scratching the animals (no signs of blood were observed during hair trapping) (Fig. 2). Thus, no beavers or other wildlife were harmed following the placement of the hair traps or in the process of collecting hair samples. In contrast to Herr & Schley (2009), we did not use bait to attract the animals. Beavers emerging from water onto the land, or returning to the water, passing under the trap, left a sample of fur containing both guard hair and undercoat (Fig. 3). The number of traps varied between individual trips (Table 1).

Fig. 2. Location of beaver occurrence in the Stobrawa Landscape Park (southwestern Poland) (photo Marta Sobkowiak).

Fig. 3. A beaver hair sample containing undercoat and guard hair (photo Marta Sobkowiak).

The first day of each trip was devoted to setting the traps, which were then checked during the following days. Traps were placed at the study areas for two days on each trip. Our research was not conducted on a continuous basis, but in the form of ten separate trips. A hair sample was defined as all the hair collected from a single barb, including both guard hairs and undercoat fur. Samples were placed in test tubes with ethyl alcohol, and stored at –20 °C.

Results

The research was conducted for 27 days and was divided into ten separate field trips. The total number of control days was 17, with the remaining ten days devoted to setting the traps on the first day of each trip.

The total number of samples obtained was 12 (Table 1), translating into a hair-trapping success of 0.7 samples per control day. Eleven samples were collected in the spring (from March to April), and one in the winter (from December to February). Seven fur samples were collected at the first site, and five samples at the second site. The majority of samples included both guard hair and undercoat; only one of them consisted only of undercoat, and one sample was a single guard hair. When only considering samples with guard hairs, trapping success was 0.65 samples per day (Table 1). All hair samples were collected using the modified hair traps presented by Herr & Schley (2009). Based on hair morphology, all collected hair samples were assigned to a target species (Pucek 1984).

Discussion

The results of this study demonstrated that obtaining hair samples from the European beaver in a non-invasive way is an effective method. As indicated by Anile et al. (2012), the effectiveness of hair traps depends on the studied species, duration of the

Table 1. The summary of hair trapping data collected at two sites in the Stobrawa Landscape Park (SLP), Poland.

Trip		Number of traps		Collected samples		
Ordinal number	Date	Site 1	Site 2	Total (n)	Site	Type
1	12/2017	3	5	1	2	guard hair and under-fur
2	01/2018	3	5	-	-	-
3	02/2018	3	5	-	-	-
4	03/2018	3	6	1	2	guard hair and under-fur
5	03/2018	3	7	1	1	guard hair and under-fur
6	03/2018	3	8	1	1	under-fur
7	03/2018	3	8	3	1 (2)*, 2	guard hair and under-fur
8	04/2018	3	8	2	1, 2	guard hair and under-fur
9	04/2018	3	8	2	1, 2	guard hair and under-fur
10	05/2018	3	8	1	1	single guard hair

* in brackets: a number of samples collected at a given site.

research, and the ecological characteristics of the studied area. Taking into account the conditions in which beavers live, the trap model made by Herr & Schley (2009) seems to be the most effective for this species. Metal rod based hair traps, constructed like those used by Balestrieri et al. (2010) and Scheppers et al. (2007), turned out to be ineffective. The ground near the river bank was too unstable for a trap with such a structure to remain intact. In a few cases, beavers passing under the trap pulled it from the ground. In addition, periodically rising water levels sometimes flooded the traps located near the river bank. Each overturned or sunken trap was repaired or replaced with a new one. In all of these situations, we were able to retrieve the hair traps.

The average number of samples taken was 0.7 per control day, a similar number to that obtained by Herr & Schley (2009) (0.87 samples per control day). In addition to setting hair traps, in the previous study researchers used bait in the form of cut, suspended apples. Many researchers showed that first hair samples appeared a few days after the trap had been set (e.g. Herr & Schley 2009, Magioli et al. 2018). In our research, the first hair samples were collected on the day after the traps were set.

In this study we show that the best time for hair sampling from beavers is early spring, since almost all samples were obtained in March and April. This finding confirmed the fact that these animals show the highest activity at times of herbaceous vegetation growth. No samples were collected during winter; this might have been a result of a decrease in activity by beavers in trapping sites. According to Dzięciołowski (1996), the average daily activity of beavers significantly decreases after water freezes. During this time, animals stay in their burrows and consume stored supplies, without the need to go ashore. In spring, almost all of the studied area, at both sites, was abundantly grown with herbaceous vegetation, of which the most dominant species was nettle (*Urtica dioica* L.).

Traps located in sites covered with nettles did not provide any samples, and hair samples were obtained from places that was not covered in vegetation, possibly indicating that beavers may express aversion to nettles.

Studies on rodent populations are often difficult to perform due to their nocturnal activity (Green et al. 2013). Direct observations at night are inefficient, and live-trapping is an expensive and time-consuming process (Alasaad et al. 2011). In addition, trapping affects animals negatively, being a strong stress stimulus (Moncrief et al. 2008). As demonstrated in our research, in the case of protected and endangered species such as beavers, passive acquisition of genetic material is a cheaper and effective alternative. In Poland, the legal provisions regarding species protection stipulate that beaver live-trapping is only allowed between October 1 and March 15. Therefore, the use of hair traps not only limits negative impacts on animals (Woods et al. 1999), but also creates the possibility to conduct research for a longer period than the legally-permitted capture of these animals.

Acknowledgements

We thank A. Frantz, T. Strzała for discussion and anonymous reviewers for helping to improve this paper. The authors are also grateful to Joanna Miodońska for help with field work. Author contributions: J. Kochan: conception of the work; data analysis and interpretation, critical revision of the article, final approval of the version to be published; M. Sobkowiak: data collection, data analysis and interpretation, drafting the article; W. Kruszyński: final approval of the version to be published.

Literature

Alasaad S., Soriguer R.C., Jowers M.J. et al. 2011: Applicability of mitochondrial DNA for the identification of Arvicolid species from faecal samples: a case study from the threatened Cabrera's vole. *Mol. Ecol. Resour. 11: 409–414.*

Anile S., Arrabito C., Mazzamuto M.V. et al. 2012: A non-invasive monitoring on European wildcat (*Felis silvestris silvestris* Schreber, 1777) in Sicily using hair trapping and camera trapping: does it work? *Hystrix 23: 45–50.*

Auster R.E., Puttock A. & Brazier R. 2019: Unravelling perceptions of Eurasian beaver reintroduction in Great Britain. *Area 52: 364–375.*

Badora K., Furmanek M., Hebda G. et al. 2003: Studies Stobrawa Landscape Park make for conservation. *BIO-PLAN, Krasiejów, Poland. (in Polish)*

Balestrieri A., Remonti L., Frantz A.C. et al. 2010: Efficacy of passive hair-traps for the genetic sampling of a low-density badger population. *Hystrix 21: 137–146.*

Batbold J., Batsaikhan N., Shar S. et al. 2016: *Castor fiber*. The IUCN Red List of Threatened Species 2016: e.T4007A115067136. Downloaded on 01 August 2021. *https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T4007A197499749.en*

Campbell-Palmer R., Gow D., Campbell R. et al. 2016: The Eurasian beaver handbook: ecology and management of *Castor fiber*. *Pelagic Publishing, Exeter, UK.*

Central Statistical Office 2016: Statistical information and elaborations. *Warsaw, Poland. https://stat.gov.pl/ (in Polish)*

Cutler T.L. & Swann D.E. 1999: Using remote photography in wildlife ecology: a review. *Wildl. Soc. Bull. 27: 571–581.*

Davoli F., Schmidt K., Kowalczyk R. & Randi E. 2013: Hair snaring and molecular genetic identification for reconstructing the spatial structure of Eurasian lynx populations. *Mamm. Biol. 78: 118–126.*

Depue J.E. & Ben-David M. 2007: Hair sampling techniques for river otters. *J. Wildl. Manag. 71: 671–674.*

Dzięciołowski R. 1996: Beaver. *SGGW Publishing House, Warsaw, Poland. (in Polish)*

Frantz A.C., Schaul M., Pope L.C. et al. 2004: Estimating population size by genotyping remotely plucked hair: the Eurasian badger. *J. Appl. Ecol. 41: 985–995.*

Frosch C., Kraus R.H.S., Angst C. et al. 2014: The genetic legacy of multiple beaver reintroductions in central Europe. *PLOS ONE 9: e97619.*

Giżejewski Z. & Goździewski J. 2016: Management of the European beaver *Castor fiber* population. In: Popczyk B. & Kniżewska W. (eds.), Animal population management. *Polish hunting association, Warsaw, Poland: 61–69. (in Polish)*

Green M., Ting T., Manjerovic M. & Mateus-Pinilla N. 2013: Noninvasive alternatives for DNA collection from threatened rodents. *Nat. Sci. 5: 15–25.*

Halley D., Rosell F. & Saveljev A. 2020: Population and distribution of *Castor fiber* and *Castor canadensis* in Eurasia. *Mamm. Rev. 51: 1–24.*

Herr J. & Schley L. 2009: Barbed wire hair traps as a tool for remotely collecting hair samples from beavers (*Castor* sp.). *Lutra 52: 123–127.*

Macdonald D.W., Mace G. & Rushton S.R. 1998: Proposals for a national mammal monitoring network. *Department of Environment, Transport and the Regions, London, UK.*

Magioli M., Abreu Bovo A.A., Alberici V. & Ferraz K. 2018: The use of hair traps as a complementary method in mammal ecology studies. *Mammalia 83: 144–149.*

Moncrief N.D., Van Den Bussche R.A., Dueser R.D. et al. 2008: Diagnostic genetic marker than differentiates Eastern fox squirrels from Eastern gray squirrels. *J. Wildl. Manag. 72: 320–323.*

Mowat G. & Paetkau D. 2002: Estimating marten *Martes americana* population size using hair capture and genetic tagging. *Wildl. Biol. 8: 201–209.*

Nolet B.A. & Rosell F. 1998. Comeback of the beaver *Castor fiber*: an overview of old and new conservation problems. *Biol. Conserv. 83: 165–173.*

Pucek Z. 1984: Keys to vertebrates of Poland: mammals. *Państwowe Wydawnictwo Naukowe, Warsaw, Poland. (in Polish)*

Sadlier L.M.J., Webbon Ch.C., Baker P.J. & Harris S. 2004: Methods of monitoring red foxes *Vulpes vulpes* and badgers *Meles meles*: are field signs the answer? *Mamm. Rev. 34: 75–98.*

Scheppers T.L.J., Frantz A.C., Schaul M. et al. 2007: Estimating social group size of Eurasian badgers *Meles meles* by genotyping remotely plucked single hairs. *Wildl. Biol. 13: 195–207.*

Wilsson L. 1971: Observations and experiments on the ethology of the European beaver (*Castor fiber* L.): a study in the development of phylogenetically adapted behaviour in a highly specialized mammal. *Stockholm University, Stockholm, Sweden.*

Woods J., Paetkau D., Lewis D. et al. 1999: Genetic tagging of free-ranging black and brown bears. *Wildl. Soc. Bull. 27: 616–627.*

Żurowski W. 1979: Preliminary results of European beaver reintroduction in the tributary streams of the Vistula River. *Acta Theriol. 24: 85–9.*