

Vilnius University  
Vytautas Magnus University

**5<sup>th</sup> International  
Beaver Symposium**

Dubingiai, Lithuania 20-23 September 2009

**PROGRAMME**

**ABSTRACTS**

**PARTICIPANTS**



Vytautas Magnus University  
Kaunas, 2009



Symposium was sponsored by the **Lithuanian State Science and Studies Foundation**

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# Programme of the 5<sup>th</sup> International Beaver Symposium

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## Sunday, 20 Sept.

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All the day Arrivals, accommodation

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17:00 – 22:00 Registration

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## Monday, 21 Sept.

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8:00 – 9:00 Registration

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9:00 – 9:15 Opening of the symposium

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### Session 1: **Beaver Biology**

Chaired by dr. Glynnis Hood and dr. Algimantas Paulauskas

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9:15 – 9:45 Plenary lecture 1:  
**Beaver fossils and functional morphology: Insights into the evolution of a habitat engineer**  
Rybczynski N.

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9:45 – 10:15 Plenary lecture 2:  
**Phylogeny of Tertiary beavers**  
Stefen C.

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10:15 – 10:30 **The effects of high ungulate densities on foraging choices by beaver (*Castor canadensis*) in the mixed-wood boreal forest**  
Hood G. A., Bayley S. E.

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10:30 – 10:45 **Does monogamy influence the male reproductive system of the European beaver? Hypothesis and facts**  
Bierła J. B., Giżejowski Z.

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10:45 – 11:00 **Beavers like it mild and dry: multi-scale effects of weather on a temperate sedentary herbivore**  
Campbell R. D., Rosell F., Macdonald D. W.

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11:00 – 11:15 **Winter temperatures are influencing beaver's territory size**  
Maloň J., Vorel A., Válková L., Hamšíková L., Korbelová J.

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11:15 – 11:45 Coffee break

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11:45 – 12:00 **A novel method to identify beaver behaviour**  
Graf P., Rosell F., Wilson R.

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12:00 – 12:15 **Determining beaver territories on the basis of stand mark analysis and radio-tracking**  
Vorel A., Korbelová J., Korbel J., Hamšíková L., Maloň J., Válková L.

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12:15 – 12:30	<b>Genetic study of beaver</b> Paulauskas A.
12:30 – 12:45	<b>DNA from thousands of years ago: insights into the genetic history of the Eurasian beaver (<i>Castor fiber</i>)</b> Horn S., Benecke N., Hufthammer A.K., Schouwenburg Ch., Toskan B., Hofreiter M.
12:45 – 13:00	<b>Genetic relationship and diversity in Lithuanian subpopulations of European beaver (<i>Castor fiber</i>) based on RAPD markers</b> Puraite I., Paulauskas A., Ulevičius A.
13:00 – 13:15	<b>Helminthes parasitizing Eurasian beaver (<i>Castor fiber</i>) in Lithuania and their population regulation</b> Mažeika V.
13:15 – 14:30	<b>Lunch</b>
<b>Session 2: Beaver Populations</b> Chaired by dr. Peter Busher and dr. Piotr Danilov	
14:30 – 15:15	Plenary lecture: <b>Beaver population dynamics: what we can learn from Darwin and the elephants</b> Busher P. E.
15:15 – 15:30	<b>Distribution and population of <i>Castor fiber albicus</i></b> Heidecke D., Schumacher A., Teubner Jana, Teubner Jens
15:30 – 15:45	<b>Beaver distribution in Romania after 10 years of reintroduction</b> Ionescu G., Ramon J., Ionescu O., Popa M., Sarbu G., Visan D., Pasca C., Scurtu M., Popescu I., Boronia V.
15:45 – 16:00	Coffee break
16:00 – 16:15	<b>Long-term dynamics of re-introduced population of European beaver Central-Forest reserves' area</b> Korablev N., Zheltukhin A., Zavyalov N., Puzachenko Yu.
16:15 – 16:30	<b>Swiss wide census of beaver (<i>Castor fiber</i> L.) population in Switzerland and its management implications</b> Angst C.
16:30 – 16:45	<b>Causes of death among beavers in the European North of Russia</b> Danilov P. I.
16:45 – 17:30	Discussions, poster installation

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**Tuesday, 22 Sept.**

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**Session 3: Beavers and Ecosystems**

Chaired by dr. Vadim Sidorovich and dr. Alius Ulevičius

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9:00 – 9:45	<b>Plenary lecture: Beaver impacts on ecosystems and landscapes: benefits and losses</b> Ulevičius A.
9:45 – 10:00	<b>The changes of riparian ecosystems in Karelia under beaver activities impact</b> Fyodorov F. V.
10:00 – 10:15	<b>Horizontal distribution of zooplankton in parts of small rivers regulated by beavers</b> Krylov A.V., Chalova I.V.
10:15 – 10:30	<b>The main changes in water quality of a small river under effect of beaver activities</b> Tselmovich O.
10:30 – 11:00	Coffee break
11:00 – 11:15	<b>Influence of construction activity of beavers (<i>Castor fiber</i>) on the species diversity and ecology of riparian vertebrate predators in Belarus: review of results and pressing questions</b> Sidorovich V.
11:15 – 11:30	<b>Beaver meadow formation theory: moving beyond the pond</b> Westbrook Ch.
11:30 – 11:45	<b>Beaver-human interactions in the past</b> Coles B.
11:45 – 12:00	<b>The assessment of beaver inundation effect on drained coniferous forest stands in Mālpils forestry</b> Gackis M.
12:00 – 12:15	<b>Parasitological research on small mammals dwelling in beaver sites</b> Butautytė G., Samas A., Ulevičius A.
12:15 – 13:45	<b>Lunch</b>

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### Session 4: **Beaver Management**

Chaired by dr. Alexander Saveljev and dr. Marijan Grubešić

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13:45 – 14:30	<b>Plenary lecture: The European beaver on trial in Scotland: The case so far</b> Gaywood M. J., Batty D.
14:30 – 14:45	<b>The Scottish Beaver Trial</b> Jones S., Bantick A.
14:45 – 15:00	<b>Evaluation of beaver management in Bavaria</b> Türschmann J., Zeitler E., Zahner V.
15:00 – 15:15	<b>Solutions to beaver-human conflicts that are long-lasting, reliable, and preserve precious wetlands: an update of successful flow device techniques in North America and Europe</b> Lisle S., Czech A.
15:15 – 15:45	Coffee break
15:45 – 16:00	<b>Non-lethal methods of beaver impact management: a review</b> Halley D.J.
16:00 – 16:15	<b>The effect of regulating stream flows on the beaver habitat in Croatia</b> Grubešić M., Margaletić J., Tomljanović K., Vucelja M.
16:15 – 16:30	<b>Beaver in open drains: consequences and behaviour reacting to restriction of their activity</b> Lamsodis R.
16:30 – 16:45	<b>European beaver (<i>Castor fiber</i> L.) distribution in the mixed spruce-deciduous forests and control of the local population</b> Belova O.
16:45 – 16:55	Discussions
16:55 – 17:00	Short break
17:00 – 18:00	<b>Poster session</b>
19:00	<b>Evening social &amp; Awards</b>
<b>Wednesday, 23 Sept.</b>	
9:00 – 10:00	Lost presentations, closing remarks and invitation to the 6 <sup>th</sup> IBS in 2012
10:00 – 15:00	Excursion
	Relaxing, saying good bye, departure, etc.

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## List of the poster presentations

1	<b>The chronology of the return of the beavers to Baden-Württemberg</b> Allgöwer R.	Beaver population dynamics
2	<b>The populations of beavers (<i>Castor fiber</i> L.) in Dnepropetrovsk region (Ukraine)</b> Antonets N. V.	Beaver population dynamics
3	<b>The influence of beaver building activity on reproduction success of amphibians</b> Bashinskiy I. V., Zavyalov N. A., Dgebuadze Yu. Yu.	Beaver impacts on ecosystems
4	<b>Winter diet and selective foraging of European Beaver (<i>Castor fiber</i> L. 1758) in Serbia</b> Ćirović, D. Bandura, S.	Beaver biology
5	<b>The influence of beaver on fish assemblages of small river in Rdeysky State Nature Reserve (Russia)</b> Dgebuadze Yu. Yu., Skomorokhov M. O., Zavyalov N. A.	Beaver impacts on ecosystems
6	<b>20 years of beavers (<i>Castor fiber</i>) in the Netherlands</b> Dijkstra V.	Beaver population dynamics
7	<b>Monitoring the Scottish Beaver Trial</b> Gaywood M. J., Batty D.	Beaver management
8	<b>Some features of beavers territorial behaviour after reintroduction</b> Gorshkov D.	Beaver biology
9	<b>The density of beaver families in the stream flows of central Croatia</b> Grubešić M., Margaletić J., Tomljanović K., Vucelja M.	Beaver population dynamics
10	<b>Population and distribution of Eurasian beavers. Declaring victory and moving on</b> Halley D. J., Rosell F.	Beaver population dynamics
11	<b>Age structure determination on European beaver (<i>Castor fiber</i> L.)</b> Hamšíková L., Vorel A., Válková L., Korbelová J., Maloň J., Korbel J.	Beaver biology
12	<b>Barbed wire hair traps as a tool for remotely collecting hair samples from beavers</b> Herr J., Schley L.	Beaver biology
13	<b>Characteristic of abandoned beaver meadows vegetation in the natural stream valleys</b> Ingelevič I.	Beaver impacts on ecosystems

14	<b>Dynamics of the beaver meadows development in Kaluga Region, Russia</b> Korol'kova C.O.	Beaver impacts on ecosystems
15	<b>Geomorphological effects of beaver activity in open drains</b> Lamsodis R., Ulevičius A.	Beaver impacts on ecosystems
16	<b>Isolation and identification of plant phytohormones cytokinins in beaver's blood</b> Maloň J., Válková L., Novák O., Amakorová P., Svačinová J., Doležal K.	Beaver biology
17	<b>Adapted behaviour of Elbe-Beavers (<i>Castor fiber albicus</i>) at low water levels in flood plain areas of the rivers Elbe and Mulde near Dessau, Saxony-Anhalt, Germany</b> Nitsche K.-A.	Beaver biology
18	<b>Beaver (<i>Castor fiber</i>) impact on fish of the small rivers of zapovednik "Privolzhskaya lesostep"</b> Osipov V.	Beaver impacts on ecosystems
19	<b>Implementing Beaver Management in Lower Austria - first results and further steps</b> Parz-Gollner R., Hölzler G.	Beaver management
20	<b>Small mammal community structure and demographic parameters of their populations in beaver sites</b> Samas A., Ulevičius A.	Beaver impacts on ecosystems
21	<b>Some problems in beaver resource management in Russia in an economic crisis</b> Saveljev A. P.	Beaver management
22	<b>Beavers and forestry - An Austrian case study from the Danube floodplain area</b> Scheikl S.	Beaver management
23	<b>Distribution of beavers in Luxembourg</b> Schley L., Herr J.	Beaver population dynamics
24	<b>Evidence for the presence of the North American beaver <i>Castor canadensis</i> in Western Europe</b> Schley L., Herr J., Dalbeck L., Denné R., Manet B., Schwoerer M.-L., Venske S., Michaux J.	Beaver management
25	<b>The return of the beavers to the Danube Watershed</b> Schwab G.	Beaver management
26	<b>Autumn activity and food caching behavior of the North American Beaver, <i>Castor canadensis</i> in Western Massachusettes, USA</b> Sollars E., Busher P. E.	Beaver biology

27	<b>Can Eurasian beavers (<i>Castor fiber</i>) discriminate between anal gland secretion of a simulated intruding male territory owner and his old or young son?</b> Tinnesand H. V., Jojola S. M., Rosell F.	Beaver biology
28	<b>Settlement of a beaver (<i>Castor fiber</i> L.) in a steppe zone of the east of Ukraine</b> Tokarskaya N. V.	Beaver biology
29	<b>North-East Ukrainian settlements of European beavers (<i>Castor fiber</i> L.)</b> Tokarsky V. A.	Beaver biology
30	<b>The beaver – a keystone species for water management?</b> Törnblom J., Henrikson L., Angelstam P., Sjöberg G., Hartman G.	Beaver management
31	<b>Simplification of wintering food niche of beavers in Central Europe</b> Vorel A., Válková L., Hamšíková L., Korbelová J., Maloň J.	Beaver biology
32	<b>The some new data about beavers (<i>Castor fiber</i>) in Polisto-Lovat' bog system (Northwest Russia)</b> Zavyalov N., Letsko I.	Beaver population dynamics
33	<b>The beavers of the Tyudma River (Central Forest State Biosphere Reserve, Russia): from a reintroduction to a climax population</b> Zavyalov N., Zheltukhin A., Korablev N.	Beaver population dynamics

# ABSTRACTS

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**Note:** English language of the abstracts is under the responsibility of authors

# SWISS WIDE CENSUS OF BEAVER (*CASTOR FIBER* L.) POPULATION IN SWITZERLAND AND ITS MANAGEMENT IMPLICATIONS

CHRISTOF ANGST

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The beaver *Castor fiber* has been completely eradicated in Switzerland in the early 19<sup>th</sup> century. Between 1956 and 1977, about 141 beavers have been reintroduced in over 33 different places all over Switzerland. These actions have absolutely not been coordinated. This is one of the reasons why the re-establishment of the Swiss beaver population had a lot of troubles in the beginning. A first census in 1978 revealed only 132 beavers, less than there were released. In 1993 a second one estimated some 350 individuals. There were several small, fragmented sub-populations that have colonized most of the natural riverbeds and specialists worried about the future of the beaver, if these sub-populations couldn't be connected. After that, everything went very quickly: observations from all over the Swiss plateau occurred and complaints about beaver damage increased, and with that, demands for beaver regulation. Therefore in 2006 the Federal Office for the Environment mandated the *Biberfachstelle* to organize a Swiss wide census.

We formed about 250 people – volunteers, game wardens and biologists – in a tree day course so everybody was applying the same method which should allow in the end to delimit the territories and to distinguish between solitary/couples and family territories. Between November 2007 and April 2008, 6'400 km of potential beaver watercourses have been searched for beaver signs which have been drawn direct on maps 1:10'000 A4. After that, all the 16'000 signs have been digitized directly in a GIS and each sign has been attributed to a beaver territory.

Today, some 1'600 beavers in 470 territories settle the main rivers of the Swiss plateau. The different sub-populations are now connected via the main rivers and beavers are recently colonizing the smaller feeder rivers and drainage canals.

There, the beavers are returning in a highly used agricultural landscape, that has totally been altered in the past 200 years: drained surfaces and rectified and squeezed riverbeds by diverse infrastructures. No wonder, beaver activity is colliding with human claims: flooded fields by dam building or collapsed country roads by burrows beneath.

But these are only the symptoms of a structural problem of our water bodies: they have too little space. Swiss authorities demand some 50 km<sup>2</sup> of space, so that the rivers can play their ecological role and help to decrease high-water discharge in the future. Water management is demanding buffers of 5-10 m, depending on the river size.

And this is exactly the range where beavers are mainly active and where conflicts arise. If we are willing to leave this space to the river bodies, this would be a very cost effective solution and a profit for everybody: we would have a more attractive landscape, a habitat network via the water bodies, a better prevention of water pollution and flood control.

If we want to face challenges of our water bodies we have to give them more space. If we try to see the beaver as a partner in conservation issues, he can help us to

revitalize our water bodies and to contribute to biodiversity and to more attractive rivers for free. At the same time buffers help to avoid conflicts with beavers before they occur which helps to maintain its acceptance.

## THE POPULATIONS OF BEAVER (*CASTOR FIBER* L.) IN DNEPROPETROVSK REGION (UKRAINE)

NADEZHDA V. ANTONETS

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At present, beaver (*Castor fiber* L.) – is a rare aboriginal species in the flood land complexes of Dnepro river (Антонец, 1998; 1998а; Антонец, 2000; 2001) and its tributaries (Антонец, Водяной, 1999; Антонец, 2003; Антонец, Водяний, 2006). Behind the Dnepro – in the Orel's Natural Reserve beavers inhabit flood lands of Domotkan River (right tributary of Dnepro River, Zareshe Verhnedneprovski region of Dnepropetrovsk) (Антонец, Водяной, 1999). This place is inhabited by two families of beavers – nearly 10 individuals. There can be created a complex preserve "Domotkan" which overwhelms approximately 200 hectare area covered by flooded forest-meadows. Moreover colonies of beavers exit in the flooded meadows from river to village Акумовка. Beavers on right bank of Dnepro river (Dyevskie flood lands) where inhabit two families (5 individuals) exist from 2005. Beavers also inhabit left bank of Dnepro River, near the boat aquatic centre "Zozulay" in Samarsky region of Dnepropetrovsk, which exist from 2000, too. In this case, it is recommended to create 250 hectare complex preserve near the distance river Orel (old river-bed) at Dneprodzerghynsk aqua storehouse Petrykovsky region because a territory is inhabited by 5 individuals (Черорка, Манюк и др., 2000). In this colonies inhabit several families of beavers (nearly 30 individuals). In 70<sup>th</sup> of XX century forest guard from Shulgovsky forestry Petrykovsky forest economy, I. A. Poleno carried out 6 beavers (4 female and 2 male) in flood lake Orel's river - "Shtanthtsy" and "Doroshova niva" from Vorskla river Poltava region. This colony of beavers was disposed from territory which was provided for creation of National Natural Park "Orel'sky". Beavers were discovered in the Upper Dneprodzerghynsk aqua storehouse on the islands at the right bank of Dnepro River near the village Ortshik. Here inhabit colony of 20 individuals. Absolute number of *Castor fiber* in the Dnepro-Orel's Natural Reserve (left bank flood lands of Dnepro River) was same from 1991 to 2008, but later increased from 5 to 30 individuals.

In Dnepropetrovsk region from Dnepro river and its tributaries inhabits southern marginal population of *Castor fiber*, which consists from 6 isolated colonies with common number of 100 individuals: there colonies higher dam Dneprodzerghynsk electric power station in reservoir Dneprodzerghynsk aqua storehouse (at the islands from right bank of Dnepro river near by village Ortshik), flood lands complex of Domotkan river and flood lakes distance river Orel) and some more there lower dam Dneprodzerghynsk electric power station – in reservoir Zaporozhky aqua storehouse (flood complex Dnepro-Orel's Natural Reserve with islands, Dyevskie flood lands from right and left banks of Dnepro river by boat aquatic centre "Zozulay").

# THE INFLUENCE OF BEAVER BUILDING ACTIVITY ON REPRODUCTION SUCCESS OF AMPHIBIANS

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The purpose of our study was to research influence of building activity of beavers on reproduction of amphibians in small rivers. The study was carried out in 2006-2008, nearby the State Nature Reserve Rdeysky (Novgorod province, NW Russia), in valleys of the small rivers Gorelka and Kopeynitsa. 33 sampling sites have been established. Each sites represented a 50-m long segment of a river valley. All sampling sites have been divided into three types: without beaver activity, flooded beaver ponds and drained (abandoned) beaver ponds.

The reproduction for two species of amphibians: *Rana arvalis* and *Rana temporaria* has been registered in sites without beaver activity Spawning grounds were in large floodplain objects and shallow pools. In flooded beaver ponds, the reproduction has been registered for three species – *R. arvalis*, *R. temporaria* and *Bufo bufo*. Annual use of flooded beaver ponds for mass reproduction of amphibians has been caused by a stable water level, and complex morphological structure which provided a variety of habitats for amphibians. Spawning is located in the central parts of ponds (flooded meadows or floating vegetation). In drained beaver ponds the reproduction has been registered for three species – *R. arvalis*, *R. temporaria* and *B. bufo*. Annual use of drained beaver ponds for mass reproduction has been caused by the large variety of habitats, and probably by intense lighting (in years with cold spring).

The largest number of tadpoles was observed in drained beaver ponds in both rivers and in flooded beaver ponds in the Kopeynitsa River. The largest number of young-of-year was produced by the flooded beaver ponds. On sites without beaver activity number of young of the year was low. In drained beaver ponds number of young of the year was some more than on sites without beavers. This occurrence is connected with drying of floodplain water-bodies in May-June.

Thus, the best conditions for metamorphosis of amphibian larvae were in flooded beaver ponds. The stable high water level which is supported by beaver activity, allows tadpoles to complete of metamorphosis. Sites without beaver activity and drained beaver ponds are not favorable habitats for a metamorphosis because the majority of floodplain water-bodies dries up since the end of June up to the beginning of July.

# EUROPEAN BEAVER (*CASTOR FIBER* L.) DISTRIBUTION IN THE MIXED SPRUCE-DECIDUOUS FORESTS AND CONTROL OF THE LOCAL POPULATION

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It is notorious that the real herbivore and economically and socially important hunting object, Beaver, *Castor fiber* L. is an indispensable part of forest biota and acts on the forest significantly. The study has been conducted at the end of the vegetative and beginning of non-vegetative period in the mixed spruce-deciduous forests in the north-western Lithuania. I aimed to obtain the data for the assessment of the beaver distribution and their impact to the forest ecosystem. The census of beaver sites has been done making the round of the hydrographical network including drainage channels and other water bodies in the forest and outer wood. Animal activity has been analysed depending on the environmental factors. The transect unit is 400 x 50m. The study forests *Picetum-Betuletum* grow mostly in the *Albeluvisols* (41% of the total forest land) soils. The investigated network of sample plots comprised 58 assessed beaver sites including 7 abandoned sites, and the total study territory was 7,063 ha.

The most beaver sites have located in the drainage channels in the ecotones between forests stands and open areas while there is the increase in the beaver site number within the stands. The analysis of beaver intra-population structure helps us to follow and foresee changes in the local population. The increase in the number of single animals and pairs is the indicator of potential formation of the new sites and families. The increase in family number indicates favourable living conditions given the average three-year term of a generation. The number of young beavers is a significant factor of the population distribution on the certain territory. They are the most vulnerable while they find the favourable territory. Because of the human influence including disturbance factor, permanent destroying of dams, beavers retired from family territories into the new habitats where continued their construction and foraging activity. The main six woody species of the beaver diet are in the list of species that are important for biodiversity conservation. The important abiotic factors as the thermal factor and soil freezing are not limiting in the last period. The local population should be controlled by hunting and trapping while the eliminated norm of beavers is 15-20%. The recommendations of the control and management of the local population are prepared for use.

# DOES MONOGAMY INFLUENCE THE MALE REPRODUCTIVE SYSTEM OF THE EUROPEAN BEAVER? HYPOTHESIS AND FACTS

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It was previously described, that European beaver exhibit genetic and social monogamy. Their reproductive success is subordinated from male care in a few reasons: it is critical for female reproduction (potentially only one kid without biparental care); the female aggression against additional mating; dispersion of females on isolated territories makes impossible mating with more than one female. Morphological investigations of birds, frogs and murine rodent's shows that type of mating system has influence on relationships between body mass and testes mass. Besides those monogamous murine rodents show relatively smaller tails of sperm, unusual fast transit along cauda of epididymidis and remarkable degree of pleiomorphism of sperm heads. Any casual association between these reproductive parameters and breeding system of European beaver have not been yet described.

The testes and reproductive tracts of nine randomly selected, adult, free-living males captured during the breeding season were evaluated. The testes, epididymis, vas deference (with ampulle) were measured. Testes with epididymidis were fixed in Bouin solution for routine histological preparation. Seminal fluids from cauda epididymis and ampulla were taken. For morphological evaluation 200 randomly selected sperm were examined from each beaver. The measurements of 100 sperm/animal were determined on air dried smears of samples from ampulla of vas deference, stained with Williams method, using computer program AnalySIS (Olympus) and statistically analysed by SPSS program.

Our investigation shows that beaver have typical for monogamous rodents low ratio testis mass in body mass – 0.1%. Characteristic feature for seminal fluids was the low volume of them in cauda epididymis. Total volume of both ampullae of ductus amounted from 0.62 to 3.00 ml. The considerable variations in heads' morphology were observed; the highest influence on sperm head shape had unusually long, rolled acrosom. Moreover, the measurements of sperm showed the high variability in size of sperm tails and midpiece: 31.53 – 47.74  $\mu\text{m}$  (mean 40.45) length principal and end part of piece of a tail; 7.99 – 15.34  $\mu\text{m}$  (mean 10.71) length of midpiece. We distinguished 27 categories of sperm morphology, among them 12 categorized as normal. The obtained results seem to confirm the hypothesis that the low level of intermale sperm competition, which is a consequence of monogamous mating system, has influence on male of European beaver.

# BEAVER POPULATION DYNAMICS: WHAT WE CAN LEARN FROM DARWIN AND THE ELEPHANTS

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Understanding how populations grow, stabilize and decline is key to understanding many other aspects of the biology of wildlife species. Knowledge of population patterns is especially important for species that utilize resources critical to human populations. Both species of beavers (*Castor fiber* and *C. canadensis*) utilize and manipulate wetland habitats, which often brings them into conflict with humans. Beaver population dynamics (both species) have been the subject of numerous short-term and long-term investigations during the past 50 – 60 years. This paper discusses the general patterns of beaver population growth using as a model Darwin's description of elephant population growth from his 1859 publication, *On the Origin of Species*. Since 2009 is Darwin's bicentennial and also the sesquicentennial of the publication of, *On the Origin of Species*, it seems appropriate to begin with Darwin's observations regarding populations. Elephants are the largest land mammals, are long-lived and have few natural predators (at least as adults). Beavers, in a population sense, can be regarded as "mini elephants" since they are also relatively large (for rodents), long-lived and have few predators (other than humans) in most natural situations. Darwin's analysis of elephant population dynamics suggests the way we should view beaver population dynamics.

In this paper I present data from a number of beaver populations in North America that illustrate the general pattern of beaver population dynamics. It is critical to note that long-term investigations are key since any short-term study does not allow a full understanding of the natural pattern of change in beaver populations. The general long-term pattern is one of slow initial growth, exponential growth (traditional "J" shaped curve), decline and stabilization around a carrying capacity (a modified logistic growth curve). Factors influencing beaver population dynamics are natality (including mortality factors influencing the kits), two-year-old dispersion, and landscape factors that encourage dispersers to find and utilize suitable habitat. The pattern observed in the metapopulation on the Prescott Peninsula, Quabbin Reservation, in western Massachusetts, USA, serves as a model for understanding changes in larger populations. Additionally, life table analysis from three North American studies suggests a Type II survivorship curve, which should be considered when analyzing beaver populations.

The natural patterns of change in many animal populations (especially long-lived species) are only visible over time frames determined by the life history of the species. This is especially true for beavers. The compounding factors in beaver-human relations are understanding how a beaver population will change over an appropriate long-term time frame, and for humans to be able to develop a reconciliation approach to living with this critical species in the wetland habitats vital to both beavers and humans.

# BEAVERS LIKE IT MILD AND DRY: MULTI-SCALE EFFECTS OF WEATHER ON A TEMPERATE SEDENTARY HERBIVORE

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1. Understanding the impact of weather on vertebrate populations will inform management of the consequences of anticipated climate change, but there are few studies of weather on non-ungulate herbivores. We examined the effects of weather variation on body mass and reproduction in the Eurasian beaver *Castor fiber* in southern Norway from 1998-2008.
2. As predicted, cold winters were related to lower body-mass in both yearlings and two-year olds.
3. Also as predicted, higher spring temperatures resulted in a more rapid spring green up and reduced body-mass in adults but not in other age-classes.
4. The effect of rainfall was wide-ranging and ran contrary to predictions: Rainfall over spring and summer was inversely related to the body mass of adults, yearlings and newborns. Similarly, rainfall during the summer and autumn had a negative influence on the number of young seen in the following year.
5. Body masses of individuals were related to their body mass when younger and therefore factors affecting their early development may have long-term consequences.
6. The effect of rainfall was not due to beavers avoiding higher predation risk or higher energetic costs in wet weather since they did not change the time invested in foraging or in sheltering on wet nights.
7. We found that the growth of 68 grey alder *Alnus incana* trees, the main food of the beavers in the study area, was affected differently by rainfall depending on the tree's proximity to water. Trees growing <0.5m above water showed reduced growth while trees 0.5m above water showed increased growth in wet years.
8. Thus temperature influences beavers directly and also indirectly at the landscape scale through its influence on spring phenology. In contrast, rainfall may influence beavers at smaller spatial scales through its effects on plant growth on low ground.
9. Unlike other herbivores, beavers are tied to living near water and are therefore less able to take advantage of better growth further from water in wet years.
10. We suggest that accounting for topographic variation in other herbivore studies will improve understanding of the interaction between weather and topography.

# BEAVER - HUMANS INTERACTIONS IN THE PAST

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Working as an archaeologist in wetlands, I have always been interested in the use of wood in prehistory, researching in particular the human exploitation of woodlands during the Holocene (c.10000 BC to c.100 BC). Through this research, I became interested in the former presence of beavers in Britain and mainland Europe, and in 1980 John Coles and I published an article on their probable influence on the mid-Holocene forests of Europe. Much of the information for the article was drawn from the North American literature and from observations of beavers in Canada, as relatively little had been published on *Castor fiber*. However, by the mid-1990s the expansion of beavers in Europe made it possible to carry out field studies more relevant to the European past, and in 1996 the *Beaver Works Project* was initiated. The research presented here stems from these field studies, which I will briefly describe, and from a parallel archaeological project on *Beavers in Britain's Past*.

The archaeological evidence comes from beaver skeletal elements and gnawed wood, the remains of beaver structures and features, and more indirectly from wetland sediments and palaeohydrological indicators, as well as a rare find of beaver hairs. This evidence can be used to trace human-beaver interactions. Through the study of present-day beavers and their habitats, it has been possible to reinterpret some classic archaeological sites as a mixture of human and beaver activity, and to suggest that humans at first used the products of beaver activity and then began to develop their own environmental manipulations based on their understanding of beaver actions –the practice of coppicing (felling trees to encourage new growth of long straight shoots from the stump) is a case in point.

Early in the Holocene, it can be argued that beavers had a greater influence on the environment than did humans, but at some point the balance shifted to humans having the greater impact. I will examine briefly when this might have happened, and suggest that we have underestimated the significance of beavers in the periods when they were the chief environmental manipulators.

# CAUSES OF DEATH AMONG BEAVERS IN THE EUROPEAN NORTH OF RUSSIA

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Exogenous causes of beaver death such as predation including that by stray dogs and human-caused death due to poaching, lodge destroying, traffic accidents, drowning in fishing gear (n=154) are to be considered.

A beaver's lifespan can be cut short by predators. Adults are commonly taken by large predators like bears, wolves, lynx and wolverines. Kits and yearlings have many predators including foxes, racoon dogs, otters, American mink, eagle owls, white-tailed eagles, golden eagles, and even goshawks.

The first years of beavers naturalization in their former habitats after more than 200 year absence their death caused by predation was rather accidental and the death-rate was small. Beavers were few in number and in fact they were an unusual prey for the local predators. However, as soon as these rodents became common on the most part of the territory they also became a regular prey for large predators. Lynx discovered a new prey. First lynx attacks on beavers in Arkhangelsk Region were recorded in the late 1940s. In Leningrad and Pskov Regions where beavers appeared later, not before the 1970s they took the second place in lynx diet after mountain hare. Since then throughout the North lynx predation is the second leading cause of death among beavers (18,3%) after poaching.

Wolf attacks on beavers became more frequent in the late 1980s – early 1990s after sharp decrease in elk number. It seems that wolves just begin to become familiar with a new prey as in the areas where both species have been co-existing for a long time the share of beavers in the wolf diet makes up from 20 to 50% (Mertz, 1953; Peterson, Shelton, 1983).

Potential threat is being imposed on beavers by bears and wolverines. Beaver hairs were found in 17 food samples out of 276 taken from bears (Parovschikov, 1960). However, the major harm bears do to beavers by destroying their lodges. Wolverines are rare animals themselves, therefore beaver death is extremely rarely is caused by wolverines. In Pechoro-Ilychsky Nature Reserve there were no beaver remains found in 753 food samples taken from wolverines (Yazan, 1972). We know only one case of beaver death caused by wolverine predation.

Stray dogs are more significant source of beaver mortality. This can be considered as an indirect result of human activity (not holding dogs on a leash), but in fact it is a biotic factor that causes death of beavers (14,3%). However, the death-rate due to poaching is considerably higher (37.1%) and it should be noted that the aim of beaver hunting recently has changed radically. Earlier beavers were bagged for getting revenue from selling pelts and seldom hunters consumed beaver's flesh, but mainly they fed dogs with it and used it for luring. Nowadays beavers are being bagged mainly for their meat and often just as a manifestation of hooliganism. Such hunting results in up to 80% of injured animals that subsequently die and is indeed does the major harm to beaver population.

# THE INFLUENCE OF BEAVER ON FISH ASSEMBLAGES OF SMALL RIVER IN RDEYSKY STATE NATURE RESERVE (RUSSIA)

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European beaver (*Castor fiber*) as keystone species can modify morphology and hydrology of small forest rivers by cutting wood and building dams. While there are many locations in Russia where European beaver populations have been restored, there are not so many data available yet on this species influence on water ecosystems. The background of this study is observations on diversity, density, distribution and feeding of fish in the Gorelka River (tributary of the Lovat River, Baltic Sea basin) in nearby the State Nature Reserve Rdeysky (Novgorod province, NW Russia), in summer of 2004 and 2005. The sampling sites represent two parts of the river, 4 sites in beaver ponds, and 14 sites in area without beaver activity. Three types of river habitats, riffle, raceway and pond were determined in the last one area. The sets of gill nets and electrofishing gear were used for fish sampling. 9 species of fish has been found in the Gorelka River. Only two of them, young pike (*Esox lucius*) and dace (*Leuciscus leuciscus*) inhabited the beaver ponds. Pike was more abundant than dace in all sites subjected by beaver impact. The relative density of fish in habitats in limits of area without beaver activity was 10 times more than in the beaver ponds. Species composition of fish assemblages in different habitats and years in area without beaver activity was variable. In raceways the chub (*Leuciscus cephalus*) prevailed in 2004, but dace had highest number in 2005. In river ponds the bleak (*Alburnus alburnus*) has dominated. The riffles were inhabited by loach (*Barbatula barbatula*) only. There were no observed big differences between fish density in three types of habitat of area without beaver activity in 2004. Thus data from the Gorelka River support our previous result from small forest beaver rivers of the Volga basin have showed that fish avoid beaver ponds. Lowest fish diversity and density were observed in such type of habitats. Imago and larvae of insects were dominated in fish diets in all observed habitats of the Gorelka River. Fish was not found in diet of piscivorous species: pike (*Esox lucius*), burbot (*Lota lota*) and perch (*Perca fluviatilis*).

## 20 YEARS BEAVERS (*CASTOR FIBER*) IN THE NETHERLANDS

VILMAR DIJKSTRA

Dutch Mammal Society

In 1988 reintroductions of Eurasian beaver started in the Netherlands. Until 2009 about 150 beavers were released on several sites throughout the country. Within a period of 20 years, the population grew to approximately 450 animals of at least one year old. Beavers are colonizing rivers, lakes and small streams in an increasing rate. Until now beavers have been creating only minor problems. In the future however, the number and seriousness of beaver-induced problems is expected to increase. The Dutch Mammal Society aims to collaborate with water authorities to make an inventory of the biggest problems that can be foreseen, like digging burrows in dykes, after which preventive measures can be explored and tested.

# THE CHANGES OF RIPARIAN ECOSYSTEMS IN KARELIA UNDER BEAVER ACTIVITIES IMPACT

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Results of beaver activities were studied at inhabited and abandoned beaver settlements and non-beaver territories on waterbodies of Southern Karelia.

A beaver family staying in the same place for a long period of time gnaws down nearly all the trees of their preferred species in the area. This impact causes profound transformations in the composition and structure of waterside vegetation. Beavers had felled nearly a half (47 %) of aspen, 12.5 % of birch, 27.5% of alder, 22.5 % of rowan, 85.0 % of willow plants.

Beavers gnawed aspens and birches that had different diameters. Average diameter of aspens growing on the bank was 22.7 cm. ( $\sigma = 11.28$ ;  $n=1145$ ) and birches – 17.0 cm. ( $\sigma = 6.22$ ;  $n=1680$ ). The account of beaver cuts at the same places showed that the average diameter of fallen aspens was 23.1 cm. (the standard deviation was 9.05), for birches that index being 11.9 cm. ( $\sigma = 4,04$ ).

The “felling” event is followed by regeneration of trees and shrubs. Five years after being felled by beavers, 9.4% (48 of 510) aspen and 21.9% (45 of 205) birch trees produced stump sprouts. A strong sprouting capacity was demonstrated by alder, rowan and willows – sprouts were produced by 50.9%, 56.7% and 50% of all plants of the species, respectively.

Yet more profound changes in waterside forest associations are induced by beaver construction activities. After beavers have left the area and the dams have gradually fallen to ruin a totally different type of the biocenosis forms at the place of beaver pond. Investigation of abandoned beaver ponds demonstrates the following: a) the waterside forest cenosis is replaced by mire communities constituting a mosaic structure with different types of vegetation, water and nutrient supply, chemical and physical characteristics of the environment; b) the species diversity in the cenosis and the prevalence of certain ecological groups of plants within it undergo significant changes; c) the soils where inundation ceased after beaver departure are more acidic. Besides, the range of pH values in them is wider, as evidenced by the standard deviation and the coefficient of variation; d) areas regenerating from inundation upon beaver departure experience also a sharp, nearly ten-fold increase in the soil humus content; e) the accumulation of silt and other sediments during pond maintenance by beavers results later in a notable rise in the content of the main plant nutrients – phosphorus and potassium – in the soil; f) in the margins of abandoned beaver ponds covered by herbaceous vegetation typical for forest edges and felled sites the significant changes in the soil and herb layer mesofauna have been observed. Invertebrate abundance on such areas increased 2-2.5 times. The species and age diversity of invertebrates was also expanded.

# MONITORING THE SCOTTISH BEAVER TRIAL

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The Scottish Beaver Trial is now underway at Knapdale Forest in Scotland, following the release of beavers in May 2009. The Trial is being managed by the Scottish Wildlife Trust (SWT) and the Royal Zoological Society of Scotland (RZSS) on land owned by Forestry Commission Scotland. A condition of the Scottish Government licence issued to the SWT and RZSS is that the monitoring of the Trial must be done independently, and coordinated by Scottish Natural Heritage (SNH).

A number of monitoring projects are currently underway. SNH is leading on some of these projects, in some cases in partnership with other independent organisations, for example:

- Beaver ecology (in partnership with Oxford University)
- Riparian mammal ecology (in partnership with Oxford University)
- Odonata (in partnership with the British Dragonfly Society)
- Fish (in partnership with the Argyll Fisheries Trust)
- Woodland
- Aquatic macrophytes
- River habitat and hydrology
- Socio-economics
- Water chemistry (in partnership with Scottish Environment Protection Agency)

The monitoring of public health is being led by Argyll and Bute Council, and the monitoring of an archaeological site is being led by Historic Scotland. SWT and RZSS are involved in the collation of some data (e.g. beaver tracking) using standardised protocols.

The outputs of these monitoring projects will be made publically available at [www.snh.org.uk/scottishbeavertrial](http://www.snh.org.uk/scottishbeavertrial). At the end of the Trial, SNH will advise the Scottish Government who, in turn, will decide on the future of beavers in Scotland.

# THE EUROPEAN BEAVER ON TRIAL IN SCOTLAND: THE CASE SO FAR

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European beaver families were released for the first time into the wild in Scotland on 28 May 2009. The reintroduction is being done on a trial basis, and for the next five years the beavers will be monitored closely by independent bodies.

It has taken fifteen years to reach this point. During the 1990s, the preparatory work undertaken by Scottish Natural Heritage involved an assessment of the historical evidence of beaver presence, the identification of potential donor populations, reviews on the effects of beavers on various biological issues and land uses, and an overall examination of the ecological feasibility of beaver reintroduction. This was followed by an assessment of the public desirability of reintroducing beavers, and a decision to undertake a trial reintroduction to test the various issues and concerns raised by some parties. The IUCN Guidelines on Species Reintroductions were followed throughout the process.

Despite the proposal to undertake just a trial reintroduction, controversy remained during the 2000s. An initial licence application was turned down, and a licence was only finally approved by the Scottish Government Minister of Environment in May 2008. A number of bodies continue to raise objections over beaver reintroduction in general, and the trial reintroduction in particular. Media interest has been extensive.

Why has this issue created so much debate in Scotland, and the rest of Britain? We present our experiences from the last fifteen years, summarise the lessons we have learnt from colleagues across Europe, analyse the arguments for and against reintroduction to Scotland, and set out ongoing work and possible future scenarios.

# SOME FEATURES OF BEAVERS TERRITORIAL BEHAVIOUR AFTER REINTRODUCTION

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Beavers were reintroduced to the territory Volzhsko-Kamsky National Nature Biosphere Reserve to solve the problems of water storage regulation and to slow up the sediment flow into the lakes of the reserve. These problems could be effectively alleviated by beavers constructing dams on the waterways flowing into the lakes of the reserve.

The animals used for founding the population in the reserve were live trapped in beaver ponds of the Viatka River plain of the eastern part of Tatarstan Republic (300 km from the introduction site). During four years 21 beavers were released on the territory of the reserve and its buffer zone. During the study, five adult beavers were implanted with abdominal transmitters (Telonics model IMP/400). These transmitters had a range of > 2 km and a duration of about 1000 days. They were operative for 12 hours (from midday to midnight) each day. Beavers with implanted radio transmitters were released on the next day after surgery. The animals were set free in artificial dens as a "soft" release. For the investigation of beaver's territorial behaviour regular observations were used together with telemetry. During these investigations we noticed the common type of the beaver's behaviour after reintroduction.

The artificial den was always used by reintroduced beavers, at least during the first days after release. In all cases beavers start to construct dens or stick-lodges after detailed investigation of the new territory (place where they were released, or to which they moved by themselves).

After reintroduction beavers moved both upstream and downstream from the release site. The resulting vector of beaver movements after reintroduction made up 4.5 km downstream.

In all cases the animals stayed at the place of release for 5-10 days and only then moved to the new habitat. An explanation for such a behaviour could be that the animals use this time for investigation of the new habitat where they were released, and then decide about its suitability. It is also possible that they just recover after the surgery, but the same behaviour was also noticed in other cases when the animals didn't have any surgery.

During the reintroduction two out of eight beaver families remained in the places of the release till there was enough food, and other six ones moved to the new habitat.

## THE DENSITY OF BEAVER FAMILIES IN THE STREAM FLOWS OF CENTRAL CROATIA

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Since the end of beaver reintroduction in Croatia in 1998, continuous monitoring of the expansion and distribution was made. With the release of 56 beavers into the Sava river basin, the initial population has been formed, and it immediately began to expand.

During the first few years, the dynamical expansion took place. In the first 2 or 3 years beavers colonized remote sites within the range of more than 100km. On some sites only one family was registered. The distances between families were from 3 to 130 km.

In the next period, the number of the beaver families continued to grow which diminished the distances between them and led to a better use of the habitat.

During the last 10 years, the upper parts of the streams were filled practically to their full capacity. The results of the research showed that larger stream flows were less populated than the smaller ones. At present, in the most populated areas, there is one beaver family on every 2,4km.

According to our research the number of the beaver families doubles every 4 years.

# THE EFFECT OF REGULATING STREAM FLOWS ON THE BEAVER HABITAT IN CROATIA

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Beaver adjusts well to all the changes in its habitat on condition that food and water is provided throughout the year. In some cases beaver inhabits areas with very few food resources.

The fact that beavers unexpectedly choose some quite unusual habitats to settle on was in fact the reason for doing the research on these seemingly marginal habitats in the first place.

Although in Croatia there is a fair amount of well preserved habitats, some smaller stream flows are permanently being regulated, and that's which has to a higher or a lesser degree diminished their natural quality. In order to establish the real effect of stream flow regulation on the beaver habitat, research was made on 9 rivers in Central Croatia and it consisted of fieldwork and mapping the stream flows. As a control method we used topographic maps 1:25.000 and satellite photos provided by Google Earth.

938 km of stream flows were inspected on 9 km of rivers. It was recorded that natural vegetation covers 70% of those stream flows. 18% of stream flows were previously regulated (leveling beds, building dams etc.), but, due to ecological succession, herbaceous and ligneous vegetation - which we named "successive vegetation" - recovered and made it possible for the beaver to inhabit those terrains once again. On those parts of stream flows, beavers are commonly present, but there is also a danger of them getting hurt or forced out because of the stream flow regulation that periodically takes place.

Some time after the stream flow regulation, beavers cannot settle on those terrains because they have no vegetation. The stream flows that are regulated every year, cannot be inhabited by beaver at all.

Instructions that can be given to the company that conducts the stream flow regulations are not to remove the vegetation directly on the banks or inside the 5m perimeter. That would provide the conditions for the beavers, birds and other semi aquatic animal species. It would also prevent water temperature from rising and enrich the water with oxygen. Those instructions are being partly accepted, but in the future they should be applied on the majority of regulated stream flows.

# POPULATION AND DISTRIBUTION OF EURASIAN BEAVERS. DECLARING VICTORY AND MOVING ON

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Formerly widespread throughout much of the Palaearctic region, Eurasian beaver *Castor fiber* populations were reduced through overhunting to c. 1200 animals, in eight isolated populations, by around the end of the 19th Century; by current IUCN criteria the species would have been classified as Endangered C2a(i). Since the 1920s, effective protection of these remnants, the resultant natural spread, and widespread reintroductions have led to a powerful recovery in both range and population.

The minimum population estimate in 2009 is 642 000 individuals; the real population figure is probably considerably higher. There are also c. 12 500 North American beaver *C. canadensis* established in Finland and Russian Karelia; however, other populations of *C. canadensis* introduced to Austria, Poland and France appear to be extinct.

Populations are now established in all modern countries of the former natural range in Europe, with the exception of Great Britain (a trial reintroduction to Scotland commenced in 2009), Portugal, Italy, and the southern Balkans; in Asia the species is well distributed in western Siberia with smaller populations in eastern Russia, Mongolia, and China (Xinjiang). Habitat occupied varies from wilderness areas to intensively managed landscapes with dense human populations, and from warm temperate to subarctic climates. Reintroductions are continuing. Considerable further expansion of both range and population, especially in western Europe and the lower Danube basin, can be expected.

As a result of these changes, in 2008 the IUCN reclassified Eurasian beavers as LC (Least Concern).

The progress of population recovery has been well studied. Once established, beavers spread rapidly throughout watersheds, selecting the best unoccupied habitat and progressively relaxing habitat requirements as population development proceeds. Rapid range extension within the watershed is followed only later by rapid population growth. Later, populations typically decline somewhat as marginal habitat is occupied and then exhausted; and finally stabilise; on larger watersheds the whole process takes c.40-50 years. The period of peak and declining populations often coincides with a peak in conflicts with human landuse interests, as marginal habitats are more likely to require extensive modification by beavers. Watershed divides are a significant barrier to population spread; beavers should therefore be managed at a watershed scale.

While some populations of beaver remain threatened and require special protection, Eurasian beavers have now, as a species, moved past the point of requiring protection through the traditional endangered species paradigm. Management and official designations, perhaps especially of the expanding populations in western and central Europe, should take account of this change in status. The future of beaver

management is as a normal species with regard to national and international practices for nature conservation and sustainable management. In a world of increasing pressure on nature, this is an encouraging success of 80 years of conservation effort.

## AGE STRUCTURE DETERMINATION ON EUROPEAN BEAVER (*CASTOR FIBER L.*)

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For our further research we wanted to know age structure of the European beaver population in study areas. Most often used method for age determination of live-trapped animals is categorization based on weight. This method is not fully reliable, because the weight frequently reflects the individual's condition and quality of habitat. We decided to find out better way to determine age classes.

We analyzed 48 skulls of the European beaver, which we obtained from dead found animals. Based cranial measurements were measured in all skulls. According to the tooth development the individuals were assigned to three categories. Juvenile category (up to 1 year) and subadult category (up to 2,5 year) were distinguished according to convergence of the lower external edge of loops and closure of the root. Animals of adult category (more than 3 year) were determined by a number of cement layers.

We knew morphometric characteristics and weight of 20 dead animals from our data sample. This data were compared with characteristic of age known skulls. By the integration of three methods (skulls and teeth characteristics, measurement, weight) we attained to the specification of age determination which can be use for following research.

# DISTRIBUTION AND POPULATION STATUS OF *CASTOR FIBER ALBICUS*

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The autochthonous subspecies *Castor fiber albicus* is an example for successful nature conservation and long-term monitoring among mammals. In 1890 only a small relict area existed in the middle reaches of the Elbe river: 90 colonies with 200–300 beavers. Only since 1970 population has developed persistently progressive.

Today *Castor f. albicus* colonizes a complete area from the Baltic Sea to the low mountain ranges including the federal states of Schleswig-Holstein, Mecklenburg-Western Pomerania, Lower Saxony, Brandenburg, Saxony-Anhalt, Saxony and the northern parts of the Czech Republic. Furthermore subpopulations based on reintroduction projects can be found in Emsland and Saarland, the Hessian Spessart, and Rhoen as well as in Denmark and in the Netherlands.

Contact zones to East-European beaver populations exist in the Oder-Neisse region and in the upper reaches of the Elbe river. A mixed population is emerging here. This process should be accompanied by genetical investigations to answer phylogenetic and management questions. Allochthonous beaver-forms also migrate into Hesse, Thuringia and Saxony as well as into the range of the Dutch subpopulation. Therefore genetic resources of *Castor f. albicus* seem to be threatened by migration of allochthonous forms in the long term.

The whole population of *Castor f. albicus* amounts to a total of 8500 beavers. It was calculated that from 2005–2009 the population of *Castor f. albicus* in Germany consists of 8000 beavers living in 2400 colonies in 11 federal states. The largest numbers can be found in Saxony-Anhalt and Brandenburg. On average 7.6 beaver colonies (26.5 beavers) are recorded per ordinance survey map in Saxony-Anhalt. Ordinance survey map Coswig 4140 has the highest abundance with 43 beaver colonies, i.e. 142 animals per 127 km<sup>2</sup> (= 1.12/km<sup>2</sup>).

43% of the present population are based on reintroduction projects. The population growth rate decreased in all subpopulations from 22% to <5 %. Population, abundance, and growth rate have stagnated in Saxony-Anhalt since the beginning of the 21st century.

The population of *Castor f. albicus* is saved, but still threatened. Based on population data management measures are discussed.

## BARBED WIRE HAIR TRAPS AS A TOOL FOR REMOTELY COLLECTING HAIR SAMPLES FROM BEAVERS

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The recolonisation of much of Europe by the Eurasian beaver (*Castor fiber*) entails new management, conservation and research challenges. DNA analysis can function as a powerful method in this respect. We conducted a trial to determine the effectiveness of barbed wire hair traps for remotely plucking hair from free-ranging beavers. At all sites it was possible to rapidly obtain hair samples containing guard hairs with follicles. Hair trapping efficiency was 0.87 samples per trap-control day. We showed that barbed wire hair traps can be employed as a cost effective way of collecting DNA from this semi-aquatic mammal without subjecting it to the stress of capture and handling.

# THE EFFECTS OF HIGH UNGULATE DENSITIES ON FORAGING CHOICES BY BEAVER (*CASTOR CANADENSIS*) IN THE MIXED - WOOD BOREAL FOREST

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In some areas of North America previous management policies have created competition between beaver (*Castor canadensis* Kuhl, 1820) and ungulates resulting in dramatic declines in beaver populations. Some authors attribute this decline to competitive exclusion. Generally, the less niche overlap between competitors, the lower potential competition between them. Differences between foraging behaviour of beaver and ungulates suggest that they could not compete to the point of either competitive exploitation or complete exclusion except in restricted habitats. We tested this assumption under 2 levels of foraging intensity by ungulates by examining the effects of resource competition on beaver forage choices in the context of central place foraging theory. Ungulate densities and foraging intensity within Elk Island National Park (EINP) in Alberta Canada were significantly higher than those immediately adjacent to the park, where foraging pressure was lower. Within EINP, forage availability (e.g., stem densities and stem diameters) of many woody plants preferred by beaver, such as *Populus* L. and *Salix* L., were depressed by intense foraging by ungulates. Beaver adapted to the effects of high ungulate densities on forage resources by adapting their foraging behavior. This finding suggested competitive exploitation, rather than exclusion exists in EINP. EINP is a productive system that offers an array of forage species, which potentially buffers the effects of competition between ungulates and beaver.

# DNA FROM THOUSANDS OF YEARS AGO: INSIGHTS INTO THE GENETIC HISTORY OF THE EURASIAN BEAVER (*CASTOR FIBER*)

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Today, the Eurasian beaver is a protected species in many countries. Contrarily, in former times, the beaver was hunted extensively and, at the end of the 19<sup>th</sup> century only isolated relict populations had survived. This population bottleneck shaped the genetic diversity of recent beavers. Previous studies were able to show a pronounced phylogeographic pattern of DNA sequences typed of beaver individuals from relict populations.

Now, analysis of ancient DNA aims to explain the development of this phylogeographic structure and to investigate the genetic diversity of beavers that had been lost during the population bottleneck.

Ancient DNA was extracted from beaver bone and tooth samples, excavated at historical sites. PCR amplified DNA was sequenced using Sanger and 454 pyrosequencing technology. Our analyses of extinct beaver populations allowed the identification of colonization routes taken by beavers in Europe after the end of the last glacial maximum. Furthermore, many new ancient DNA sequence variants (haplotypes) were observed, which today are extinct. Understanding the genetic structure of these ancient beaver populations, existing thousands of years ago, is interesting also in the context of conservation management.

Efforts have been made to maintain Eurasian beaver relict populations, from which the species began to recover. In the course of conservation management, beavers have been relocated to support foundation of new populations in areas which missed beavers after the population bottleneck. Ancient DNA can provide information on the indigenous beavers of a certain area. These results, reflecting the history of this species, can now be taken into account by maintenance projects, when planning the relocation of beavers.

# CHARACTERISTIC OF ABANDONED BEAVER MEADOWS VEGETATION IN THE NATURAL STREAM VALLEYS

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The work presents exploration and evaluation of the data on the vegetation which forms in abandoned beaver meadows and its alteration in time. Likewise, comparison of the abandoned beaver meadows phytocenoses with the plant communities of naturally flooded meadows is presented. Research on meadows phytocenoses occurred in 2007 – 2008, each year explorations were carried out from July to August, in the Savalka stream valley (East Lithuania). Three abandoned beaver meadows and three naturally flooded meadows were studied. Botanical composition of plant communities was determined using Braun-Blanquet method (Braun-Blanquet, 1964). Totally, 48 plots of 4 m<sup>2</sup> in size, in six meadows were sampled. The scale of H. Ellenberg (2001) was used to evaluate plant species regarding their hydrological regime, soil reaction, and trophical needs. Coefficients of Sørensen (Magguran, 1992) and Jaccard (Jaccard, 1901) were used to express floristical similarity of communities.

In abandoned beaver meadows 99 plant species were identified meanwhile in naturally flooded meadows – 100. Various phytocenoses are formed in beaver meadows, however, communities belonging to the Cl. *Molinio-Arrhenatheretea elatioris* R. Tx. 1937 are the most frequent. In comparison with naturally flooded meadows, phytocenoses of beaver meadows are distinguished by the following peculiarities: there are plenty of species tolerant to higher soil dampness and acidity. Plant communities of beaver meadows have features characteristic of the early successive stages, and their features can be explained by specific habitat conditions, the most important of which seem to be the increased soil dampness and acidity.

## THE SCOTTISH BEAVER TRIAL: PROGRESS SO FAR

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The end of May 2009 saw the first ever, formal reintroduction of a mammal species to the UK. Following the issue of a Scottish Government license three families of European beavers were released into lochs within the Knapdale forest on the west coast of Scotland.

The project, which is a five year experimental trial involving a large number of national and international organizations and agencies has created a great deal of media interest within the UK and is widely viewed as a groundbreaking initiative for Scottish biodiversity.

In our presentation we will briefly outline how this trial reintroduction has begun, how our beavers have behaved and what early observations and management issues we have experienced over the first months of the project.

# LONG-TERM DYNAMICS OF RE-INTRODUCED POPULATION OF EUROPEAN BEAVER CENTRAL-FOREST RESERVES' AREA

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The considered beaver population of watershed region of Volga and Western Dvina (Daugava) location has been formed of eight specimen of earlier Voronezh spring that had been reintroduced in nature in 1936-1937. The square under check control makes 70 000 hectares. It includes core area of Central-Forest Reserve (24415 ha), with geographic coordinates: 56°26' – 56°39' north latitude, 32°39' – 33°01' eastern longitude, and its transition area (46061 ha). The area actually occupied by the considered beaver population is obviously greater but hasn't been estimated yet. Nature and economic regime at mentioned area varies from completely preserved area to the adjusted forest felling operating with clear cutting and sport hunting. Observation time range with intervals lasts for 73 years (1936-2008). Last years records were carried out considering the geographic coordinates. Within observation period the population has increased from 3 colonies (8 beavers) in 1937 to 71 colonies (285 beavers) in 2001. Population dynamics is formally expressed with logistic equation. Indeed, initial population parameter is less than one essentially; consequently that doesn't have physical meaning. Nevertheless this model makes it possible to distinguish two levels of equivalent populations conforming with different area capacities: from 1936 till 1971 - 27 specimen, and from 1981 up to present - 195 specimen. Coefficient of reproduction is  $r=0.22659$  with high level transition. It may be presumed that the population displays theoretically predicted in population dynamics models spasmodic transition with slight changes of external or internal parameters. Statistical analysis shows that the mentioned transition is, first of all, determined by March and April growing slightly warmer with corresponding drop of flood capacity. Essential is the fact that sensitivity of the new state of population has been reduced in relation to spring temperature falls and high flood power. It may be presumed that for the last 30 years population autocyclic fluctuations have been formed. Beaver forms an important share in lynx and wolf daily diet. Whether predators exercise regulatory influence - the subsequent research has to define.

# DYNAMICS OF THE BEAVER MEADOWS DEVELOPMENT IN KALUGA REGION, RUSSIA

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At last ten years the problem of beaver's meadow was formed at science literature (Gurnell, 1998). For some territories were lead long-time observations (Rosell, 2005). These observations demonstrate large manifolds landscapes, the result of beaver's activity. At fact, what species and rate regenerations process disturbed plant association was depend for many factors. However, still questions more, than answer. Firstly, are beavers meadow unique associations or many one's of them are repeated a general way phytocenosis, was originated for appoint climate zone, the result of naturals reservoir reclamation? Secondly, will be returner theirs (associations) to nature state, before flood or its irreversible change, possibly it?

Beavers was inhabit different types reservoir. Today, was detail investigation the phytocenosis, who growing in the beaver ponds in peatland areas (Ray, 2001), the beaver meadows at delta of large rivers (Simonaviciute, 2005).

In Russian, beavers usually inhabit at flood-lands of small rivers and forest's stream, therefore, investigation these plant association was interesting about us. The students' experimental station of our university standing in Kaluga region, and situated in watershed by Volga and Dnieper. The object of our investigation is forest stream. In these stream there are three dams one by one. All of dams have various ages. We laid three sample areas. One area has been at the flood land of stream uninhabited by beavers, two near the reflooded beaver ponds. In inviolate flood land the wood synfolium was present black alder-tree (*Alnus glutinosa*) and shrubby synfolium was present willows (*Salix fragilis*). The herbaceous synfolium was present a typically eutrophic species (*Urtica dioica*, *Filipendula ulmaria*, *Impatiens noli-tangere*). Dry pond, leaving recently obliteration reed (*Phragmites australis*). The beavers leaved next pond nearly ten years ago, maybe more. At these space growing a motley grass. The motley grass typically for low bog or swamped meadow, there are: sedges hillock (*C. vesicaria*, *C. pseudocyperus*); cereals (*Deschampsia cespitosa*, *Phalaroides arundinacea*), eutrophic spices. So, we can prognosticate, what we shall have swamped meadow at that place very soon. The meadow will cross to mesophytic association of perennial herbaceous, when the dam will be drain.

# HORIZONTAL DISTRIBUTION OF ZOOPLANKTON IN PARTS OF SMALL RIVERS REGULATED BY BEAVERS

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In the course of the study of lowland small rivers in the Upper Volga basin it has been found that the most productive habitats in small rivers are portions subjected to beaver's activity. The building of ponds by beavers in most of watercourses leads to formation of backwaters (from 100 m up to 2.5 km) where water masses of different physical and chemical parameters mix. The aim of the work is to study patterns of zooplankton distribution along the longitudinal section of parts in small rivers transformed by beavers depending on their form.

It has been found that the most common are regulated parts of "a typical form": the head of the backwater zone is narrow and lies within the river channel and the lower waters of the backwater zone flood the flood-plain. After a recurring occupation of the river by beavers the parts of an "atypical" form can appear. The authors investigated a part of the small river which wide and stagnant portion was located in the backwater zone and water in its narrow, near-dam part was running during flood and postflood periods. The obtained data show that current velocity and water level in ponds is of crucial importance for formation of zones with a high quantitative abundance of zooplankton within regulated parts. As a rule in May and October unregulated parts are characterized by the maximal current velocity promoting the matter transport to the near-dam zone in ponds. During the summer low water period the current velocity in unregulated parts decreases and the water level in the pond rises creating favorable hydrological and trophic conditions for zooplankton at upper boundaries of the backwater zone in ponds. The exception is ponds of an atypical form in which due to their specific morphometry and as a result of the hydrological regime the portions with high quantitative development of zooplankton in postflood periods are in the head of backwaters or as well as in low water periods manifest no significant differences.

Highly productive zones formed in streams regulated by beavers are similar to the zones, formed in the parts of extension the river backwaters in mouth reaches of small tributaries of reservoirs, and corresponding to the concept of the marginal effect (Krylov, 2005).

The work was supported by the Program of Fundamental research of the Presidium of RAS "Biodiversity and Dynamics of Genofond", the Subprogram "Biodiversity".

# SOLUTIONS TO BEAVER-HUMAN CONFLICTS THAT ARE LONG - LASTING, RELIABLE, AND PRESERVE PRECIOUS WETLANDS: AN UPDATE OF SUCCESSFUL FLOW DEVICE TECHNIQUES IN NORTH AMERICA AND EUROPE

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Beaver-human conflicts have been a widespread problem in North America for decades and they are a growing concern in Europe. The majority of conflicts, and certainly the most expensive ones, are related to flooding. The worst of these are associated with narrow, manmade outlets like road culverts.

There are only two ways to effectively protect a vulnerable property: by immediately extirpating all the beavers in the vicinity, and all dispersers that might arrive in the future (both usually done lethally), or by controlling their behavior, and therefore water levels, with fixed defenses. As regional populations grow and become "healthy," the former approach becomes increasingly less efficient because more beavers translate to shorter periods before vacant habitats are re-filled. The latter strategy has many variations, but it mostly involves flow devices, which essentially sneak water away from beavers. Well-designed and well built, they have a persuasive logic. Although they usually cost more than an initial extirpation event, they offer long-lasting protection that is in place all the time. By contrast, extirpation almost never happens immediately upon the return of a beaver(s) so properties are vulnerable during these periods. As a result, maintenance costs and property damage are frequently part of the extirpation cycle. Non-extirpative defense strategies also negate the need to remove this important keystone species from ecosystems, which benefits wildlife and society in numerous ways.

This paper is an update of effective non-lethal strategies being used in North America. It also emphasizes the complexity of the problem and the delicate nature of success. High-quality design and workmanship is vital. Moreover, every conflict site is different so numerous decisions have to be made to ensure that the best strategy is used to match its unique qualities. Consequently, the skill, experience, and judgment of the person doing the work are every bit as important as the use of top-notch flow devices. Finally, we include observations on how governments and management agencies might better encourage a successful approach to, and resolution of, the beaver-human conflict while fully exploiting the impressive and diverse values associated with beavers.

# BEAVER IN OPEN DRAINS: CONSEQUENCES AND BEHAVIOUR REACTING TO RESTRICTION OF THEIR ACTIVITY

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Given both a high beaver population density and lack of intact water-bodies suitable as habitats, the animals readily occupy open drains – both regulated (straightened, deepened and trapezium-shaped) natural streams and new-dug ones to collect and discharge the surface runoff from rural territories and the water from subsurface tile drains. Dimensions of open drains are based on hydraulic calculations and hydrological requirements for all drainage system. Inhabiting open drains, beavers, however, need to build dams to create ponds for hydrological conditions to make them suitable for their existence. Thereby, beavers also dam up the subsurface tile drain systems that fall into the impounded stretches of open drains. Each such case results in the conflict between a land user and a beaver.

We aimed to try (1) to mitigate these conflicts by installing pond drains in beaver dams to lower the water level in beaver-dammed open drain stretches as well as by removing of some dams and (2) to examine the behaviour of beavers reacting to the lowered water level. The study was carried out in Lithuania; the studied open drain was the stream of the first order. The soils of the surroundings were of light texture, as well as the period that was rather dry.

It was found that competently installed pond drains were able to maintain water in ponds at the desired level that somewhat benefited the workings of subsurface tile drain systems. However, the beavers did not become reconciled with the lowered water level in their ponds and made the effort to maintain it as high as possible by trying to stop the pond drains and rebuild the previously removed dams. Having failed, the beavers lost interest in the pond drains and in the dams in which the pond drains had been installed as well as in these dams that were not allowed for them to rebuild but started building of new dams. It shows that installation of pond drains did not prevent beavers from building new dams, and did not encourage the animals to abandon the beaver-site. It means that beaver population must be reasonably managed – sized up and distributed.

# GEOMORPHOLOGICAL EFFECT OF BEAVER ACTIVITY IN OPEN DRAINS

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Inhabiting open drains, beavers (1) adjust unfavourable hydrological conditions in the drains for their needs by building dams and digging lateral canals, and (2) set up their shelter by burrowing bank dens or constructing lodges. All these activities result in the direct geomorphological alterations of open drains. Moreover, beaver dams change the hydraulic conditions of flow that activates sedimentation and scouring processes affecting geomorphology of open drains too. It seems that given high population density, beaver activities in open drains can significantly move the geodynamical processes in a landscape and assist in renaturalization of those artificial waterways. The objective of the study was to quantify these processes occurring in open drains densely populated by beavers.

The investigations were carried out in the Nevėžis River basin, Lithuania. A study area (25×25 km) and nine smaller basins were chosen in which all open drains were explored. The total length of them amounted to 1048km; the cumulative area of their catchments approached to 950 km<sup>2</sup>. All the explored open drains were streams of the first to third order.

Two methods were used to record dams, beaver-sites, lateral beaver-canals and beaver-burrow failures, curvatures of the open-drain channels and meanders, *etc.*: (1) aerial photographs of the scale of 1:10,000 combining with consequent checking *in situ*, and (2) a global positioning system (GPS) to map the explored open drains and all available beaver-created structures therein. The dimensions of these structures were measured directly.

The percentage of the beaver population currently inhabiting open drains in Lithuania makes up 40–56 % in total (according to experts, the total population makes 86,000–121,000 beavers). It was found that density of the beaver dams in open drains averaged 0.61 dam/km<sup>1</sup> or 0.70 dam/km<sup>2</sup>; the mean number of dams per one beaver-site equalled 3.1; and mean beaver-site density made up 0.19 unit/km<sup>1</sup> or 0.21 unite/km<sup>2</sup>. The mean dimensions of the dams (height (m) × length of crest (m) × volume (m<sup>3</sup>)) were 1.1×5.8×11.2; and the mean amount of substance cumulated in the dams within one beaver-site equalled nearly 35 m<sup>3</sup>.

The data showed that beavers' burrowing activity in open drains was rather high making up slightly more than 26 burrows within one beaver-site on an average. Four types of them – simple without any branch, branchy, U-shaped and combined – were recorded. The amount of earth, which was released from one burrow and discharged into the open drain channel, averaged 1.3 m<sup>3</sup>. Digging their borrows, beavers were capable to release about 33.8 m<sup>3</sup> of earth within one beaver-site which would

accumulate on the bed of the impoundments but also could be both moved downstream in case of beaver dam failures, or transferred anywise and anywhere else.

The sediment accumulation rate in the open-drain beaver pond was assessed approaching to 0.08–0.13 m<sup>3</sup>/m<sup>1</sup>/yr. However, the earth released from beaver burrows was estimated being able to present about 20 % of total sediment amount deposited in the pond during 10 yr. only.

Building of dams, digging of burrows, accumulation of sediment in ponds and other processes caused by beavers' activities are the ones, effects of which possess the cumulative character over time. It will always be kept in mind when the geomorphologic effect of beaver activity is discussed. The available data showed that currently this effect that might be considered in Lithuania was expressed by 160 m<sup>3</sup> per one kilometre of the open drain net or 185 m<sup>3</sup> per one sq. kilometre of the territory.

# ISOLATION AND IDENTIFICATION OF PLANT PHYTOHORMONES CYTOKININS IN BEAVER'S BLOOD

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Cytokinins, an important group of phytohormones, play crucial roles in the control of various physiological processes in plants, including the promotion of cell division and the counteraction of senescence. Moreover, a detailed screening of chemically synthesized cytokinin analogues revealed the fact that additional substitutions of the BAP molecule can lead to a strong and specific inhibition of several important protein kinases. These compounds have a strong ability to induce apoptosis, especially in these cancer cell lines where cell-cycle regulators are mutated. Naturally occurring cytokinins are adenine derivatives, substituted at the N<sup>6</sup> position by either an isoprenoid side chain or an aromatic ring. In most cases, also nucleosides, nucleotides and other sugar conjugates have been found as naturally occurring substances in plants. However, their endogenous occurrence, formation and/or function in an animal/human body have not been satisfactorily elucidated up to date.

Since plant hormones are present in minute quantities even in plant tissues and, moreover, fairly large numbers of samples containing broad range of metabolites must often be analyzed to investigate physiological processes thoroughly, rapid but sensitive techniques are essential for analyzing them. Our recent effort comprises development of a protocol for extracting and analyzing cytokinins involving immunoextraction using monoclonal antibodies followed by UPLC-ESI(+)-MS/MS separation and quantification. The method provides sufficient robustness, sensitivity, convenience, through-put and cost-effectiveness over previous methods. Using this method, several cytokinin metabolites have been clearly identified and quantified in beaver's blood. Search for their biosynthetic pathway and/or relation to the diet as well as their possible function in the body will be the subject of our future research.

## WINTER TEMPERATURES ARE INFLUENCING BEAVER'S TERRITORY SIZE

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Current theories of territoriality expect that animal will defend the smallest area that can provide resources for maximization of fitness. But there can be extrinsic factors influencing the territory size. We studied two beaver populations living in different habitats (floodplain forest and agricultural landscape) where we analysed more than 70 beaver families. Main focus of study was to test if the territory length is dependent on winter season coldness. Data were collected from winter 2005/2006 to winter 2008/2009, when two colder and two warmer winters occurred. Temperatures between cold and warm winters were significantly different.

We found out strong relation of beaver's behaviour to the temperature conditions. Their territories (similarly in both tested areas) were during colder winter significantly shorter than during the warmer ones. On the other hand there were neither differences in the length of territories between areas in same years nor between two winters with the similar temperature. Average winter temperatures had great impact on the territory size, no matter in which habitat type. In general, movement in colder temperature is energetically more demanding, thus the territorial activity could result into the smaller territory size (even ice cover can limit the movement of beavers). But in warmer winter it is easier to defend larger areas and allocate more food sources. It seems that there is some trade off between territory size and survival. In colder winter beavers have to focus on their own survival but in warmer one they can allocate as much resources as possible.

# HELMINTHS PARASITIZING EURASIAN BEAVER (*CASTOR FIBER*) IN LITHUANIA AND THEIR POPULATION REGULATION

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Here data on helminths of Eurasian beaver (*Castor fiber*) are presented. The beavers were hunted in: Molėtai, Šilutė, Klaipėda and Jurbarkas districts in Lithuania in 2001-2007 years. The method of total helminthological dissection of distinct organs was used. The intestines, stomach and internal organs were examined. The content of the intestines and the stomach was studied by a method of consistent flushing. There were dissected 46 beavers.

All investigated beaver individuals were infected by two parasite species: fluke - *Stichorchis subtriquetrus* and nematode - *Travassosius rufus*.

The fluke *S. subtriquetrus* is a helminth specific to the beavers, which parasitizes the large intestines. In trematodes eggs, which get into water, miracidiae are formed. The miracidiae hatch in 21–27 days. They penetrate into appropriate molluscs (*Planorbis vortex*, *Radix ovata* or other). There the rediae emerge from the miracidiae. In 22 days rediae begin to produce cercariae. Five to six weeks after the already mature cercariae could be found in the molluscs' livers. They emerge from the molluscs. Having found appropriate substrate, the cercariae begin encysting; metacercariae are formed. A beaver swallows them together with water, grass, or tree or bush bark, and in the animal's intestines the fluke gets free of the cyst. Then it migrates to the large intestines and gets sexually mature.

The nematode *T. rufus* is a parasite specific to the beavers. The parasite localizes in the stomach. Its eggs get into the outer environment, and invasive larvae hatch out of them.

Quantitative dependence between fecundity – mean eggs number per female, size of *T. rufus* and number of the parasite in beaver individuals were analyzed. The negative relation between these variables indicates the regulation of *T. rufus* population at beaver individual level. In the work was analyzed quantitative dependence between *S. subtriquetrus* in beaver individual and their size too. The negative relation between these variables shows a regulation in beaver individual level.

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## BEAVER IMPACT (*CASTOR FIBER*) ON FISH OF THE SMALL RIVERS OF ZAPOVEDNIK "PRIVOLZHSKAYA LESOSTEP"

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According to our research (2007 – 2008) impact of beaver (*Castor fiber*) on fish of the river-head of Sura River (basin of the Average Volga) in the zapovednik "Privolzhskaya lesostep" were researched.

Beaver dams the hydrological regime has changed the river-head of Sura. It has caused reduction in speed of current of the water-currents, to reduction of the dissolved oxygen in water and to increase in average water temperatures. Influence of these factors has determined spatial distribution and number oxi-reophilic species of fishes. Sensitive to transformation of places of dwelling appeared minnow (*Phoxinus phoxinus*) which number in the Sura River was sharply reduced.

# GENETIC STUDY OF BEAVER

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The Eurasian beaver, *Castor fiber* L., suffered extreme demographic reduction through overhunting until the end of the 19th century, but active protection measures have led to a powerful recovery in range and population numbers. Biochemical genetic markers (allozymes) and different DNA based methods were used to assess levels of genetic variation in European beaver populations. Genetic relationship and genetic distances between the subpopulation were estimated using a wide range of different genetic markers. The absence of panmixia at all hierarchical levels of the European beaver communities down to individual families implies a complex organization of the population-genetic structures of the species, in particular, a large intergroup component of gene diversity in the populations. The data suggesting genetic heterogeneity among individual settles within colonies have been obtained. The factors affecting the structure of the beaver communities of the lower hierarchical ranks are considered: the common origin, founder effect, selection, gene drift, assortative mating, and social and behavior features of the species. The founder effect could be the primary factor of population differentiation only at the time of their formation. The heterogeneity among colonies and among settles is maintained largely by isolation of colonies from one another. Extremely low value of effective reproductive population size largely explains the high tolerance of European beaver to inbreeding and striking viability of the species, which from the early 19th century has been for more than hundred years on the brink of survival in the condition which would made any other mammalian species vanish from the Earth.

# GENETIC RELATIONSHIP AND DIVERSITY IN LITHUANIAN SUBPOPULATIONS OF EUROPEAN BEAVER (*CASTOR FIBER*) BASED ON RAPD MARKERS

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Randomly amplified polymorphic DNA (RAPD) markers were used to analyze genetic diversity and genetic relationship among European beavers (*Castor fiber*) subpopulations in Lithuania. DNA from 78 beavers representing 7 subpopulations (Rusne, Kintai, Kieles, Taukeliai, Mituva, Giedraiciai and Vilkaraištis) was used to amplify with 10 highly polymorphic primers (ROTH-180-01, ROTH-180-02, ROTH-180-03, ROTH-180-04, ROTH-180-05, ROTH-180-06, ROTH-180-07, ROTH-180-08, ROTH-180-09, ROTH-180-10). The 10 primers yielded 121 markers, with an average of 12.1 markers per primer. The most polymorphic primers were ROTH-180-07, ROTH-180-08, ROTH-180-05, ROTH-180-10 and they fit the best to evaluate the genetic diversity of *Castor fiber* subpopulations. Genetic diversity among separate individual ranged from 0.11 to 0.84. We found out that molecular diversity is high inside subpopulations (79%), but comparing subpopulations with each other the diversity was not high (21%). Based on the similarity matrix, cluster and principal coordinate analysis was performed. A dendrogram of genetic relationship was obtained. The extent of genetic diversity and genetic relationship among subpopulation is discussed. From these parameters we can see that the most genetic diversity is observed in subpopulation from Mituva and the smallest in subpopulation from Rusnes island.

# IMPLEMENTING A BEAVER MANAGEMENT IN LOWER AUSTRIA – FIRST RESULTS AND FURTHER STEPS

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30 years after reintroduction the resettlement of beavers in Austria can be considered as a story of success. The beaver population living along the main lowland river systems Danube, March and Inn as well as along many adjacent tributaries is well established and expanding. Approximately 3000 beavers are the national population estimate with Lower Austria holding the majority of at least 2000 individuals. The ongoing expansion and colonization of numerous man made and modified water bodies in the cultural landscape though has increased the level of tension and encounters between beavers and human caused interests.

Provided that the favourable status of the species is secure, a new beaver management concept following a stepwise action plan has been issued in Lower Austria in the winter season 2006/07. Beside damage prevention and habitat modifications, mitigation measures taken for the first time also include trapping and killing of individuals. Derogations issued by nature conservation authorities are time and area restricted focusing on locally adapted case specific solutions and are executed in cooperation with the existing beaver management.

Cases handled were categorized and efficiency of measures taken evaluated for 90 cases of known status. 30% of reported conflicts were dealing with the impact of beaver activities on water engineering (interrupting functional capability as well as structural damage of banks or dams), followed by impacts on infrastructure within settlement areas (28%), agriculture (27%), ponds (12%) and forestry (5%). All together mitigation measures used are considered to reduce or solve conflicts in about 60% of registered cases under investigation. Derogations for trapping beavers have been used in 14 cases, applications for the removal of beavers have increased during the past two years. So far 4 (2006), 16 (2007), 25 (2008) and 18 beavers (2009) have been trapped and killed.

Recently two new funding guidelines have been implemented as additional tools to support conflict resolution covering to some extent extra maintenance repair costs with respect to water resources management as well as to offer limited financial support for set-asides in forestry along rivers inhabited by beavers. Relevant funding is restricted to Natura 2000 sites.

## DISTRIBUTION OF BEAVERS IN LUXEMBOURG

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In Luxembourg, the Eurasian beaver went extinct at an unknown date probably located between 200 and 300 years ago. In the year 2000 the first signs of beaver activity were discovered in the North of the country. After this individual was killed by a train, new activity signs appeared in 2006. Since then, beavers have been confirmed at various distinct locations on several water courses. At the time of writing, no reproduction has been confirmed. It is hoped that 2009 will yield the first beaver offspring in Luxembourg for at least 200 years.

# EVIDENCE FOR THE PRESENCE OF THE NORTH AMERICAN BEAVER *CASTOR CANADENSIS* IN WESTERN EUROPE

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Over the past decades various reintroductions of, supposedly, Eurasian beavers (*Castor fiber*) were carried out in Belgium (clandestine "project"), Northern France (official project) and the two German counties of Saarland and North Rhine-Westphalia (both official projects). Luxembourg and the German county of Rhineland-Palatinate, located in the proximity of these regions, have not reintroduced any beavers, arguing that population increase in the other 4 regions would inevitably lead to recolonisation of their respective areas. Indeed a number of beaver sites are now known in Luxembourg and Rhineland-Palatinate. However, species identification (AGS colour, skull characteristics, RFLP analysis / sequencing of a mitochondrial gene) of a number of beavers showed that North American beavers (*Castor canadensis*) are without any doubt present in at least two of the six areas mentioned above. With the scale of the problem not yet known and the origin of the North American beavers subject to speculation, the presence of this species has led to a major concern over the conservation of the Eurasian beaver in this region of Europe.

# BEAVERS AND FORESTRY: AN AUSTRIAN CASE STUDY FROM THE DANUBE FLOODPLAIN AREA

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This case study is dealing with the occurrence of beavers living in the Danube floodplain forests on a territory owned and managed by a private real estate forest enterprise located within the Natura 2000 site "Tullnerfelder Donauauen". An area of 2800ha was investigated monitoring beaver activity signs to identify the size and density of actual existing beaver territories. Data was analyzed referring to real estate boundaries under investigation.

In the whole area the amount of trees and shrubs used by beavers as food resources was recorded and additionally at two randomly selected watercourses species composition of woody plants used was recorded. The actual forest stock was not determined.

42 beaver territories were identified in the study area. 31 territories with an average size of  $2,22 \pm 0,72$ km length, covering both riverbanks, were located along linear watercourses, additionally 11 territories were found at standing waterbodies. Density averaged  $0,57 \pm 0,21$  territories per stream km. Considering the fact that 12% of shore lines were related to ponds and gravel pits, with respect to the whole area an average of  $1,25 \pm 0,77$  territories/km<sup>2</sup> was calculated.

438 locations with cuttings and 496 locations with gnawing marks were investigated. At 66% of all mapped locations the cut stems had a diameter less than 10cm and only 1% contained cut stems with a diameter of more than 50cm. With increasing stem diameter the number of cuttings per mapping location decreased.

Gnawing marks were showing a different pattern: 36% were found at stems with a diameter less than 10cm, 15% on trees with a diameter of more than 50cm.

A more detailed inventory with respect to species composition showed that cuttings mostly affected poplars *Populus* spp. (38%) and cornus *Cornus sanguinea* (29%) followed by black cherry *Prunus padus* (16%). Gnawing marks were dominant at stems of black cherry (30%) and alder *Alnus* spp. (21%), followed by cornus (17%), willows *Salix* spp. (13%) and poplars (11%).

Mapping results of beaver density and distribution can be used by the forest enterprise to evaluate the impact of beavers in context with silvicultural management targets.

# THE RETURN OF THE BEAVERS TO THE DANUBE WATERSHED

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The Danube watershed, one of the biggest in Europe, was completely free of beavers by the mid of the 19<sup>th</sup> century. The new history of beavers in the Danube covers now more than 40 years of a successful return, from the first releases in Germany in 1966 to the most recent reintroduction in Bosina - Herzegowina in 2008.

In the poster I present the present status of the beaver in the Danube and the history of the come back.

# INFLUENCE OF CONSTRUCTION ACTIVITY OF BEAVERS (*CASTOR FIBER*) ON THE SPECIES DIVERSITY AND ECOLOGY OF RIPARIAN VERTEBRATE PREDATORS IN BELARUS: REVIEW OF RESULTS AND PRESSING QUESTIONS

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The presentation reviews the results of long-term studies on the question that were conducted by the Vertebrate Predation Research Group of the Institute of Zoology of National Academy of Sciences of Belarus.

The study took place mainly in north-eastern and central-western parts of Belarus and were carried out at small watercourses, where beaver construction activity is pronounced most of all. The beaver population density and construction activity were estimated along small watercourses of various types. In variety of situations hydrochemistry of beaver ponds, species diversity, population density and biomass of fish, crayfish, big aquatic beetles, frogs in beaver ponds compared to the adjoining non-inundated stream stretches of comparable length were investigated. The data gained were analyzed taking into account age of beaver ponds and their eutrophication with age. The changes in small rodent community affected by inundations by beavers and depending on pond eutrophication and overgrowing with macrophytes were studied.

In turn, respective changes in riparian predator community were revealed. Population density, distribution patterns and diets of predators that appeared to be influenced by beaver construction activity also were assessed.

# AUTUMN ACTIVITY AND FOOD CACHING BEHAVIOR OF THE NORTH AMERICAN BEAVER, *CASTOR CANADENSIS* IN WESTERN MASSACHUSETTS, USA

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The two beaver species (*Castor fiber*, Eurasian Beaver; *C. Canadensis*, North American Beaver) are semi-aquatic, primarily nocturnal and live in family groups exhibiting both genetic and social monogamy. They are described as choosy, generalist herbivores utilizing many species of herbaceous and woody plants found in their riparian habitats. Both beaver species cut and store branches of woody species during the autumn, which they use as food during the winter when the nutrient value of living vegetation is low and ponds may freeze limiting beaver movement. The food cache is generally constructed in front of the lodge (or burrow) where the beaver family resides during the winter months. Published reports indicate that beavers are less selective in species choice for the food cache as the autumn progresses and that there is a clear correlation between food caching activity and decreasing air temperature. In this paper we examine the weekly and seasonal food caching behavior by using motion activated and time-lapse photography. Beavers were less active around the food cache during the early stages of food cache construction (early to mid October), but increased their activity later in the caching season. Peak weekly activity occurred between week 5 and 6 (late October) and beavers were more active in caching branches later in the autumn. Total activity around the food cache increased after the last week in October and is strongly correlated with decreasing air temperature. These preliminary data support earlier published reports and allow further study of individual (specific family member) contribution to the construction of the winter food cache. These data are significant due to the evolutionary importance of the food cache in the life history of the beaver and will allow testing of theories into the evolution of monogamy in beavers.

# PHYLOGENY OF TERTIARY BEAVERS

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Beavers are a well defined group of rodents which are known from the late Eocene to recent times. Today only one genus with two generally accepted species, *Castor fiber* and *Castor canadensis* – both with several described subspecies – occur in Eurasia and North America respectively. During the Tertiary beavers have been much more diverse in North America, Europe and Asia ranging in size from about a mouse to a capybara. At least 23 genera have been described. In Europe there is one major radiation starting in the Late Oligocene or Early Miocene with *Astenofiber* or *Steneofiber*, with several subsequent species of *Steneofiber*, leading to *Chalicomys* and *Trogotherium*. Some generic distinctions are still not quite clear here. Probable immigrants to Europe include *Anchitheriomys*, *Dipoides*, and possibly *Castor*. In America at least two radiations occurred: the Palaeocastorine beavers restricted to North America and terrestrial and fossorial. The other probably including *Monosaulax*, *Eucastor*, *Dipoides* with aquatic affinities. So far no consensus on the systematic position of all species is achieved and new forms continue to be described. One difficulty is posed by the fact, that especially in Europe, beavers are usually found in low numbers and the bulk of the fossil material consists of isolated teeth and mandibular or small maxillary fragments. Skulls and even substantial skull fragments are generally rare. Therefore, and on the basis of the relatively large metric and ontogenetic as well as to a lesser degree also morphological variability of Recent *Castor* it is strongly suggested to discuss beaver taxonomy on the basis of populations or representative statistical samples, not in individual teeth or extremely fragmentary material. More names and descriptions won't help our understanding of this group of rodents.

Arguing for the use of larger samples to describe populations some results of statistical analyses of teeth morphometry are presented concerning *Steneofiber* as well as some palaeocastorine beavers.

Even though the phylogeny of the Castoridae has already been addressed several times a phylogenetic study of beavers was started with about 40 characters partially as already defined and used in the literature and according to own measurements and observations. Original material was studied where possible, but in some cases figures and information from the literature had to be used. Skull and teeth characters were used separately or together, mainly with European beavers, and the results and discrepancies are discussed. Preliminary results indicate a strong grouping of *Steneofiber* and *Trogotherium* as expected with all characters, a grouping of *Dipoides*, *Chalicomys* and partially also with *Castor*. This has to be discussed. Not well resolved were the positions of *Anchitheriomys* and *Monosaulax* so far.

# CAN EURASIAN BEAVERS (*CASTOR FIBER*) DISCRIMINATE BETWEEN ANAL GLAND SECRETION OF A SIMULATED INTRUDING MALE TERRITORY OWNER AND HIS OLD OR YOUNG SON?

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Anal gland secretion (AGS) is an important pheromone source in mammals that can provide detailed information about the sender's sex, age and social status, and can play a central role in competitor assessment. In many territorial species, before subordinates can successfully reproduce, males usually leave their natal colony to obtain a territory and mate of their own. These floaters could be expected to be more aggressive opponents in antagonistic encounters with territory owners, as they will have little to lose (the desperado effect). In this study we investigated whether information about age and territory ownership is coded in the AGS of male Eurasian beavers (*Castor fiber*), using a free-ranging population in Telemark County, Norway. Beavers normally disperse as two-year-olds, but population densities influence the time of dispersal. Yearlings can also leave when vacant territories are abundant, but may be less likely to be a threat in physical conflict due to their low body weight. We conducted two behavioral field bioassays simulating territorial intrusion, presenting a two-way-choice between experimental scent mounds (ESMs) treated with AGS from (a) territory owner (TO, age 4 - >11 years) and old son (OS, age 2-7 years) (N=12) and (b) TO (age 3 - >9 years) and young son (YS, age 1 year) (N=10). To support any findings of discrimination, we also performed chemical analyses using gas chromatography-mass spectrometry (GC-MS) of all samples used in the bioassay. Our results showed that residents (i) spent significantly more time sniffing scent from OS and YS than TO, (ii) spent significantly more time responding aggressively (straddling, pawing and/or over-marking the ESM) to scent from OS than TO and (iii) spent the same time responding aggressively towards scent from YS and TO. Multivariate analysis of the chromatographic data supported that there is a difference in the chemical composition of AGS between the three categories of male beavers. Our findings suggest that the AGS of the Eurasian beaver contains intrinsic information about the donor's age or social status, and that conspecifics can use this information to assess the threat an intruder is posing. We also suggest that dominant beavers carry a "territory owner" badge, making them perceived as less of a threat than beavers without a territory.

## SETTLEMENT OF A BEAVER (*CASTOR FIBER L.*) IN A STEPPE ZONE OF THE EAST OF UKRAINE

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The settlement of beavers is noted in the east of the Kharkov region. The family of beavers living near Stuzkivka village of Velykiy Burluk district is known to us. Beavers have been living on the Oskol inflow of the little river Lizhnyaya Dvurechnaya since 2003. Carried research has shown that 2 river beaver families live on a 3 km line along the river bank. These beavers came here from the Severskii Donets in Dvurechansky district along the Oskol river. In 2004 beavers settled in a little pond near Mechnikovo village of Dvurechansky district but unluckily by the autumn 2005 that settlement stopped existing. This settlement has ceased to exist. Beavers are also noticed in a storage lake at Mikhailovka village.

During the environmental work at the beginning of 70<sup>th</sup> of the last century in the Severskii Donets river in Lugansk region 20 beavers brought to Kremensky forest area (Lugansk region) have well got acclimatized in flood lakes of the river. The number of animals in the particular area has been increased more than in 5 times (Panov, 1990) in 9 years. 34 beavers have been recorded on the marshland of the Loznaya river flood lands near Ovcharovo village; 21 beavers – on the Kranaya River flood – lands near Tarasovka village and 34 beavers on the marshland further downstream near Novochervonoye village. This kind has also been found within 10 km on the marshland of Gnilaya river flood lands at Pokrovskoe village. Here 87 beavers have been counted.

Now settlements of a beaver are known on r. Aydar.

At the end of 90<sup>th</sup> in XX century 2 families have been counted in the Zherebets river flood forest, a family in the Bahmut river and a family in the Severskii Donets flood lands on the National Park "Svyatiye Gory" territory of Donetsk region.

Growth of number of beavers on any reservoir has the limits. Maximum density of beaver settlements is seldom over 1 per km<sup>2</sup> and a bank line even in first class arable land. Despite of greater population of areas of area, that the part of reservoirs is involved in economic use, beavers due to natural moving have practically occupied all flood and adjoining water-marsh arable the basic rivers of the Kharkov and Lugansk regions.

# NORTH-EAST UKRAINIAN SETTLEMENTS OF EUROPEAN BEAVERS (*CASTOR FIBER L.*)

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In an antiquity beavers were so numerous in the Kievan Russia, what their fur was used to make clothes not only inside of the country ("A word about Igor regiment"), but also served as a subject of export. Arabian writer of X century Massudi wrote that this fur and beaver jet were taken out to Andaluzia (Pohilevich, 1883). In the middle of XVI century, according to the statement of Polish author Michalonis Lituani, numerous beavers were found in coasts of Ukrainian rivers (Michalonis Lituani, 1550). In the end of XVIII century beavers were found here in a great number, apparently, as far as just in the territory of Chernigovschina only in 1782 1098 beaver-hunters were totaled (Karnauhov, 1913). However in the first half of XIX century the hunting on beavers, having existed in Ukraine not less than eight centuries, has lost its value.

The reason of reduction of quantity of beavers is easy to define. First, it is an excessive elimination of an animal earlier known as "introduction into trapping". The second one but not less important reason is the reduction of areas of biotopes, suitable for beavers existence, and, in particular, destruction of overflow land woods with sites, overgrown mainly with soft tree species like various sorts of willows (except a red rod), poplars, partly with an alder and other trees. Long ago Ia.V. Sharleman (1923) has noted in the literature, that beavers in conditions of Ukraine, here and there, had already starved, apparently, that they sometimes had to eat a bark and phloem of such of little use for them breeds, as an oak, and, occasionally, even a pine. The author had described and had given photos of some large oaks that were gnawed by beavers. One of such oaks reached 90 cm in diameter (Sharleman, 1923, 1927).

Time to time after that various researchers described cases of relative starvation of beavers. In the beginning of XX century beavers were eliminated in most part of the territory of Poltava area. Just three small settlements on Dnepr River near Kremenchug had stayed. From utter elimination, beavers were rescued by full interdiction of hunting. This decision was accepted in 1919 and in 1924. Works on reacclimatization of beavers in Ukraine has begun in the end of 20th of XX century.

In Poltava area, these works were carried in 70-80-th. In the end of XX century the decrease of agricultural load on the near banks flora, organization of numerous drain-channels promoted banks overgrowing by soft tree breeds that, in its turn, resulted in increase in the number of biotopes suitable for beavers living. Now steady settlements exist on the rivers Sulla, Psyol and Vorskla, as well as on their inflows. Therefore, our research carried out in April 2004 had shown that animals were usual for reservoirs of Mirgorod district. Except the river-bed of Horol beavers settle in marshland deepening and regularly updating the channels by which the forage located in distance of 70-80 m from the lodge (fig.) is delivered. Such settlements are usual in flood-lands near Zuevtsy village, Khomutets village and others in Mirgorod district. Beavers also inhabit water basins of Dnepr, but the best conditions for their existence were formed in mouth of

Psyol and Vorskla rivers. Beavers also inhabit flood-lands, Zolotonoshka and some islands of Kremenchug water basin of the rivers Ros, Olshanka. In Donetsk area beavers inhabit flood-lands of Zherebets river (3 families), Bahmut river (one settlement) and Martynenkovskie bogs in the territory of natural national park "Saint Mountains" (4 settlements). In the mouth of Severski Donets in the Rostov region a beaver had appeared in the beginning of 90th years of XX century. In the area of hunting economy "Kundrjuchenskoe" - 3 families near Bystryanka on Grachinyj Island and near Vavilov farm on Avilovskaya spit were fixed at that time. Now the beaver meets everywhere, but water regulation by means of sluices is not given it opportunities to master coasts of the basic channel.

# THE MAIN CHANGES IN WATER QUALITY OF A SMALL RIVER UNDER THE EFFECT OF BEAVER ACTIVITIES

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The analysis of chemical composition of water and its changes in the process of beavers' settling in a small river (the tributary of Rybinsk reservoir) has been held in the years 1999-2005 on 7 standard stations during the vegetation period.

At the beginning of the observations there was only one beavers' dam in the river and by 2005 there have been more than 20 dams. There was registered the difference in hydrochemical conditions of the river sections non-subjected to the influence of beavers and beavers' ponds. The adjustment of the river flow led to the reduction of the amplitude of concentration fluctuations of the basic ions along the river flow as well as during the vegetation period. In beavers' ponds the decrease (if compared with the control station) of the amount of sulphates was registered (in the period of the maximum warming up of water- up to zero ). The concentration of the dissolved oxygen decreases considerably (especially in the period of the maximum warming up of water) with simultaneous increase of carbone dioxide content. The correlated analysis of the data during the whole period of observations showed the presence of interconnection between the quantity of CO<sub>2</sub> and pH (r up to -0.96). The concentration of carbone dioxide is the main factor determining the quantity of the hydrogen indicator in ponds, where the values of pH are lower if compared with the control section. There revealed the dependence of the concentration of the dissolved oxygen and organic substances on the size and the age of the pond – the bigger and younger the pond is, the lower is the content of oxygen and the bigger is the amount of organic substances. The slowdown of the water flow leads to the sedimentation of the suspended matters. The absence of the correlated relations between the amount of the suspended matters and the content of the organic substances indicates that the latter exists in the ponds in the dissolved form mainly. In the ponds the concentration of the ammonium ions is higher and the nitrate ions is lower than on the control station, meanwhile the bigger part of nitrogen (about 70%) exists in the organic form.

With the presence of the source of the anthropogenic pollution (uncleaned sewage waters of the cheesmaking plant) beavers' ponds play a positive role in the processes of autopurification.

The processes of destruction and mineralization of the organic substances in the ponds run more intensive than on the control station. The communities of the hydrobionts create favourable conditions for the fastest utilization of the organic substances in the ponds.

# THE BEAVER - A KEYSTONE SPECIES FOR WATER MANAGEMENT?

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The EU Water Framework Directive was adopted in 2000 and is now being implemented in national legislations in the Member States. According to the directive, all waters should have good ecological and chemical status. Good ecological status signifies only a slight departure from the biological community which would be expected in conditions of minimal anthropogenic impact. To achieve this goal, knowledge about historical reference conditions for different ecoregions is obviously needed.

The beaver is an ecological engineer for both aquatic and terrestrial environments. As the species was commonly occurring in large parts of Europe in historic times, the landscape that we now regard as reference conditions was to a great extent created by its activities. Therefore the condition of "good ecological status" of small – medium sized streams in many cases would need to include characteristics created by beavers. Here we define these criteria and how they can be related to the concept of ecological status in European waters. We also describe how the varying status of beaver populations over Europe may contribute to the ecological status in different parts of the continent. This also means that the re-establishment of the beaver on the European continent is a way to approach good ecological status.

However, increased knowledge needs to be included to re-establish the beaver as a keystone species for water management. This makes it necessary with studies of the following: The historical beaver distribution in different types of watersheds, as well as modeling, and studies in reference landscapes where beavers are still present; Present density and impact of beaver in the landscape; Interactions with terrestrial ecosystems; Analysis of economic and ecological trade-offs, especially in areas with high beaver or human population densities. Finally, the current attitudes and understanding related to beavers in areas with differing history and density of beavers will need to be studied as a base for governance and management of watersheds.

# EVALUATION OF BEAVER MANAGEMENT IN A DISTRICT OF BAVARIA

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The scope of this study was the evaluation of beaver management in an district of Bavaria (Pfaffenhofen /Ilm) where Beaver management has been implemented in 1997 (about 10 years ago). To start this analysis of acceptance qualitative research methods were chosen in order to find out the atmosphere about beaver management and the beaver acceptance. This study is meant to form a basis for quantitative as well as standardized analyses. The problem centered interviews focused on two different groups of people: Experts and Landowners with beaver occurrence. 13 experts formed one group. All of them are in touch with the topic by means of their profession. The second group comprised 12 persons affected directly. All interviews included questions about beavers and recent wildlife management actions. The experts' questions were more fundamental, persons concerned were asked about their farming and specific problems caused by beavers. The number of newspaper reports about beavers was analysed to get an impression of the public opinion in this area. Striking differences were found between experts and landowners.

The knowledge of proactive beaver management was high in both groups. The ecological understandig was little and there wasn't a real acceptance of the beaver in the group of landowners. The awareness of the beaver management was connected with nature conservation which has a negative image in the group of the landowners. Although the support for farmers are high and lots of informations are placed they show little acceptance for the beaver and are nihilistic about its management.

# BEAVER IMPACTS ON ECOSYSTEMS AND LANDSCAPES: BENEFITS AND LOSSES

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Lithuania is an appropriate model region to monitor beaver impacts on ecosystems and landscapes with respect to the population restoration history. Started in the middle 1940s, the Lithuanian beaver population has reached high densities to the end of the 20th century. Nowadays the mean territorial density of beaver sites in the approximately 5000 ha sized plots was  $4.12 \pm 3.58$  SD sites/1000 ha (n=36). In some territories it was much higher, especially in the hilly moraine landscape of Lithuania. This is an example of a very quick restoration of a key stone species of ecosystems from its fully extirpation to the numbers nearly reaching carrying capacity of an anthropogenically transformed environment.

What can be the structural alterations and functional responses of ecosystems to such a short-tempered disturbance trend? Majority of investigations on beaver impact on ecosystems are dealing with impact on local scale, and few – on the landscape or even regional scale. It is hard to detect beaver impact on the population level because of the known methodological difficulties to get reliable data on population numbers of majority of species. In Lithuania, populations of game mammals, that potentially could benefit from beaver impact on habitats, have stabilized and grew up during several last decades, when beaver population and respectively its impact on habitats became high. However, it is not necessary related with beaver alterations.

More is known about the structural alterations of environment induced by beavers. They create specific complex habitats which consist of a number of the environment elements like beaver ponds, standing dead wood and debris, beaver dams, lodges, burrows, etc. Size of these habitats varies considerably depending on type of water bodies, vegetation cover, relief, beaver family size and duration of occupancy. The largest beaver sites have area more than 20 ha. However, overall proportion of the beaver altered habitats is comparatively low, reaching about 6–7 % of the total coverage of the territories that are densely inhabited by beavers (up to ca. 9 beaver sites/1000 ha of territory). This could explain lack of the significantly expressed functional responses on population level of mobile and euritopic species. More intensively beavers impact linear habitats, like riparian zone. In Lithuania, this impact was estimated to be up to 18% of the total length of drainage canals. In natural rivers of various sizes, intensity of beaver impact was estimated being much higher: frequency of occurrence varied from 82 to 100% in 0.5 km segments of shoreline (n=555). Spatial correlations between beaver and the other semi aquatic mammals were detected.

Several main types of beaver sites are characteristic for temperate lowland and anthropogenically changed landscape of Lithuania: 1) beaver sites on lakes (ca 16%); 2) on large rivers without dams (ca 18%); 3) on small streams with dams (ca 12%); 4) on drainage canals (ca 36%); 5) on swamps (ca 15%) (n=1310). Respectively, the impact of beavers can be different depending on the site type. The maximum effect of

beaver impacts should be expected where they are able to alter the hydrological characteristics of water bodies, such as small streams, drainage canals and small swamps.

The most obvious is beaver impact on phytocenoses. Plant communities of beaver meadows have features characteristic of the early successive stages, and their features can be explained by specific habitat conditions, the most important of which seem to be the increased soil dampness, acidity and nutrition. At the same time, beaver meadows contain relatively high species richness that is comparable with natural flooded meadows.

Reduction of the lotic habitat amount along the stream continuum and related changes of species composition in small natural streams, flooding of habitats of rare plant species, reduction of spawning areas for salmon fish can be listed among major losses resulted from beaver impact. Beavers support some invasive species (muskrat, American mink, raccoon dog, and some plant species).

Temporal aspects of beaver impacts should be taken into account when estimating the beaver induced ecosystem alterations. In Lithuania, the longest and still persisted beaver impact at the same site reaches more than 30 years, but proportion of such sites is rather small not exceeding 10% of all known sites. Appearance and structural characteristics of these old beaver sites are different from the newly established beaver sites.

# DETERMINING OF BEAVER TERRITORIES ON THE BASIS OF STAND MARK ANALYSIS AND RADIOTRACKING

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Nowadays population of European beaver is increasing slowly, but detailed and reliable information about abundance are still missing. At present research, population status is based on numbers of unique territories. There is no consensus about techniques how to determine borders of the territories if no radiotracking data are accessible. Assessing the borders and central places in separate territory is quite simple. In dense population it becomes more complicated, because one territory is situated next to another one and the border is not so perspicuous.

We focused on testing of two methods of determining the territory size – radiotracking and noninvasive method based on stand marks produced by beavers (like for example quantity and diameter of cut trees, number of dens, dams or scent marks). Both data sets were collected in floodplain forests in the south of Moravia (m) and on small creeks under Český les Mountains (cl) during the years 2006-2008. We also radio tracked 28 beavers ( $n_m=14$ ,  $n_{cl}=14$ ;  $n_{2006}=6$ ,  $n_{2007}=8$ ,  $n_{2008}=14$ ) in 17 territories ( $n_m=9$ ,  $n_{cl}=8$ ). Spatial telemetry locations obtained from October to January were compared with intensity and distribution of stand marks localized in the same place in the same period.

We used kernel density estimation methods, autocorrelations, nonlinear mixed models and generalized linear models. We can say that between intensity of stand marks and movement of radiotracked beavers in one territory exists significant similarity (GLM<sub>nbinom</sub>:  $F_{916}=6.087$ ,  $p<<0.001$ ). Also spatial distribution of both data sets is closely similar, thus both methods can provide the comparable and quantitatively same results. In the future we would like to find an algorithm to assess the size of the territory, when both these methods (radiotracking and stand mark analysis) can be interchangeable and determining of beaver territories in dense populations could be more exact and effortless.

# SIMPLIFICATION OF WINTERING FOOD NICHE OF BEAVERS IN CENTRAL EUROPE

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Because food sources are limited and their distribution is random or patched they strongly influence animal's behaviour, their population dynamics and distribution. There exist two main food strategies between mammalian herbivores – specialists and generalists. Type of food strategy relates from food requirements of herbivores on one side and the constraints given from quality and composition of food on the other side. We used Eurasian beaver (*Castor fiber*) as a model large mammalian generalist herbivore to test whether is possible to simplify his winter food niche for generalisation of food behaviour in linkage to spatial pattern of source. The food behaviour was studied in 110 territories in five environments with significantly different composition of riparian stands, using preference indices. To set the linkage between availability and usage of food sources PCA was used. We found out strong preferences for willow, which was positively selected in 73% territories and for poplar positively selected in 70% territories. Also, generally evidentially positive linkage between food behaviour and presence of willows and poplars in riparian stands was detected. Eigenanalysis showed, that distribution of territories in all selected areas were mainly ordered alongside two axes represented by Salicaceae, which explained 85.8-99.7% of variability per selected areas. The consummation of both preferred trees was significantly depended on its availabilities. When availability of food preferred source decreased the selection of these trees increased. It seems that there exists strong relationship between distribution of beaver territories and distribution of poplars and willows.

## THE SOME NEW DATA ABOUT BEAVERS (*CASTOR FIBER*) IN POLISTO-LOVAT' BOG SYSTEM (NORTHWEST RUSSIA)

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In 2006-2009 the monitoring of beaver population in east part of Polisto-Lovat bog' system (Novgorod province, NW Russia) was proceeded. In the study area, the total amount of beaver settlements has made 117. From them in 2003-2009, 11 settlements have been continuously abandoned, and 20 - continuously occupied. Beavers periodically occupied and abandoned other settlements. Some settlements we could check only once, and we have on them incomplete data. In 2006-2007, 85 settlements it has been surveyed, from them 50 (59%) were inhabited. In 2007-2008, 88 settlements has been surveyed, from them 60 (68%) were inhabited. In 59 settlements the account of beavers by a Lavrov's method (1952) has been carried out. The search of kits by registration of traces of hinder legs, prints of incisors on thin branches and listening of beaver lodges has been made in a sub-sample in 20 settlements. The kits have been found in 13 (65%) settlements. For check of accuracy of number estimation the visual observations have been made. Results of the account: 6 settlements - weak (1-2 beavers), 35 - averages (3-5 beavers), 18 - large (6-8 beavers). The big percent of large settlements (31%) is characteristic for a periphery of hydrological network. The huge beaver lodges have been found in large settlements. The sizes of the greatest lodges: 11.0×8.0×3.0 m; 19.0×6.0×1.9 m; 21.0×5.0×1.9 m.

The lower limit of quantity of wood forages has been counted up for 3 modeling beaver ponds. *Nuphar lutea*, *Calla palustris* and *Carex* sp play a key role for the bog's beavers.

For the bog's beavers the autumn rains are most favorable, the summer droughts are the worst.

Large predators. The lynxes constantly check beaver settlements, but especially for beavers do not hunt. The wolves know the locations of all inhabited lodges; the wolves make rectilinear routes from one inhabited lodge to another, they actively hunt of beavers and dig out of lodges.

In an open bog the beaver lodges are important refuges for raccoon dogs, foxes, minks, otters.

# THE BEAVERS OF THE TYUDMA RIVER (CENTRAL FOREST STATE BIOSPHERE RESERVE, RUSSIA): FROM A REINTRODUCTION TO A CLIMAX POPULATION

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What can be a population density and an ecological role of the European beavers at a long absence of anthropogenous influence? The answer to this question can give the analysis of a modern condition of the oldest Russian beaver populations from the Tjudma River (Central Forest State Biosphere Reserve, Tver province, Central Russia). First 22 km the Tjudma River is flowing in the reserve. This river has a watershed 114 sq km. In the virgin forests the natural processes remain throughout last 400 years (Minayeva, Shaposhnikov, 1999). The strong hurricanes and extensive windfalls were marked in 1961, 1987 and 1996 (Karpatchevsky et al., 1999). Large predators constantly are living in the territory. The average long-term lynx density is 3.0–5.6 inds/100 sq km, and the wolf density is 0-3 inds/100 sq km.

In 1936-1937, 8 beavers from Voronezh have been released in the Tjudma River.

In 2007-2008 29 km of water-currents in the Tjudma watershed are surveyed. 20 inhabited settlements, from which 12 (60%) large (more than 4 beavers) are found. Population density is 0.7 settlements/km of channel. Average distance between the next inhabited burrows or lodges  $1211\text{m} \pm 422$  ( $\pm$ SD,  $n=21$ ) m. Beaver trails rather short, in average  $11 \pm 5.4$  m ( $\pm$ SD,  $n=31$ ). The various beaver artifacts are numerous: on 19 km of Tjudma channel 90 dams are; there are «beaver meadows»; there are the anastomosing systems of river channels; the great volumes of sediments are accumulated above beaver dams, sometimes up to full filling of a channel. Windfalls - the basic places where beavers prepare the winter forages: a mountain ash, a bird cherry, a hazel, an elm, a grey and black alder, a willow, an aspen. Marking activity is very high, especially on borders of settlements. Some wolfs and lynxes are specialized on capture of beavers. In 2008, in the Tjudma watershed the beaver wool is registered in 83% ( $n=12$ ) of wolf's excrements and in 25% ( $n=18$ ) of lynx's excrements. However, despite the constant pressure of the large predators, the natural dynamics of forests and building activity of beavers have created conditions for maintenance of high beaver population density.

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**For notes**

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**PROGRAMME  
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