Beavers and forest management. Trade-offs, solutions and co-existence

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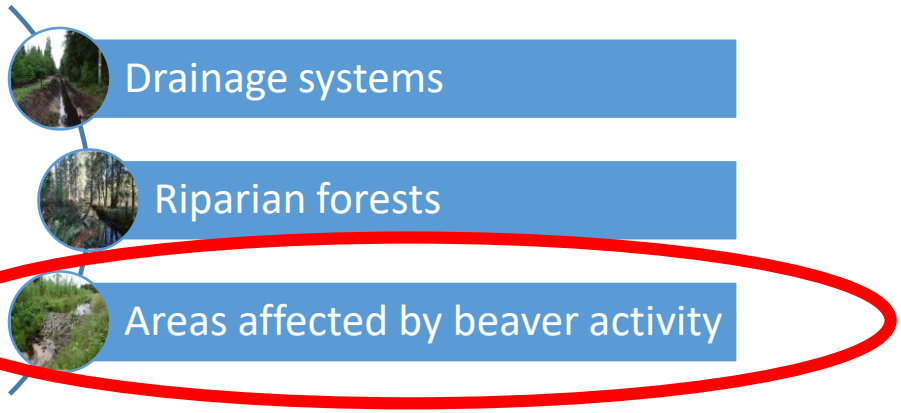
Water Management in Baltic Forests - WAMBAF

Project aim: by focusing on drainage issues, riparian forests and beaver dams, to reduce nutrient and mercury export from forestry sites to streams and lakes.



- **Project duration:** March 2016 – February 2019
- **Total budget:** 2.9 mill. EUR
- **ERAF budget:** 2.3 mill. EUR
- **Lead Partner:** Skogsstyrelsen (SE)
- **Partners:** Skogforsk (SE), SLU (SE), LUKE (FI), Metsähallitus (FI), LSFRI Silava (LV), LRCAF (LT), Lithuanian Ministry of Environment (LT), IBL (PL)

Toolbox for management of areas affected by beaver activity

- Handbook «Beaver as a resource» with information on beaver population and management in partner countries
- Decision support tool for the classification of beaver dams
- Demonstration objects - management and monitoring of management impact of beaver-affected areas
- Training courses

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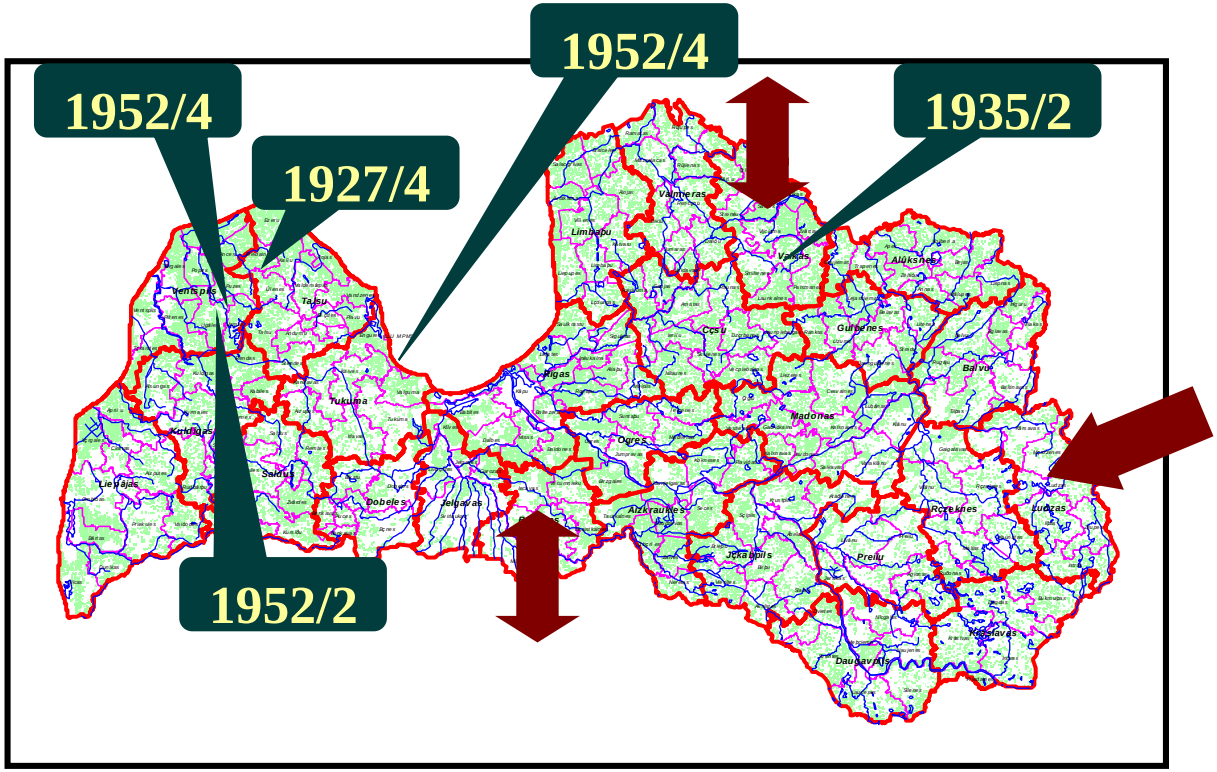
History

- Last beavers in Latvia hunted in 1871-1873
- Reintroduction started in 1927. Population origin: Norway, Belarus, Russia (Voronezh)
- Hunted species since 1980
- Studied by Dr.hab.biol. M. Balodis (1919-2001)
- 2 PhD theses, 1 monograph, approx.20 scientific papers

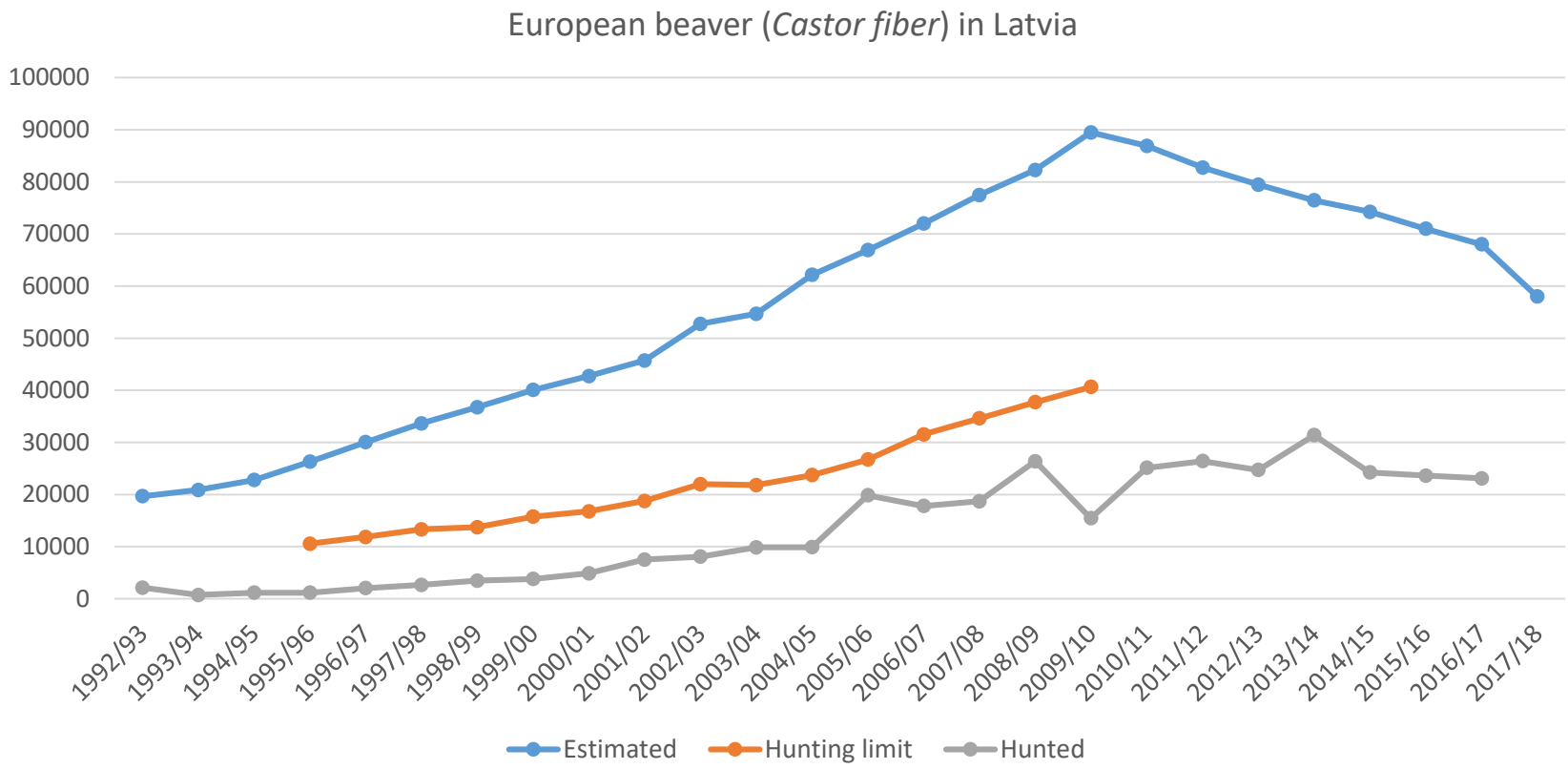


There are only **European beavers** (*Castor fiber*)in Latvia! No Canadian beavers (*Castor canadensis*)!

Conservation status

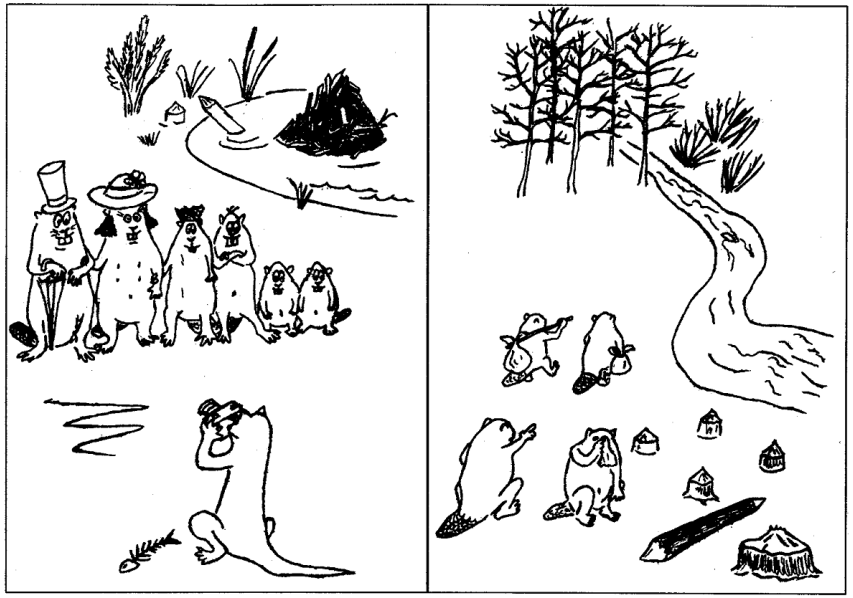
- Beaver is **Annex V** species of the **Habitats Directive 92/43/EEC** - Member States must ensure that their exploitation and taking in the wild is compatible with maintaining them in a favourable conservation status. Reporting each 6 years. No hunting during the time of reproduction allowed. Forbidden means of hunting: artificial light sources, unselective hunting gear, explosives, «smoking» out of the dens, automatic or half-automatic guns with more than 2 patrons in the magazine.
- According to Regulations No. 421 of the Cabinet of Ministers, beaver is **game animal**, with no hunting limit. Hunting season lasts from July 15th to April 15th.

Population dynamics in Latvia



Life cycle

End of winter… …in three months… …next autumn… …into new life.



Pictures from Balodis M. 1982

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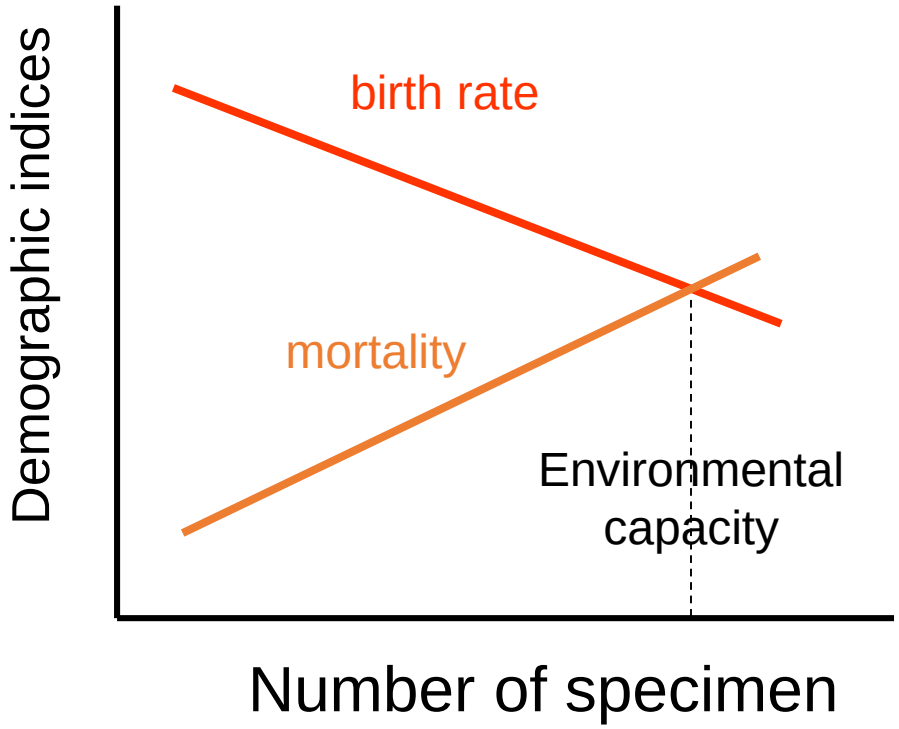
Population size and environmental capacity



When the size of population has reached the environmental capacity of specific area, no hunting is necessary, for as many specimien perish as are born.

According to Gackis (2013), on average there are 4.6 beavers in one beaver family in Latvia.

Māris Gackis 2013. Population aspects of beaver *Castor fiber* L. in drained forests. Jelgava: LUA, PhD thesis.

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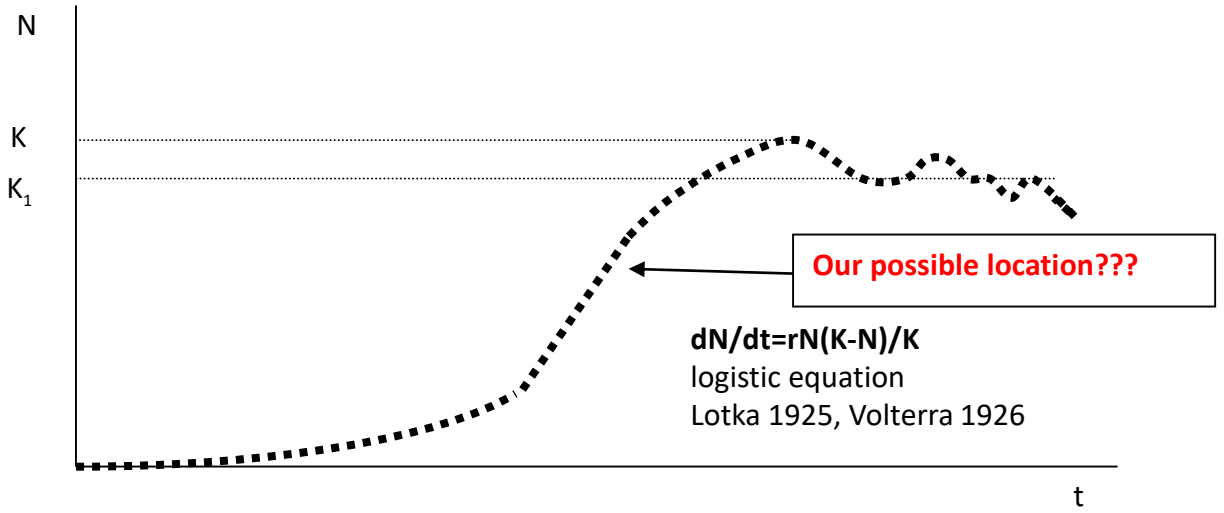
Dependence of the population size on the biological (ecological) capacity of the hunting areas



K – max possible number of specimen, mainly limited by food and habitat resources
r – increment coefficient within a full reproductive cycle: from birth to the new generation
K_1 – biological capacity of the environment (in reality slightly less than K)

Habitats suitable for beavers in Latvia

In 1990ties a survey was carried out to characterize the beaver habitats according to the length of the coastline (per 1 km^2 of the country area)

Large rivers(>50m width) – 12m;

Medium rivers (20-50m) – 8m;

Small rivers (2-20m) – 123m;

Brooks (<2m) – 62m;

Ditches (<2m) – 636m;

Channels (>2m) – 99m;

Lakes – 122m

Total – 1062m

Total environmantal capacity of Latvia is one beaver family (at least 4 specimen) per each km^2 or at least 250 000 beavers, as long as there are sufficient food resources.

Habitats

Small natural rivers

Large rivers

Lakes

Straightened rivers

Forest drainage systems

Sea coast

Impact on forestry and infrastructure

Beaver activity in the drainage systems negatively affects forest growth. Gackis (2009) found that inundation by beaver reduces the annual increment by 62% in the adjacent pine stands and by 70% in the adjacent spruce stands. Estimated economical losses were 124 EUR ha^{-1} annualy if pine stands were inundated and 276 EUR ha^{-1} annually if spruce stands were inundated.

Gackis, M. (2009). The impact of beaver inundation on drained coniferous stands in the Mālpils forest district. Mežzinātne / Forest Science 20(53): 68-82

Impact on biodiversity and landscape (1)

- In general, **beaver activity favours biodiversity** in the affected area by increasing habitat heterogeneity on temporal and spatial scale. Beaver impoundments increase the landscape-level species richness (Ecke et al. 2017).
- **Beaver activity in Latvia favours Eurasian otter (*Lutra lutra*)**, a protected species according to Annex II and IV of the Habitats Directive, by providing favourable habitat for its main food source - frogs.

Ecke *et al.* 2017. Meta-analysis of environmental effects of beaver in relation to artificial dams. *Environ. Res. Lett.* **12** 113002

Impact on biodiversity and landscape (2)

- **Some species may be affected adversely**, for example, beavers destroy the habitats of **freshwater pearl mussel** (*Margaritifera margaritifera*), species of Annexes II and V of the Habitats Directive and **thick-shelled river mussel** (*Unio crassus*), species of Annexes II and IV of the Habitats Directive. Action plans for conservation of these species emphasize the need to limit beaver activity in streams where populations of these mussels are found (Latvian Fund for Nature 2004, Latvia Union of Malacologists 2010). Beaver activity has been identified as one of the factors favouring the decline of pearl mussel habitats in western part of Russia (Popov&Ostrovsky 2013). Negative effects on the survival of large freshwater mussels have been found also in the USA by Hoch (2012).
- **Beaver activity significantly alters landscape pattern**, that may in some cases be undesirable, even in protected areas. Brezge & Soms (2013) concluded that flooding by beaver has adversely affected the small river valley ecosystems in the nature park «Daugavas loki».

Popov&Ostrovsky. 2013. Survival and extinction of the southern populations of freshwater pearl mussel Margaritifera margaritifera in Russia (Leningradskaya and Novgorodskaya oblast). Hydrobiologia, DOI 10.1007/s10750-013-1640-4
Brežģe&Soms. 2013. Bebri kā nozīmīgs ainavas elementu veidošanās ietekmējošs faktors dabas parkā «Daugavas loki». Latvijas Universitātes 71.Zinātniskās konferences referātu tēzes.

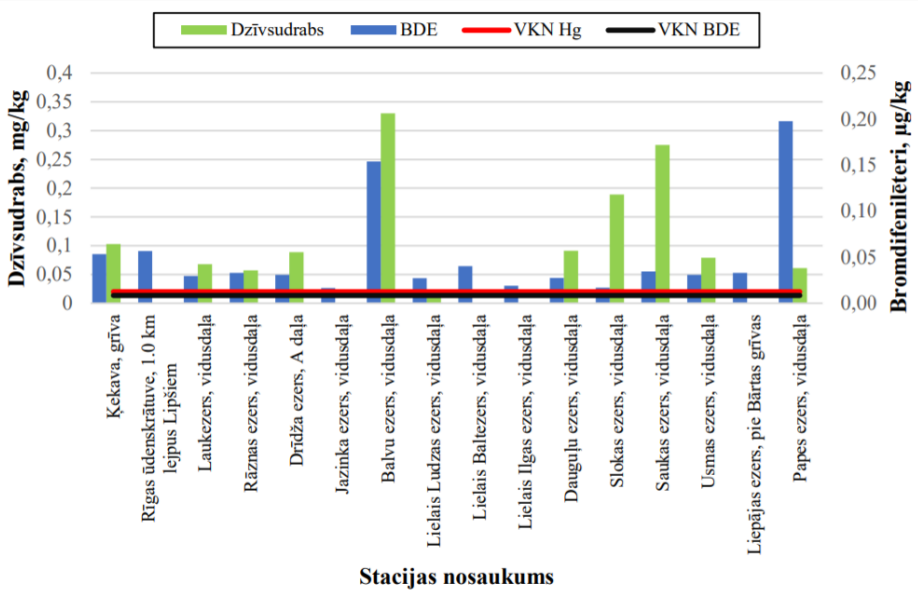
Impact on water quality (1)

- Beaver activity is usually considered **beneficial** for downstream water quality. **The effects vary** depending on the land use, hydrology and other factors. Puttock et al. (2018) found that beaver ponds may help to mitigate accelerated soil erosion and diffuse pollution from intensively managed agricultural landscapes.
- Beaver-induced hydrological changes significantly alter **nutrient cycling pathways**, but the reported results are often controversial and ambiguous, for example, beaver ponds may act both as phosphorus (P) sources and sinks (Ecke et al. 2017).
- Beaver ponds are **potentially important source of methylmercury** (MeHg), a potent neurotoxin. Levanoni et al. (2015) found that pioneer inundation by beavers can increase MeHg concentrations in streams. Impoundment age may be a significant factor influencing methylation rates (Ecke et al. 2017).

Ecke *et al.* 2017. Meta-analysis of environmental effects of beaver in relation to artificial dams. *Environ. Res. Lett.* **12** 113002
Puttock et al. 2018. Sediment and nutrient storage in a beaver engineered wetland. Earth Surf. Process. Landforms 43, 2358–2370

Impact on water quality (2)

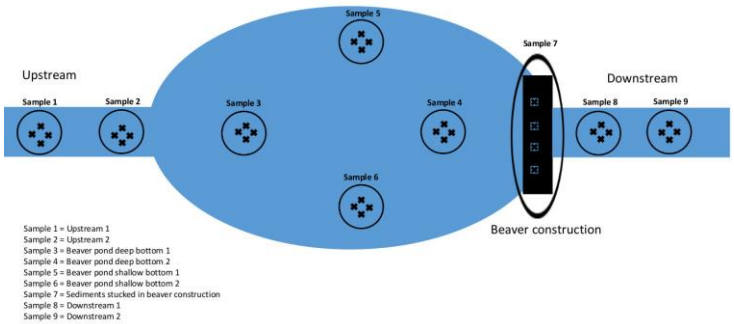
- Why is mercury (Hg) important?



Concentrations of mercury and bromdiphenyl ethers in monitoring stations in Latvia in 2017 (in perch, mg/kg wet weight), as compared to the environmental quality norms (From: Latvian Environment, Geology and Meteorology Centre, 2018)

- Priority hazardous substance, as related to water quality.
- Organic form, methylmercury (MeHg) is a potent neurotoxin, highly mobile, prone to accumulate in the trophic chain.
- Methylation mechanisms are complex, therefore comparatively little studied and poorly understood so far.

Impact on water quality (3)



- Beaver dam removed in August 2017
- Sampling in 29.05.2017 (prior to the dam removal) and 06.10.2017 (after the dam removal) – Hg and MeHg in sediment and biota

- Hg in biota (*Pungitius pungitius* and *Lymnaea stagnalis*) **far exceeds** EQS for fish (20 ng/g wet weight)
- In water, MeHg concentrations **highest** in Latvia (2,5-7,0 ng/L); also percentage of MeHg from total Hg **extremely high** – 17-33%
- THg concentration in sediments not too high (0,8-46 ng/g), but the **percentage** of MeHg (~3%) anyway indicates high methylation rate.
- Correlation with the content of organic matter and nitrogen? Microbial activity impact?

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Solutions

To keep the beaver population halfway to the environmental capacity, when the growth is largest, at least 40% of the population must be hunted (instead of 25%), that is, more than 60 000 beavers per year – 2-3 times more than at present.

This intensity of hunting is not realistic, therefore, two solutions should be implemented simultaneously:

1. Allow beavers to reach environmental capacity in places where they do not damage the infrastructure, thus enabling the self-regulation of the population.

2. Prevent beavers from settling in places where they make damage, intensively hunting these areas and eliminating the animals there completely.

3. More knowledge on the effects of beaver activity on water quality is needed, especially in light of the climate change.

Need for aid in decision making – WAMBAF (1)

«The Baltic Beaver Handbook – the beaver as a resource» - in preparation. Main editor: Göran Sjöberg (SLU).

1. Foreword: The purpose of the WAMBAF project
2. General biology of beavers
3. Distribution in Europe and country-specific population status, challenges, relevant legislation and management schemes
4. Beavers' role in the ecosystem, and in soil and water processes
5. Short history of Eurasian and North American beaver species populations around the Baltic Sea
6. General aspects of hunting and trapping of beavers
7. The processing, marketing and use of beaver products: Fur, meat, and castoreum
8. The beaver as a resource for tourism business and education: Hunting tourism / nature tourism /nature guiding
9. Prevention of beaver damage to economic interests
10. Management of beavers for water quality
11. Practical tools for making decisions concerning beaver dams
12. Conclusions. Guidelines for management of beavers and beaver ponds

Why yet another beaver handbook?

Baltic Sea Region has specific conditions regarding this species.

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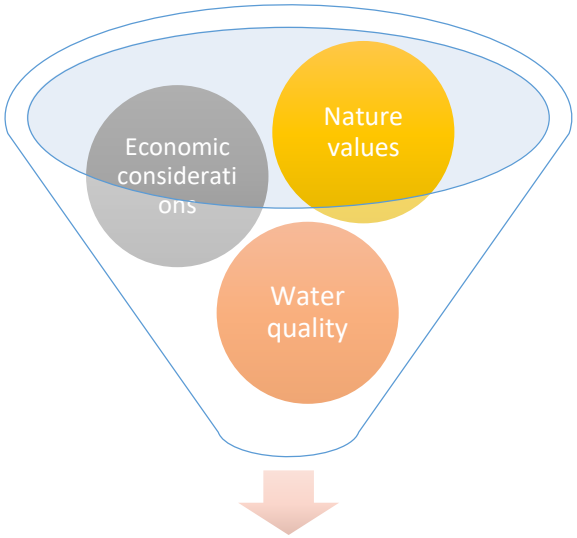
Need for aid in decision making – WAMBAF (2)

Beaver dam classification tool – in preparation

	A	B	C	D
1	**Site information**			
2	Beaver system (name):	drainage ditch		
3	Name of observer: Viktoras Kalvaitis	Date: 2017-09-11		
4	Country: Lithuania			
5	Province: Skuodas district Coordinates: X: Y:		Coordinate system:	
6				
7	**Background data**			
8	Total size of the beaver pond (sqm):			
9	Number of dams in the beaver system	Total: 2	Upstream: 1	Downstream:1
10	Total water surface in the beaver pond (sqm):	2000	800	120
11	Age of the beaver pond < 5 yrs	≥ 5 - 10 yrs	> 10 yrs	
12	Colonization history of beaver pond	Pioneer	Re-colonized	Unknown
13	Height of beaver dam (m): 1,2			
14	Is the dam maintained by beavers?	Yes	No	
15	Flooded area (%)	Forest:0	Arable land:0	Mire/swamp:0
16	Flooded forest type	Broad-leaved	Coniferous	Mixed
17	Is the beaver dam built in a ditch or natural stream?	Ditch	Natural stream	Heavily modifie
18	Are the trees in the flooded forest still alive?	Yes	No	
19				
20	**Water quality**			
21	Is the stream a clear- or brown water system?	Not colored	Colored	Very colored
22	Is the water downstream the dam more transparent than upstream? Visual assessment	Yes	No	
23	Water transparency	Species & unit	Upstream:	Pond:
24	Absorbance	Species & unit	Upstream:	Pond:
25	Oxygen	Species & unit	Upstream:	Pond:
26	**Concentrations of nutrients and metals**			
27	Nitrogen	N-species & unit	Upstream:	Pond:
28	Phosphorous	P-species & unit	Upstream:	Pond:
29	Mercury	Hg-species & unit	Upstream:	Pond:
30	Temperature	Species & unit	Upstream:	Pond:

To beaver or not to beaver?



Remove the dam(YES/NO)

Yes/no questions, scoring system

https://www.skogsstyrelsen.se/en/wambaf/

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Which picture gives more precise information about the object?

Details and halftones are important if we are to gain **sufficient knowledge** and make **well-informed** management decisions.

Thank you!

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