
The Warme Moldau River

Chemical, hydromorphological, and other environmental parameters of optimal habitats for the freshwater pearl mussel: Czech experience

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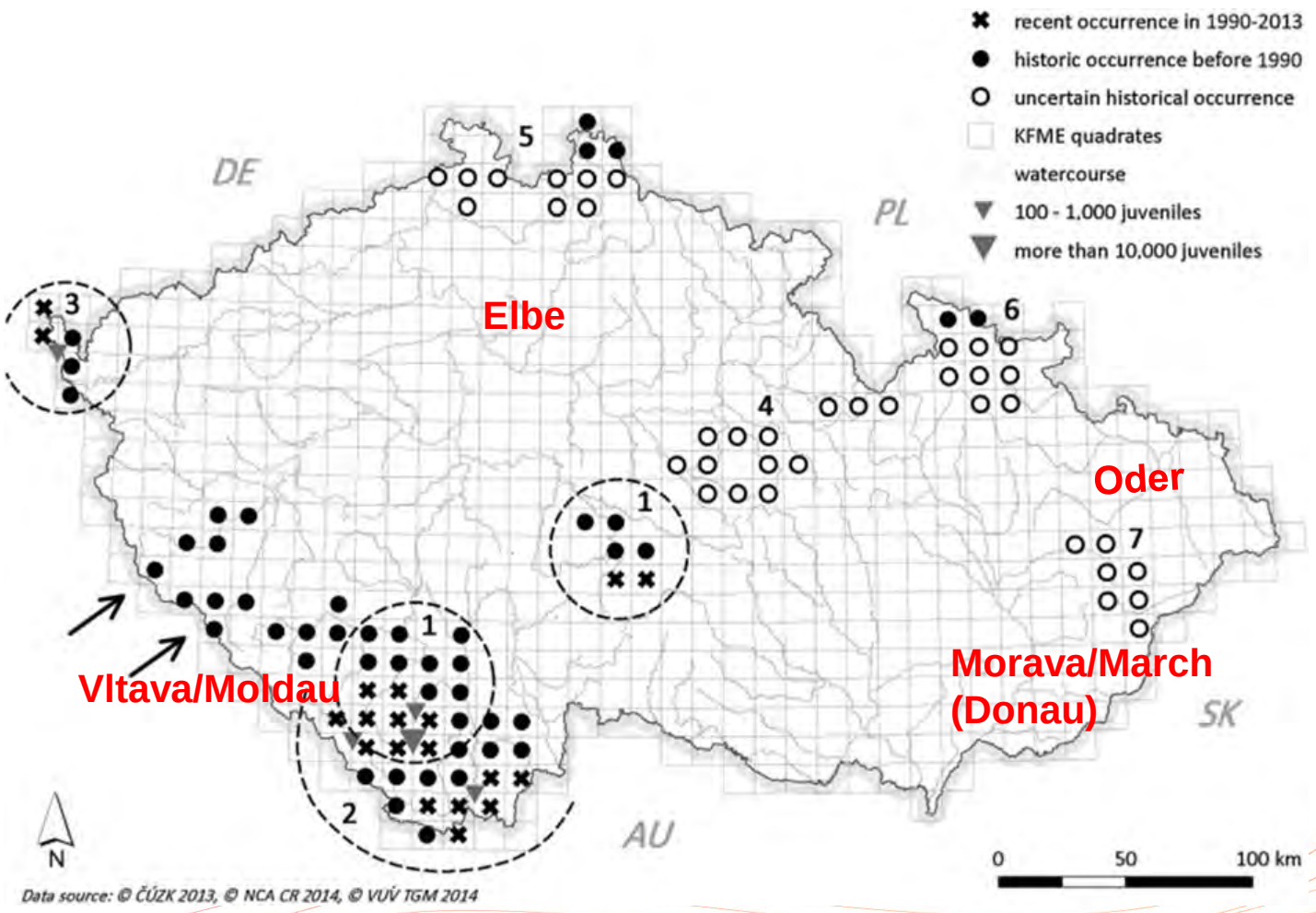
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Margaritifera margaritifera: Past (●) and present (x) occurrence

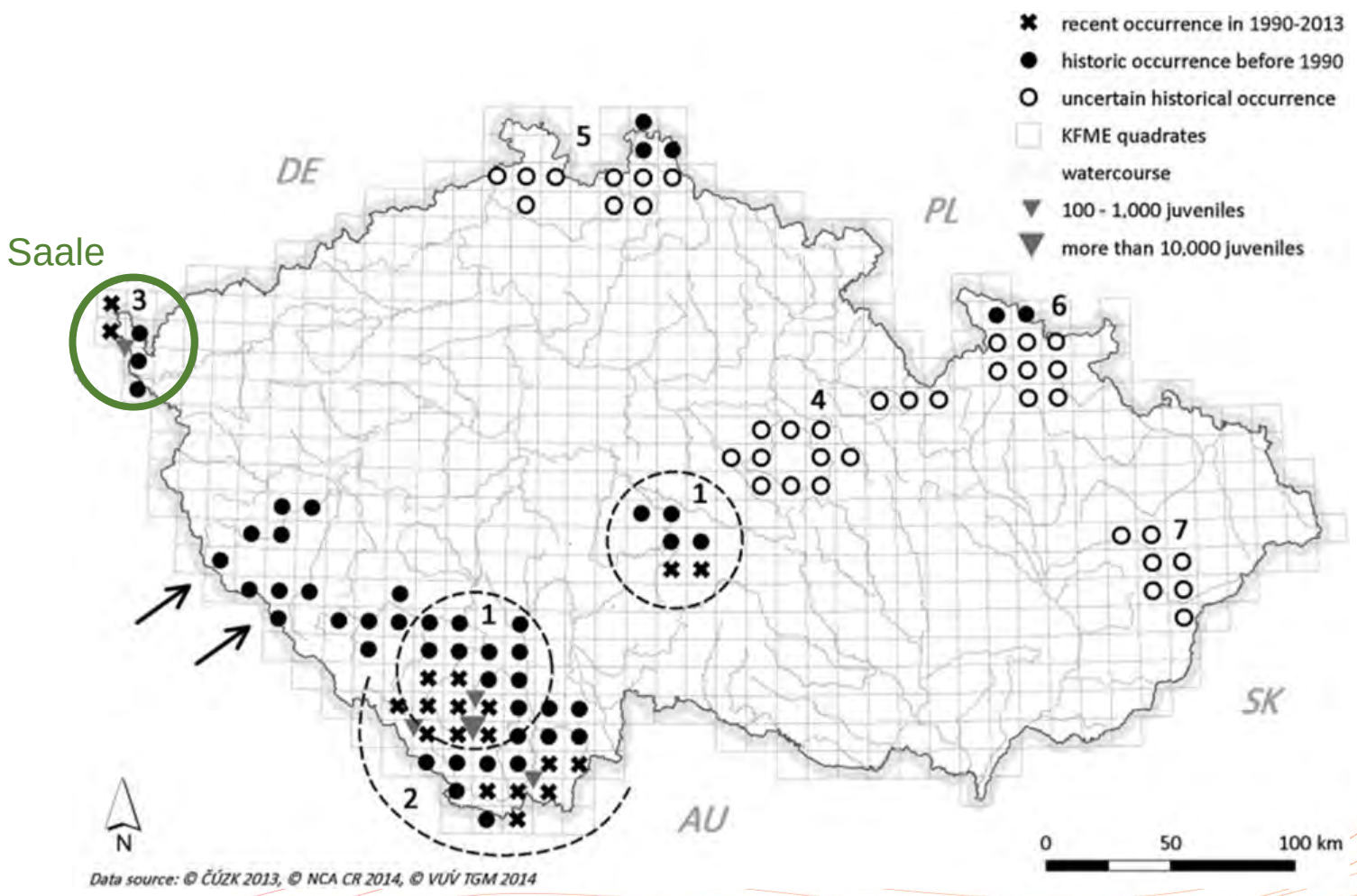


Historically:
catchments of **the Moldau**, **the Elbe**, **the Oder**, **the Donau** Rivers (often colonies of tens to hundreds of thousands individuals)
.....
sporadic occurrence until 1937

Conservation units:
1 – the Blanice (Flanitz)
2 – the Malše (Maltsch)
3 – the Saale

Simon et al., 2012

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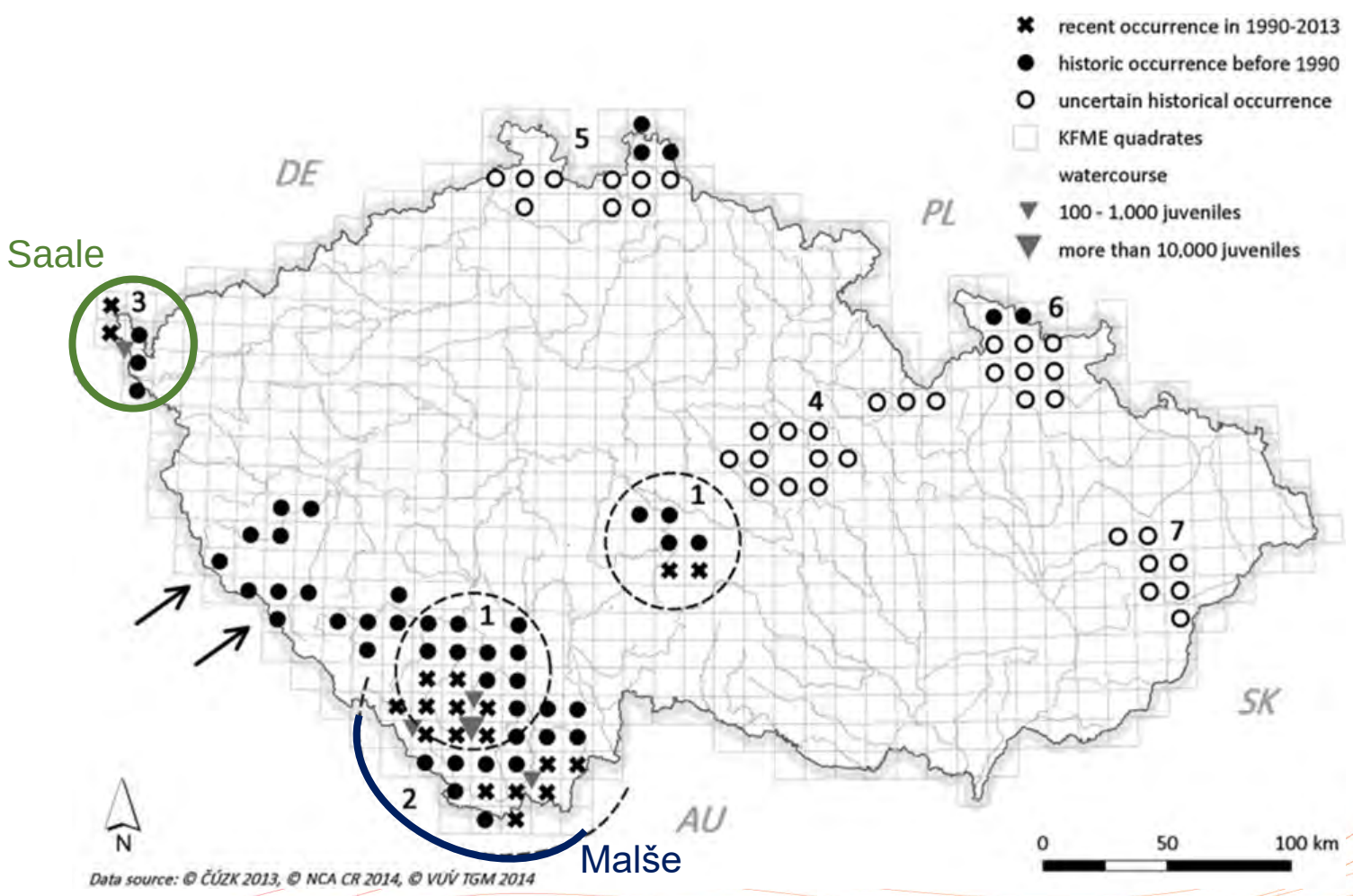


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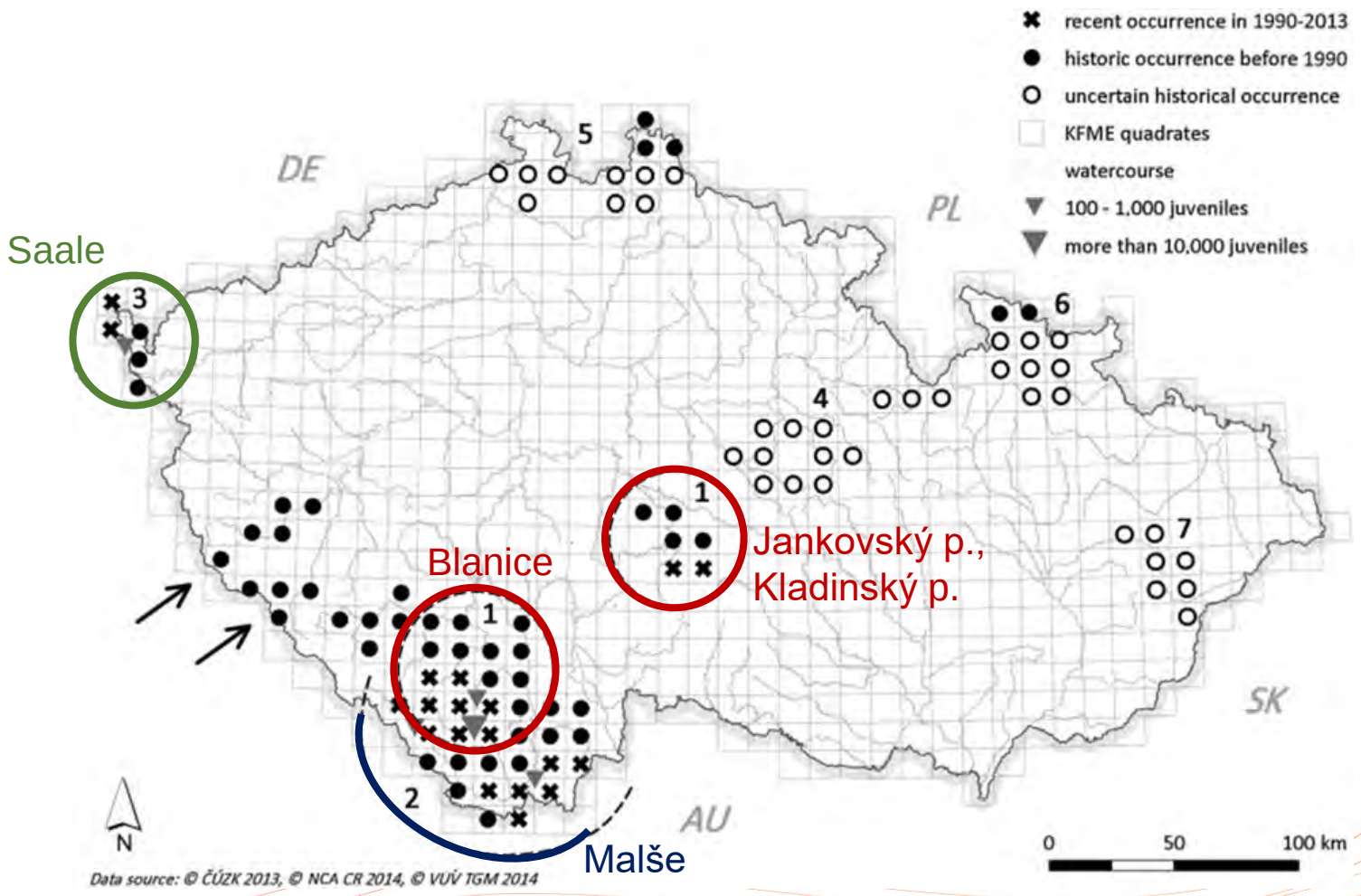


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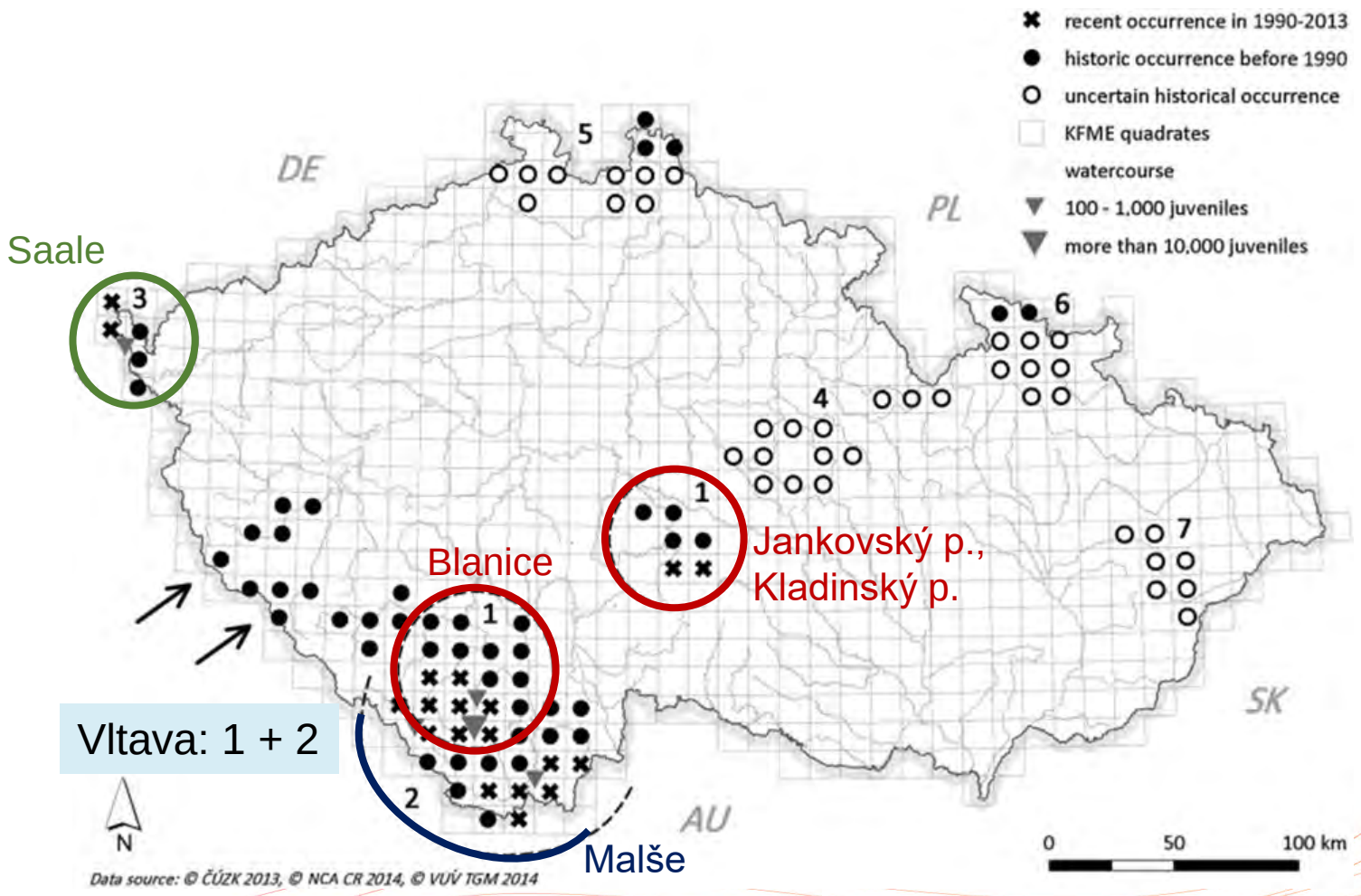


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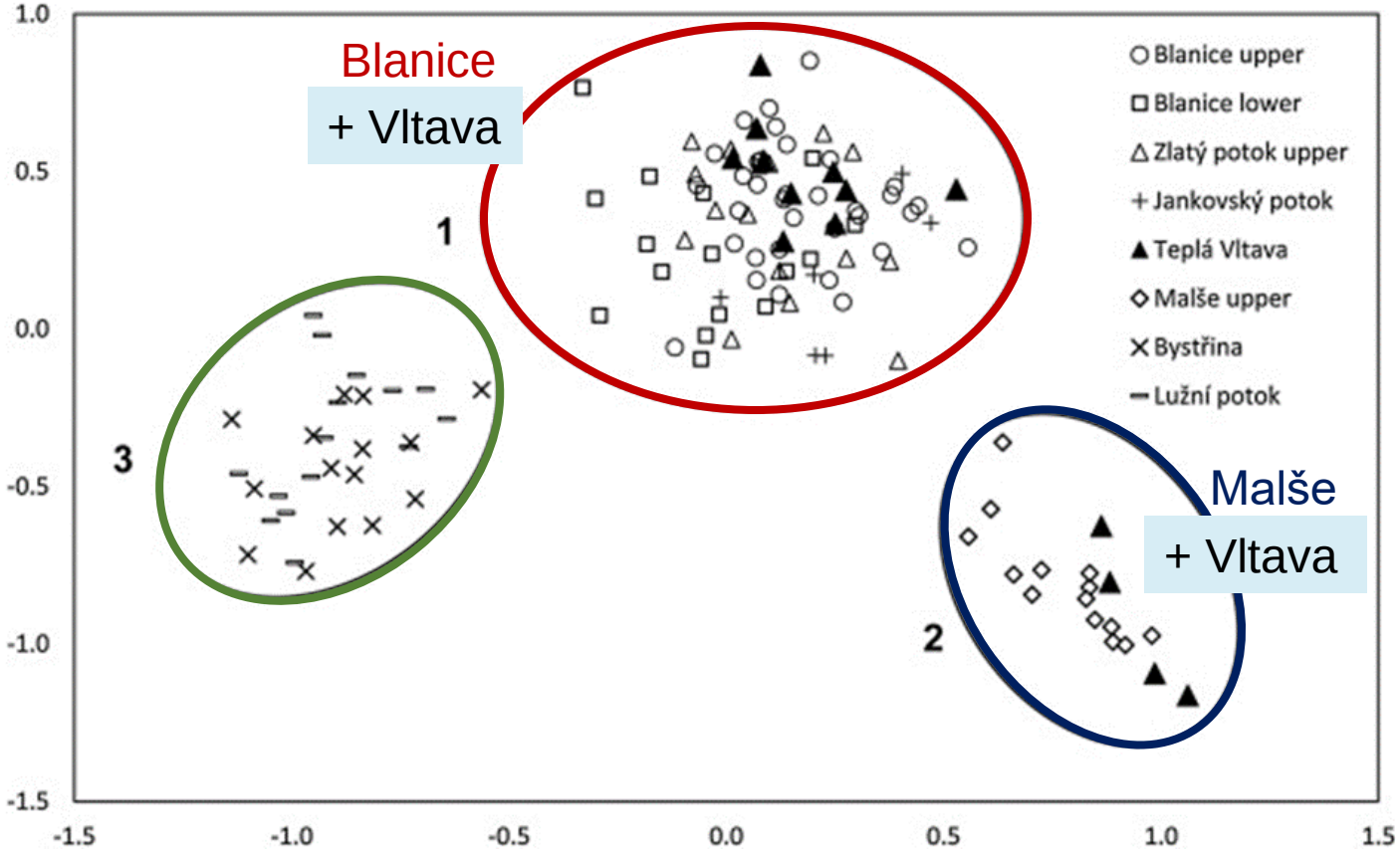


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Genetic structure



microsatellite analysis – results of the factorial correspondence analysis, each genotyped individual is displayed as a point in a two-dimensional space, which is defined by two factorial axes that represent **factors explaining the majority of the variability** in the given dataset

3 clusters ~ conservation units:
1 – the Blanice (Flanitz)
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Simon et al., 2012

Research and conservation history



attention payed since the early 1970s...

Jaroslav Hruška

- biology & environmental requirements of the species
- methods of semi-natural breeding (**Czech method**)
- protection: FPM action plan

- **FPM Action Plan**, phase 1 (Hruška, 1993), phase 2 (Absolon & Hruška, 1999), phase 3 (2013)

  protection of remaining **populations** + the **biotope**, including adjacent parts of catchments
  list & value ranges of basic parameters: **optimal conditions**

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  protection of remaining **populations** + the **biotope**, including adjacent parts of catchments
  list & value ranges of basic parameters: **optimal conditions**

- **Conservation methods for FPM habitats** (Simon et al., 2018)

recently – FPM protection within

European areas of conservation, EAC (EVL/FFG) – Natura 2000

... but there are problems in border areas:
different status of protection

- Bieberbach (Kamenný potok), Bayerischer Schwarzach (Černice), Mähringsbach (Újezdský potok), Höllbach (Pekelský potok): EAC on the Bavarian side, no protection in CZ
- Filzgraben (Řáska), Schweizerbach (Švýcarský potok) → **Wolfaubach (Řasnice)**: the Šumava National Park in CZ, but no protection in DE
- **the Maltsch (Malše)**: EAC in CZ, no protection of FPM in AU (signal crayfish!)

CZ x AU: **different legislation in fish management!** (the Maltsch – cooperation with Blattfisch)

Basic parameters of a FPM biotope in the Czech Republic

FPM Action Plan (Absolon & Hruška, 1999)

Typology:

Geology: granite, granulite, gneiss, phyllite
Vegetation zone: submontane
Altitude: max. 850 m
Gradient (Ø discharge 5 m^3/s): 0.05 – 0.1 %
Gradient (Ø discharge ≤0.5 m^3/s): 0.2 – 0.7 %

Ecomorphology:

Flow: fluviatile to moderately torrential
Ø velocity: 20 – 40 cm/s
Discharge: >20 l/s
Water level: >10 cm
Directing: predominantly meandering
Banks: loose shore vegetation, shade 60 – 100 %
Adjacent territory: autochthonous forest,
extensive meadows
Intensive agriculture in the catchment: <20 %

Water quality: physical, chemical, and biological conditions (limits & short-term maxima)

parameter	range of values	unit	
temperature	0 – 20 (max. 23)	°C	(peak of daily average temperatures: 15.5 °C for 10 days)
pH	6.0 – 7.1		
conductivity (K_{20})	50 (max. 60): **type A**	µS/cm	A – long-lived form of FPM (the Moldau)
	70 (max. 80): **type B**		B – short-lived form of FPM
Ca^{+}	< 8	mg/l	
Mg : Ca	1:2.8 – 1:3.2		
NH_4^{+}	< 0.1 (max. 0.5)	mg/l	
NO_3^{-}	< 2.5 (max. 6.0)	mg/l	
Cl^{-}	< 10	mg/l	
BSK_5 (organic matter)	< 1.5	mg O_2/l	
TP	< 20 – 35	µg/l	
$KNK_{4,5}$	0.2	mmol/l	
turbidity	(max. 15)	NTU	
saprobity index	0.8		
fish stock	*Salmo trutta* m. *fario*	autochthonous population, natural reproduction	
predators	*Lutra lutra*		

Bauer, 1988; Absolon & Hruška, 1999

Our focus in the FPM studies:

South Bohemia populations

lately – **the Blanice (Flanitz) River, the Zlatý potok stream**

- long-term monitoring of the water chemistry
- whole catchment studies
- → protected areas established in these catchments
- FPM food sources
- pollution sources in catchments
- **recovery from eutrophication**, ...

... (O. Simon, next presentation)



The Blanice River

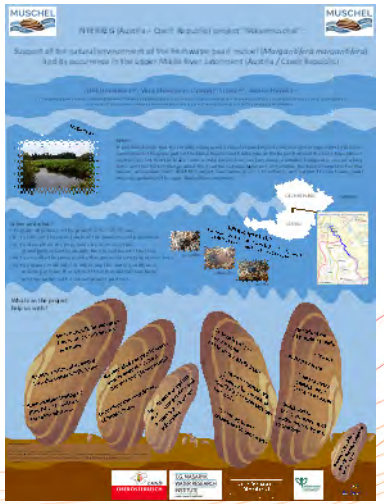
Our focus in the FPM studies:

at present –

the Teplá Vltava (Warme Moldau), the Malše (Maltsch) rivers

- reinforcement of both the FPM and the host (brown trout) populations
- genetic studies: FPM – brown trout
- semi-natural breeding of FPM
- releasing indigenous semi-naturally bred juveniles into the river
- search for optimal **microhabitats**…

... (J. Horáčková, Z. Hořická – posters)





Why the Maltsch?

- FPM occurrence expected
- state border – little knowledge about the catchment & water quality in AU
- **INTERREG Austria – Czech Republic project:**
  mapping of FPM → **juvenile, adult, and subadult individuals found:**
  the only naturally reproducing FPM population on our territory
- a small FPM population (cca 300 ind.)

newest findings, 2018: juveniles

the last completed growth period (6 mm)

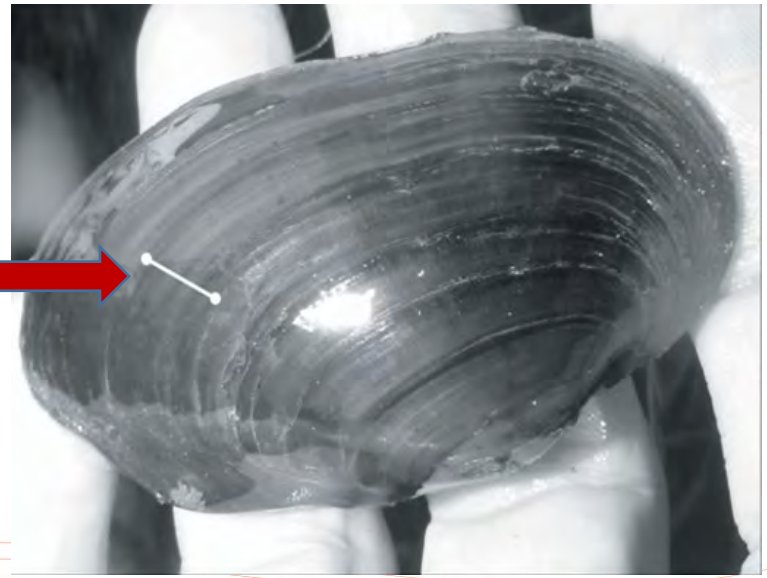


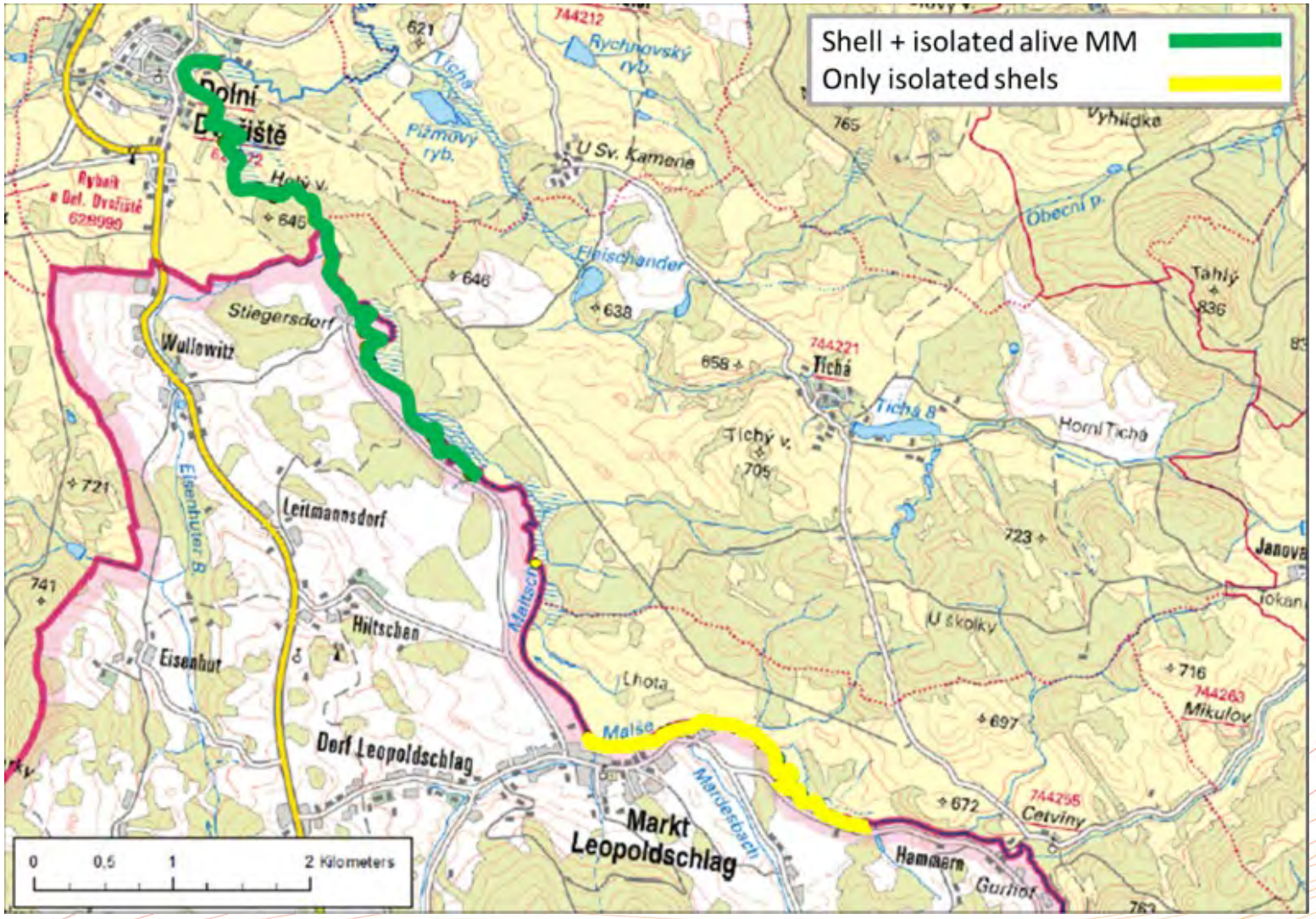
Photo: J. Hruška

the first subadult found in the Maltsch, 2012 (length 38 mm)



Photo: J. Horáčková

The Maltsch: FPM found



living FPM – only in the lower part of the border transect (the upper reach of the river)

Map: J. Horáčková

Water quality – threat of eutrophication: conductivity, forms of N and P

- **conductivity** – important parameter of the water quality in oligotrophic catchments
- salting! (Cl^-)

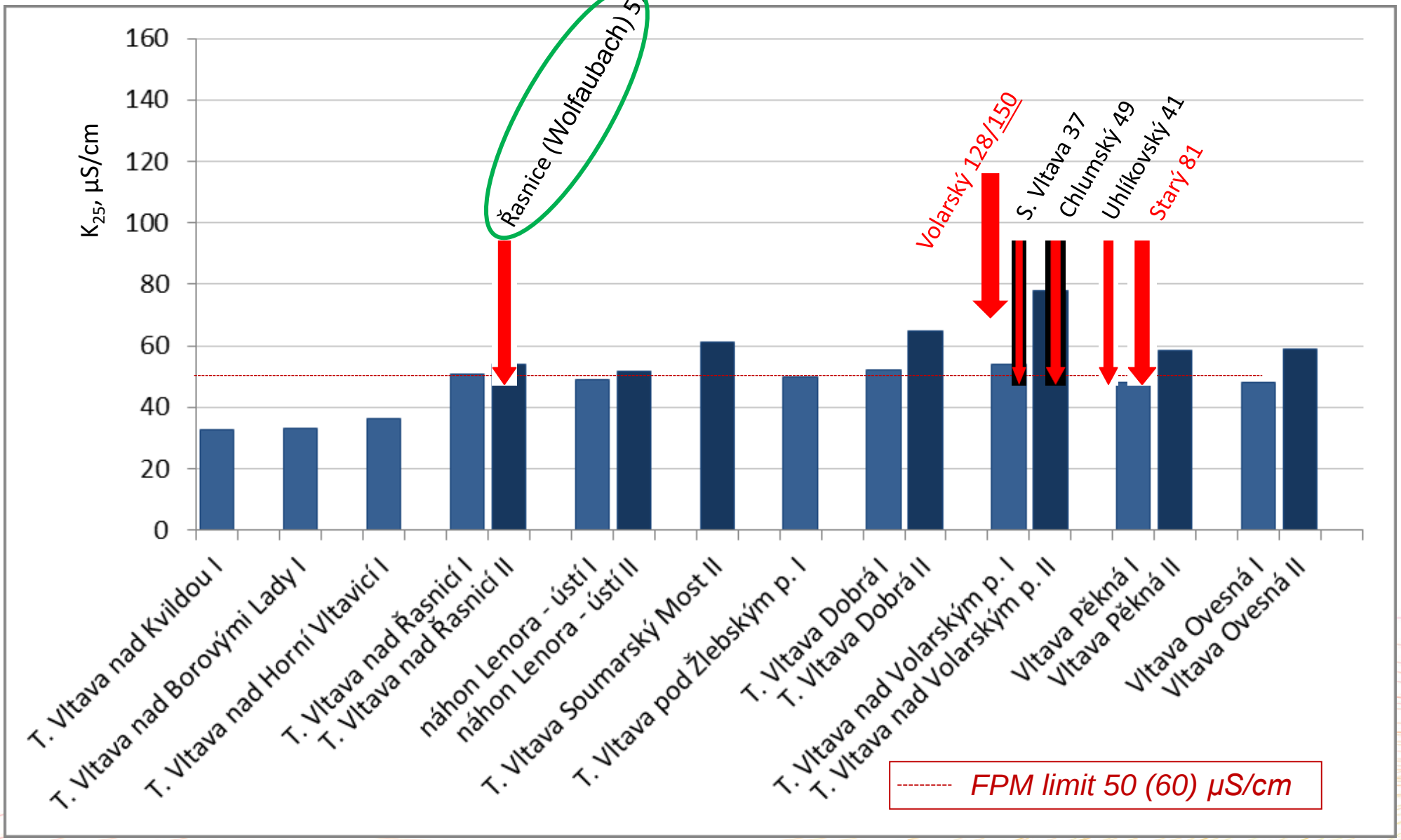
- **nitrate** – permanent / long-term pollution by N

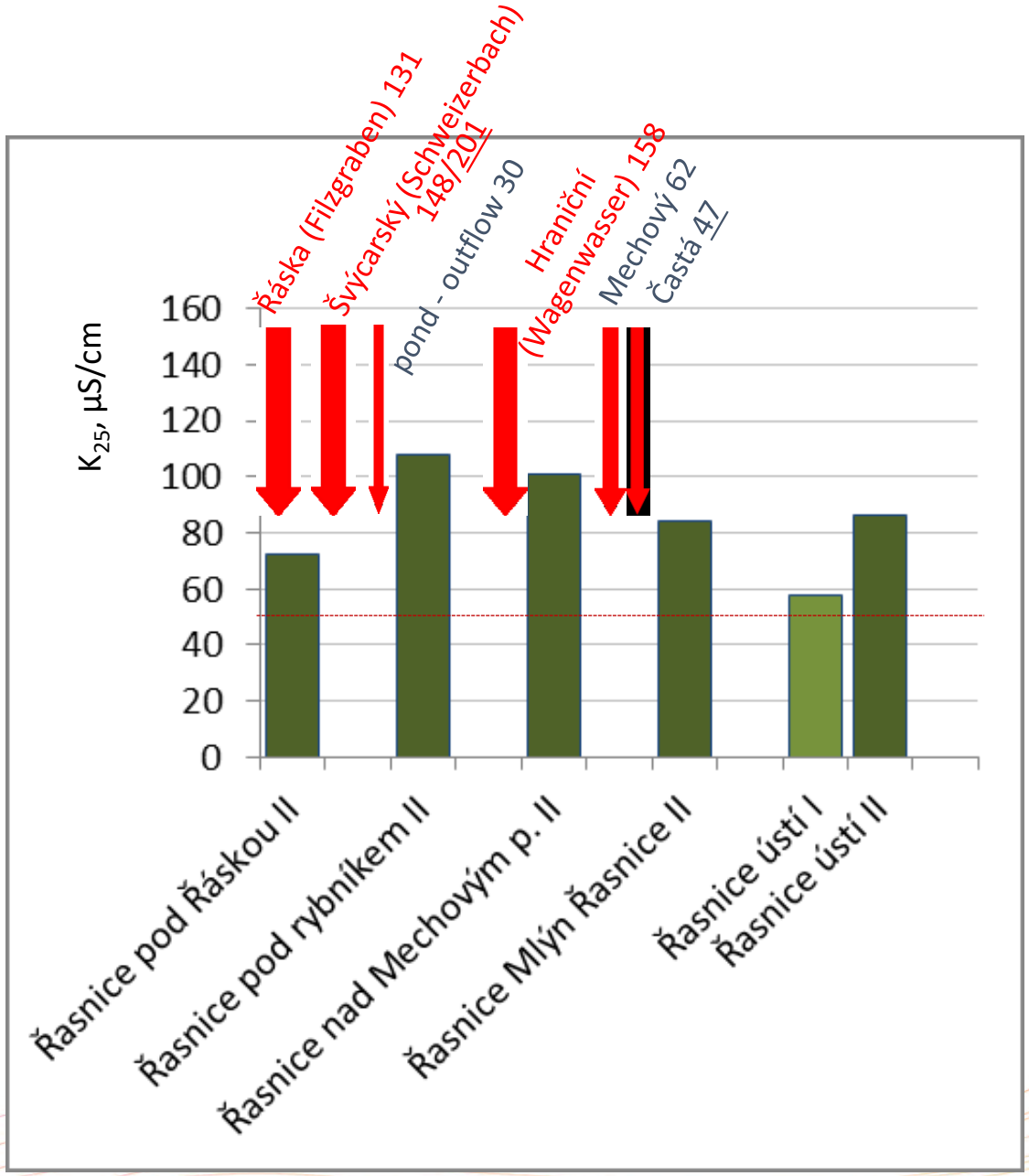
  vs.

- **ammonium** – episodic / fresh pollution by N
- **total phosphorus** – permanent pollution
  (the Maltsch: high values of TP below the spring x the Moldau)

Nutrients:
under/on limit values in the whole transects with the FPM occurrence

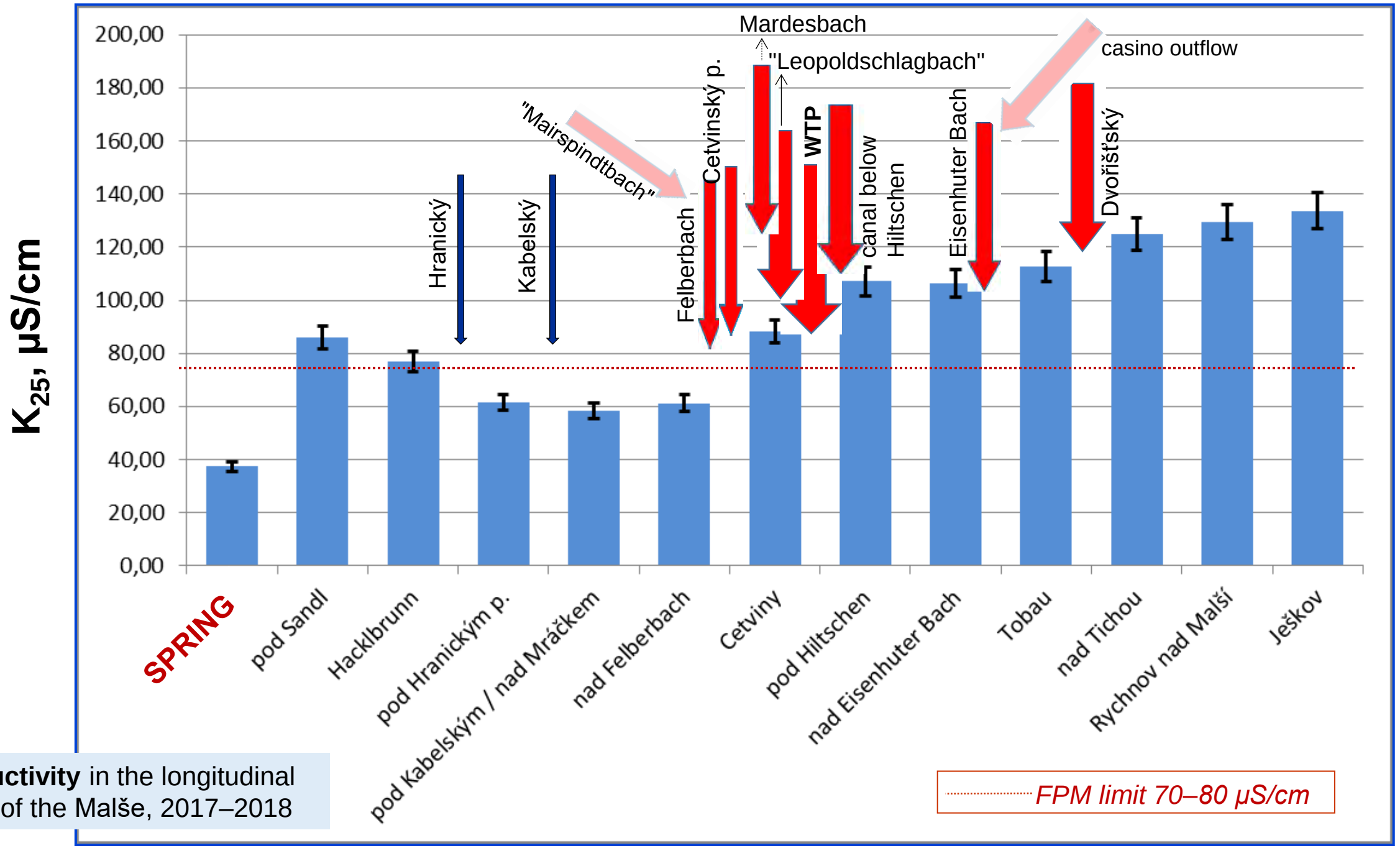
Conductivity in the longitudinal profile of the Moldau, 2017–2018



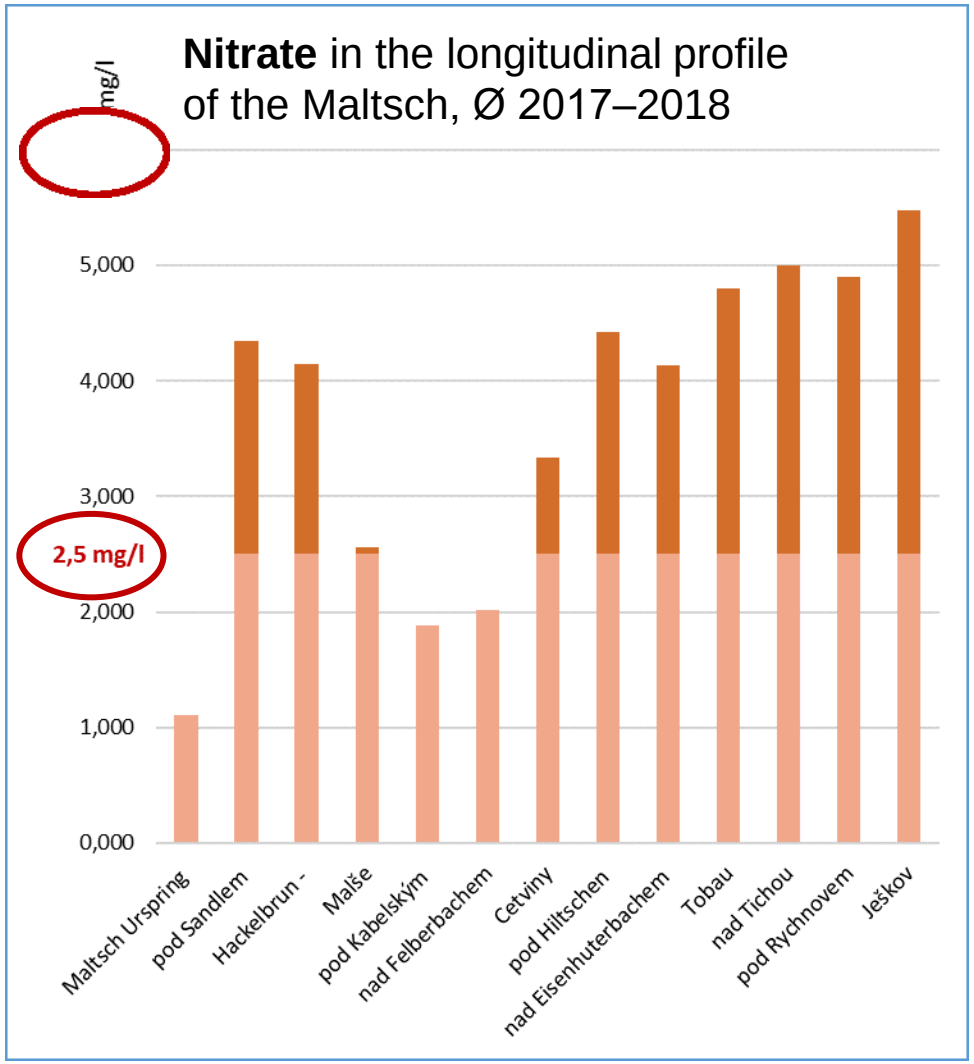


Conductivity in the longitudinal profile of the Řasnice (Wolfaubach), 2017–2018

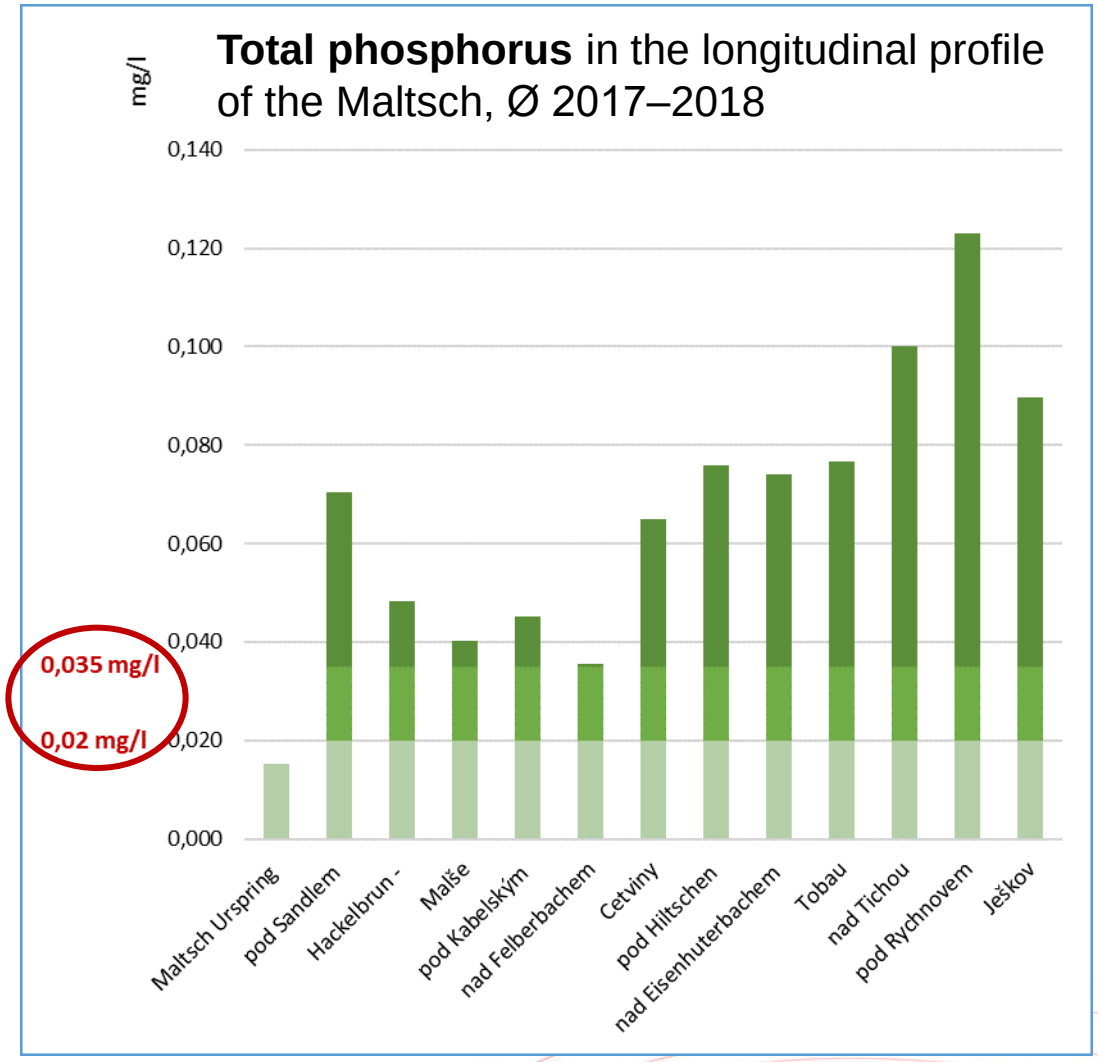
FPM limit



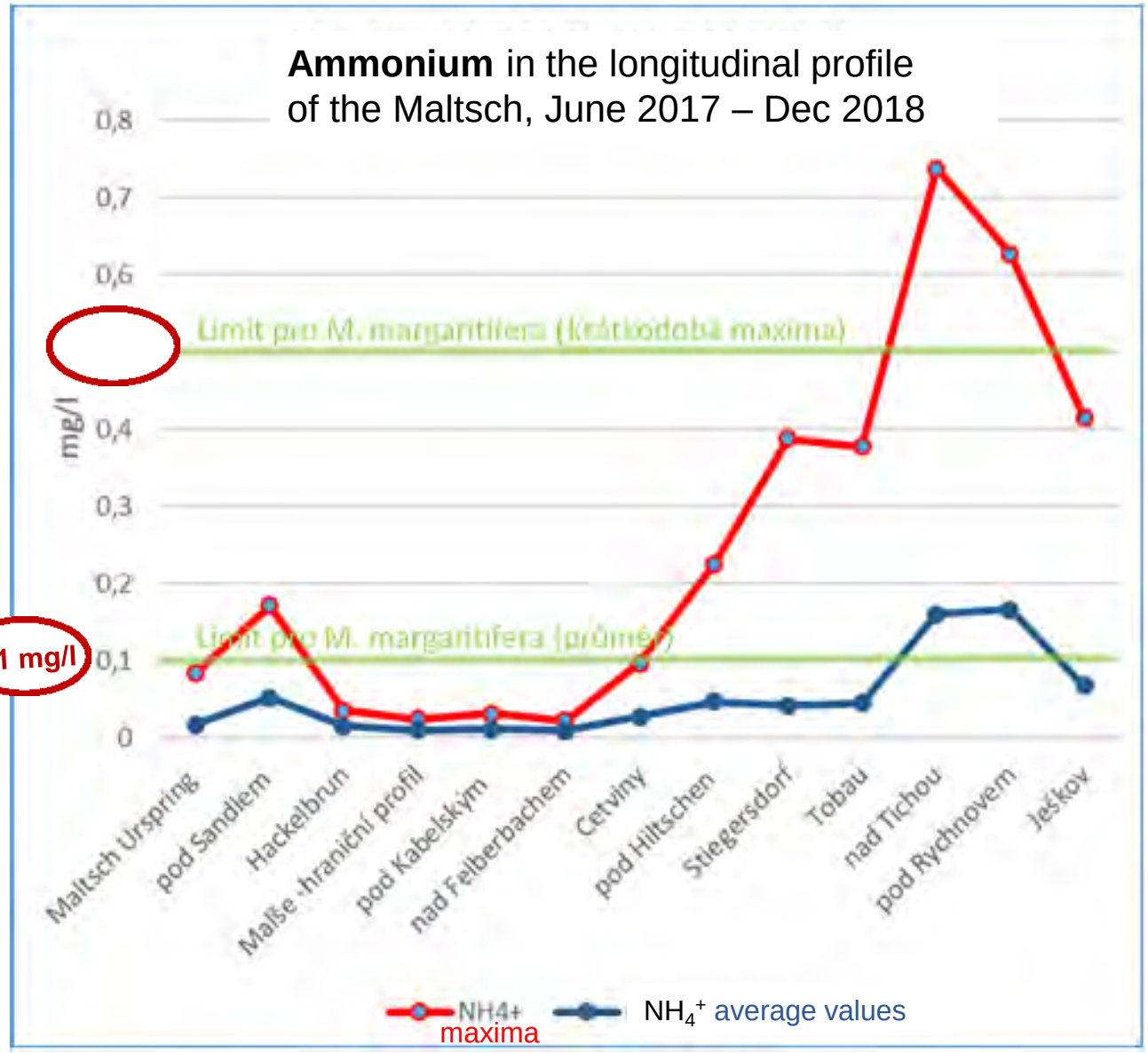
Conductivity in the longitudinal profile of the Malše, 2017–2018



FPM Action Plan (2013): NO_3^- limit for FPM: 2.5 mg/l, **6 mg/l** for a short time (infant drinking water: 15 mg/l)



FPM Action Plan (2013): TP limits for FPM: 0.02–0.035 mg/l



FPM Action Plan (2013): ammonium ions limit for FPM: 0.1 mg/l, **0.5 mg/l** for a short time

Threats: other sources of pollution

- Cu, Be, As – all data under the detection limit, under limits for surface waters
- Ni, Cd, Al, Zn, Pb, Mn, Mg – measured values above the detection limit, but under limits for surface waters
- Hg – on the detection limit even during snowmelt

- 242 pesticides and their metabolites analyzed, only 7 substances above the detection limit (no limits for surface waters in the Czech Republic...)

sum of pesticides: under the surface waters limit (0.5 µg/l)

Many more threats...

- human settlement
- channelization
- pasture (slopes, no fencing)
- grass left on the banks
- **erosion →**



FPM survived the “bad years” **on the upper edge of its natural area (& on the populations’ carrying capacity)**

COMPROMISING:
the Moldau, the Maltsch, the Flanitz:
optimal conditions downstream, but also worse water quality there, risk of direct damage by people

Possible improvements

- **What can not be removed from a catchment:**
  buildings, villages and towns, ponds, pasture...

- **What can be improved/reduced:**
  forest management practices – a limited use of heavy mechanization

  water treatment plants + sewerage systems in villages (farms!)

  pasture control (fencing)

- **What can be removed from catchments:**
  grass, fresh clover-grass mixture (silage juices), potato tops... on river banks

  control of revitalized streams

  control of invasive species!
  signal crayfish, *Pacifastacus leniusculus* – a FPM predator
  (also crayfish plague, *Aphanomyces astaci*)



Conservation methods for freshwater pearl mussel (*Margaritifera margaritifera*) habitats Simon et al., 2018

English version (for central Europe) *in prep.*:

We will welcome any cooperation, namely

- other countries' experience
- erosion
- fish – suitable hosts for FWPM
- co-authors & reviewers...

https://heis.vuv.cz/data/webmap/datovesady/projekty/perlorodkametodika/docstazeni/metodika2018-11-low.pdf