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Institut für Hydrobiologie

CAWR Center for Advanced Water Research

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Fakultät Umweltwissenschaften Fachrichtung Hydrowissenschaften Institut für Hydrobiologie

Predicting impacts of climate change on survival and growth of freshwater pearl mussels in Vogtland (Germany)

For further information see www.flussmuschel.de

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Bundesministerium für Bildung und Forschung

Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit

BfN Bundesamt für Naturschutz

Bayerischer Naturschutzfonds

Status quo of Pearl mussels in Vogtland rivers

1920

- The entire river system was settled with pearl mussels
- up to 1000 FPM/m^2

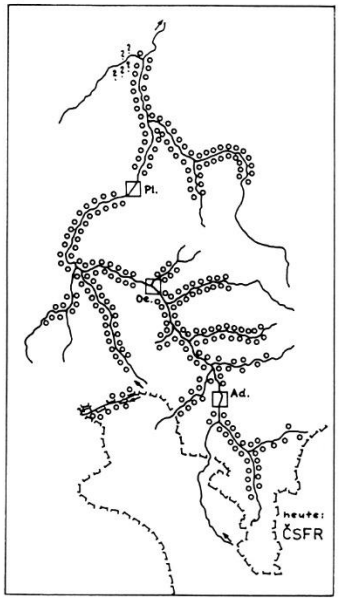


Abb. 4: Vogtländische Vorkommen der Flußperlmuschel um 1800. Pl Plauen, Oe Oelsnitz, Ad Adorf. Nach FIEDLER (1937) und HERTEL (1959).

Otto Baer 1995

1960

- Stong decline of populations
- lack of natural recruitment despite 30% of adults are gravid

2000

- only three relict populations
- since 2002 successful captive breeding (Hruška-method),

➢ First release to the wilderness 2009

➢ What are best habitats for future reintroduction?

Questions

1. Effects of change in temperature and precipitation on survival and growth of juvenile mussels (*Margaritifera margaritifera)*
2. Probability for the occurence of critical condition in low mountain region in Germany
3. General implications for the conservation management:
   What are best habitats for future reintroduction?

Combined approach and methods

Field studies in Vogtland brooks (2009-2019)

Bioindication

Discharge

Water temperature (data-Logger)

Turbidity

.....

Statistical analysis

Hypothesis for effects of temperature on survival and growth of FPM

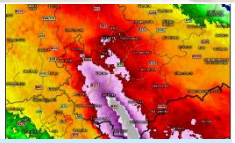
Laboratory experiments

Temperature control

Meteorological Data Station Bad Sohl (1950-2019)

Air temperature

Precipitation



Hydrological data Pegel Adorf (1970-2019)

iDA Sachsen.de

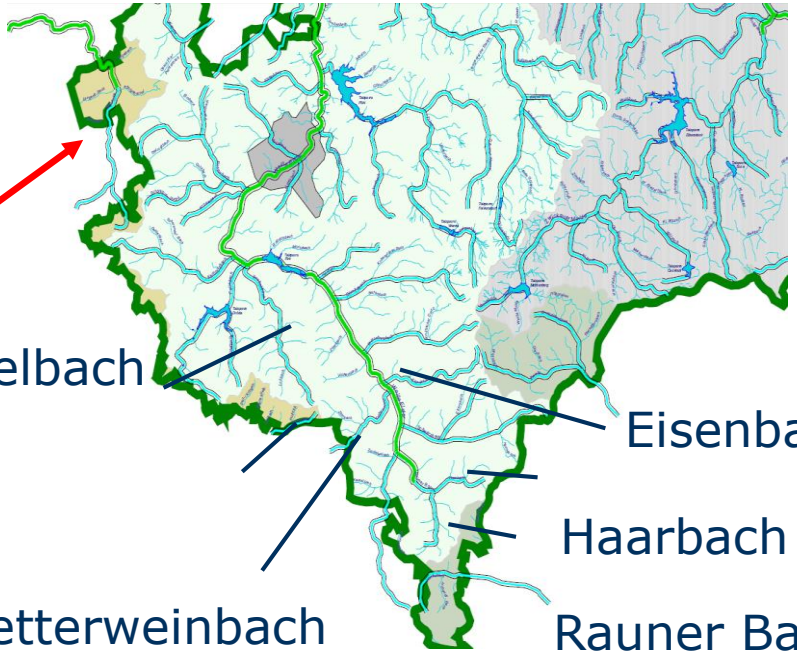
Empirical approaches

- Prediction of climate-driven changes in mussel habitats
- Identify most suitable brooks for reintroduction captive-bred FPM

Study area in Vogtland

Germany

Mittelgebirgsregion: 550 m NN



Triebelbach (TB)

Eisenbach (EB)

Haarbach (HB)

Tetterweinbach (TW)

Rauner Bach (RB)

Map „Fischregionen 2011“ (LfULG)

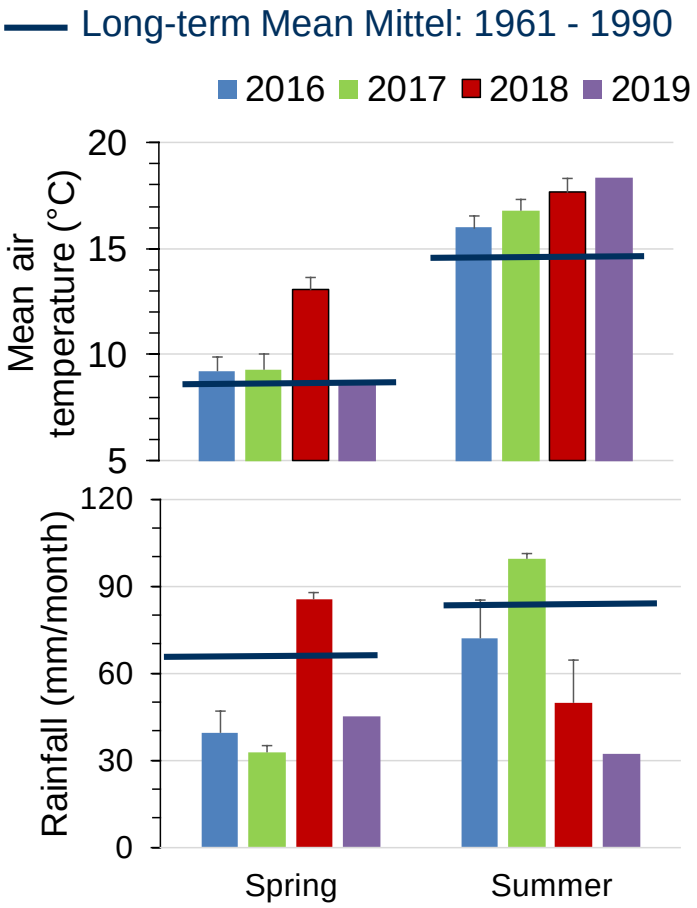
Comparison of investigation years

2016
relatively cool summer
Rainfall: moderate in Jun/Jul and low in Aug

2017
no extremes, always sufficient rain

2018
Extreme flooding at the end of May,
during summer lack of precipitation and high air temperatures

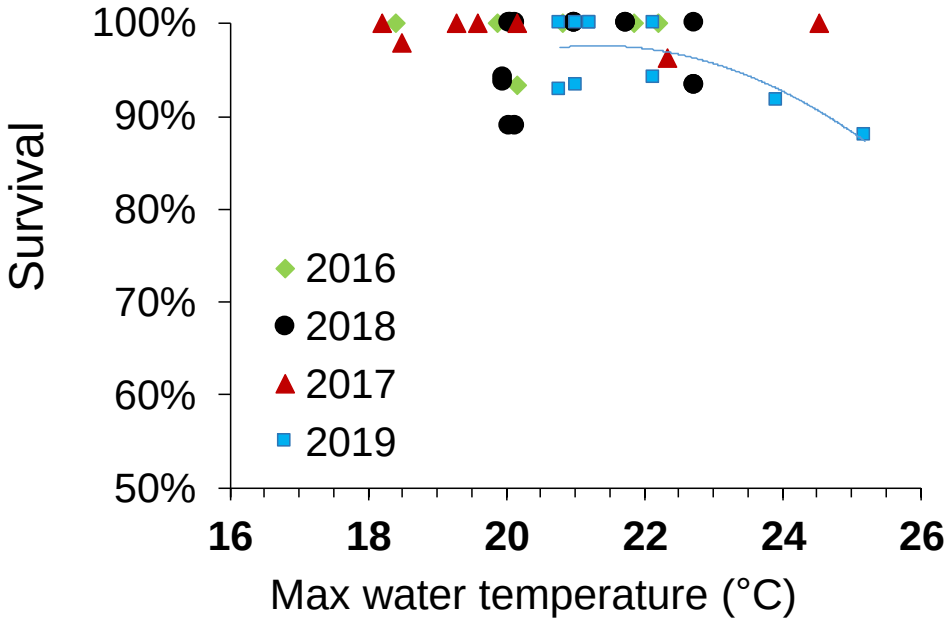
2019
Low rainfall throughout the summer

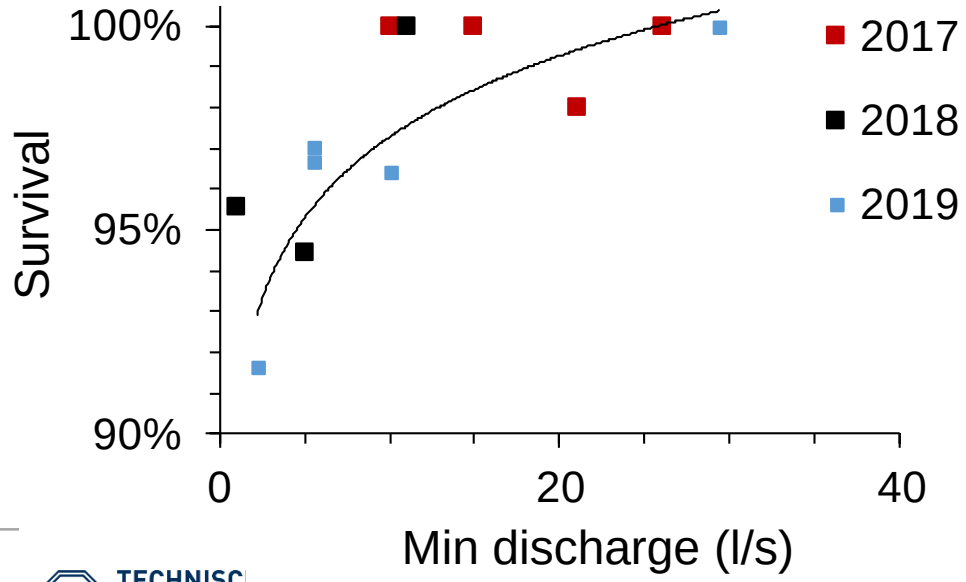


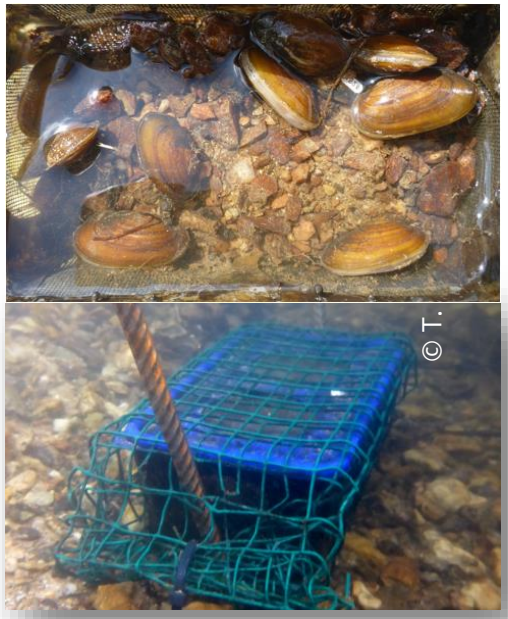
In-situ Bioindikation mit semi-adulte FPM

- **flow-through sediment cages**
- **in 5 streams**
- **each 15 PM of age 10-15**
- **control at 1. Juni and 31. August**
- **2016 - 2019**

Lethale effects on semiadult FPM



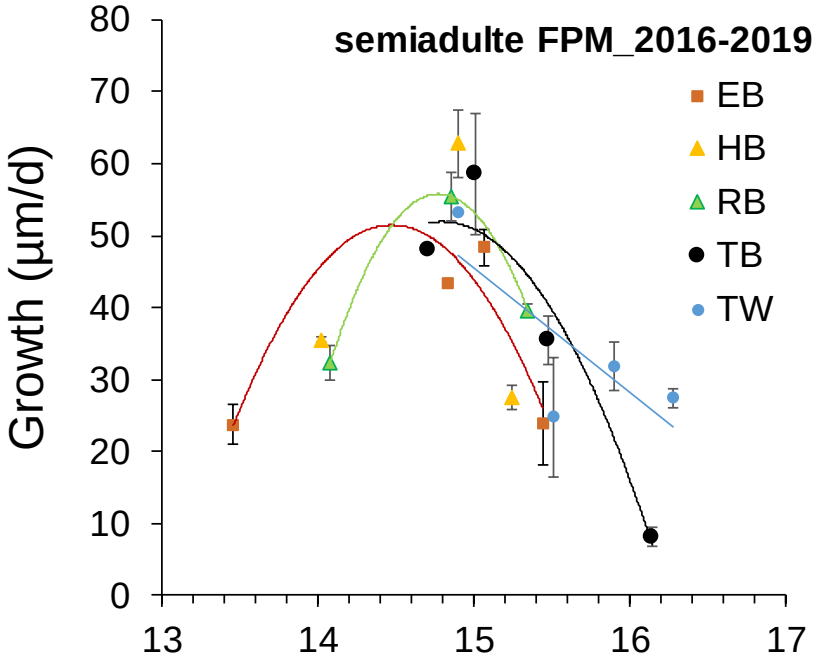


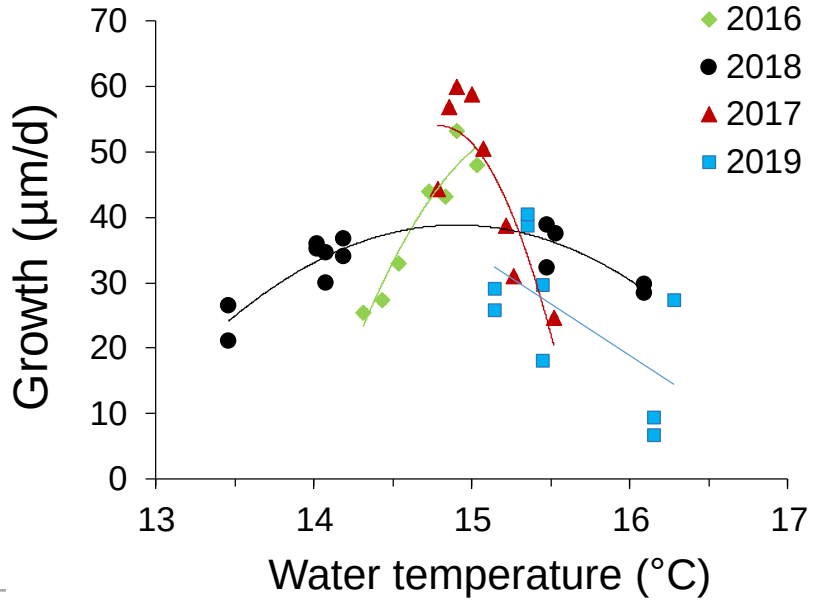


Discharge<10 l/s und WT≥25°C
→ increase in mortality

extreme flooding
→ no mortality

Temperature optimum of semiadulte PM





gro= 48,3*exp(-0,5*((WT-14,75)/1,1)^2)
R=0,76
P<0,001

Maximum growth
60 µm/d = 5,5 mm/Jahr
Temperature optimum 14,8 – 15,4°C

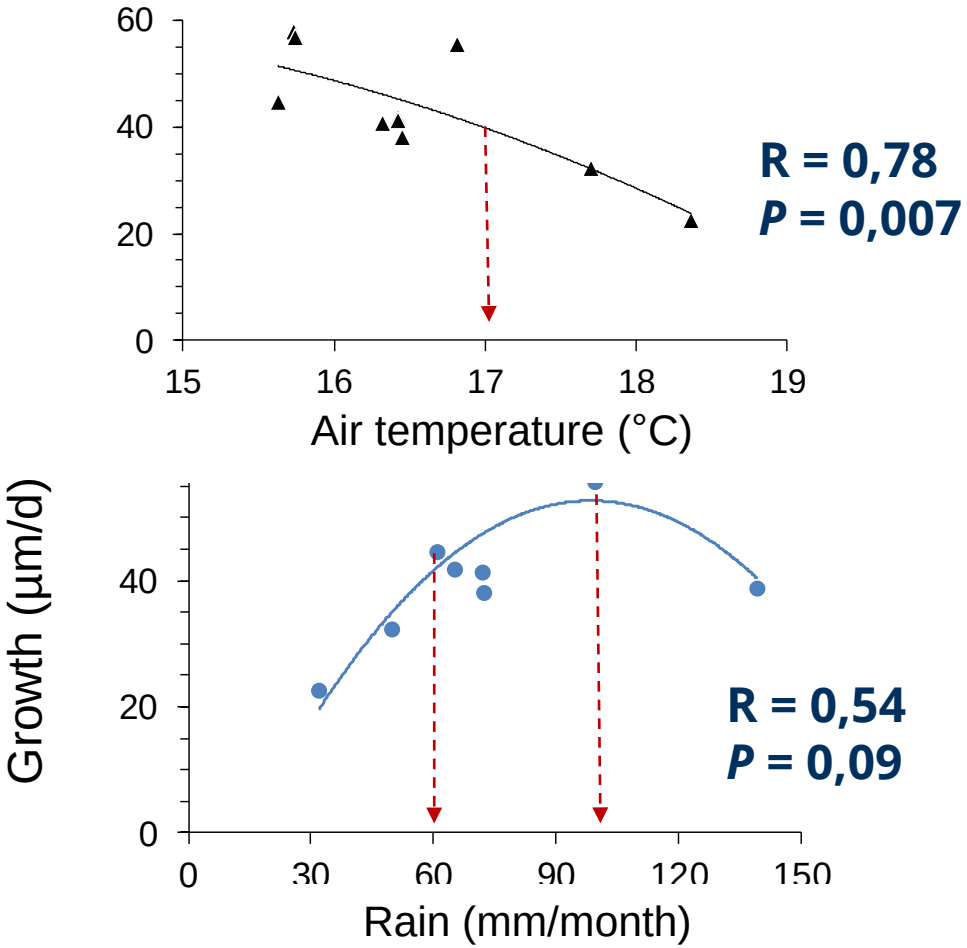
Factors cotrolling growth semi-adulter PM

- flow-through sediment cages
- in Rauner Bach
- Each 15 semiadulte FPM
- Control at 1. Juni and 31. August
- 2009 -2019

2009-2014 data to bioindication from Michael Lange

Factors cotrolling growth of semi-adulter PM

Jun-Aug 2009-2019

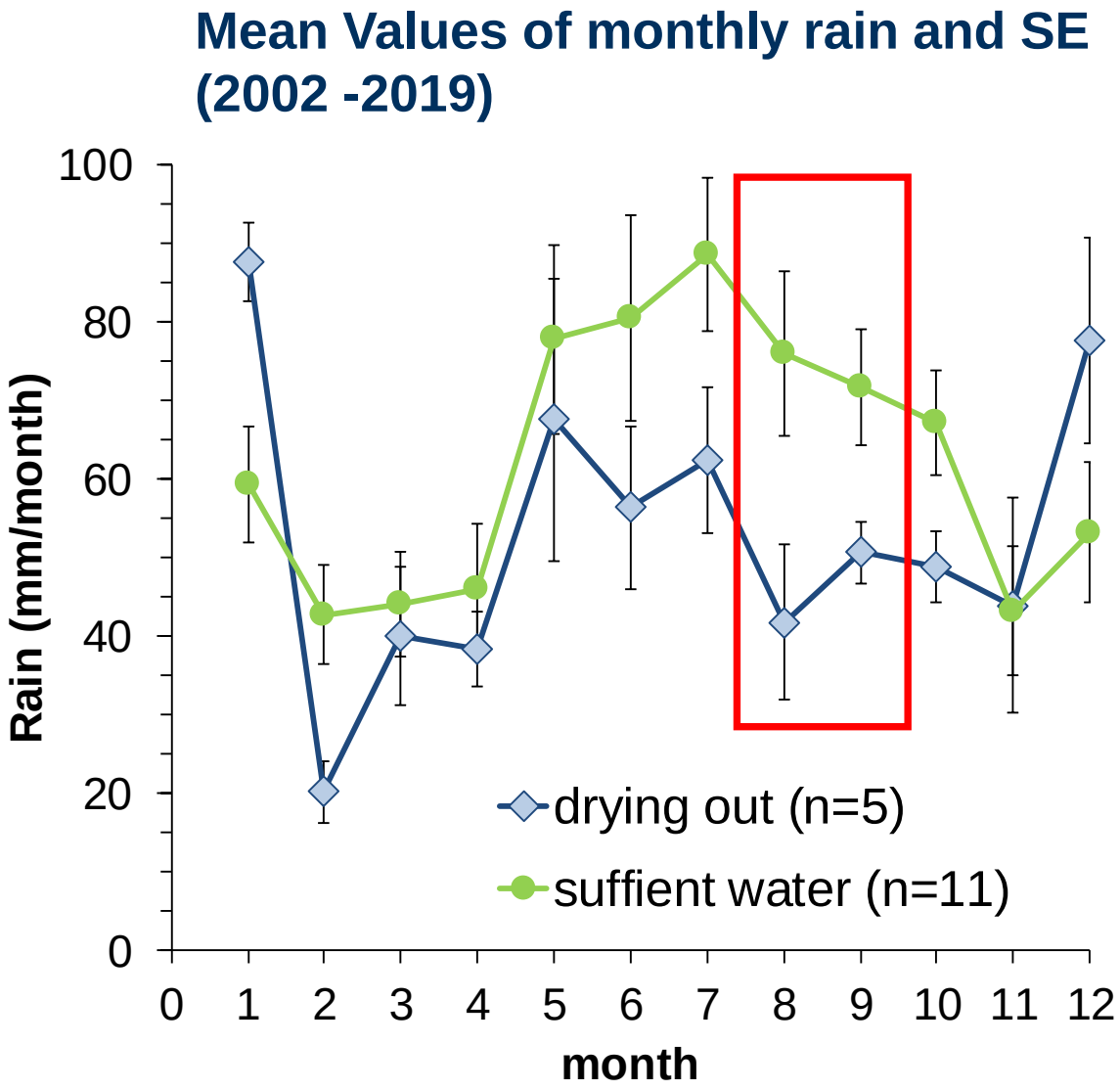


High growth at
precipitation > 60 < 100 mm/month
> 8 rainy days/month
Average air temperature <17°C

Risk of partial drying of the streams

2003, 2012, 2015, 2018, 2019

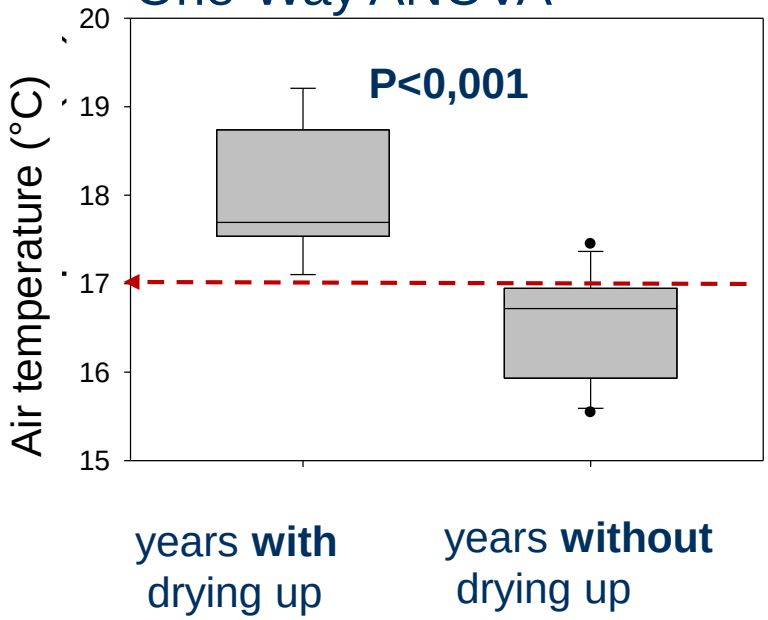
Risk of partial drying of the streams

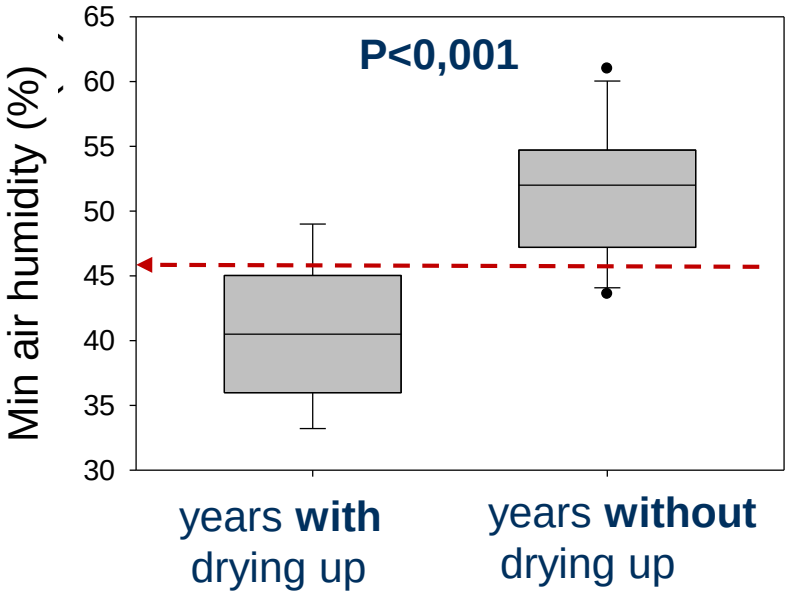


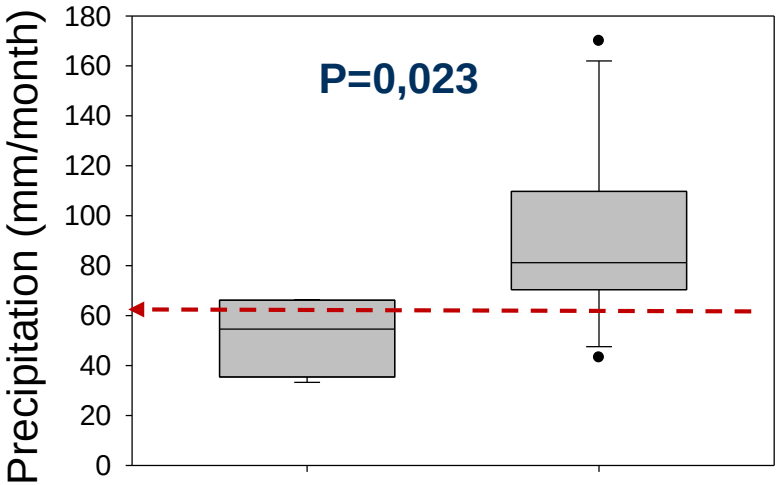
2003, 2012, 2015, 2018, 2019

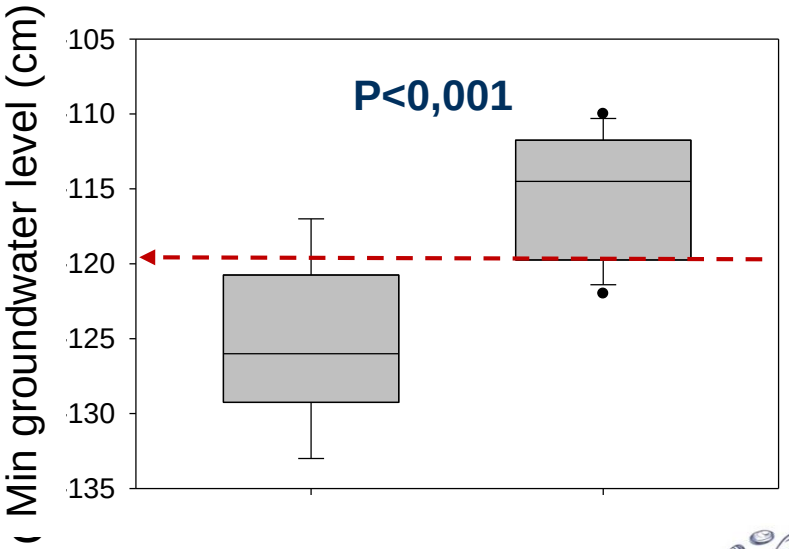
Data: Jul-Aug 2002-2019
One-Way ANOVA

Years with drying-up n=5
years without drying-up n=11









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Data meteorology: Station Sohl (sklima.de)
Groundwater level_Adorf (iDa Sachsen)

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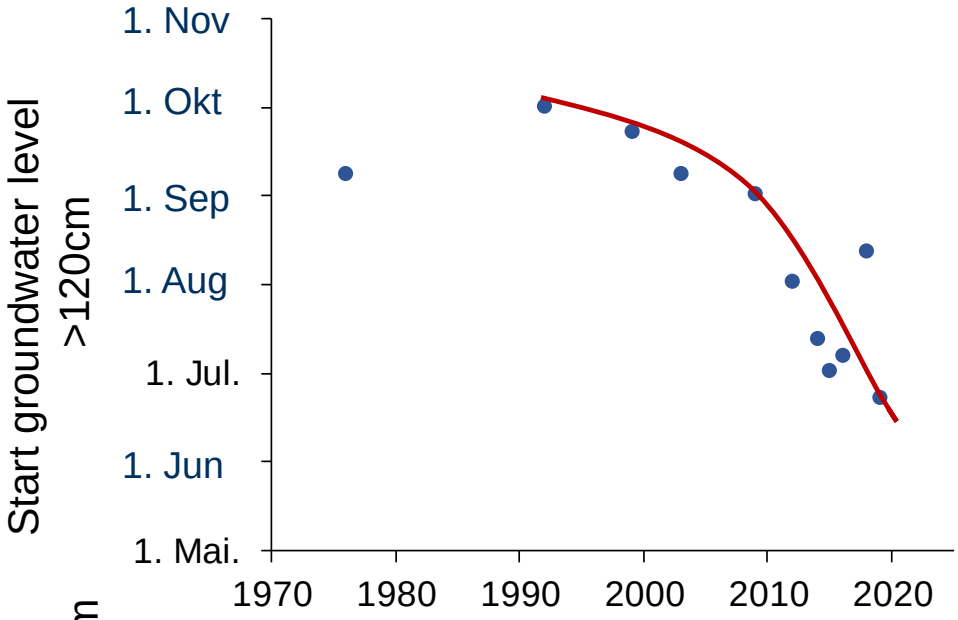
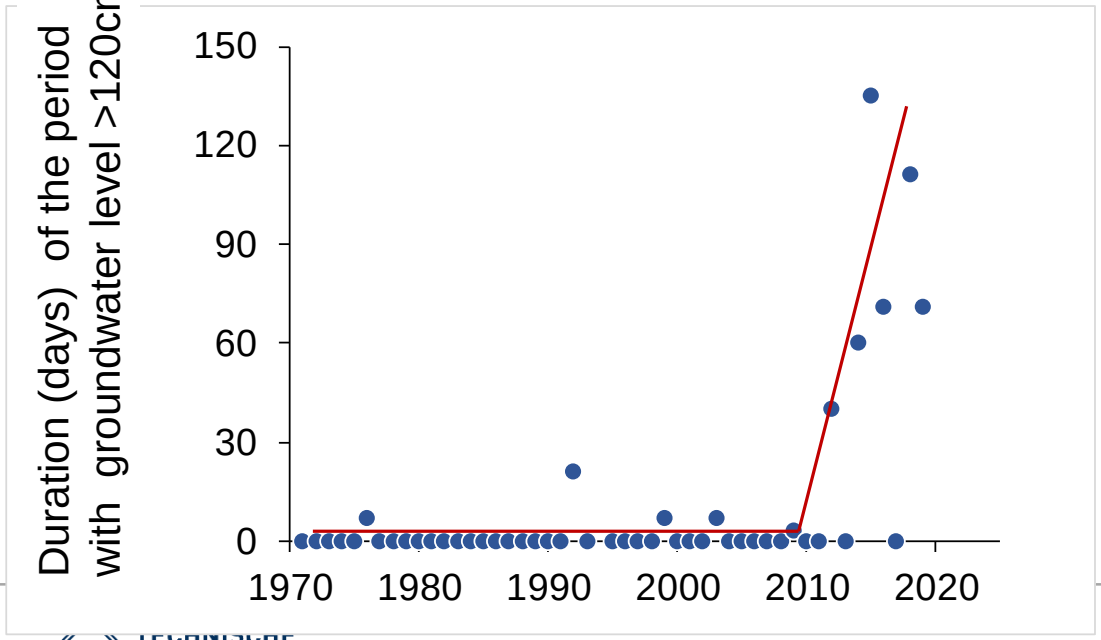
Trend to decreasing groundwater levels



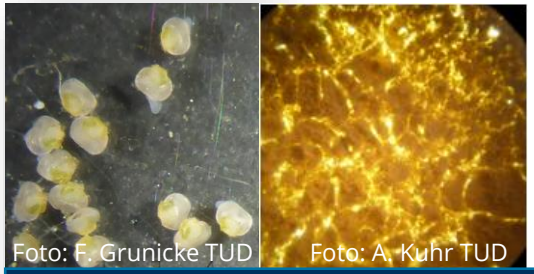


Periods with extremely low groundwater levels start earlier in the year and last longer

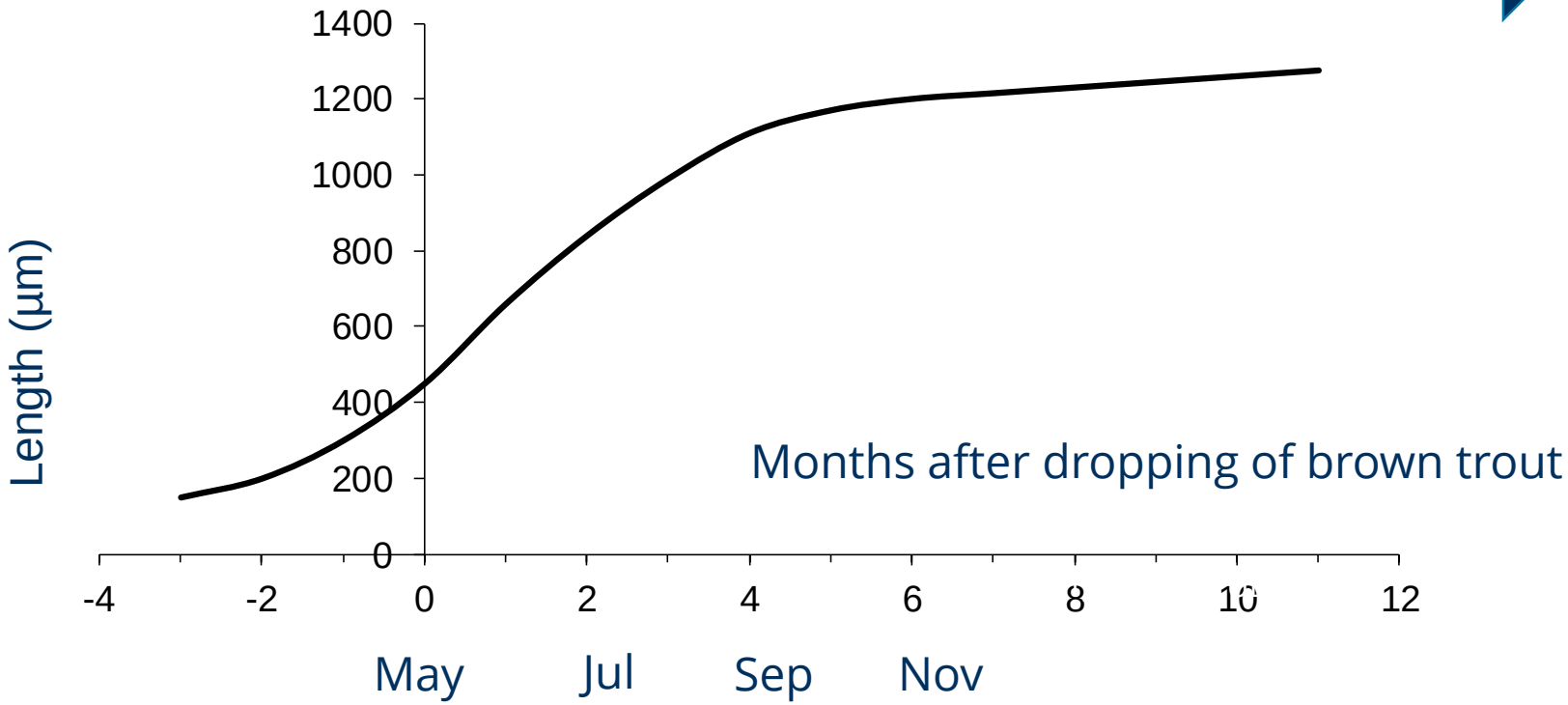
Data meteorology : Station Sohl (sklima.de)
groundwater levels_Adorf (iDa Sachsen)

Life cycle

Metamorphosis at the gill of brown trout



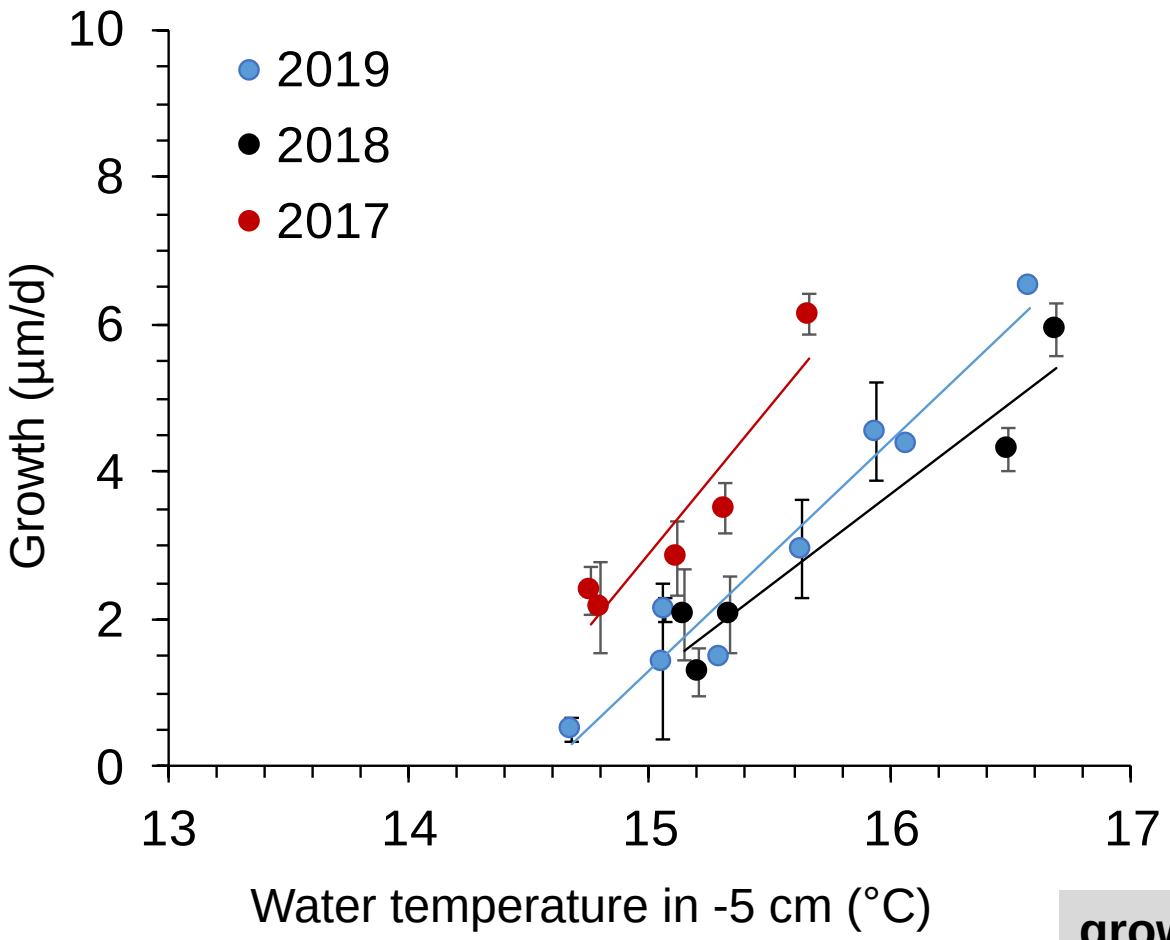
FPM lives in the hyporheic zone



In-situ bioindication with 0+ PM

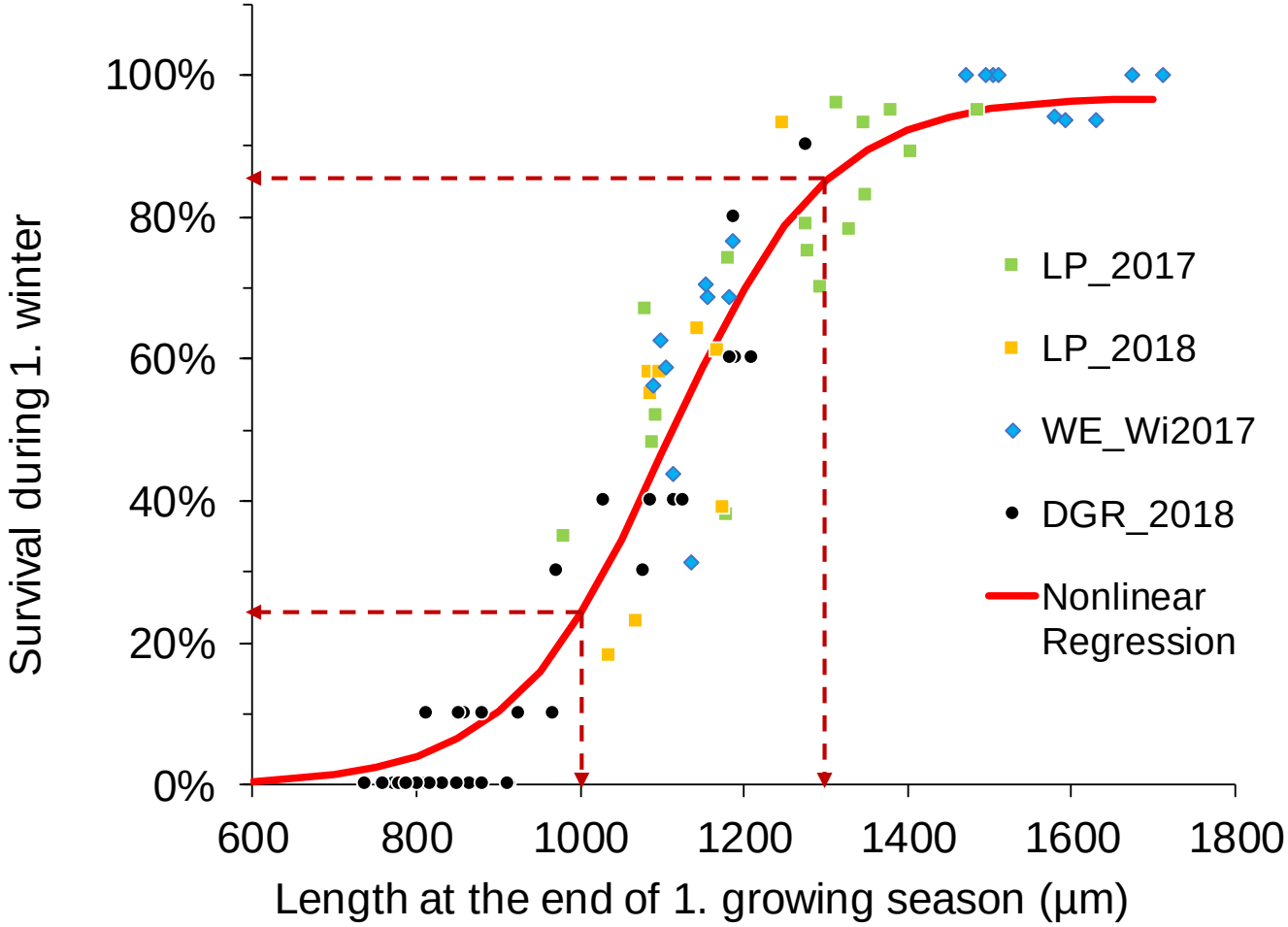
- In each brook 6-9 cylindrical tubes mesh size of 0.42 mm
- filled with brook-specific gravel (2-6 mm)
- 50 post-parasitic mussels
- Exposed to 5 brooks and buried in the sediment at a depth of 5 cm
- From Juni bis 31. August
- 2017 -2019

Temperature control of growth of 0+PM



growth = -35,373 + (2,483 * WT)
R^2 = 0,73
P < 0,001

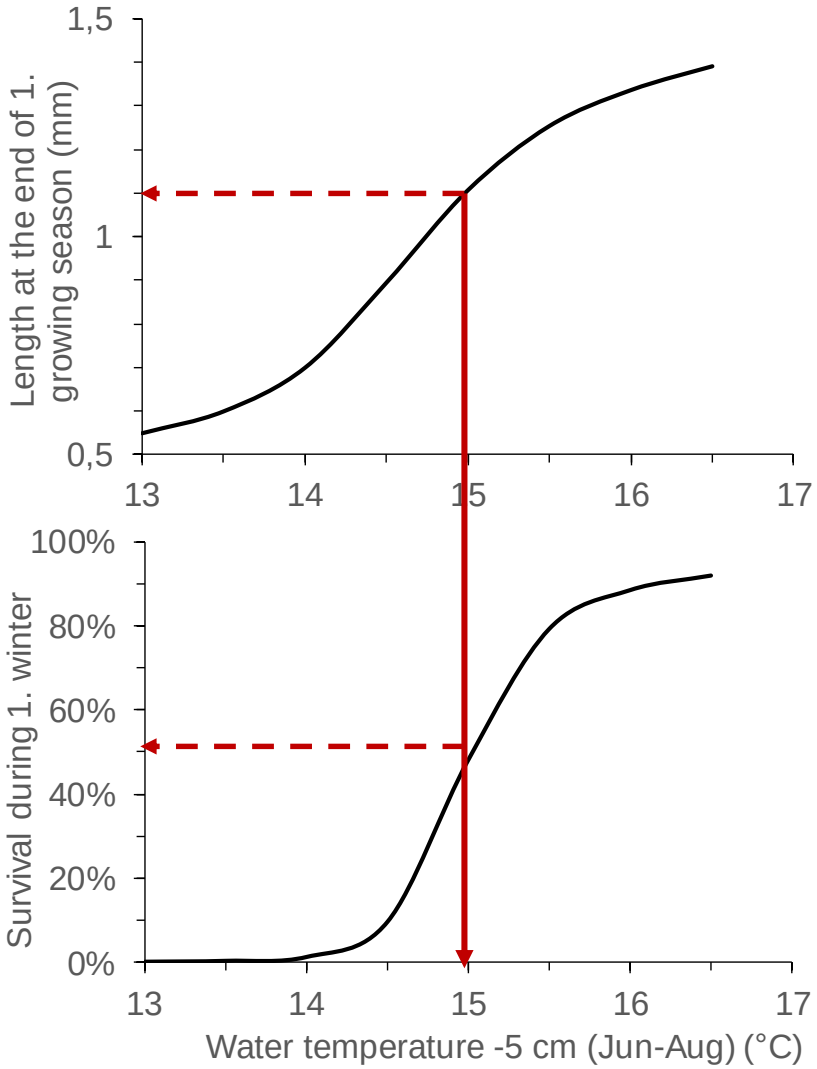
Influence of length in autumn on survival of 0+PM during first winter



Sigmoidal Regression:
Surv_wi = 0,97/(1+exp(-(L-1107)/97,2))
R^2= 0,92
P<0,001

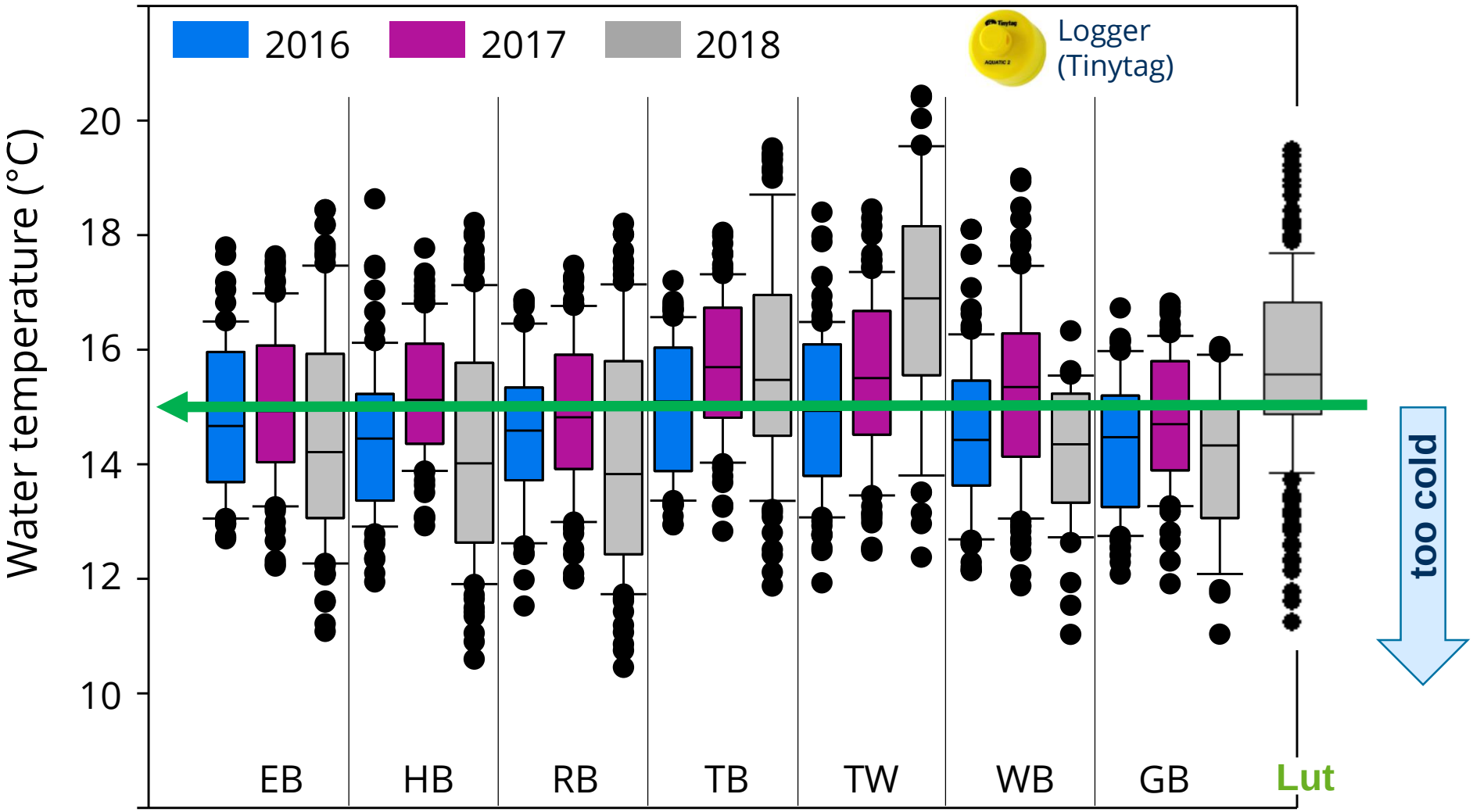
Survival during autumn+winter
Two Way Analysis of Variance
Startlänge p<0,001
Temperature winter p=0,91

Estimated effect of water temperatures during summer on survival of 0+PM during first winter



15°C during summer
corresponds to a survival of 50%

Water temperatures during summer (Jun, Jul, Aug) 2016-2018



Mean water temperature of river Lutter: 15.7 °C

(Data: M. Lange)

Temperature in krenal and rhithral

Reservoir

Oelsnitz: **15,4** / **15,9**

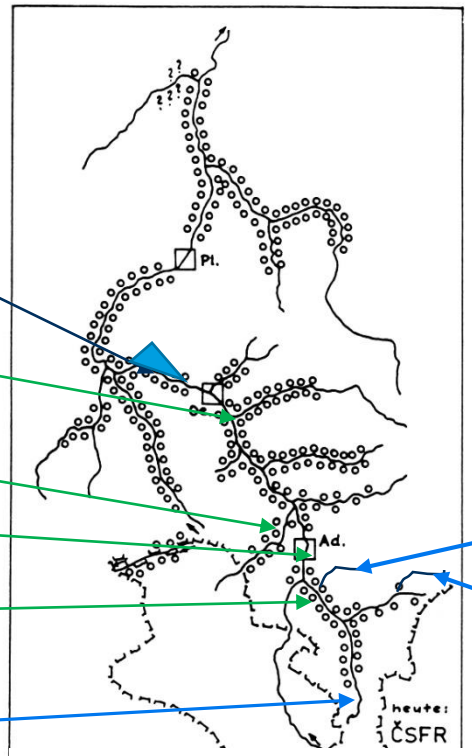
TW: **15,1** / **17,1**

Adorf: **14,1** / **15,7**

Mühlhausen: **13,6** / **15,3**

Rauner Mühle: **12,3** / **12,8**

Weiße Elster 1800



Otto Baer 1995

Abb. 4: Vogtländische Vorkommen der Flußperlmuschel um 1800. Pl Plauen, Oe Oelsnitz, Ad Adorf. Nach FIEDLER (1937) und HERTEL (1959).

Mean Water temperatures (iDA) (Jun-Aug) 2002-2016:
Cold years Air temp<16°C
warm years Air temp>16°C

Small tributaries
JB: **11,4** / **13,4**
Wer **12,1** / **13,9**

Bottleneck in mussel conservation strategy
krenal and epi-rhitral of rivers more suitable for the FPM in terms of morphology and water quality compared to the meta- or hyporhitral, but often too cold

Conclusions to hazard factors

Semiadulte Muscheln

- Low rain or at less than 8 days/month
- Decrease of ground water levels
- Discharge <10 l/s
- Water temperatures >24°C

Age-0 FPM

- Average water temperatures during summer <15°C

- Increasing probability of streams drying out.

For a successful freshwater mussel conservation approach, it is crucial to consider consequences of climate warming.

Thank you very much for your attention!

Many thanks to all partners, to our advisory boards and to the supporters in the state ministries and offices.

For further information see www.flussmuschel.de

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