Influences of beavers (Castor fiber) on the spawning dynamics of trout (Salmo trutta) in the North German lowlands

Part 1: Evaluation of spawning dynamics based on abiotic factors and habitat conditions

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Research questions

a) Are beaver dams a **migration barrier** for adult trout during the spawning season?

b) Do beaver dams lead to the **loss of spawning habitats**?

c) Are the **spawning dynamics** of the trout affected?


Sweden
Denmark
Baltic Sea
Peene
Tollense
Mecklenburg-Western Pomerania
Linde
Lake Tollensesee
Poland
Germany
Esri, HERE, Garmin, (c) OpenStreetMap contributors, and the GIS user community

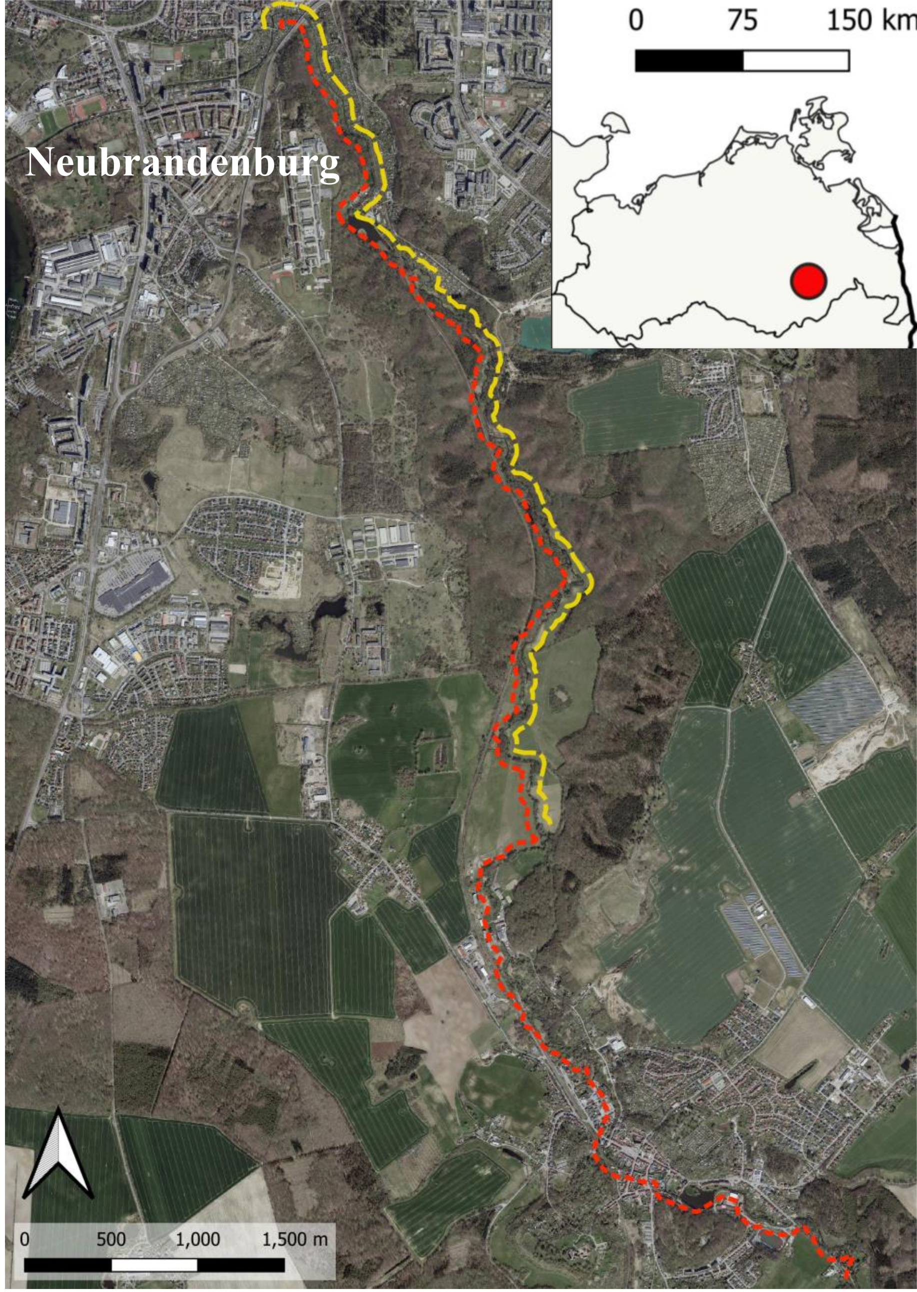
Study area: Linde (river)

- **Ground moraine**
- **Sandy lowland stream**
- **Valley floor slope: approx. 0.32 %**
- **Catchment: 125.5 km²**
- **Flow:**
  - **→ nQ : 0.02 m³/s**
  - **→ mnQ : 0.09 m³/s**
  - **→ mQ : 0.51 m³/s**
  - **→ mhQ : 3.13 m³/s**

- **Alteration: heavily altered**
  - → Flow conditions (drainage)
  - → Sediments (erosion)

Spawning bed/spawning substrate monitoring : *11.7 km*

Monitoring section of beaver dams: 6.7 km



Methods

1) Dam categorisation *(weekly, Oct-Jan)*

- Category 1: easily passable
- Category 2: passable
- Category 3: conditionally passable
- Category 4: not passable

2) Mapping of spawning substrates

- Fine gravel (2.0-6.3 mm)
- Medium gravel (6.3-20 mm)
- Coarse gravel (20-63 mm)

3) Mapping spawning beds (redds)

- Dimensions (length & width)

  → to estimate the ecotype of trout

- Coordinates

Results

Research question a)

Are beaver dams a migration barrier for adult trout during the spawning season?

Season	2021		2022						2023						
CW	D11-21	mQ [m^3/s]	D8-22	D10-22	D12-22	D14-22	D18-22	mQ [m^3/s]	D3-23	D6-23	D7-23	D8-23	D9-23	D13-23	mQ [m^3/s]
43			4	4	4	1	4	0.07	4	4	3	4	4	4	0.12
44			4	3.5	3.5	2	3.5	0.06	4	4	4	4	4	4	0.08
45	4	0.29	4	4	4	4	3.5	0.09	4	4	4	4	4	4	0.09
46	4	0.36	4	4	4	4	4	0.11	4	4	4	4	4	4	0.10
47	4	0.35	4	4	4	3.5	4	0.13	4	3.5	3.5	4	3	4	0.19
48	4	0.48	4	3.5	4	4	4	0.13	3.5	3.5	3.5	3.5	4	4	0.20
49	4	0.49	4	3.5	3.5	4	4	0.16	4	3.5	4	3.5	4	4	0.22
50	4	0.59	4	4	4	4	4	0.14	3.5	3.5	4	3.5	3	4	0.24
51	4	0.50	4	4	4	4	4	0.20	4	3.5	3.5	2	4	3.5	0.32
52	4	0.77	4	4	4	4	4	0.18	3	2	3.5	2	3	1.5	0.76
1	3	1.33	4	4	4	4	4	0.27	3	2	3.5	2	3	1.5	0.85
2	4	0.89	4	4	4	4	4	0.30	3	2	3.5	2	3	1.5	1.05
3									3	2	3.5	2	3	2	0.82

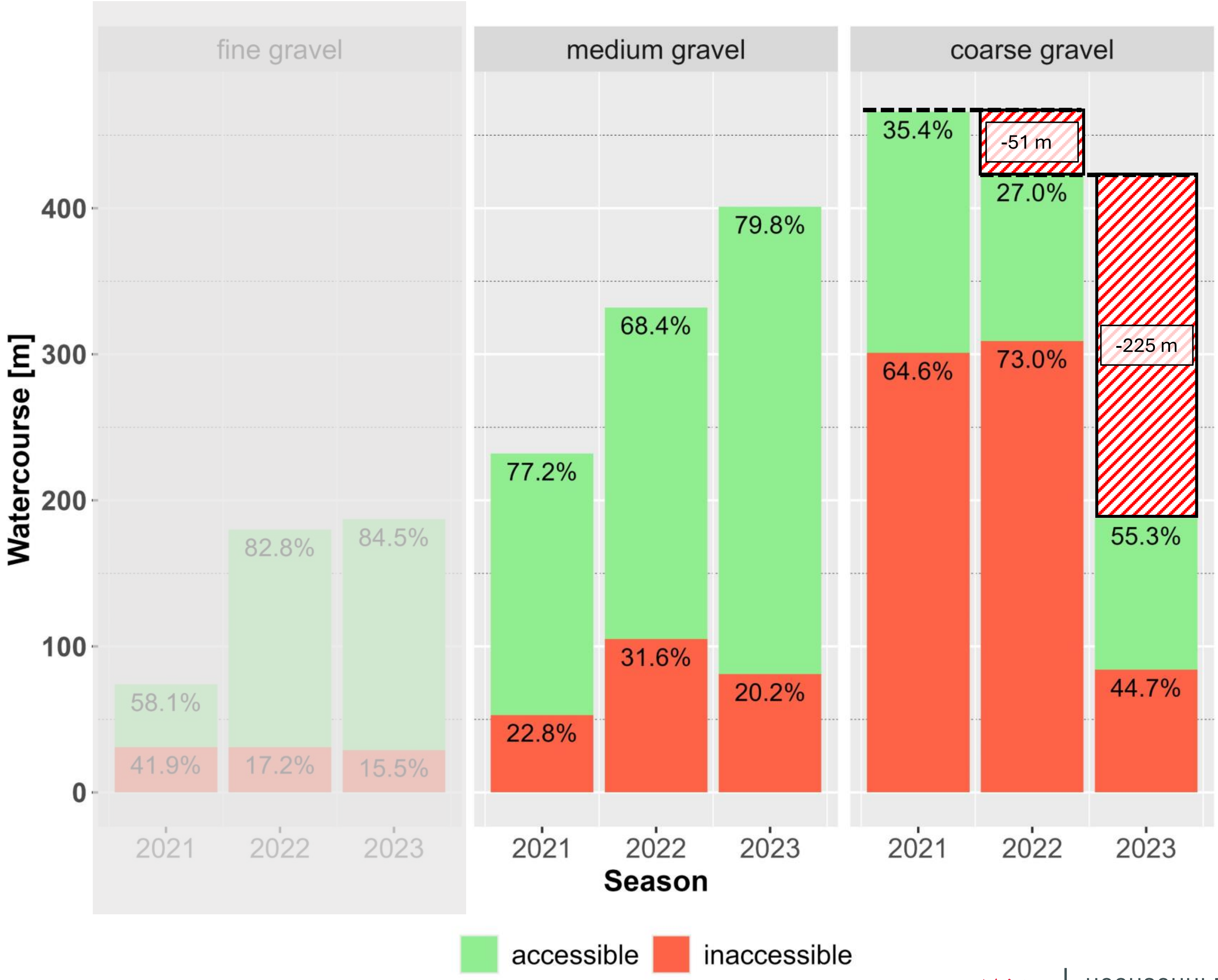

D3-23 at 25th December 2023


D3-23 at 25th Oktober 2023

Results

Research question b)

Do beaver dams lead to the loss of spawning habitats?



Lost by **damming** (D6-22/D7-22)

Sedimentation independent of beaver dams

D6-22 Autumn 2022

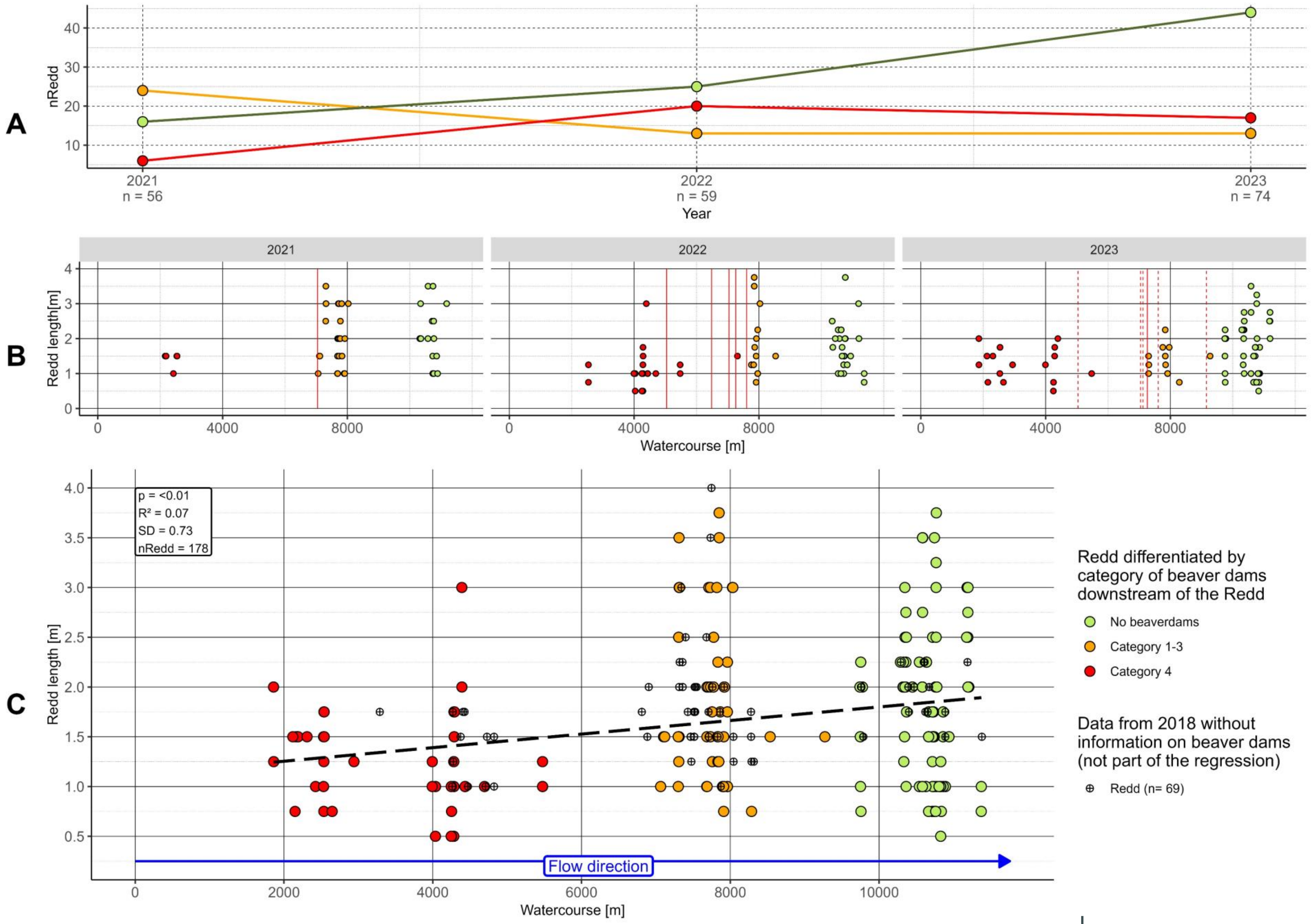

D6-22 Spring 2023


D6-22 Winter 2023

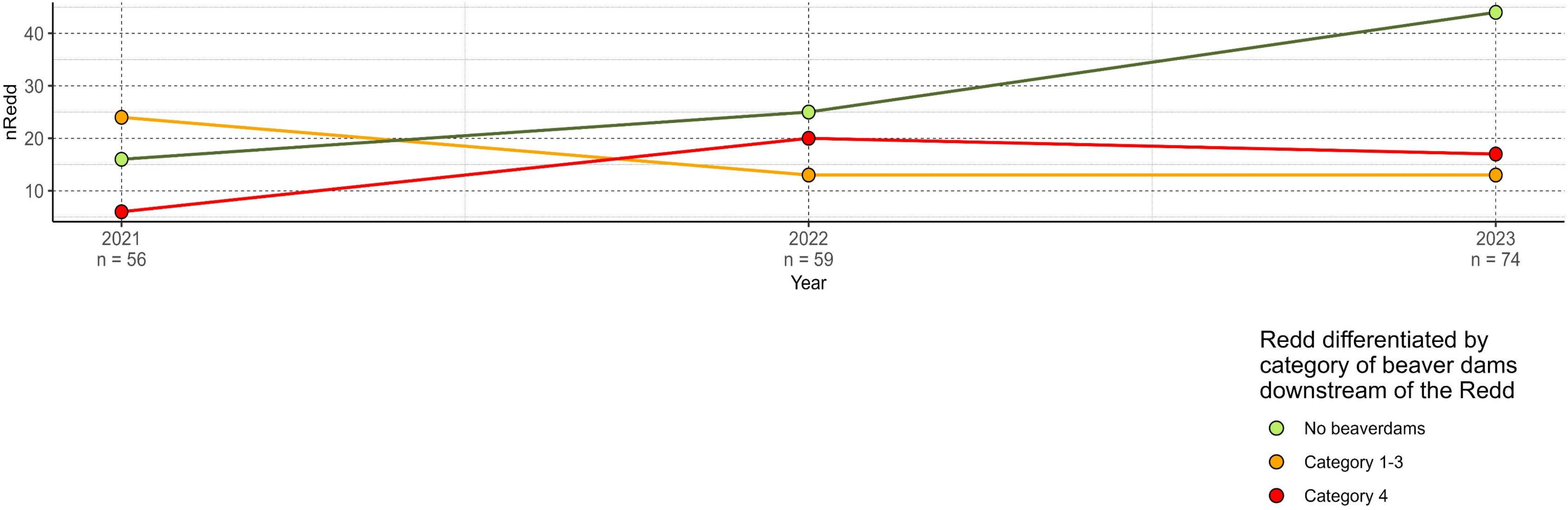
Results

Research question c)

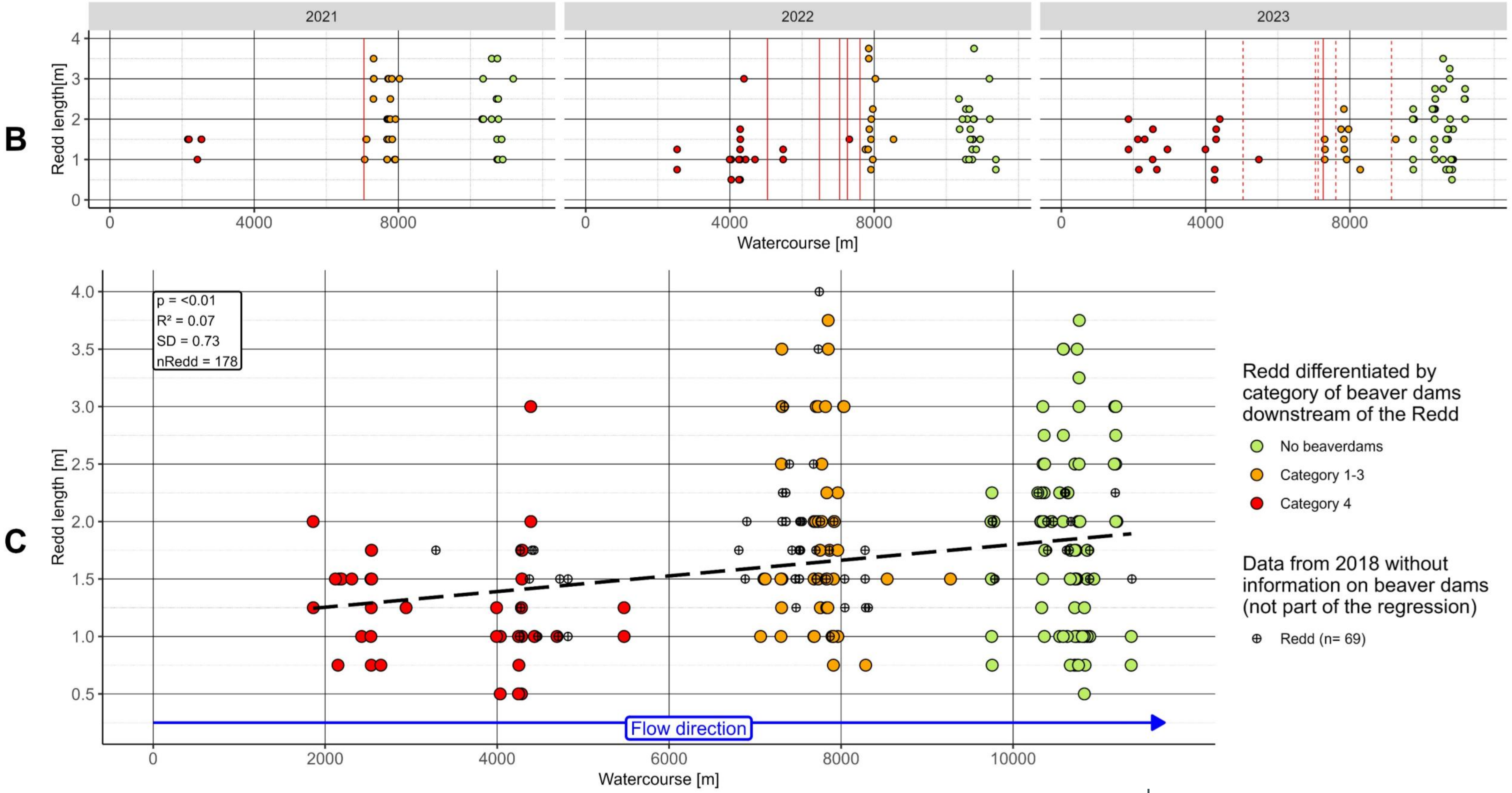
Are the spawning dynamics of the trout affected?


A
nRedd
40
30
20
10
2021
n = 56
2022
n = 59
2023
n = 74
Year
B
2021
2022
2023
Redd length[m]
Watercourse [m]
C
p = <0.01
R² = 0.07
SD = 0.73
nRedd = 178
Redd length [m]
Flow direction
Watercourse [m]
Redd differentiated by category of beaver dams downstream of the Redd
No beaverdams
Category 1-3
Category 4
Data from 2018 without information on beaver dams (not part of the regression)
Redd (n= 69)

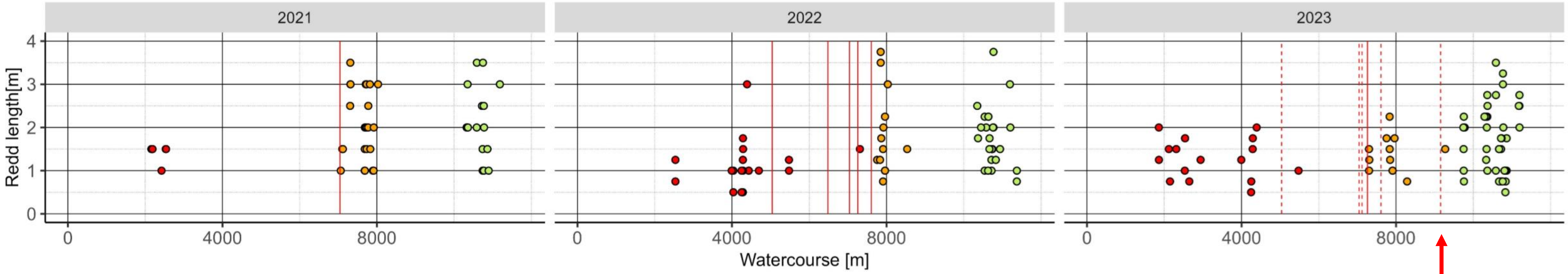
A



nRedd
10
20
30
40
2021
n = 56
2022
n = 59
2023
n = 74
Year
Redd differentiated by category of beaver dams downstream of the Redd
No beaverdams
Category 1-3
Category 4


B
2021
2022
2023
Redd length[m]
Watercourse [m]
C
p = <0.01
R² = 0.07
SD = 0.73
nRedd = 178
Redd length [m]
Watercourse [m]
Flow direction
Redd differentiated by category of beaver dams downstream of the Redd
No beaverdams
Category 1-3
Category 4
Data from 2018 without information on beaver dams (not part of the regression)
Redd (n= 69)

B


2021
2022
2023
Redd length[m]
Watercourse [m]
0
1
2
3
4
0
4000
8000


D3-23 at 25th December 2023
D3-23 at 25th Oktober 2023

Conclusion

- Some beaver dams can be a **temporary obstacle** to trout migration.

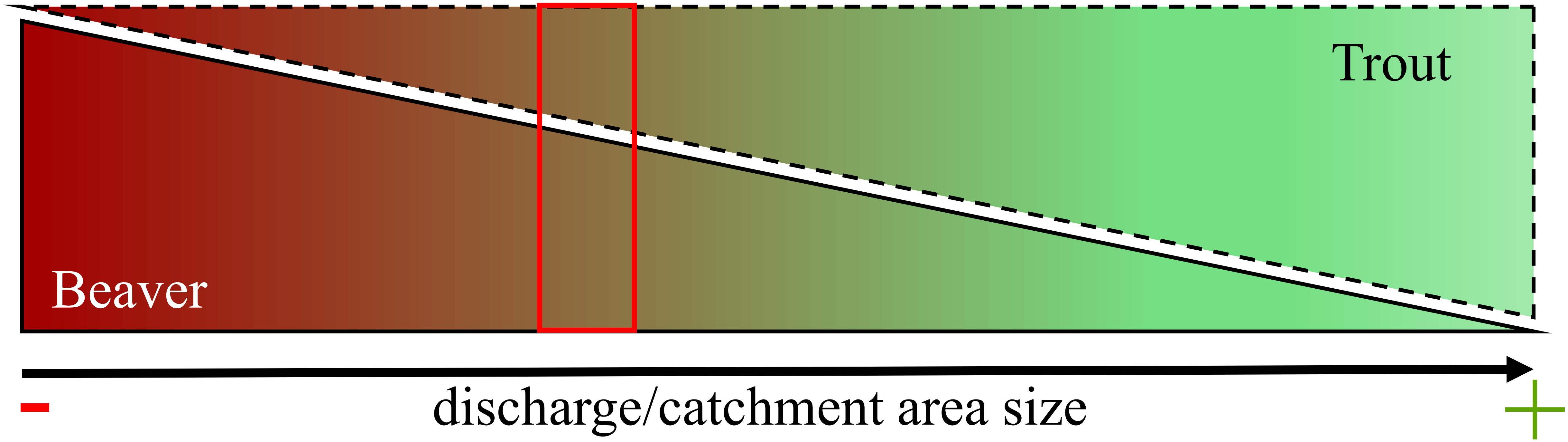
→ *Different ecotypes have different sensitivities (cf. Ferguson et al. 2019)*

- Beaver dams can lead to the **temporary loss** of spawning habitats characterised by gravel.

- The durability of beaver dams and their passability for trout is influenced by the **discharge behaviour** of the watercourse *(cf. Schlosser 1995; Collen and Gibson 2001; Pollock et al. 2003; Elmeros et al. 2003; Mitchell and Cunjak 2007; Taylor et al. 2010; Kemp et al. 2012; Ecke et al. 2017; Larsen et al. 2021)*

Outlook

- How should the **ecotypes** of trout (Salmo trutta) be taken into account when assessing the potential for conflict between trout and beavers?
- How can the interaction between trout and beaver be assessed/quantified on a **landscape scale**?
- Is there an influence of **catchment area characteristics** and spatial distribution patterns?



Naturschutz & Landnutzungsplanung

NATÜRlich Zukunft planen

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Felix Krause. Hennes Brendler und Jonathan Stender

Thank you for your attention!

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ResearchGate

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Anex

Dam categorisation

Each spawning season between November and January. all beaver dams were mapped and categorised according to their passability for trout

	Category 1	Category 2		Category 3		Category 4
passability for trout	easily passable	passable		conditionally passable		not passable
Dam condition	damaged	intact	damaged	intact		intact
Width of the damage (m)	>0.3 and	-	0.1-0.3 and	-	-	-
Depth of the damage (m)	>0.7	-	0.2-0.7	-	-	-
Dam height (m)	<0.5	<0.1	<0.5	<0.5	>0.5	>0.5
Gewässertiefe h. D. (m)	-	-	-	<1	>1	<1
Flow velocity (m/s)	0.3-1.3	-	0.3-1.3	-	-	-

**Values are based on DWA Code of Practice 509 - Fish ladders and fish passable structures: design. dimensioning. quality assurance*

Mapping of spawning substrates

Classification of the substrates according to the pedological mapping guidelines (Eckelmann et al. 2006)

- Fine gravel (2.0-6.3 mm)
- Medium gravel (6.3-20 mm)
- Coarse gravel (20-63 mm)

(Estimate without sampling the sediments)

Annual mapping of the stretch of water dominated by a grain size fraction

- Are spawning habitats lost due to **damming**?
- Are the spawning habitats inaccessible due to the **barrier effect** of the beaver dams?

Mapping the spawning beds (redds)

Investigation of effects on the spawning behaviour of trout using the indicators **number** and **size of redds**.

- The **number** of redds to estimate the number of spawning fish
- The **size** of the redds to estimate the constitution/ecotyp of spawning fish

→ Size of spawning redds correlates with the size of female trout (Crisp and Carling 1989)

→ Sea trout are potentially larger than brown trout (Ferguson et al. 2019)

Redd length = length pit + tailspill

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