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The effect of agglomeration bonus schemes on biodiversity

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Research Group *Managerial Economics in Agriculture*

FRIES Seminar - ETH

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Introduction

- Agricultural activities threat to biodiversity (Maxwell et al., 2016)
- Conservation efforts needed!
- Connected habitats suggested for biodiversity conservation (Eisner et al., 1995)
- One policy tool for creating connectedness: incentivize coordination of private conservation through coordination payments to farmers (“agglomeration bonus payments”)
- Our **Project “Network”** aims at *understanding the benefits of connected habitat and of agglomeration bonus payments as a policy instrument*

Connected habitat: the relevant questions

Biology point of view

- What is the effect of connecting habitats on biodiversity?
- Which species react how sensitively?
- How quick is a recovery?
- What type of connected habitat benefits which species?
- How does the effect depend on properties of the habitat?

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Econ point of view

- What possible coordination «devices» can be used?
- What is the role of norms and trust for coordination («commons» point of view)?
- Can a coordination payment solve the coordination problem?
- Does an optimal payment size exist and how can the planer choose it?
- What happens if the payment is too low (multiple equilibria) or too high (windfall gains)?

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Ag Econ point of view

- How do farmers choose plots to connect?
- How large are the forgone profits?
- Which institutions and rules lead to successful coordination
- ….

Connected habitat: the relevant questions

Biology point of view

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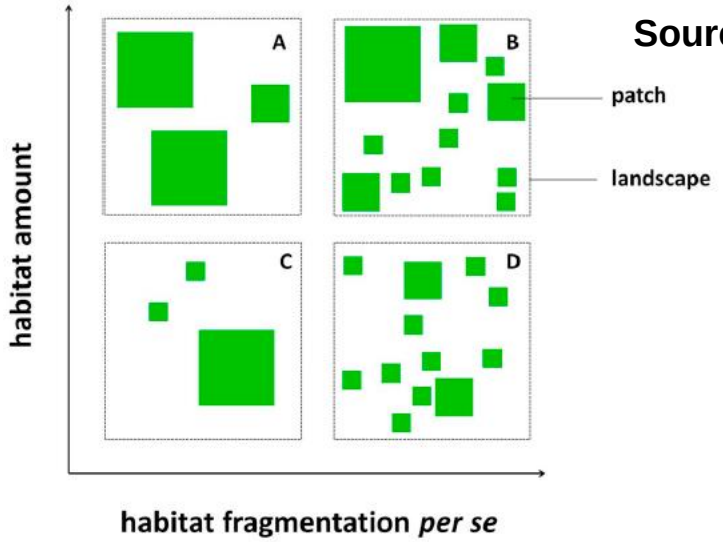

Source: Fahrig et al. (2019)

Connecting habitat is (something like) the reverse process of fragmentation of habitat

- Unsettled question: having the **same size of land**, is it better to have it fragmented or connected?
- Different from «**Is more habitat better**». Size is held fixed.
- No clear evidence: e.g. **Fahrig et al. (2019):**
  - Most responses to habitat fragmentation per se are **non-significant**.
  - Most significant responses to habitat fragmentation per se are **positive**.
  - Sets of small habitat patches with a large total area have high conservation value.

Connected habitat: the relevant questions

Biology point of view

- **What is the effect of connecting habitats on biodiversity?** ← **Remains an open question.**
- Which species react how sensitively?
- How quick is a recovery?
- What type of connected habitat benefits which species?
- How does the effect depend on properties of the habitat?

Recent contributions:

- Moor et al. (2022) PNAS: creation of new ponds leads for some species to higher populations in better connected than in worse connected ponds, while for others the reverse effect
- Meier et al. (2024) AGEE: plots in agglomeration projects have higher biodiversity. **CAN BE BOTH** due to land selection and connecting.
- Rich literature on **edge effects**: e.g. Laurance et al. (2007)

These studies do not rely on experimental or quasi-experimental evidence.

Connected habitat: the relevant questions

Theory of coordination:

- **Spatial externalities** lead to divergence between individual incentives (through market prices) and collective payoff (Swallow and Wear, 1993)
- Spatial externalities create **multiple Nash equilibria** on which parcels to enroll (Helfland and Rubin, 1994)
- Models on coordination payments: Bell et al. (2016), Drechsler et al. (2016), Bareille et al. (2022), Drechsler (2023). Main finding: **coordination payments potentially effective**

Evidence on effect of payments on coordination:

- **Lab experiments**: Parkhurst et al. (2002), Parkhurst et al. (2007): **coordination payment** + communication upfront leads to **optimal Nash equilibrium**
- Further lab experiments on coordination: Ferre et al. (2022), Banerjee et al. (2011, 2015), Bamiere et al. (2013)

Econ point of view

- What possible coordination «devices» can be used?
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Need for empirical evidence with observational data «in the field»

Connected habitat: the relevant questions

Ag Econ point of view

- How do farmers choose plots to connect?
- **How large are the forgone profits?**
- Which institutions and rules lead to successful coordination
- What are the nonmonetary bariers to enrollment (norms, attitudes, «literacy»)

→

- Huber et al. (2021): conservation costs drive enrollment
- **Need for empirical evidence**
- ….
- …..

RESULT OF HUBER ET AL. (2021) HIGHLIGHTS THAT ENDOGENOUS SITE SELECTION IS A POTENTIAL ISSUE WHEN ASSESSING EFFECT ON BIODIVERSITY

Research question in this talk

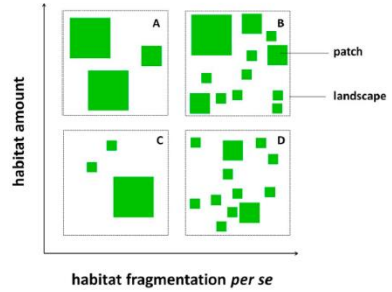
What is the effect of agglomeration projects in Switzerland on «landscape» fauna diversity?

- Aim: provide causal evidence with a clear and credible identification design

- Aim 2: understand the (habitat and farm) drivers behind the effect

Institutional setup (1)

- Three main types of agri-environmental payments to farms:
  a) Action-based payments (“Q1”)
  b) Result-based payments (“Q2”)
  c) Aglomeration bonus (“Vernetzungsbeiträge”): paid on top of a) and b)
- Requirements for c): slightly stricter than for a) (almost equivalent).



Institutional setup (2)

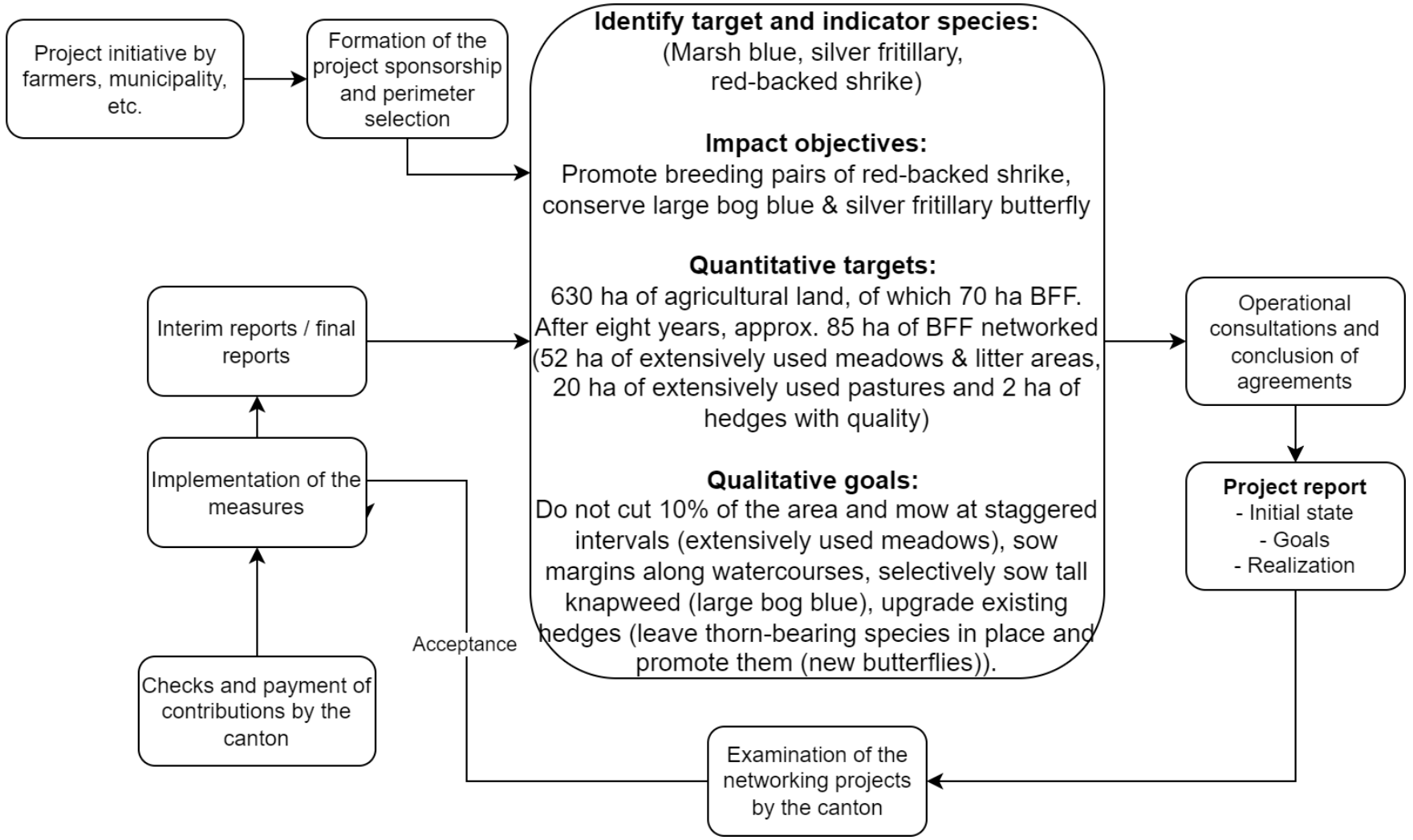
Eligibility for agglomeration **bonus** payments: two steps

1. Municipality participates in an agglomeration **project**
2. Farmers within an agglomeration **project** sign a contract for participation (and get agglomeration **bonus** payments) for **any chosen plot(s).**

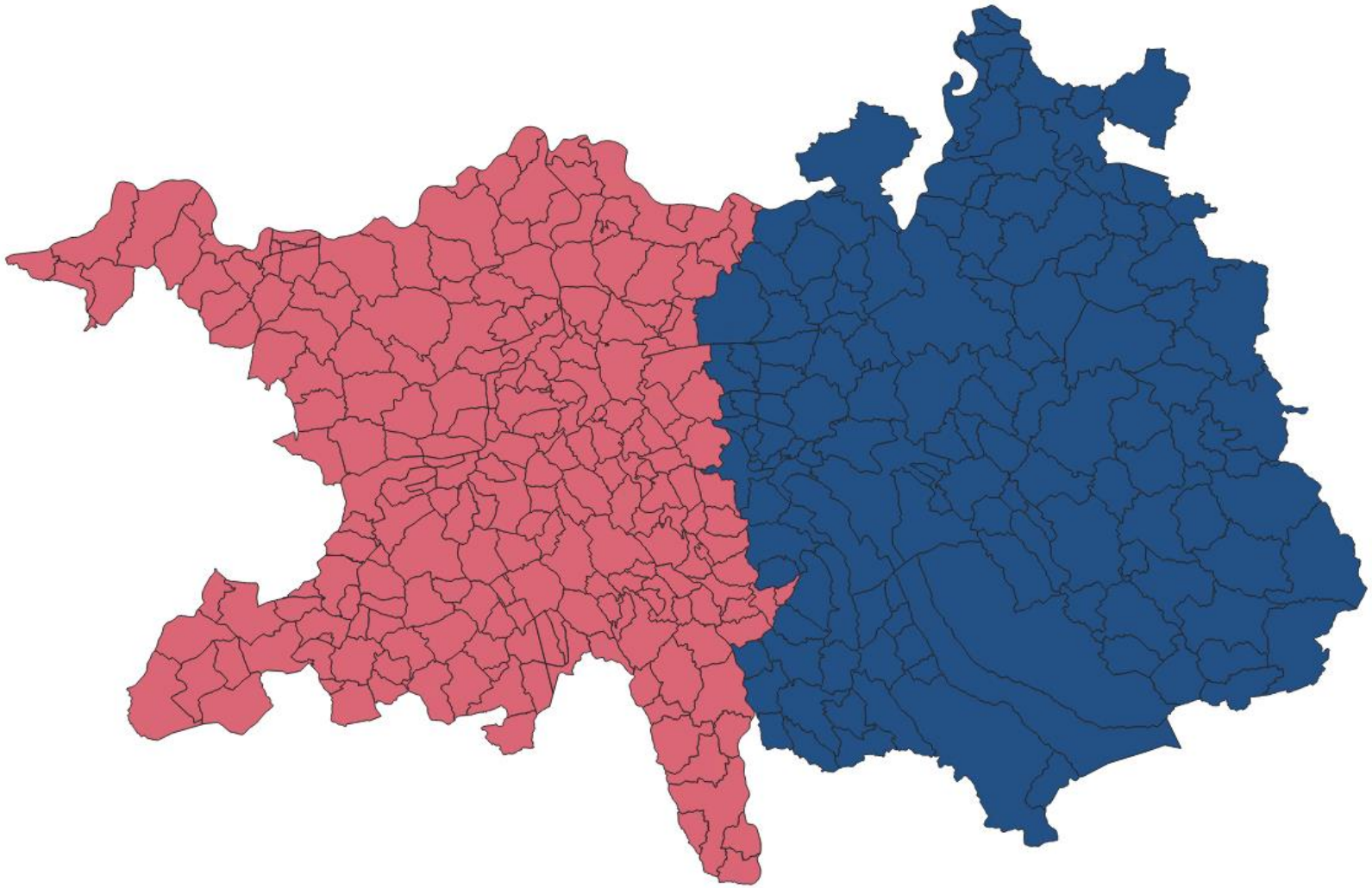
Remark: setup slightly differs from the typical coordination setup in the literature. Neither true connectedness nor threshold required (as in e.g. Drechsler (2023)).

Remark 2: in this talk, effect of **project** (and not of **bonus** payment) on biodiveristy

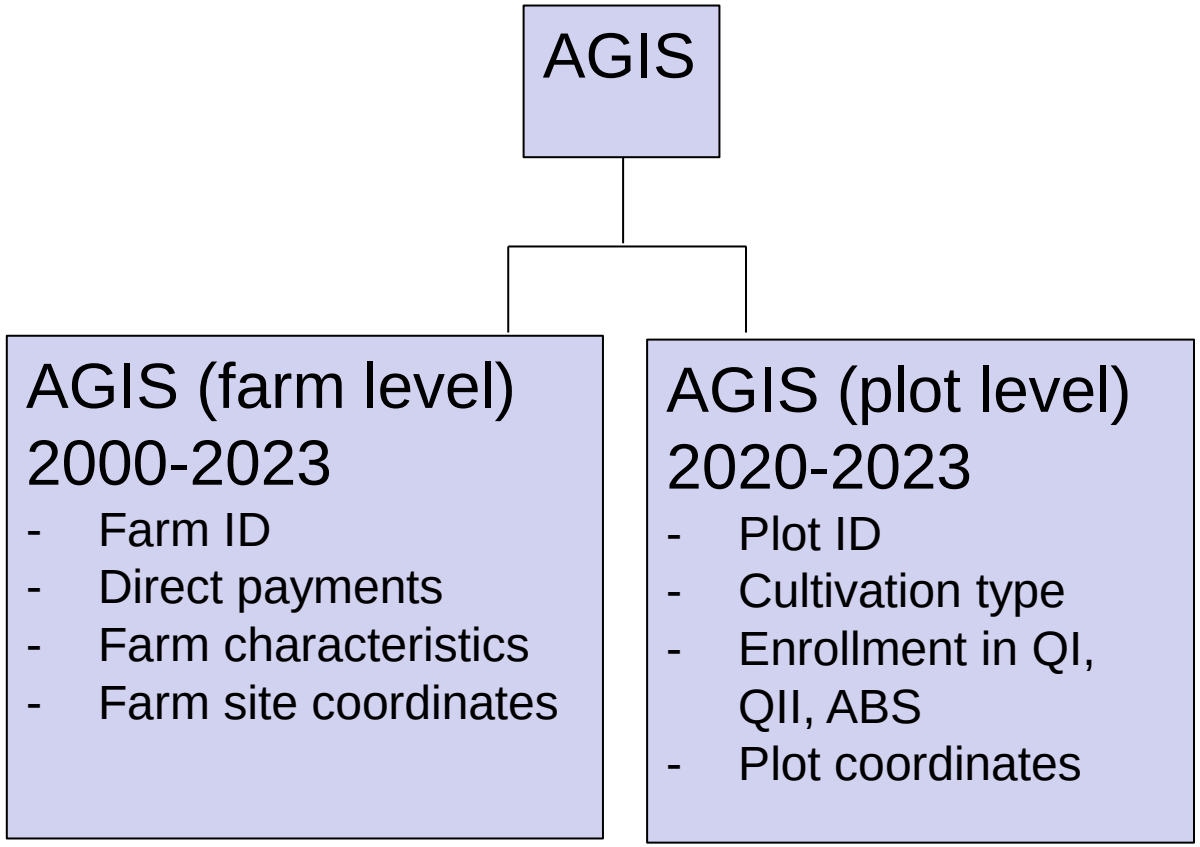
Agglomeration Project Cycle: a complex picture



Area of study: cantons Aargau and Zürich



Data and data sources



Agglomeration project perimeters (source: cantons)

- Name of community / agglomeration project
- Starting year (if community participates)
- Coordinates of community/ agglomeration project

Fauna observations 1923-2023 (source: Infofauna)

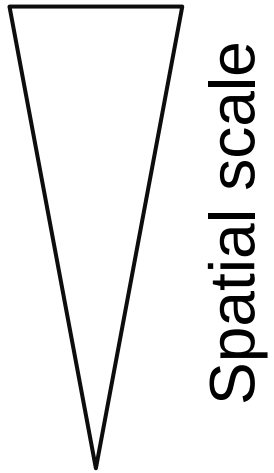
- Name of taxon
- Year of observation
- Coordinates of observation (including uncertainty radius)

Novel dataset

We match these geo-referenced datasets to obtain a unique dataset:

1. Municipality & ABS project data:

   346 municipalities or projects
2. Farm-level data: ~ 7700 farms (2002 - 2022)
3. Plot-level data: ~ 210,000 plots (2021)
4. Biodiversity: ~100,000 fauna observations (1923 - 2021)



Treatment and outcome

- Treatment: municipality/region participating in an ABS project
- Outcome:
  1. Fauna species abundance and diversity
  2. Area under action- and results-based AES (as share of total farm land)

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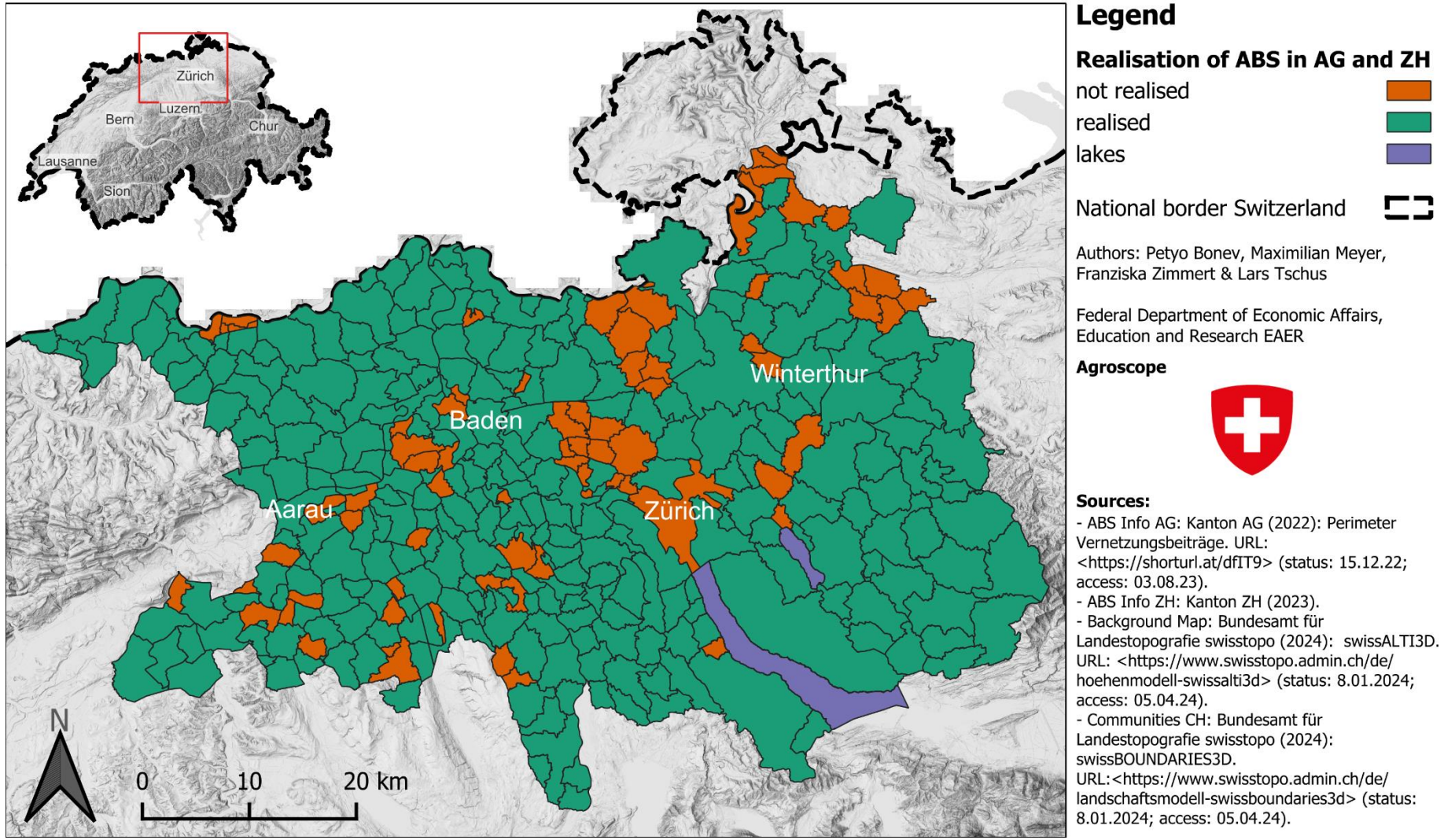
Agglomeration projects (current status)



Treatment and outcome

- Treatment: municipality participating in an ABS project

- Outcome:

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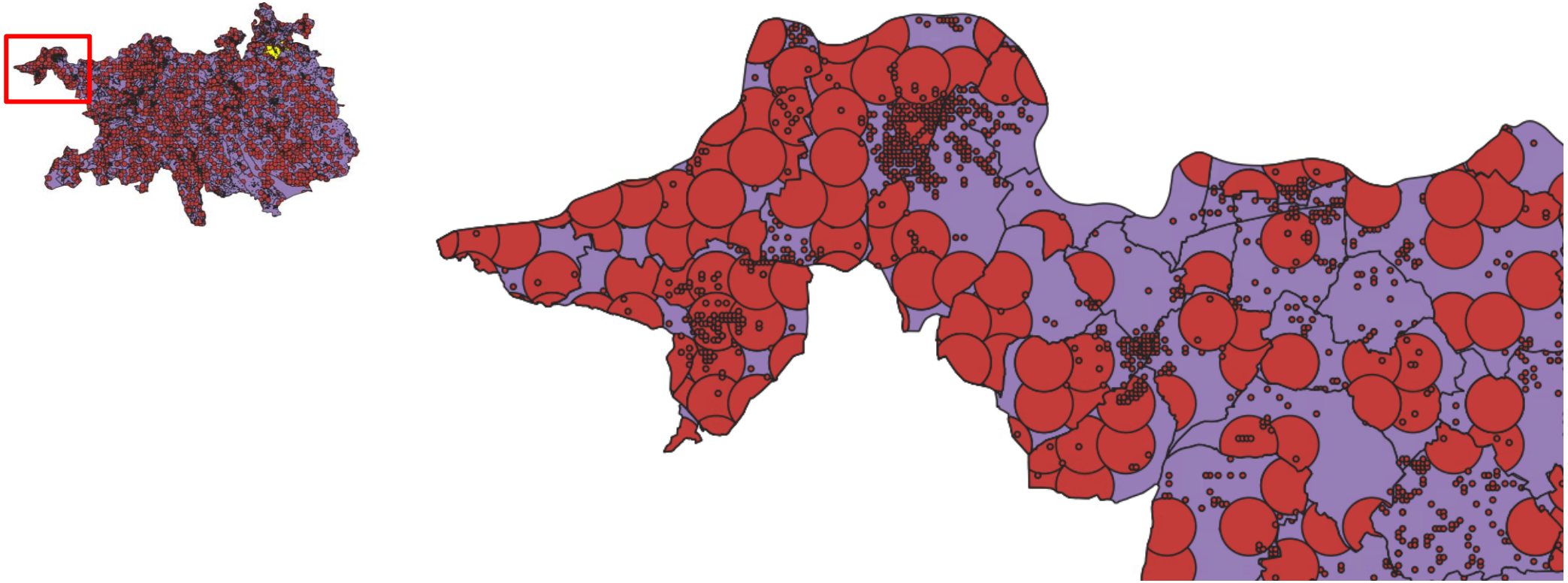
Outcome: species richness

- **Species considered**: 5 groups fauna species
  1. Amphibia
  2. Gastropoda
  3. Insecta
  4. Mammalia
  5. Reptilia

- **Outcomes**:
  1. Number of species seen in a region within a given year
  2. Shannon Index (considers number of species and abundance of each category)

Outcome: we assigned biodiversity observation to municipalities/regions



Treatment and outcome

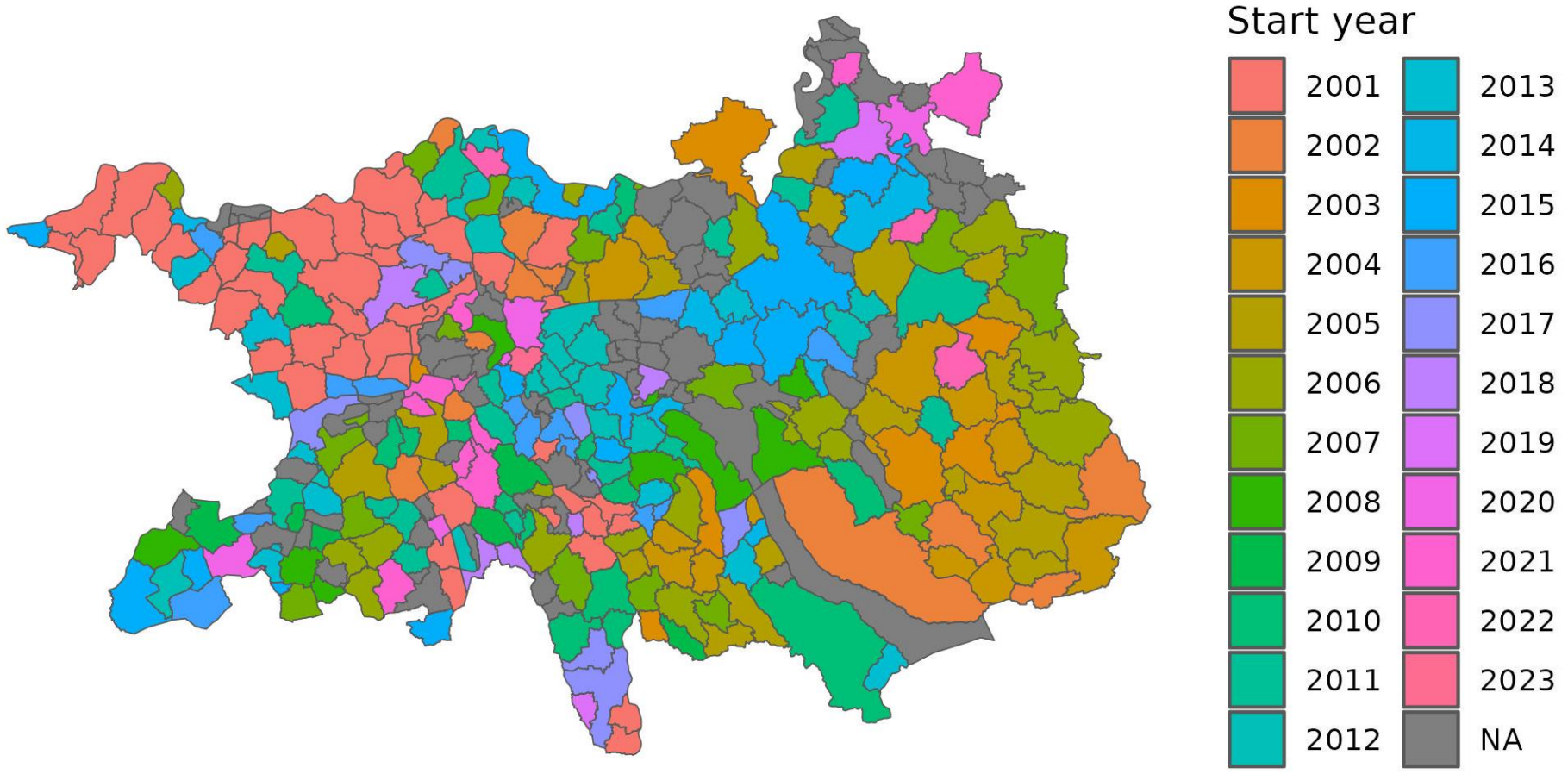
- Treatment: municipality participating in an ABS project

- Outcome:

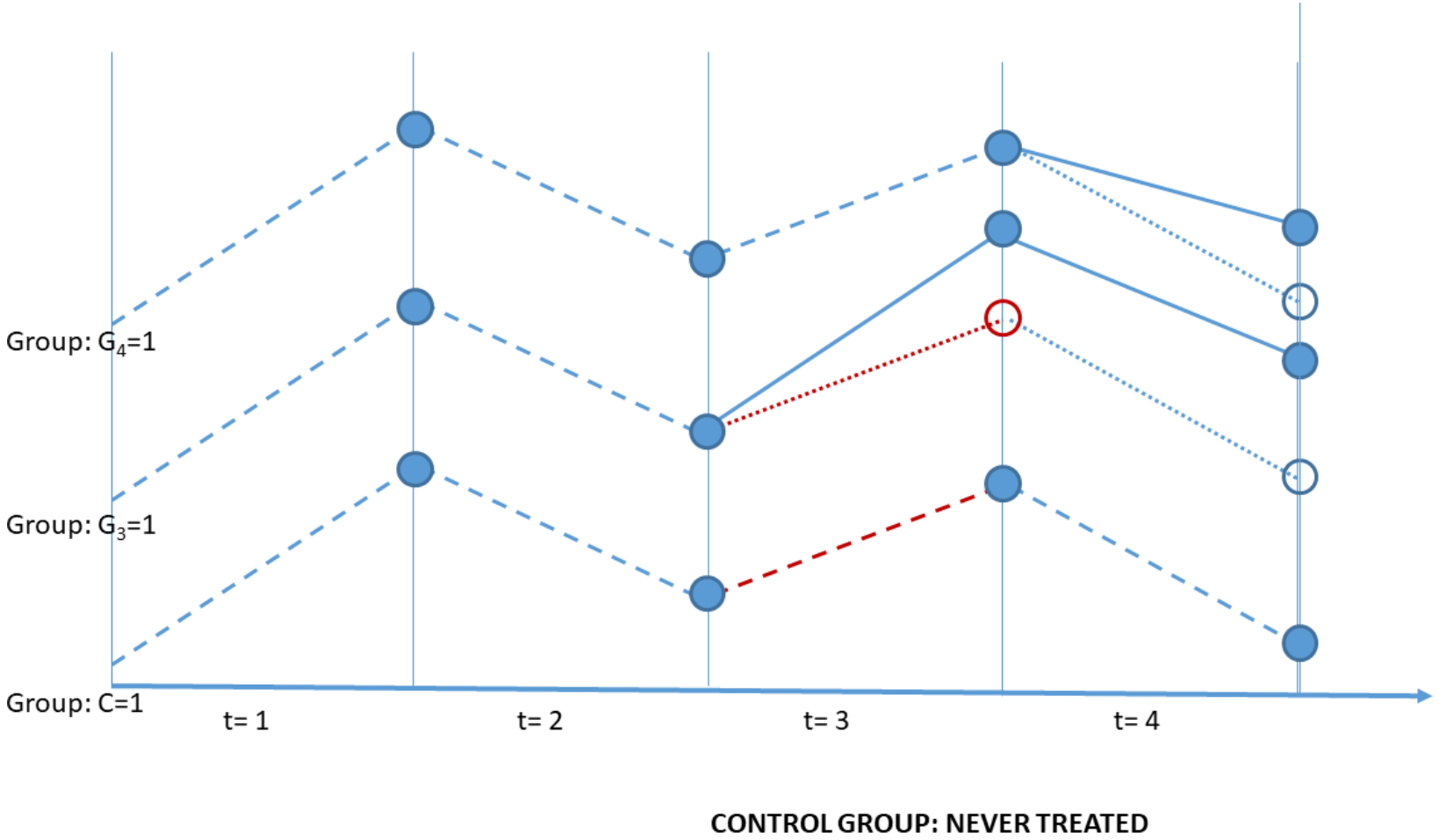
  1. Fauna species abundance and diversity

  2. Area under action- and results-based AES (as share of total farm land) (WHY WE USE IT: LATER!).

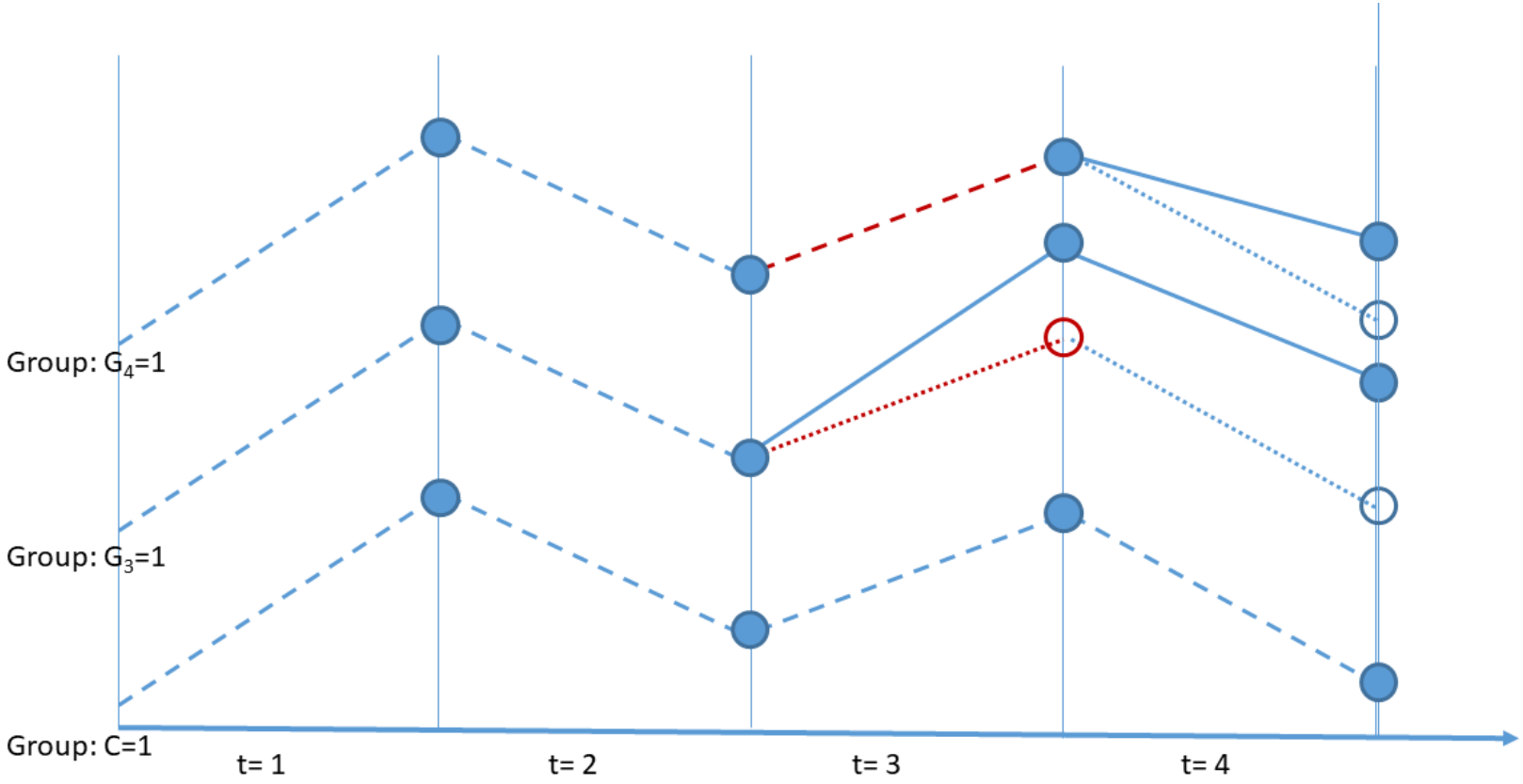
Identification (1): use staggered implementation



Identification (2): assuming parallel trends



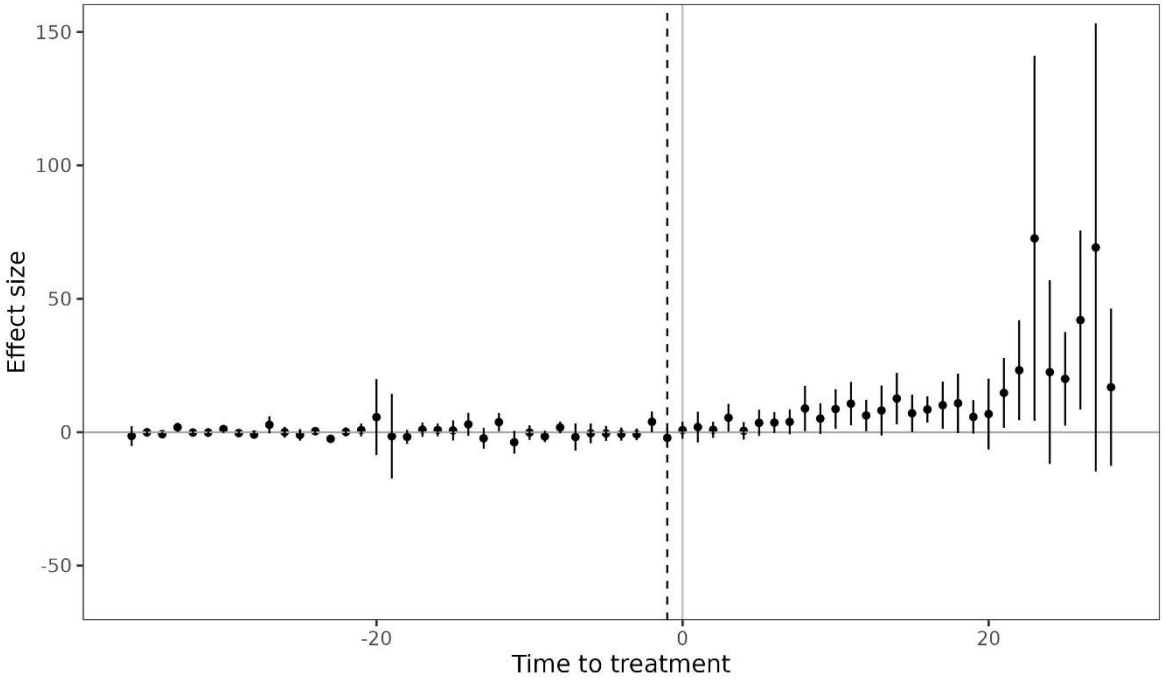
Identification (3): assuming parallel trends



WE USE A STAGGERED DIFF-IN-DIFF APPROACH

Results: effect of agglomeration projects on species

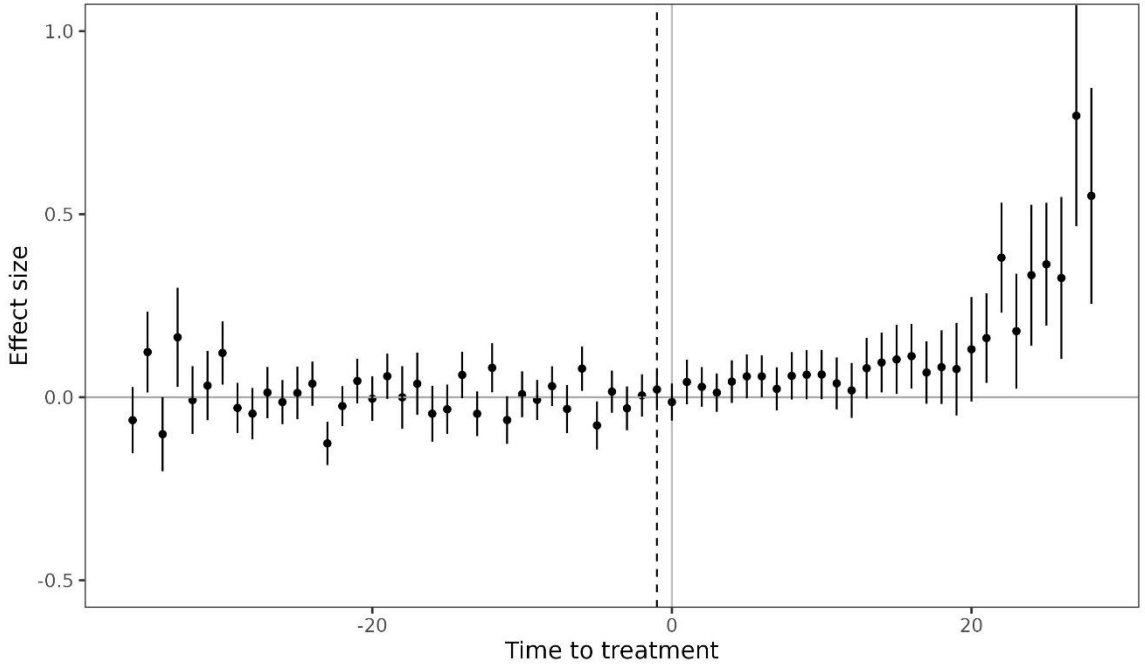
Species abundance (No. of species observations)



Simple ATT:

6.88 [95% Conf. Int. = 3.47, 10.31]

Species diversity (shannon index)



Simple ATT:

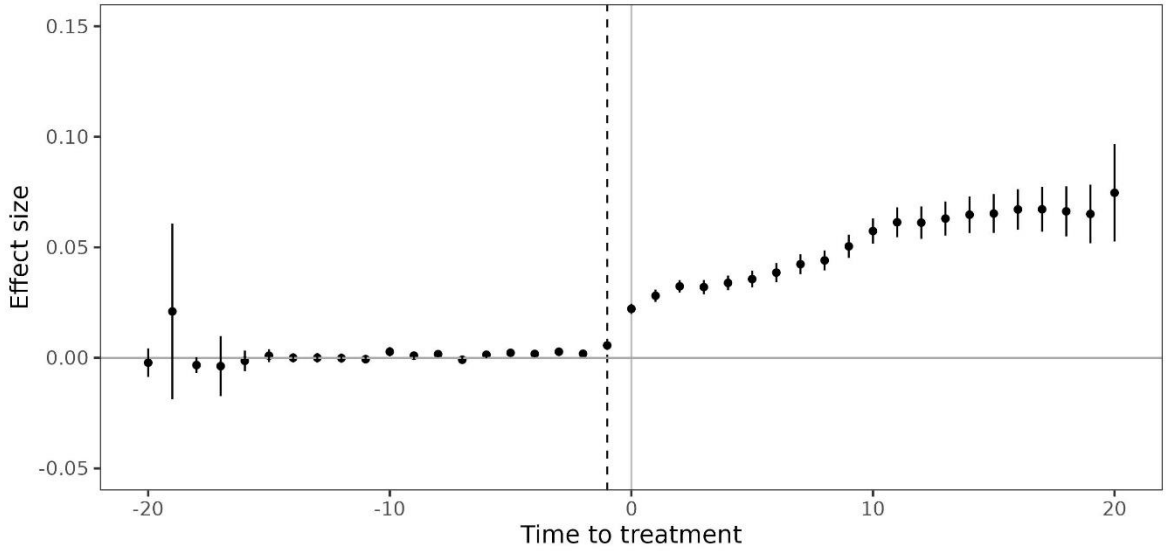
0.064 [0.0139, 0.113]

Mechanisms

- **Main question**: is the positive effect due to (1) higher habitat connectedness or (2) more habitat?
  - Hard econometric/identification problem;
  - Two pieces of indirect evidence:
    1. Have agglomeration projects increased total habitat?
    2. Have agglomeration projects provided connected habitat at all?

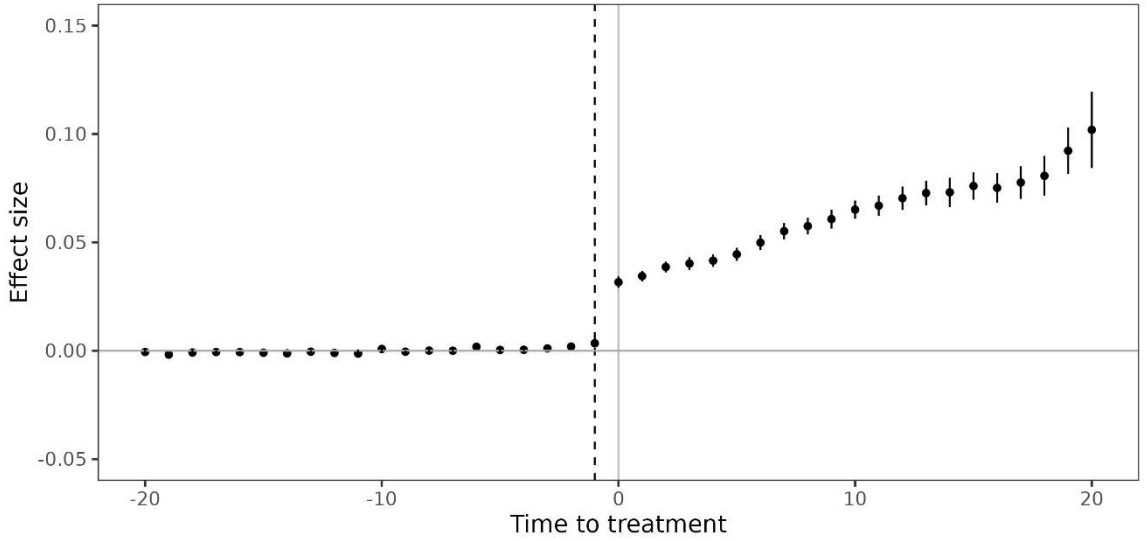
Effect of agglomeration projects on habitat surface

Share of Q1 on total farmland



Simple ATT:
0.045 [95% Conf. Int. = 0.040, 0.049]

Share of Q2 on total farmland



Simple ATT:
0.054 [95% Conf. Int. = 0.051, 0.057]

Parallel trends very likely to hold as estimates before treatment are very close to zero.

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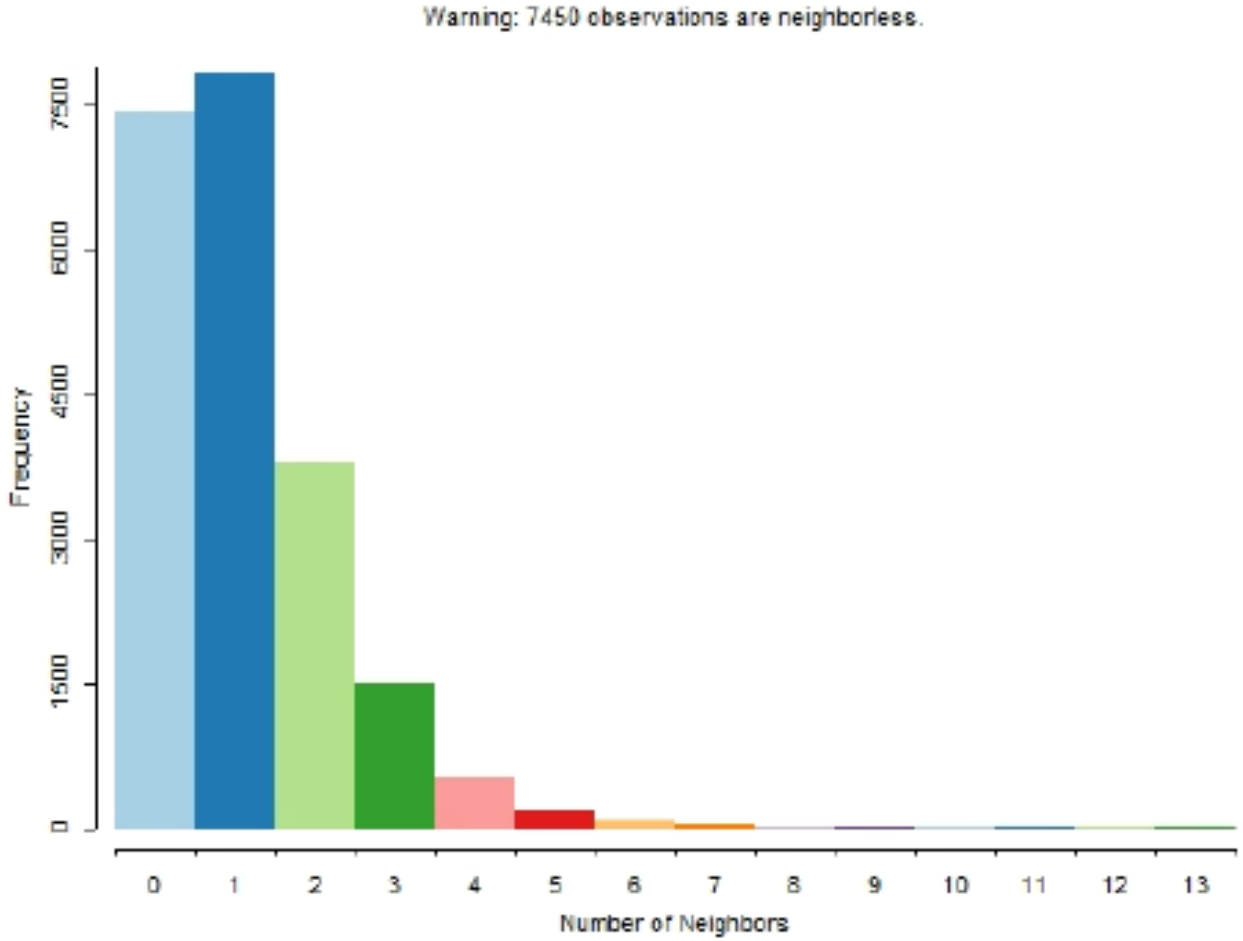
Have agglomeration projects lead to high connectedness?

Association of ABS schemes participation with plot connectivity and perimeter to plot area ratio (potential edge effects)

Number of municip alities	Treatment: ABS participation	Share of *action-based* AES area on total agricultural area	Share of *result-based* AES area on total agricultural area	Mean Moran's I of action-based AES areas	Mean Moran's I of result-based AES areas	Mean plot perimeter to plot area ratio (potential edge effect)
280	1	0.17	0.08	0.25	0.26	0.17
74	0	0.13	0.05	0.23	0.24	0.13

Have agglomeration projects lead to high connectedness?



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Mechanisms

- **Main question**: is the positive effect due to (1) higher habitat connectedness or (2) more habitat?
  - Hard econometric/identification problem;
  - Two pieces of indirect evidence:
    1. Have agglomeration projects increased total habitat? **Yes, by much!**
    2. Have agglomeration projects provided connected habitat at all? **Not entirely clear yet, seems not to be the case.**

Next steps in this project

- Study the effect for separate species: which species react most sensitively?
- Study effect heterogeneity for different initial habitat conditions
- Study effect heterogeneity for different “farm landscapes” (which farming type dominates the subregion?
- **$1.000.000 question: disentangle the effects of area and connectedness**

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PROJECT «NETWORK»: a bundle of projects

GOAL 1: extend the analysis on the whole of Switzerland (work in progress)

GOAL 2: add matched FADN data to study forgone profits due to participation in agglomeration projects (work in progress)

GOAL 3: link to further datasets (future task)

GOAL 4: study properties of coordination Nash equilibria

GOAL 5: provide a comprehensive dataset on agglomeration projects to the research community and establish a network research programm (double network…)

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Thank you for your attention

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