Which areas to restore?
Quantifying the biodiversity potential of local restoration efforts

SustainScapes

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Land CRAFT

WORK OF A TEAM! IN PROGRESS!

TOGETHER WE RETHINK LANDSCAPES FOR A SUSTAINABLE FUTURE

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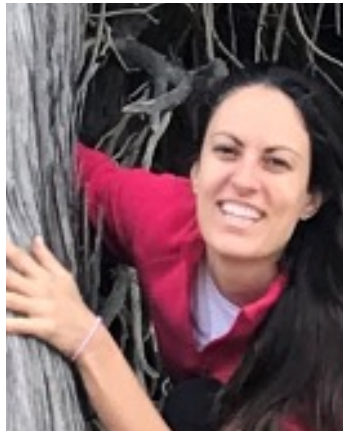

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Land CRAFT

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Danish National Research Foundation
CARLSBERG FOUNDATION
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We know why biodiversity declines! How to revert loss? Goals!

- Lack of space
- Lack of quality
- Lack of time

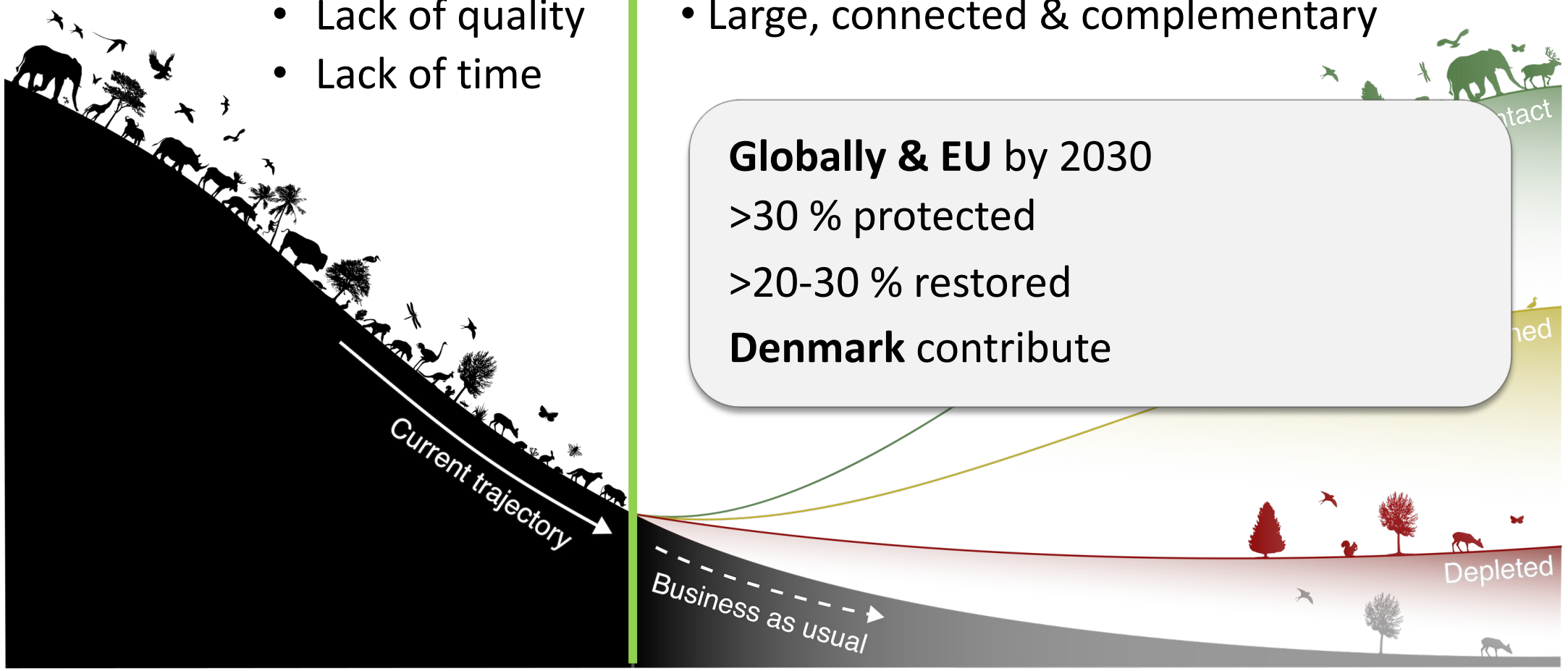
- Protect, restore, establish
- Large, connected & complementary

Globally & EU by 2030

>30 % protected

>20-30 % restored

Denmark contribute



- **Quality =** undisturbed ecological processes, functional networks, minimized pressure

Illustration: Michael Munk

WHERE MATTERS! WHERE TO PROTECT? RESTORE? ESTABLISH?

Areas with the highest **realized biodiversity** or **biodiversity potential**

Areas that contribute to create **large, connected**, **complementary** areas for biodiversity

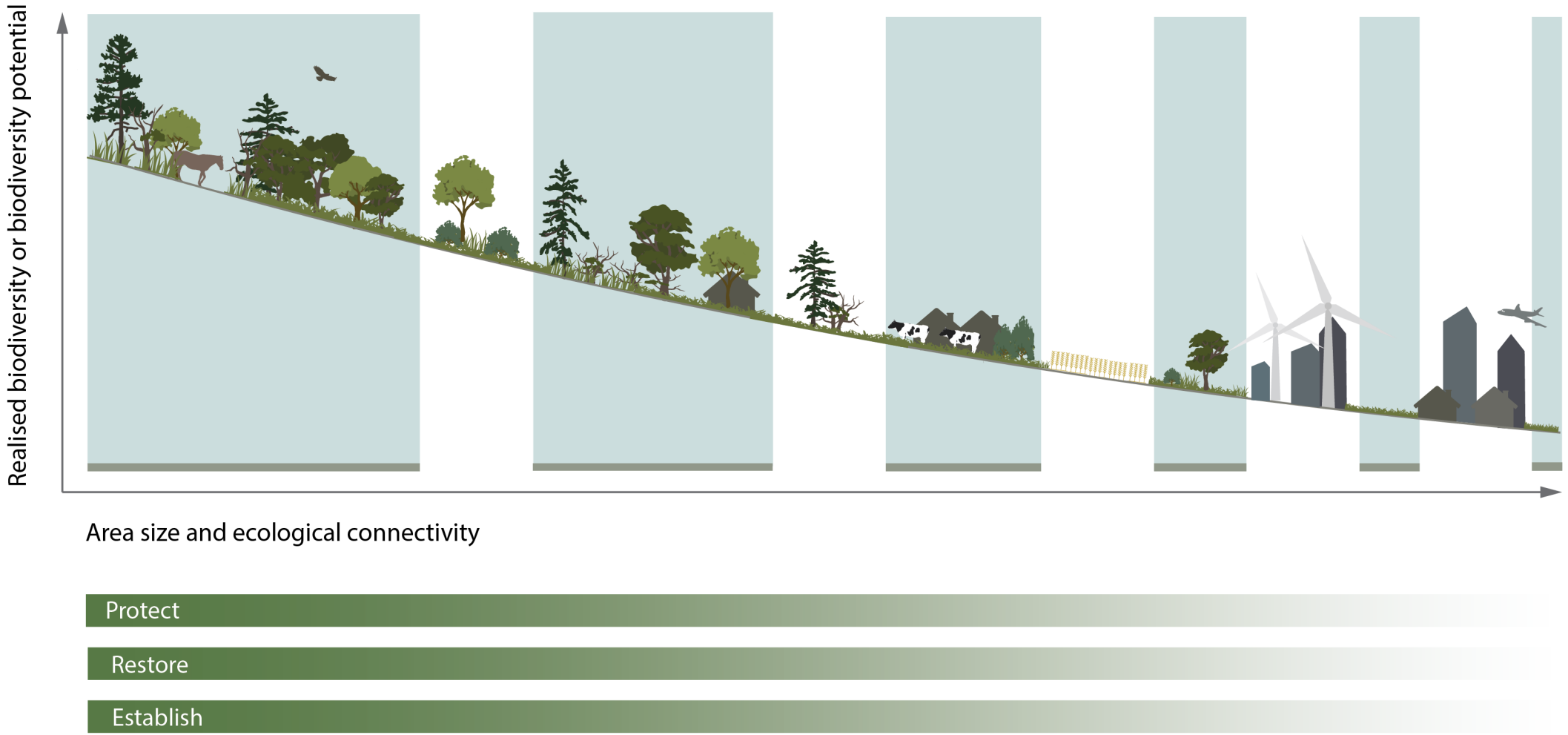
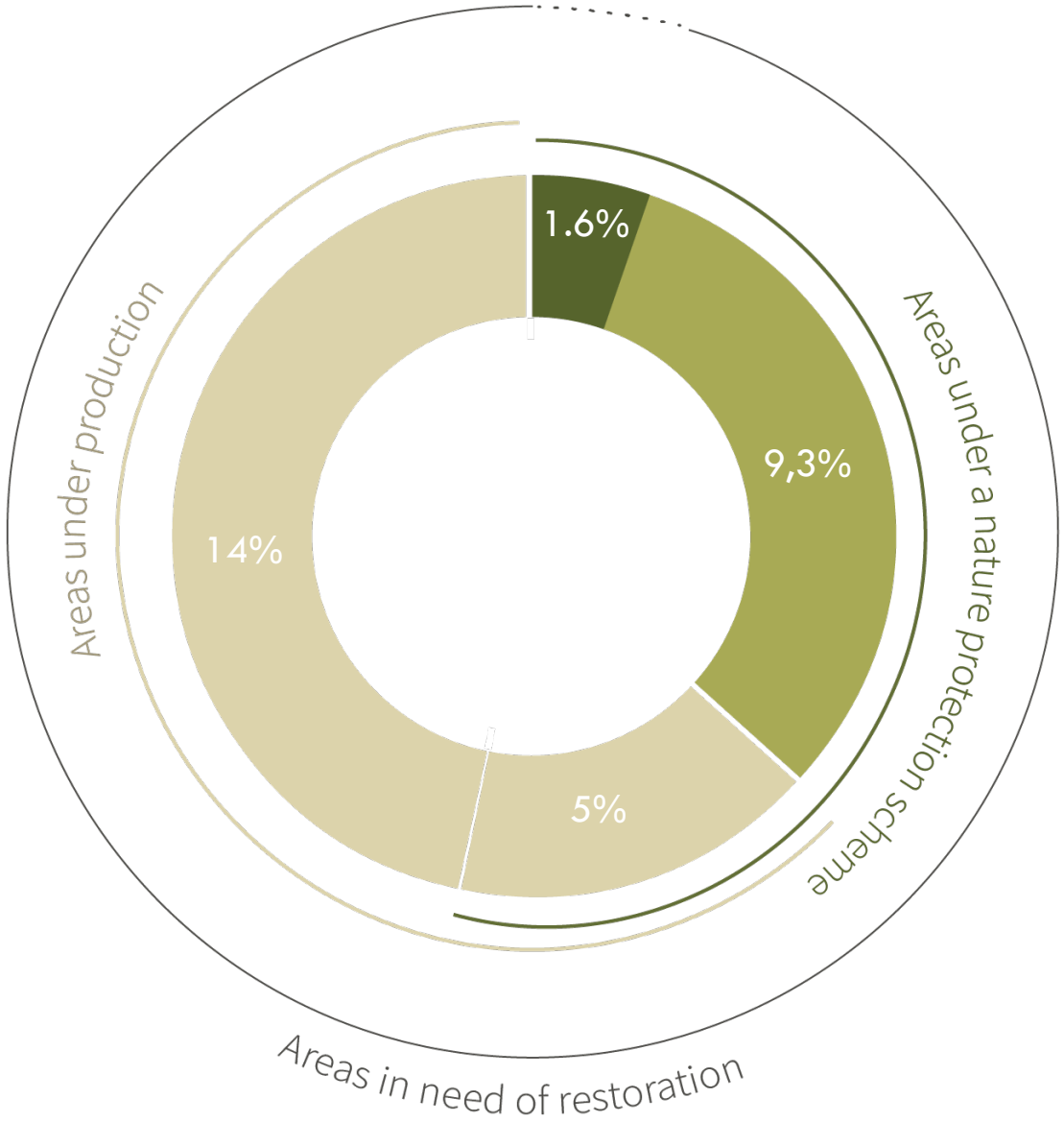


Illustration: Aleksandrina Leonidova Mitseva, modified from Biodiversitetsrådet (2024)

Which areas in Denmark? If the goal is 30 %?



Within the 30 %

- **~2 %** contributes to EU's 30 % goal
- **~9 %** needs individual assessment & most likely **improved restoration efforts**
- **~19 %** under production (forestry or agriculture); returned to nature through restoration

Exsisting protected areas contributing to the 30% goal

Areas in need of individual assessment and restoration

Areas under production

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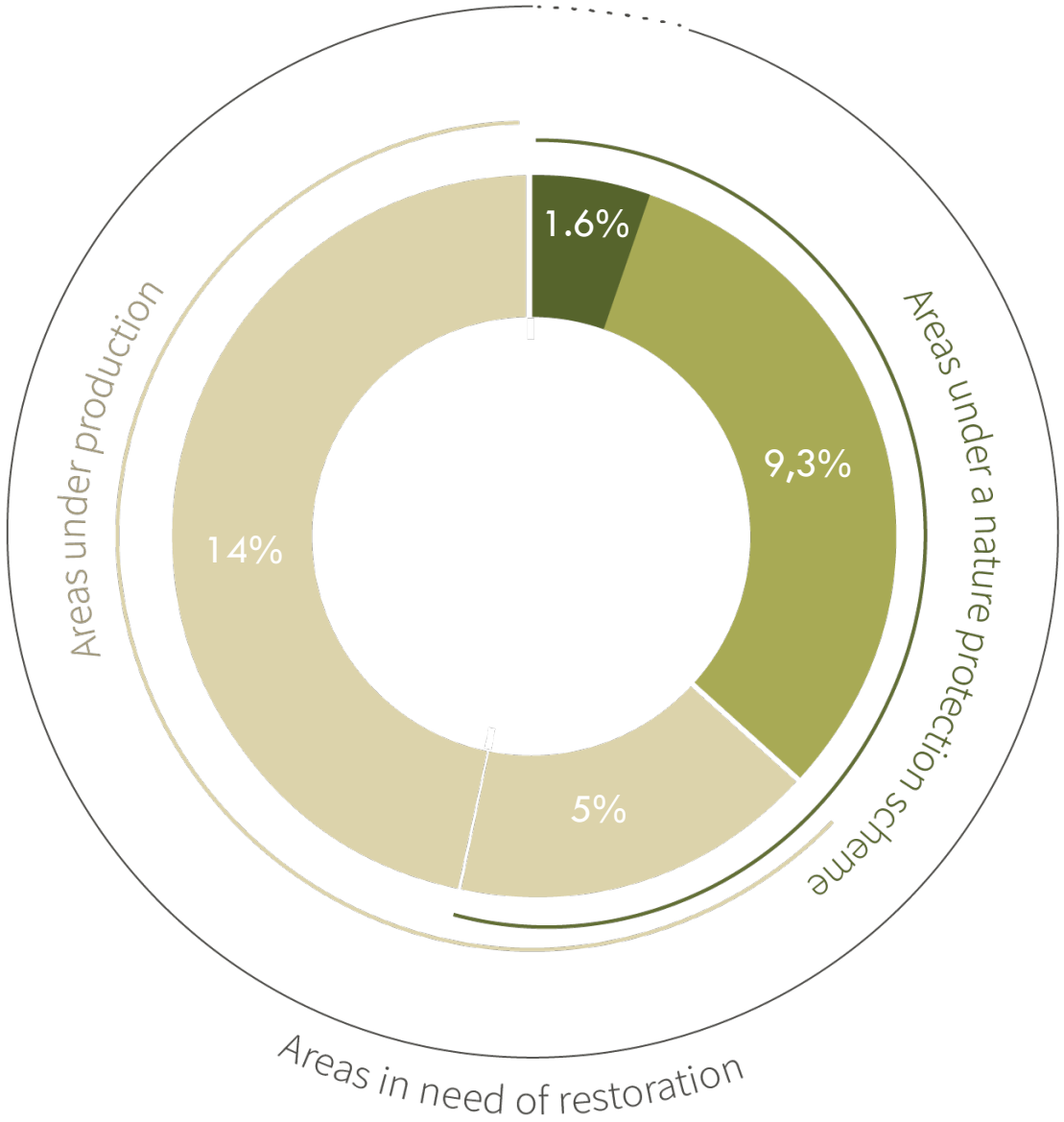

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Today focus on restoration & establishment

The 70 % beyond, is also important

Exsisting protected areas contributing to the 30% goal

Areas in need of individual assessment and restoration

Areas under production

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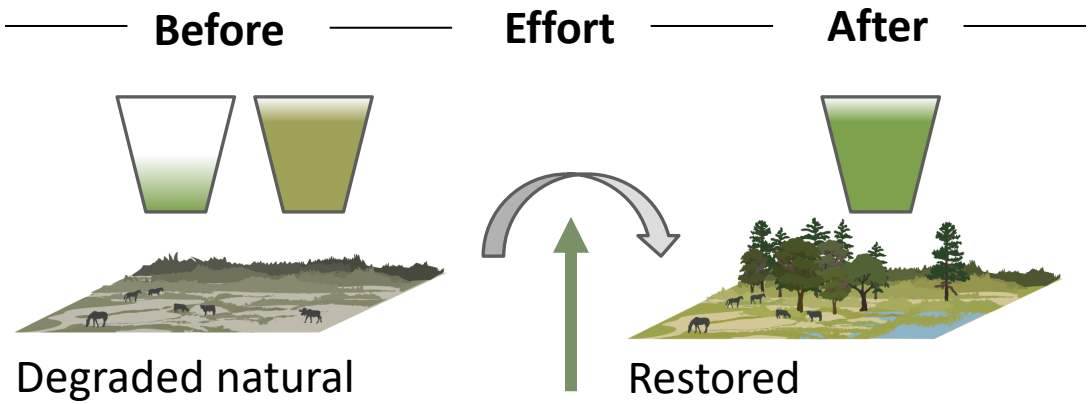
Which areas? Efforts & outcome - example



Within the 30 %

Realized biodiversity

Potential biodiversity

Example where efforts related to restoring natural processes:

- Grazing
- Natural vegetation dynamics
- Hydrology

Illustration: Aleksandrina Leonidova Mitseva

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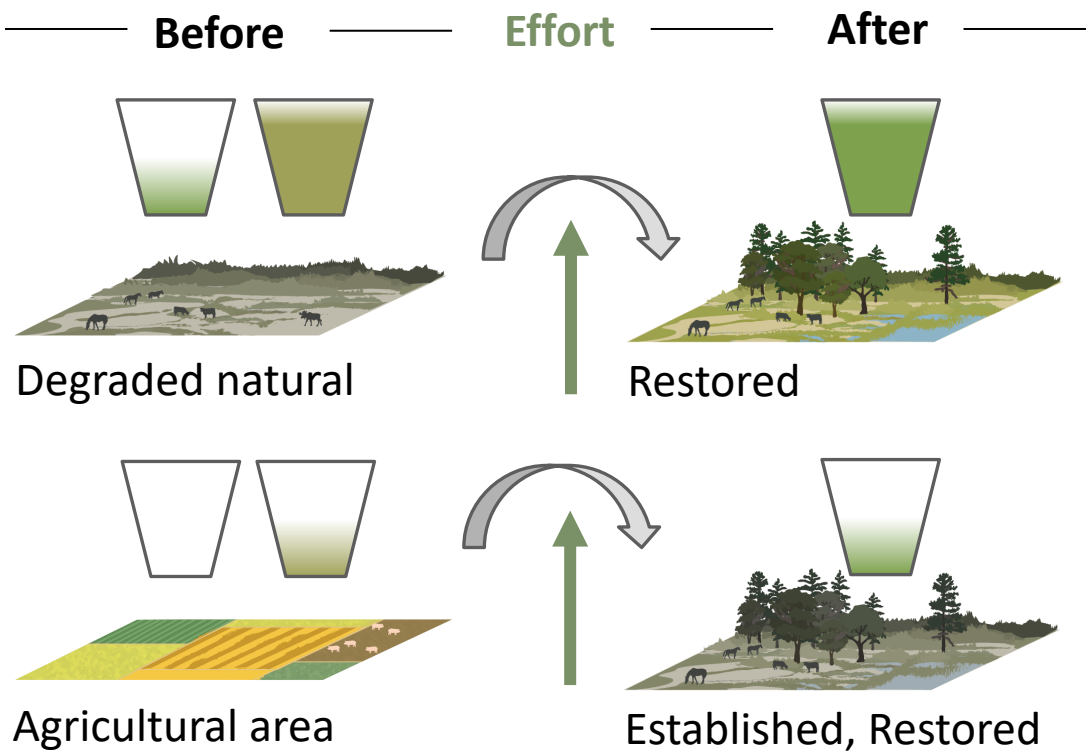

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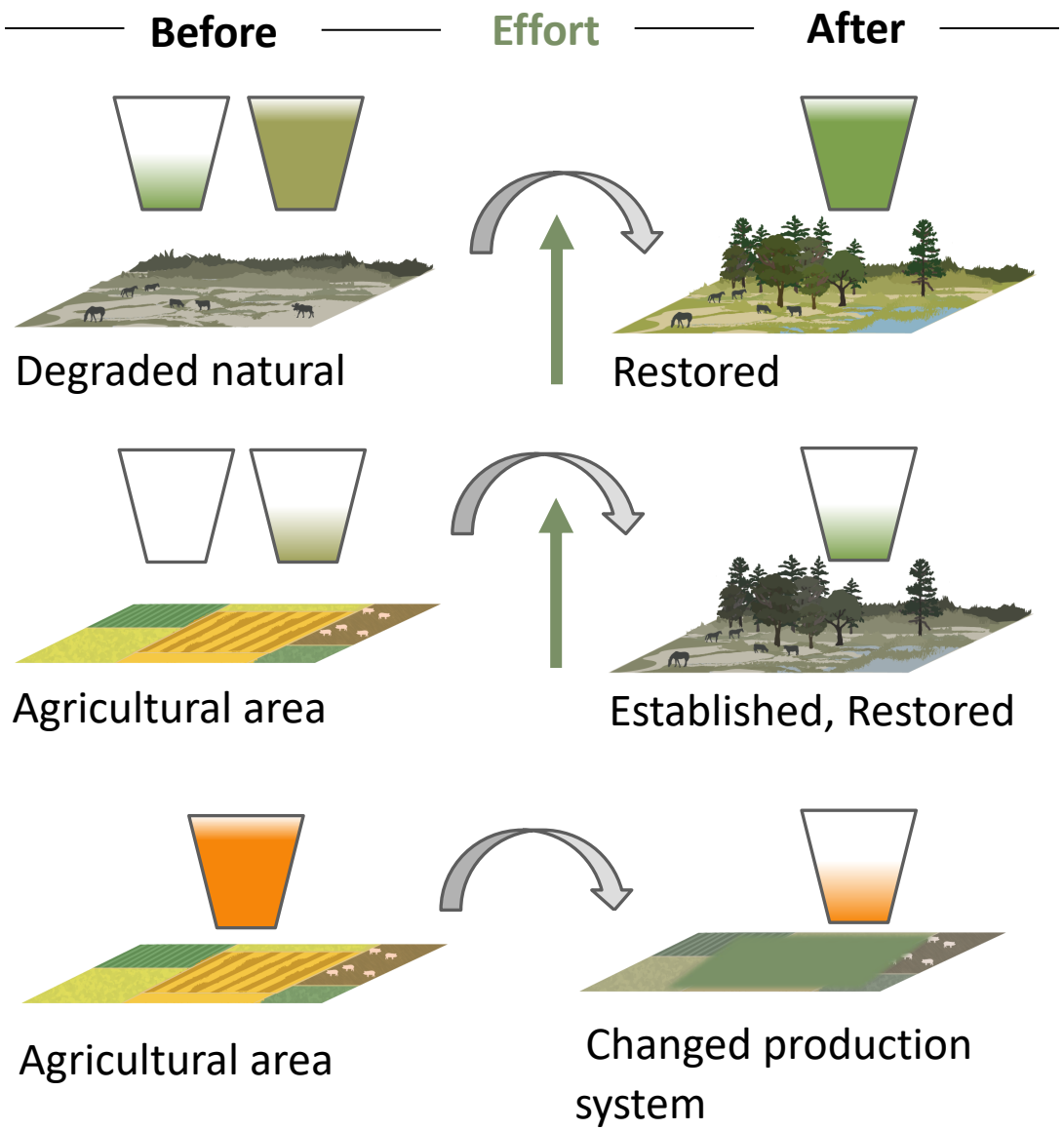

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Example where efforts related to restoring natural processes:

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The 70 % beyond

- Pressure

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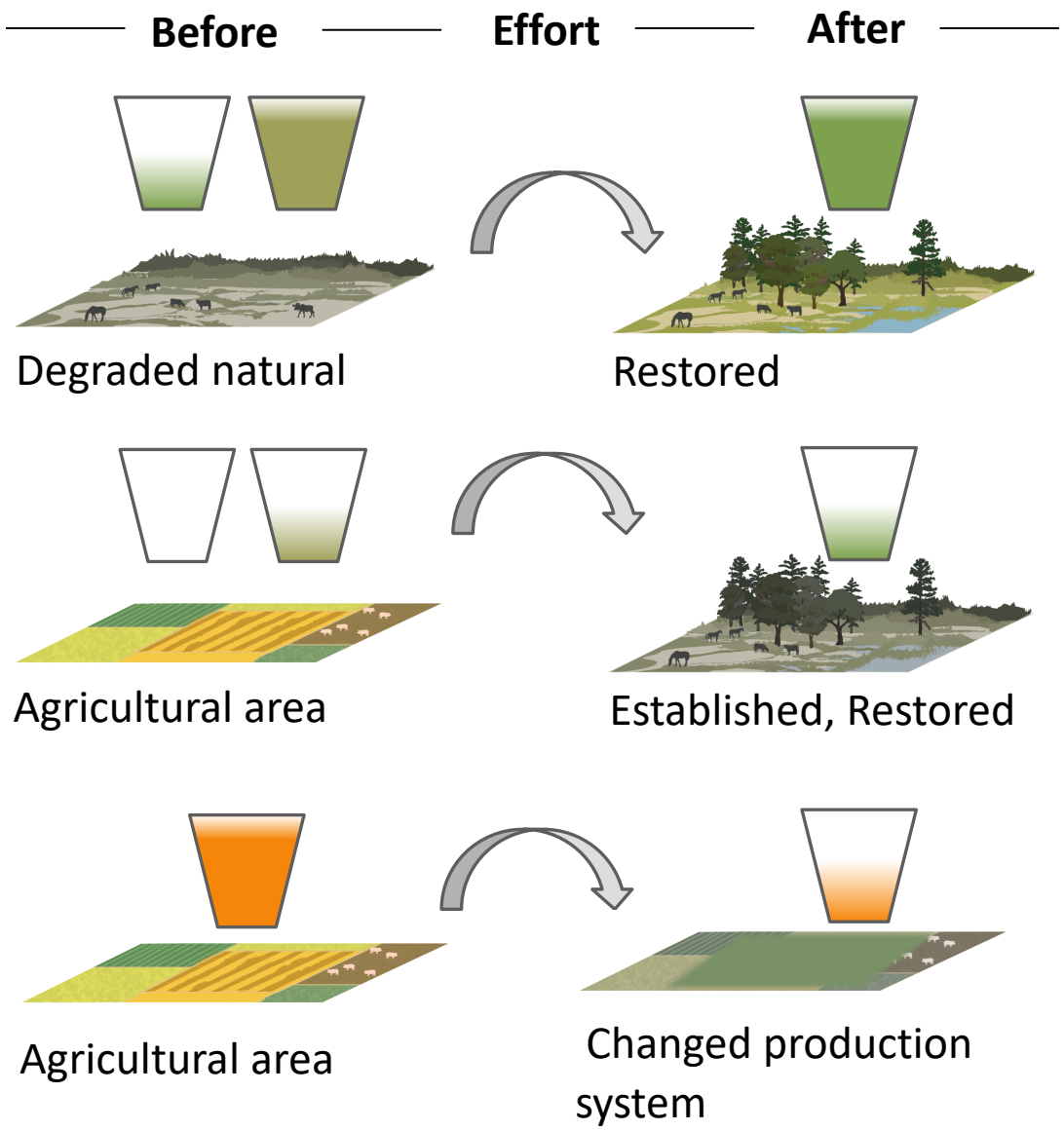
Which areas? Efforts & outcome – Approach!



Within the 30 %

- Realized biodiversity
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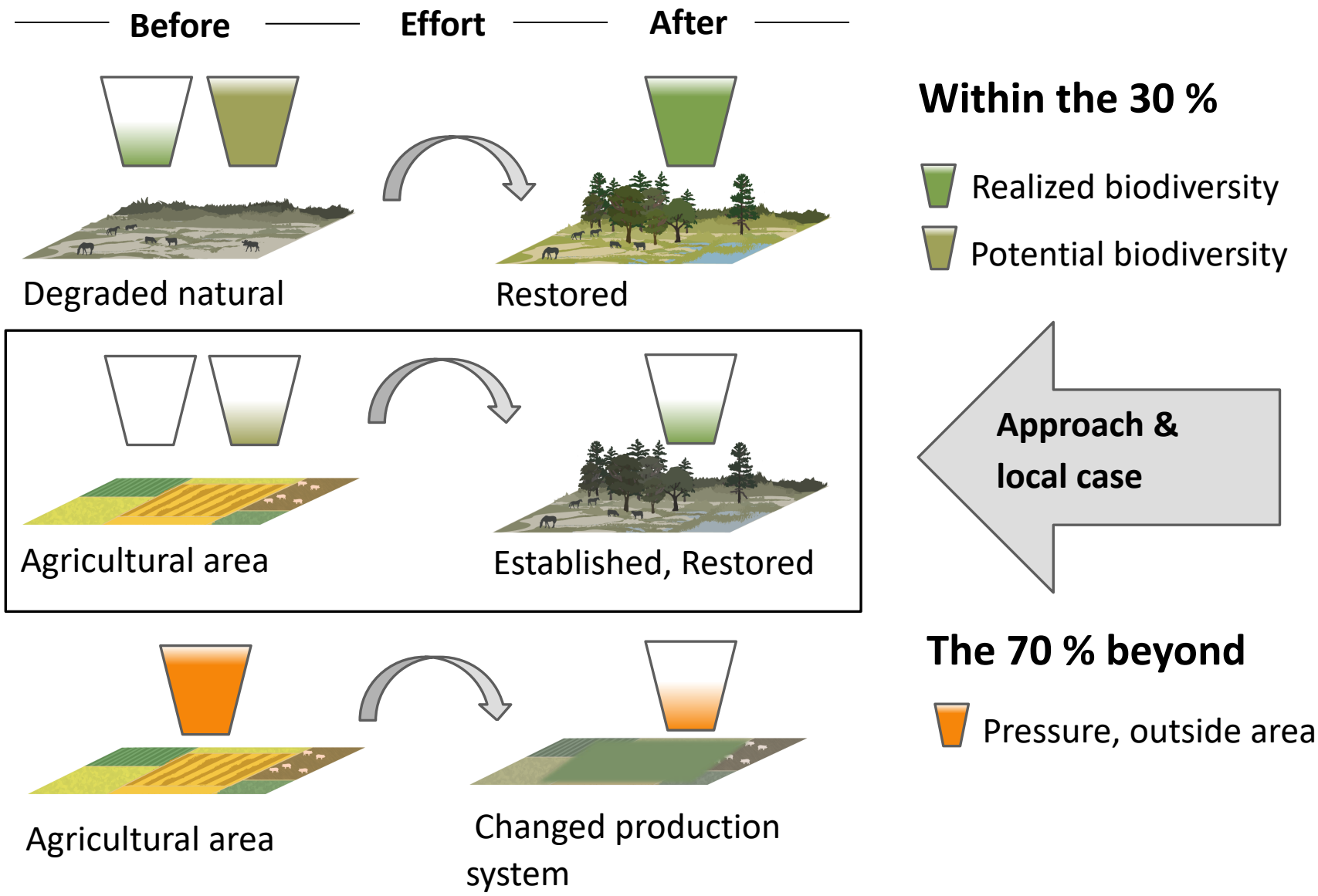
The 70 % beyond

- Pressure

- Dynamic & scalable
- What before? What after? Which species?
- For multiple aspects of biodiversity
- Updatable w. project specific field data & constraints
- Can quantify the contribution of local projects to regional or national goals?

Illustration: Aleksandrina Leonidova Mitseva

Which areas? Efforts & outcome – Approach!



Within the 30 %

Realized biodiversity

Potential biodiversity

Approach & local case

The 70 % beyond

Pressure, outside area

- Dynamic & scalable
- What before? What after? Which species?
- For multiple aspects of biodiversity
- Updatable w. project specific field data & constraints
- Can quantify the contribution of local projects to regional or national goals?

Illustration: Aleksandrina Leonidova Mitseva

THE APPROACH INCLUDES TWO MAIN PARTS

Quantifying the biodiversity potential of different restoration efforts in local areas across Denmark (10x10 m or 200x200m)

Selecting area-based restoration efforts by optimizing biodiversity potential at project, landscape to national scale

Illustration: Aleksandrina Leonidova Mitseva

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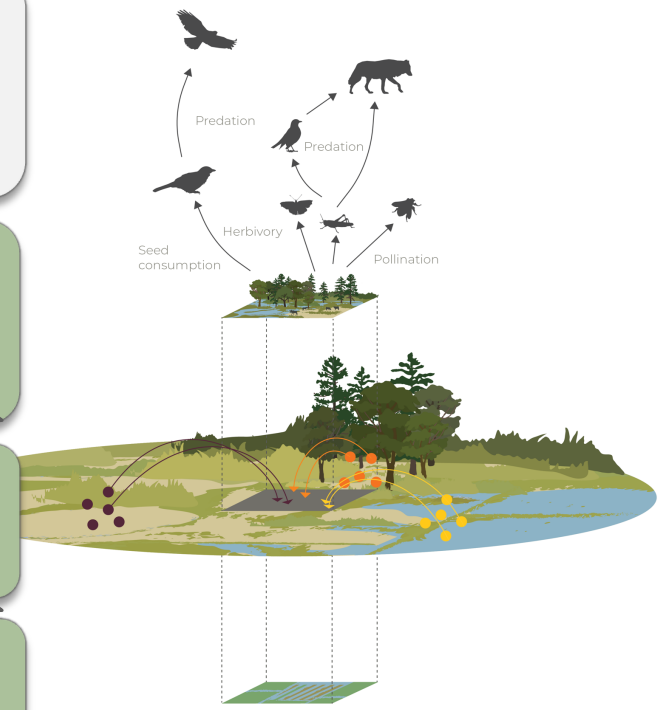
Cascading effects; network completeness

Biodiversity more than a number; rare, unique, phylogenetic

Plant community pr. effort (multiple)

Environment of local area



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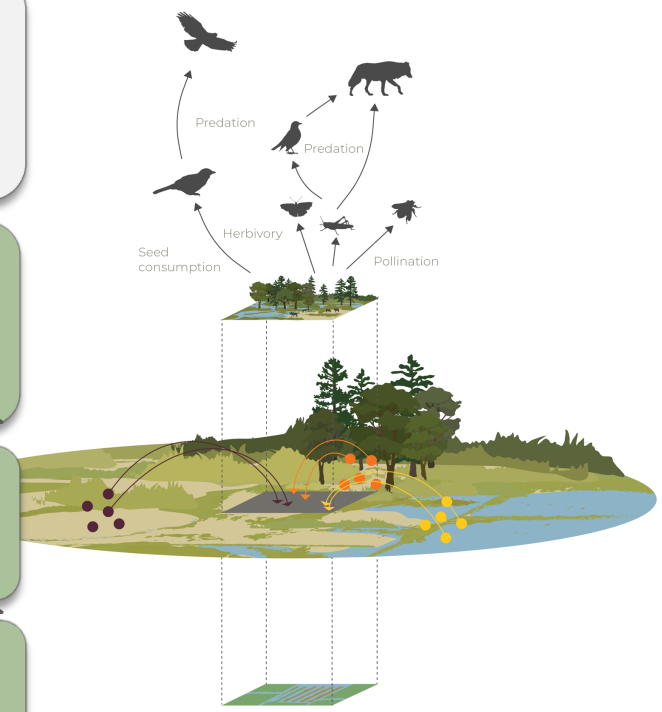


Selecting area-based restoration efforts by optimizing biodiversity potential at project, landscape to national scale

Optimal restoration effort pr area = Biodiversity + Connected/Heterogeneity

… e.g. plus local considerations
+ Legal restrictions
+ Human dimension
+ Future climate change

$$\max_{\text{ConservationIndex}} \sum_{l,c}^{L,C} \text{LanduseDecision}_{l,c} \cdot \text{S}_{l,c} \cdot \text{PD}_{l,c} \cdot \text{Rar}_{l,c}$$

Illustration: Aleksandrina Leonidova Mitseva

A local case study – Vilhelmsborg, Aarhus Municipality

From fields to nature (300 ha)

- National plant diversity data plus local targeted field survey (e.g., biotopes)

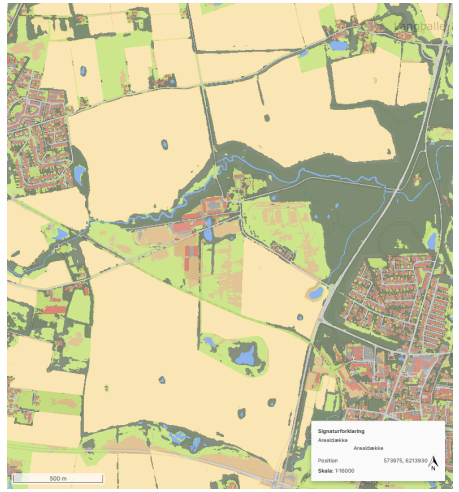
Main restoration efforts

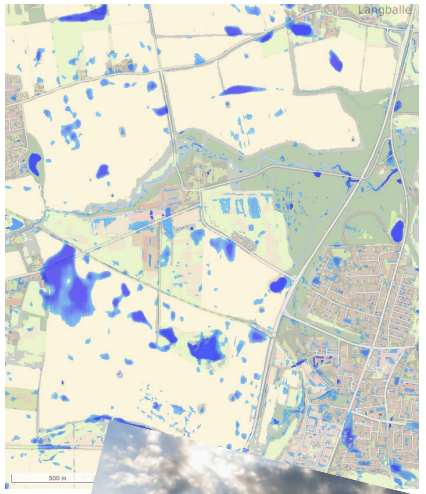
- Rewetting
- Forest (active)
- Grazing

Local constraints considered

- Landscape protection (old Manor)
- Future precipitation, flash flood (85 mm)
- Municipality plan for climate mitigation
- Plan after local stakeholder involvement

Current => future wet areas

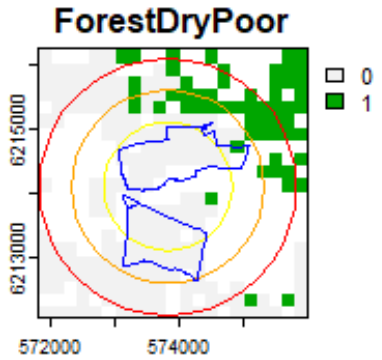


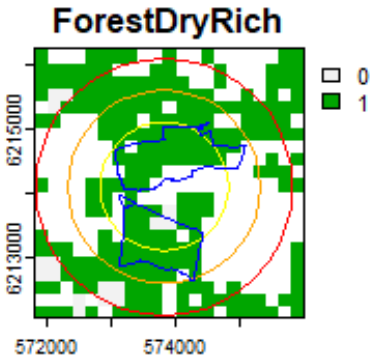


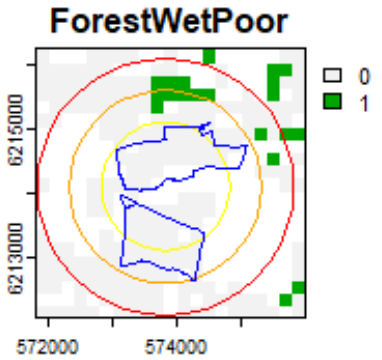
Plan after stakeholders

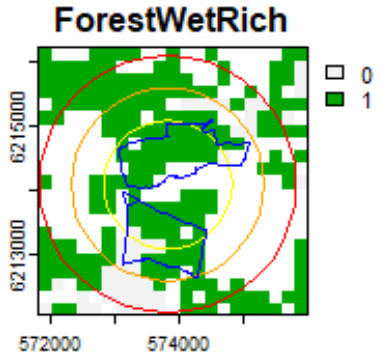
- 75% open, 25% forest
- Forest on 50% of the southern part

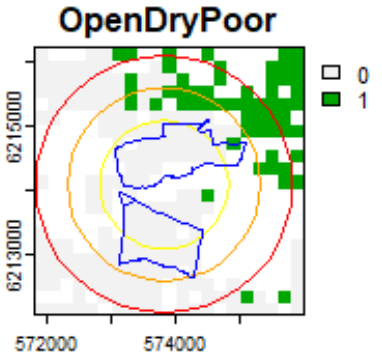
Quick look in the machine – potential environments x efforts

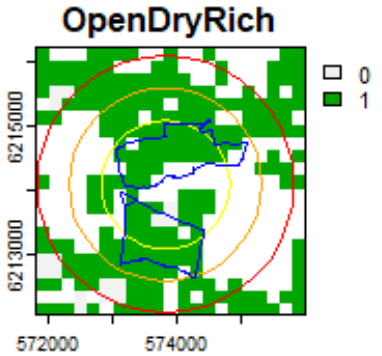


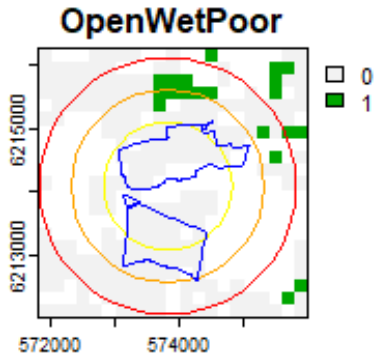


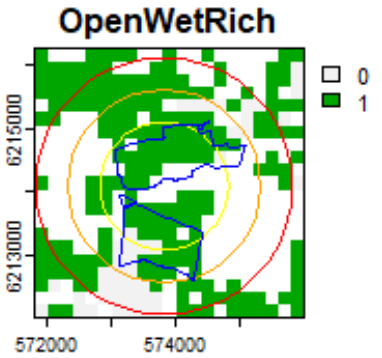




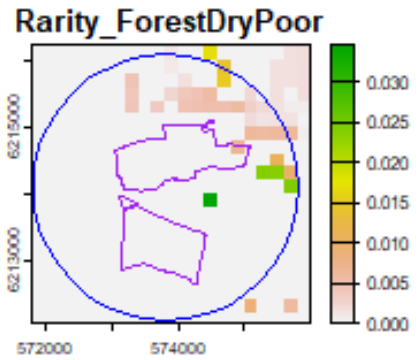


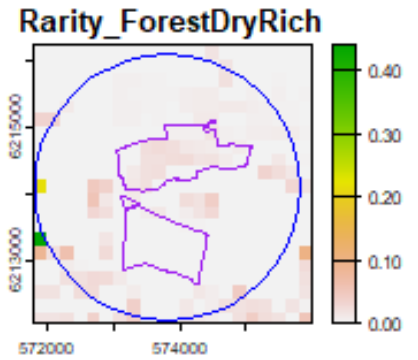


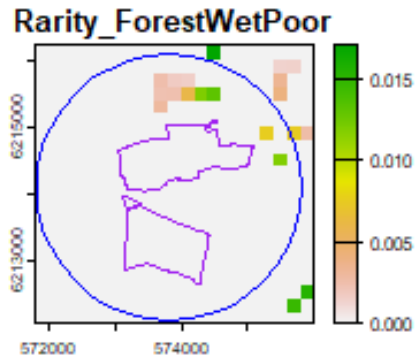


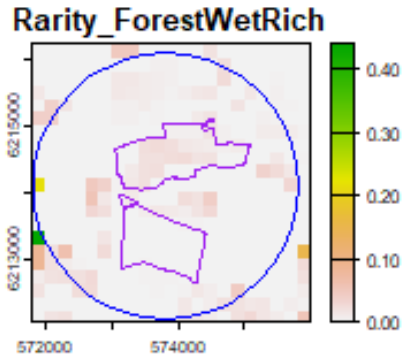


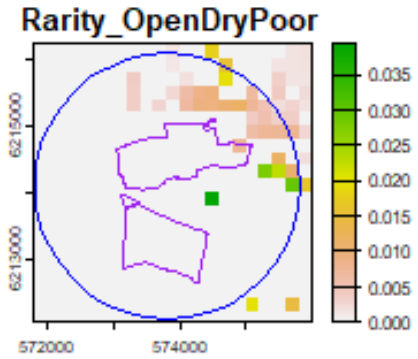
Quick look in the machine - Rarity

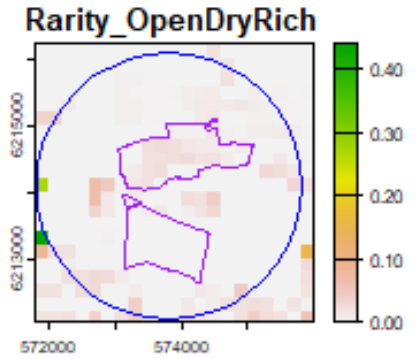


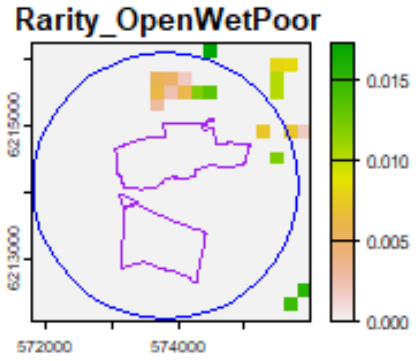


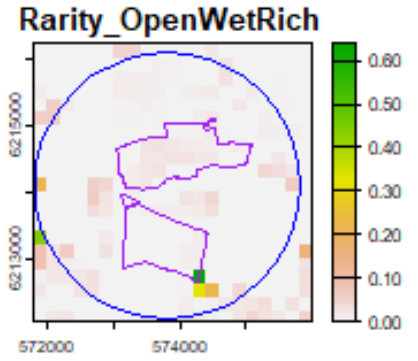




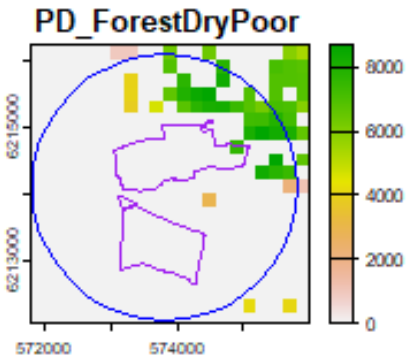


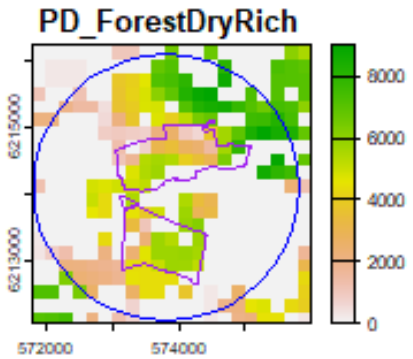


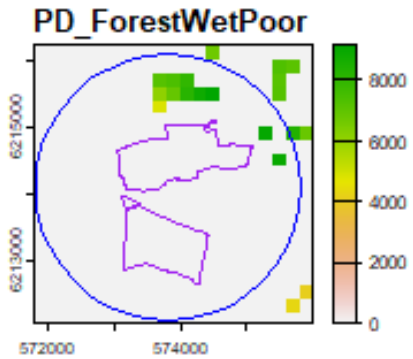


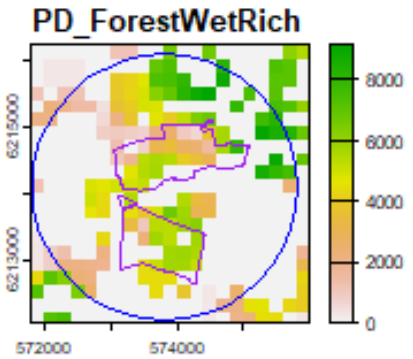


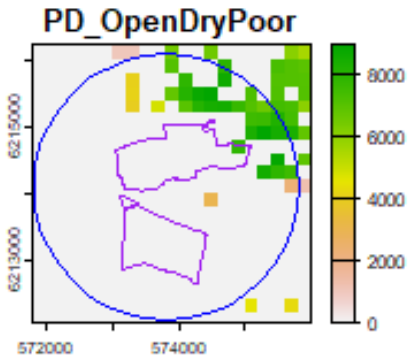
Quick look in the machine - Phylogenetic diversity

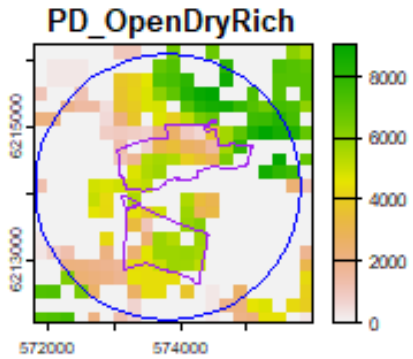


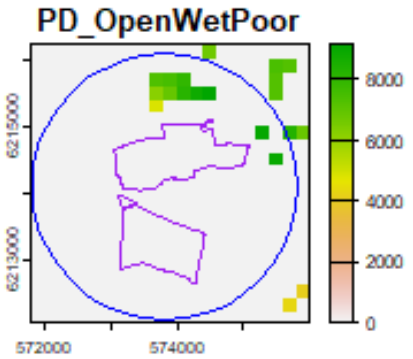


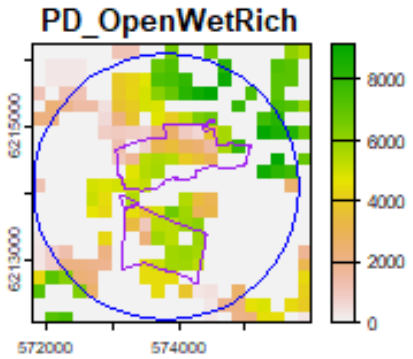




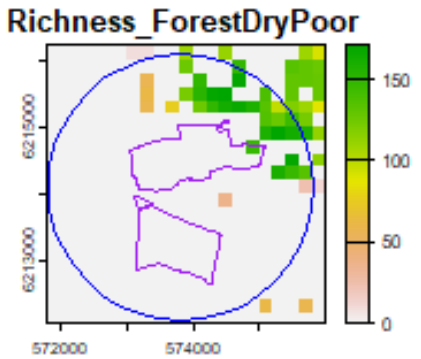


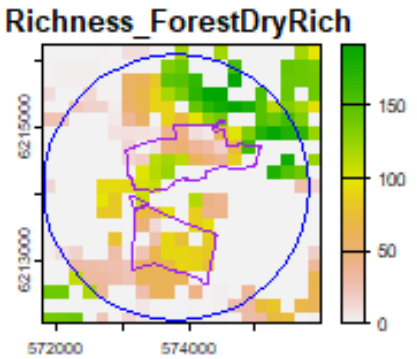


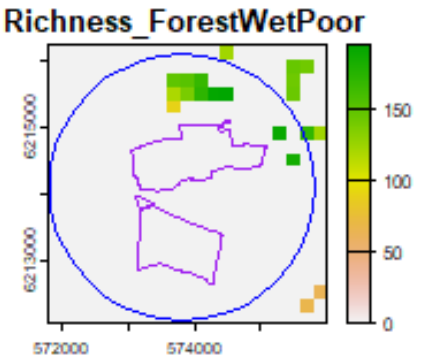


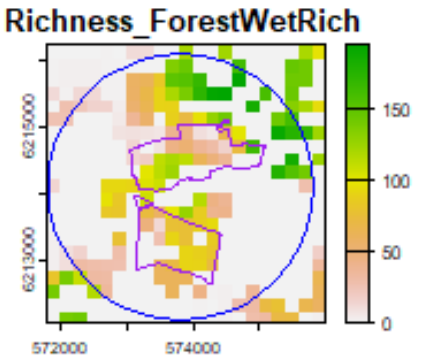


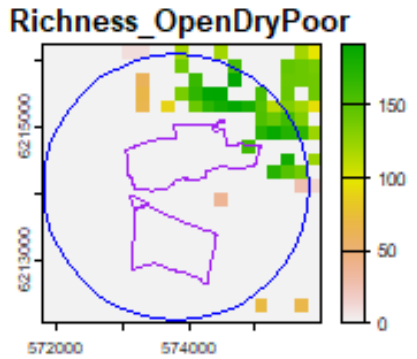
Quick look in the machine - Richness

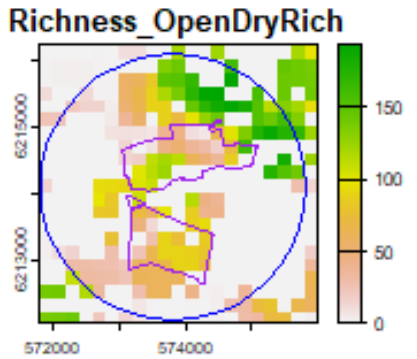


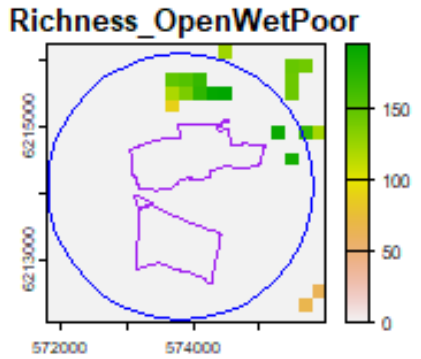


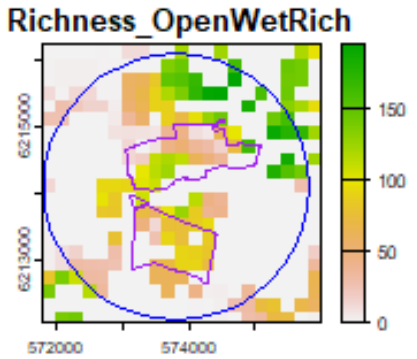








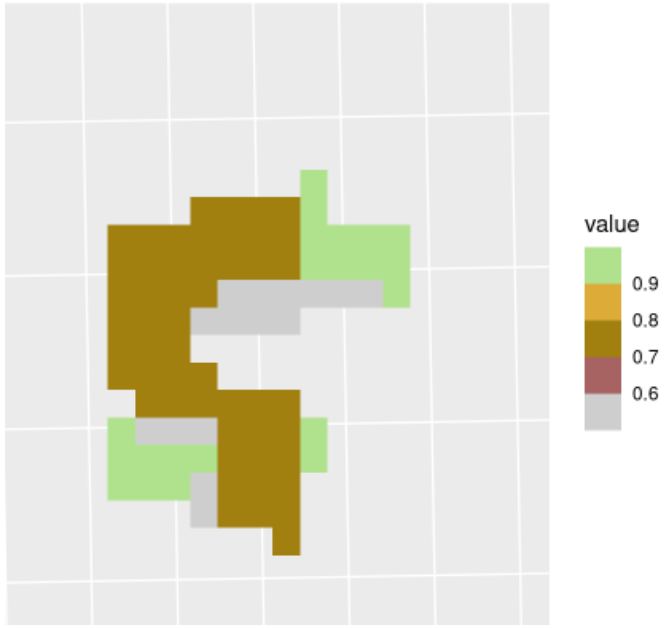




QUICK LOOK IN THE MACHINE — OPTIMIZED SOLUTIONS

Maximized for biodiversity

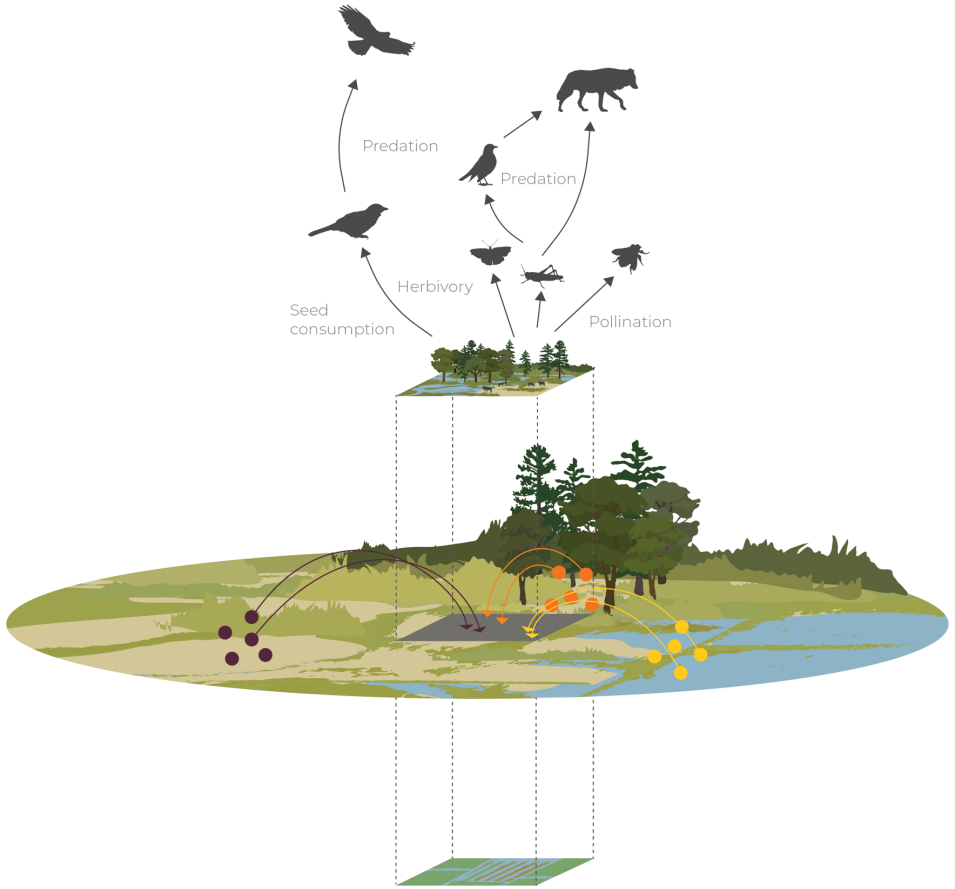
Congruence across solutions



In summary – Dynamic approach

We can quantify biodiversity potential

… dynamically & scalable
… response to different restoration efforts
… from local projects to larger scales
… optimized relative to local constraints



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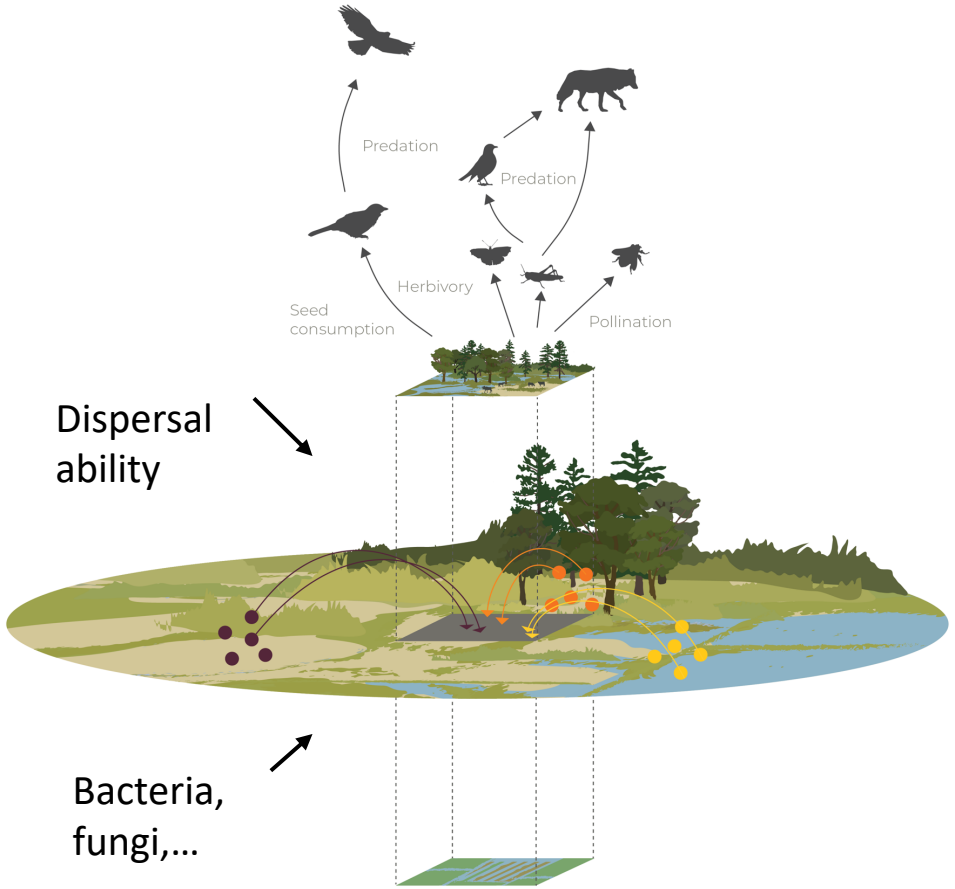
We are working on including:

… trophic cascading effect
… species specific dispersal
… time until realizing the potential of restoration
… effects on ecosystem functioning
… Improve species environmental affinity
… potential for degraded nature
… effects of converted agricultural practices in 70 %



In summary – Dynamic approach – for setting goals?

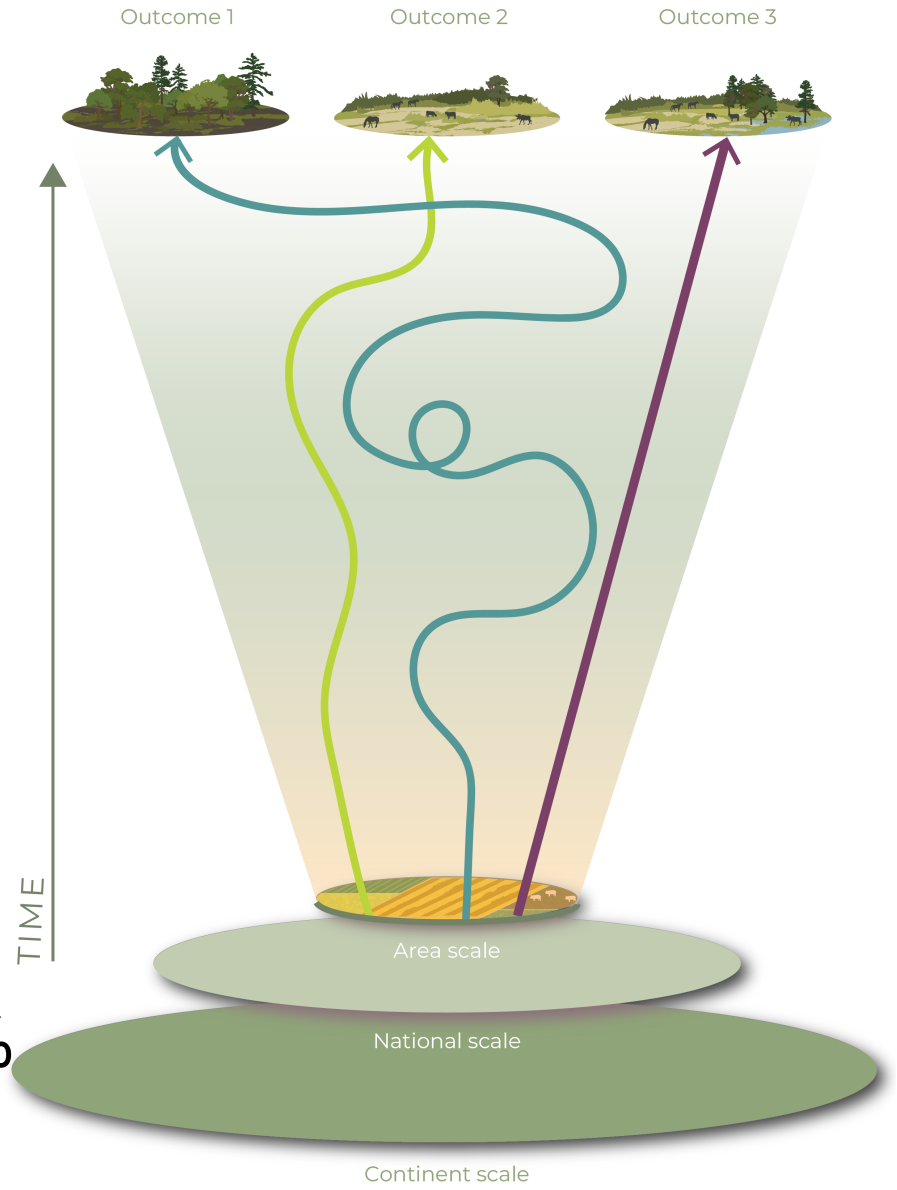
We can quantify biodiversity potential

… dynamically & scalable
… response to different restoration efforts
… from local projects to larger scales
… optimized relative to local constraints

We are working on including:

… trophic cascading effect
… species specific dispersal
… time until realizing the potential of restoration
… effects on ecosystem functioning
… Improve species environmental affinity
… potential for degraded nature
… effects of converted agricultural practices in 70 %

As decision support for setting local goals



Thank you to all in SustainScapes

Together we rethink landscapes for a sustainable future

SustainScapes

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Danish National Research Foundation
CARLSBERG FOUNDATION
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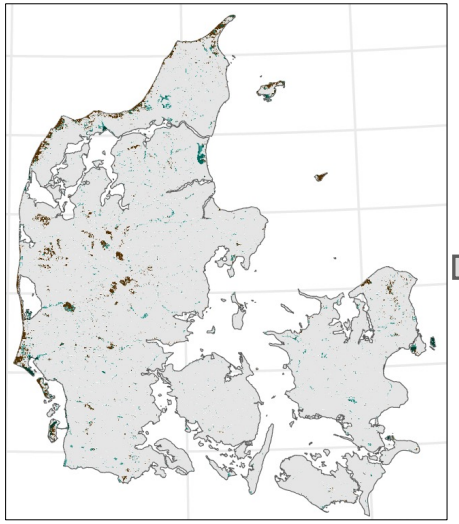
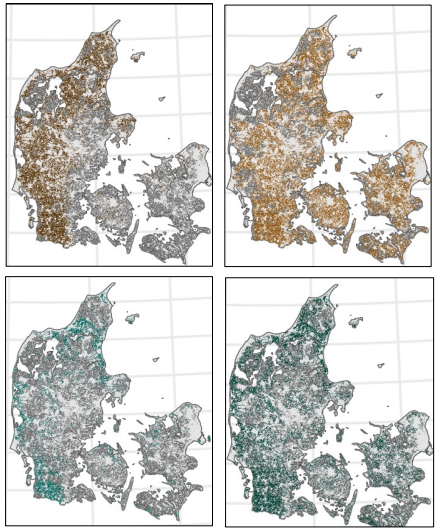
Approach: Quantifying biodiversity potential

Plant species occurrences & habitat affinities

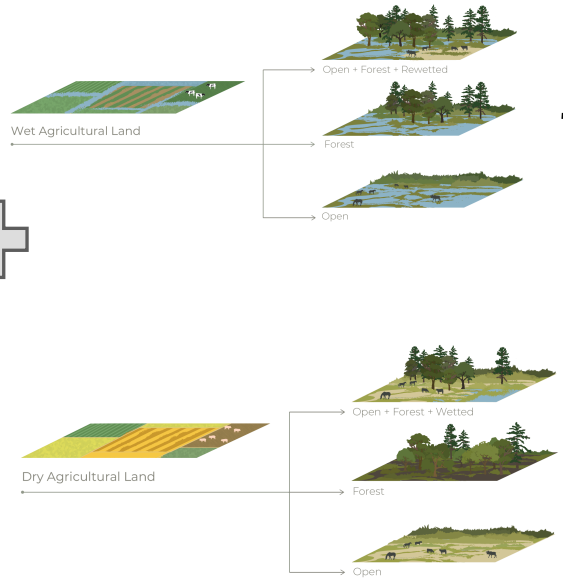


- Wet-dry
- Poor-rich
- Open-closed

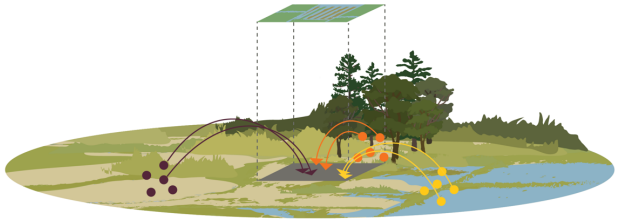
Modelled potential environmental dimensions



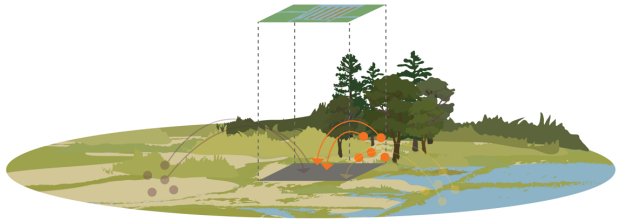
Possible restoration efforts depending on environment



Local species pool for each restoration effort (e.g., lowland peat soil)



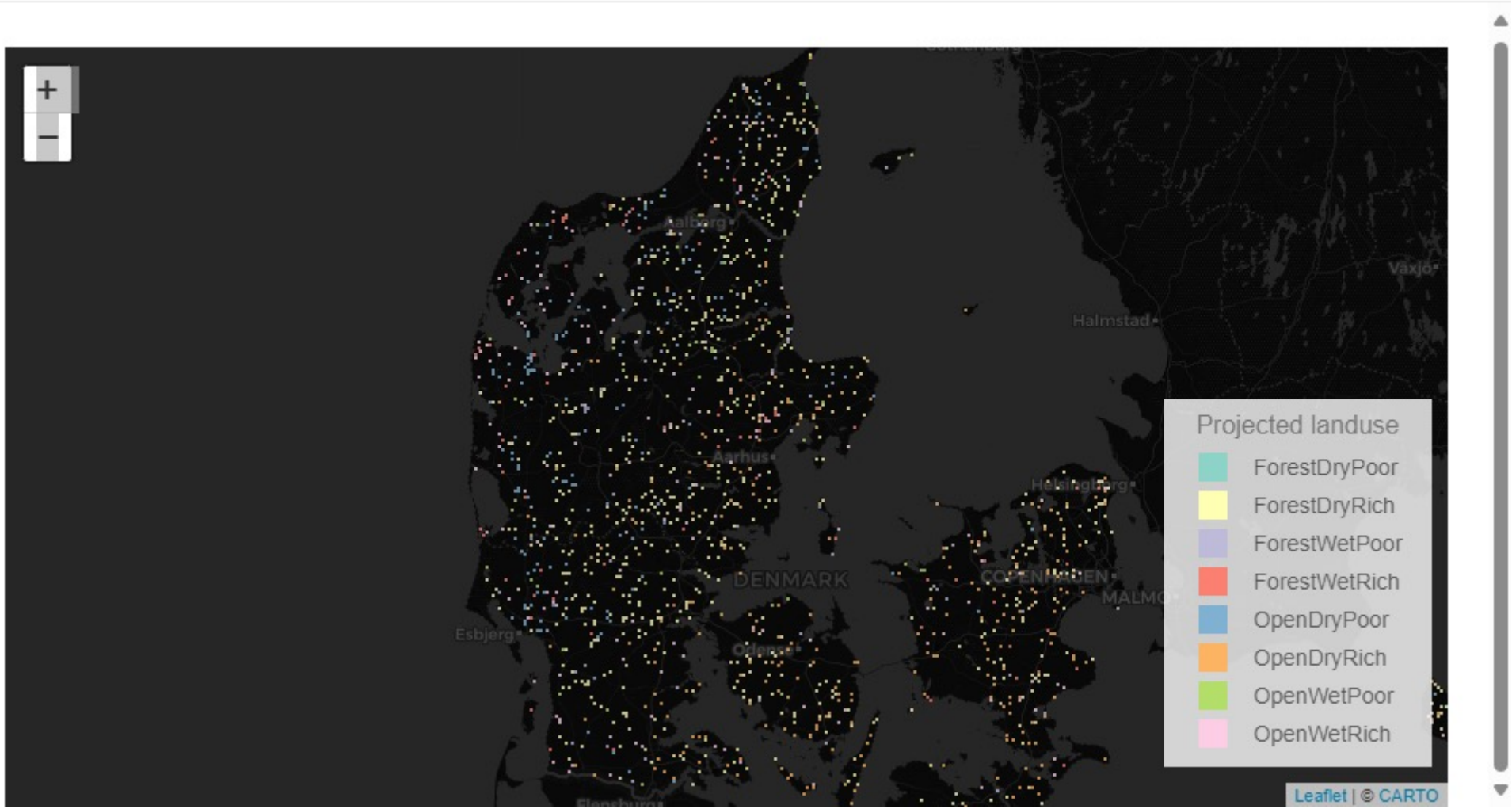
- **Grazing (open)**
- **Passive/active establishment of forest**
- **Rewetting**



- **Passive/active establishment of forest**

Illustration: Derek Corcoran, Aleksandrina Leonidova Mitseva

Example results



RPubs - SystematicLandscape

QUICK LOOK IN THE MACHINE – OPTIMIZED SOLUTIONS

Maximized for biodiversity

Solution current wetness

Solution future wetness