

BIOdelta4 : Biodiversity Assessment in Tyrol

25.11.2020



Project I : Sept. 2018 - Sept. 2019

- **Preproject work:** Biodiversity indicators most relevant in the Biosphere Reserve „Vienna woods“
- **Literature research:** Interdisciplinary research on possibilities to aggregate indicators
- **Literature research:** Biodiversity indicator choice in European countries
- **Statistic evaluation:** Reliability of national biodiversity reporting and monitoring in Europe



- Collecting all **monitoring data available** for Tyrol
- Extracting **possible biodiversity indicators**
- Ranking biodiversity **indicators with highest significance** for biodiversity based on literature research
- Developing a **flow chart for biodiversity assessment** quality
- Creating a **structure** for a potential composite biodiversity index in Tyrol and adjacent countries
- **Choosing biodiversity indicators** for Tyrol
- Searching for **reference areas**
- Get **inventory data** from multiple data providers
- Agree on theoretical **indicator evaluation**
- **Scientific discussion of the BIODelta4 concept**

Flow chart for improving biodiversity assessment quality

Revise National Biodiversity Monitoring Systems

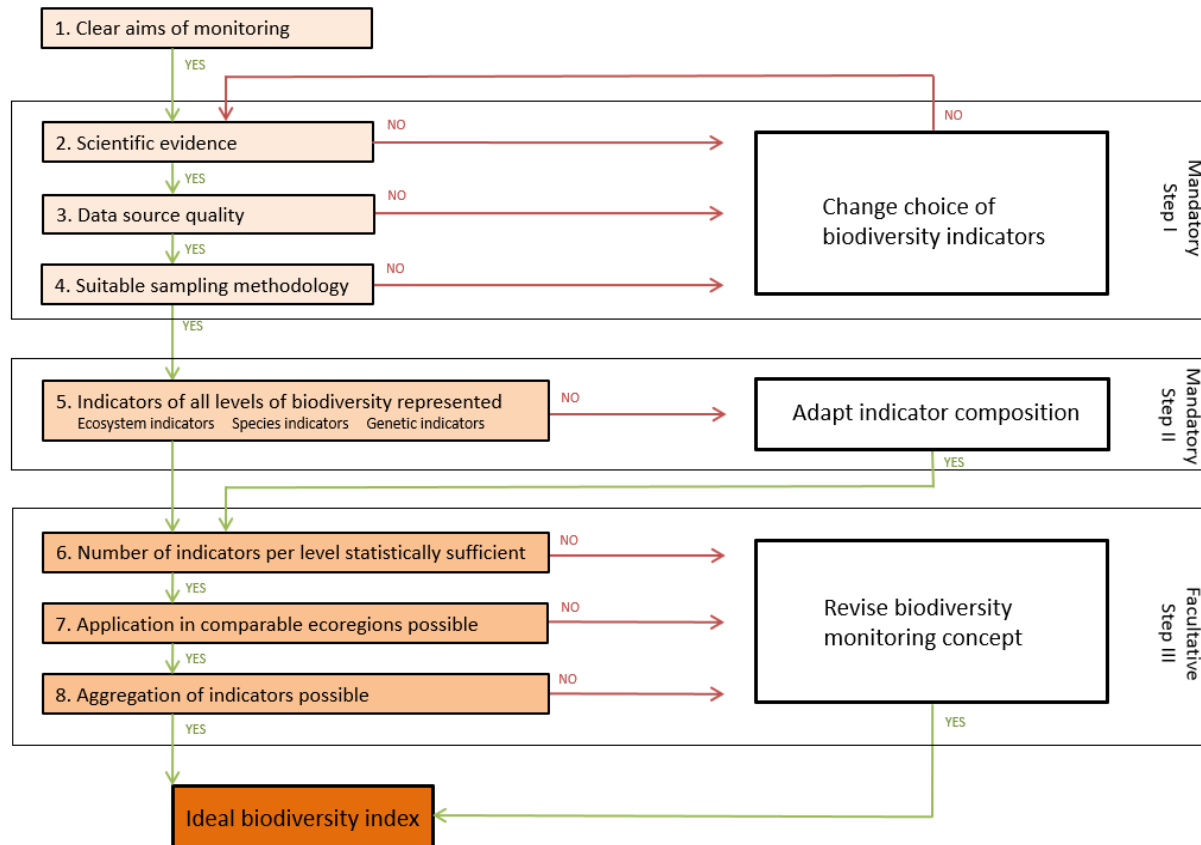
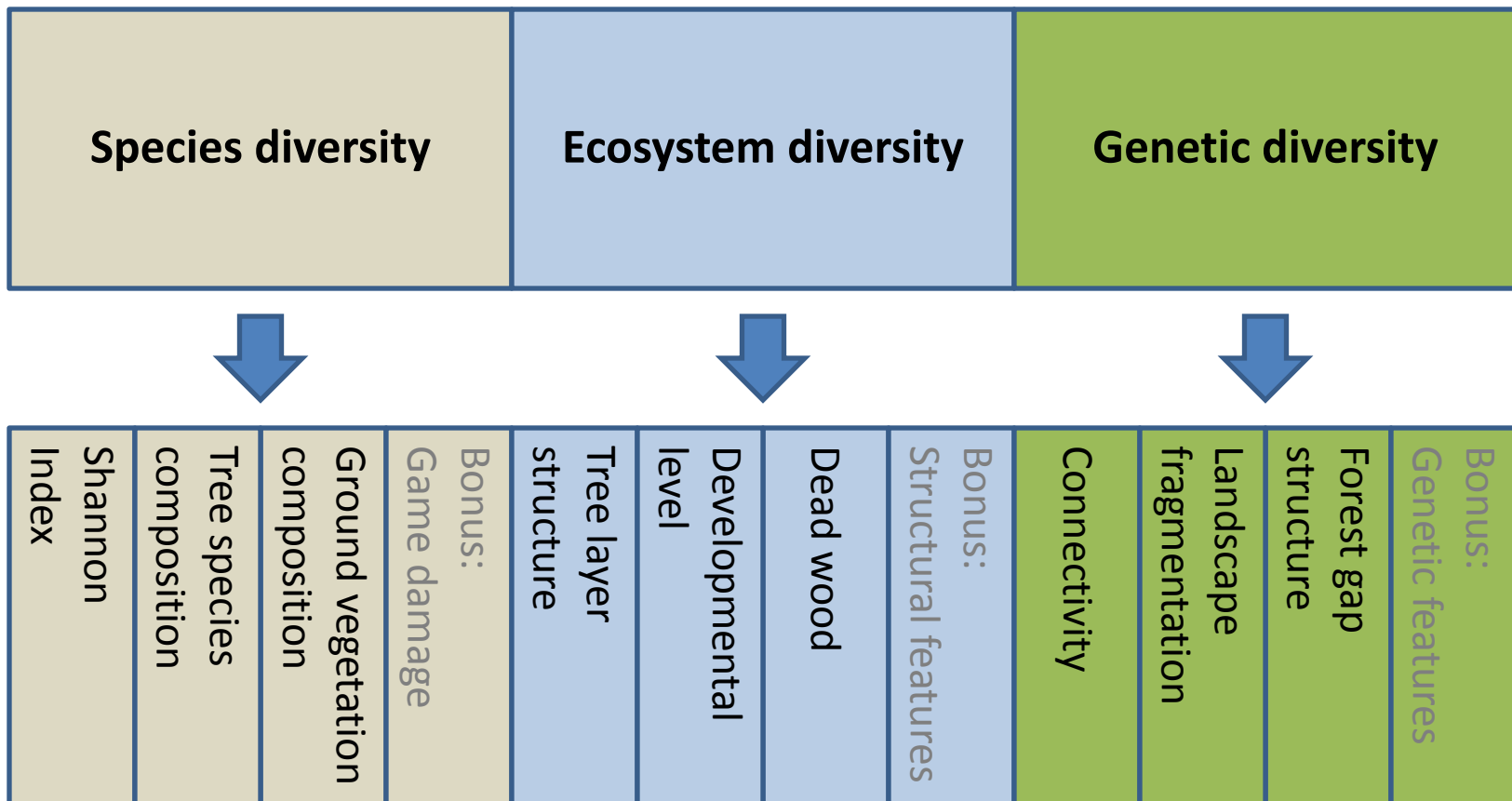


Fig. 1: Flow chart guiding to the revision of national biodiversity monitoring systems according to the CBD. Step I and step II should mandatory be fulfilled by all CBD countries, whereas step III could be applied facultatively to further enhance quality of biodiversity monitoring and reporting (Ette & Geburek 2020).

Composition of the biodiversity index

All three dimensions of biodiversity are considered equally in the indicator set:



SWOT Analysis of BIOdelta4

| | |
|--|--|
| <p>Modular concept</p> <p>Based on available inventory data</p> <p>Applicable on different scales & countries</p> <p>In line with Convention on Biological Diversity (CBD) requirements</p> <p>Transparency of biodiversity assessment</p> | <p>Indicator choice impacts outcomes</p> <p>Missing inventory data for some forest types</p> <p>Statistical security for rare forest types</p> |
| <p>Transferable to all areas with forest typing</p> <p>Most indicators are dirigible by forest managers</p> <p>Smart phone application for biodiversity possible</p> <p>Impact of forest management/policy assessable in advance</p> | <p>Political support for BIOdelta4</p> <p>Acceptance of forest owners for BIOdelta4</p> <p>Missinterpretation</p> <p>S. Ette</p> |


Project II : Sept. 2019 - Sept. 2020

- **Literature research:** Different Modelling approaches for indicators chosen
- **Literature research:** Impacts of Forest management on biodiversity in Tyrol
- **Literature research:** Negative effects of Austrian climate change adaption strategies on biodiversity




- **Harmonization** of inventory data
- **Data Gap analysis**
- Adapting **calculation methods**
- **Statistical reliability checks** on biodiversity indicator choice
- **Preparations for modelling single indicators**
- Creation of **QGIS projects**
- Evaluation of **single biodiversity indicators**
- **Aggregation** of biodiversity evaluation outcomes
- **Management scenario analysis** for Tyrol
- **Handbook on biodiversity monitoring and assessments** using the BIODelta4 index
- **Scientific publication** of project I outcomes in the journal AMBIO
- **Scientific publication** of project II outcomes in preparation


Scientific discussion



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Forest Biodiversity: Monitoring and Assessment

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1. Introduction

With global extinction rates being one hundred to one thousand times greater than the natural baseline (CBDALCO et al. 2023), the loss of biodiversity is one of the greatest and most serious ecological challenges of our time (CBD 2020). Biodiversity loss threatens the provision of ecosystem services as an accelerating rate and endes the foundation of humanity (IPBES 2023). Nonetheless, the main drivers of extinction are of anthropogenic origin (SALA et al. 2020). The lack of success in biodiversity policy implementation is partly related to gaps in biodiversity monitoring (CBD 2023).

2. Objectives

The aim of the doctoral project is to develop and apply a novel index for forest biodiversity monitoring and assessment in Austria. To enhance biodiversity policy implementation and forest management, the scientific questions are:

- (1) Can forest inventory data be used for biodiversity monitoring?
- (2) Which forest characteristics are most important for biodiversity assessments in Austria?
- (3) Which kind of biodiversity indicators are monitored most frequently in Europe?
- (4) Is European biodiversity monitoring and reporting reliable?

3. Material

To answer the first two questions, inventory data from the Biosphere Reserve Vienna Woods was used. The last two questions were tackled systematically analyzing all European biodiversity reports to the Convention on Biodiversity (CBD). Applying the novel biodiversity index to Tyrolean forests, forest inventory data, forest typing data, and reference area data is utilized.

4. Methods

The inventory data from the core area of the Biosphere Reserve is analyzed using 8 random forests and 10,000 to 25 models. The impact of 27 forest characteristics (age, structure, stand conditions, gaps, and soil) on seven already established biodiversity indices is examined.

To find out which kind of biodiversity indicators are monitored on the European level, 42 national CBD reports are evaluated systematically using a binary-coded indicator list. European biodiversity reporting and monitoring reliability is examined with the help of negative binary generalized models and Poisson generalized linear models.

5. Preliminary Results

Our findings show, that using forest inventory data is possible for biodiversity monitoring and assessments as those data not usually cover stand density and stand age characteristics, which are of major importance to forest biodiversity. In European biodiversity reporting, species and ecosystem diversity indicators are overrepresented compared to genetic diversity indicators. For species diversity, we show that national biodiversity monitoring is heavily biased towards certain taxonomic groups. This conception of biodiversity, which is not in line with the CBD, may be disadvantageous for halting the loss of biodiversity. Therefore, we developed a flow chart guiding the revision of biodiversity monitoring systems (Fig. 1).

Fig. 1: Flow chart to revise monitoring systems.

6. Outlook

The biodiversity index for Tyrol is already developed in the EU Internat Project Biodi (Fig. 2). The outcomes of biodiversity evaluation in GIS will be available by the end of 2023. Hence, three forest management scenarios will be tested.

Fig. 2: The novel forest biodiversity index for Tyrol.

References

CBD 2020: Global Biodiversity Outlook 2: A Report by the Secretariat of the Convention on Biological Diversity, Montreal, Canada, November 28 August, 2020. From <https://www.cbd.int/gbo/gbo2/gbo2-01.pdf>

CBD 2023: Update on progress in implementing global and transboundary national biodiversity strategies and action plans, including national action plans, submitted by all parties, including the European Union, to the Secretariat, CBD/COP/15/Doc.13/Montreal, Canada

Malhotra, S., H. Schulze, A.J. Bennett, & S. Diaz. 2024. High and rising rates of biodiversity loss: A global assessment of the state of biodiversity. *Science* 384(6697): 102-107.

IPBES 2023: Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Bonn, Paris, 2023. 114 pp. <https://www.ipbes.org/global-assessment-report/>

SALA, O.E., H. Chapin, L.J. Armesto, R. Berlow, J. Blomfeldt, K. Diaz, R. Huber-Sanzotobi, et al. 2000. Global biodiversity scenarios for the year 2100. *Science* 287: 1753-1756.

- Within BFW institutes
- With LK Tirol
- At University of Life Sciences Vienna
- With biodiversity experts from sixteen forest research institutions of Germany
- At a biodiversity conference in Germany

Scientific Publication

1 **Why European biodiversity reporting is not reliable**

2 **Ette Sophie & Thomas Geburek (2020)**

3 Accepted Version, will appear in *AMBIO: the Human Environment*

4 d. Abstract

5 The Convention on Biological Diversity (CBD) aims to end the loss of biodiversity, which
6 is one of the greatest ecological challenges of our time. The lack of success in
7 biodiversity policy implementation is partly related to gaps in biodiversity monitoring.
8 Our overall objective is to contribute to the preparation of the upcoming post-2020
9 period by a review of biodiversity indicator choices in European CBD reports and hence
10 in national monitoring systems. Negative binary generalized models and poisson
11 generalized linear models prove that through free indicator choice in CBD reporting,
12 countries do not choose biodiversity indicators according to their national geographic
13 and socioeconomic characteristics. Moreover, species and ecosystem diversity
14 indicators were chosen with a disproportionate frequency compared to that of genetic
15 diversity indicators. Consequently, trends derived from national CBD reports and
16 monitoring systems in Europe are not reliable, which should be an alarming signal
17 concerning biodiversity policy implementation. Finally, a flow chart to revise national
18 biodiversity monitoring systems is proposed.

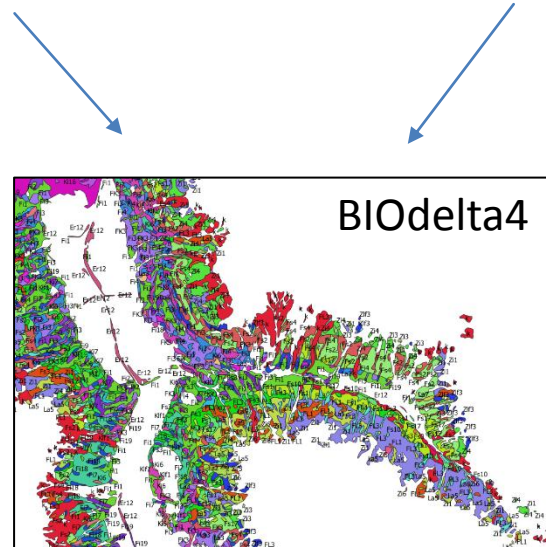
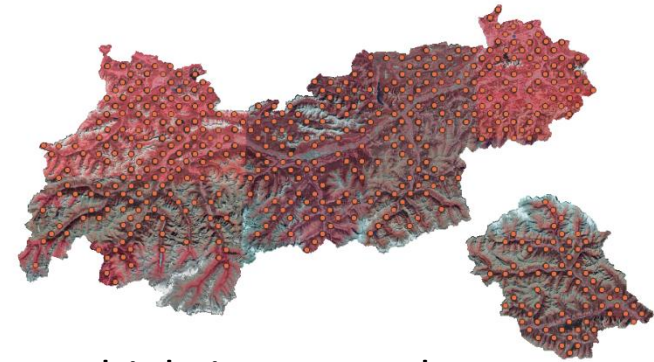
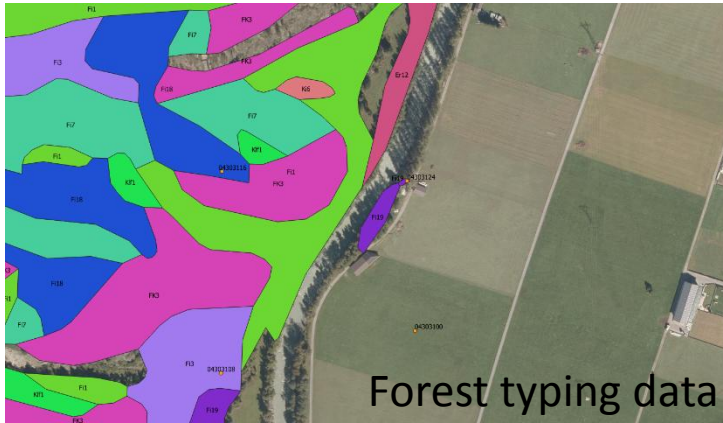
20 e. Key words

21 Biodiversity indicators, biodiversity monitoring, biodiversity policy implementation,
22 European species diversity

Main results of BIODelta4 - Project I
will soon be published in *AMBIO*
named:

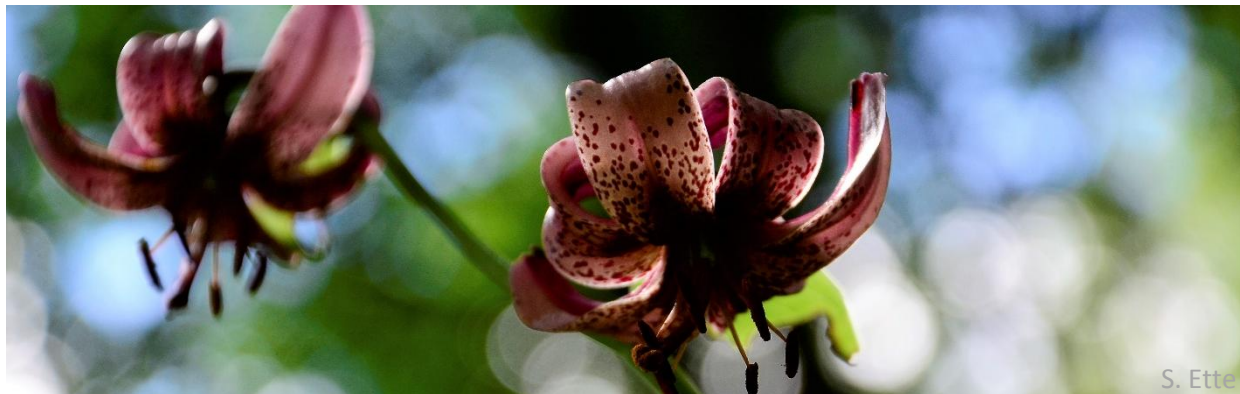
‘Why European biodiversity reporting
is not reliable’ (Ette & Geburek 2020)

Visualisations of BIOdelta4 outcomes



Challenges in BIOdelta4 interpretation: Genetic Diversity

- Genetic consequences may be species-specific (Kavaliauskas et al. 2018) or even population-specific (Neale et al. 1985, Adams et al. 1998, Piotti et al. 2013)
- Tree populations are able to buffer or delay effects of disturbance (Piotti 2009, Kavaliauskas et al. 2018)
- Formal comparison between managed and unmanaged stands in central European forests often is prevented (Sabatini et al. 2018)
- Genetic diversity loss may therefore be more nuanced than signals look like (Lowe et al. 2013)



Challenges in BIOdelta4 interpretation: Species Diversity

- For impact assessment, it is necessary to consider a variety of biodiversity metrics as taxa response is highly complex (Aubin et al. 2013)
- Different spatial scales play a crucial role in evaluating consequences of forest management on species diversity
- Gamma-diversity frequently is neglected while alpha-diversity is heavily focused
- Common problems of statistical biodiversity indicators are reference period and reference surface size
- Biodiversity indicator (species) choice heavily influence the evaluation outcome (Ette 2018). It is hence hardly possible to evaluate biodiversity in an objective way to be in 'good' ecological condition

Challenges in BIOdelta4 interpretation: Ecosystem Diversity

- Ecosystems can vary heavily in size and therefore system borders do overlap multiple times
- Therefore, biodiversity assessments are mainly executed in large ecosystems (forest types) or ecosystems of conservation interest (red listed)
- For rare and small ecosystems, interactions between species assemblages, reestablishment or fragmentation is hence poorly understood



Options:

Landscape planning tools for Tyrol

Tab. 2: Biodiversity conservation principles and suitable forest management strategies (Adapted from Lindenmayer & Franklin 2002):

| Principle | Management Strategy |
|---|--|
| Maintenance of connectivity | <ul style="list-style-type: none"> Ecological corridors Protection of sensitive habitats Retention forestry Careful planning of road infrastructure |
| Maintenance of landscape heterogeneity | <ul style="list-style-type: none"> Ecological corridors Protection of sensitive habitats Spatial planning of cut over sites Increased rotation length Planning of road infrastructure Mimicry of natural disturbance regimes |
| Maintenance of stand complexity | <ul style="list-style-type: none"> Retention forestry Habitat creation (Cavity tree formation) Prolonged rotation length Mimicry of natural disturbance regimes |
| Landscape and stand heterogeneity | <ul style="list-style-type: none"> Mimicry of natural disturbance regimes |

Options: Strategies for Tyrol



- **Very natural forests:** Non-intervention management, passive management or benign neglect strategy (Friedel et al. 2006, Brunet et al. 2010, Müller & Bütler 2010, Lassauce et al. 2011, Müller et al. 2013, Bernes et al. 2015). Applied in strictly protected areas.
- **Extensive Forests:** Active management is needed to keep characteristics (Lindenmayer et al. 2006, Verschuyt et al. 2011, Kuuluvainen et al. 2012, Fartman et al. 2013, Hedwall & Mikusinski 2015, Sebek et al. 2015, Löff et al. 2016). Applied in less strict protected areas.
- **Heavily degraded forests:** Stand scale restoration may reintroduce ecological values (Barnes et al. 2015). The European Union's Biodiversity Strategy aims to restore 20% of all degraded ecosystems by 2020.

Options: Management restrictions

Tab.3: Various types of timber management restrictions, their general cost level and value for threatened species in general (Bergseng et al. 2012).

| Type of measure | General cost level | Qualitative value for biodiversity |
|---------------------------------------|---------------------------|------------------------------------|
| No treatment | Low - High ^a | High |
| Increased rotation cycle | High | High |
| Min. proportion of old growth forests | High ^a | High |
| Shelterwood cutting | Low - medium ^a | Low - medium ^b |
| Selective cutting | Low - medium ^a | Low |
| Retention of trees | Low | Low - medium |
| No planting or thinning | Low | Low |

^a Cost depends on the area covered.

^b Value for biodiversity depends on the type of cutting (Higher value for more closed cutting).

Options:

Continuous cover forestry (CCF)

- Enriches forest structure, while artificially limiting intraspecific competition (MacArthur & MacArthur 1961, Carey et al. 1999, Wilson 2000, Brunet et al. 2010)
- **Pro** : Often shown to be better in providing timber and non-timber ecosystem services than clear-cut forestry (Pukkala et al. 2011/2016, Tahvonen 2016, Tahvonen & Rämö 2016, Peura et al. 2018). Moreover, ecosystem modelling shows higher biodiversity values for CCF than for clear cutting (Peura et al. 2018) particularly for species of late successional stages (Kuuluvainen et al. 2012)
- **Contra**: Uneven-aged management raises alpha-species diversity while beta-diversity decreases (Whittaker et al. 2001, Schall et al. 2017). On the landscape scale management units tend to become more homogenous whereas within stand species diversity rises (Schall et al. 2016)
- Artificial gap creation can generally have negative effects on the spruce-fir mixing balance and hence on genetic and taxonomic diversity of the understory layer and associated species (Lafond et al. 2015)

Options:

Retention forestry

- Much scientific evidence for biodiversity benefits arising from different retention tree approaches (Vanderwel et al. 2007, Lindenmayer et al. 2012, Fedrowitz et al. 2014)
- Positive response to forest structural complexity for a wide spectrum of forest taxa (Roth 1976, Poulsen 2002, Tews et al. 2004, Hedenas & Hedström 2007, Gustafsson et al. 2010, Stein et al. 2014, Baker et al. 2015)
- The positive effect on species diversity rises with the retention level applied (Fedrowitz et al. 2014)
- Rotation time may be shortened if levels of retention rise (Lindenmayer et al. 2006)
- The ecological effects of retention forestry depend strongly on the individual trees chosen for selection and their spatial arrangement (Scott & Mitchell 2005, Rosenvald et al. 2008)
- Moreover, maintenance of genetic diversity Austrian *Picea abies* stands can be favored through retention forestry (Unger et al. 2011)

Options:

Mimicry of disturbance regimes

- Enhance structural diversity (Bergeron et al. 1999, Seymour et al. 2002), stand **resilience** (Cordonnier et al. 2008, Lafond et al. 2014) and dead wood abundance (Bolton & D'Amato 2011)
- Facilitate characteristic alpha-diversity and natural disturbance refugia (Johns 1996, Van Nieuwstadt et al. 2001, Mackey et al. 2002)
- For alpine sites group selection is more advantageous than single tree selection (Gauquelin & Courbaud 2006, Lafond et al. 2015)
- Unclear if always advantageous compared to traditional shelterwood systems if small-scale gap dynamic is not the prevailing natural disturbance (Schall et al. 2016)



Conclusions of BIOdelta4 for Tyrol

- Biodiversity can never fully be represented by a single number
- Oversimplifying biodiversity might lead to inappropriate conclusions
- For decision making, always focus on the consequences of practice on different spatial and temporal levels as well as on the three dimensions of biodiversity: Ecosystem Diversity, Species Diversity and Genetic Diversity
- There will always be positive and negative responses of practices depending on landscape conditions, taxonomic groups, and temporal and spatial scale of the analysis

Conclusions of BIOdelta4 for Tyrol

- Management needs to become more flexible and use novel measures like predictions from forest models to face large uncertainties
- Harvest should be targeted to sites with highest timber production potential and smallest losses to biodiversity. Contrary, it is reasonable to promote nature conservation in areas of high ecological and social values and low economic potential
- Indicators need definition of suitable baselines and become meaningful in comprehensive indicator sets
- Large spatial scales (regional- national) should be of higher importance for decision-making in forest management than small spatial scales (stand scale)



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