

Management of stand structures for biodiversity benefit

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Content

- Here, nature-oriented management (NOM) = measures that aim at objectives parallel to wood production (included in so-called close-to-nature forestry)
- Perspective: Fennoscandian boreal forests
- Focus on species that face existence risks in the current management regime = red-listed species and strict resource specialists
- Four themes:
 - Structural changes in forests, consequences, and NOM as a cure
 - The unbearable heaviness of the "how much?" question in the NOM context
 - Research-based recommendations for NOM
 - Knowledge gaps, or where to focus future NOM research

Structures of pristine and current boreal forests

Structural feature	Pristine	Current
Old (>150 years) forests (%)	50-95	4-11
Young phases of post natural disturbance (%)	5-50	<1
Deciduous-dominant forests (%)	ca50	10
Deadwood (m ³ /ha)	90	5-10
Large (DBH >40 cm) trees (nr/ha)	40	1
Old (>150 years) trees (nr/ha)	ca50	1
Forest fires (%)	0.05-1	0.004

Case Finland

Henttonen et al. 2019, Berglund & Kuuluvainen 2021, Koivula et al. 2022, Mönkkönen et al. 2022

Biodiversity consequences of structural changes

Case Finland (similar in Sweden and Norway)

- Hyvärinen et al. 2019, Kontula & Raunio 2018
- Table: numbers of primary forest species
 - Top primary reasons and future threats for being threatened
 - Top primary reasons for extinction

Factor	Reason	Threat	Extinctions
Shortage of old forests and very old trees	175	161	22
Forest regener./mgmt.	158	161	8
Shortage of deadwood	156	155	15
Tree-species composition	105	111	5
Other reasons, pooled	235	242	24
Total	829	830	74



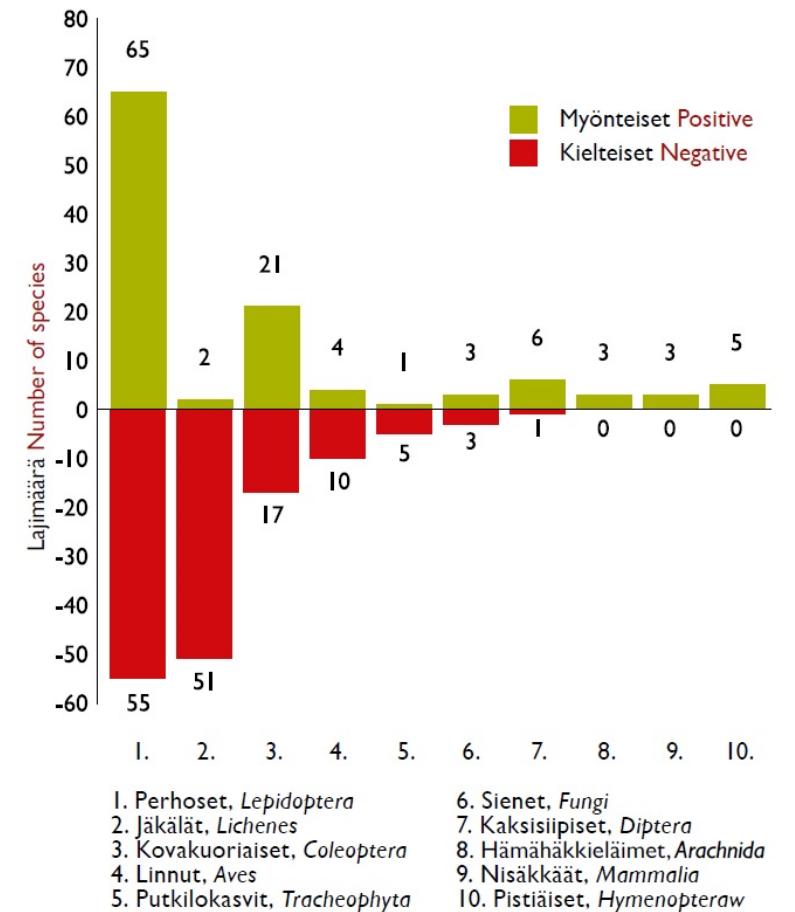
Nature-oriented management – has it helped?

Case Finland: the use of NOM begun in the 1990s

- **Key biotopes** (legislation): on average 0.7 ha
- **Retention trees** (certification): 10-20 trees/ha (3 m³/ha)
- **Buffer zones** (certification): 5-10 m (selection logging)
- **Artificial snags** (certification): 1-5 nr/ha
- **Deciduous % and prescribed burning** (recommendations); both have remained at the same level in the 2000s

Reliably documented changes in IUCN categories

- **Some species have benefited** (e.g., the beetle *Peltis grossa*)
- **Most positive changes** in butterflies and beetles concern species associated with "southern" deciduous trees (e.g., oak)
- **Most negative changes** concern species of boreal forests (notably epiphytic lichens of old deciduous trees)

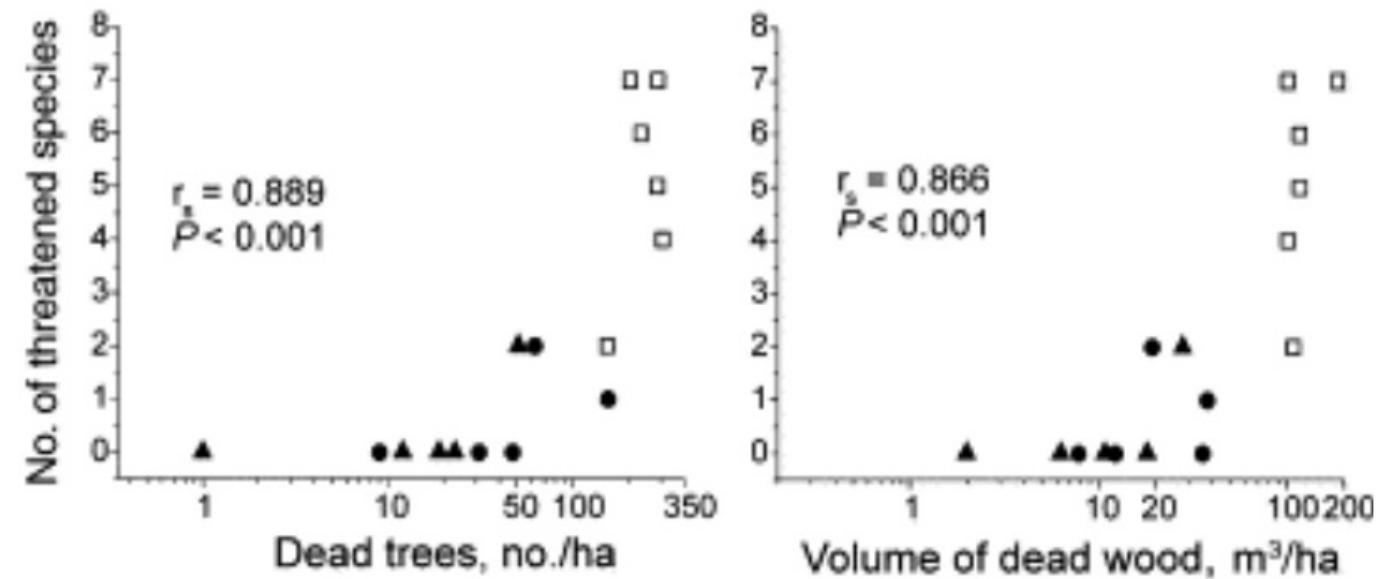


Hyvärinen et al. 2019

How much structural features should be retained?

Example deadwood: "help some" or "save them all"? Occurrence thresholds

- * Different deadwood-dependent species 10-50 m³/ha (Koivula & Vanha-Majamaa 2020)
- * Occurrence thresholds for red-listed polypore fungi 20 m³/ha (Junninen & Komonen 2011)



Red-listed polypore fungi and deadwood (Penttilä et al. 2004)

How much structural features should be retained?

Example deadwood: "help some" or "save them all"? Ecological theory and empiricism

- Resource decrease by 80-90% => extinctions speed up (Hanski 2011, 2015, Rybicki & Hanski 2013)
- Deadwood levels in pristine vs current managed forests (90 vs 4 m³/ha in Southern Finland) => clearly below the speed-up threshold
- The "how much" issue also concerns key-biotope and retention-patch sizes

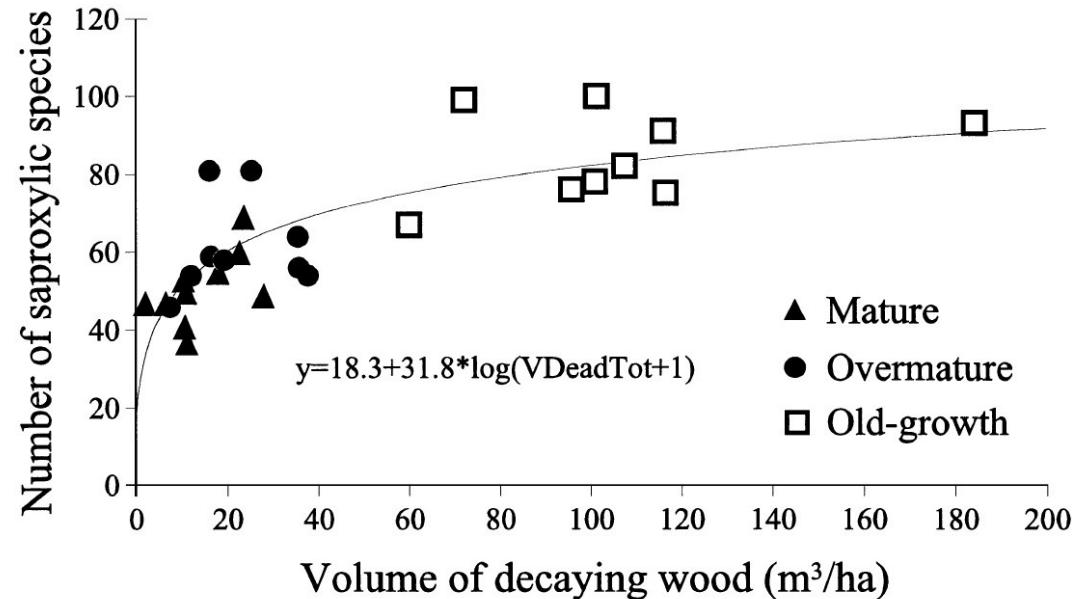


Fig. 3. Relationship between the volume of decaying wood and the number of saproxylic species.

Beetles and deadwood (Martikainen et al. 2000)

Recommendations for structural features

Measure	Recommendation	Reasoning
Key biotopes	Several ha	Edge effect, amounts of features, population sizes
Living trees (permanent)	>30 m ³ /ha	Shade, protect legacies, secure deadwood continuity
Buffer zones	>25 m	Micro-climate, shade species, patch connectivity
Deadwood	10-20 m ³ /ha	Continuity and diversity of deadwood
Deciduous trees	10-20%	All tree species are important
Very large and old trees	5 nr/ha	Epiphytes, nest trees, deadwood continuity
Prescribed burning	5% / 0.1%	5% of land set as fire continuity areas; burn 0.1% per year

Koivula & Vanha-Majamaa 2020, Koivula et al. 2022

Conclusions

- **We know a lot** – sufficiently much to efficiently support biodiversity in managed forests
- **Messages to a forest owner:**
 - Any retention of large living and dead trees is good
 - Some NOM measures are free (deadwood, non-commercial deciduous), some cost very little (artificial snags), others require more financial sacrifices (high retention and prescribed burning) and improve forest tolerance against climate change (deciduous %)
- Landscape- or **regional-level planning** of NOM measures is important
- Notable **knowledge gaps** regarding NOM and biodiversity
 - Long-term effects
 - Large-scale (regional) application of measures
 - Considerably higher levels of measures than at present
 - Consideration of measures in forest types other than the dominant spruce and pine
 - Climate-change interactions with NOM and logging

Thank you!

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