



Changes in biodiversity as a result of bark beetle outbreaks

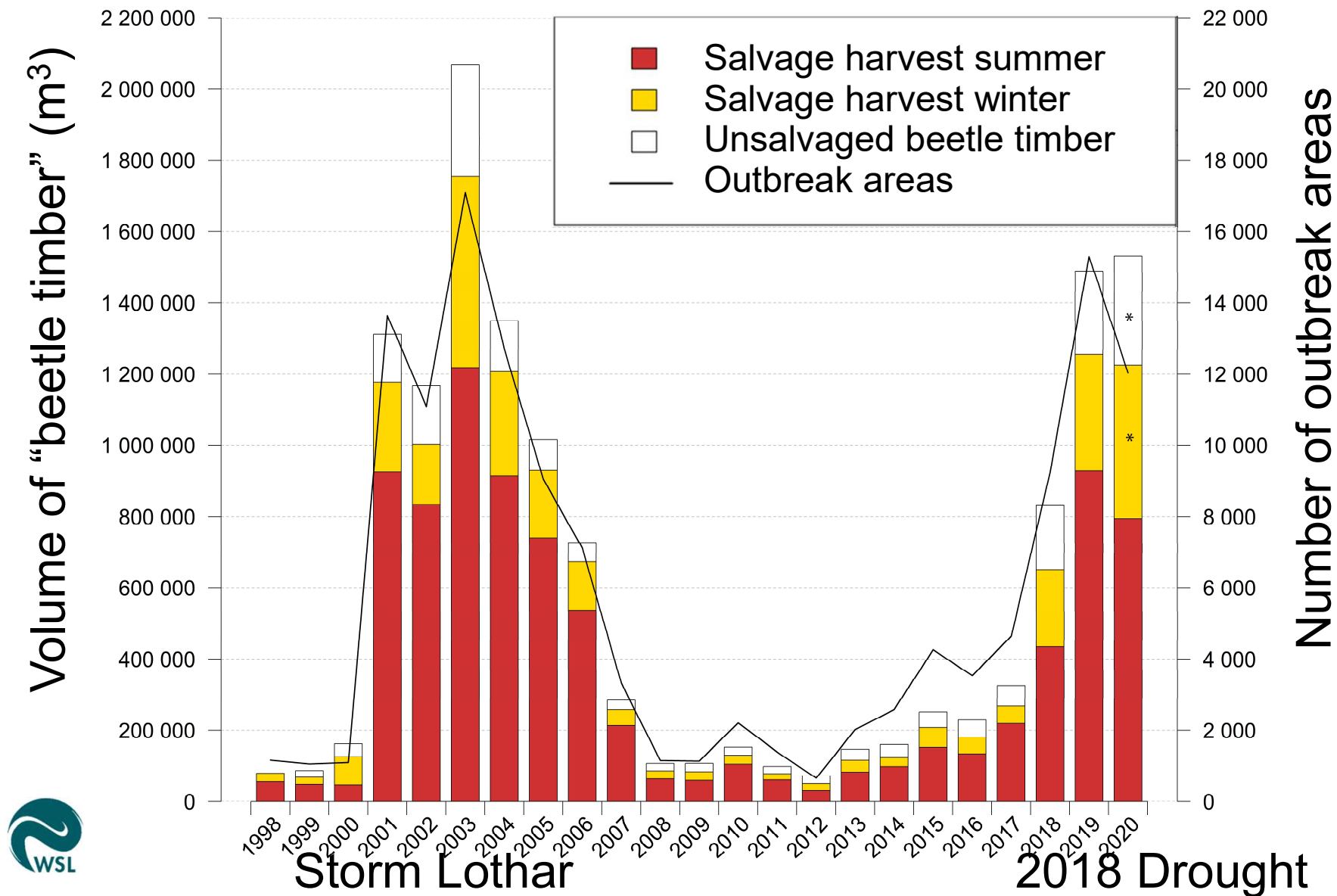
Eckehard “Ecki” Brockerhoff

Martin Bader, Martin Gossner, Valentin Queloz,
Sophie Stroheker, Beat Wermelinger



**Swiss Federal Institute for Forest, Snow
and Landscape Research WSL**

Volume of timber attacked by Ips typographus and number of outbreak areas, Switzerland 1998-2020





***Ips typographus* outbreak, Switzerland**
Ca. 3 million m³ spruce (timber) killed 2019 & 2020

Sihlwald, Canton Zurich, Photo: Beat Wermelinger

Some species benefit from bark beetle outbreaks

(Examples from the Bavarian Forest)



Antrodiella citrinella (Polyporales)
only where deadwood > 140 m³ ha⁻¹
Bässler & Müller (2010) Fungal Biol.

Danosoma fasciata (Elateridae) and
Peltis grossa (Silphidae) live in ca. 10-yr
old deadwood colonised by certain fungi

Müller (2015) Natur und Landschaft



Flat bug *Aradus obtectus* (Aradidae) normally rare
but common on dead spruces after Ips outbreaks

Gossner and Müller (2020) Biodiversität im Schweizer Wald

Photo: Iwan Van Hoogmoed <https://naturforskaren.se/species/555bcc72-78c5-4e30-869e-feeb9b2fb1ee>

... Species benefiting from bark beetle outbreaks

Woodpeckers: greater availability of food and nest sites

Three-toed woodpecker (*Picoides tridactylus*)

- a spruce (bark beetle) specialist



Effects of salvage-harvesting on biodiversity?

In managed forests, **beetle-killed and –infested logs are salvaged and removed from the forest**

- Little dead wood may remain in the forest



Salvage-harvested log pile in Czechia

Photo: Roman Modlinger

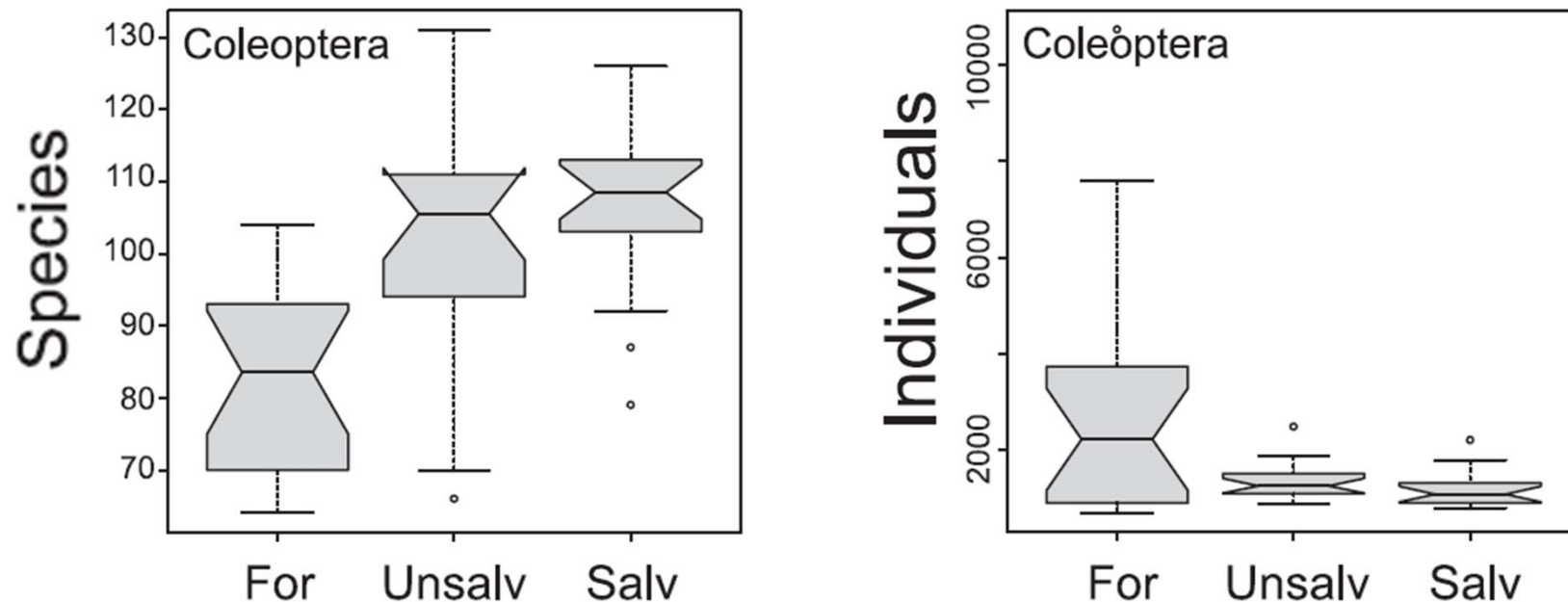
Potential effects of bark beetle outbreaks on biodiversity – good or bad?

“Disturbance” can be positive for biodiversity

- e.g., increased availability of dead wood

Management of outbreaks can be negative for biodiversity

- salvage logging (removes dead wood)



Wermelinger et al. (2017) *For. Ecol. Man.* (Flight interception and pitfall traps)
Thorn et al. (2017) *Journal of Applied Ecology*

Salvage harvesting effects on biodiversity

DOI: 10.1111/1365-2664.12945

REVIEW (2017)

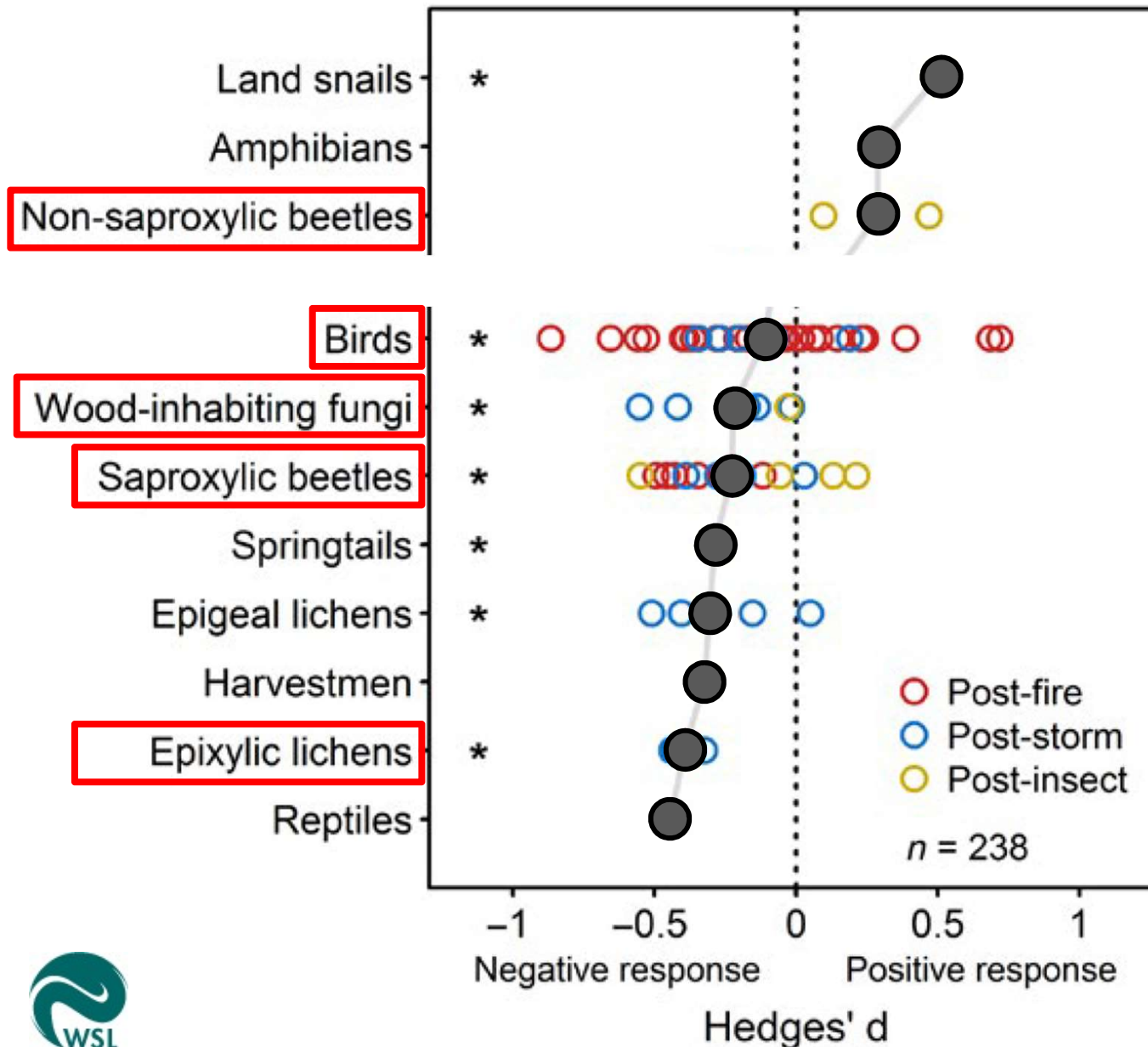
Journal of Applied Ecology 

Impacts of salvage logging on biodiversity: A meta-analysis

Simon Thorn¹  | Claus Bässler² | Roland Brandl³ | Philip J. Burton⁴ | Rebecca Cahall⁵ | John L. Campbell⁵ | Jorge Castro⁶ | Chang-Yong Choi⁷ | Tyler Cobb⁸ | Daniel C. Donato⁹ | Ewa Durska¹⁰ | Joseph B. Fontaine¹¹ | Sylvie Gauthier¹² | Christian Hebert¹² | Torsten Hothorn¹³ | Richard L. Hutto¹⁴ | Eun-Jae Lee¹⁵ | Alexandro B. Leverkus¹⁶  | David B. Lindenmayer¹⁷  | Martin K. Obrist¹⁸ | Josep Rost^{19,20} | Sebastian Seibold^{2,21}  | Rupert Seidl²² | Dominik Thom²² | Kaysandra Waldron²³ | Beat Wermelinger²⁴ | Maria-Barbara Winter²⁵ | Michal Zmihorski²⁶ | Jörg Müller^{1,2} 

- **238 data points, 24 taxonomic groups**
- **Salvage post-bark beetle / -storm / -fire ...**

Salvage harvesting effects on species richness



Conclusion:
Response depends on taxon and association with wood

Thorn et al. (2017)
J. Appl. Ecol.



Bark beetle outbreaks may benefit biodiversity

- Availability of dead wood
 - benefits saproxylic insects, deadwood fungi, etc.
 - **but only if** some dead wood stays in the forest
- Forest gaps resulting from outbreaks
 - benefit species preferring forest gaps and open habitat
- Gaps increase habitat diversity
 - mixture of forest and open areas
 - increases diversity at the landscape scale



Müller et al. (2008) Biodiversity and Conservation
Thom and Seidl (2016) Biological Reviews
Thorn et al. (2017) Journal of Applied Ecology
Wermelinger et al. (2017) Forest Ecol. Manage.

A 'before-after' comparison (not an actual one)



Before outbreak / salvage

Photo: S. Müller-Kroehling www.lwf.bayern.de/biodiversitaet/biologische-vielfalt/171489

After outbreak / salvage (very large area)

(Northeastern Czechia, Olomouc county)



Photo: **Roman Modlinger** (Hlásny et al. (2021) Forest Ecology & Management)

Scale effects: size of outbreak / salvage area

1. Very large salvage-logged areas (without forest)
2. Mosaic of forest and gaps

Forest edge and
unsalvaged “gap”
(Bavarian Forest)

Müller et al. (2007)
Silva Gabreta



Potential detrimental effects on biodiversity of large-scale bark beetle outbreaks

Direct effects:

- Initial large availability of dead wood eventually leads to shortage of dead wood
 - negative for saproxylic insects
- Loss of old-forest habitat
 - negative for old-forest specialists
- Decrease of habitat diversity, over-abundance of open habitat, then young regenerating forest
 - negative for diversity at the landscape scale

Potential detrimental effects on biodiversity of large-scale bark beetle outbreaks

Indirect effects:

- Effects of salvage harvesting
 - Negative for dead wood-dependent species
- Other effects of salvage harvesting
 - Natural enemy removal (insect predators, parasitoids)
 - Removal / disturbance of woodpecker nests
- Increased pesticide use (in some countries)
 - Negative effects on most natural enemies
 - Pesticide residue in the environment

Hlásny et al. (2021) Forest Ecology and Management
Brockhoff et al. (unpubl.)

Conclusions and recommendations


- Bark beetle outbreaks can be positive for biodiversity
 - dead wood, forest gaps, habitat diversity ...
- Salvage logging may be detrimental
 - especially for dead wood-dependent species
- Richness and diversity are greatest in landscape mosaic:
 - undisturbed forest + unsalvaged + salvaged areas
- Ideally some damaged forest should remain unsalvaged
- Thorn et al. (2020) suggest 50% unsalvaged disturbed area retains 73% of unique species (of naturally disturbed areas)
- Reduced salvaging creates **trade-off** with perpetuating outbreaks as bark beetle populations remain higher

Wermelinger et al. (2017) For. Ecol. Man.

Thorn et al. (2017) J. Appl. Ecol.

Thorn et al. (2020) Nature Communications



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- Thank you to the organisers of the Forests' Future conference!
 - and to Roman Modlinger and Tomáš Hlásny for Photos

Ips typographus outbreak, Switzerland, Sihlwald, 2020 (B. Wermelinger)