# Environmental assessment of thinning with Bracke C16c Smallwood version

# Smallwood

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**Polytechnic University of Madrid**

# Objective

- To quantify and compare tree and soil damages and thinning emissions of boom corridor thinning and selective thinning in small-diameter-tree stands of various characteristics in Sweden, Finland, Slovenia, and Spain.

# Location


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Europe
Barents Sea
ICELAND
Norwegian Sea
White Sea
SWEDEN
FINLAND
NORWAY
Gulf of Bothnia
UNITED KINGDOM
Gulf of Finland
ESTONIA
Baltic Sea
North Atlantic Ocean
North Sea
LATVIA
RUSSIA
DENMARK
LITHUANIA
RUSSIA
NETHERLANDS
IRELAND
BELARUS
POLAND
GERMANY
Celtic Sea
English Channel
BELGIUM
LUX.
SLOVAKIA
UKRAINE
LIECH.
FRANCE
SWITZERLAND
HUNGARY
MOLDOVA
ROMANIA
SLOVENIA
CROATIA
ITALY
BOS. & HER.
SERBIA
SAN MARINO
Black Sea
MONACO
BULGARIA
MACEDONIA
GEOFGIA
ANDORRA
ALB.
ARMENIA
AZERBAIJAN
PORTUGAL
SPAIN
VATICAN CITY
TURKEY
Mediterranean Sea
GREECE
MALTA
Ionian Sea
SYRIA
IRAN
CYPRUS
IRAQ
ALGERIA
MOROCCO
TUNISIA
LIBYA
Map not to scale
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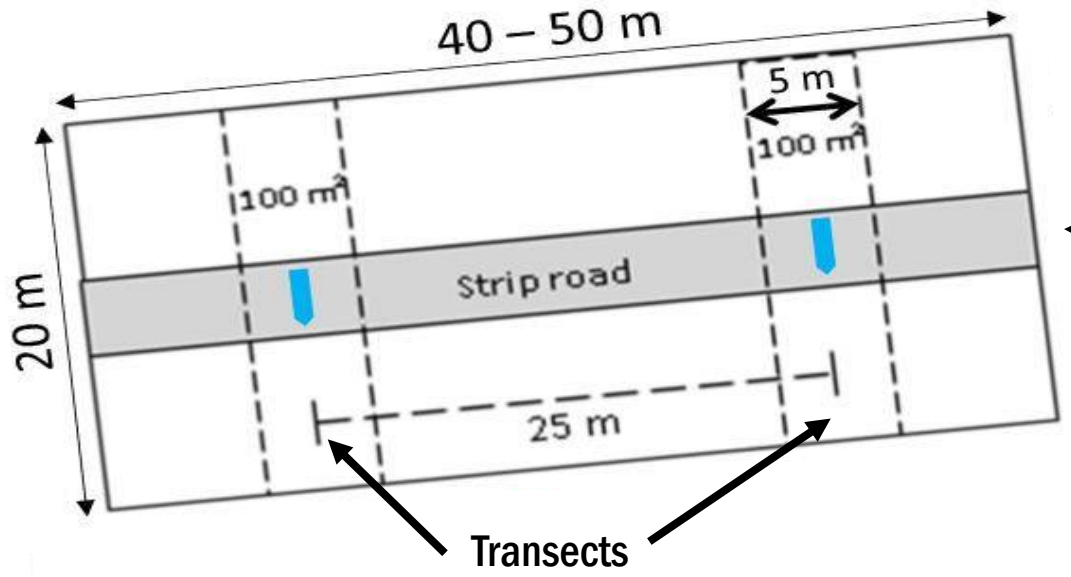
# Methodology

## Tree and soil damages

**Trees with dbh ≥ 7cm were sampled throughout the strip roads after thinning and throughout the transects after forwarding.**




84 study units analyzed in the four countries

Study unit

Soil damages (rutting > 10 cm depth) were measured along the strip road before forwarding

Stump height

was measured in all the stumps with diameter > 1 cm within the transects

# Harvesting emissions

Harvester fuel consumption was estimated by the engine management computer. Data was taken for each study unit.

A Life cycle perspective was used to calculate the environmental impacts of the harvesting process.

# Results

## Damaged tree number per working method

| Working method | Number of damaged trees / 100 m strip road after thinning | | | |
|---|---|---|---|---|
| | Sweden | Finland | Slovenia | Spain |
| Boom C. | 4.4 (4.0) | 2.3 (2.7) | 6.6 (4.2) | 2.3 (2.2) |
| Selective | 5.1 (2.2) | 4.3 (5.3) | 12.0 (5.1) | 2.5 (2.6) |

Values are average per study unit and working method with standard deviation in brackets.

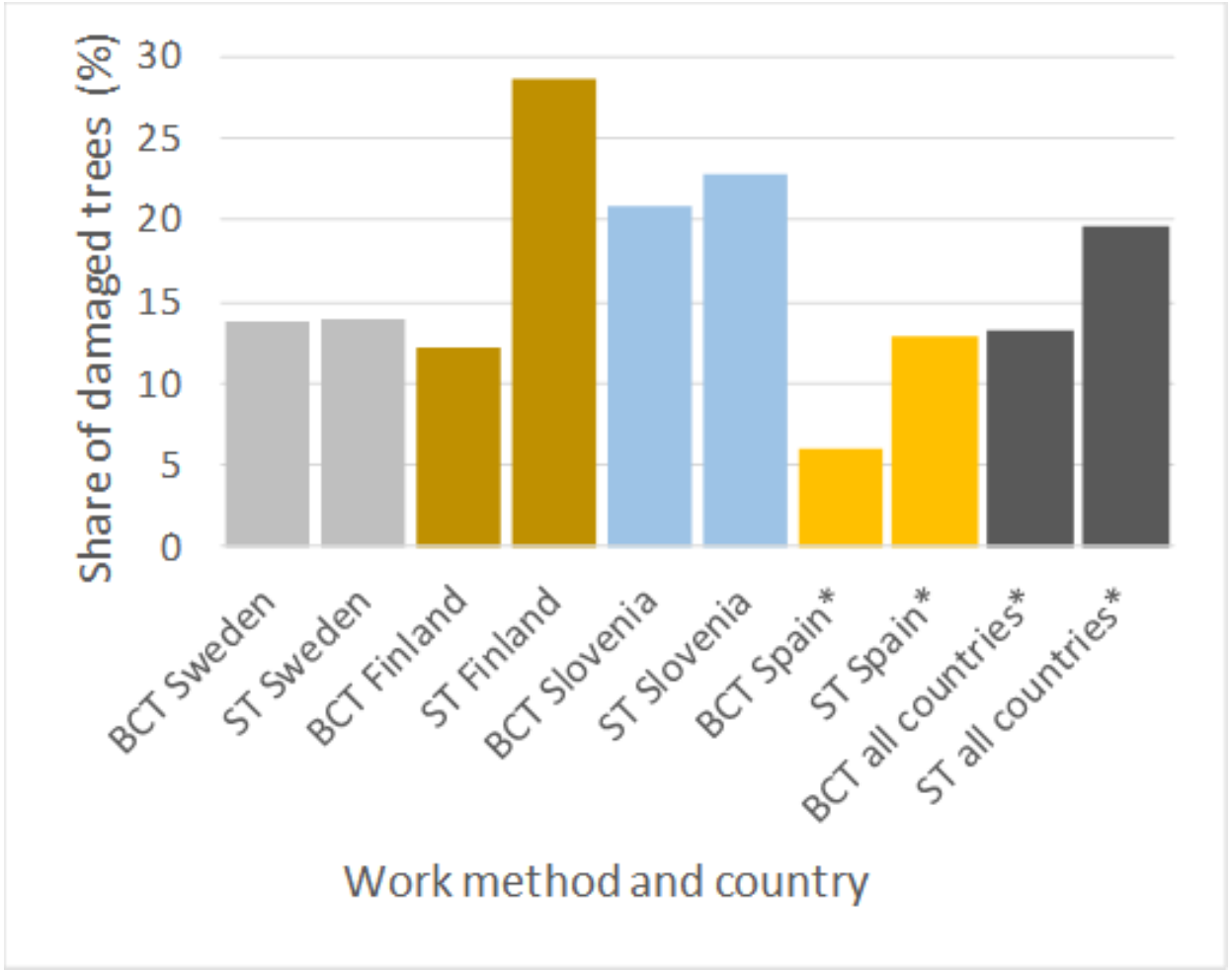
**The difference between working methods was statistically significant at 90% confidence level (p-value=0.069)**

# Damaged tree number per working method

| Working method | Number of damaged trees / ha after forwarding | | | |
|---|---|---|---|---|
| | Sweden | Finland | Slovenia | Spain |
| Boom C. | 125.0 (35.4) | 91.7 (58.5) | 185.7 (98.9) | 75.0 (48.6) |
| Selective | 120.0 (88.8) | 133.3 (112.5) | 210.7 (100.3) | 165.0 (94.4) |

Values are average per study unit and working method with standard deviation in brackets.

# Share of damaged trees in relation to remaining trees (DBH ≥7cm) after forwarding




The damaged tree number after forwarding was 32% significantly lower in BCT (p-value = 0.041)

# Damage characteristics

In Sweden and Finland most of the damages were "squeezed bark", while "scratched bark" and "wood damage" were the most common damages in Slovenia and Spain, respectively.

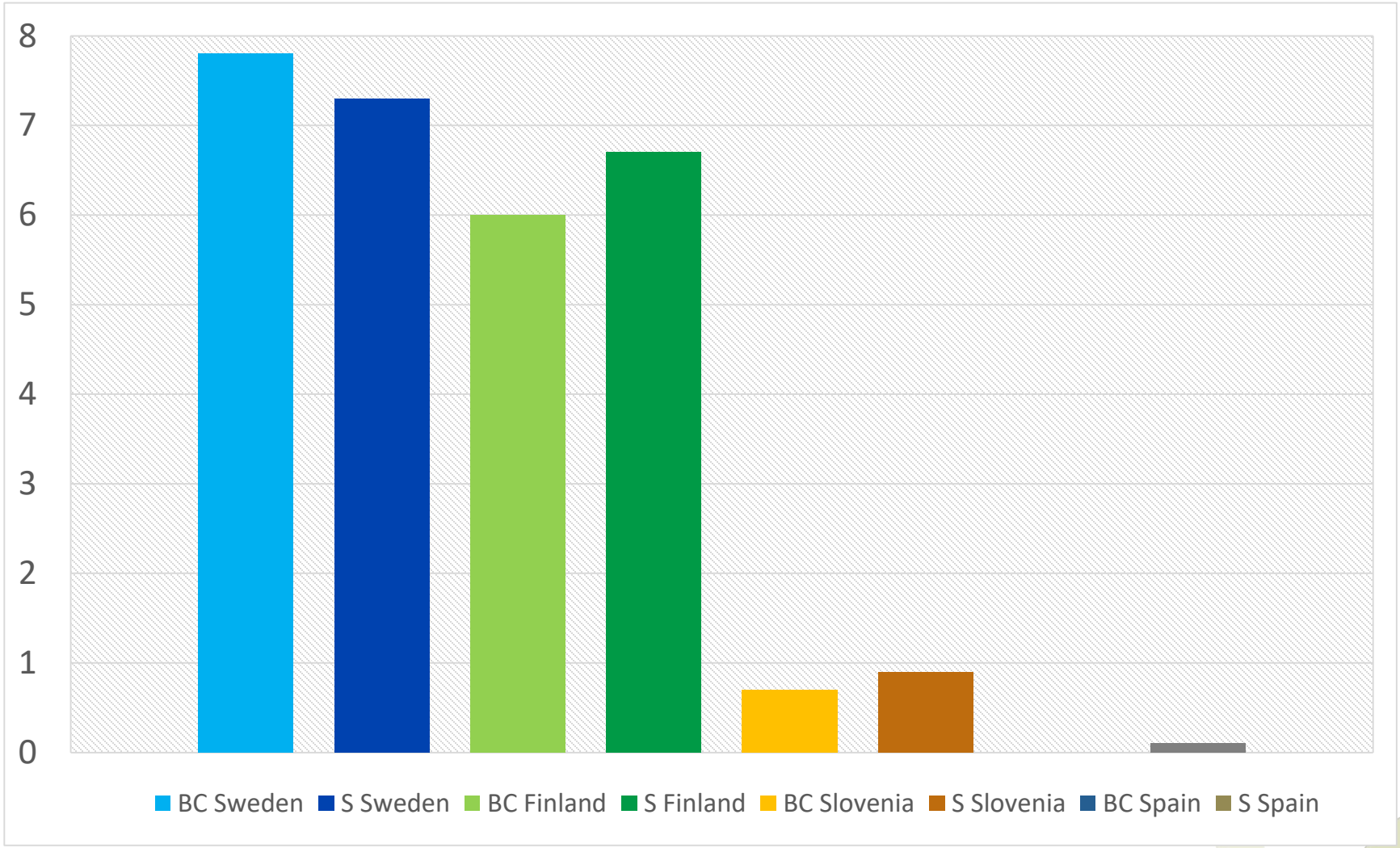

The location of the damages along the tree varied in height between countries and working methods. However, in Finland and Spain most of the damages were lower than 30 cm for both working methods.

Most of the damages were smaller than 50 $cm^2$ in the four countries and for both working methods, with the exception of ST in Slovenia, which showed a larger amount of damages bigger than 200 $cm^2$.

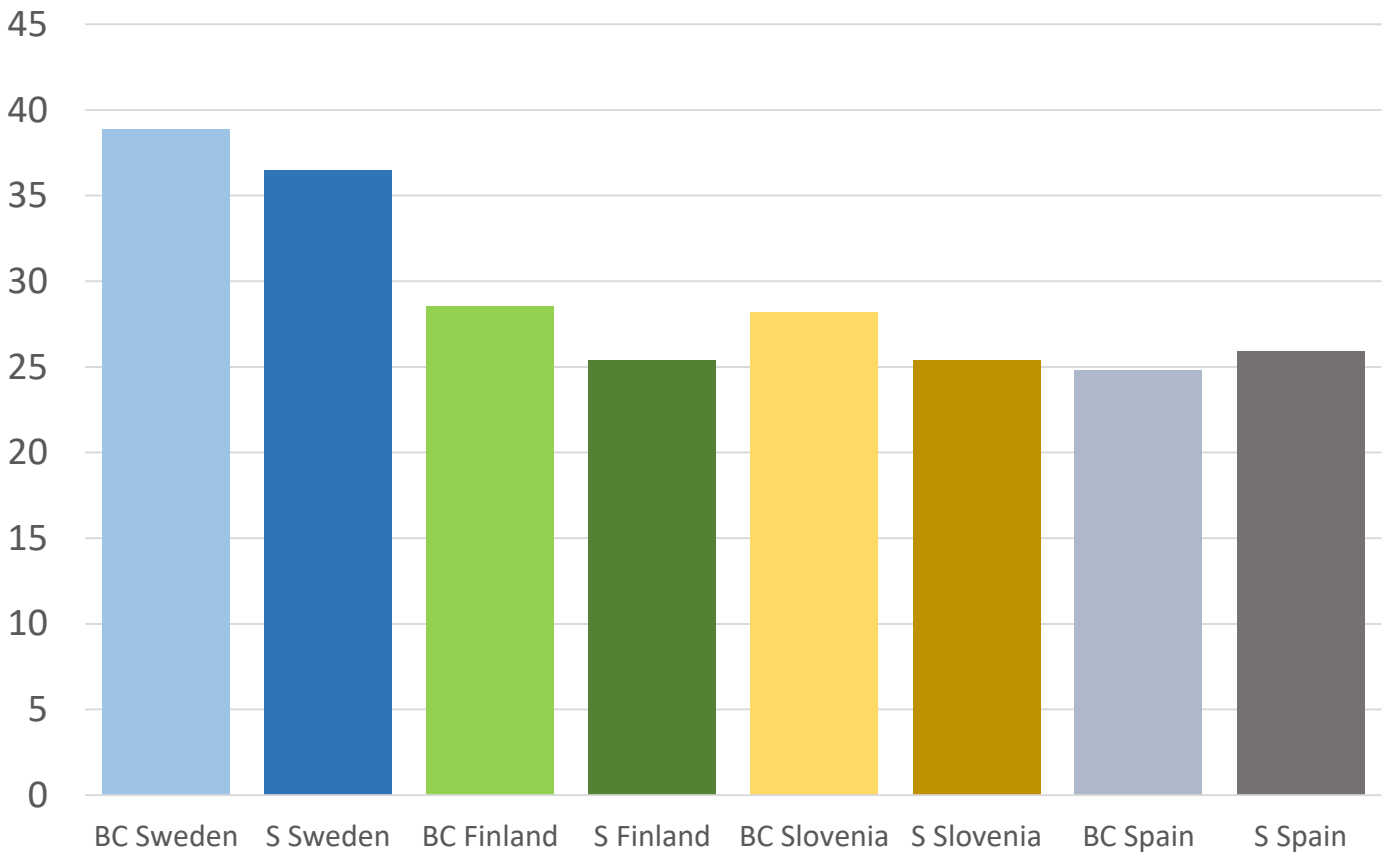
The main **damage cause** was the **harvester head** movement for all countries and for both working methods.

The **destroyed tree number** was **very low** in all countries and for both working methods (between 0 and 0.3 trees per study unit)

# Soil damages m/100 m strip road



# Average stump height (cm)



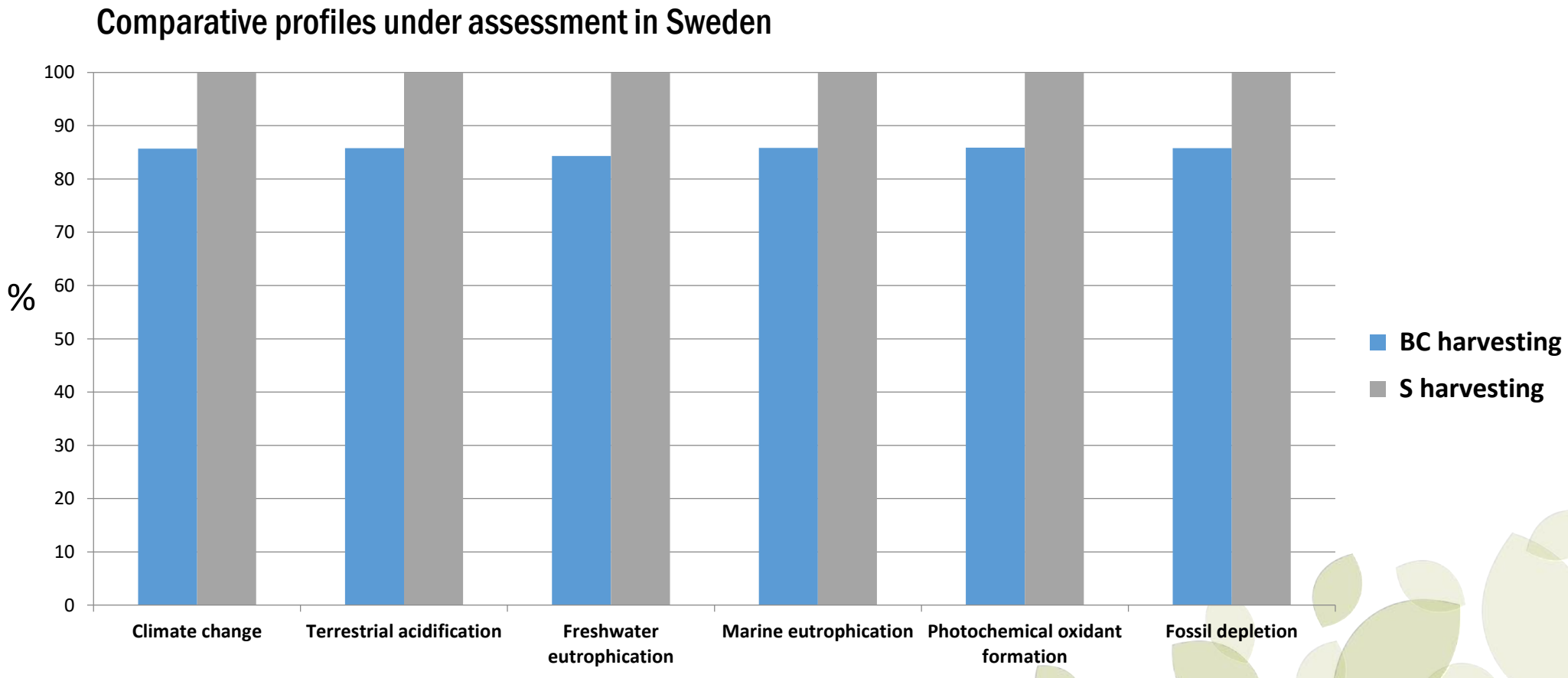
There was no statistical difference between the working methods in the damage characteristics, soil damages and stump height.

# Harvesting fuel consumption

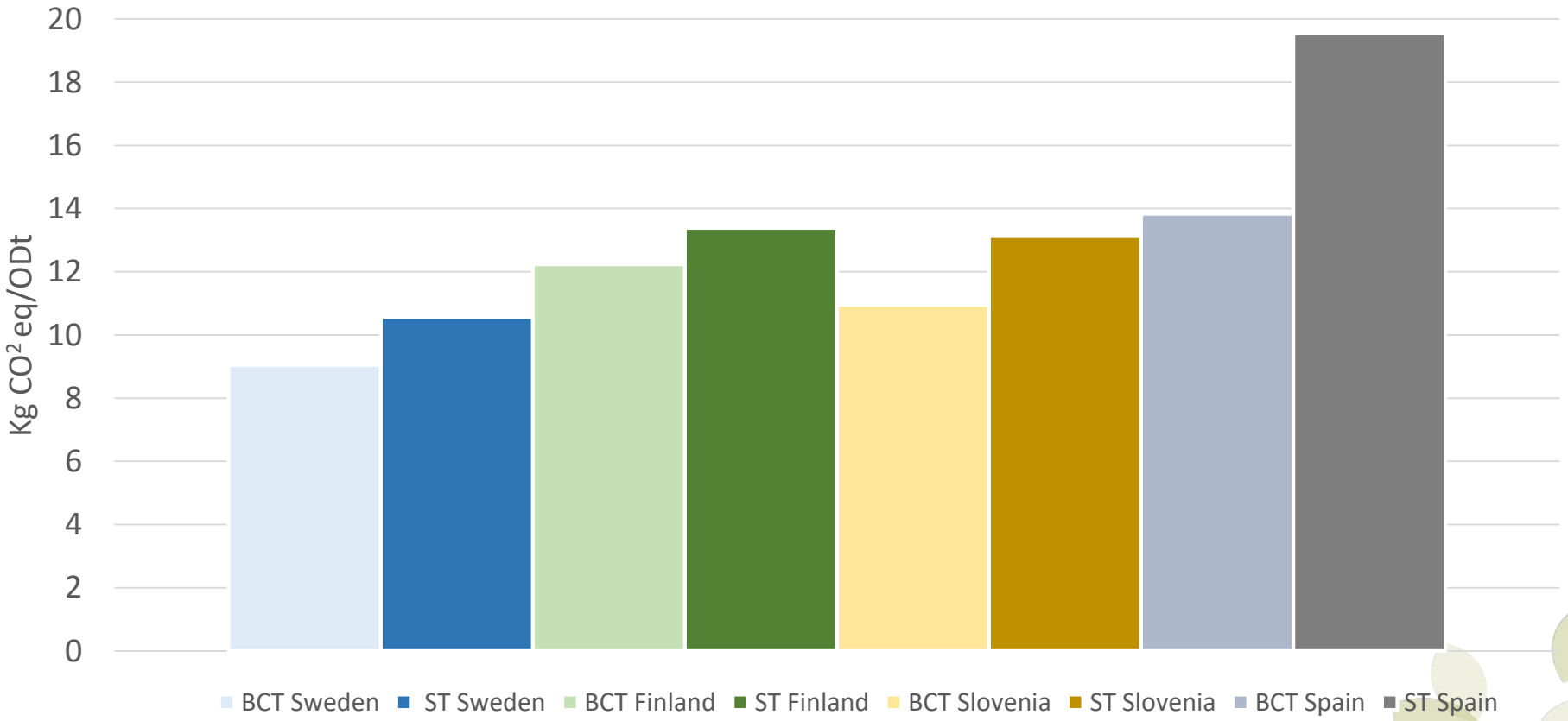
| Working method | Average diesel consumption (l/ODt) | | | |
|---|---|---|---|---|
| | Sweden | Finland | Slovenia | Spain |
| Boom C. | 2.32 | 3.12 | 2.87 | 3.52 |
| Selective | 2.77 | 3.42 | 3.41 | 5.06 |

# Harvesting emissions

**Boom corridor thinning exhibited the lowest emissions on average in all the environmental impact categories.**



In terms of greenhouse gas emissions, BC harvesting emissions were 14%, 16%, 9% and 29% lower than S harvesting in Sweden, Slovenia, Finland and Spain, respectively.



# Conclusions

- The number of damaged trees observed after thinning was lower in boom corridor thinnings than in selective thinning.

- Damages on soil, the  average stump height, the tree damage characteristics and the main cause of tree damages  were similar in both working methods.

- Boom corridor thinning seems to be more energy efficient than selective thinning due to a lower time consumption, and therefore a lower fuel consumed.

sustainability

MDPI

*Article*

# Environmental Impacts of Boom-Corridor and Selectively Thinned Small-Diameter-Tree Forests

Teresa de la Fuente [1], Dan Bergström [2], Raul Fernandez-Lacruz [3], Teppo Hujala [4], Nike Krajnc [5], Ruben Laina [1], Tomas Nordfjell [2], Matevz Triplat [5,6] and Eduardo Tolosana [1,*]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