Forest Management Impacts on Ecosystem Services–A Bayesian Belief Network Approach

Kathleen Conroy

Dr. Francesco Martini, Professor Jane Stout, Professor Yvonne Buckley, Professor Mary Kelly-Quinn, and Dr. Matheus Etges

UCD DUBLIN

COILLTE nature

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

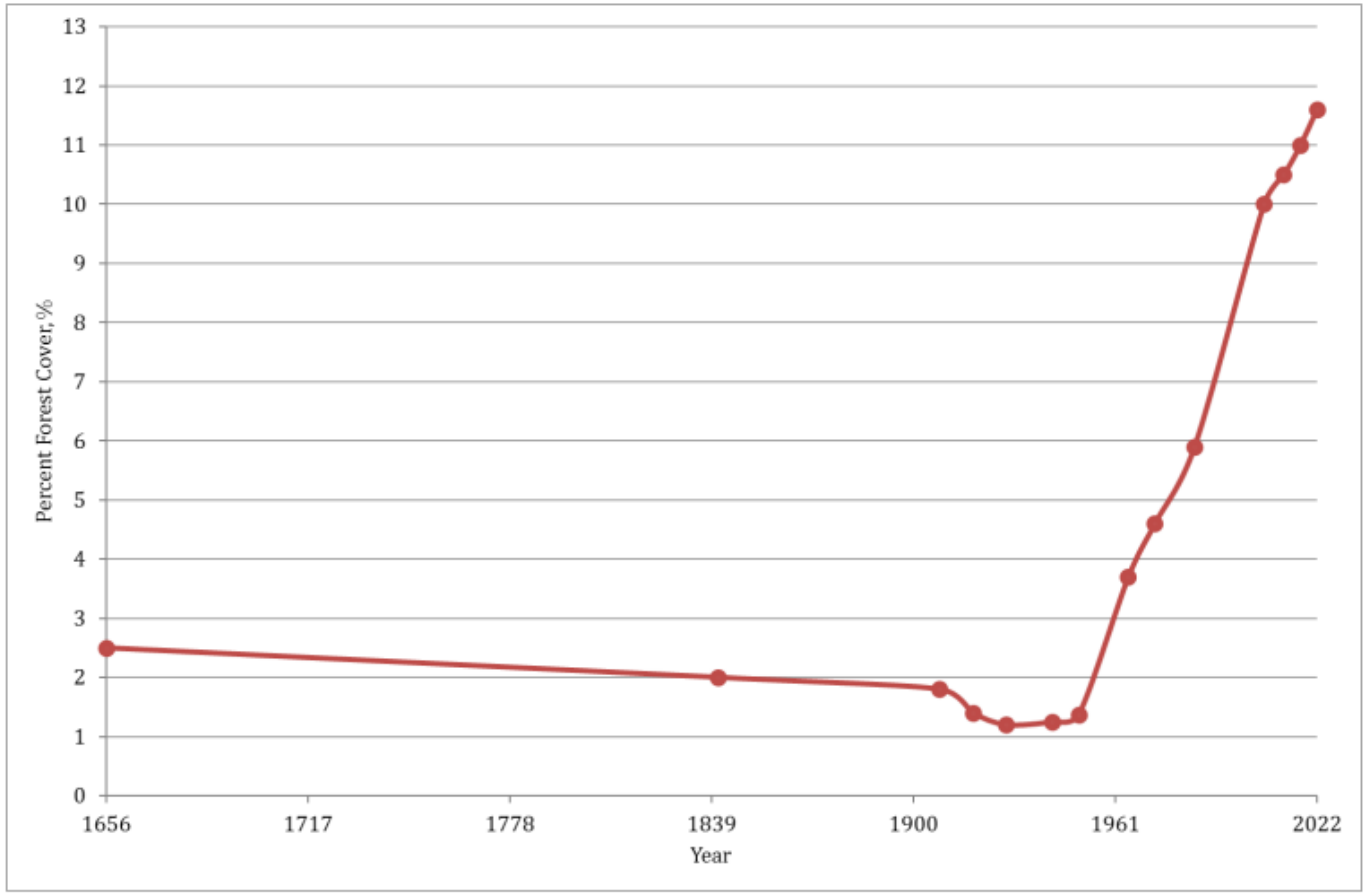
FORES

Overview

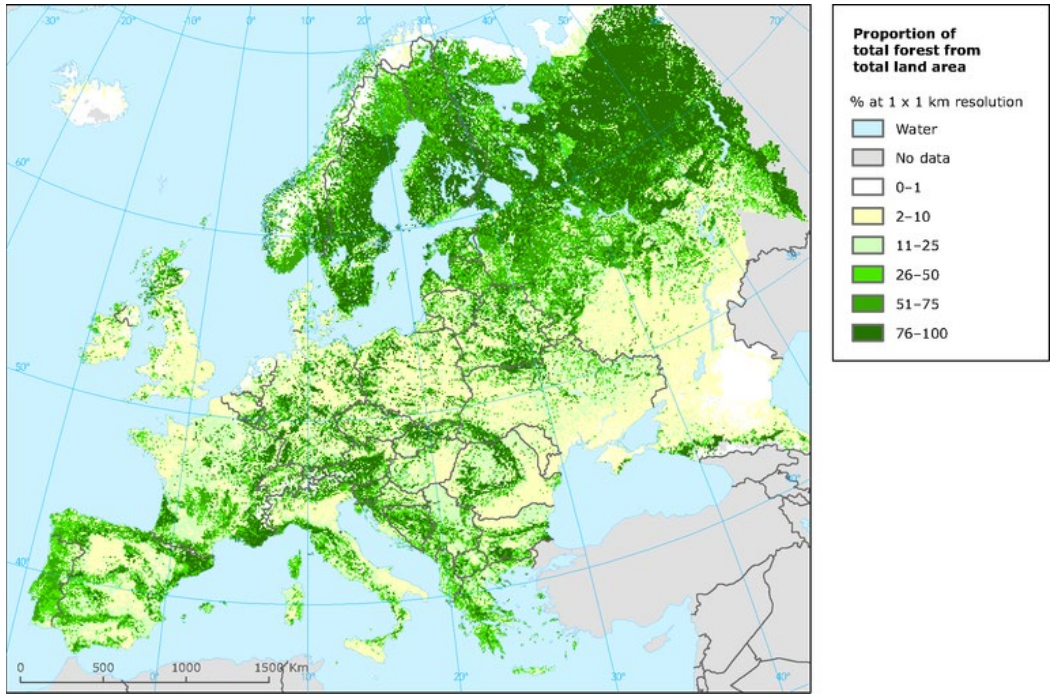
- Forestry in Ireland
- Ecosystem Services selection
- BBN Overview
- Our BBN
- Next Steps

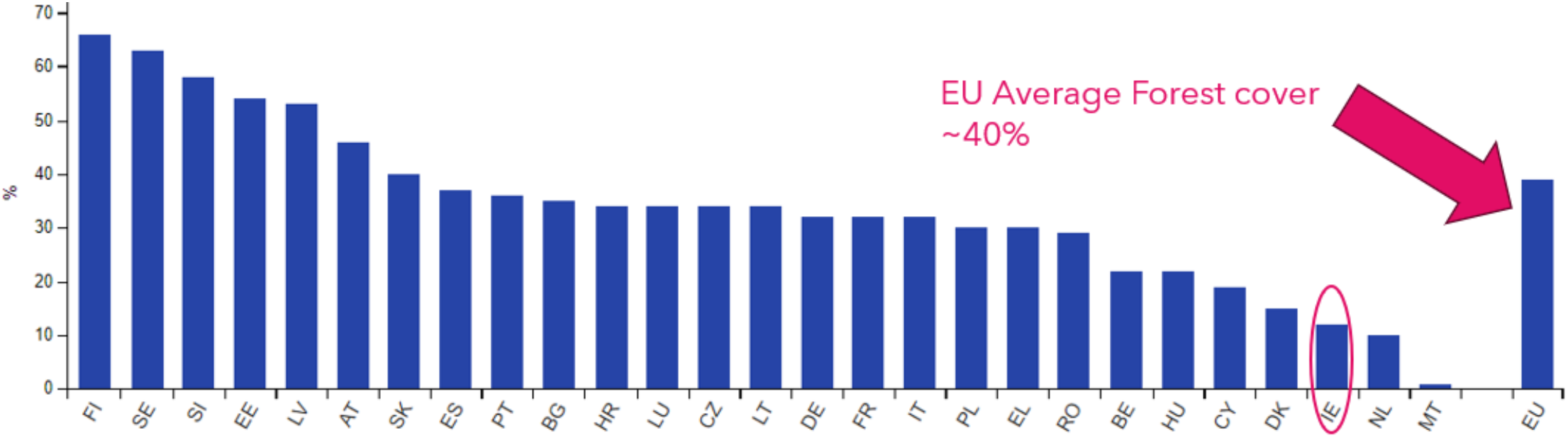
What should forests be managed for?

Forestry in Ireland

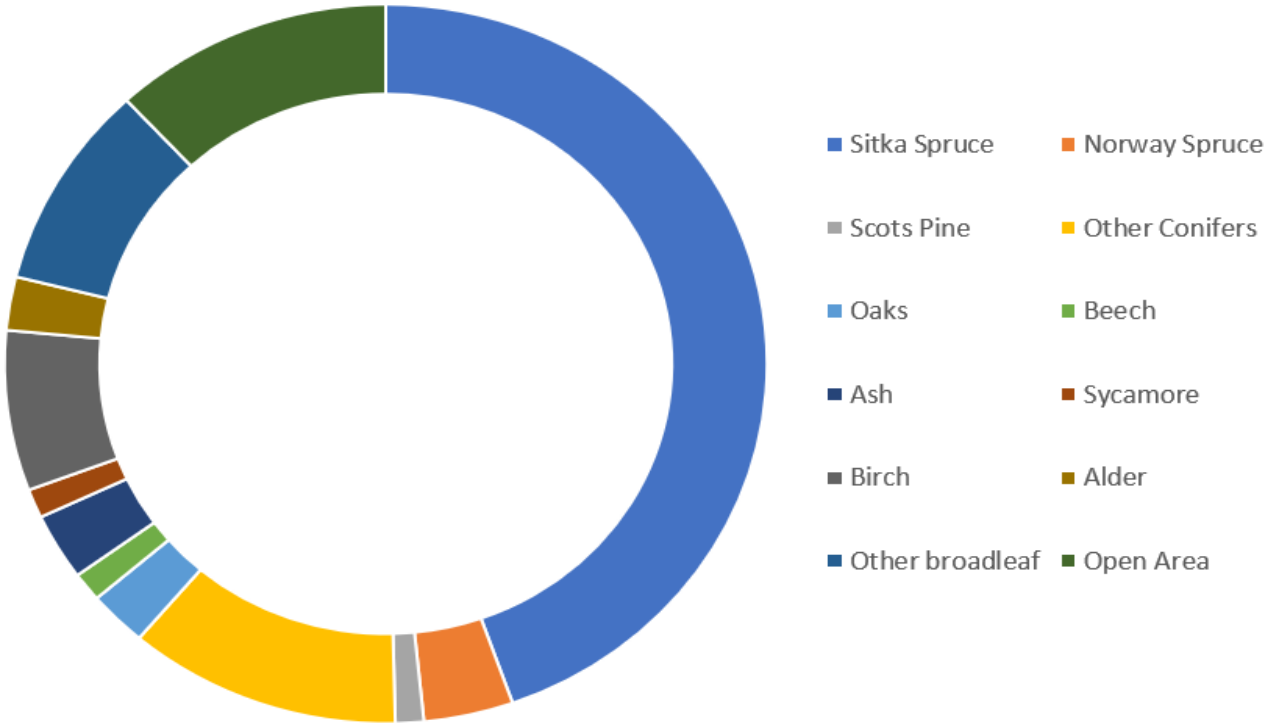


Irish Forestry vs EU

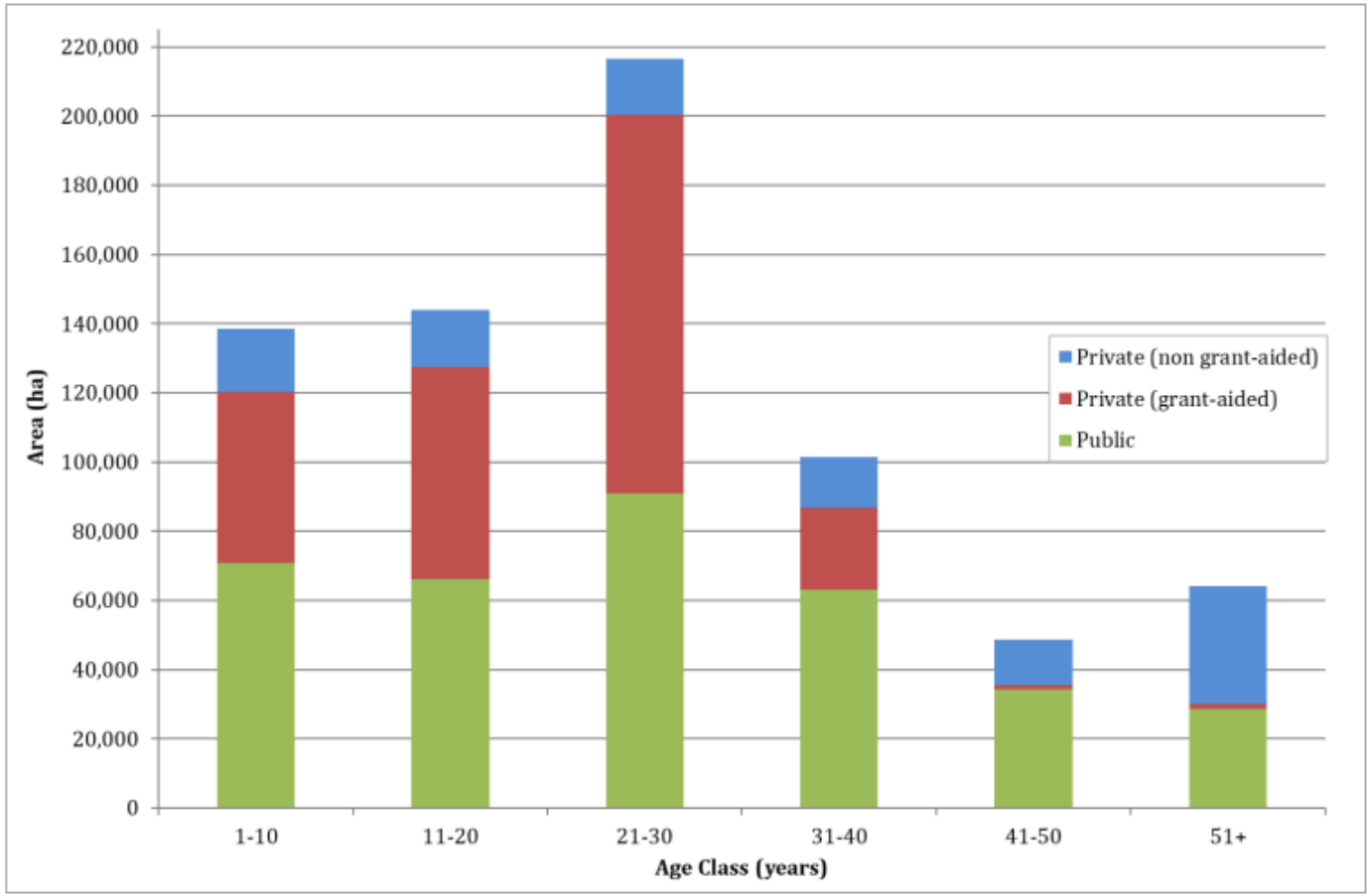




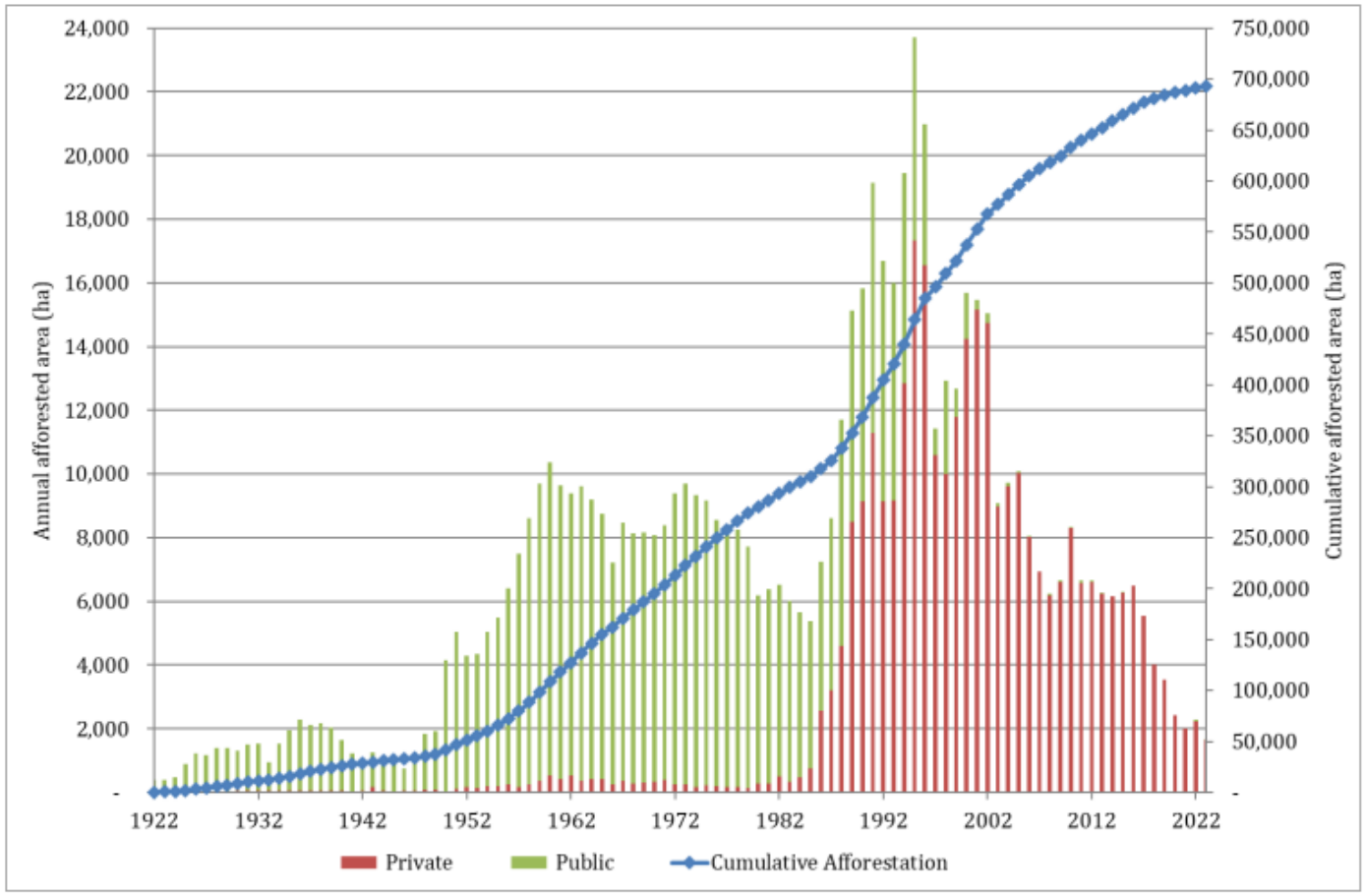
Forest Species Composition



Forest Age


220,000
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
Area (ha)
1-10
11-20
21-30
31-40
41-50
51+
Age Class (years)
Private (non grant-aided)
Private (grant-aided)
Public

Afforestation Rates



Year	Number of Forest Visits
1999	8,500,000
2004	11,000,000
2005	18,000,000
2015	29,105,759

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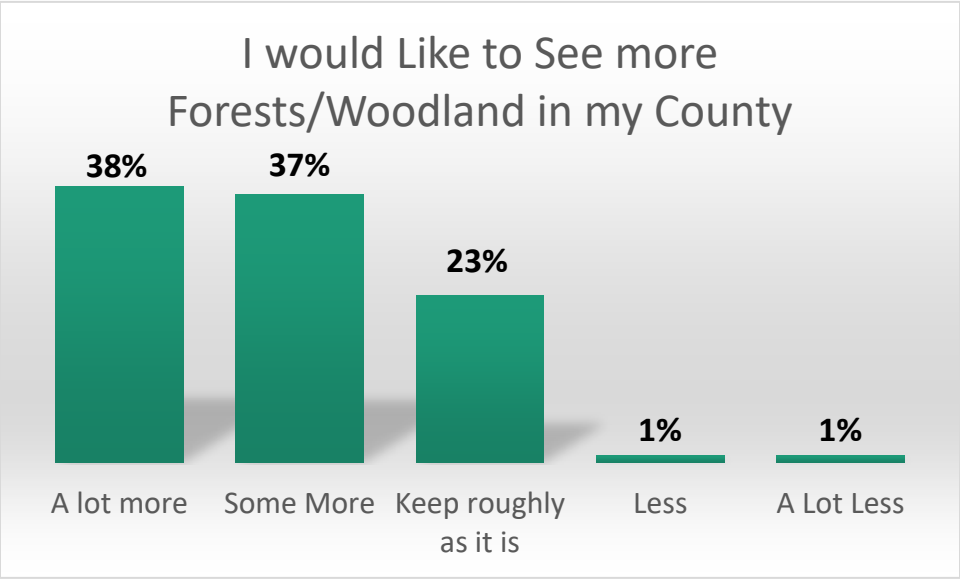
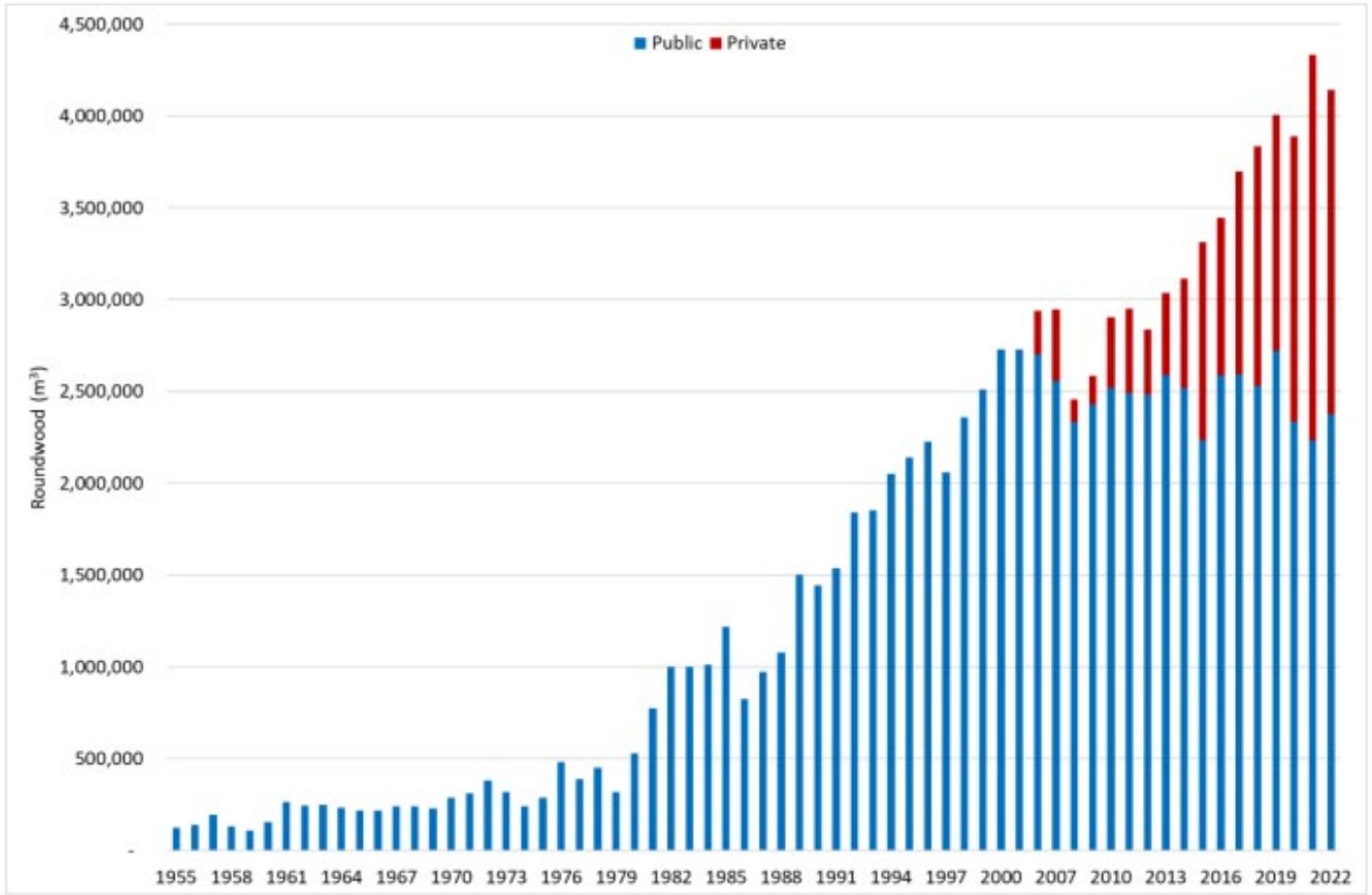
1999	8,500,000
2004	11,000,000
2005	18,000,000
2015	29,105,759

€179 million/year



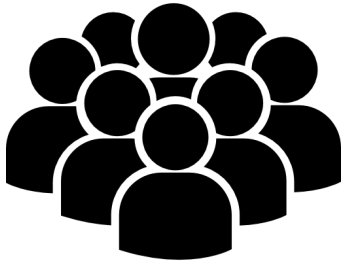
Timber (Roundwood)



Carbon Stock

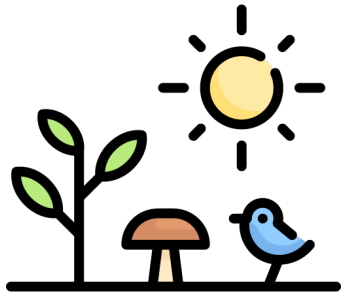
	2006		2012		2017		2022	
Carbon stock	**Million t**	**%**	**Million t**	**%**	**Million t**	**%**	**Million t**	**%**
Above-ground biomass*	31.4	11.8	40.3	14.1	46.0	15.0	52.6	16.3
Below-ground biomass**	6.9	2.6	9.0	3.2	10.5	3.4	12.3	3.8
Deadwood***	1.5	0.6	1.9	0.7	2.2	0.7	2.5	0.9
Litter	2.1	0.8	1.9	0.7	2.1	0.7	3.6	1.1
Soil	225.3	84.3	232.7	81.4	246.9	80.2	252.1	78
Total	**267.4**	**100**	**286.0**	**100**	**307.9**	**100**	**323**	**100**

What should forests be managed for?

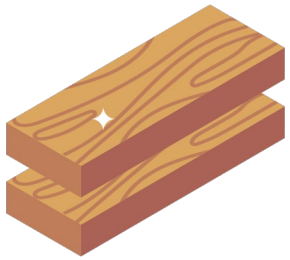


For People

For Climate



For Nature

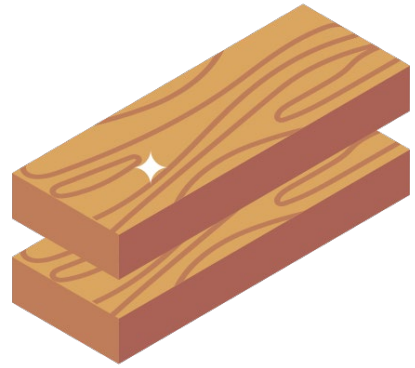


For Wood

Forests For…

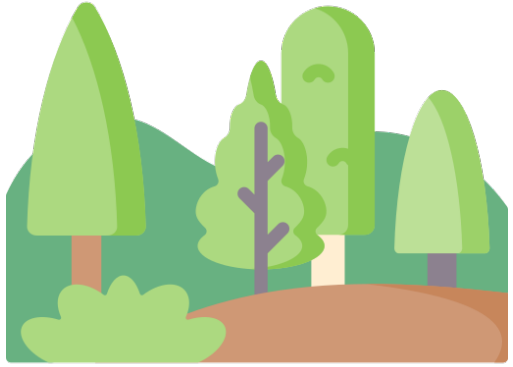
Public—Coillte

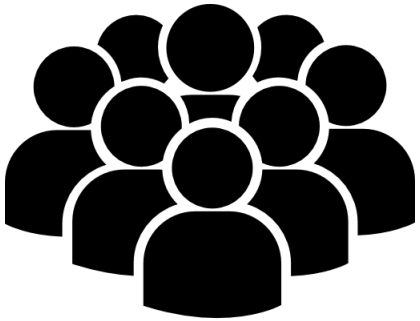
For Climate ES:
Global Climate Regulation Services



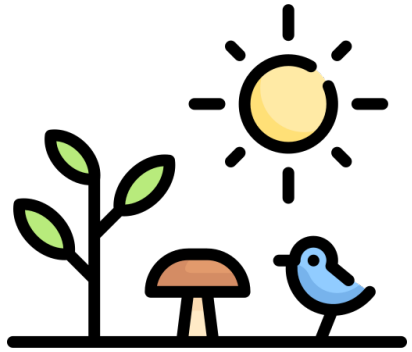
For Wood ES:
Wood Provisioning Services

Forests for…





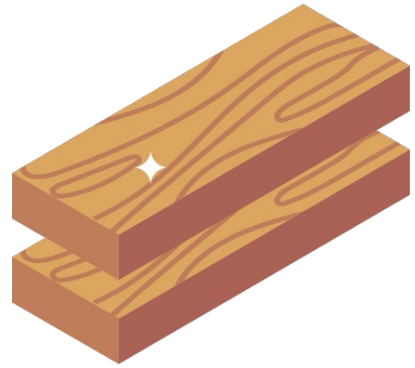
For People ES:
Recreation Related Services



For Nature ES:
Wild animals, plants and other biomass provisioning services

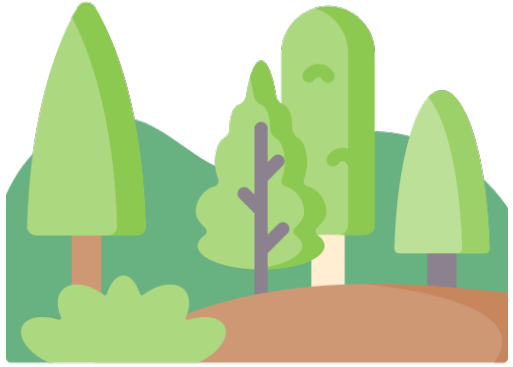
Private

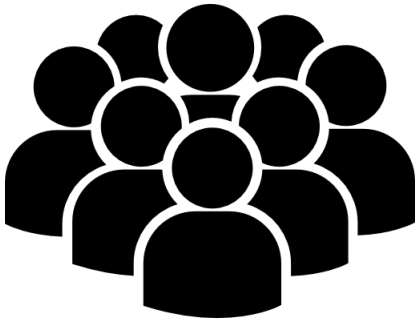
For Climate ES:
Global Climate Regulation Services



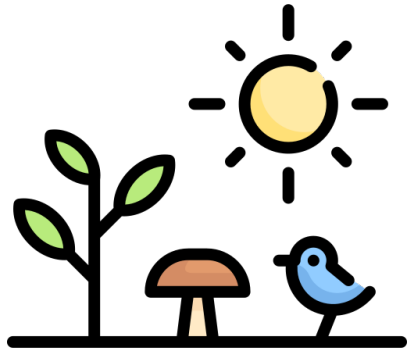
For Wood ES:
Wood Provisioning Services

Forests for…





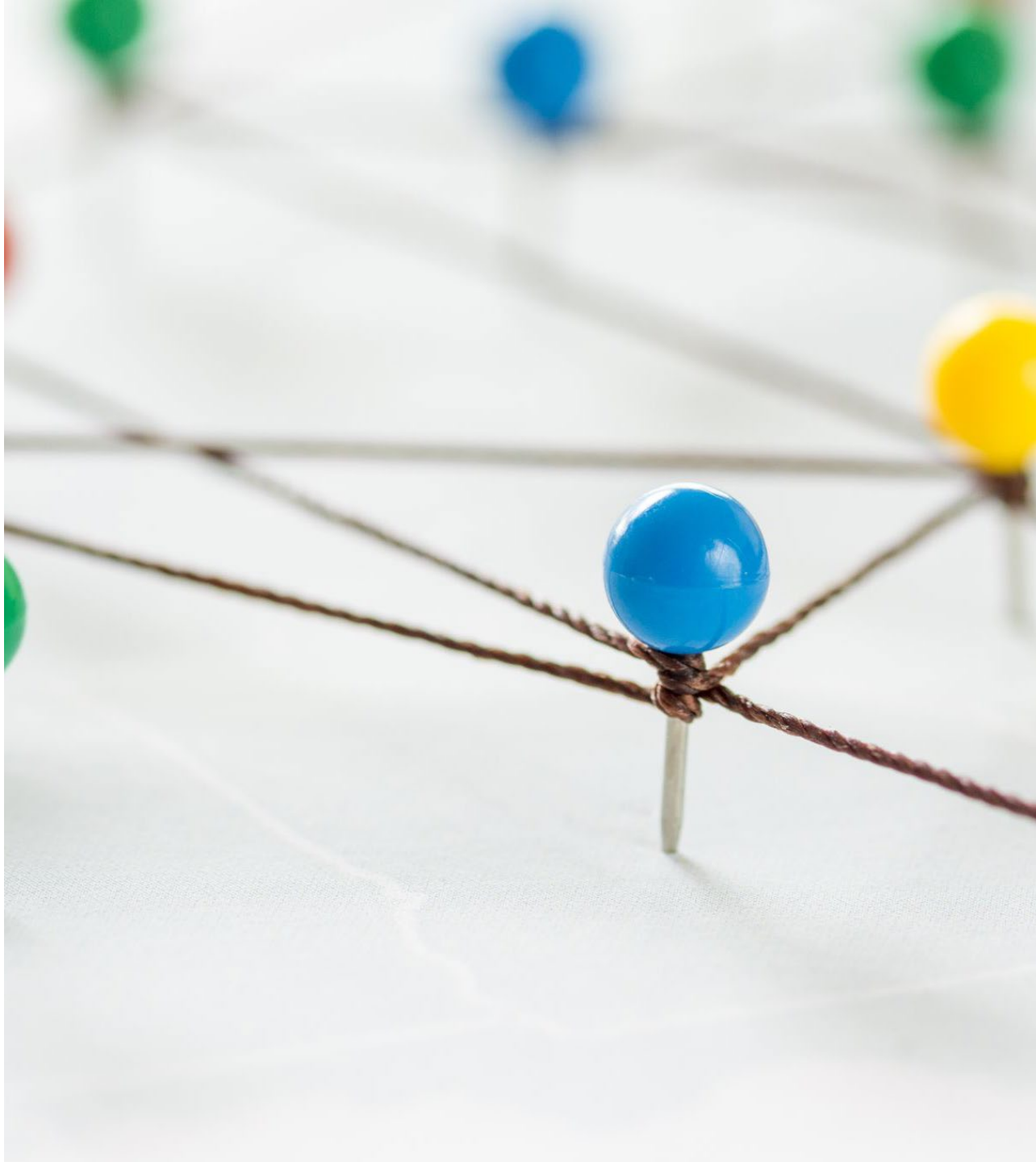
For People ES:
Recreation Related Services

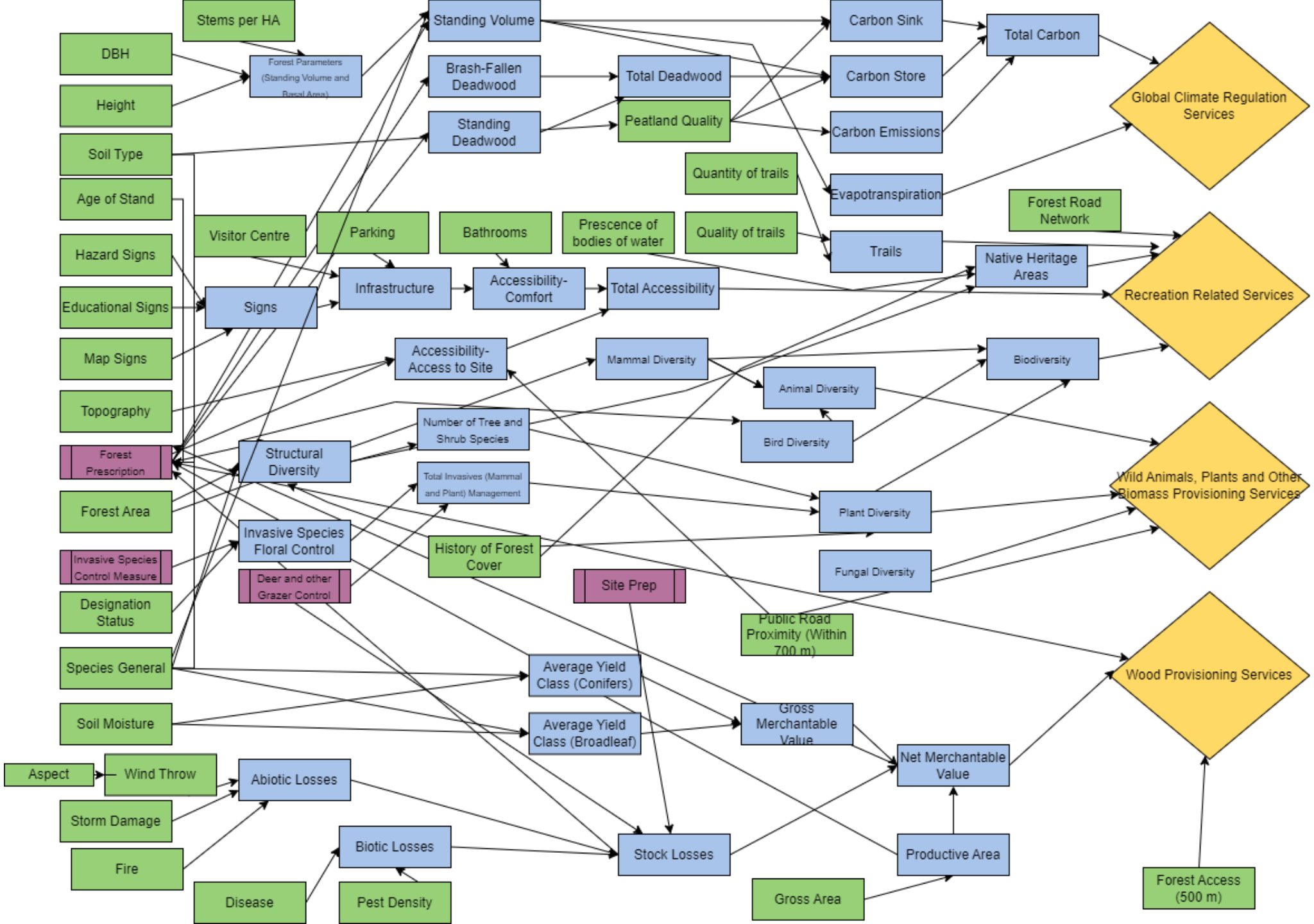


For Nature ES:
Wild animals, plants and other biomass provisioning services

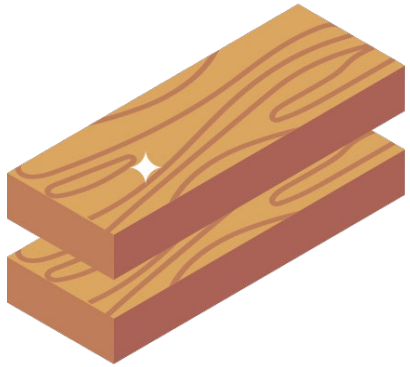
Decision Support Tool—Powered by BBN

- Bayesian Belief Network Model→ a probabilistic network depicting causal relationship between variables.
- BBNs use uncertainty, incomplete datasets, collected data and expert elicited information

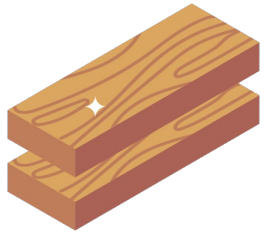



Stems per HA
DBH
Height
Forest Parameters (Standing Volume and Basal Area)
Soil Type
Age of Stand
Hazard Signs
Educational Signs
Map Signs
Topography
Forest Prescription
Forest Area
Invasive Species Control Measure
Designation Status
Species General
Soil Moisture
Aspect
Wind Throw
Storm Damage
Fire
Abiotic Losses
Disease
Biotic Losses
Pest Density
Standing Volume
Brash-Fallen Deadwood
Standing Deadwood
Total Deadwood
Peatland Quality
Visitor Centre
Parking
Bathrooms
Prescence of bodies of water
Quality of trails
Quantity of trails
Signs
Infrastructure
Accessibility-Comfort
Total Accessibility
Accessibility-Access to Site
Structural Diversity
Number of Tree and Shrub Species
Total Invasives (Mammal and Plant) Management
Invasive Species Floral Control
Deer and other Grazer Control
History of Forest Cover
Site Prep
Average Yield Class (Conifers)
Average Yield Class (Broadleaf)
Stock Losses
Gross Area
Carbon Sink
Carbon Store
Carbon Emissions
Evapotranspiration
Total Carbon
Trails
Mammal Diversity
Animal Diversity
Bird Diversity
Biodiversity
Plant Diversity
Fungal Diversity
Public Road Proximity (Within 700 m)
Gross Merchantable Value
Net Merchantable Value
Productive Area
Forest Road Network
Native Heritage Areas
Global Climate Regulation Services
Recreation Related Services
Wild Animals, Plants and Other Biomass Provisioning Services
Wood Provisioning Services
Forest Access (500 m)

For Wood ES:
Wood Provisioning Services



An Example



Wind Rowing
Absent
Present

Mounding
Absent
Present

Fertilizattion
Absent
Present

Tubing
Absent
Present

Respacing
Absent
Present

Site Prep
Low
Medium
High

Species-General
Conifer
Mix
Broadleaf

Forest Prescription
Thin_Clear ...
Extended_ ...
CCF
No_Thin_Cl...

Wild Game manage...
Low
Medium
High

Pest density
Low
Medium
High

Biotic Losses
Low
Medium
High

Total Losses (Abioti...
Low
Medium
High

Stock losses
Low
Medium
High

Volume Quality (Larger d...
Below_Avera ...
Average
Above_Aver ...

Disease
Absent
Present

Abiotic Losses
Low
Medium
High

Storm Damage
Absent
Present

Net Merchantable V...
Low_7_13 ...
Mid_14_19...
High_20cm

Wood Provisioning
High
Medium
Low

Average Yield class (Conifers)
Low (6..12 ...
Mid (12.1.. ...
High (18.1.....

Gross Merchantabl...
Low (0..8)
Mid (8..14)
High (14..20)

Wind Throw
Absent
Present

Fire
Absent
Present

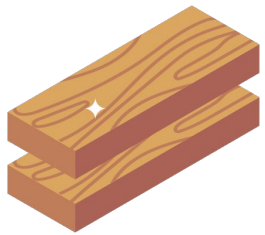
Productive Area
Low
Medium
High

Soil Moisture
Wet
Medium
Dry

Average Yield class (Broadleaves)
Low (4..8)
Mid (8..12)
High (12..14)

Gross Area
Low
Medium
High

Forest Access (500 m)
Absent
Present



Wind Rowing
Absent
Present
Mounding
Absent
Present
Fertilizattion
Absent
Present
Tubing
Absent
Present
Respacing
Absent
Present
Site Prep
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Volume Quality (Larger d...
Below_Avera ...
Average
Above_Aver ...
Disease
Absent
Present
Abiotic Losses
Low
Medium
High
Storm Damage
Absent
Present
Wind Throw
Absent
Present
Fire
Absent
Present
Net Merchantable V...
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Mid_14_19...
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Gross Merchantabl...
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Medium
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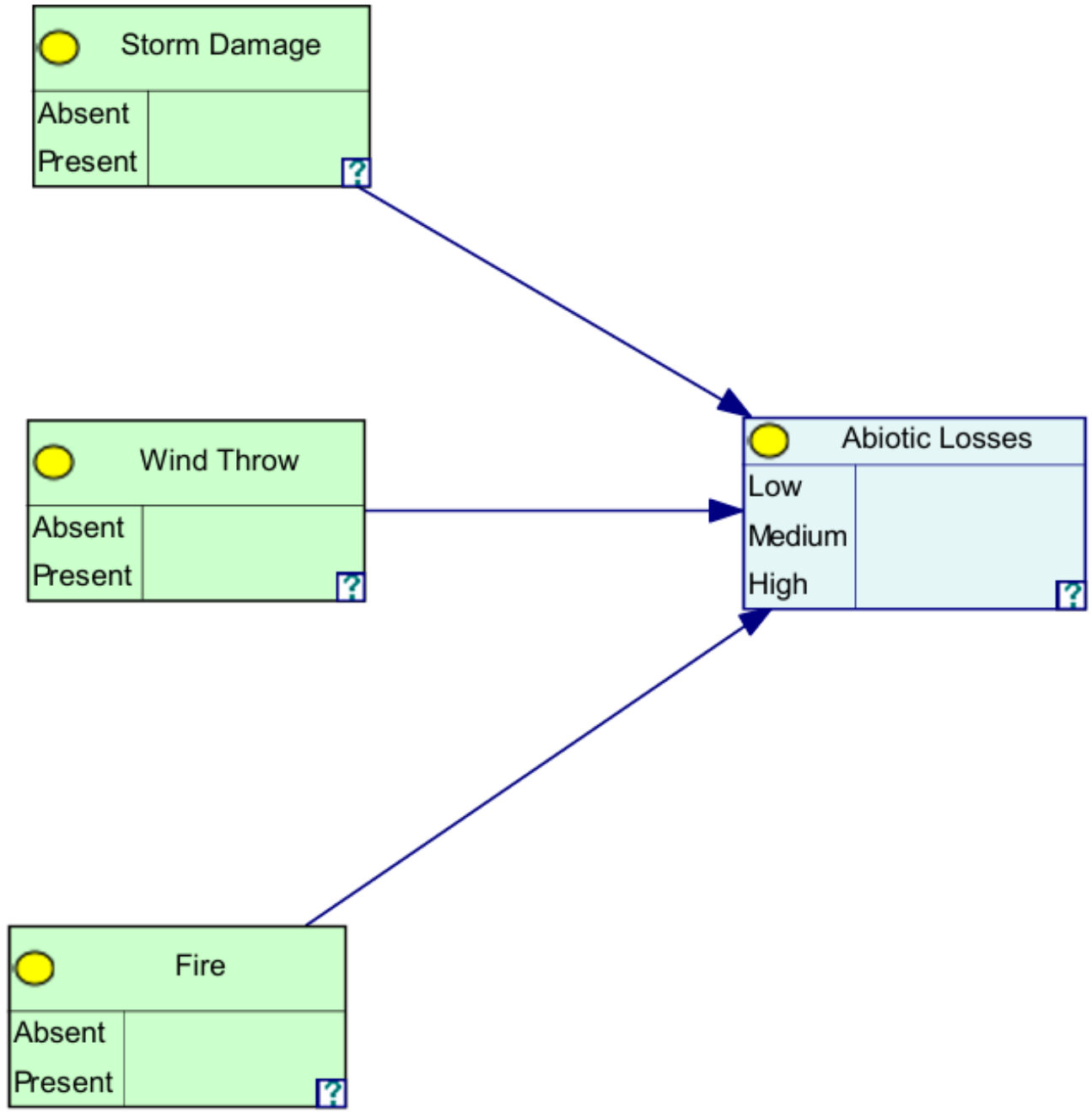
Wet
Medium
Dry
Average Yield class (Broadleaves)
Low (4..8)
Mid (8..12)
High (12..14)
Gross Area
Low
Medium
High
Forest Access (500 m)
Absent
Present


Storm Damage
Absent
Present
Wind Throw
Absent
Present
Fire
Absent
Present
Abiotic Losses
Low
Medium
High

Probability Table

Storm Damage		Absent				Present			
Wind Throw		Absent		Present		Absent		Present	
Fire		Absent	Present	Absent	Present	Absent	Present	Absent	Present
Abiotic Losses	High								
	Med								
	Low								

Probability Table

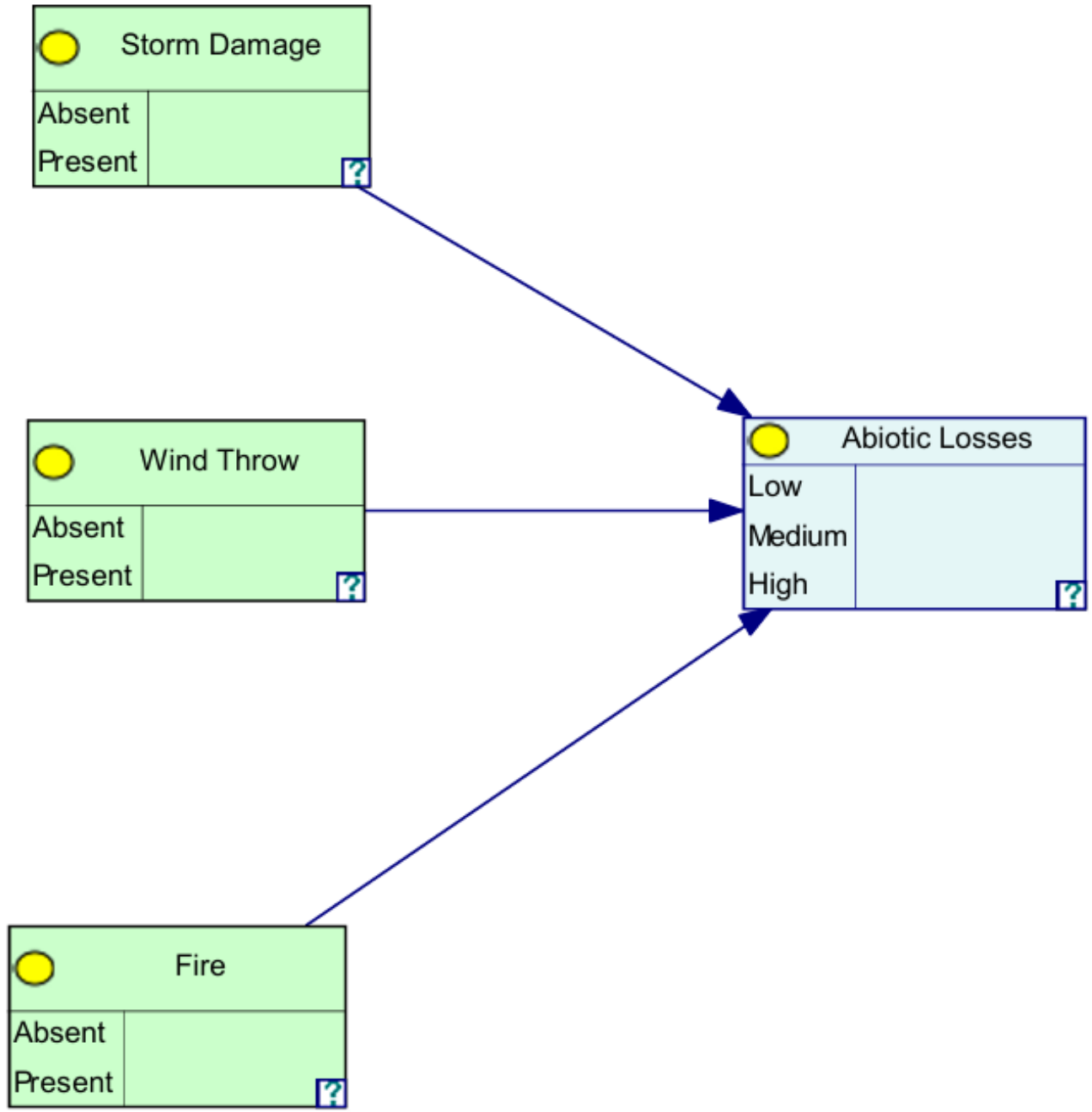
Storm Damage		Absent				Present			
Wind Throw		Absent		Present		Absent		Present	
Fire		Absent	Present	Absent	Present	Absent	Present	Absent	Present
Abiotic Losses	High	0							
	Med	0							
	Low	1							

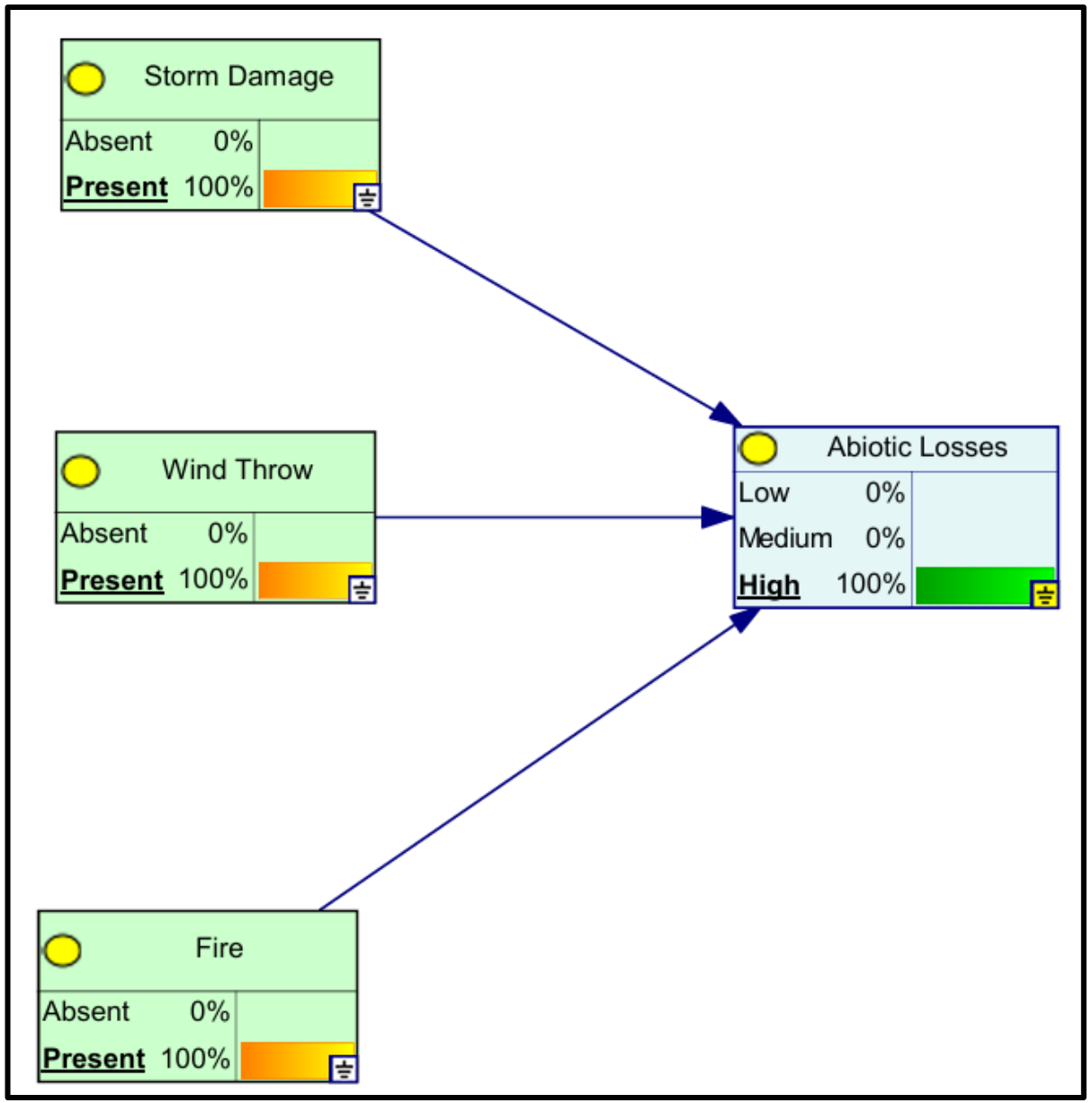
Probability Table

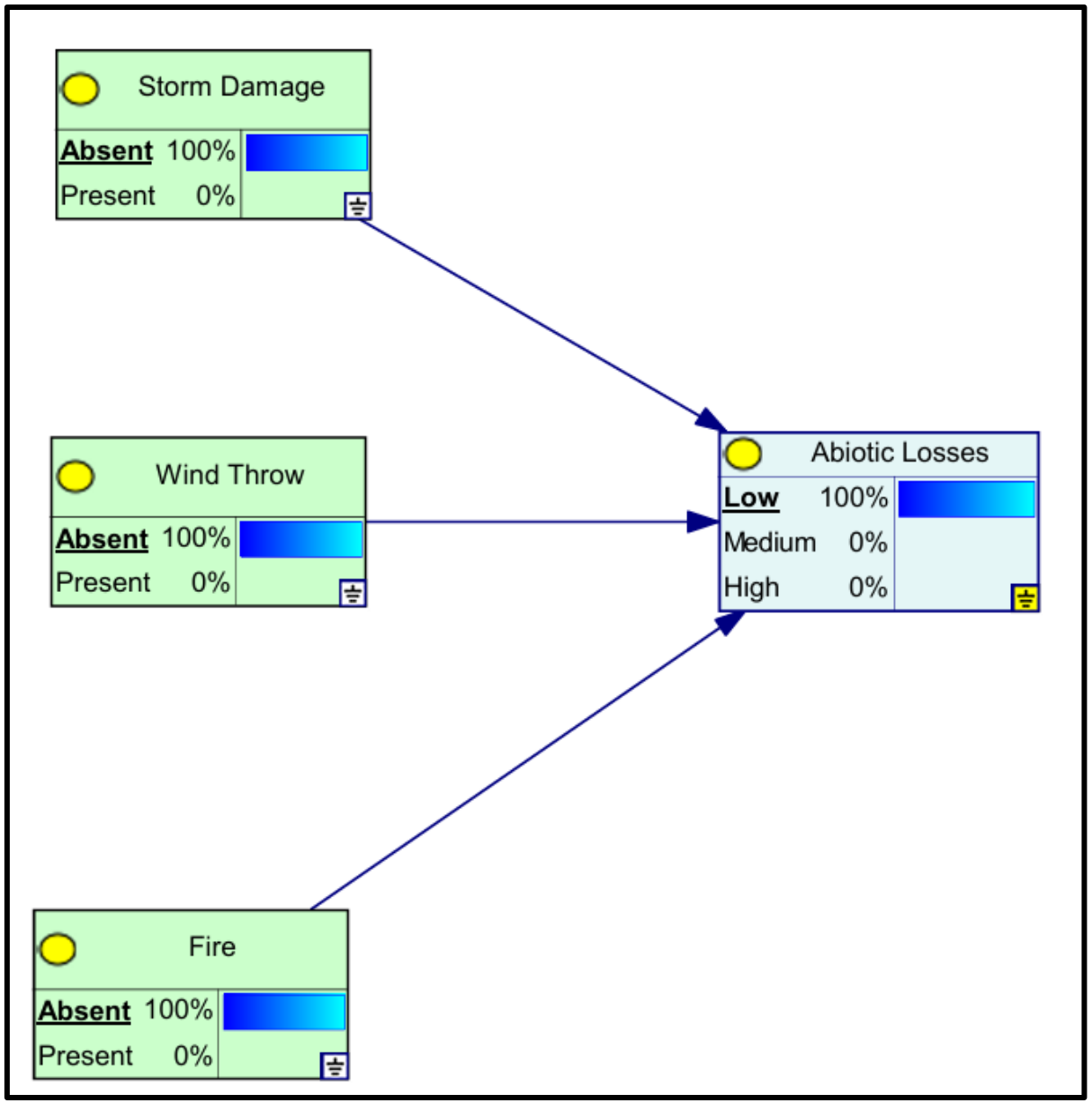
Storm Damage		Absent				Present			
Wind Throw		Absent		Present		Absent		Present	
Fire		Absent	Present	Absent	Present	Absent	Present	Absent	Present
Abiotic Losses	High	0	0	0.1	0.2	0.35	0.65	0.75	0.9
	Med	0	0.1	0.15	0.25	0.45	0.3	0.25	0.1
	Low	1	0.9	0.75	0.55	0.2	0.05	0	0

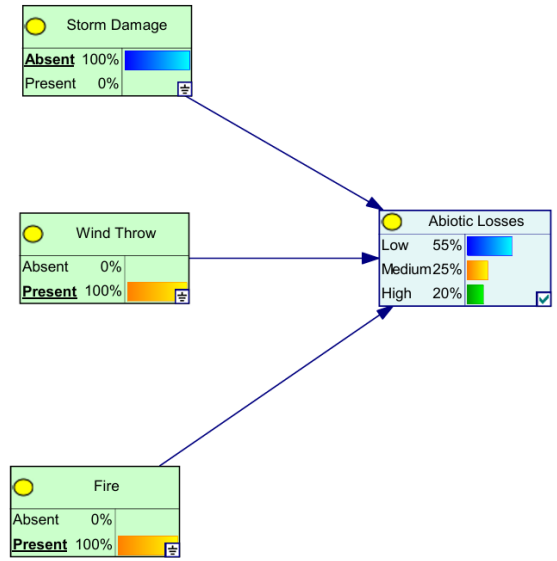
Confidence Table

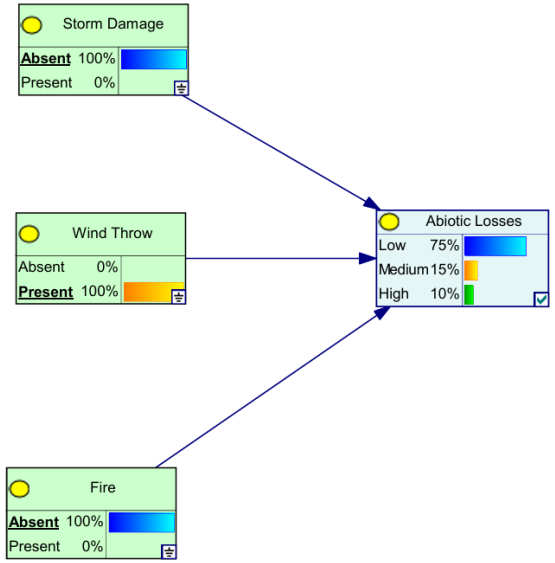
Storm Damage		Absent				Present			
Wind Throw		Absent		Present		Absent		Present	
Fire		Absent	Present	Absent	Present	Absent	Present	Absent	Present
Abiotic Losses	High	1	.8	.7	.75	.9	.75	.75	.9
	Med	.5	.5	.6	.6	.5	.75	.8	.8
	Low	.8	.8	.7	.7	.8	.8	.9	1

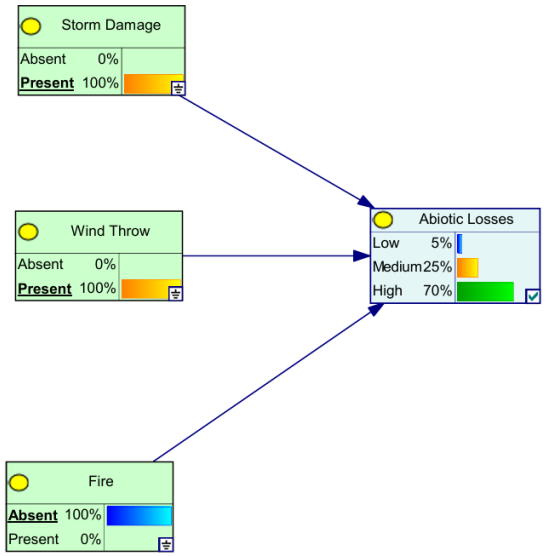

Storm Damage
Absent
Present
Wind Throw
Absent
Present
Fire
Absent
Present
Abiotic Losses
Low
Medium
High

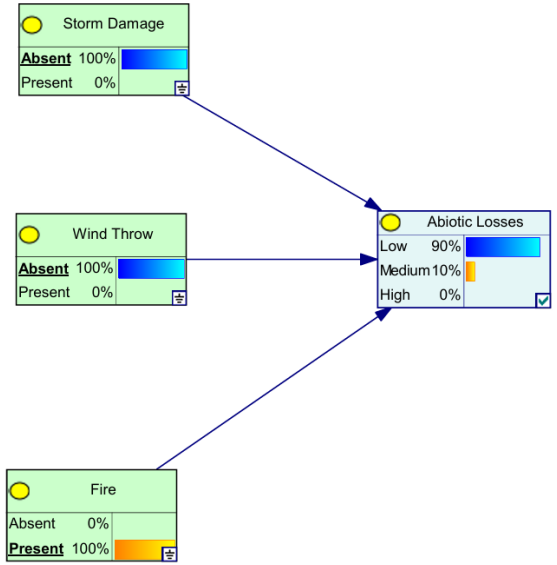

Storm Damage
Absent 0%
Present 100%
Wind Throw
Absent 0%
Present 100%
Fire
Absent 0%
Present 100%
Abiotic Losses
Low 0%
Medium 0%
High 100%

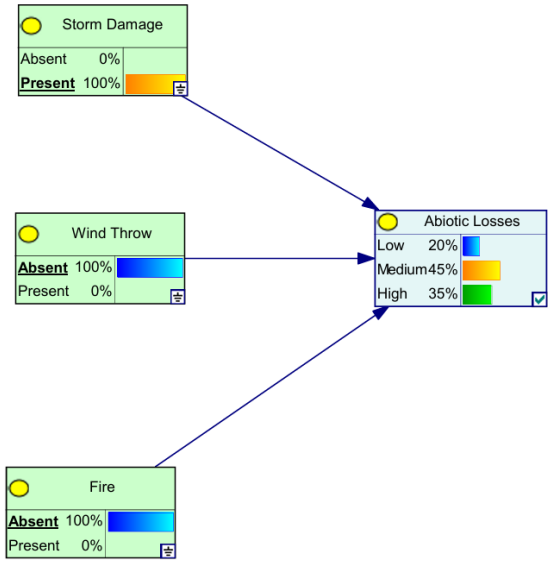

Storm Damage
Absent 100%
Present 0%
Wind Throw
Absent 100%
Present 0%
Fire
Absent 100%
Present 0%
Abiotic Losses
Low 100%
Medium 0%
High 0%

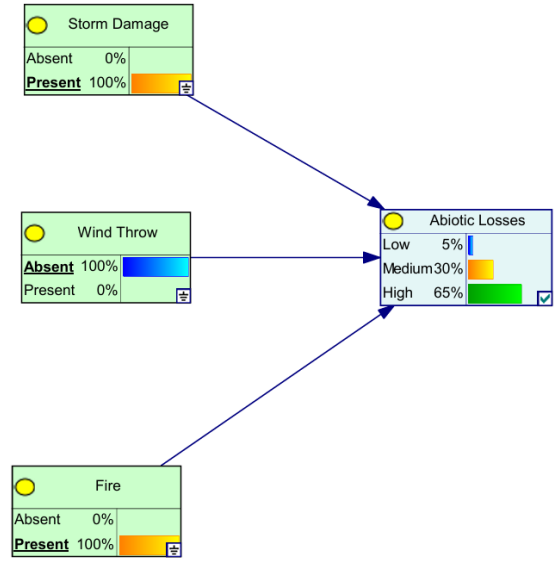

Storm Damage
Absent 100%
Present 0%
Wind Throw
Absent 0%
Present 100%
Fire
Absent 0%
Present 100%
Abiotic Losses
Low 55%
Medium 25%
High 20%

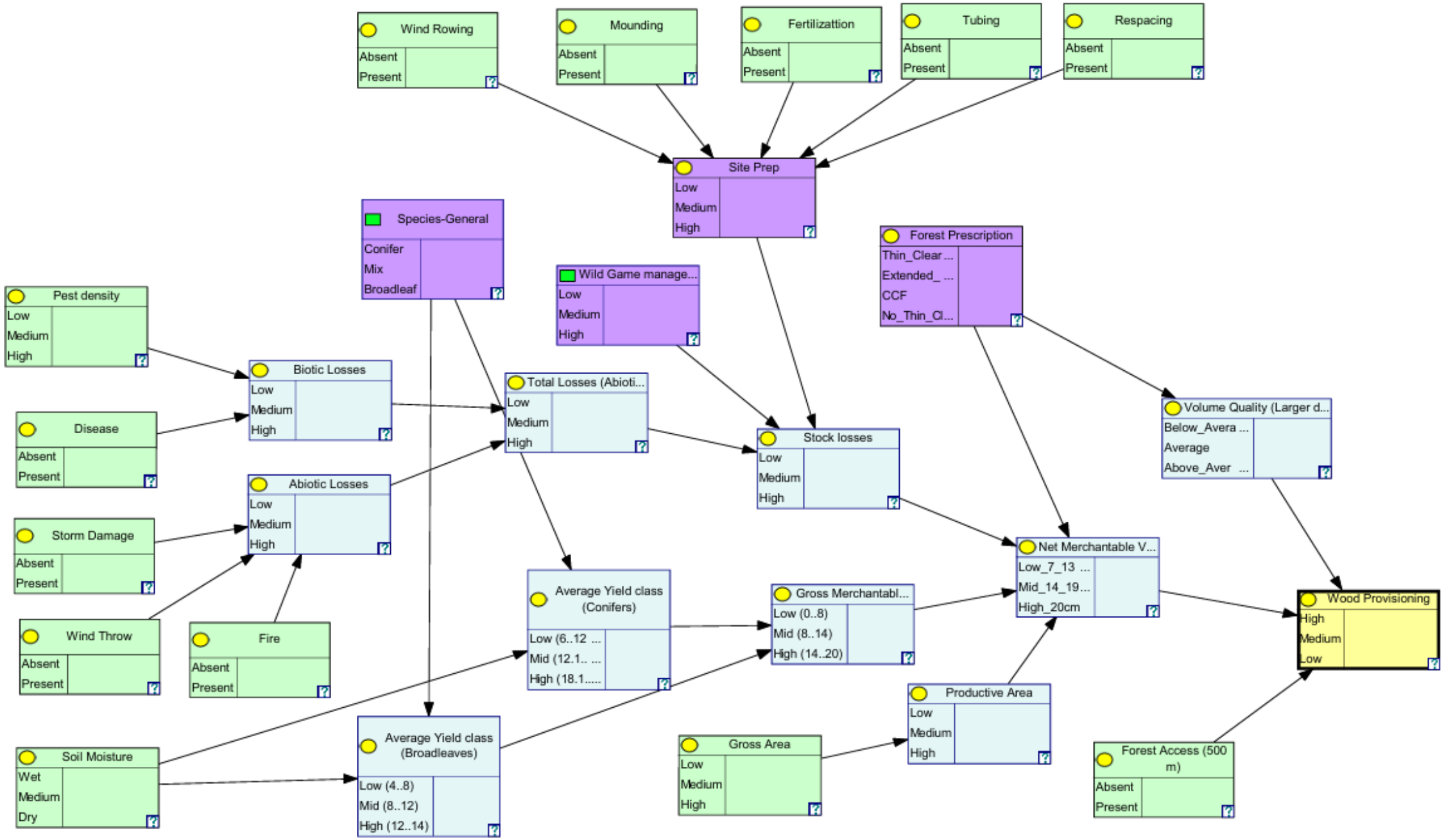

Storm Damage
Absent 100%
Present 0%
Wind Throw
Absent 0%
Present 100%
Fire
Absent 100%
Present 0%
Abiotic Losses
Low 75%
Medium 15%
High 10%

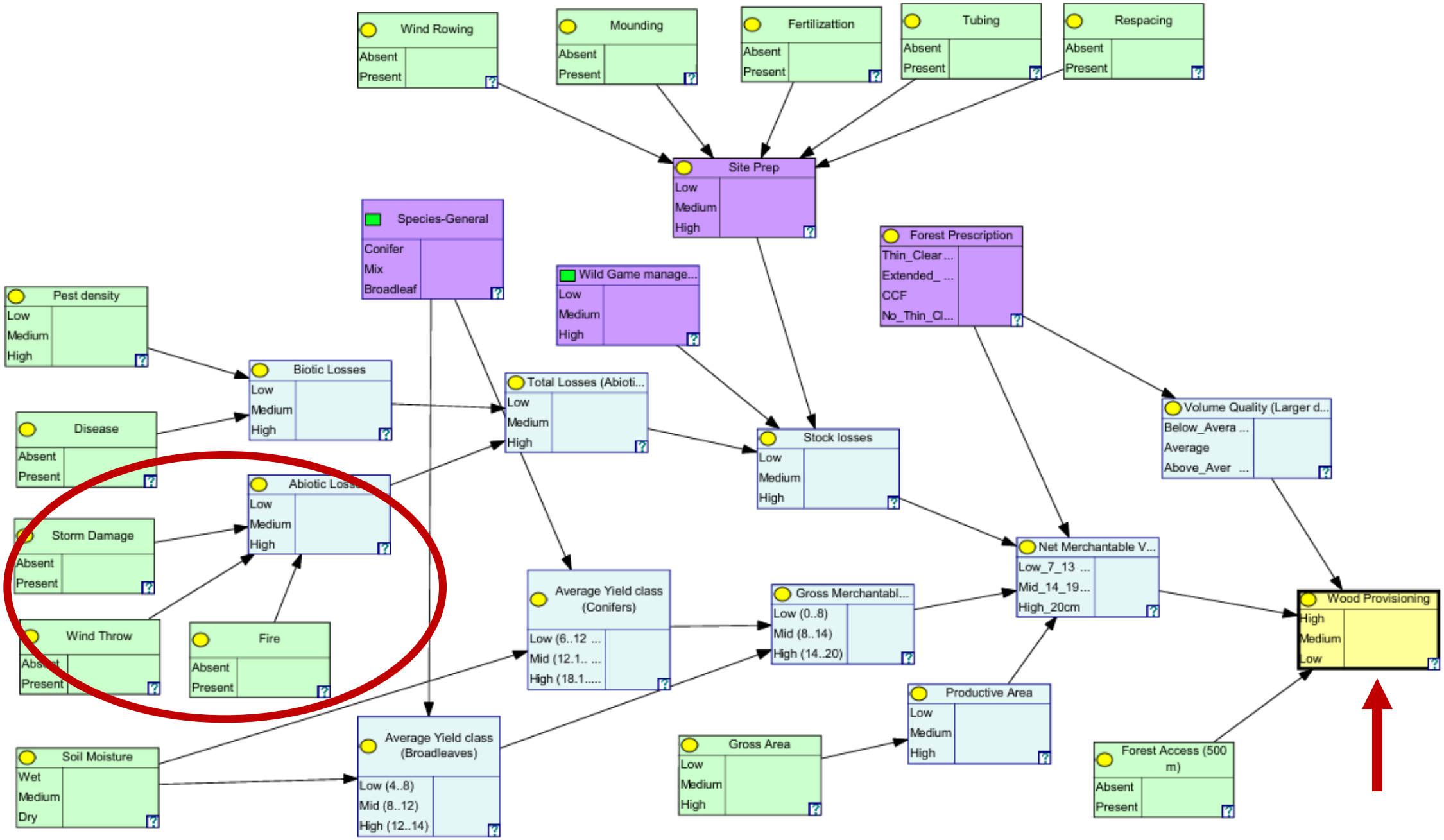

Storm Damage
Absent 0%
Present 100%
Wind Throw
Absent 0%
Present 100%
Fire
Absent 100%
Present 0%
Abiotic Losses
Low 5%
Medium 25%
High 70%


Storm Damage
Absent 100%
Present 0%
Wind Throw
Absent 100%
Present 0%
Fire
Absent 0%
Present 100%
Abiotic Losses
Low 90%
Medium 10%
High 0%


Storm Damage
Absent 0%
Present 100%
Wind Throw
Absent 100%
Present 0%
Fire
Absent 100%
Present 0%
Abiotic Losses
Low 20%
Medium 45%
High 35%


Storm Damage
Absent 0%
Present 100%
Wind Throw
Absent 100%
Present 0%
Fire
Absent 0%
Present 100%
Abiotic Losses
Low 5%
Medium 30%
High 65%


Wind Rowing
Absent
Present
Mounding
Absent
Present
Fertilizattion
Absent
Present
Tubing
Absent
Present
Respacing
Absent
Present
Site Prep
Low
Medium
High
Species-General
Conifer
Mix
Broadleaf
Wild Game manage...
Low
Medium
High
Forest Prescription
Thin_Clear ...
Extended_ ...
CCF
No_Thin_Cl...
Pest density
Low
Medium
High
Biotic Losses
Low
Medium
High
Total Losses (Abioti...
Low
Medium
High
Stock losses
Low
Medium
High
Volume Quality (Larger d...
Below_Avera ...
Average
Above_Aver ...
Disease
Absent
Present
Abiotic Losses
Low
Medium
High
Storm Damage
Absent
Present
Net Merchantable V...
Low_7_13 ...
Mid_14_19...
High_20cm
Wood Provisioning
High
Medium
Low
Average Yield class (Conifers)
Low (6..12 ...
Mid (12.1.. ...
High (18.1.....
Gross Merchantabl...
Low (0..8)
Mid (8..14)
High (14..20)
Wind Throw
Absent
Present
Fire
Absent
Present
Productive Area
Low
Medium
High
Soil Moisture
Wet
Medium
Dry
Average Yield class (Broadleaves)
Low (4..8)
Mid (8..12)
High (12..14)
Gross Area
Low
Medium
High
Forest Access (500 m)
Absent
Present


Wind Rowing
Absent
Present
Mounding
Absent
Present
Fertilizattion
Absent
Present
Tubing
Absent
Present
Respacing
Absent
Present
Site Prep
Low
Medium
High
Species-General
Conifer
Mix
Broadleaf
Wild Game manage...
Low
Medium
High
Forest Prescription
Thin_Clear ...
Extended_ ...
CCF
No_Thin_Cl...
Pest density
Low
Medium
High
Biotic Losses
Low
Medium
High
Total Losses (Abioti...
Low
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Stock losses
Low
Medium
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Volume Quality (Larger d...
Below_Avera ...
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Above_Aver ...
Disease
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Medium
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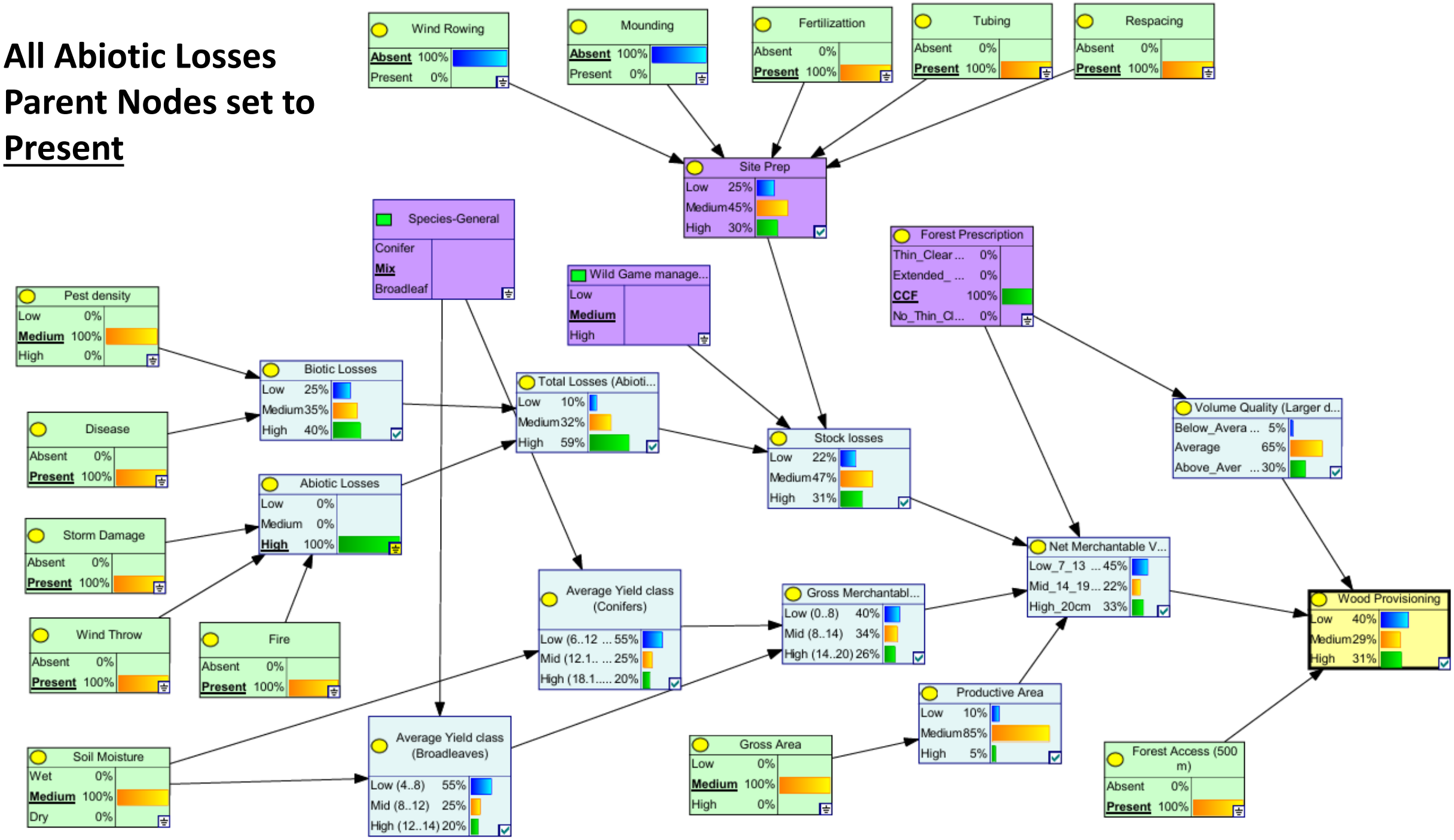
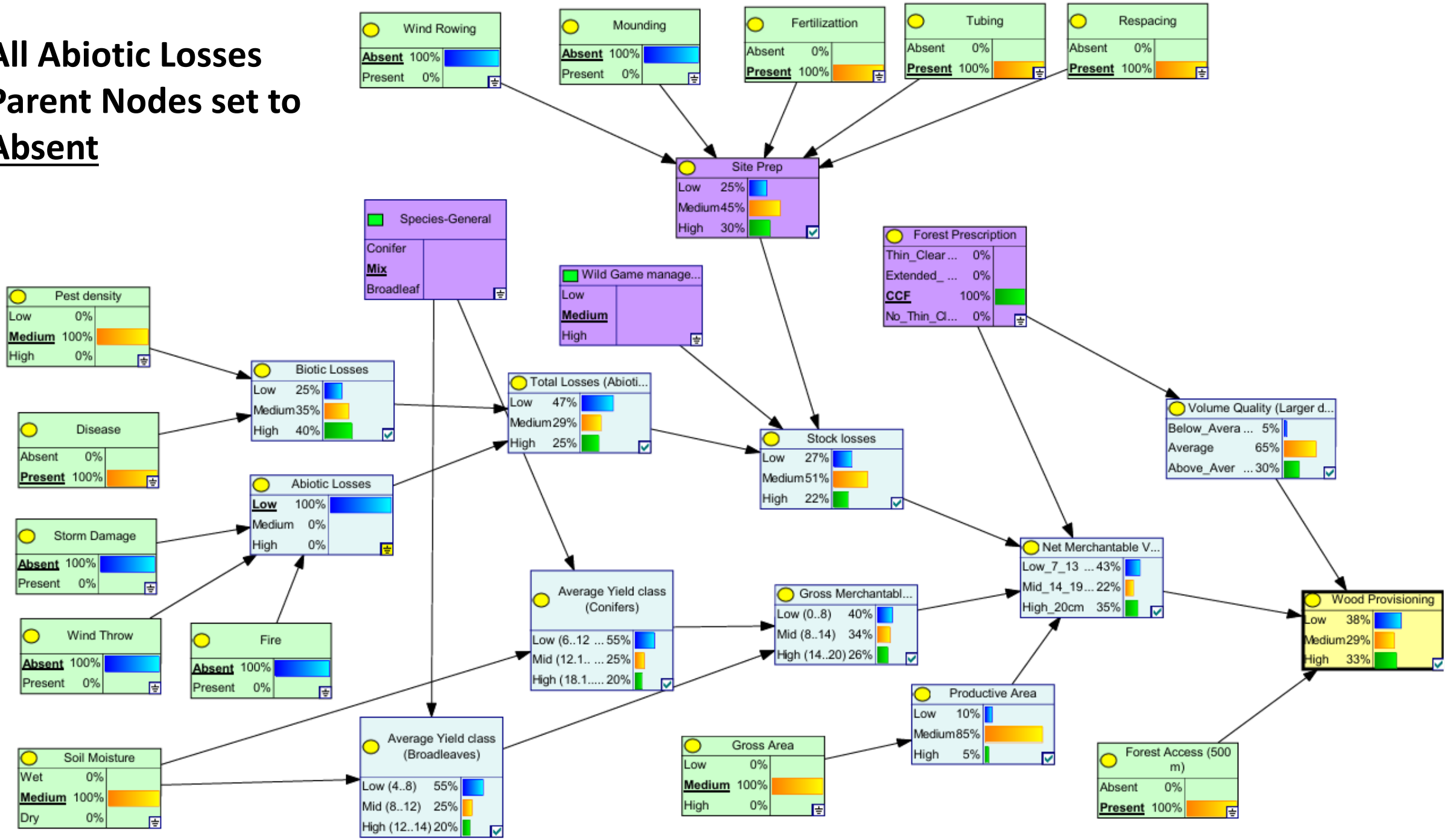
Soil Moisture
Wet
Medium
Dry
Average Yield class (Broadleaves)
Low (4..8)
Mid (8..12)
High (12..14)
Gross Area
Low
Medium
High
Forest Access (500 m)
Absent
Present

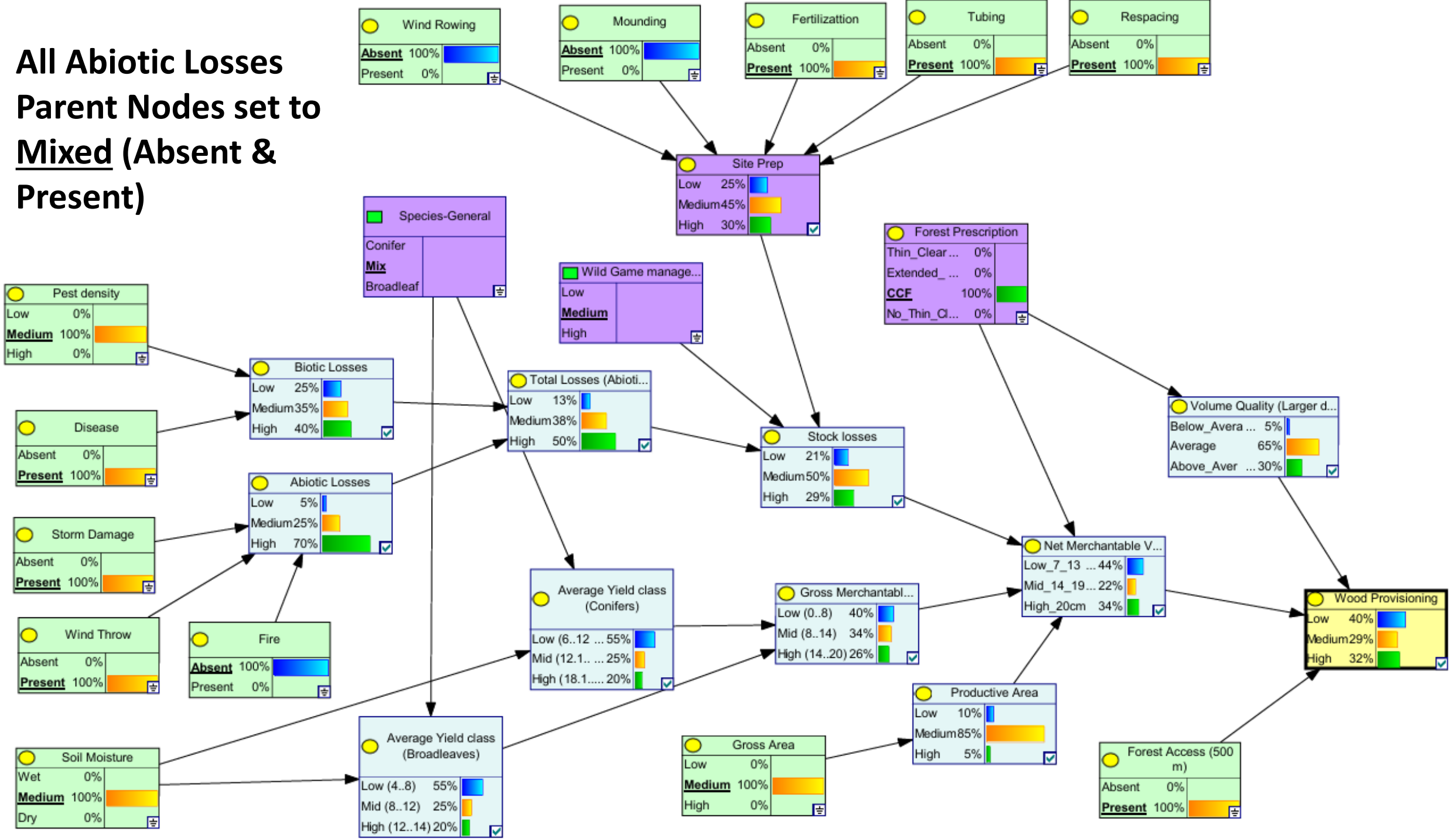
All Abiotic Losses Parent Nodes set to Present



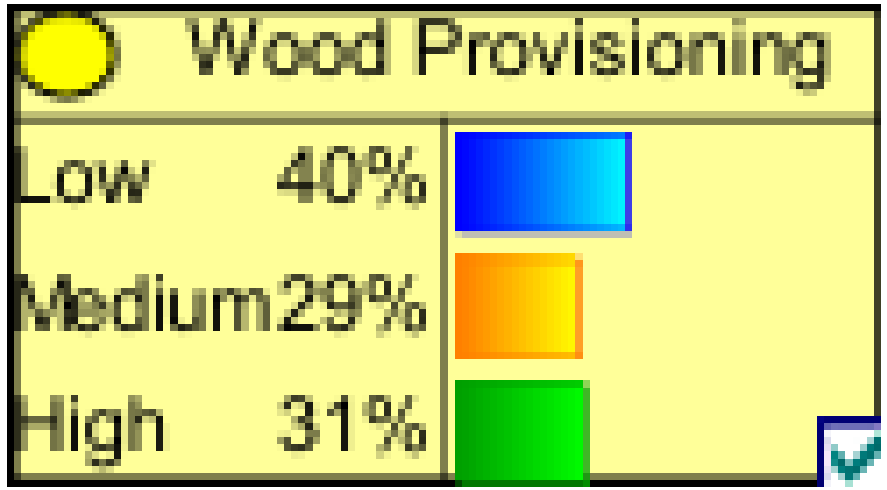
All Abiotic Losses Parent Nodes set to Absent



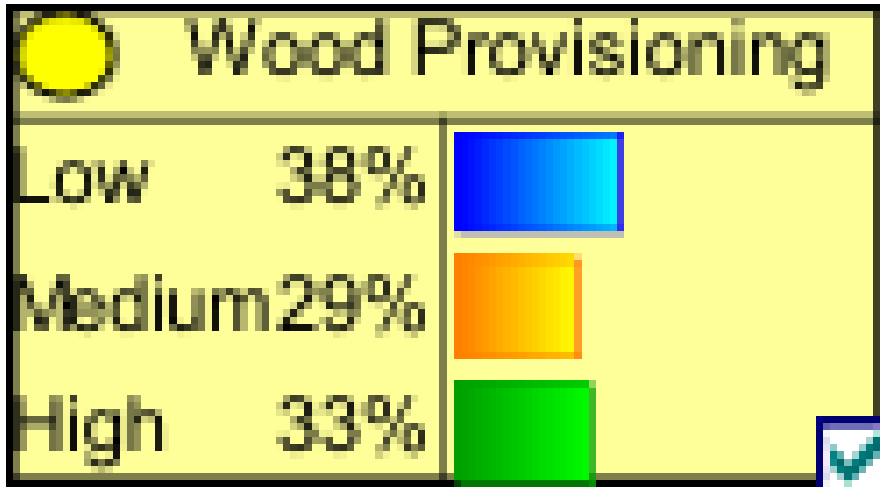
All Abiotic Losses Parent Nodes set to Mixed (Absent & Present)



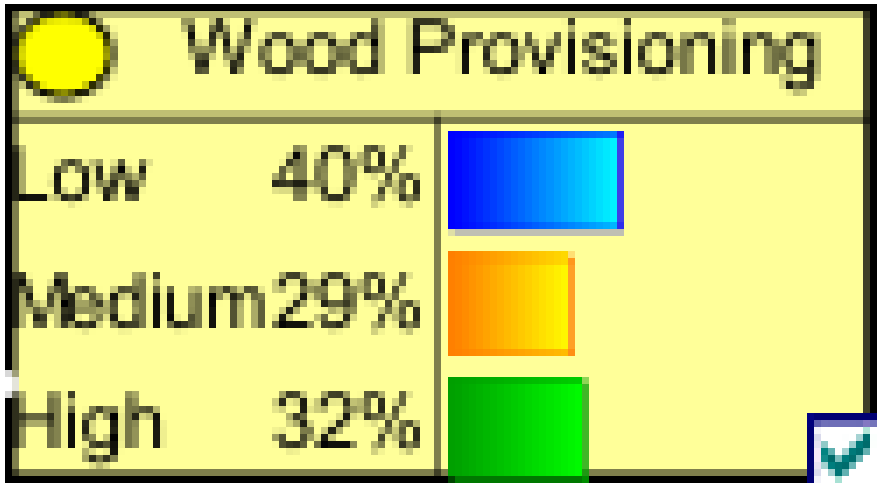
Final ES for All Absent



Final ES for All Present



Final ES for Mixed



Decision Support Tool

Ecosystem Service Toolkit

Home

All Services

About the Model | Input Parameters | Scenario Comparison

This comprehensive model combines multiple ecosystem services, providing a holistic perspective on how forest areas contribute to climate regulation, biodiversity, recreation, and wood provisioning. By integrating these services, the model supports informed decision-making, enabling managers to balance diverse forest functions and ensure sustainable management that meets environmental, social, and economic goals.

Global climate regulation services:

Global climate regulation services are the ecosystem contributions to reducing concentrations of GHG in the atmosphere through the removal (sequestration) of carbon from the atmosphere and the retention (storage) of carbon in ecosystems. These services support the regulation of the chemical composition of the atmosphere and oceans. This is a final ecosystem service.

Wild animals, plants and other biomass provisioning services:

Wild animals, plants and other biomass provisioning services are the ecosystem contributions to the growth of wild animals, plants and other biomass that are captured and harvested in uncultivated production contexts by economic units for various uses. The scope includes non-wood forest products (NWFP) and services related to hunting, trapping and bio-prospecting activities; but excludes wild fish and other natural aquatic biomass (included in previous class). This is a final ecosystem service.

Recreation-related services:

Recreation-related services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, that enable people to use and enjoy the environment through direct, in-situ, physical and experiential interactions with the environment. This includes services to both locals and non-locals (i.e., visitors, including tourists). Recreation-related services may also be supplied to those undertaking recreational fishing and hunting. This is a final ecosystem service.

Wood Provisioning Services:

Wood provisioning services are the ecosystem contributions to the growth of trees and other woody biomass in both cultivated (plantation) and uncultivated production contexts that are harvested by economic units for various uses including timber production and energy. This service excludes contributions to non-wood forest products. This is a final ecosystem service.

About the Model | Input Parameters

Upload Scenario Inputs

Browse... No file selected

Input parameters

Soil Type ?

○ Mineral ◉ Organic ○ Mineral_Organic

Forest Access (within 500 m) ?

◉ Absent ○ Present

Wild Game management ?

◉ Low ○ Medium ○ High

Felling Prescription ?

○ NoThin_ClearFell ◉ Thin_ClearFell ○ CCF

○ ExtendedRotation ○ Other

Productive Area ?

About the Model | Input Parameters

Upload Scenario Inputs

Browse... No file selected

Input parameters

Soil Type ?

○ Mineral ◉ Organic ○ Mineral_Organic

Forest Access (within 500 m) ?

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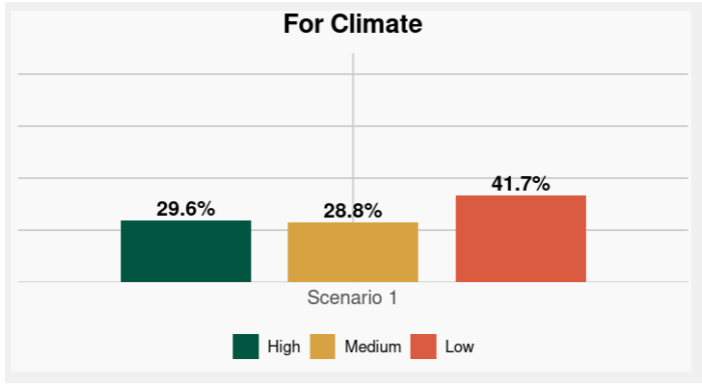
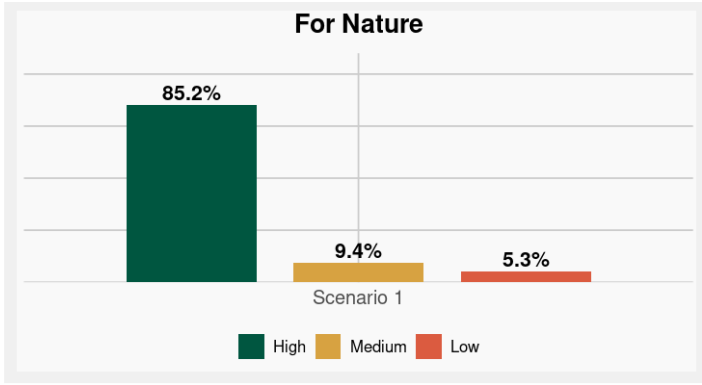
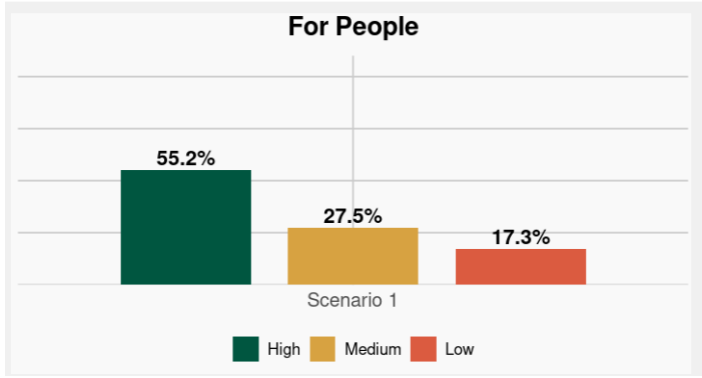
○ NoThin_ClearFell ◉ Thin_ClearFell ○ CCF

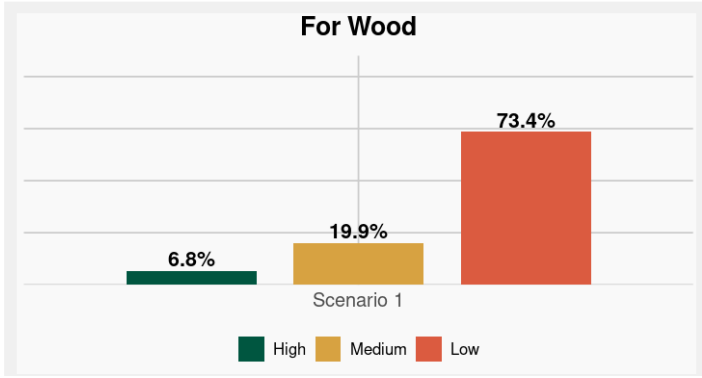
○ ExtendedRotation ○ Other

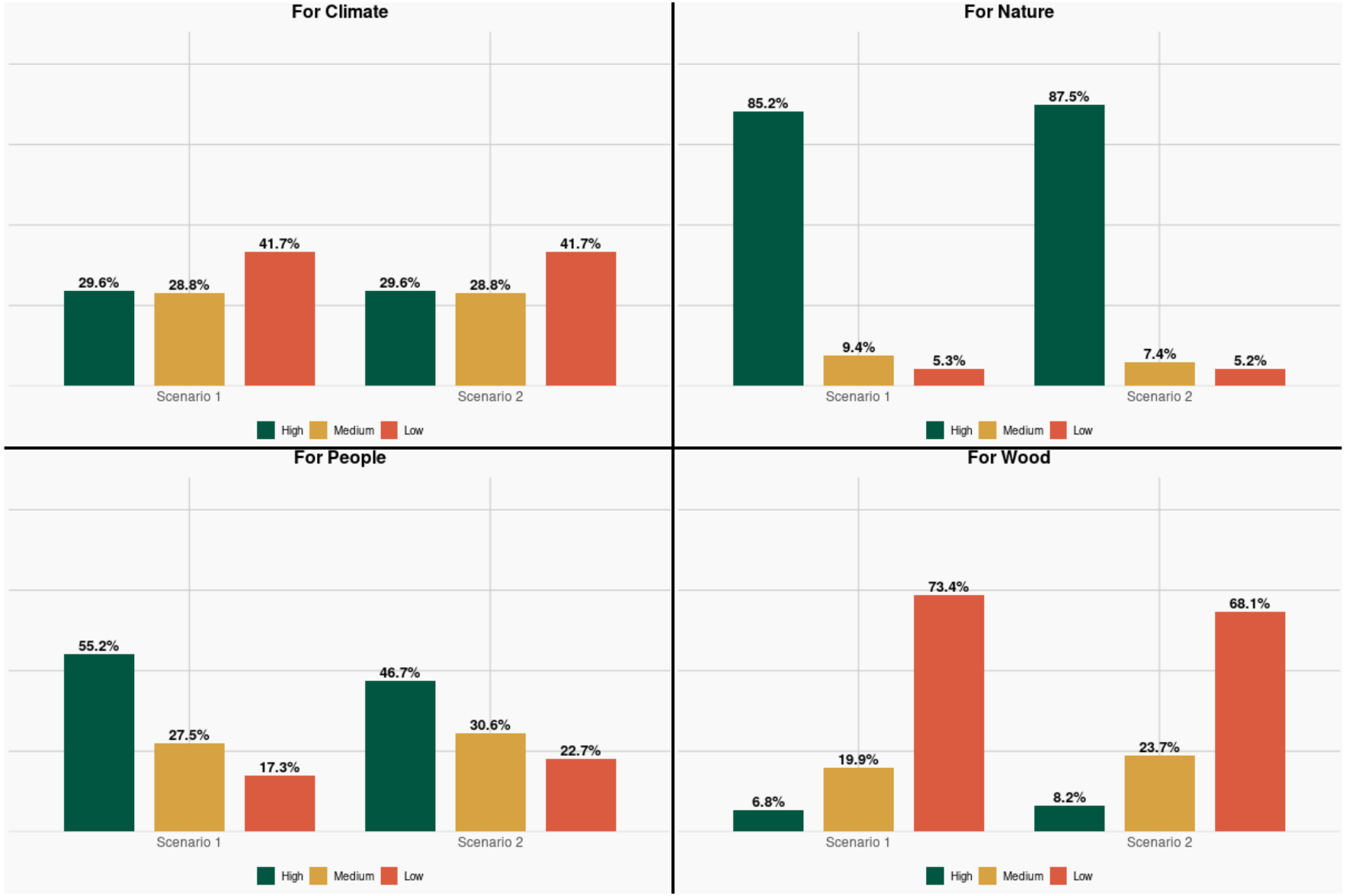
Productive Area ?







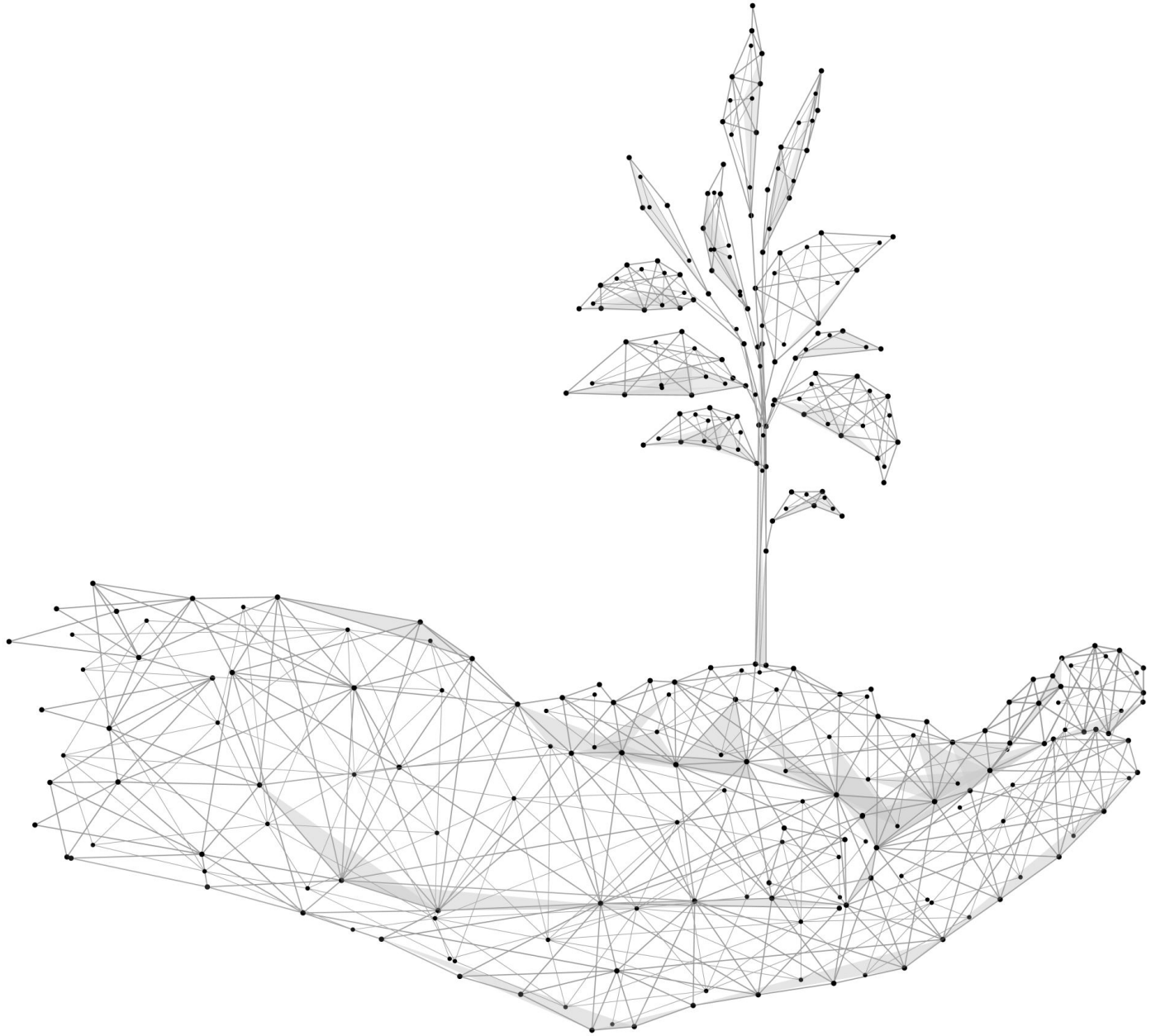



For Climate
29.6%
28.8%
41.7%
29.6%
28.8%
41.7%
Scenario 1
Scenario 2
High
Medium
Low
For Nature
85.2%
9.4%
5.3%
87.5%
7.4%
5.2%
Scenario 1
Scenario 2
High
Medium
Low
For People
55.2%
27.5%
17.3%
46.7%
30.6%
22.7%
Scenario 1
Scenario 2
High
Medium
Low
For Wood
6.8%
19.9%
73.4%
8.2%
23.7%
68.1%
Scenario 1
Scenario 2
High
Medium
Low

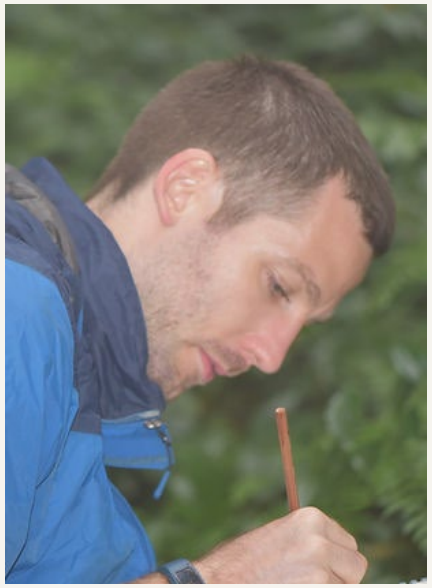
	Variable	Scenario 1	Scenario 2
1	**Soil Type**	Organic	Organic
2	**Forest Access (within 500 m)**	Absent	Absent
3	**Wild Game management**	Low	Low
4	**Felling Prescription**	Thin_ClearFell	Thin_ClearFell
5	**Productive Area**	Mid	Mid
6	**Soil Moisture**	Medium	Medium
7	**Aspect**	Low	**Medium**
8	**Storm Damage**	Medium	Medium
9	**Species General**	Conifer	**Broadleaf**
10	**Fire**	Low	**Medium**
11	**Disease**	Low	Low
12	**Pest Density**	Low	Low
13	**Road Proximity (Within 700m)**	Present	Present
14	**DBH**	High	**Medium**
15	**Height**	High	High
16	**Stems per HA**	Medium	**High**

Next Steps

- Finalize BBNs
  - Private
  - Public
- Create Lit Values BBNs
- Decision Support Tool
- Fact check BBNs






- **ForES Team**
- **DAFM**
- **Coillte and Private Stakeholders**

UCD DUBLIN

COILLTE nature

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

FORES