Assessment and monitoring of the health status of the Talassemtane fir forest (Western Rif, Morocco)

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Appendices

Appendix 1

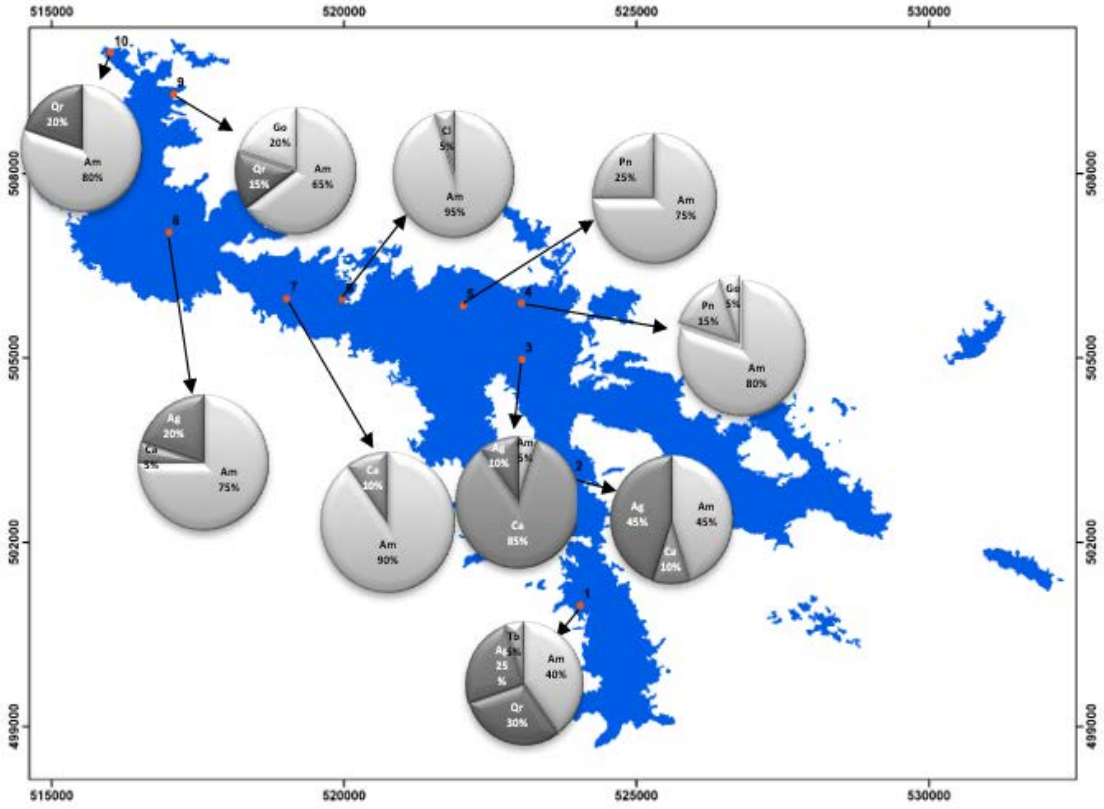

Figure. Frequency distribution of woody species present in the ten study plots.

Am: *Abies marocana*; Ag: *Acer granatense*; Cl: *Crataegus laciniata*; JO: *Juniperus oxycedrus*; Qr: *Quercus rotundifolia*; Ca: *Cedrus atlantica*; Pn: *Pinus mauretanica*, Tb: *Taxus baccata*.

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Appendix 2

Table. Stand types with composition and species abundance in the studied plots.

Stand type	Plots	Abundance and species composition								
		Am	Ca	Ag	Qr	Pn	Jo	Tb	Cl	
Pure Am	2	9	2	9						
	6	19								1
	7	18	2							
	8	15	1	4						
Mixed Am–Ca	3	1	17	2						
Mixed Am–Qr	1	8		5	6			1		
	9	13			3		4			
	10	16			4					
Mixed Am–Pn–Pm	5	15				5				
	4	16				3	1			

Am. *Abies marocana*; Ag. *Acer granatense*; Cl. *Crataegus laciniata*; JO. *Juniperus oxycedrus*; Qr. *Quercus rotundifolia*; Ca: *Cedrus atlantica*; Pn: *Pinus mauretanica*, Tb. *Taxus baccata*.

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Appendix 2

Table. Mean values and standard deviations of trees showing defoliation less than 25% or more than 25% following four environmental variables.

	Defoliation < 25 %		**Defoliation > 25 %**	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Altitude (m a.s.l.)				
1500 – 1700	6	6.11	0.5	0.71
1700 – 1800	5.5	1.18	2	0.82
Slope (%)				
10 – 20	4.3	2.75	0.4	0.7
21 -30	8.9	5.17	0.6	0.96
31 – 40	4.4	2.1	1.4	1.51
Aspect				
North	5.4	2.32	0.4	0.7
Northwest	5.4	2.32	0.4	0.7
Southeast	3.4	1.17	1	1.16
East	1.7	0.68	0.5	0.27
Northeast	1.7	0.68	0.1	0.32
Stand type				
Mixed Am–Qr	1.7	0.68	1.2	1.03
Pure Am	7.2	2.97	0.6	0.7
Mixed Am–Ca	5.2	2.86	0.3	0.48
Mixed Am–Pn–Pm	3.5	2.27	0.3	0.48

Am. *Abies marocana*; Qr. *Quercus rotundifolia*; Ca: *Cedrus atlantica*; Pn: *Pinus mauretanica*, Pm. *P. maghribiana.*

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Appendix 4

Table. Symptoms and damages shown in *A. marocana*, other conifers, and broadleaved trees. The score "0" means the presence of traces.

	Affected part	Symptoms	Score	Number of trees affected	Total
Conifers	Needles	Abnormal coloring (Red/Brown)	0	57	74
			1	15	
			2	2	
		Consumption	0	13	14
			1	1	
		Microphyllia	0	2	4
			1	2	
	Branches	Break	0	4	5
			1	1	
		Deformation	0	3	4
			1	1	
		Peeling bark	0	1	3
			1	2	
	Trunk	Wound	0	10	12
			1	2	
		Resin flow	0	3	4
			1	1	
		Barking	0	1	4
			1	3	
Broadleaved trees	Leaves	Abnormal coloring (Red/Brown)	0	9	14
			1	4	
			2	1	
		Consumption	0	16	19
			1	3	
		Microphyllia	0	1	1
			1	0	
	Branches	Break	0	1	2
			1	1	
		Deformation	0	1	1
			1	0	
		Peeling bark	0	0	0
			1	0	
	Trunc	Wound	0	5	6
			1	1	
		Resin flow	0	0	0
			1	0	
		Barking	0	1	1
			1	0	
A. marocana	Needles	Abnormal coloring (Red/Brown)	0	42	54
			1	11	
			2	1	
		Consumption	0	9	10
			1	1	
		Microphyllia	0	2	3
			1	1	
	Branches	Break	0	4	5
			1	1	

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	Deformation	0 1	2 0	2
	Peeling bark	0 1	1 2	3
Trunc	Wound	0 1	8 2	10
	Resin flow	0 1	3 1	4
	Barking	0 1	1 3	4

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Appendix 5

Table. Percentages of observed organisms associated with the sampled trees (irrespective of the species concerned).

Damage causes	Taxa	Percentages (%)
Lichen	*A. marocana*	54.62
	Conifères	48.8
	Broadleaved	8.82
Insect nest	*A. marocana*	0.77
	Conifères	0.6
	Broadleaved	2.94
Insect	*A. marocana*	0.77
	Conifères	1.2
	Broadleaved	0
Witch's brooms	*A. marocana*	0
	Conifères	0.6
	Broadleaved	0
Mistletoe	*A. marocana*	0
	Conifères	0.6
	Broadleaved	0

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Appendix 6

Table. Number and percentage of tree species according to the intensity of lichen colonization.

Species			Am		Ca		Pn		Jo		Tb		Qr		Cl		Ag	
Number of trees			130		22		8		5		1		13		20		1	
Score of lichen	**Colonization intensity**		**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
0	**Null**	**Absent**	59	45	12	54	8	100	5	100	1	100	10	77	20	100	1	100
		Traces	34	11	2	9	0	0	0	0	0	0	0	0	0	0	0	0
1	**Weak**		21	27	6	27	0	0	0	0	0	0	0	0	0	0	0	0
2	**Moderate**		12	13	1	5	0	0	0	0	0	0	2	15	0	0	0	0
3	**Severe**		4	4	1	5	0	0	0	0	0	0	1	8	0	0	0	0

Am: *Abies marocana*; Ag: *Acer granatense*; Cl: *Crataegus laciniata*; JO: *Juniperus oxycedrus*; Qr: *Quercus rotundifolia*; Ca: *Cedrus atlantica*; Pn: *Pinus mauretanica*, Tb : *Taxus baccata*.

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Appendix 7

Table. Number of *A. marocana* trees colonized by lichens following circumference classes.

Classes of circumference at 1.30 m (cm)	Number of trees	Number of colonized trees (%)
5 - 20	17	4 (24%)
21 - 40	15	2 (13%)
41 - 60	9	3 (33%)
61 - 80	19	9 (47 %)
81 - 100	14	4 (29 %)
101 - 120	16	12 (75 %)
121 - 140	14	14 (100 %)
141 - 160	8	5 (63 %)
161 - 180	10	10 (100 %)
181 - 200	5	5 (100 %)
201 - 220	1	1 (100 %)
221 - 240	2	2 (100 %)
Total	130	71 (55 %)

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Appendix 8

Table. Number and percentage of *A. marocana* trees colonized by lichens following branch mortality and leaf deficit classes.

		Branch mortality			Leaf deficit		
Classes		**Total number**	**Colonized trees**		**Total number**	**Colonized trees**	
			N	**%**		**N**	**%**
0	Null	94	35	37	86	34	40
1	Weak	20	20	100	28	21	75
2	Moderate	12	12	100	12	12	100
3	Severe	4	4	100	4	4	100

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Appendix 9

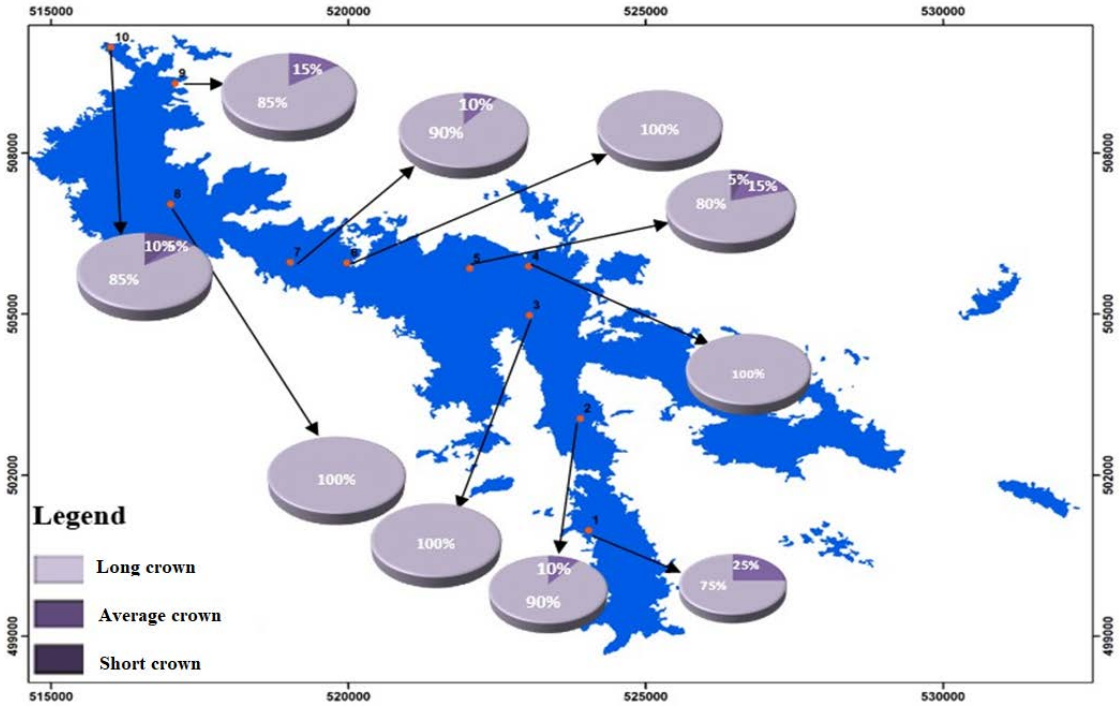

Figure. Spatial distribution of Relative Crown Length (RCL) classes of the sampled trees (all species confounded) in the study plots.

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Appendix 10

Table. Average Relative Crown Length (RCL) for *A. marocana*, other conifers, and broadleaved trees per defoliation class.

	Leaf deficit score	**Average RCL (%)**	**Standard deviation**	**Number of trees**
A. marocana	0	93	0.04	86
	1	81	0.13	28
	2	58	0.16	12
	3	57	0.31	4
Conifers	0	94	0.04	107
	1	83	0.11	38
	2	60	0.16	15
	3	55	0.32	6
Broadleaved	0	91	0.047	18
	1	75	0.2	13
	2	48	0.03	2
	3	22	0	1

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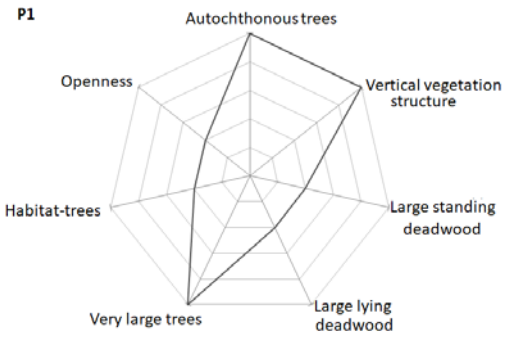
Appendix 11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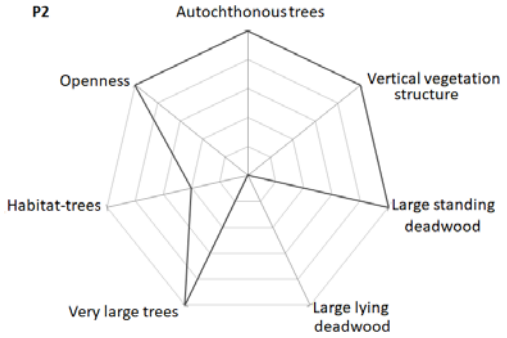
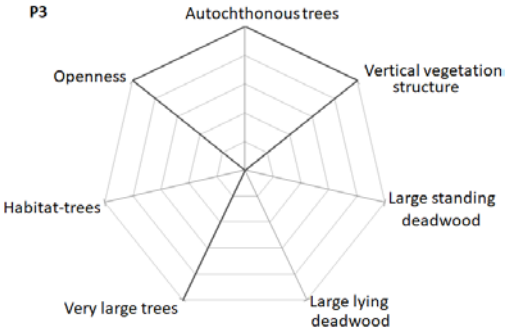
Autochthonous trees
Vertical vegetation structure
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness


P2
Autochthonous trees
Vertical vegetation structure
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness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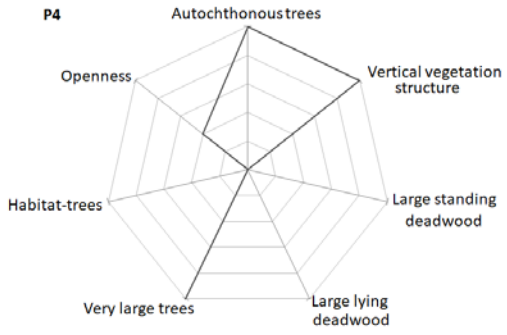
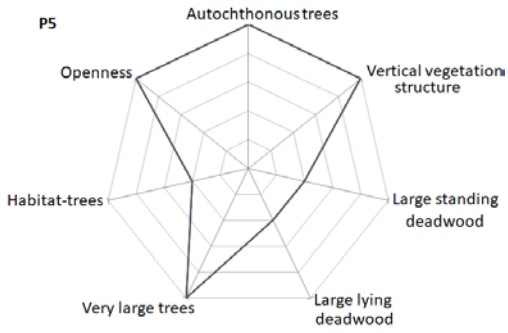
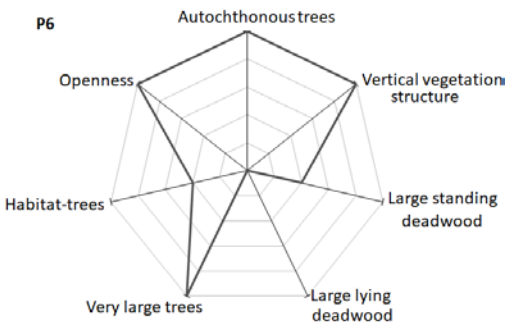
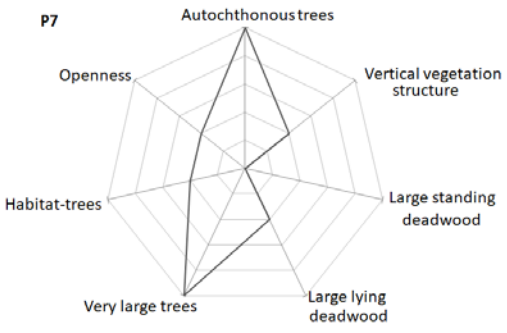
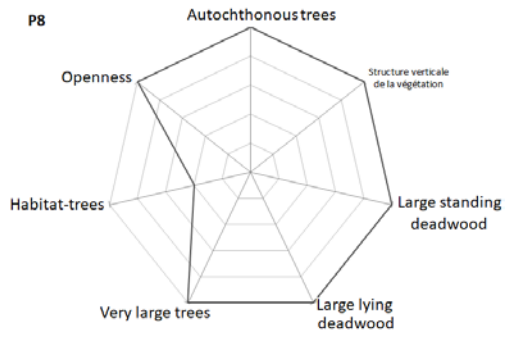
Autochthonous trees
Vertical vegetation structure
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness


P4
Autochthonous trees
Vertical vegetation structure
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness


P5
Autochthonous trees
Vertical vegetation structure
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness


P6
Autochthonous trees
Vertical vegetation structure
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness


P7
Autochthonous trees
Vertical vegetation structure
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness


P8
Autochthonous trees
Structure verticale de la végétation
Large standing deadwood
Large lying deadwood
Very large trees
Habitat-trees
Openness

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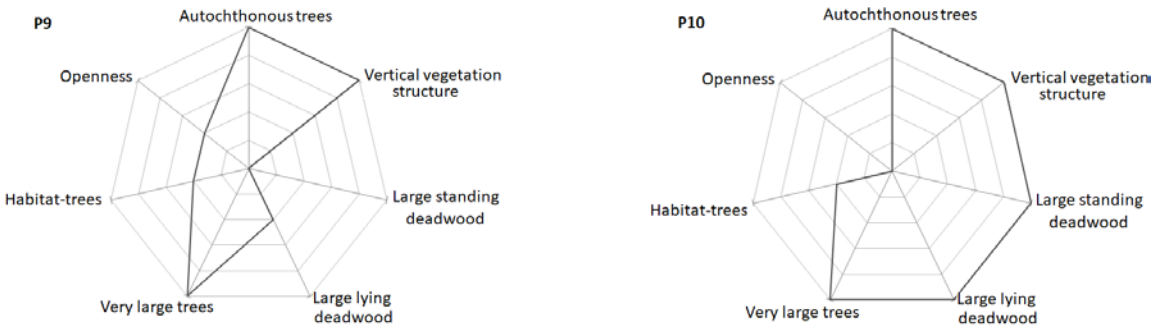

Figure. Graphical representations of management-related factors used for the calculation of the Index of Biodiversity Potential (IBP) per plot.

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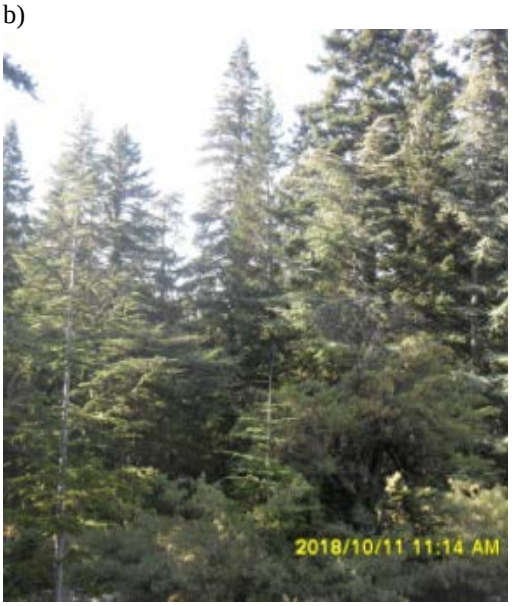
Appendix 12

a)

b)



c)

d)

e)

f)

g)

Figure. Illustrations of IBP management-related factors: a) Autochthonous species richness; b) Vegetation layers; c) Standing deadwood of *A. morocana*; d) Lying deadwood; e) Very large trees; f) and g) Habitat-trees (trees supporting micro-habitats) (Photos by Lamrhari, H., 2018).

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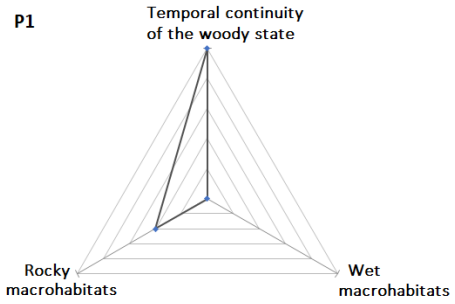
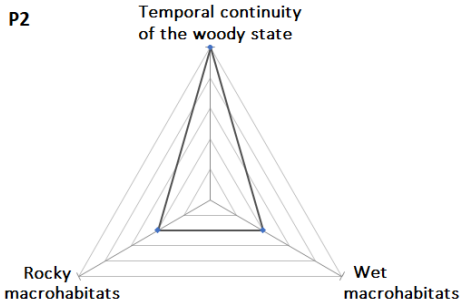
Appendix 13


P1
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats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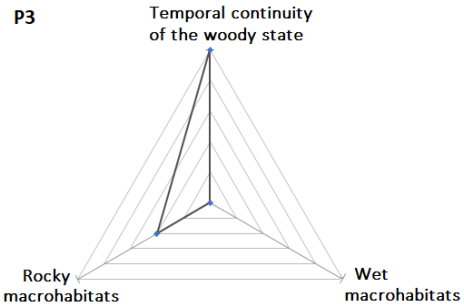
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats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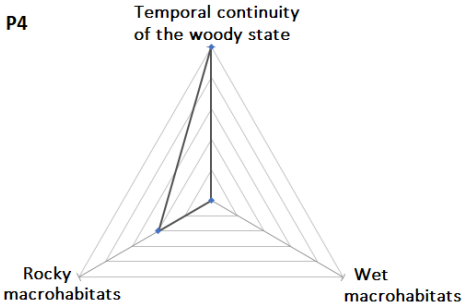
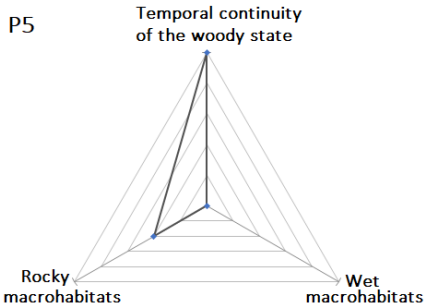
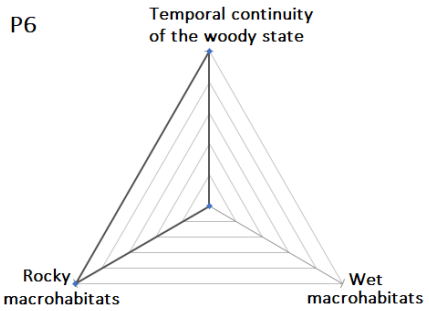
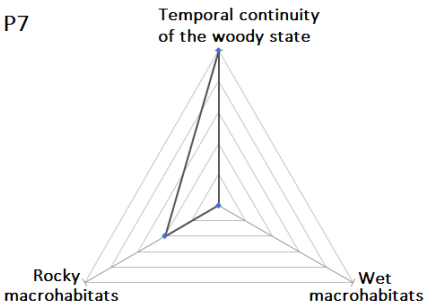
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats


P4
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats


P5
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats


P6
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats


P7
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats

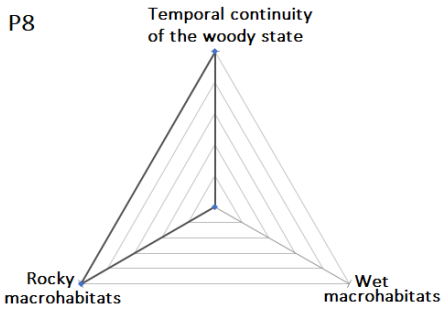

P8
Temporal continuity
of the woody state
Rocky
macrohabitats
Wet
macrohabitats

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Figure. Graphical representations of context-related factors used for the calculation of the Index of Biodiversity Potential (IBP) per plot.

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Appendix 14

a)

b)

c)

Figure. Illustrations of different types of rocky habitats existing in the study plots: a) rocky outcrops; b) unstable scree; and c) block chaos (Photos by Lamrhari, H., 2018).

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Appendix 15

Table. Total Index of Biodiversity Potential (IBP) per plot and per stand type.

Stand type	Plots	Management-related factors			Context-related factors			IBP Total		
		Class	Value		Class	Value		Value		Class
			Absolute	Relative %		Absolute	Relative %	Absolute	Relative %	
Am–Qr	1	Fairly strong	23	66	Average	7	47	30	60	Average
	9	Average	21	60	Average	7	47	28	56	Average
	10	Fairly strong	27	77	Average	10	67	37	74	Fairly strong
Am	2	Fairly strong	27	77	Average	9	60	36	72	Fairly strong
	6	Fairly strong	24	69	Average	10	67	34	68	Fairly strong
	7	Average	18	51	Average	7	47	25	50	Average
	8	Strong	32	91	Average	10	67	42	84	Strong
Am–Pn–Pm	4	Average	7	49	Average	7	47	24	48	Average
	5	Fairly strong	26	74	Average	7	47	33	66	Fairly strong
Am–Ca	3	Average	20	57	Average	7	47	27	54	Average

Am: *Abies marocana*; Qr: *Quercus rotundifolia*; Ca: *Cedrus atlantica*; Pn: *Pinus mauretanica*, Pm: *P. maghribiana.*

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