Tree sample cores of the National Forest Inventory from Romania

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- Romanian NFI
- Extraction of the tree sample cores
- Processing of the tree sample cores
- The use of the tree sample cores

1. Romanian NFI

- Countinuous Forest Inventory
- 5 Years Cycle
- Systematic Sampling Grid
- In the mountains and hills regions, the NFI grid has cells of
 4 km x 4 km, whereas in the plains region the cells are 2 km x 2 km
- The NFI measures permanent sample clusters (PSC) of 4 sample plots (SP)
- Romanian NFI has 31,201 PSC and 124,804 SP

NFI Sample Grid



NFI Sample Cluster





- More than 50,000 incremental cores were collected by the Romanian NFI (I)
- Pressler increment borer
 - internal diameter 5 mm
 - length 40 cm
- The cores were bore at 1.3 m from the ground, parallel with the contour line



- The number of trees appropriated to each SP from which cores were taken depends on the number of species, such that for one species 3-4 cores were extracted, otherwise 2-3 cores / species were collected
- For each tree identified as a core provider, only one incremental core was collected
- When two obvious cohorts exist in the same PSC, for each cohort two increment cores were extracted

- The trees from which cores will be extracted were selected randomly, conditioned to the following constraints:
- The trees are located within a 25 m radius from the center of the SP,
- The trees belong to the dominant and co-dominant canopy class,
- The diameter at breast height (dbh) should be equal or larger than the average dbh of the SP and larger than 12 cm,
- The trees do not exhibit exterior damages, exposure to diseases, or significant ellipticity.

Rigid plastic case

- After extraction, the increment cores were stored in a rigid plastic case to avoid damage during transportation
- A Field File attached to each plastic case were recorded the PSC, SP, species, and two dbh, one measured on the direction of the core and one perpendicular to the core

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Field File

Nr.	Sondaj	SP	Specia	D1	D2	Ht	Observa
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- Rigid plastic cases with stored cores
- Filled in Field Files



3. Processing of the tree sample cores

- The main information extracted from the incremental cores is the **width of each ring** and their **succession**.
- To obtain this information, the incremental cores were processed using a four steps procedure, similar to Lebourgeois and Merian (2012).
- The steps supplying the width of each ring and their relative location within a core are mounting, sanding, measurement, and crossdating.

3.1. Mounting of the sample cores

- on a solid support, on which physical enhancements are executed
- wooden board with the dimensions of 620 mm x 90 mm x 18 mm
- on each side of a board, 8 circular channels were carved (i.e., 16 channels/board)
 - channel width 5mm
 - channel depth 3mm



3.1. Mounting of the sample cores

- Each channel was painted with a slow-drying wooden glue from the vinyl acetate family
- To ensure that the increment cores are not moving once mounted, staples are used
- The increment cores were mounted on one board if less than 16 cores/ PSC were collected, or on two board otherwise
- If the incremental core was received broken, the parts were mounted on the board in the order mirroring the natural succession
- After mounting, the glue was left to dry for at least two days





3.2 Sanding of the sample cores

• Enhance the differences among the rings

Preparing for sanding – remove the used staples





3.2 Sanding of the sample cores

- using a sanding machine
- three phases: coarse sanding, with a sandpaper grit of 80, fine sanding, with a sandpaper grit of 240, and extra-fine sanding with a sandpaper grit of 400
- coarse sanding stops when the support wooden board is reached by the sanding paper
- fine sanding prepare the core for extra-fine sanding, which reveals the cellular anatomic level details.







3.2 Sanding of the sample cores

After the final sanding, the wooden board is cleaned by blowing air from an air-compressor





- A graphical procedure (Lebourgeois and Merian, 2012), based on high resolution scanning of incremental cores
- Checking the sanded sample cores for possible defects
 - knots
 - missing part of the core etc.



1 Data Echipa	Nr. Unic Sondaj SP Nr. C	Carota Specia	d1 d2 H d maduva sp deter	Placa Localitate	Nr. Rupturi Defecte Ser	ia de slefuire Observatii
11075 19.10.2023 17 FOCSANI	14032153 4	2 Frasin comun	185 191 158	31 POIANA CRISTEI	2	
11076 19.10.2023 17 FOCSANI	14032153 2	3 Fag	266 256 165	31 POIANA CRISTEI	1	
11077 19.10.2023 17 FOCSANI	14032153 2	4 Fag	276 278 174	31 POIANA CRISTEI	2	
1078 19.10.2023 17 FOCSANI	14032153 1	5 Fag	196 191 208	31 POIANA CRISTEI	0	
1079 19.10.2023 17 FOCSANI	14032153 1	6 Fag	191 196 188	31 POIANA CRISTEI	2	
1080 23.10.2023 17 FOCSANI	14048247 3	1 Salcie plesnitoare	186 176 107	5 GALATI	1	
1081 23.10.2023 17 FOCSANI	14048247 3	2 Salcie plesnitoare	186 195 111	5 GALATI	0	
1082 23.10.2023 17 FOCSANI	14048247 3	3 Salcie plesnitoare	152 161 98	5 GALATI	0	
1083 23.10.2023 17 FOCSANI	14048247 4	4 Salcie plesnitoare	207 221 145	5 GALATI	1	
1084 23.10.2023 17 FOCSANI	14048247 4	5 Salcie plesnitoare	195 211 143	5 GALATI	2	
1085 23.10.2023 17 FOCSANI	14048247 4	6 Salcie plesnitoare	171 180 138	5 GALATI	2	
1086 27.10.2023 17 FOCSANI	14036147 4	1 Gorun	211 221 121	1 GURA CALITEI	0	
1087 27.10.2023 17 FOCSANI	14036147 4	2 Gorun	187 192 111	1 GURA CALITEI	1	
1088 27.10.2023 17 FOCSANI	14036147 4	3 Gorun	261 257 127	1 GURA CALITEI	0	
1089 27.10.2023 17 FOCSANI	14036147 3	4 Tei cu frunza mare	251 266 314	1 GURA CALITEI	5	
1090 27.10.2023 17 FOCSANI	14036147 3	5 Tei cu frunza mare	355 367 318	1 GURA CALITEI	3	
1091 27.10.2023 17 FOCSANI	14036147 3	6 Fag	256 246 317	1 GURA CALITEI	2	
1092 27.10.2023 17 FOCSANI	14036147 3	7 Fag	310 295 322	1 GURA CALITEI	1	
1093 31.10.2023 17 FOCSANI	14036147 1	8 Tei cu frunza mare	245 227 141	1 GURA CALITEI	1	
1094 31.10.2023 17 FOCSANI	14036147 1	9 Tei cu frunza mare	182 186 137	1 GURA CALITEI	2	
1095 31.10.2023 17 FOCSANI	14036147 1	10 Paltin de camp	161 147 146	1 GURA CALITEI	2	
1096 31.10.2023 17 FOCSANI	14036147 1	11 Paltin de camp	146 147 143	1 GURA CALITEI	5	
1097 31.10.2023 17 FOCSANI	14036147 2	12 Gorun	224 210 219	1 GURA CALITEI	0	
1098 31.10.2023 17 FOCSANI	14036147 2	13 Gorun	229 241 224	1 GURA CALITEI	1	
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1104 01.11.2023 16 ROMAN	12101159 3	3 Carpen	216 186 182	8 SACALENI	0 tm	
1105 01.11.2023 16 ROMAN	12101159 3	4 Carpen	193 188 177	8 SACALENI	1 fm	37
1106 01.11.2023 16 ROMAN	12101159 1	5 Plop tremurator	329 306 264	8 SACALENI	1 fm	37
1107 01.11.2023 16 ROMAN	12101159 1	6 Plop tremurator	327 323 260	8 SACALENI	2 fm	37
1108 01.11.2023 16 ROMAN	12101159 1	7 Fag	334 314 237	8 SACALENI	1 b	37
1109 01.11.2023 16 ROMAN	12101159 1	8 Fag	321 308 242	8 SACALENI	0 fm	37
1110 02.11.2023 16 ROMAN	12093147 3	1 Salcie alba (samanta)	165 160 143	43 ICUSESTI	0 b	35
1111 02.11.2023 16 ROMAN	12093147 3	2 Salcie alba (samanta)	165 158 145	43 ICUSESTI	0 b	35
1112 02.11.2023 16 ROMAN	12093147 3	3 Salcie alba (samanta)	170 156 157	43 ICUSESTI	0 b	35
1113 02.11.2023 16 ROMAN	12093147 3	4 Salcie alba (samanta)	169 165 141	43 ICUSESTI	0 fm	35
1114 06.11.2023 16 ROMAN	12125211 1	1 Carpen	218 231 146	11 COMARNA	0 b	42
1115 06.11.2023 16 ROMAN	12125211 1	2 Carpen	227 216 130	11 COMARNA	0 b	42
1116 06.11.2023 16 ROMAN	12125211 1	3 Jugastru	300 298 148	11 COMARNA	2 fm	42
1117 06.11.2023 16 ROMAN	12125211 1	4 Jugastru	321 302 147	11 COMARNA	0 fm	42
1118 06.11.2023 16 ROMAN	12125211 3	5 Plop tremurator	193 189 108	11 COMARNA	3 b	42
1119 06.11.2023 16 ROMAN	12125211 3	6 Plop tremurator	161 168 118	11 COMARNA	1 fm	42
1120 06.11.2023 16 ROMAN	12125211 3	7 Plop tremurator	193 182 115	11 COMARNA	3 fm	42
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1122 07.11.2023 16 ROMAN	12133213 3	2 Plop negru	404 391 218	14 TUTORA	3 fm	44
1123 07.11.2023 16 ROMAN	12133213 3	3 Plop negru	293 295 216	14 TUTORA	0 fm	44
1124 07.11.2023 16 ROMAN	12133213 3	4 Plop negru	338 340 214	14 TUTORA	4 fm	44
1125 07 11 2023 16 POMAN	12123220 1	1 Plon alb	268 260 154	17 MACARESTI	4 fm	35

- Scanning of sample cores
- Each wooden plate was scanned with the flatbed professional scanner EPSON at 2400 dpi resolution
- image type = 24-bit Color;
- time for scanning: 3 minutes;
- one image: 25 MB;







- Cropping scanned wooden board
 - IRFAN VIEW Programme

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 Individual increment cores is selected and cropped from scanned wooden board



• Database with each image of individual sample core

• Checking the Database after the sample core image cropping

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261 19.05.2023	10 SIMERIA	13020118	4	4 Fag	274 261	268		24 PIANU	C) fm 1			11201.Jpg	293
262 19.05.2023	10 SIMERIA	13020118	4	5 Fag	218 236	221		24 PIANU	C) fm 1	> 🛓 Downloads	11017	11202.jpg	29.0
263 19.05.2023	10 SIMERIA	13020118	4	6 Fag	295 279	273		24 PIANU	C) fm 1	> 🕑 Music	11017	11203.jpg	29.0
264 25.05.2023	10 SIMERIA	11017112	3	1 Gorun	257 258	184		28 IGHIU	C) fm 1	✓ ➡ Pictures	11017	11204 ing	201
265 25.05.2023	10 SIMERIA	11017112	3	2 Gorun	241 238	178		28 IGHIU	1	. fm 1			120-199	2.51
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267 25.05.2023	10 SIMERIA	11017112	4	4 Gorun	295 315	215		28 IGHIU	C) fm 1	Screenshots	11017	11206.jpg	29.0
268 25.05.2023	10 SIMERIA	11017112	4	5 Gorun	225 240	200		28 IGHIU	C) b 1	> Videos	11017	11207.ipg	29,0
269 25.05.2023	10 SIMERIA	11017112	4	6 Gorun	279 307	189		28 IGHIU	C) fm 1				20.4
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274 25.05.2023	10 SIMERIA	11017112	2	11 Gorun	288 287	183		28 IGHIU	C) fm 1	> Date IFN (D:)	- 11017		220
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276														
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• The annual rings are identified and measured using CooRecorder Programme





Picea abies

Larix decidua



Fagus sylvatica

By measurement of the ring widths results a .POS file for each sample core

i 311211601.pos × + File Edit View Image: Control of the second of the s	1311211601.pos X + File Edit View E #DENDRO (Cybis Dendro program compatible format) Coordinate file written as D:\IFN 3\Anul 1 2020 Vcarote de masurat (3)\1311211601.pos 2023-12-14 13:53:56 #TEmagefile 1311211601.jpg #DPI 2400.0 # #DEI Coordinates in millimeters (mm) SCALE 1 # #C CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # #C CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # #C CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # #C CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # #C CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # #C CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # #C CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # #C Satistion=1200; # CalcRadius=Yes; Radius=121.147; Written=2023-12-14 13:53:56; # CalcRadius=Yes; Radius=121.147; # <tr< th=""><th></th><th></th><th></th><th></th><th></th><th>_</th><th></th><th>X</th></tr<>						_		X
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131201120	3	0 - 101	191	9	2020	102	131	2011203	.pos		0,61	7.7	101	0.0	0	maduva	D:\IFI
131240700	4	0-49	197	1	2020	50	131	2407004	.pos		0,59	5,1	49	9,4	3	fara maduva	D:\IFI
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3.4. Cross-dating sample cores

- a method of ensuring that each measured ring is allocated to the correct year
- by matching the ring width pattern among trees
- references curves are developed iteratively by pooling series of rings with high inter-correlation, for each species and region
- a reference curve is obtained from cores with clearly visible rings and a coefficient of correlation larger than 0.75
- minimum of 10 cores are used for development of a reference curve
- the cores are cross-dated while measured
- missing or false ring is shown with a poor correlation, which triggered their investigation with various statistical tests and using pointer years
- allows determination of the age of a tree

3.4. Cross-dating sample cores

• Introduce the age of the trees in the NFI Database

Data	Echipa	Nr. unic Sondaj	SP Nr. caro	ta Specia	d1	d2 H	Varsta masurata	d maduva sp deter.	Placa Localitate	Nr. Rupturi	Defecte	slefuire
27.04.2020	22 BACAU	12041129	2	1 Gorun	418	432 271	86		61 BARSANESTI	1	fm	1
27.04.2020	22 BACAU	12041129	2	2 Gorun	459	486 268	81		61 BARSANESTI	2	fm	1
27.04.2020	22 BACAU	12041129	2	3 Gorun	390	402 243	78		61 BARSANESTI	0	fm	1
22.04.2020	22 BACAU	12041145	5 1	1 Cires paduret	347	336 209	50		28 RACACIUNI	1	fm	1
22.04.2020	22 BACAU	12041145	5 1	2 Cires paduret	357	325 244	50		28 RACACIUNI	0	fm	1
22.04.2020	22 BACAU	12041145	5 1	3 Cires paduret	285	277 210	51		28 RACACIUNI	1	fm	1
22.04.2020	22 BACAU	12041145	5 1	4 Gorun	322	313 241	52		28 RACACIUNI	0	fm	1
22.04.2020	22 BACAU	12041145	5 1	5 Gorun	305	318 236	48		28 RACACIUNI	0	fm	1
22.04.2020	22 BACAU	12041145	5 1	6 Gorun	331	314 264	52		28 RACACIUNI	0	fm	1
27.04.2020	22 BACAU	12049125	2	1 Fag	417	427 299	130		17 BERZUNTI	1	fm	2
27.04.2020	22 BACAU	12049125	2	2 Fag	394	424 297	136		17 BERZUNTI	1	fm	2
27.04.2020	22 BACAU	12049125	2	3 Fag	514	533 298	138		17 BERZUNTI	2	fm	2
27.04.2020	22 BACAU	12049125	2	4 Fag	656	648 312	142		17 BERZUNTI	2	fm	2
28.04.2020	22 BACAU	12049125	5 1	5 Molid	211	219 185	24		17 BERZUNTI	1	fm	2
28.04.2020	22 BACAU	12049125	5 1	6 Molid	220	216 184	27		17 BERZUNTI	2	b	2
28.04.2020	22 BACAU	12049125	5 1	7 Molid	256	255 191	26		17 BERZUNTI	0	b	2
29.04.2020	22 BACAU	12053131	1	1 Fag	531	578 319	146		36 BERESTI-TAZLAU	1	b	1
29.04.2020	22 BACAU	12053131	1	2 Fag	624	580 318	138		36 BERESTI-TAZLAU	0	fm	1
29.04.2020	22 BACAU	12053131	1	3 Fag	527	494 313	112		36 BERESTI-TAZLAU	1	b	1
29.04.2020	22 BACAU	12053131	2	4 Gorun	360	355 220	92		36 BERESTI-TAZLAU	1	fm	1
29.04.2020	22 BACAU	12053131	2	5 Gorun	463	447 246	90		36 BERESTI-TAZLAU	0	fm	1
29.04.2020	22 BACAU	12053131	2	6 Fag	388	382 236	131		36 BERESTI-TAZLAU	1	fm	1
29.04.2020	22 BACAU	12053131	2	7 Fag	386	397 228	112		36 BERESTI-TAZLAU	1	fm	1
30.04.2020	22 BACAU	12057137	3	1 Carpen	201	202 216	44		23 STRUGARI	1	fm	2
30.04.2020	22 BACAU	12057137	3	2 Carpen	225	220 214	46		23 STRUGARI	1	b	2
30.04.2020	22 BACAU	12057137	3	3 Fag	265	258 215	54		23 STRUGARI	0	fm	2
30.04.2020	22 BACAU	12057137	3	4 Fag	274	247 217	58		23 STRUGARI	0	fm	2
23.04.2020	13 BISTRITA	11137080) 1	1 Gorun	377	389 224	75		6 CICEU- MIHAIESTI	0	fm	1
23.04.2020	13 BISTRITA	11137080) 1	2 Gorun	351	310 240	71		6 CICEU- MIHAIESTI	0	fm	1
23.04.2020	13 BISTRITA	11137080) 1	3 Carpen	247	245 240	78		6 CICEU- MIHAIESTI	0	fm	1
23.04.2020	13 BISTRITA	11137080) 1	4 Carpen	233	214 215	86		6 CICEU- MIHAIESTI	1	b	1
24.04.2020	13 BISTRITA	11137080) 4	5 Carpen	130	133 142	35		6 CICEU- MIHAIESTI	0	fm	1
24.04.2020	13 BISTRITA	11137080) 4	6 Carpen	133	137 143	20		6 CICEU- MIHAIESTI	0	fm	1
24.04.2020	13 BISTRITA	11137080) 4	7 Plop tremurator	173	176 173	32		6 CICEU- MIHAIESTI	0	fm	1
24.04.2020	13 BISTRITA	11137080) 4	8 Plop tremurator	170	170 166	32		6 CICEU- MIHAIESTI	0	fm	1
28.04.2020	13 BISTRITA	11141090) 4	1 Molid	315	313 268	38		8 CASEIU	0	fm	1
28.04.2020	13 BISTRITA	11141090) 4	2 Molid	316	318 258	35		8 CASEIU	0	fm	1
28.04.2020	13 BISTRITA	11141090) 4	3 Molid	354	348 277	38		8 CASEIU	1	fm	1
27.04.2020	13 BISTRITA	11145084	2	1 Fag	430	445 241	76		7 CHIUIESTI	1	fm	1
27.04.2020	13 BISTRITA	11145084	2	2 Fag	444	482 238	73		7 CHIUIESTI	0	fm	1
27.04.2020	13 BISTRITA	11145084	2	3 Fag	420	441 270	119		7 CHIUIESTI	1	fm	1

Precise determination of the age of the sample trees

Estimation of the forest increment at the end of first NFI cycle in a country

Studies on forest growth, regional variability of the tree species growth

New growth and yield tables for tree species at regional scale



Romanian ecoregions according to spatial contiguity, geology, soils, and geomorphology maps of the Romanian Academy

• Univariate analysis



Dynamic thru time of DBH increment and basal area increment mean by ecoregion for Norway spruce (a,b), European beech (c,d) and Sessile oak (e,f)

• Covariates analysis



Mean DBH increment versus mean DBH and mean basal area increment versus mean basal area by ecoregion for Norway spruce (a,b), European beech (c,d) and Sessile oak (e,f).

• Multivariate analysis



Grouping by ecoregions for Norway spruce, European beech, and Sessile oak with principal components 1 and 2 as axes. Because similar results were obtained for DBHi and BAi, we have represented only the results for DBHi

• Hierarchical cluster analysis



Identification of the number of groups of ecoregions using Ward's Minimum Variance and Cubic Clustering Criterion for Norway spruce (a), European beech (b) and Sessile oak (c). Because similar results were obtained for DBHi or BAi, we have represented only the results for DBHi.

• Canonical discrimination analysis



Grouping by ecoregions for Norway spruce, European beech, and Sessile oak with canonical variables as axes. Because the same conclusion is reached for DBHi and BAi only the plots for DBHi are presented

Thank you for your attention!