



東北林業大學

NORTHEAST FORESTRY UNIVERSITY



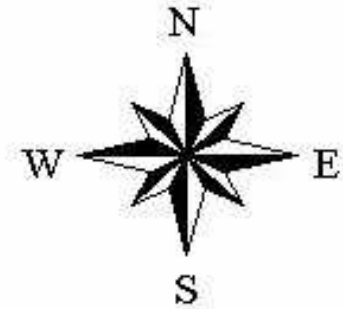
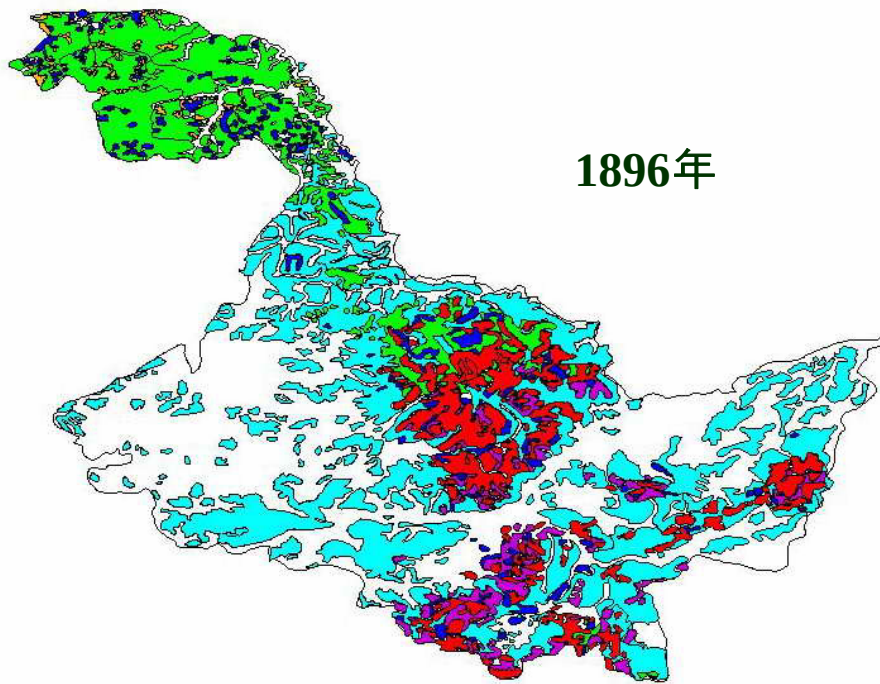
小兴安岭典型阔叶红松林 长期生态研究

东北林业大学

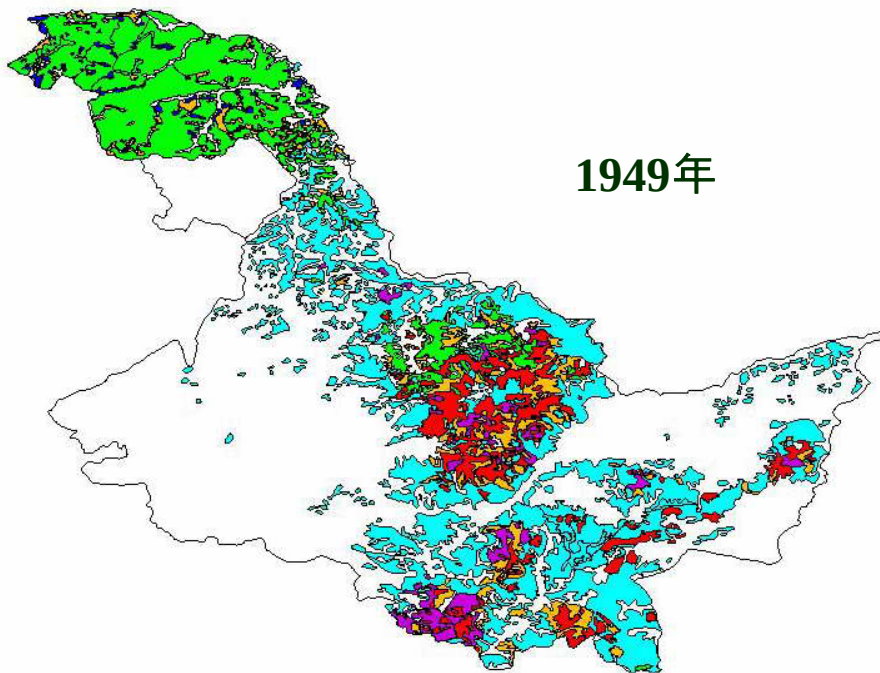
金光泽

taxus@126.com

1896年

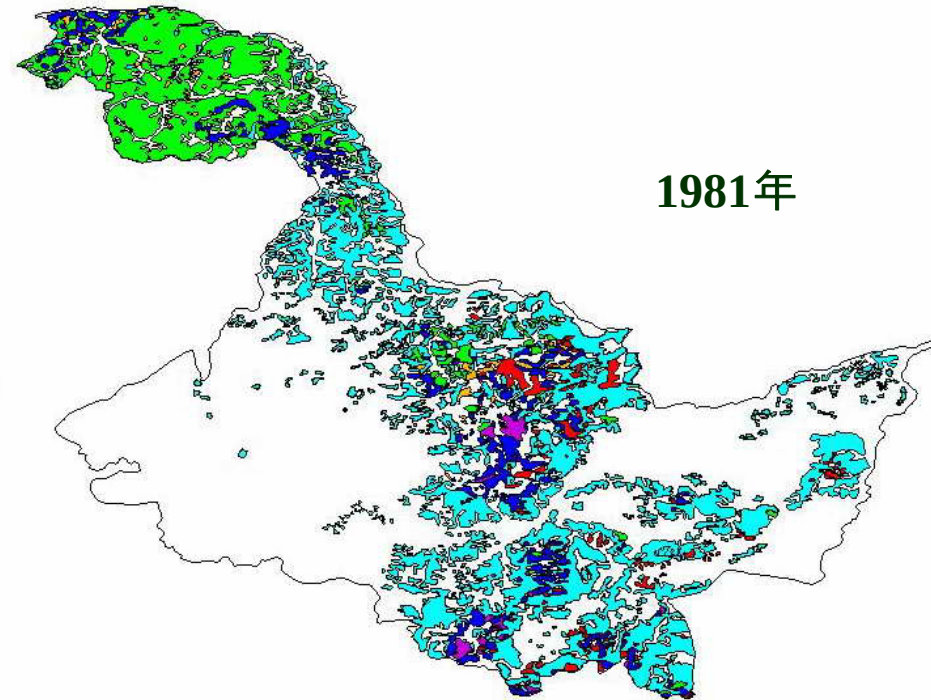


1949年



200 0 200 400 Miles

1981年



200 0 200 400 Miles

林型	面积 (hm ²)	建立时间	样地位置
• 典型阔叶红松林	9	2005	凉水自然保护区
• 谷地云冷杉林	9.18	2006	凉水自然保护区
• 白桦次生林	1	2009	凉水自然保护区
• 阔叶红松林	30	2009	丰林自然保护区

Study area : Liangshui National Reserve

General information

- Area : 12,133ha
- Location : $47^{\circ}10'N$, $128^{\circ}53'E$
- Elevation : 280-707m
- Mean annual temperature : $-0.3^{\circ}C$
- Mean annual precipitation : 676mm



Study area : Liangshui National Reserve

Vegetation

•community group

- *Pinus koraiensis* - *Quercus mongolica* comm.,
- *Pinus koraiensis* - *Picea koraiensis* comm.,
- *Pinus koraiensis* - *Tilia amurensis* comm.,
- *Pinus koraiensis* - *Betula costata* comm.,
- *Picea koraiensis* - *Abies nephrolepis* comm., etc.

• Major Tree Species

Pinus koraiensis, *Picea koraiensis*, *Abies nephrolepis*, *Tilia amurensis*, *T. mandshurica*, *Acer mono*, *Fraxinus mandshurica*, *Ulmus laciniata*, *Betula costata*, *B. platyphylla*, *Quercus mongolica*, *Larix gmelini*, *Juglans mandshurica*, *A. ukurunduense*, and *A. tegmentosum*

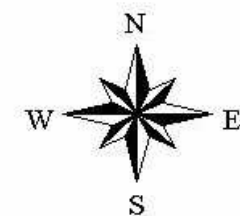
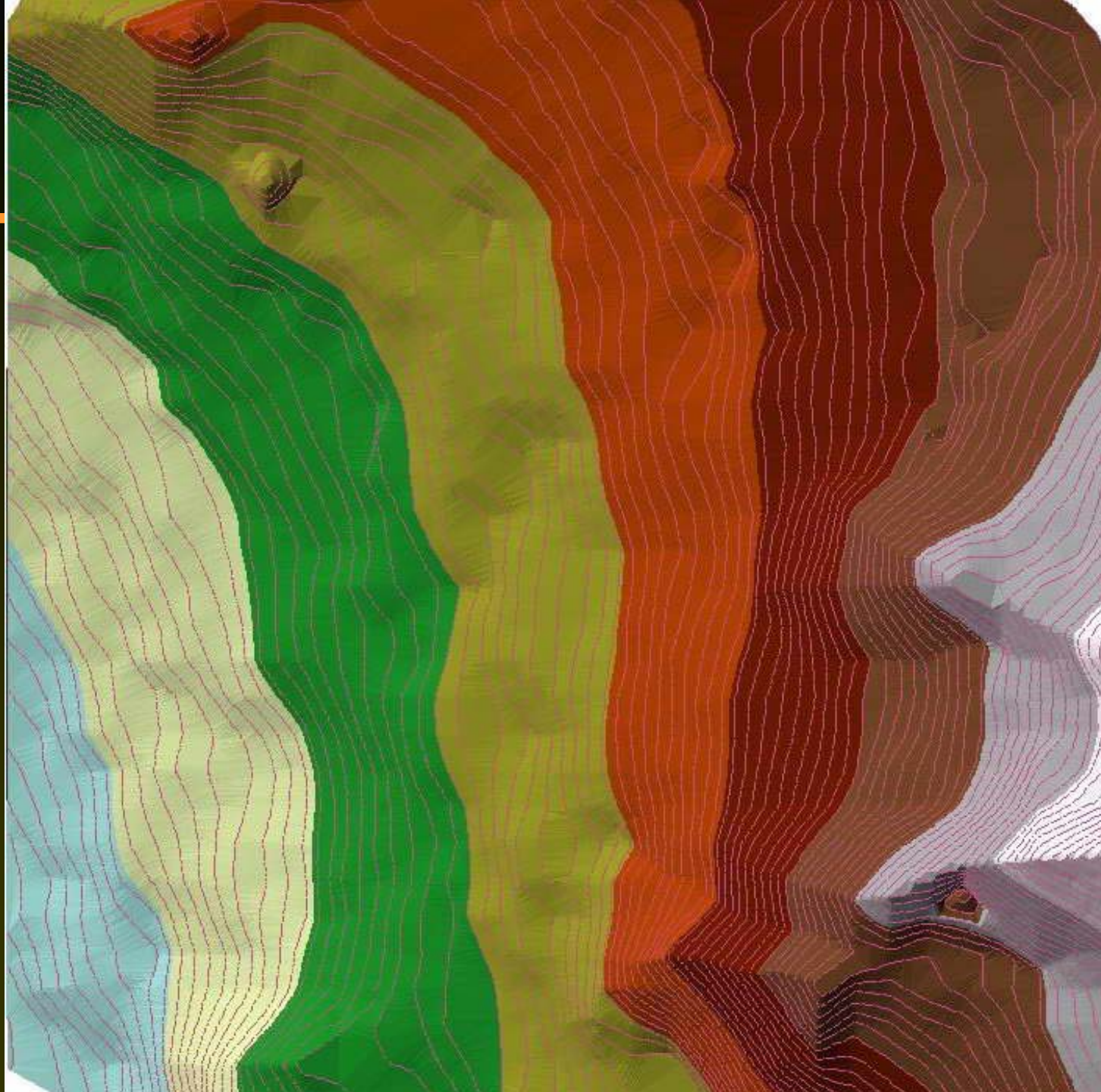




Major Ecosystem Researches : LMR

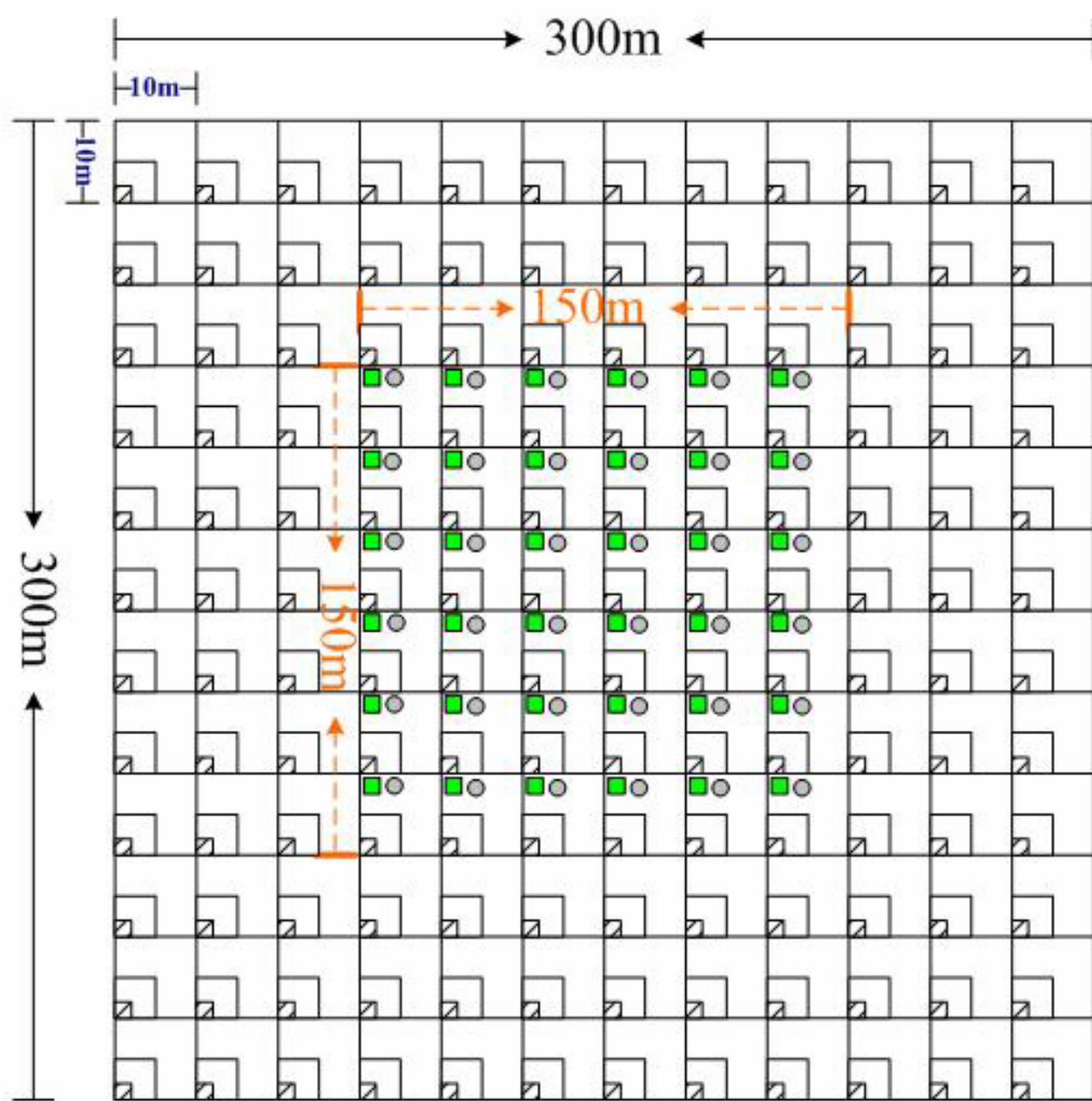
1. Forest Stand Dynamics

- 9 ha permanent quadrat
(2005)
- Measure every 5 years
- Stemmap for all living trees
larger than 2cm in DBH,
and dead stems



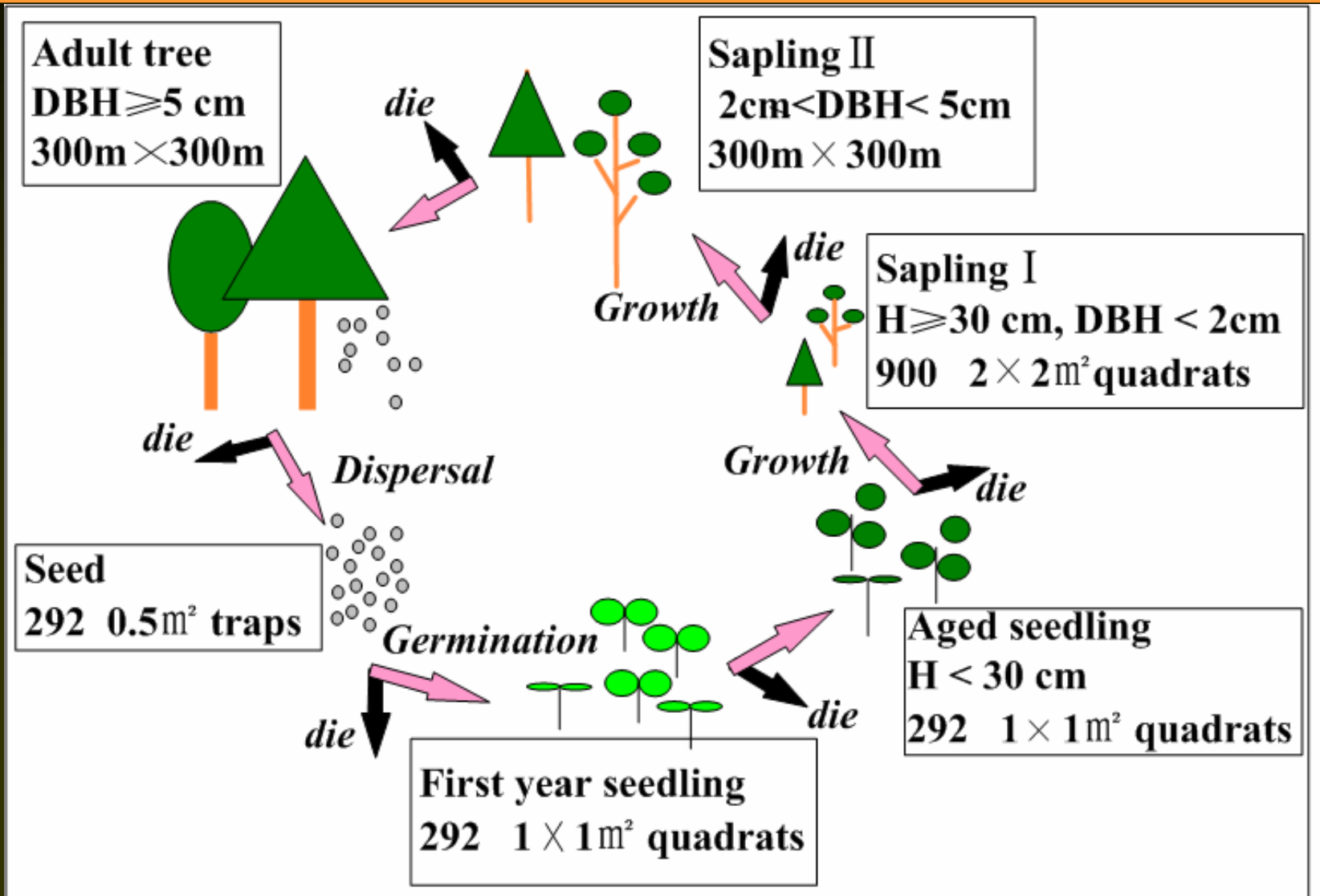
- Soft Edge
- Hard Edge
- Elevation
- 499 - 509
- 490 - 499
- 481 - 490
- 471 - 481
- 462 - 471
- 453 - 462
- 443 - 453
- 434 - 443
- 425 - 434

1:250



○:种子收集器(seed traps) ■:幼苗(seedling plots)
 ▤:幼树 I (sapling I) □:幼树 II (sapling II)

Tree life-cycle and research method in Xiaoxing'an mountains





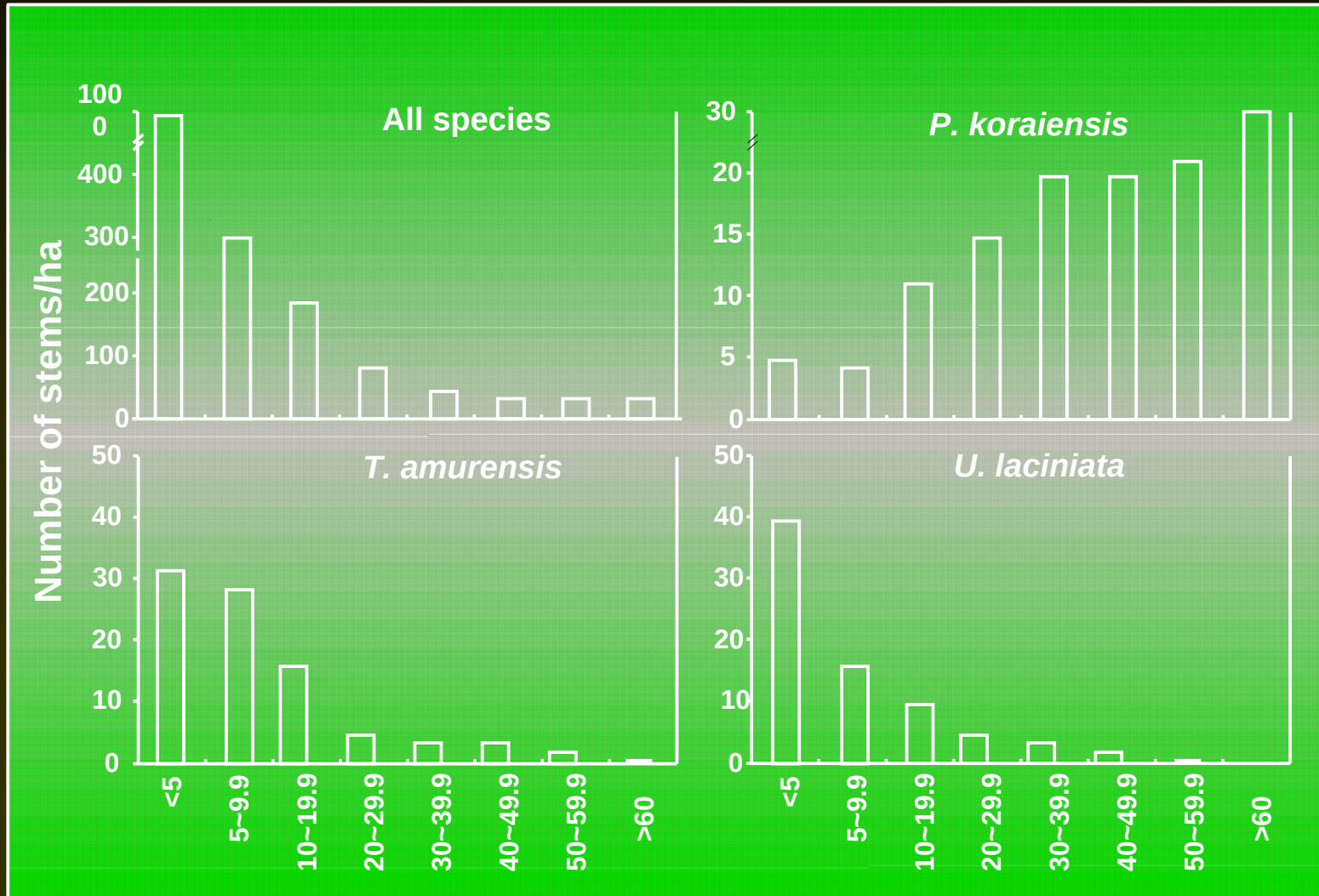




Species composition and regeneration pattern of the BKP

Species	DBH>2cm		DBH<2cm, H>30cm	H<30cm
	Stems/hm ²	BA/hm ²	Stems/hm ²	Stems/hm ²
<i>Abies nephrolepis</i>	87	2.88	17	430
<i>Acanthopanax senticosus</i>	28	0.01	2,556	703
<i>Acer mono</i>	178	2.28	808	508
<i>Acer tegmentosum</i>	86	0.41	908	977
<i>Acer ukurunduense</i>	170	0.37	361	117
<i>Betula costata</i>	74	1.97	28	-
<i>Corylus mandshurica</i>	390	0.19	2,928	117
<i>Euonymus pauciflorus</i>	30	0.02	1,686	1,250
<i>Fraxinus mandshurica</i>	38	1.14	572	898
<i>Pinus koraiensis</i>	132	23.86	172	313
<i>Syringa reticulata</i>	74	0.22	328	273
<i>Tilia amurensis</i>	93	2.97	353	273
<i>Ulmus laciniata</i>	73	1.13	286	352
<i>Ulmus pumila</i>	38	0.42	147	-
Others	215	3.22	12,197	5,117
Total	1,707	41.09	23,347	11,328

DBH Distribution of major tree species

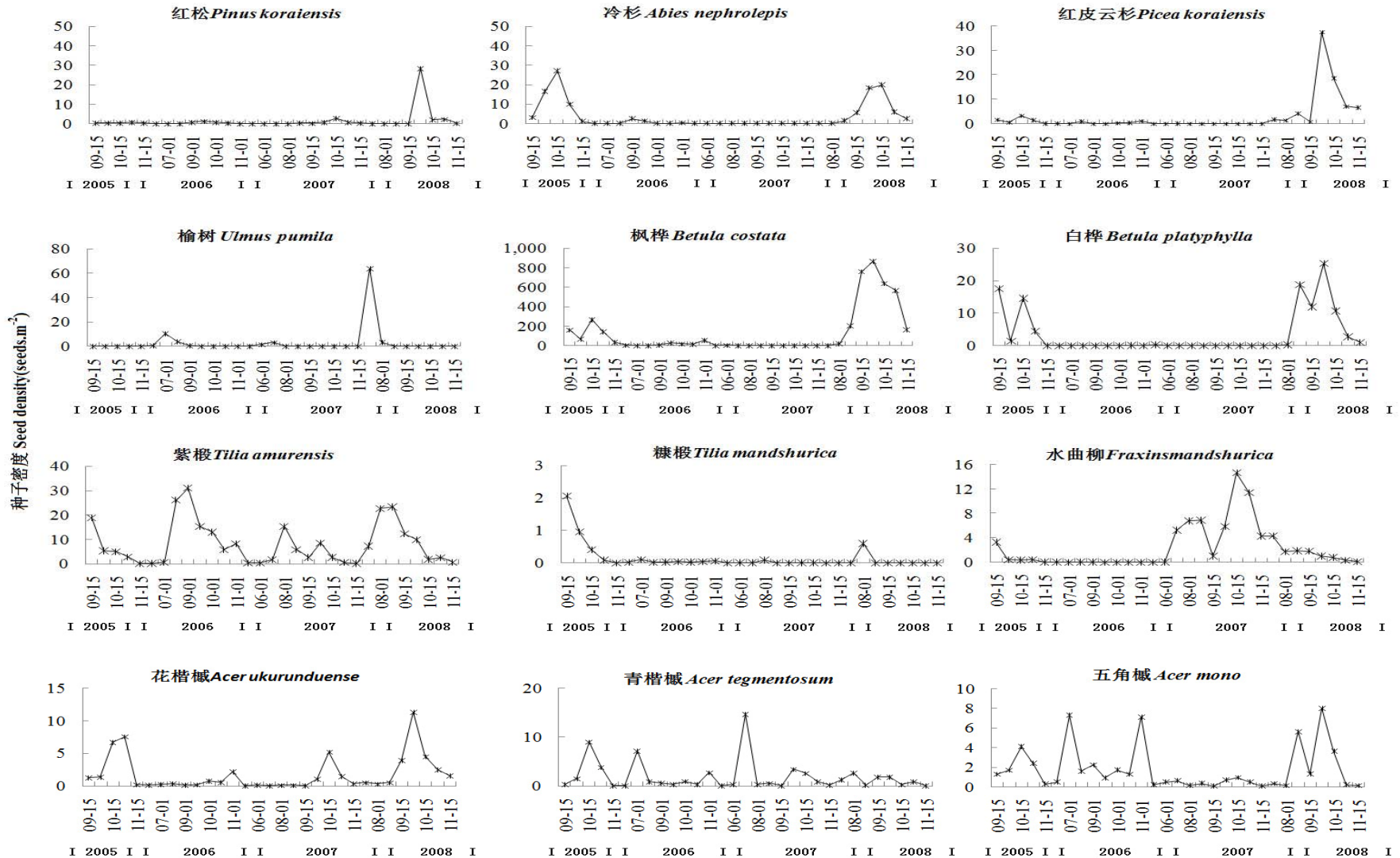




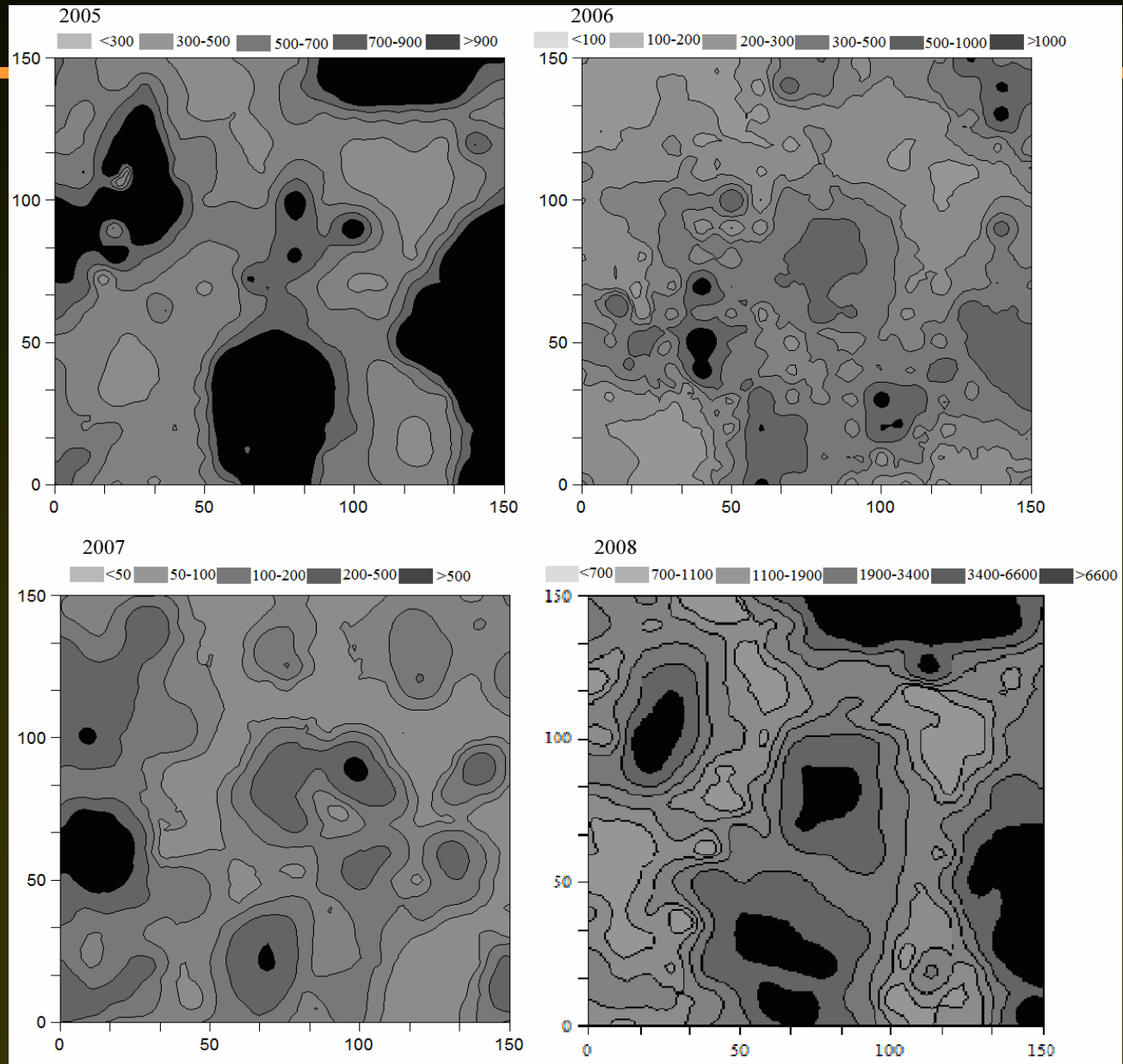
The interannual dynamics of seed rain for tree species in a broadleaved-Korean pine mixed forest

树种	年份 (inds·m ⁻²)				比例%			
	2005 (n=287)	2006 (n=319)	2007 (n=271)	2008 (n=264)	2005	2006	2007	2008
红松	19.0±70.4	3.1±14.3	5.6±23.5	25.3±136.2	2.2	1.0	3.9	0.7
水曲柳	4.5±13.2	0.1±0.4	56.2±79.8	11.8±28.0	0.5	0.0	38.8	0.3
紫椴	32.2±64.9	100.9±292.6	38.6±101.5	80.5±347.8	3.7	33.5	26.7	2.2
糠椴	3.5±14.7	0.3±1.8	0.1±1.0	0.6±7.2	0.4	0.1	0.1	0.0
五角槭	9.7±10.6	22.8±73.9	3.8±8.9	19.1±64.4	1.1	7.6	2.6	0.5
青楷槭	14.8±24.2	13.2±71.7	23.1±117.5	9.1±37.1	1.7	4.4	16.0	0.3
花楷槭	17.1±34.5	4.6±15.8	8.5±35.1	24.9±54.9	2.0	1.5	5.9	0.7
枫桦	676.0±1080.5	135.3±186.0	3.8±11.8	3211.2±4194.9	77.5	45.0	2.6	88.6
白桦	37.9±33.5	0.4±4.0	0.0±0.4	70.5±122.32	4.4	0.1	0.0	2.0
榆树	0.3±1.4	13.0±40.4	4.6±25.8	67.1±145.1	0.0	4.3	3.2	1.9
冷杉	50.5±70.0	4.5±39.8	0.2±0.8	54.3±224.1	5.8	1.5	0.1	1.5
红皮云杉	6.7±10.4	2.7±15.8	0.2±0.8	77.6±159.5	0.8	0.9	0.1	2.1
总计	872.2±1084.3	300.9±349.4	144.8±195.5	3624.6±4086.4	100	100	100	100

The temporal dynamics of seed rain for tree species in a broadleaved-Korean pine mixed forest



The spatial patterns of seed rain for tree species in different years in a broadleaved-Korean pine mixed forest ($\text{inds}\cdot\text{m}^{-2}$)







Seed bank

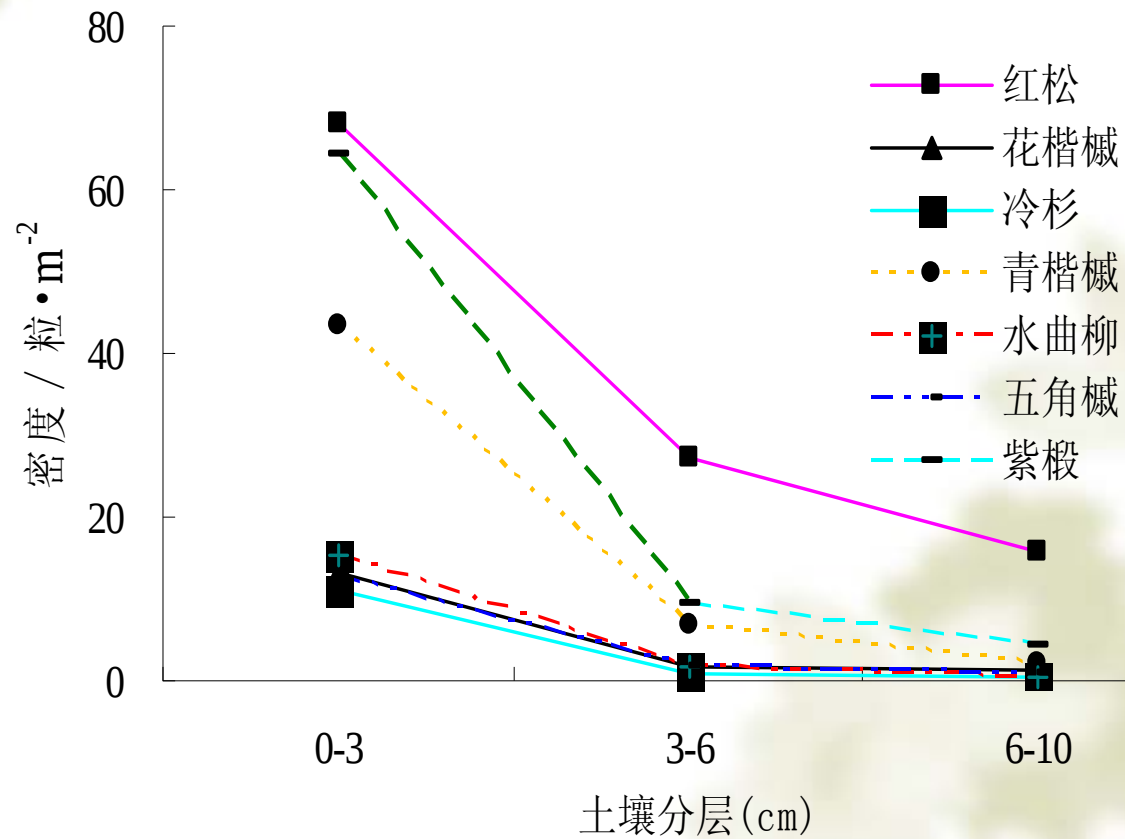


Seed bank

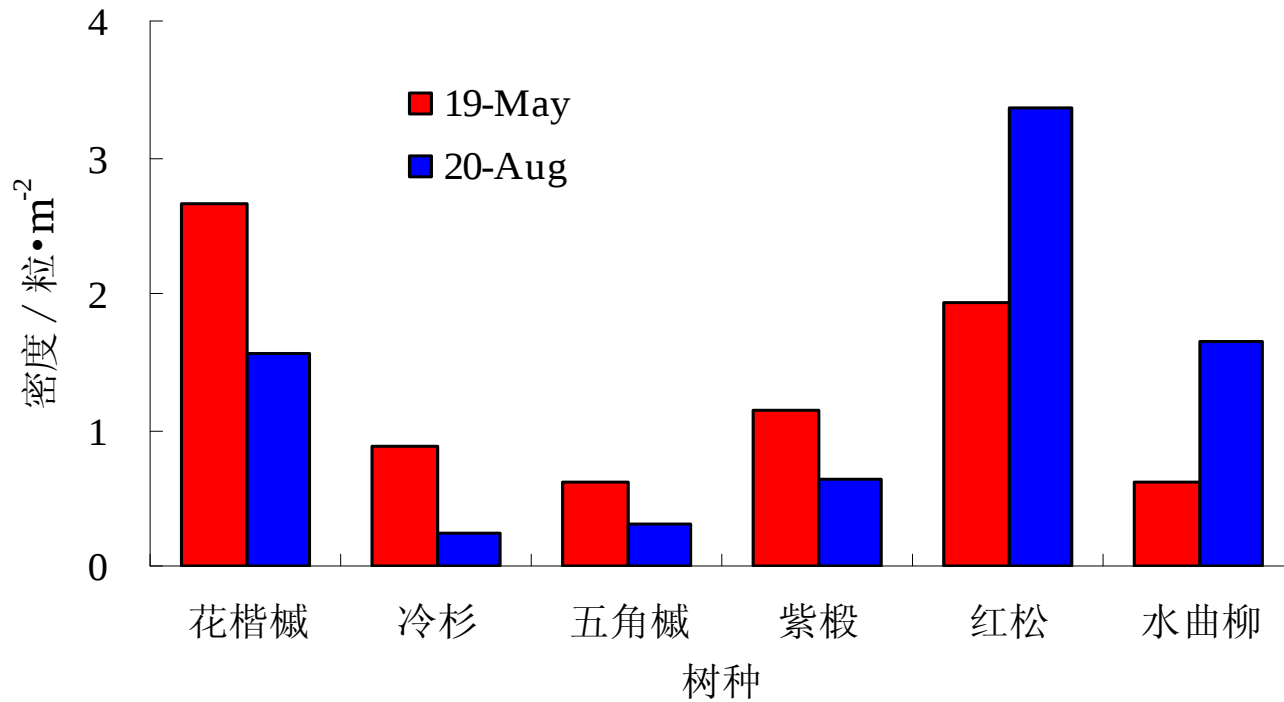


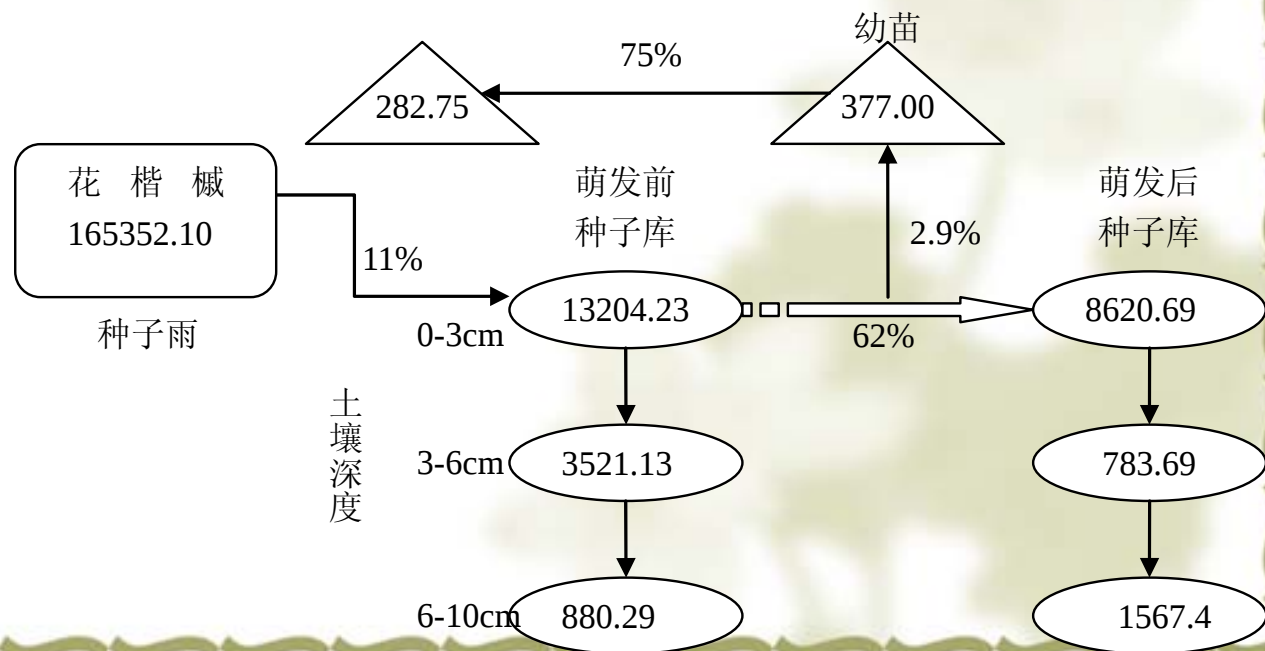
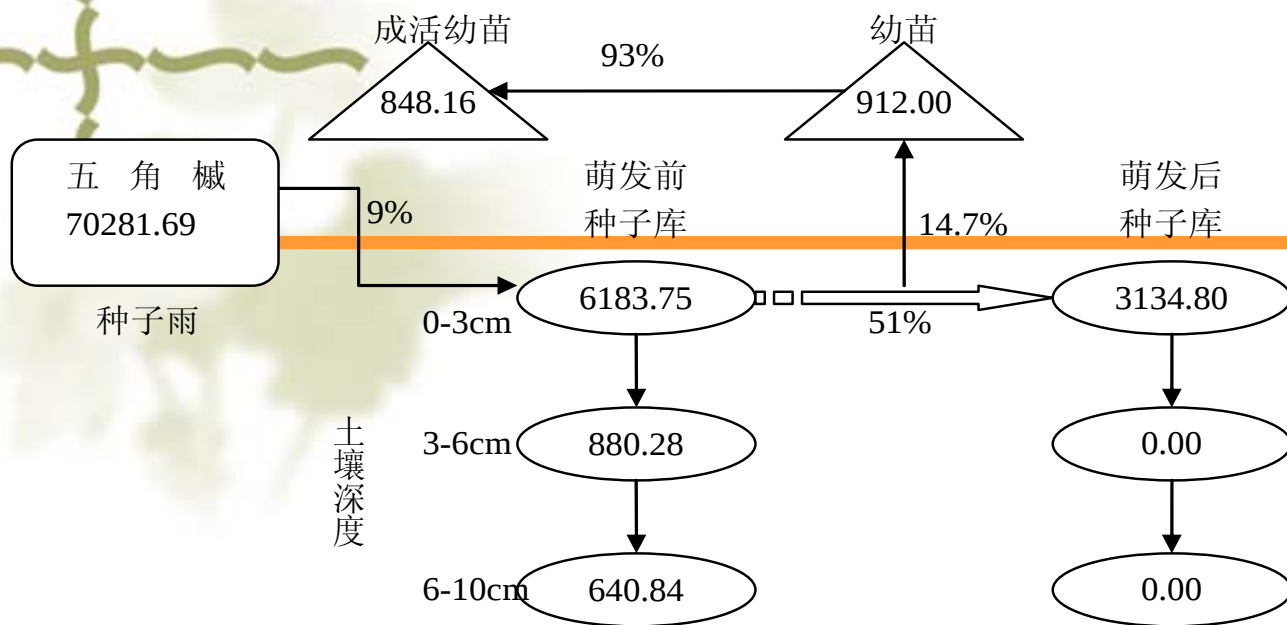
树种 Species	密度 / 粒·m ⁻² Mean±SD	发霉腐 烂 Decay	萌发 Bourgeon	百分比Percent%		
				动物侵害 Damage	成熟有效 Efficiency	成熟无效 Inefficacy
红皮云杉 <i>Picea koraiensis</i>	5.12±74.43	43	0.0	52	2.0	3.0
红松 <i>Pinus koraiensis</i>	91.61±120.31	13	1.0	82	2.0	3.0
花楷槭 <i>A. ukurunduense</i>	18.29±77.86	67	0.0	0.0	14	18
冷杉 <i>A. nephrolepis</i>	10.95±33.28	44	6.0	6.0	8.0	37
青楷槭 <i>A. tegmentosum</i>	41.43±81.98	91	0.0	1.0	3.0	5.0
水曲柳 <i>F. mandshurica</i>	16.08±39.20	59	26	0.0	4.0	11
五角槭 <i>A. mono</i>	14.49±34.45	84	0.0	2.0	4.0	10
紫椴 <i>T. amurensis</i>	67.40±268.41	91	0.0	2.0	2.0	6.0
其他Others	1.94±33.77	64	0.0	32	5.0	0.0
合计Total	267.31±350.45	57	2.0	30	4.0	7.0

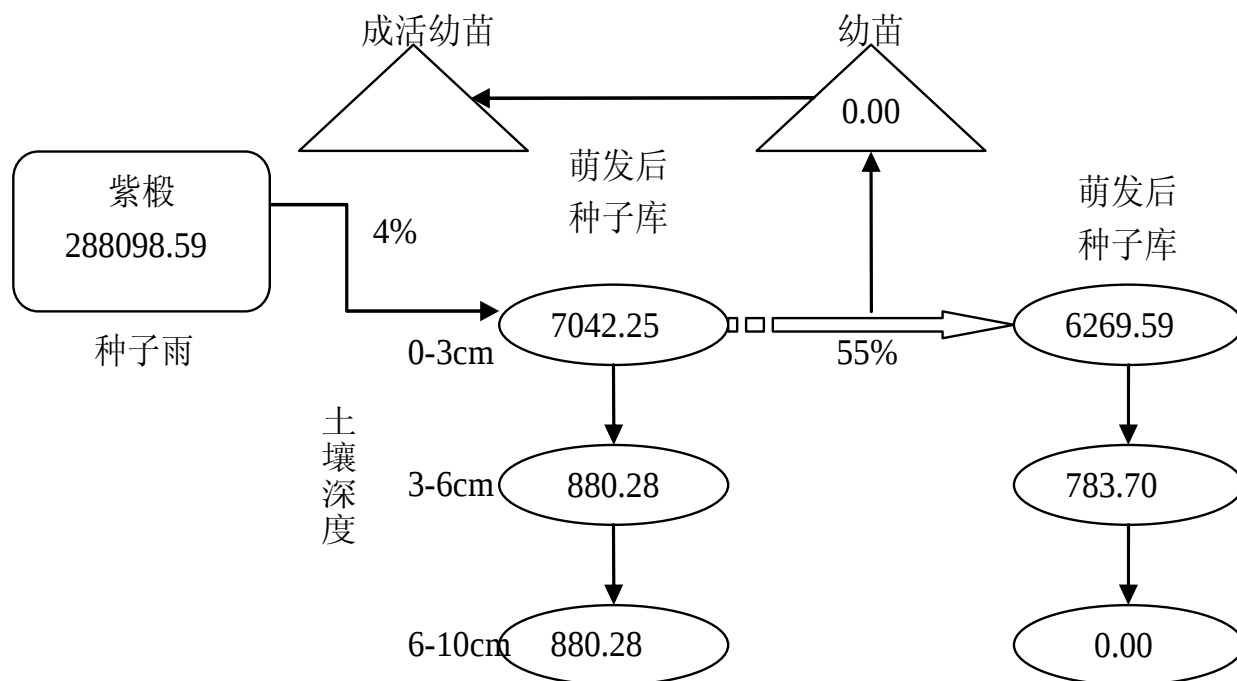
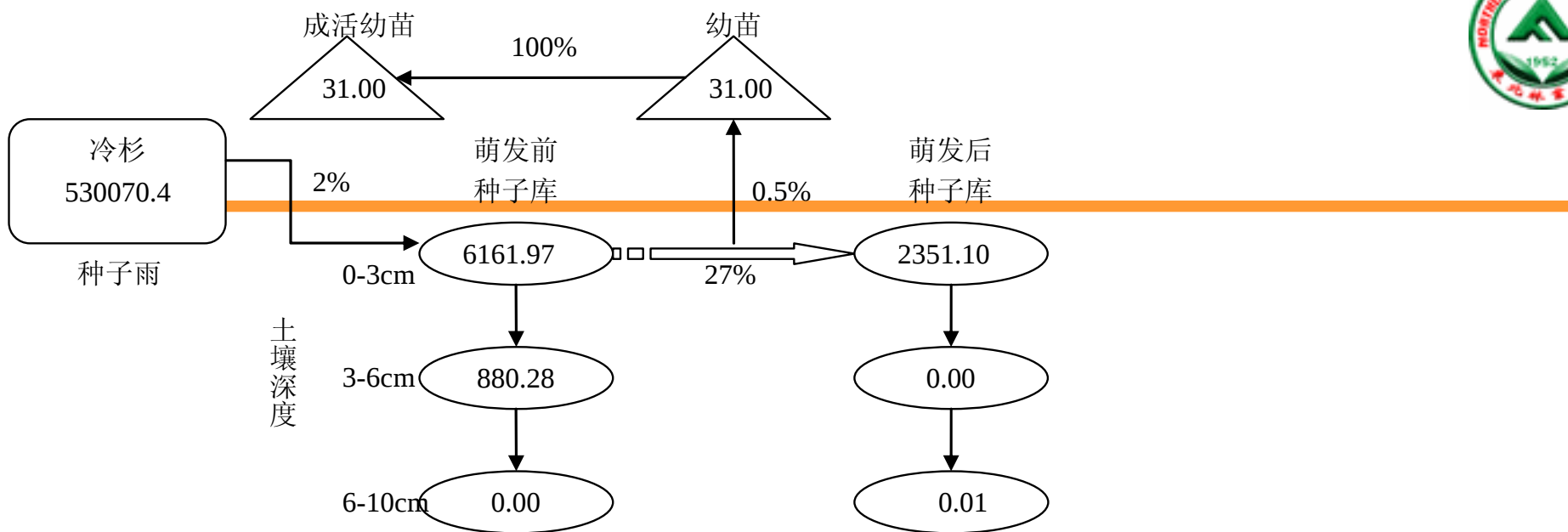
Seed bank



Seed bank









First year seedling

树种	2006		2007		2008	
	密度	百分比(%)	密度	百分比(%)	密度	百分比(%)
红松	0.0±0.1	1.5	0.4±0.9	20.1	0.2±0.6	10.1
冷杉	0.0±0.1	—	0.1±0.5	5.8	0.1±0.3	6.0
榆树	0.0±0.1	1.5	0.0±0.1	1.5	0.0±0.2	1.2
枫桦	—	—	—	—	0.0±0.2	0.6
紫椴	—	—	0.0±0.1	—	0.0±0.1	0.6
水曲柳	0.5±2.0	78.5	0.8±1.6	41.3	0.7±1.5	40.7
花楷槭	0.0±0.2	3.1	0.1±0.7	6.4	0.1±0.3	4.2
青楷槭	0.1±0.4	12.3	0.4±1.1	23.3	0.6±1.2	32.9
五角槭	0.0±0.2	3.1	0.1±0.3	2.7	0.1±0.3	3.0
总计	0.7±2.0	100	1.9±2.4	100	1.7±2.5	100



First year seedling

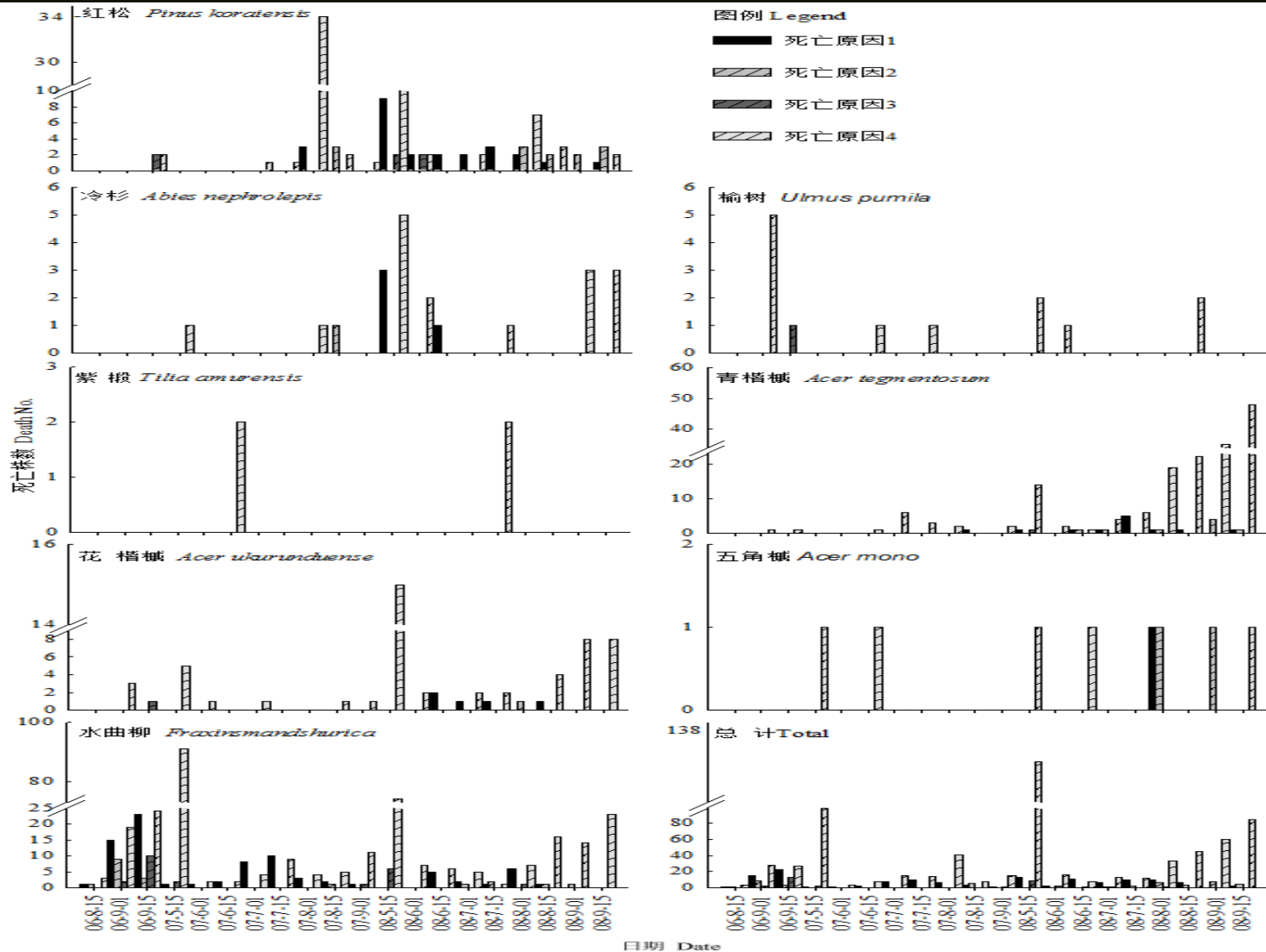
树种	2006			2007			2008		
	G	N	Sig.	G	N	Sig.	G	N	Sig.
红松	—	0.0±0.1	0.083	0.2±0.6	0.5±1.0	0.002*	0.1±0.4	0.2±0.7	0.170
冷杉	0.0±0.1	—	0.319	0.1±0.3	0.1±0.5	0.027*	0.1±0.3	0.1±0.3	0.435
榆树	—	0.0±0.1	—	—	0.0±0.1	—	—	0.0±0.2	—
枫桦	—	—	—	—	—	—	0.0±0.3	0.0±0.1	0.319
紫椴	—	—	—	0.0±0.1	—	0.319	0.0±0.1	0.0±0.1	0.566
水曲柳	0.3±0.7	0.6±2.4	0.047*	0.5±1.2	0.9±1.8	0.000*	0.5±1.3	0.8±1.5	0.004*
花楷槭	—	0.0±0.3	0.167	0.0±0.2	0.2±0.9	0.092	0.1±0.3	0.1±0.3	0.534
青楷槭	0.1±0.4	0.1±0.4	0.614	0.4±0.9	0.5±1.2	0.215	0.5±1.1	0.6±1.3	0.199
五角槭	—	0.0±0.2	0.014*	0.0±0.2	0.1±0.3	0.049*	0.0±0.2	0.1±0.3	0.202
总计	0.3±0.8	0.8±2.5	0.018*	1.3±1.8	2.2±2.7	0.000*	1.3±2.1	1.9±2.6	0.004*



First year seedling

年份	红松	冷杉	榆树	枫桦	紫椴	水曲柳	花楷槭	青楷槭	五角槭	总计
2006	6	1	8	—	—	272	11	27	7	332
2007	130	37	4	—	3	246	40	130	10	600
2008	14	15	7	4	3	149	33	207	7	439

First year seedling

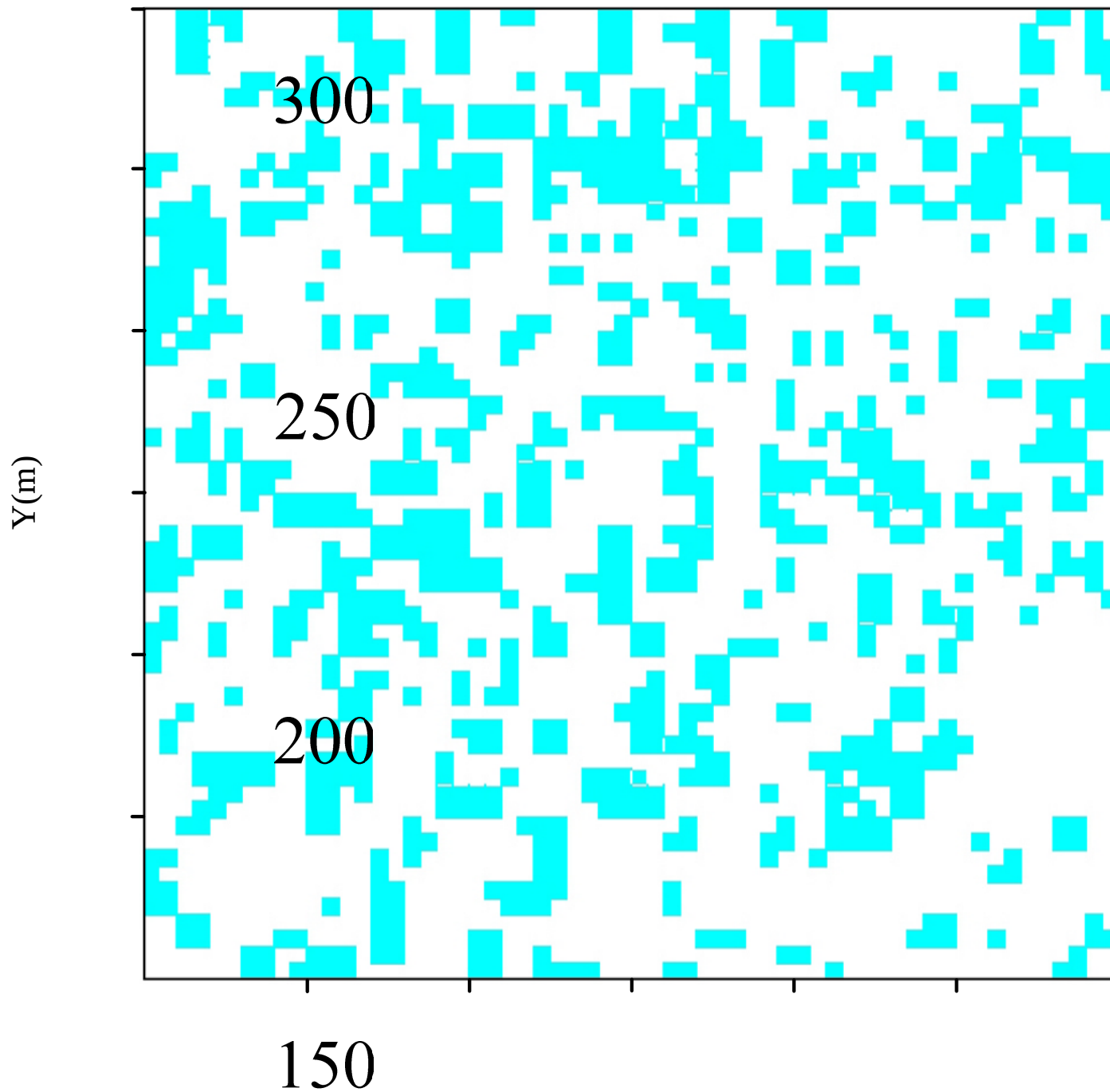


Study area : Liangshui National Reserve

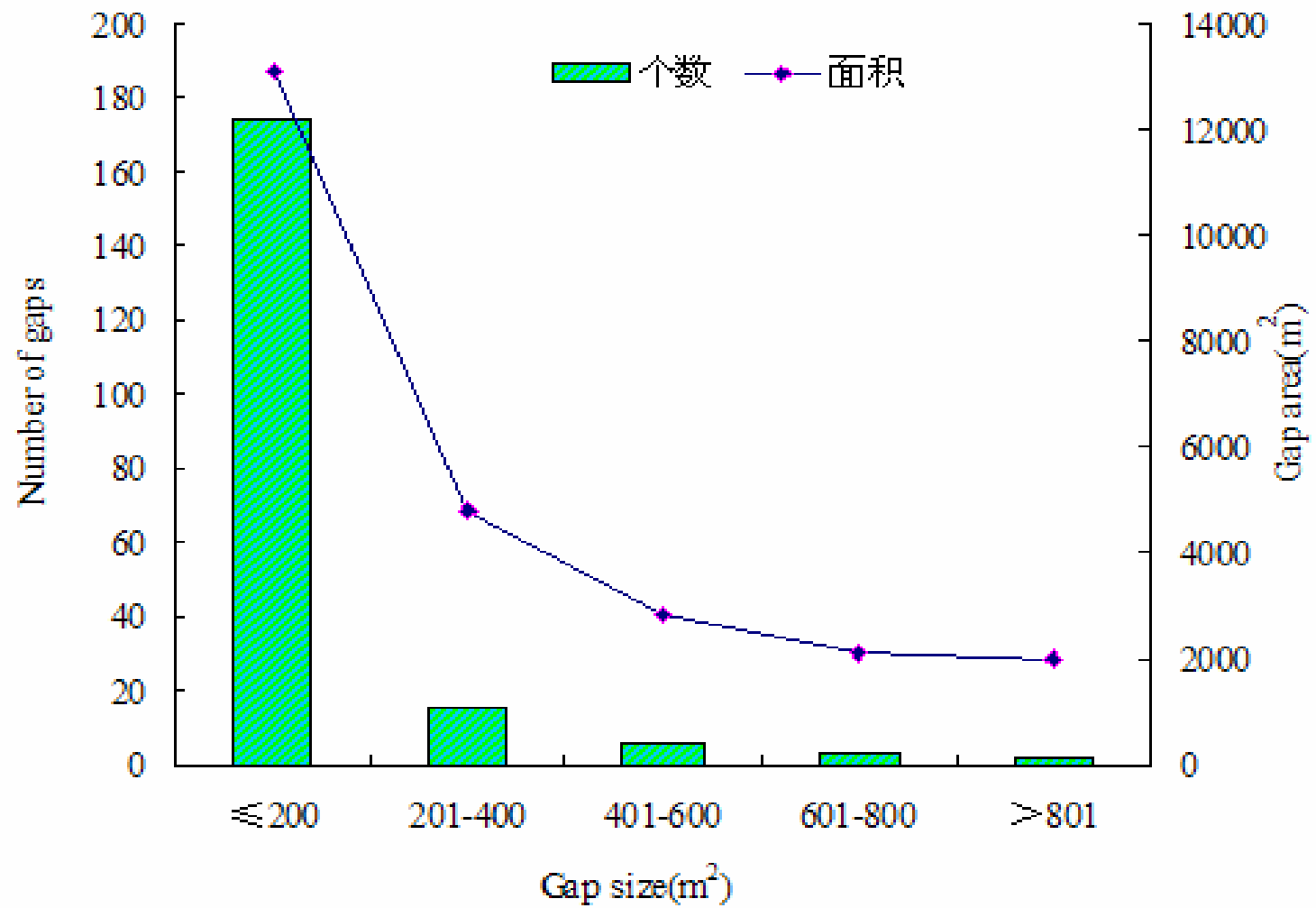
Successional cause

→ *Tree fall gaps*





Map of the 9 ha permanent plot in the broadleaved-Korean pine mixed forest. White and blue areas represent closed canopy and canopy gaps, respectively.



The number of individual per hectare of three developmental stage of tree species between forest gap and closed canopy in broadleaved-Korean pine mixedforest.



Species	Forest gap			Closed gap		
	Seedling	Sapling I	Sapling II	Seedling	Sapling I	Sapling II
<i>Syringa reticulata</i> var. <i>mandshurica</i>	1,900	225	32	1,450	75	72
<i>Fraxinus mandshurica</i>	1,125	125	8	2,050	75	8
<i>Ulmus laciniata</i>	550	475	48	200	0	96
<i>Acer mono</i>	500	250	60	1,025	450	52
<i>Acer tegmentosum</i>	450	250	68	1,425	175	32
<i>Acer ukurunduense</i>	225	200	112	300	250	96
<i>Tilia amurensis</i>	275	200	36	525	125	40
<i>Abies nephrolepis</i>	425	25	16	150	25	4
<i>Ulmus japonica</i>	200	200	24	25	200	0
<i>Betulla costata</i>	125	125	40	125	125	12
<i>Maackia amurensis</i>	50	175	0	0	0	0
<i>Prunus padus</i>	75	100	44	50	50	40
<i>Picea koraiensis</i>	150	50	4	25	0	4
<i>Pinus koraiensis</i>	50	0	16	200	75	12
<i>Rhamnus davurica</i>	50	0	0	0	0	0
<i>Populus ussuriensis</i>	0	0	32	0	0	0
<i>Phellodendron amurense</i>	0	0	8	0	0	0
<i>Tilia mandshurica</i>	0	0	8	25	25	8
<i>Salix integra</i>	0	0	8	0	0	0
<i>Alnus sibirica</i>	0	0	8	0	0	4
<i>Sorbus pohuashanensis</i>	0	0	4	0	0	4
<i>Rhamnus diamantica</i>	0	0	4	0	0	0
<i>Prunus maackii</i>	0	0	4	0	0	4
<i>Quercus mongolica</i>	0	0	0	0	0	4
Total	6,150	2,400	584	7,575	1,650	492

The number of individual per hectare of three developmental stage of Shrubs between forest gap and closed canopy in broadleaved-Korean pine mixedforest.



Species	Forest gap			Closed gap		
	Seedling	Sapling I	Sapling II	Seedling	Sapling I	Sapling II
<i>Deutzia glabata</i>	5,325	2,050	0	7,175	2,750	4
<i>Lonicera maackii</i>	4,025	600	12	6,500	700	0
<i>Philadelphus schrenkii</i>	2,025	1,000	24	2,100	950	12
<i>Corylus mandshurica</i>	975	1,675	384	1,675	2,500	288
<i>Euonymus pauciflorus</i>	2,200	700	28	4,650	925	20
<i>Acanthopanax senticosus</i>	700	1,525	0	1,650	1,450	16
<i>Sorbaria sorbifolia</i>	975	250	0	400	250	0
<i>Ribes manshuricum</i>	425	250	0	1,025	500	0
<i>Aralia mandshurica</i>	475	50	24	50	25	16
<i>Viburnum burejaeticum</i>	225	100	0	125	275	0
<i>Ribes burejense</i>	150	25	0	575	0	0
<i>Berberis amurensis</i>	125	50	0	300	150	0
<i>Spiraea elegans</i>	125	50	0	250	200	0
<i>Viburnum sargentii</i>	100	50	0	75	75	0
<i>Rosa koreana</i>	100	0	0	200	50	0
<i>Lonicera caerulea</i>	0	50	0	25	75	0
<i>Spiraea salicifolia</i>	0	0	0	75	0	0
Total	17,950	8,425	472	26,850	10,875	356



***F*-test for equality of variation and *t*-test for means of species richness between forest gap and closed canopy**

	Developmental stage	Forest gap (<i>n</i> =100)		Closed canopy (<i>n</i> =100)		<i>F</i>	<i>P</i> (<i>t</i> -test)
		Mean	Variation	Mean	Variation		
Tree species	Seedling	1.180	2.331	1.140	1.697	0.728*	0.842
	Sapling I	0.570	0.773	0.440	0.714	0.923*	0.288
	Sapling II	0.880	1.137	0.800	0.828	0.729*	0.569
Shrubs	Seedling	2.330	3.072	3.250	2.694	0.877*	0.000
	Sapling I	1.490	1.545	1.940	1.431	0.926*	0.01
	Sapling II	0.420	0.367	0.390	0.362	0.984*	0.726

*: $P \leq 0.05$ ($F_{99,99, 0.025} = 0.673$, $F_{99,99, 0.975} = 1.486$)



***F*-test for equality of variation and *t*-test for means of Simpson's index between forest gap and closed canopy**

	Developmental stage	Forest gap (<i>n</i> =100)		Closed canopy (<i>n</i> =100)		<i>F</i>	<i>P</i> (<i>t</i> -test)
		Mean	Variation	Mean	Variation		
Tree species	Seedling	0.162	0.070	0.169	0.064	0.912*	0.853
	Sapling I	0.054	0.028	0.039	0.021	0.776*	0.511
	Sapling II	0.118	0.049	0.106	0.042	0.856*	0.694
Shrubs	Seedling	0.350	0.098	0.492	0.054	0.556	0.000
	Sapling I	0.225	0.070	0.332	0.072	1.019*	0.005
	Sapling II	0.026	0.011	0.025	0.010	0.953*	0.969

*: $P \leq 0.05$ ($F_{99,99, 0.025} = 0.673$, $F_{99,99, 0.975} = 1.486$)

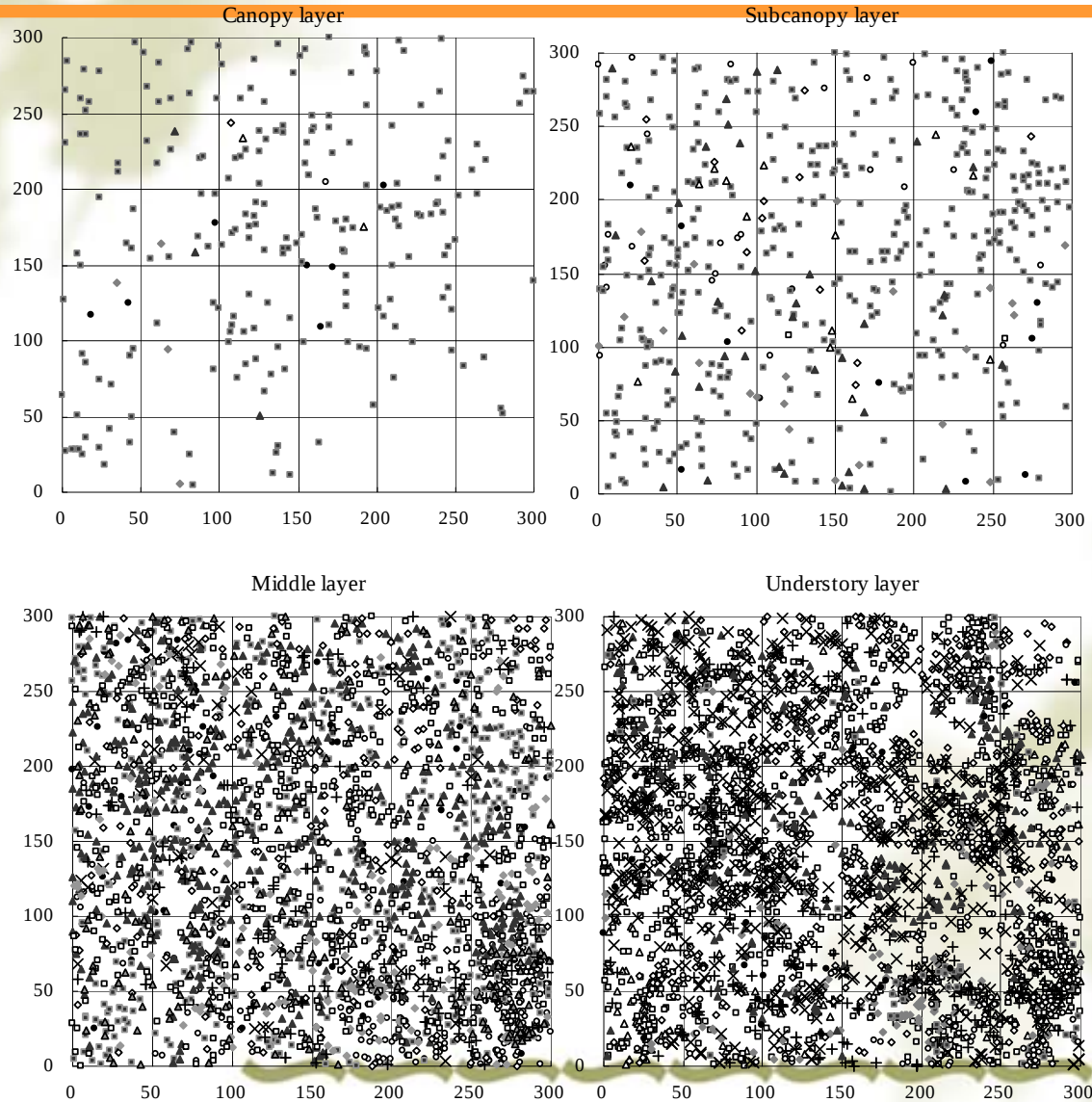


***F*-test for equality of variation and *t*-test for means of Shannon-Wiener function between forest gap and closed canopy**

	Developmental stage	Forest gap (<i>n</i> =100)		Closed canopy (<i>n</i> =100)		<i>F</i>	<i>P</i> (<i>t</i> -test)
		Mean	Variation	Mean	Variation		
Tree species	Seedling	0.275	0.223	0.277	0.185	0.830*	0.980
	Sapling I	0.086	0.075	0.064	0.063	0.829*	0.543
	Sapling II	0.186	0.129	0.156	0.094	0.731*	0.531
Shrubs	Seedling	0.623	0.342	0.881	0.214	0.625	0.001
	Sapling I	0.365	0.201	0.534	0.207	1.033*	0.009
	Sapling II	0.037	0.022	0.037	0.022	0.968*	0.979

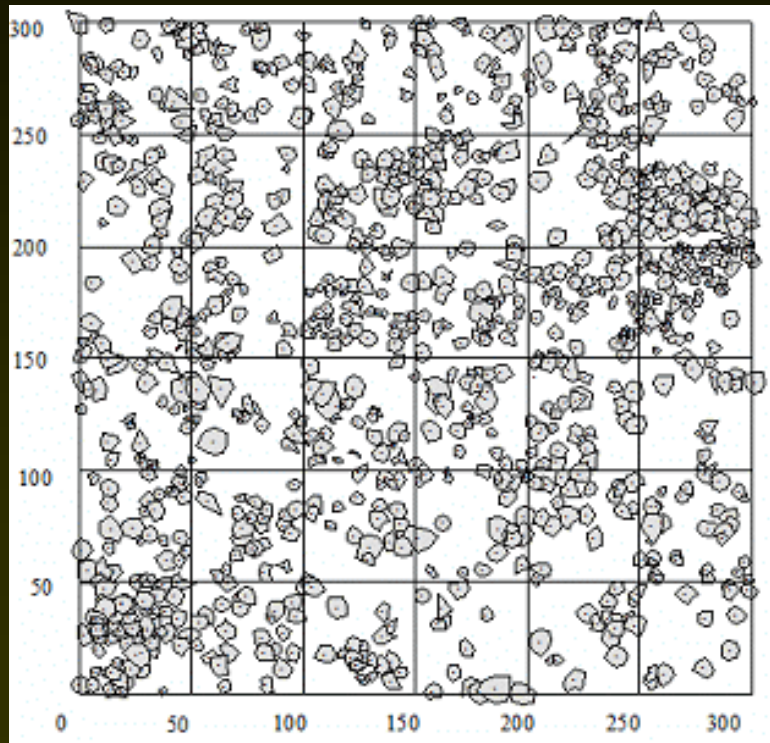
*: $P \leq 0.05$ ($F_{99,99, 0.025} = 0.673$, $F_{99,99, 0.975} = 1.486$)

Spatial Distribution Pattern and Association of Crowns and Saplings for Major Tree Species in the Mixed Broadleaved-Korean Pine Forest

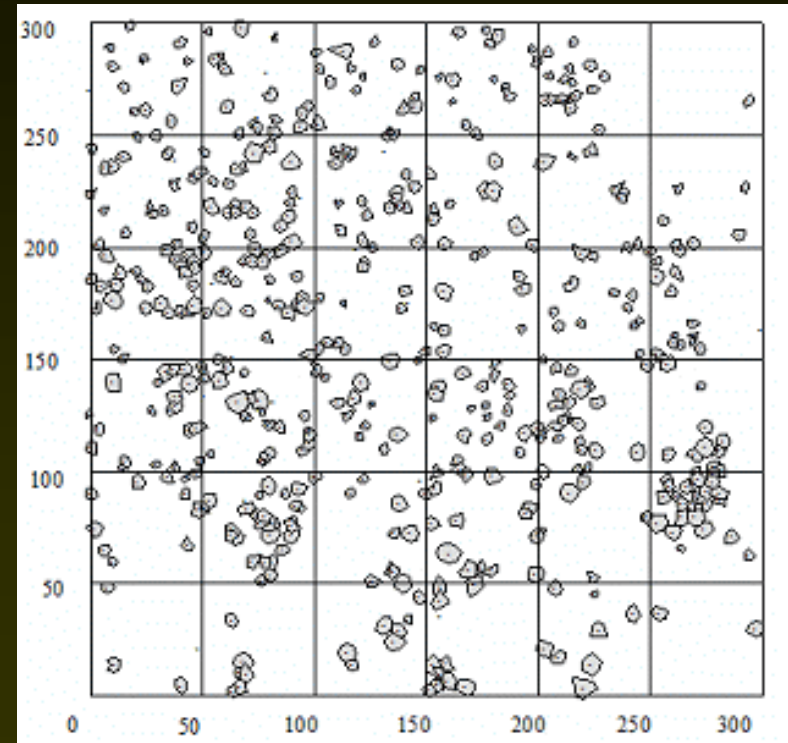


- *Betula costata*
- *Acer mono*
- *Picea koraiensis*
- *Pinus koraiensis*
- × *Acer ukurunduense*
- ▲ *Abies nephrolepis*
- ◇ *Ulmus laciniata*
- + *Acer tegmentosum*
- ◆ *Fraxinus mandshurica*
- △ *Tilia amurensis*

Spatial Distribution Pattern and Association of Crowns and Saplings for Major Tree Species in the Mixed Broadleaved-Korean Pine Forest

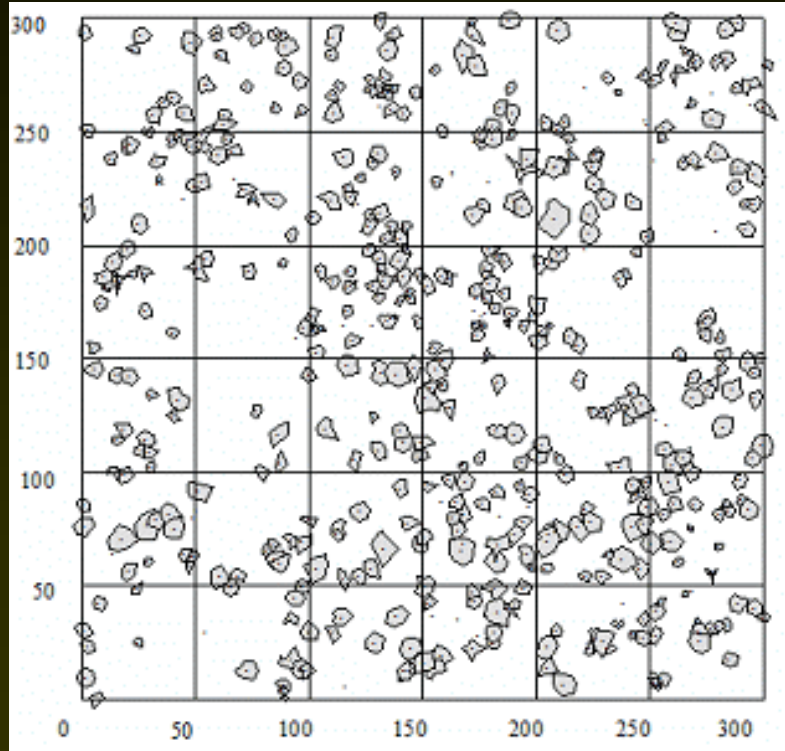


Pinus koraiensis

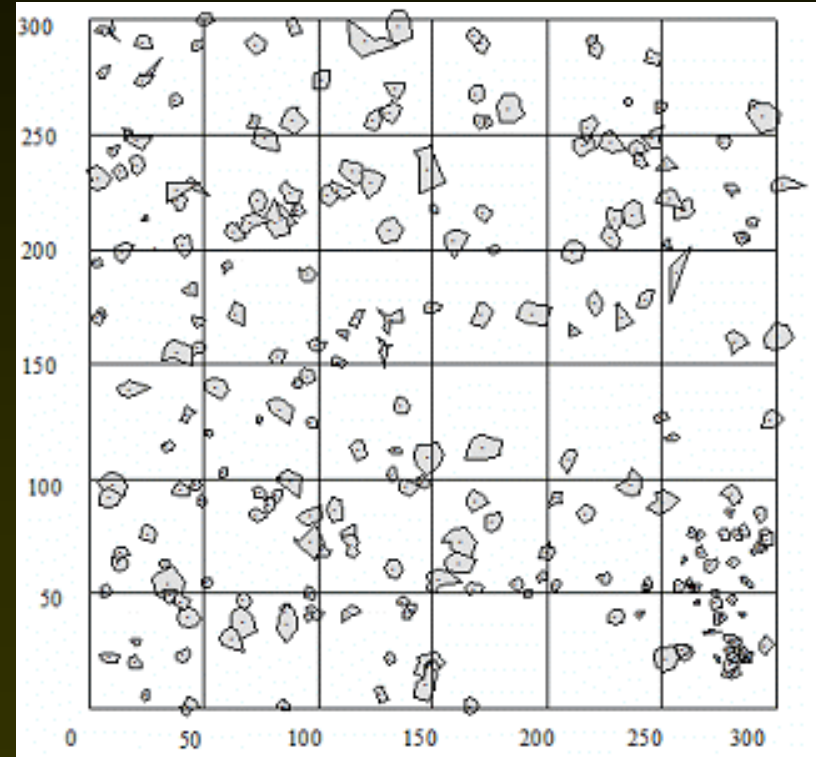


Abies nephrolepis

Spatial Distribution Pattern and Association of Crowns and Saplings for Major Tree Species in the Mixed Broadleaved-Korean Pine Forest

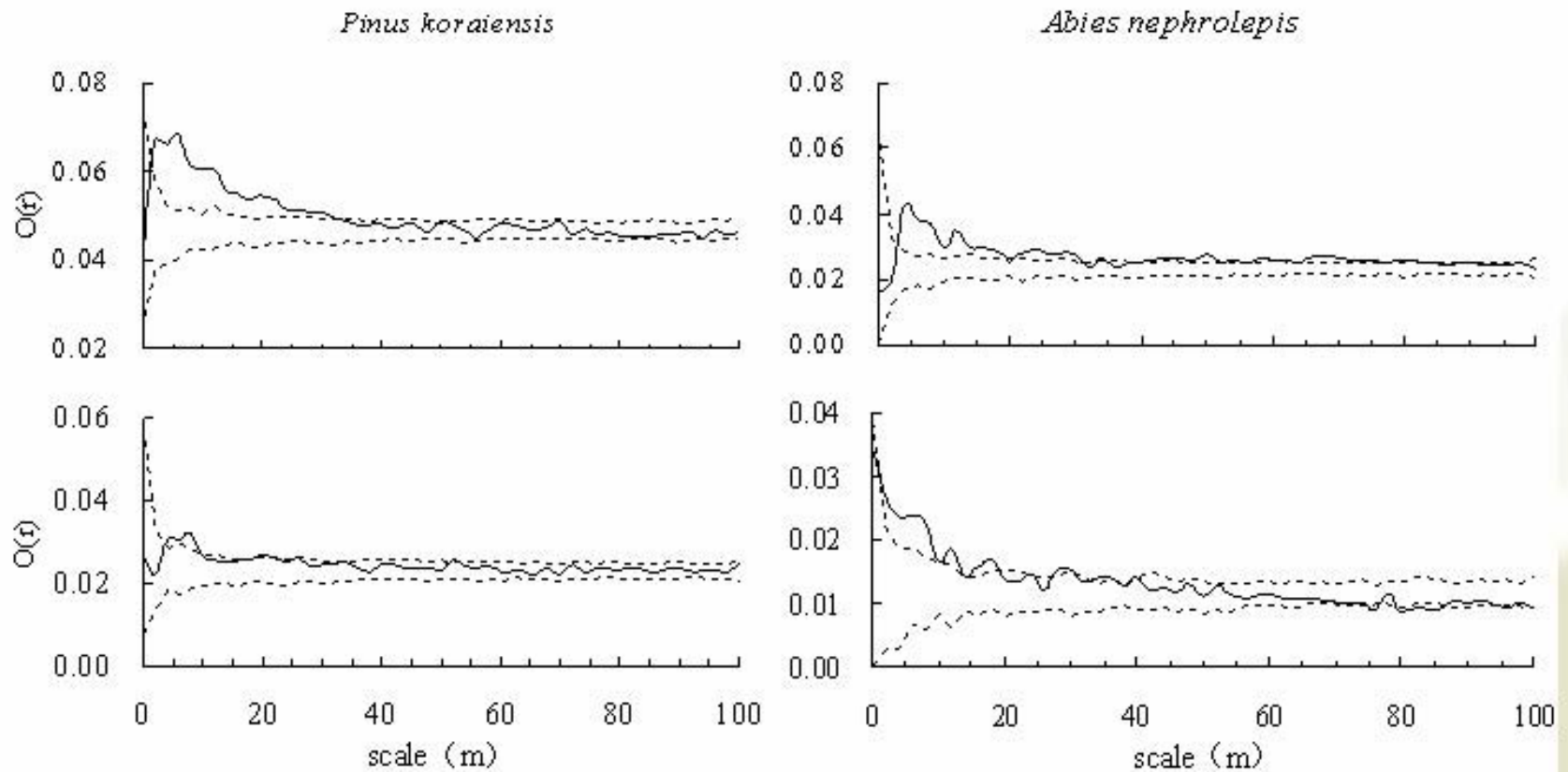


Acer mono



Tilia amurensis

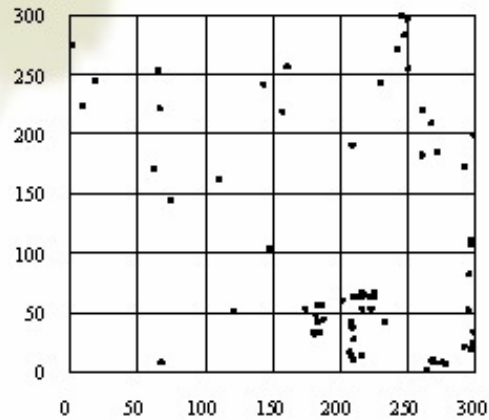
Spatial Distribution Pattern and Association of Crowns and Saplings for Major Tree Species in the Mixed Broadleaved-Korean Pine Forest



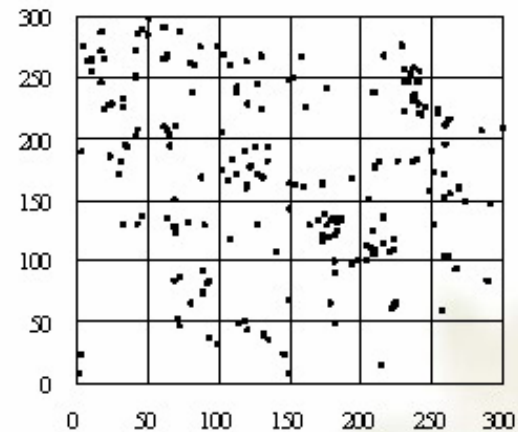
Spatial distribution patterns of crowns of major tree species at overstory in the 9ha plot

The distribution of saplings of major tree species in the 9ha plot.

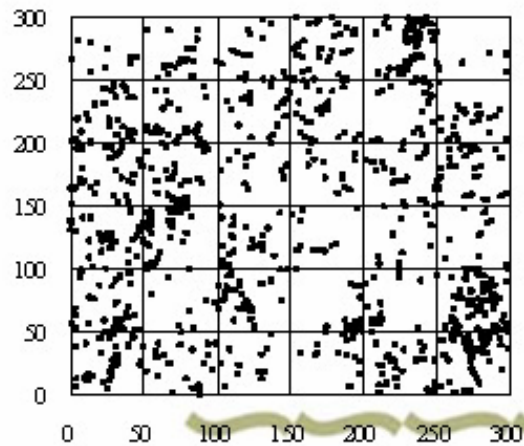
Pinus koraiensis



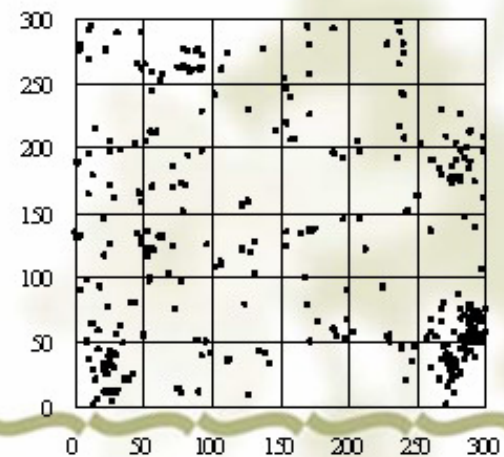
Abies nephrolepis



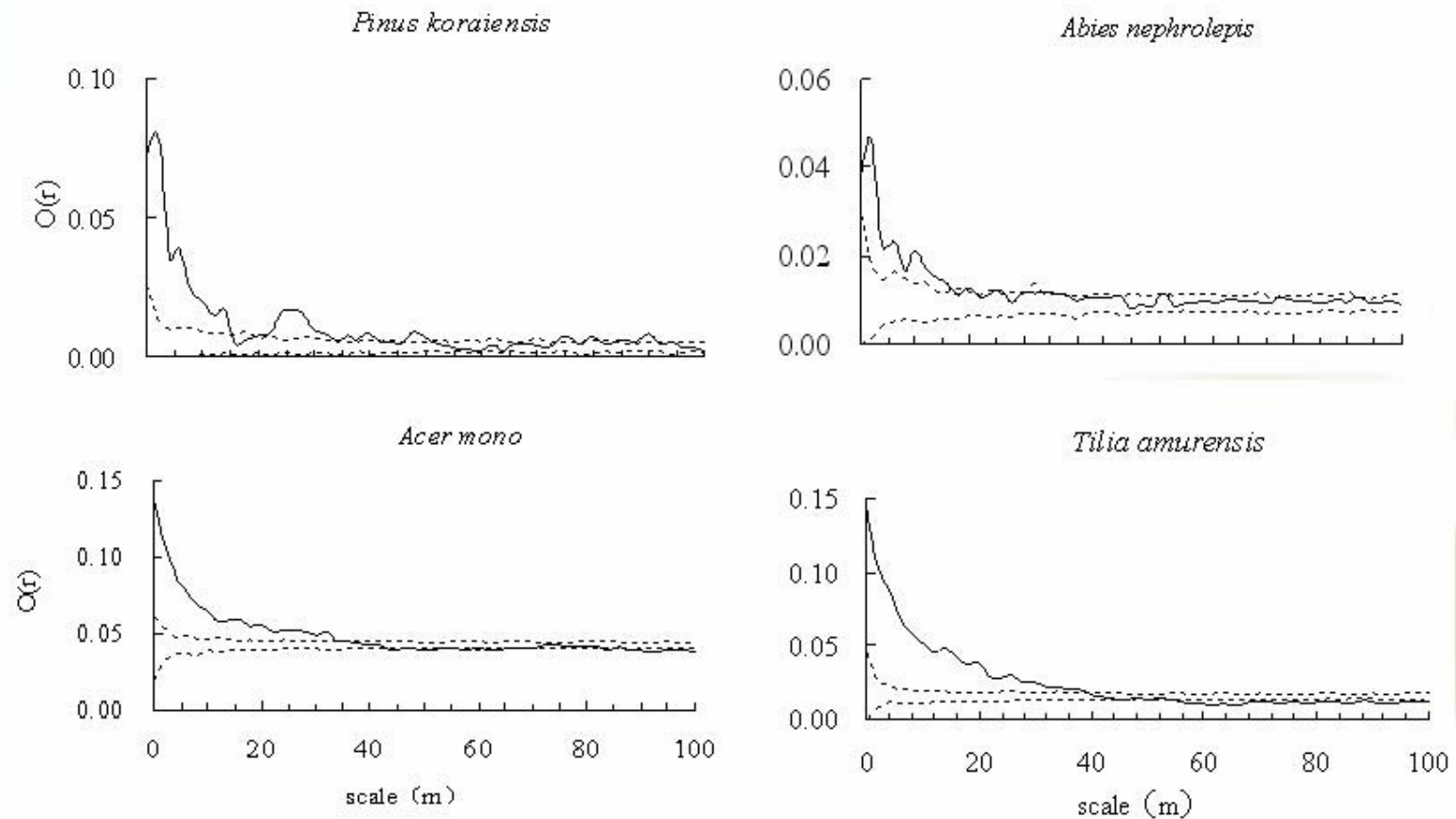
Acer mono



Tilia amurensis

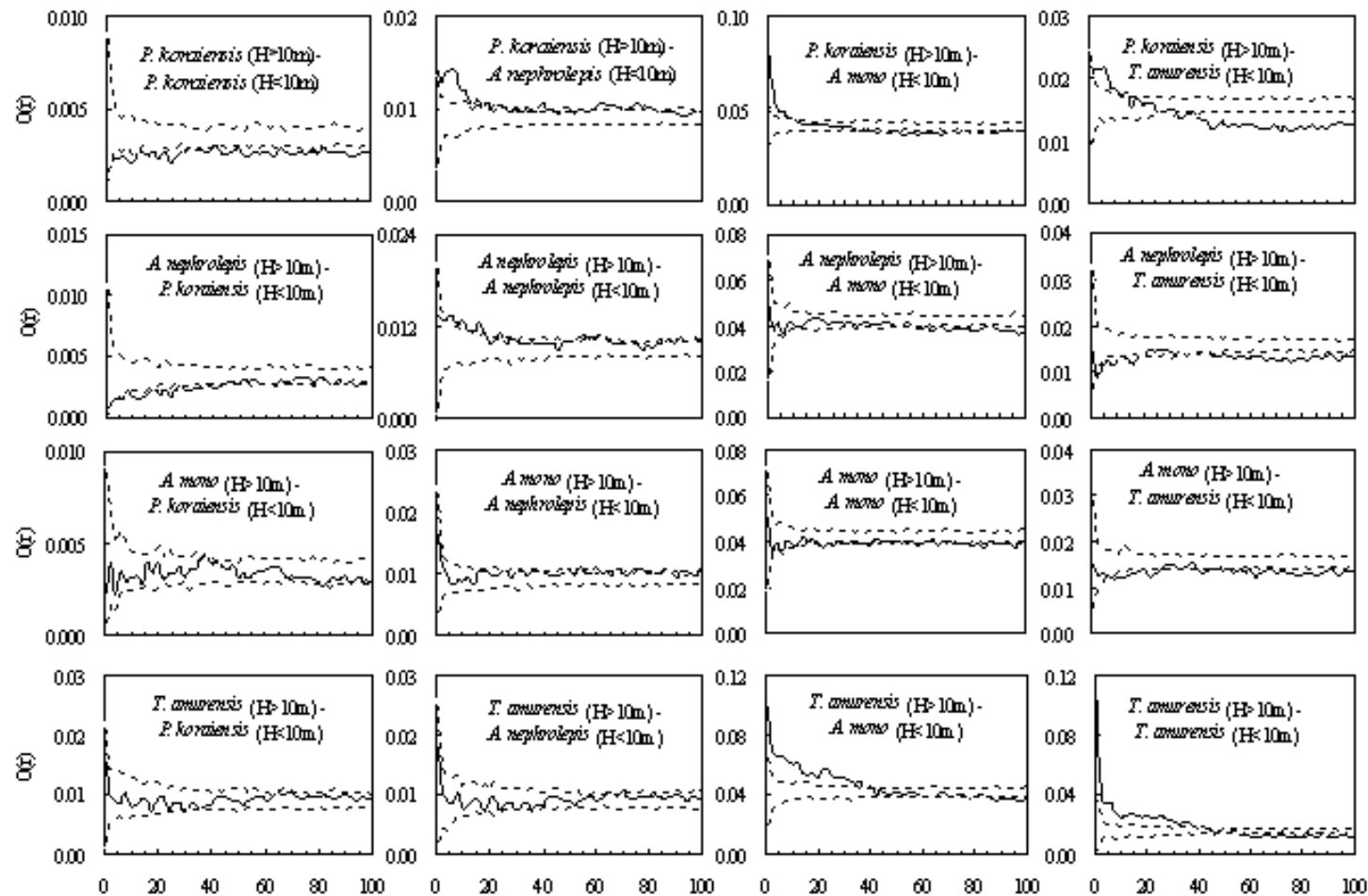


Spatial Distribution Pattern and Association of Crowns and Saplings for Major Tree Species in the Mixed Broadleaved-Korean Pine Forest

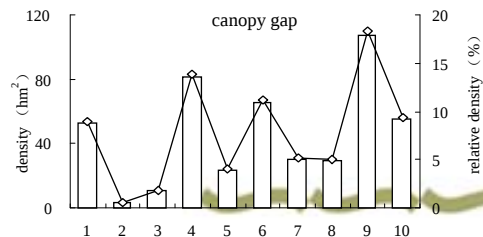
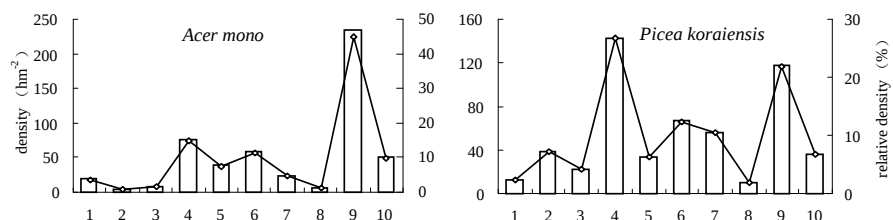
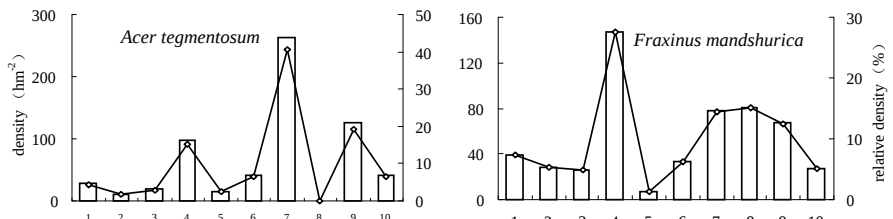
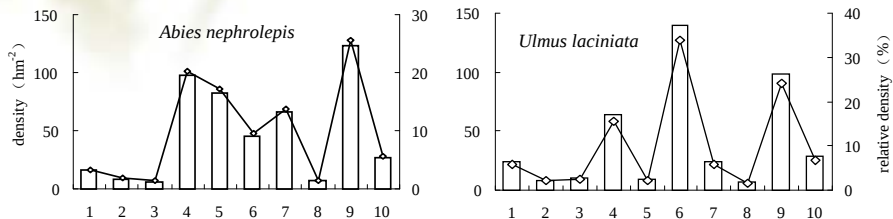
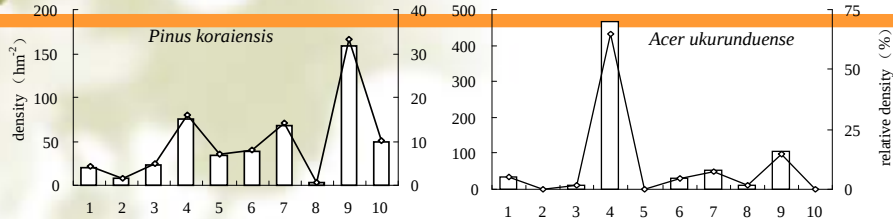
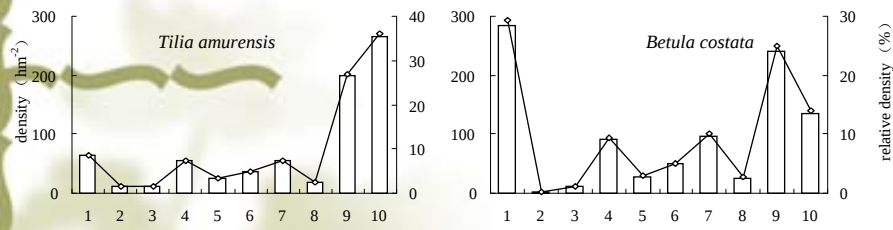


Spatial distribution patterns of saplings of major tree species in the 9ha plot.

Spatial Distribution Pattern and Association of Crowns and Saplings for Major Tree Species in the Mixed Broadleaved-Korean Pine Forest



Spatial associations of crowns and saplings of major tree species in the 9ha plot.



- 1 *Betula costata*,
- 2 *Picea koraiensis*,
- 3 *Pinus koraiensis*,
- 4 *Acer ukurunduense*,
- 5 *Abies nephrolepis*,
- 6 *Ulmus laciniata*,
- 7 *Acer tegmentosum*,
- 8 *Fraxinus mandshurica*,
- 9 *Acer mono*,
- 10 *Tilia amurensis*

Distribution of sapling of dominant tree species under canopy patches

2. Character study on the Coarse Woody Debris in the broad-leaved Korean pine Mixed forest



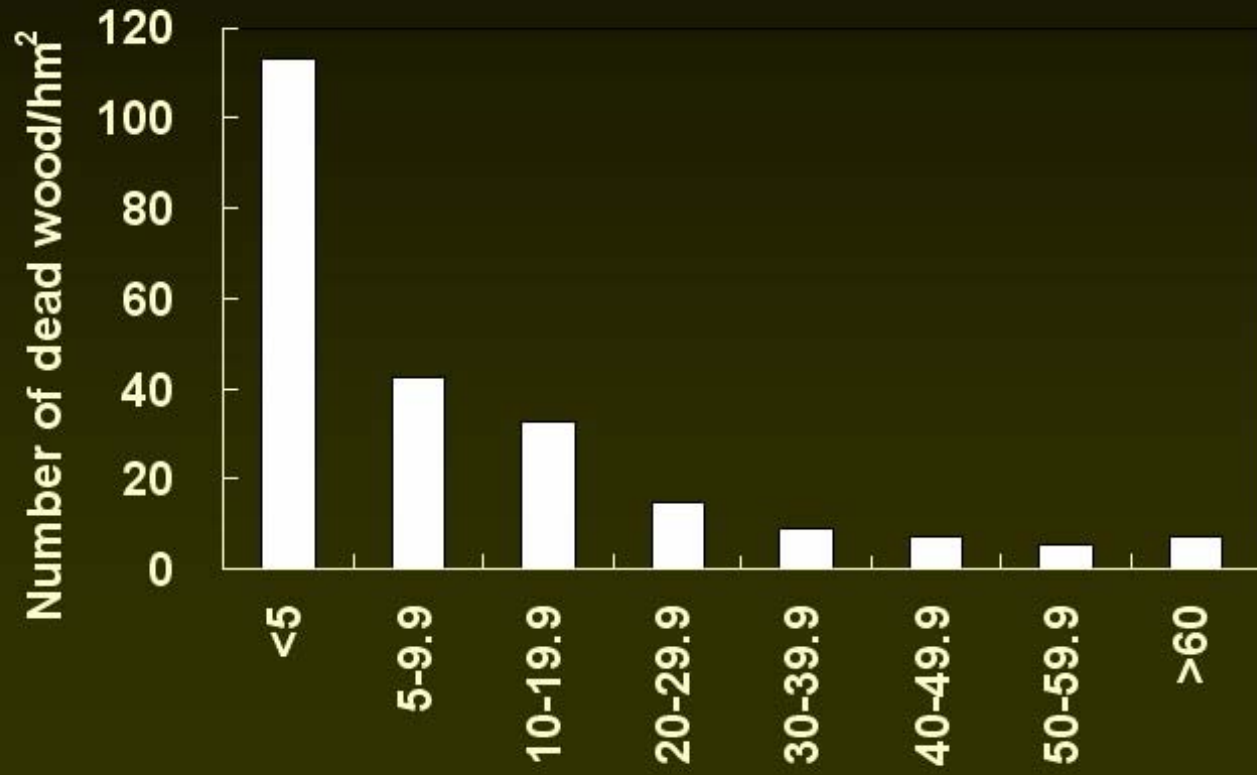


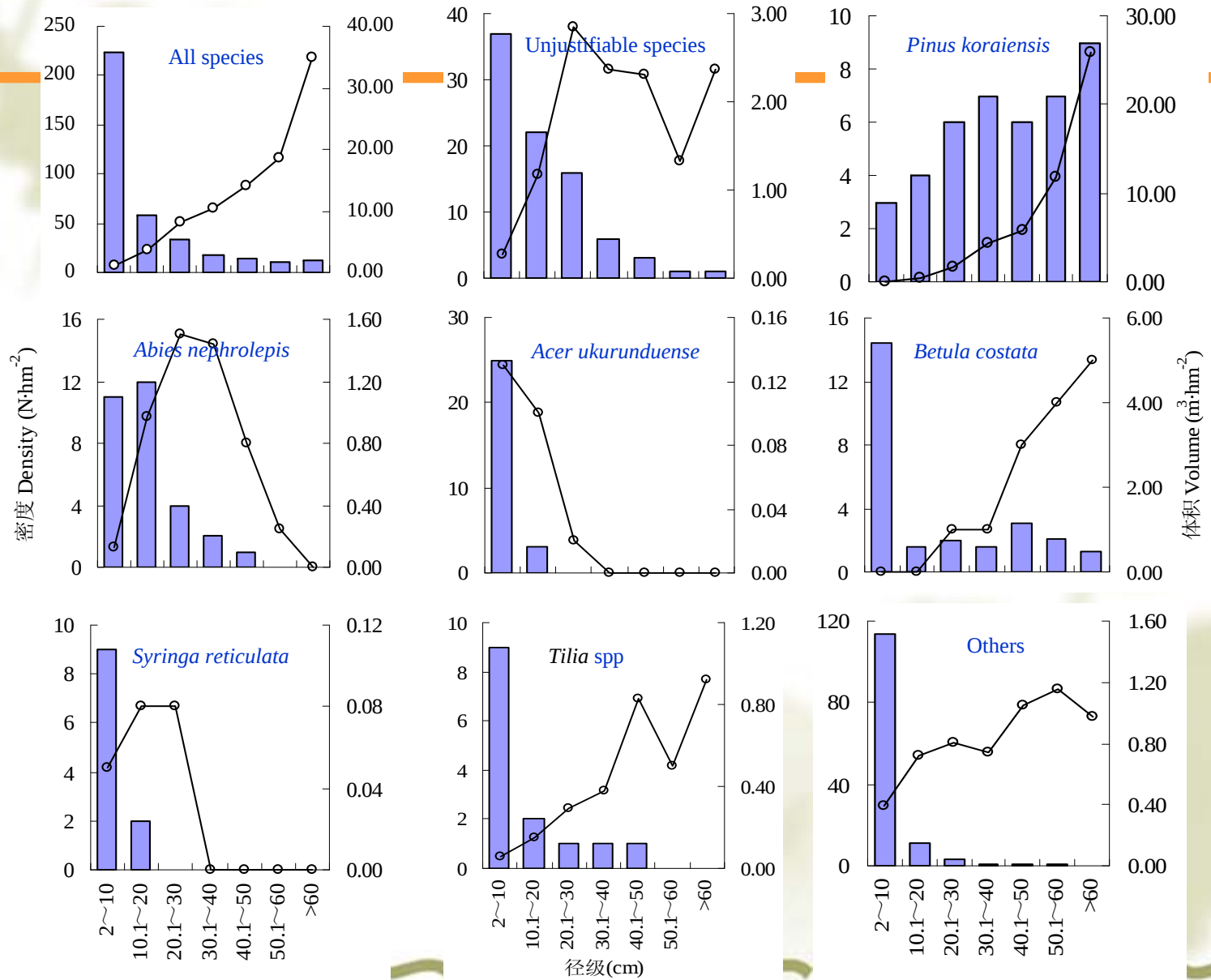


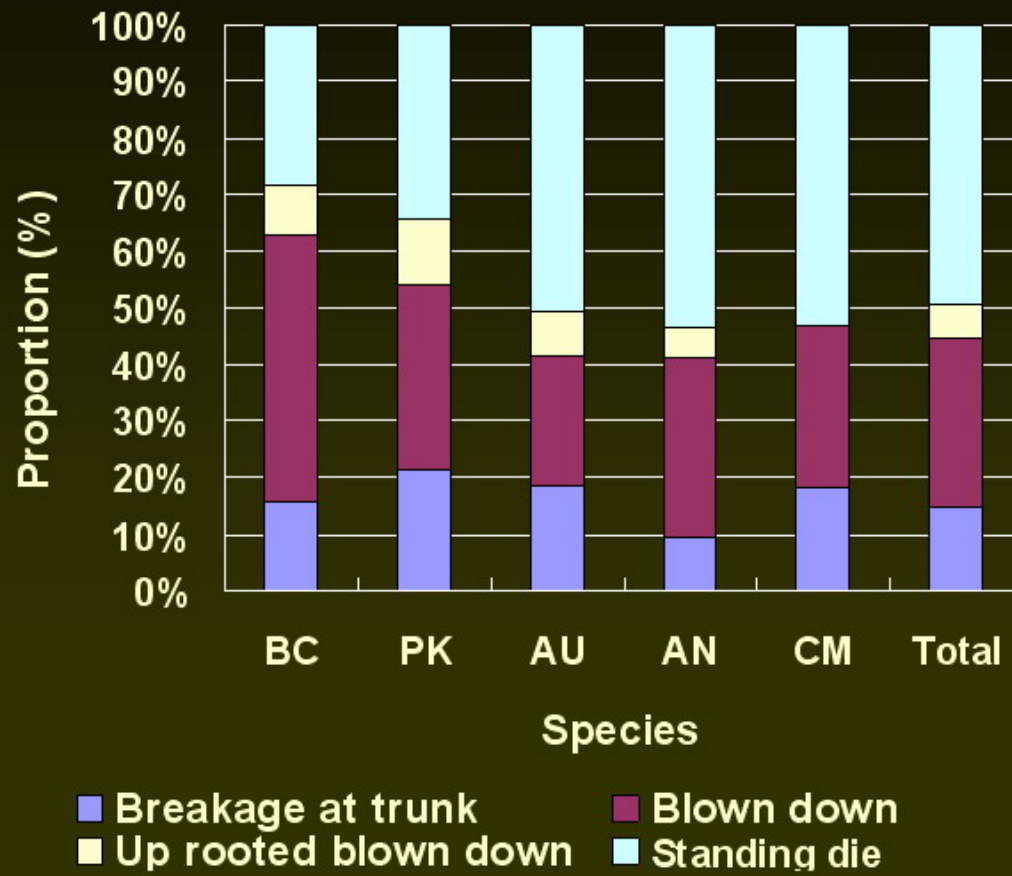


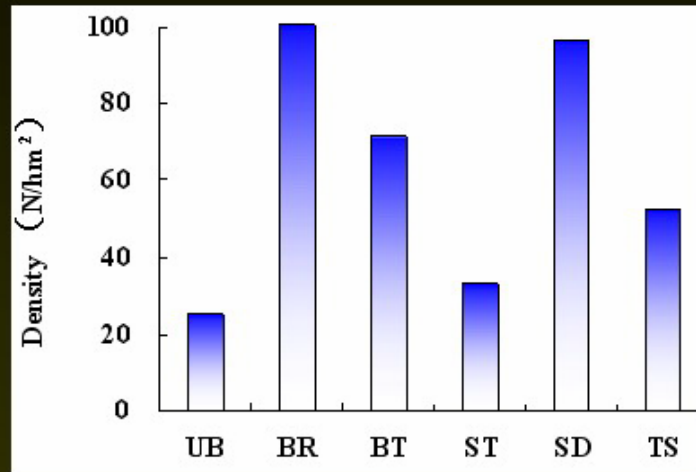
The component of CWD for species in the broadleaved-Korean pine mixed forest

Species	Density (N/hm ²)	Basal area (m ² /hm ²)	Volume (m ³ /hm ²)
<i>F. mandshurica</i>	4	0.11	0.49
<i>A. mono</i>	6	0.04	0.14
<i>P. koraiensis</i>	6	0.42	2.66
<i>A. tegmentosum</i>	9	0.11	0.46
<i>U. pumila</i>	10	0.06	0.26
<i>T. amurensis</i>	12	0.42	3.01
<i>B. costata</i>	27	1.96	13.88
<i>A. Ukurunduense</i>	28	0.10	0.24
<i>A. nephrolepis</i>	30	0.75	5.10
<i>P. koraiensis</i>	42	7.94	50.04
shrub	68	0.04	0.07
?	96	3.45	12.64

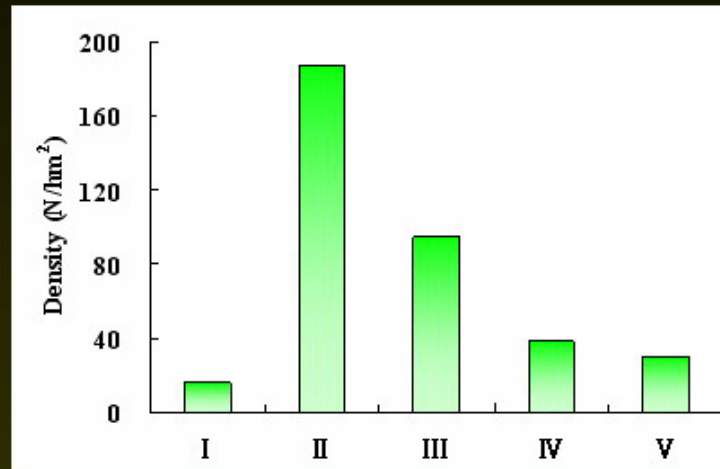






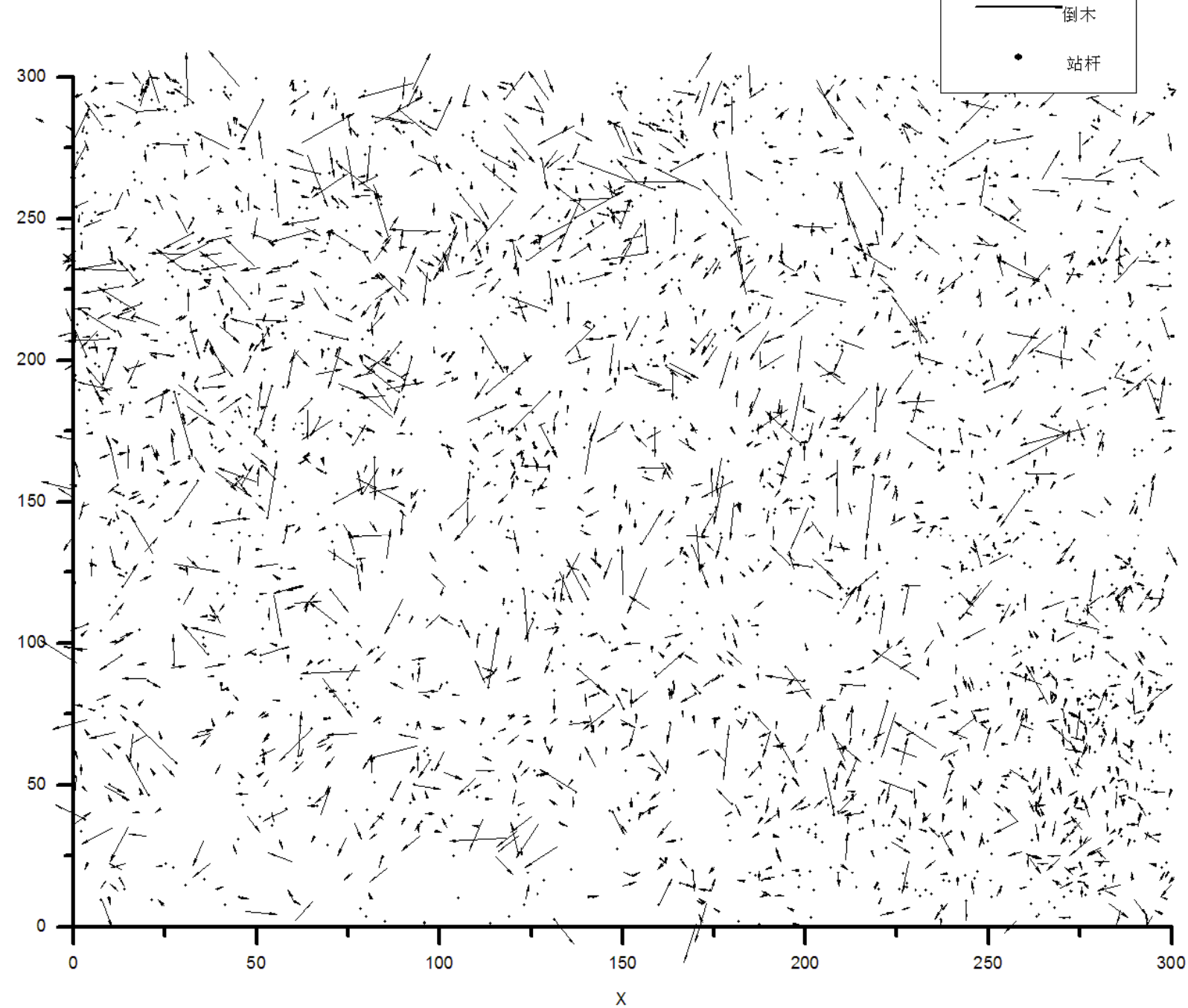


Number of existing forms for CWD



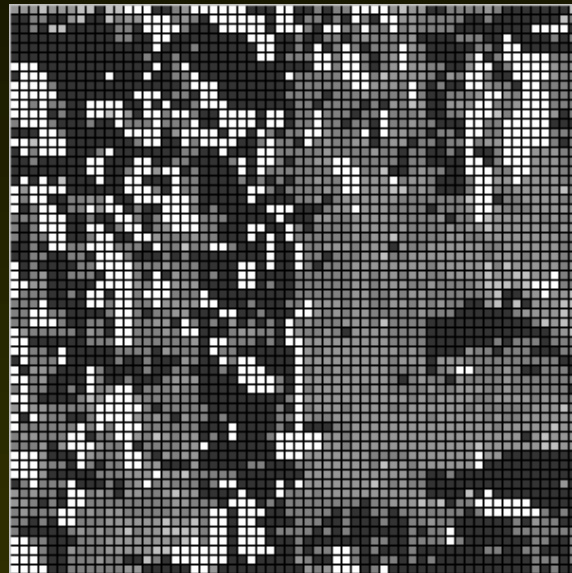
Distribution of decay classes for CWD

UB: Uprooted blow-down
BR :Breakage at rootstock
BT: Breakage at trunk
ST: Stump
SD: Standing die
TS: Trunk segment



Spatial Pattern of CWD

Number of CWD on different Topography



☐ Valley
 ☐ downgrade
 ☐ upgrade
 ☐ ridge

☐ NE, N
 ☐ E, NW
 ☐ Flat
 ☐ SE, W
 ☐ S, SW

☐ <6°
 ☐ 6°~15°
 ☐ 16°~25°
 ☐ >25°

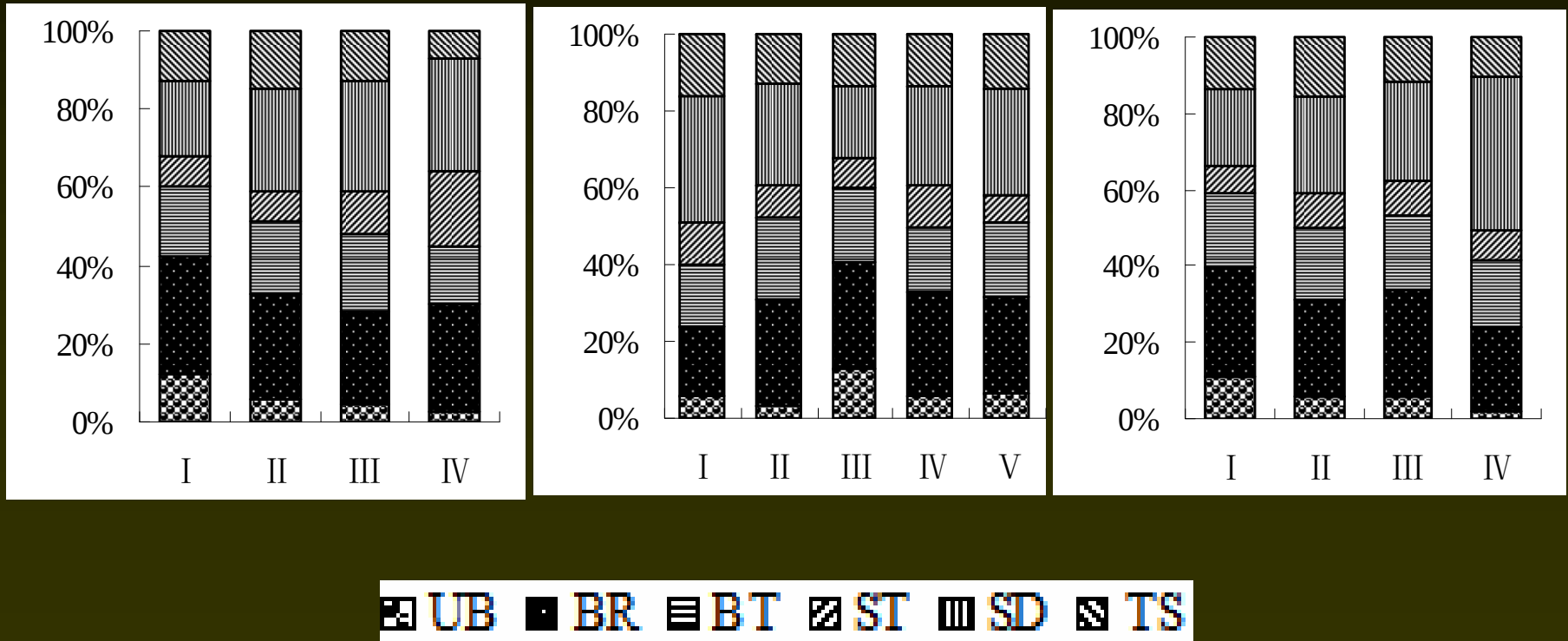
Distribution of topography



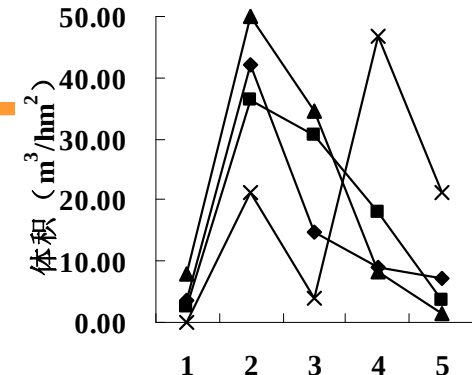
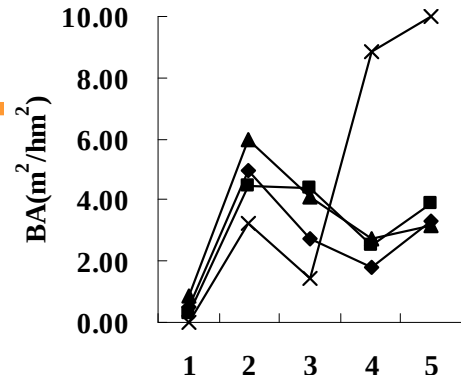
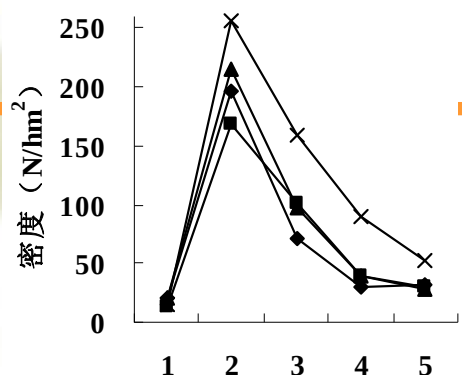
Number of CWD on different Topography

Topography		Density (N/hm ²)	Basal area (m ² /hm ²)	Volume (m ³ /hm ²)
Topographic position	Valley	363 ± 17.23	13.42 ± 1.34	76.80 ± 10.44
	Downgrade	364 ± 10.25	15.84 ± 0.96	91.32 ± 8.05
	Upgrade	417 ± 17.47	17.18 ± 1.47	102.53 ± 12.25
Aspect	Ridge	626 ± 90.48	23.95 ± 7.43	95.45 ± 35.13
	NE,N	542 ± 73.61	28.26 ± 7.01	220.97 ± 89.98
	E,NW	415 ± 19.74	21.12 ± 1.98	140.28 ± 18.24
	Flat	359 ± 17.22	13.43 ± 1.41	76.65 ± 10.96
	SE,W	395 ± 14.59	16.38 ± 1.33	84.37 ± 9.84
Gradient	S,SW	348 ± 13.51	12.68 ± 1.02	68.43 ± 7.29
	<6°	366 ± 15.61	14.09 ± 1.30	85.65 ± 10.11
	6° ~15°	363 ± 10.92	15.94 ± 1.02	93.12 ± 8.68
	16° ~25°	421 ± 18.33	17.77 ± 1.62	97.41 ± 13.32
	>25°	420 ± 35.73	13.93 ± 2.12	73.15 ± 13.87

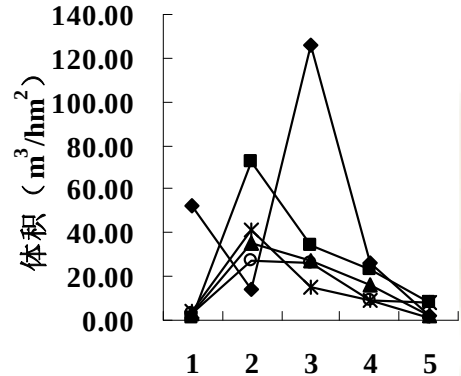
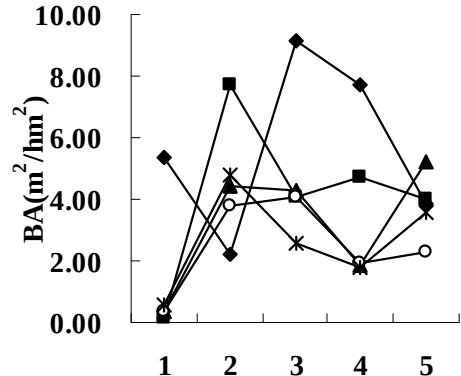
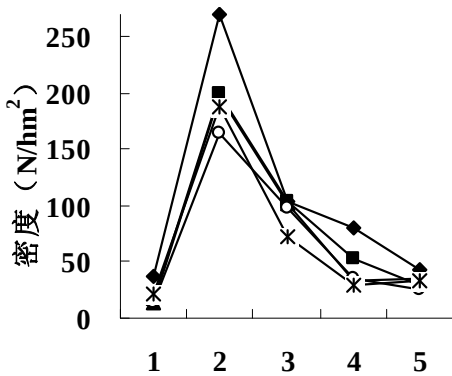
Number of CWD on different Topography



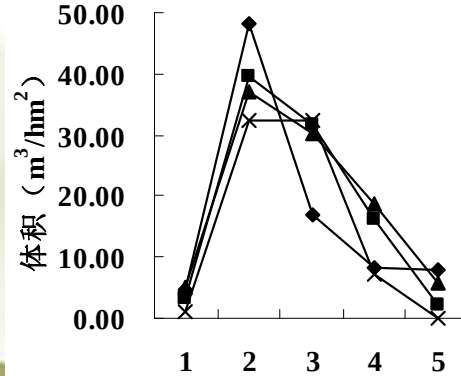
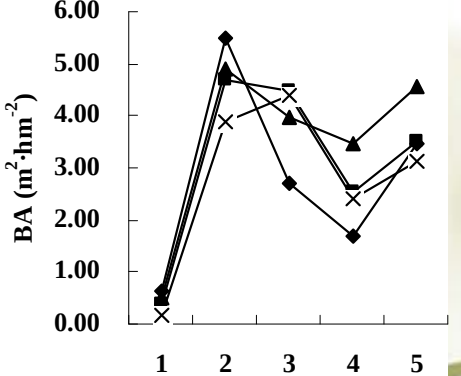
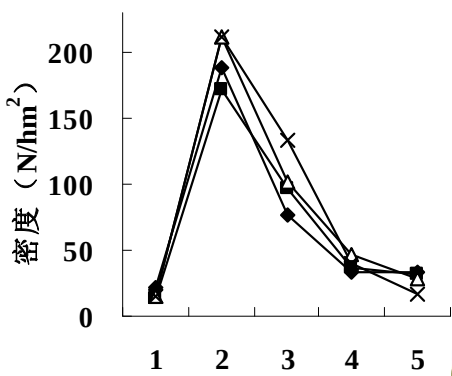
Percentage of existing forms of CWD on different Topography



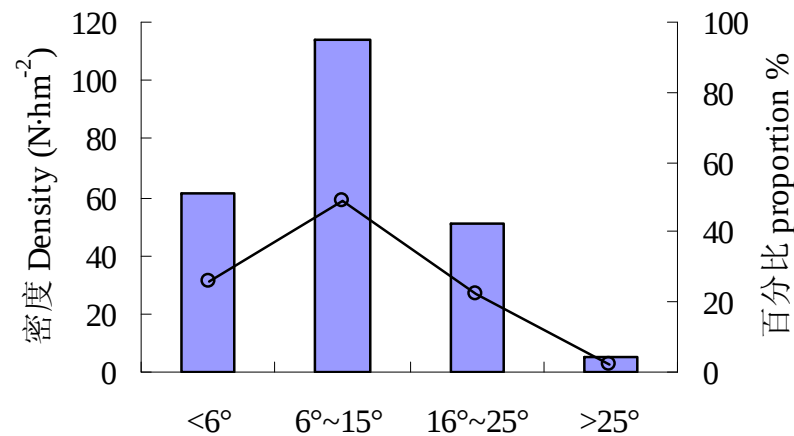
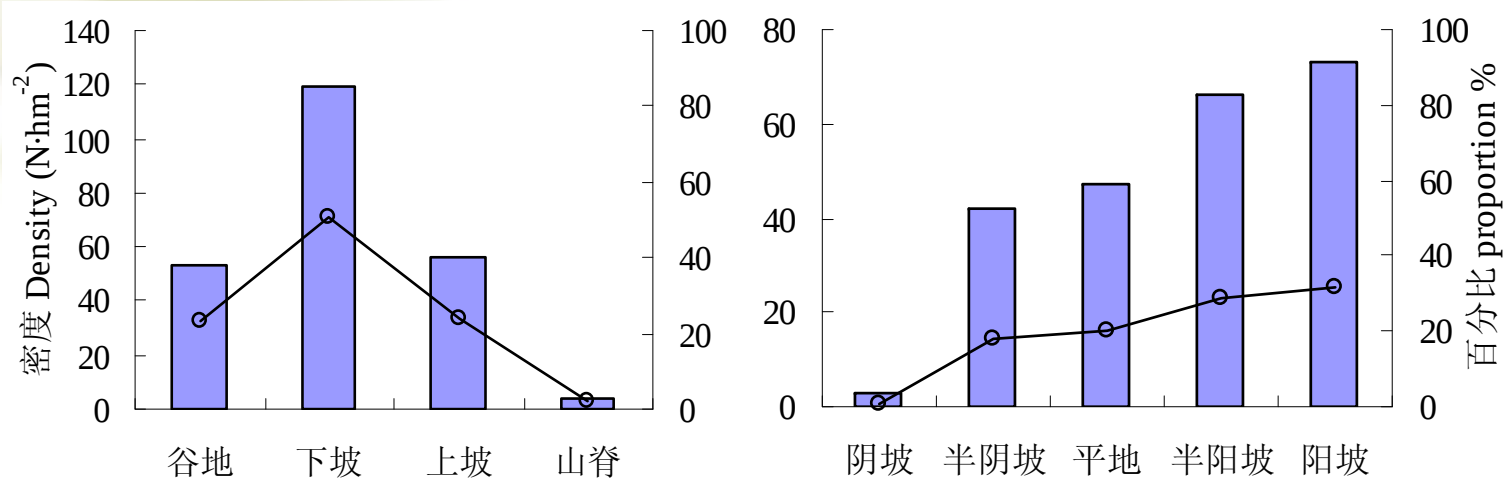
坡位



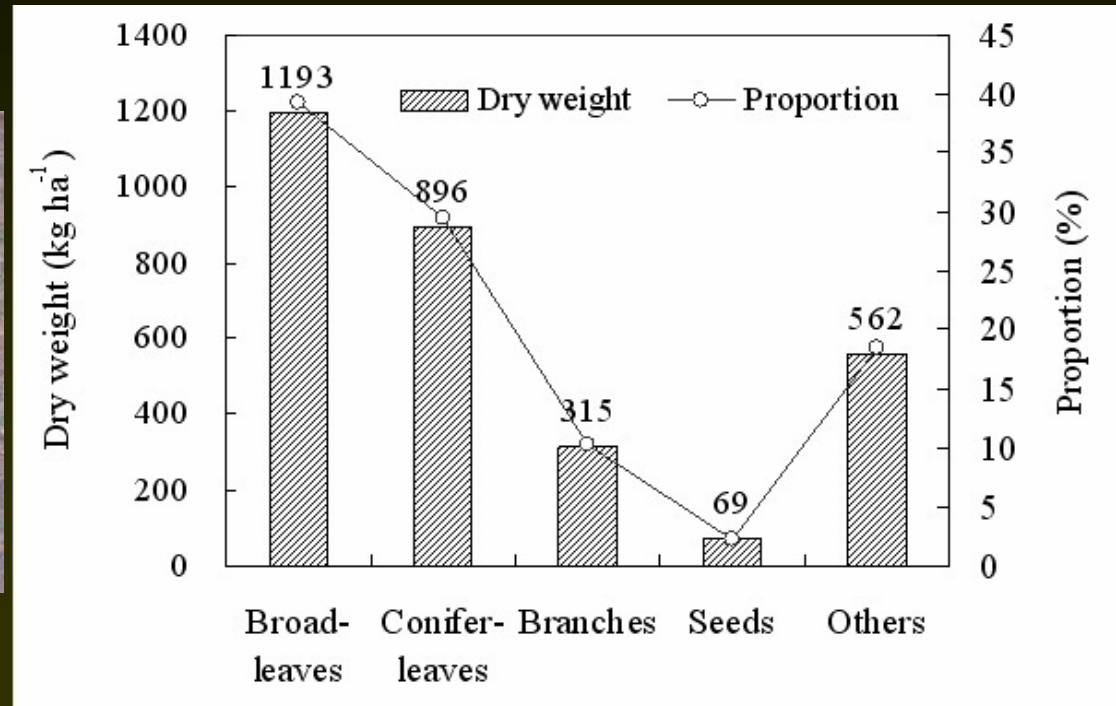
坡向



坡度

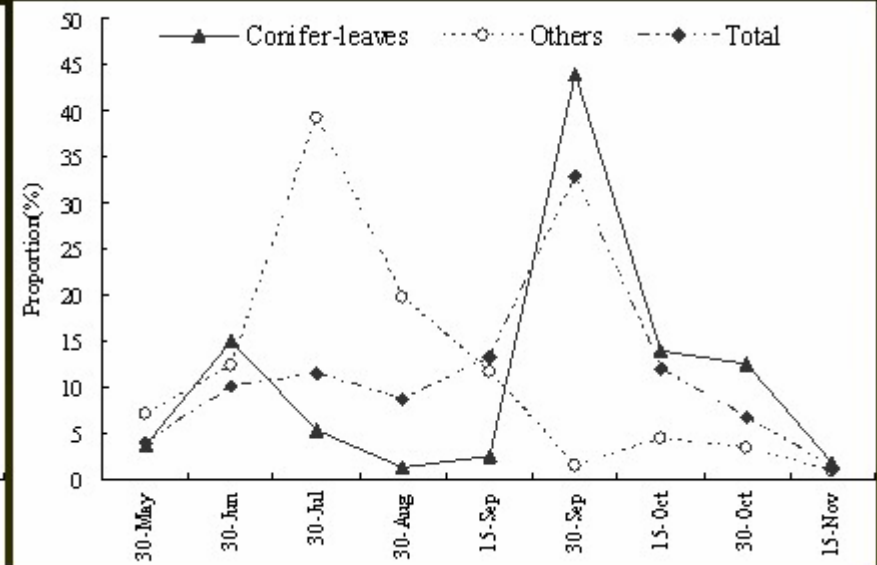
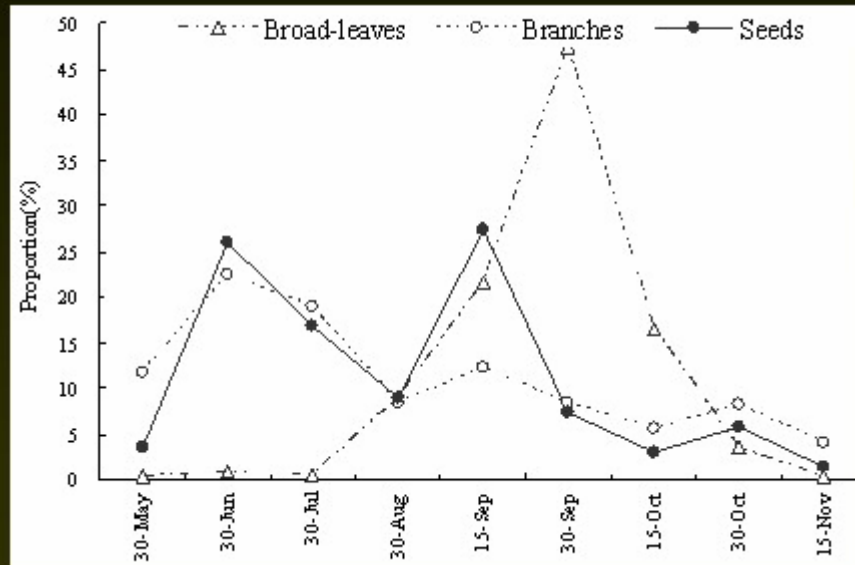


3. The Production and Spatial Heterogeneity of Litterfall in the Broadleaved—Korean Pine Mixed Forest



Annual litterfall production in the broadleaved-Korean pine mixed forest

Temporal pattern of litterfall in the broadleaved-Korean pine mixed forest

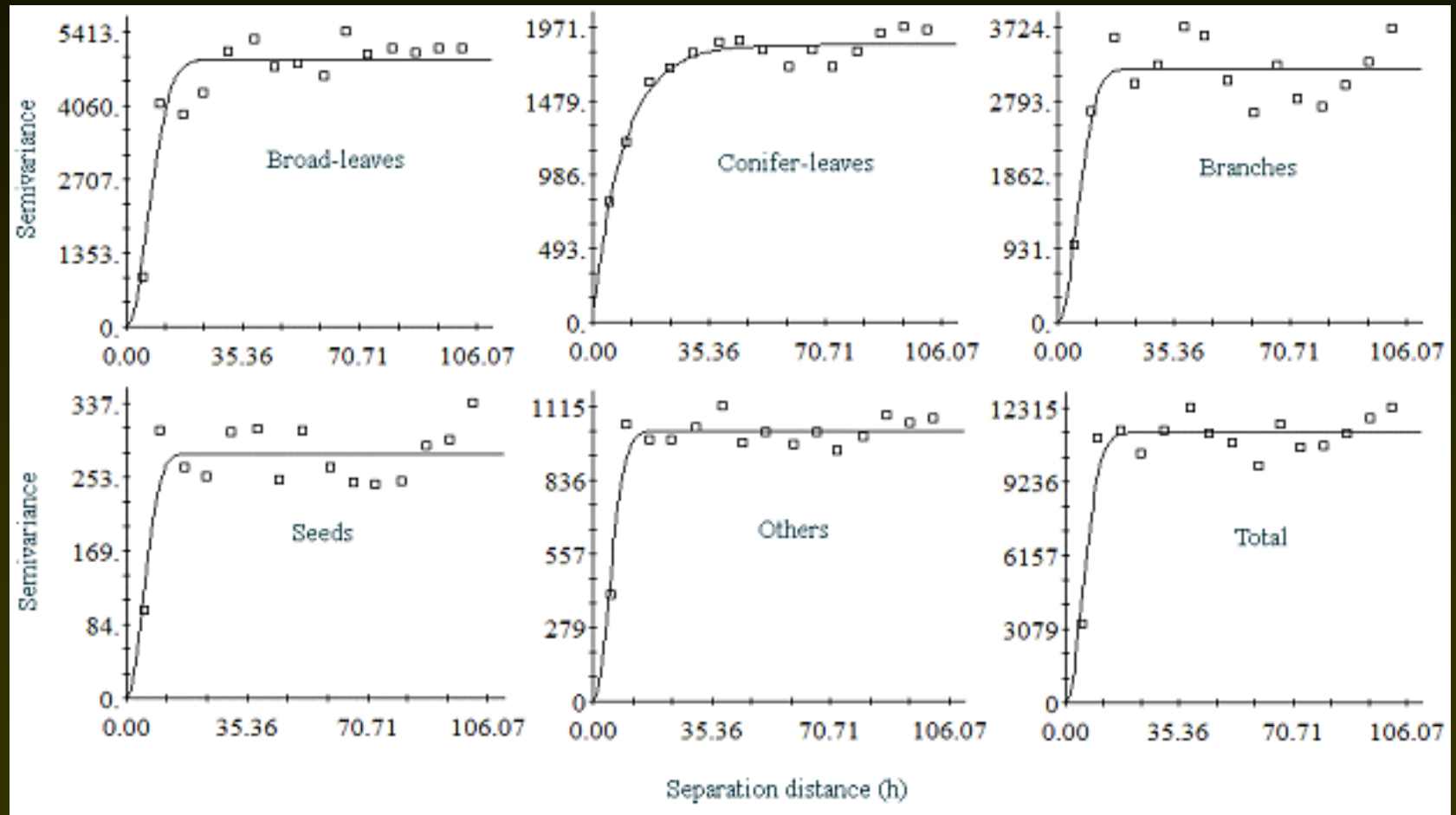




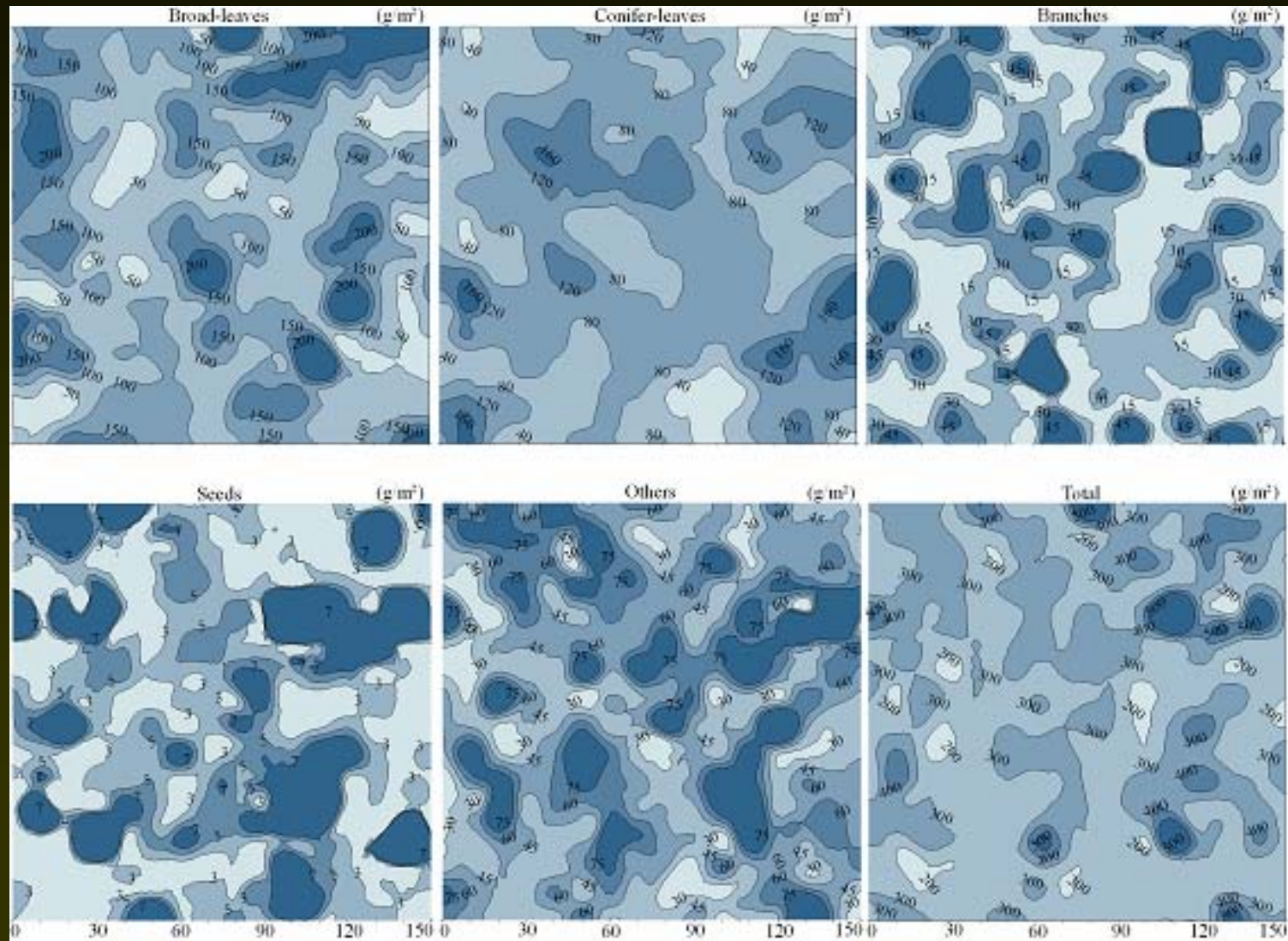
Semivariogram models and parameters of litterfall in the broadleaved-Korean pine mixed forest

Component	Model	Nugget (C_0)	Sill (C_0+C)	Range (A)	Proportion ($C/[C_0+C]$)	R^2	D^*
Broad-leaves	Gaussian	10.0	4902	15.93	0.998	0.859	1.806
Conifer-leaves	Exponential	56.0	1851	29.1	0.970	0.939	1.882
Branches	Gaussian	10.0	3198	14.03	0.997	0.731	1.885
Seeds	Gaussian	0.1	279	11.60	1.000	0.654	1.903
Others	Gaussian	1.0	1021	11.60	0.999	0.878	1.910
Total	Gaussian	10.0	11250	12.82	0.999	0.857	1.879

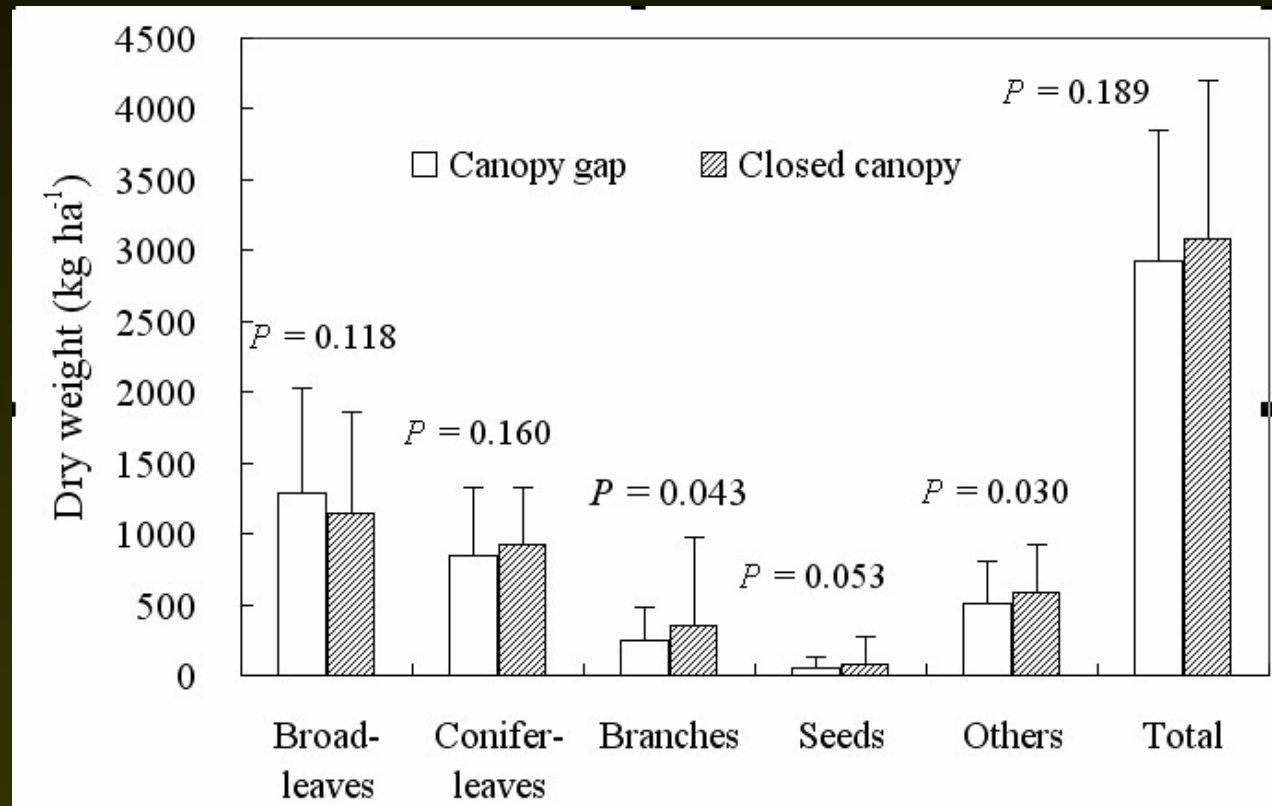
Isotropic semivariogram curves of litterfall in the broadleaved-Korean pine mixed forest



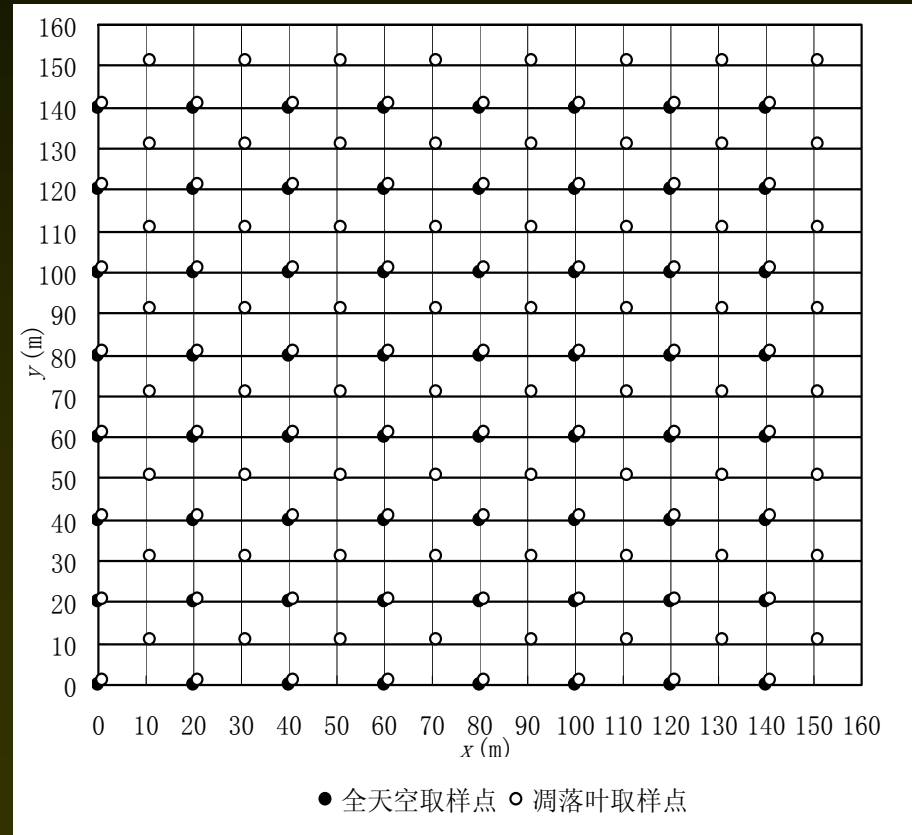
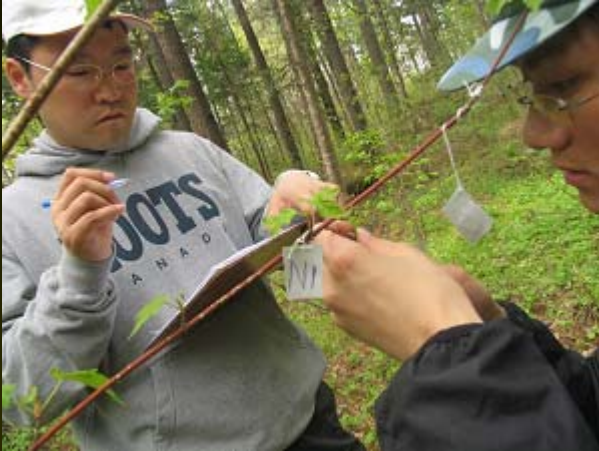
Spatially interpolated litterfall of the main permanent plot



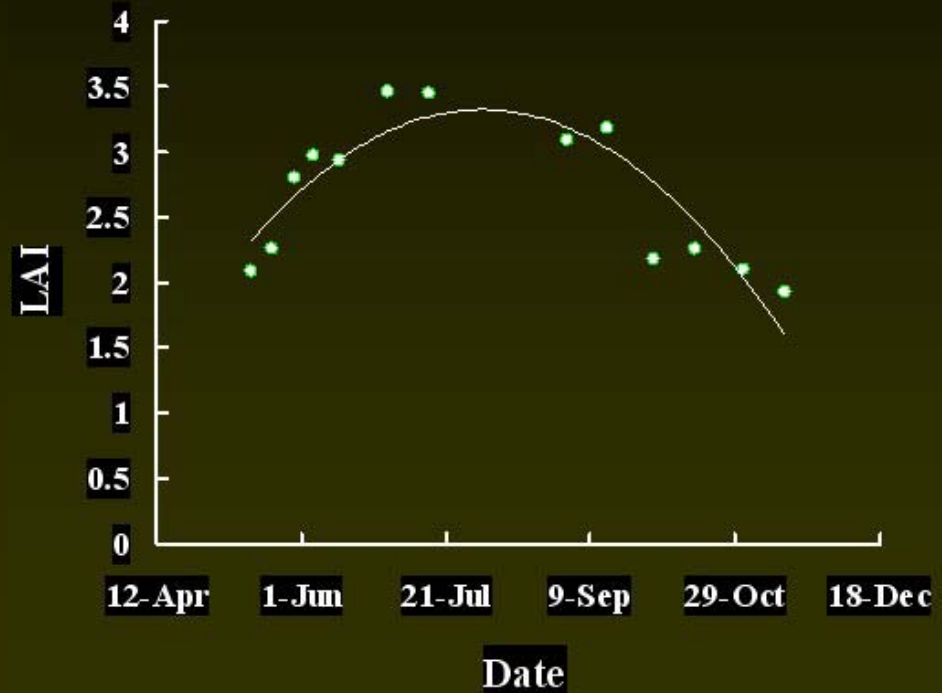
Dry weight of litterfall in the canopy gap and closed canopy. Data shows mean $\pm$ SE.



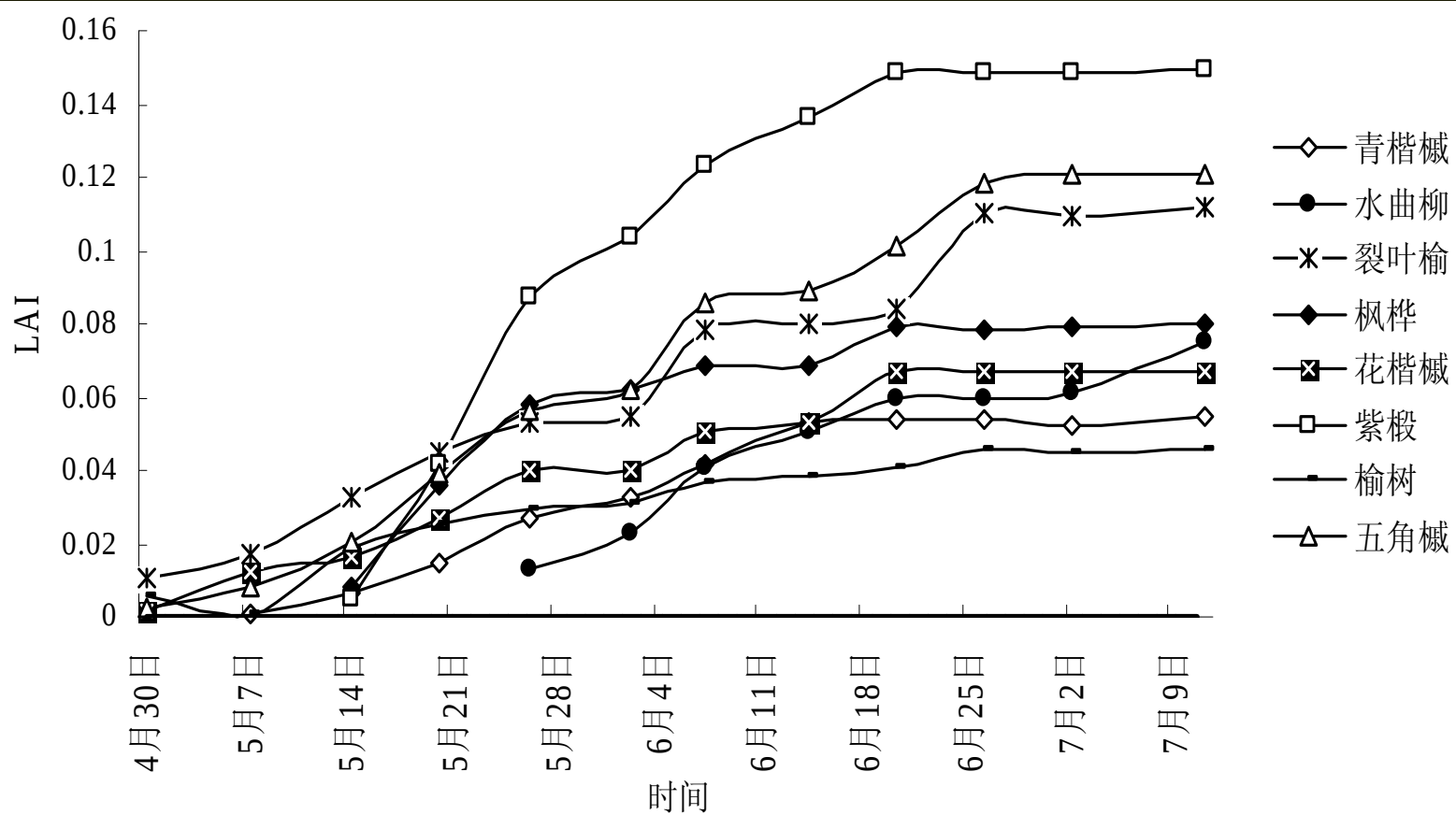
4. Seasonal Changes of LAI : LNR



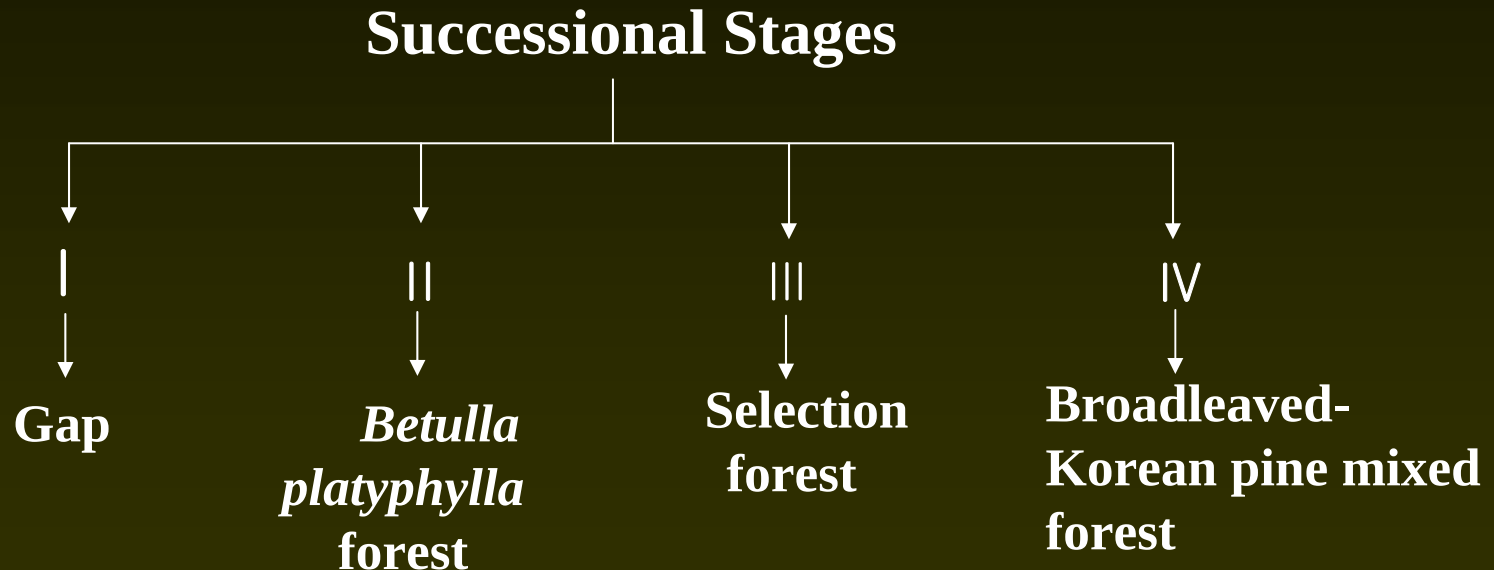
4. Seasonal Changes of LAI : LNR



4. Seasonal Changes of LAI : LNR



5. Litter Decomposition of Successional Stages in the Broadleaved—Korean Pine Mixed Forest

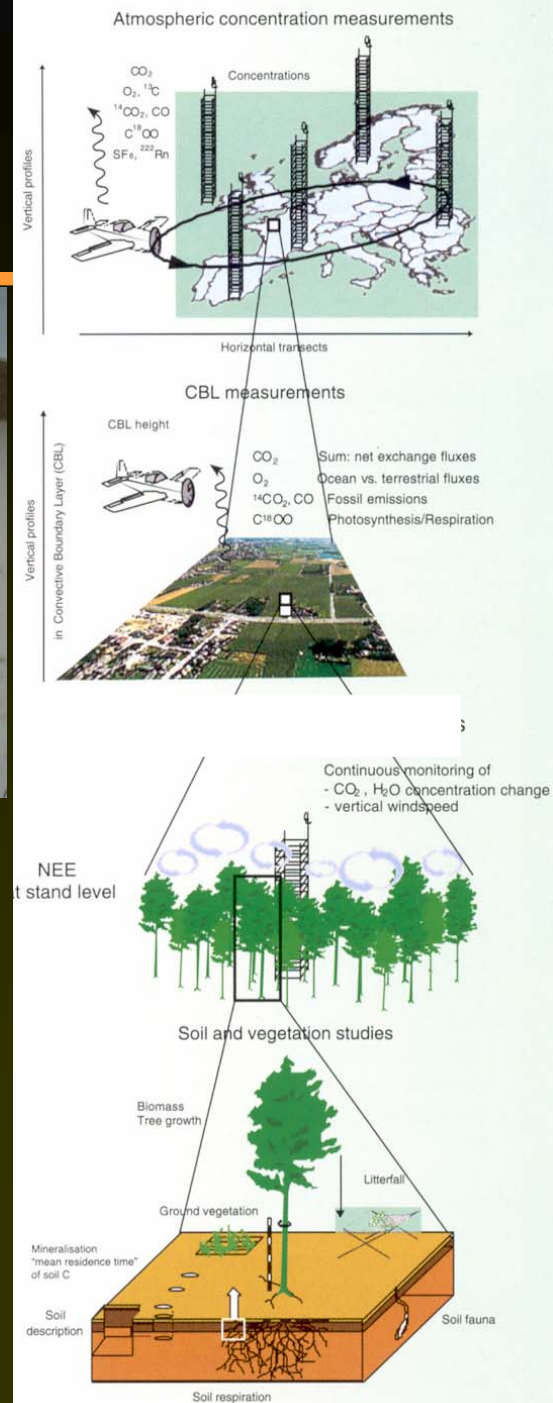








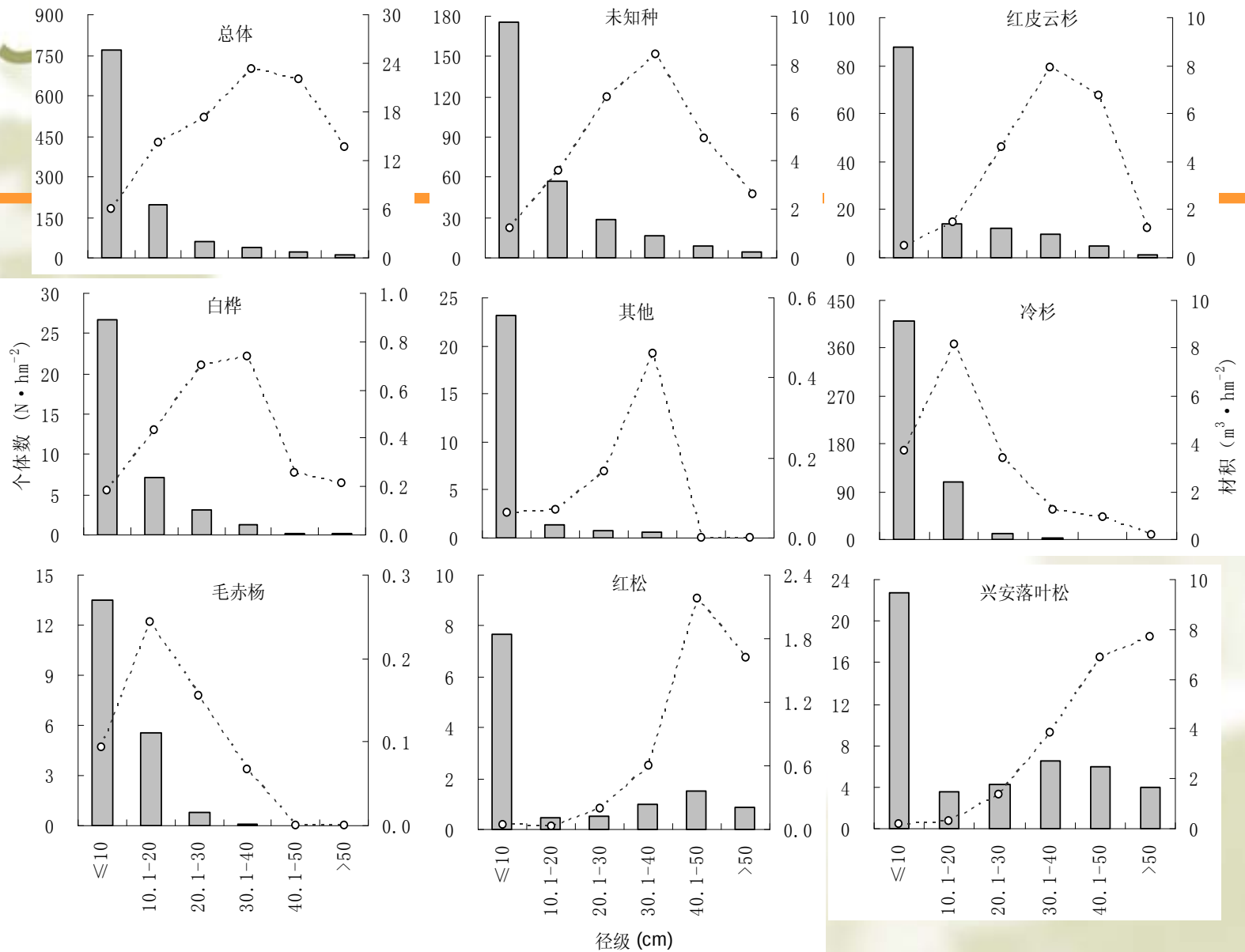
6. Biomass



Spruce-fir Valley Forest (9.12ha)

240m × 380m





DBH class distribution of CWD in the 9.12hm² plot of the Spruce-fir valley forest

Betula platyphylla Forest





05/10/2009

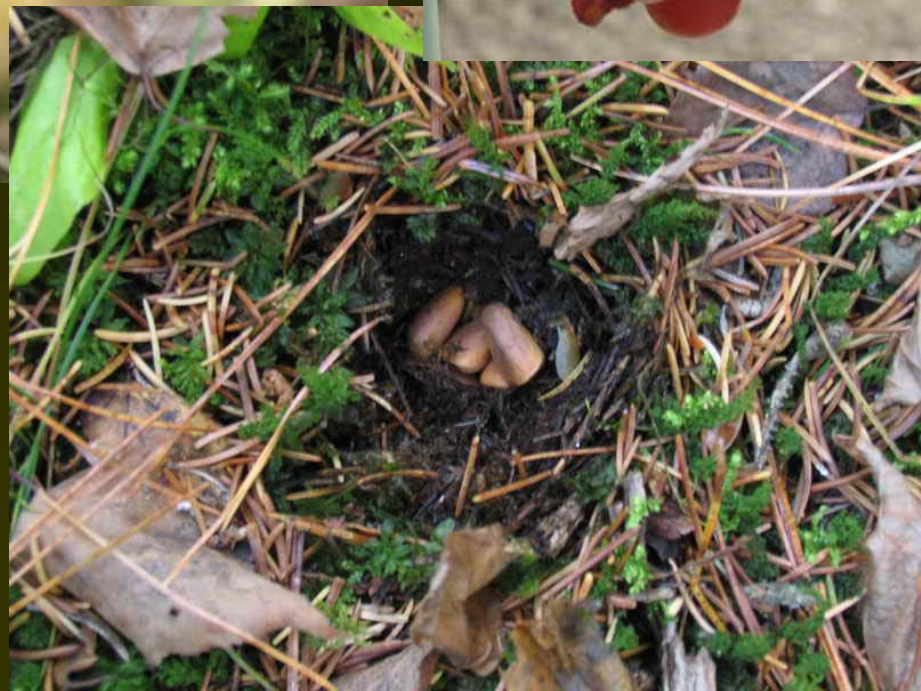
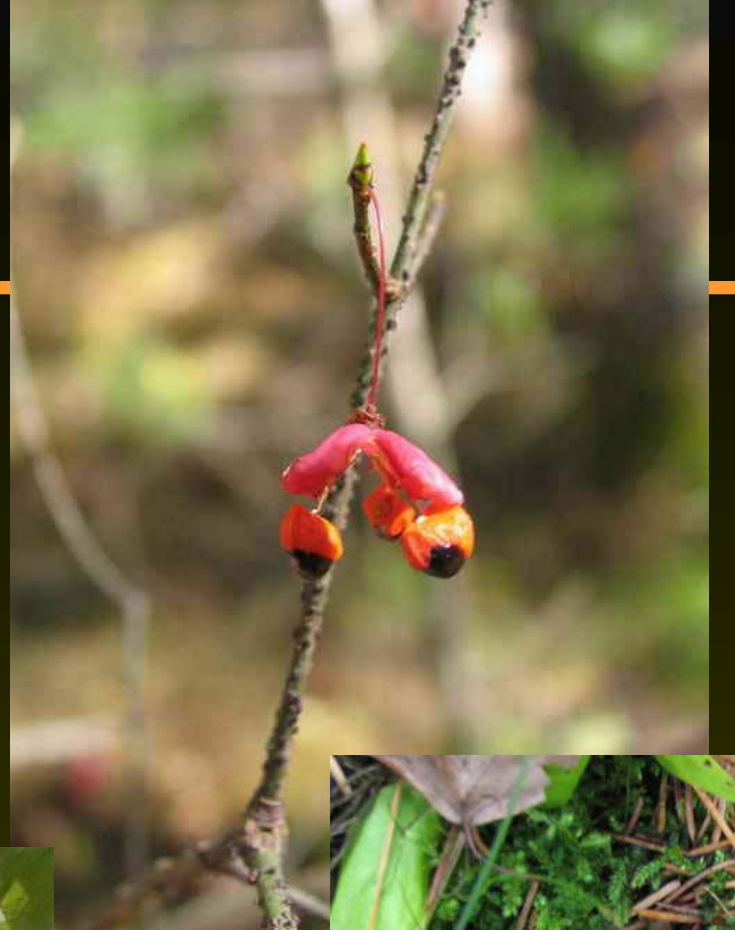






















谢谢！