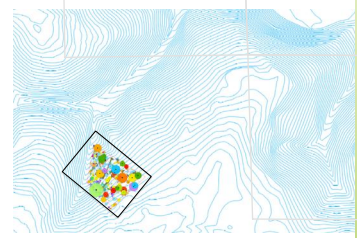
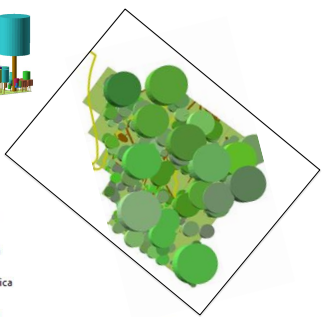
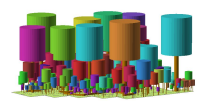
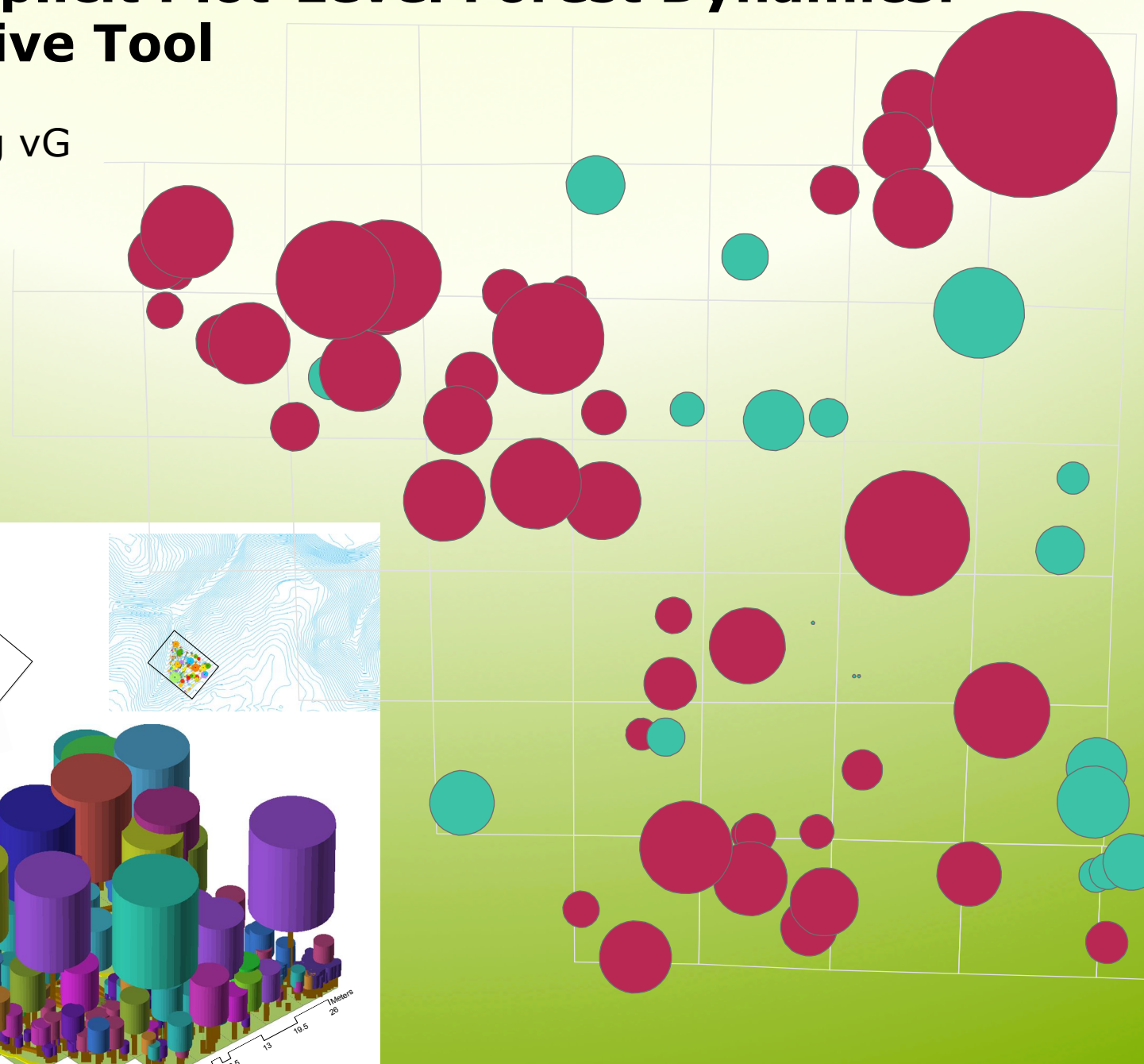
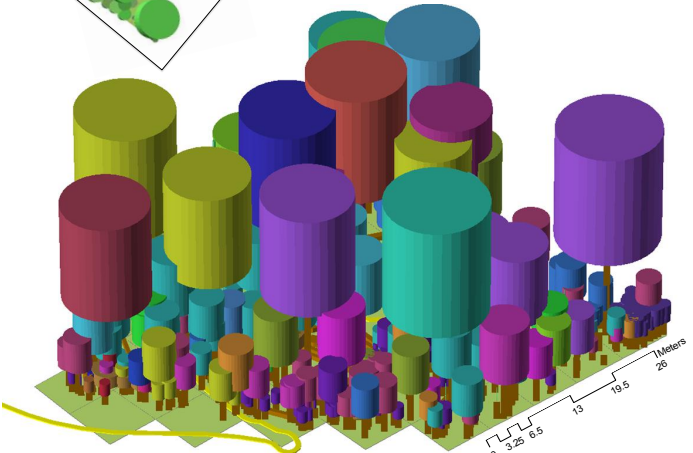


Spatially Explicit Plot-Level Forest Dynamics: An Interactive Tool

Chris Hakkenberg vG
2012-11-14



- Acer rubrum
- Aesculus sylvatica
- Camellia spp.
- Carya tomentosa
- Cercis canadensis
- Cornis florida
- Corylus americana
- Dead
- Diospyros virginiana
- Fagus grandifolia
- Fraxinus pennsylvanica
- Ilex opaca
- Juniperus virginiana
- Liquidambar styraciflua
- Liriodendron Tulipifera
- Loropetalum chinensis
- Magnolia grandiflora
- Nyssa sylvatica
- Oxydendrum arboreum
- Phyllostachys spp.
- Pinus echinata
- Pinus taeda
- Prunus serotina
- Quercus alba
- Quercus coccinea
- Quercus falcata
- Quercus rubra
- Quercus stellata
- Quercus velutina
- Sassafras albidum
- Tilia americana
- Ulmus alata
- Ulmus rubra
- Viburnum acerfolium
- Viburnum rafinesquianum
- Vitis rotundifolia





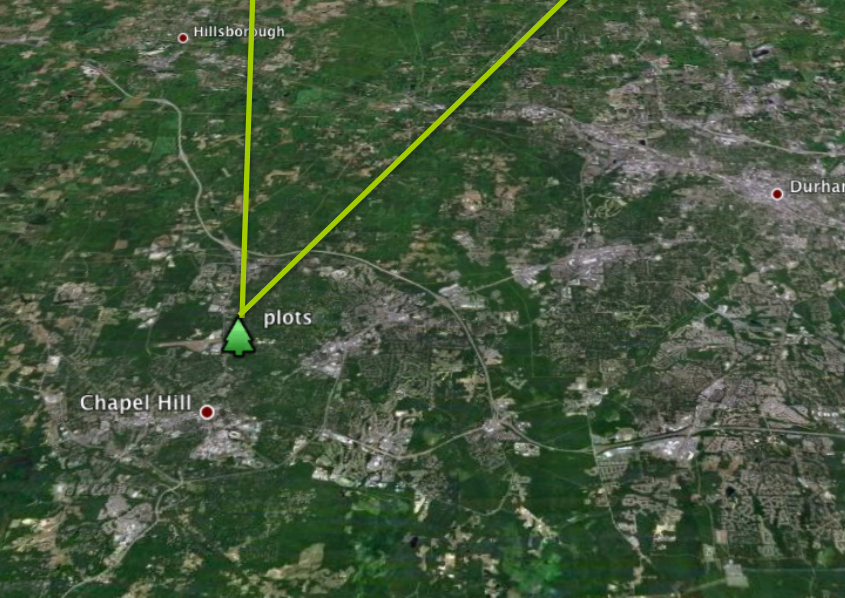
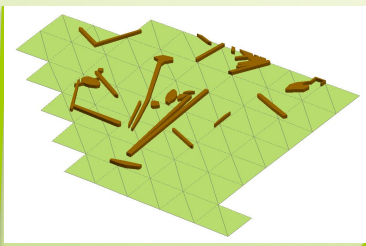
- **Study:**
 - Spatial ecology / forest ecosystems
- **User Interaction:**
 - Fast and flexible data visualization
 - Provides:
 - ecological statistics based on selected criteria
 - spatially-explicit forest dynamics map
 - change vectors
- **Producer simplicity:**
 - Requires one .txt file with three data points per tree:
 - species type
 - diameter at breast height (dbh)
 - xy location
 - Scales to larger datasets

- **R / Python tightly-coupled GIS tool**

```
1 # Spatially Explicit Plot-level Forest Dynamics: An Interactive Tool
2 # developed by Chris Hakkenberg vG 2012-11-14
3
4 #####Table of contents#####
5
6 #row 20 Import modules
7 #row 27 Set Workspace
8 #row 32 Input and Output files
9 #row 38 User inputs
10 #row 78 User's data selection list
11 #row 123 Create new feature classes
12 #row 182 Output buffer
13 #row 211 Application of preset symbology to outputs
14 #row 235 Data frame management (removal and addition of shp's)
15 #row 263 Write and open map in .pdf format
16 #row 276 Inventory Statistics Section (allometry)
17 #row 383 Ecology Statistics Section
18 #row 438 Write and open statistics file in .txt format
19
20 ## Import modules
21
22 import arcpy, sys, os, math
23 from arcpy import env, mapping
24 from math import exp, log
25 from pyper import *
26
27 ## Set workspace
```

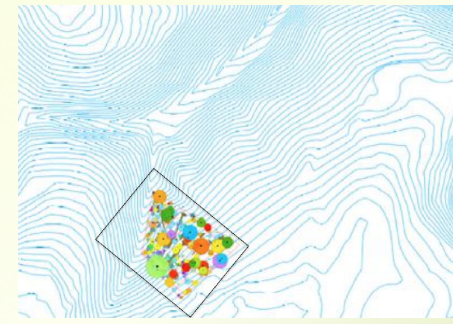
• Demonstration

- subplot $\sim 40\text{m}^2$
- 47 subplots
- location: Chapel Hill

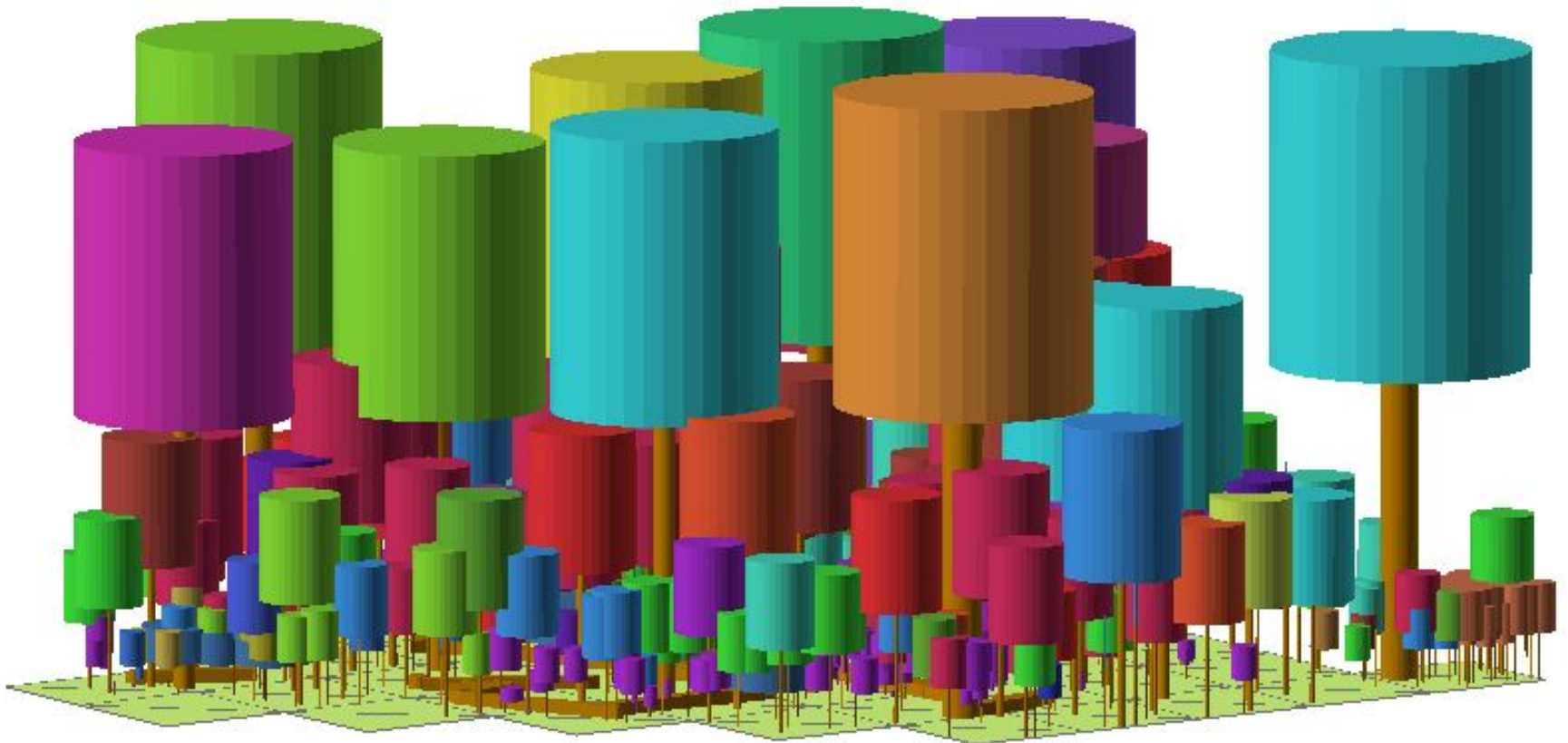


Forest

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



Spatially Explicit Maps*



Statistics:

Ecology:

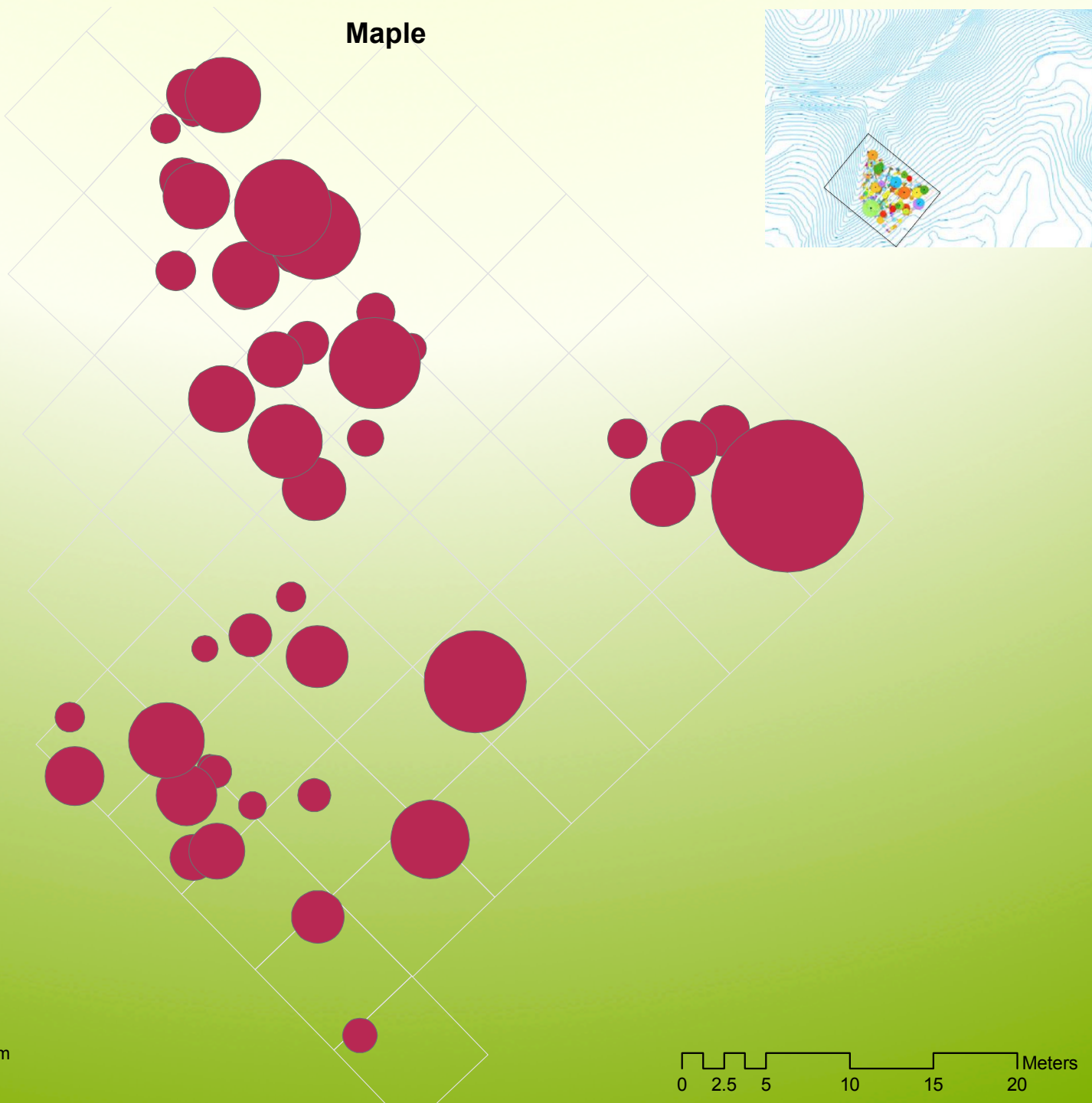
total stems:	510
total basal area:	55294 cm ²
species richness:	36
shannon index (0 - ~4.6):	2.697
simpson index (0 - 1):	0.108

Biomass:

foliar biomass:	970 kg. [17 kg. change from 2011-2012]
aboveground woody biomass:	33574 kg. [692 kg. change from 2011-2012]
coarse root biomass:	8105 kg. [164 kg. change from 2011-2012]
total biomass:	42649 kg. [874 kg. change from 2011-2012]

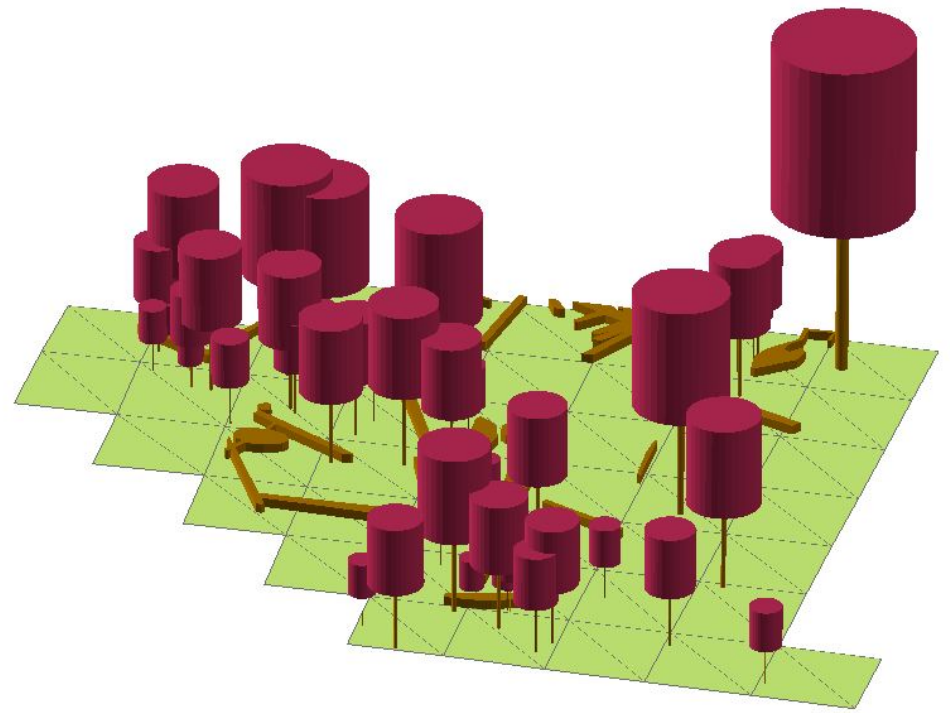
Maple

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



0 2.5 5 10 15 20 Meters

Maple



Ecology:

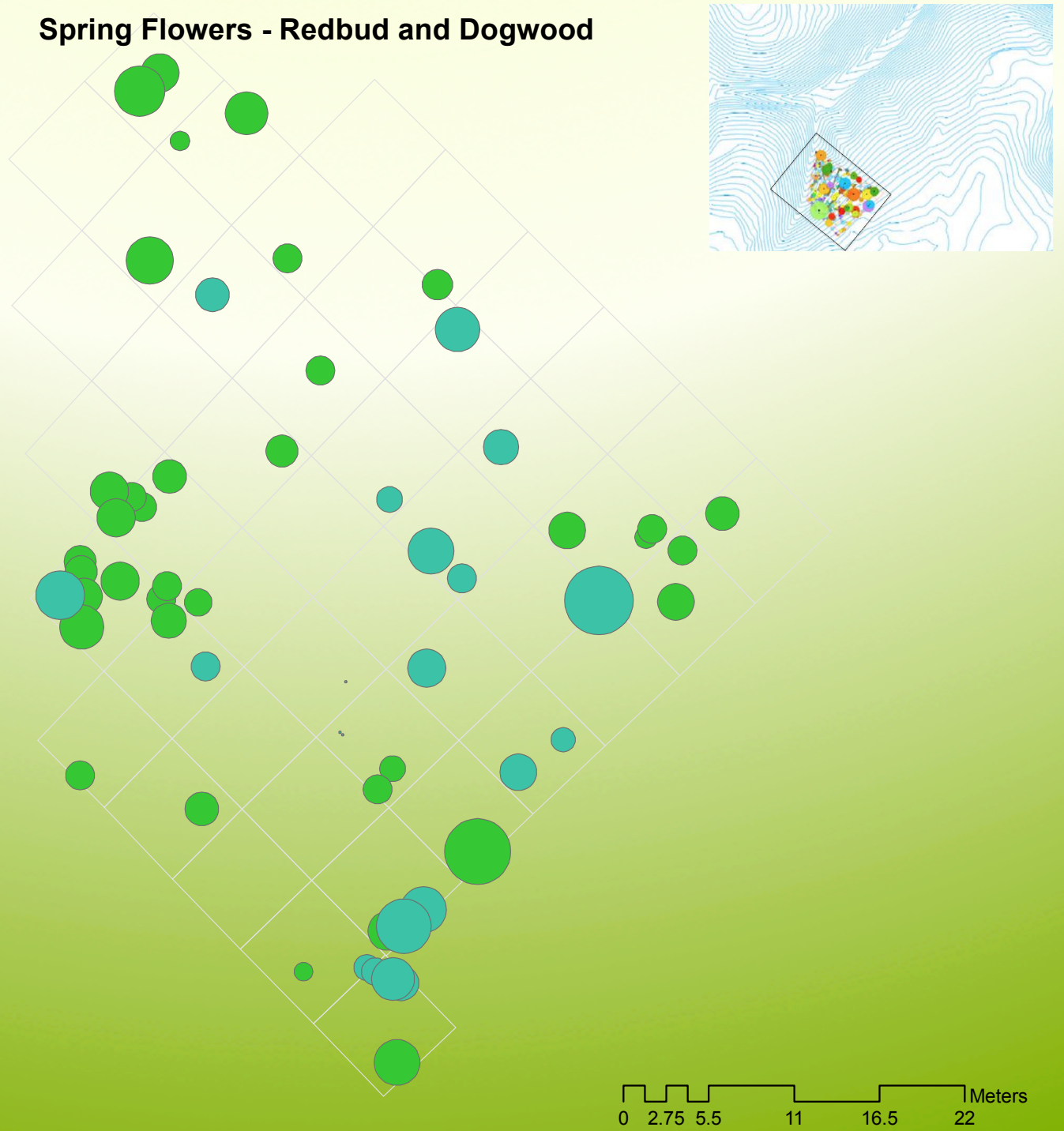
total stems:	50
total basal area:	4787 cm ²
species richness:	1
shannon index (0 - ~4.6):	0.0
simpson index (0 - 1):	1.0

Biomass:

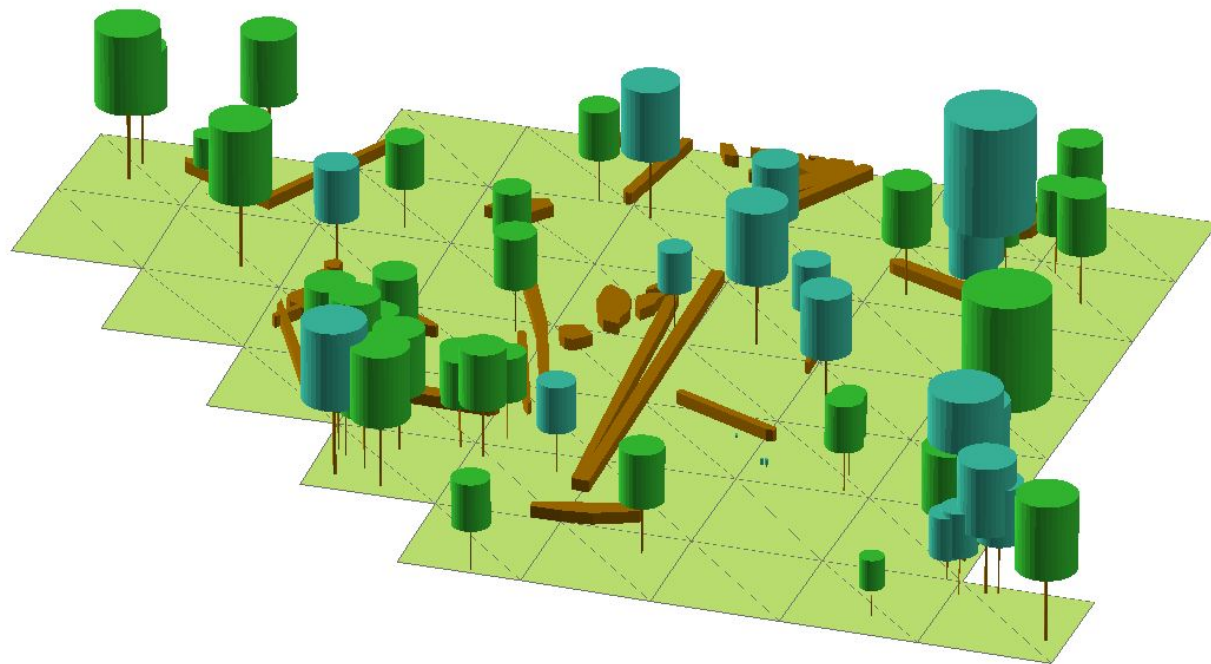
foliar biomass:	65 kg. [1 kg. change from 2011-2012]
aboveground woody biomass:	2064 kg. [34 kg. change from 2011-2012]
coarse root biomass:	510 kg. [8 kg. change from 2011-2012]
total biomass:	2640 kg. [44 kg. change from 2011-2012]

Spring Flowers - Redbud and Dogwood

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



Redbud and Dogwood



Ecology:

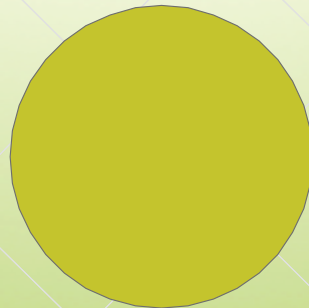
total stems:	50
total basal area:	4787 cm ²
species richness:	1
shannon index (0 - ~4.6):	0.0
simpson index (0 - 1):	1.0

Biomass:

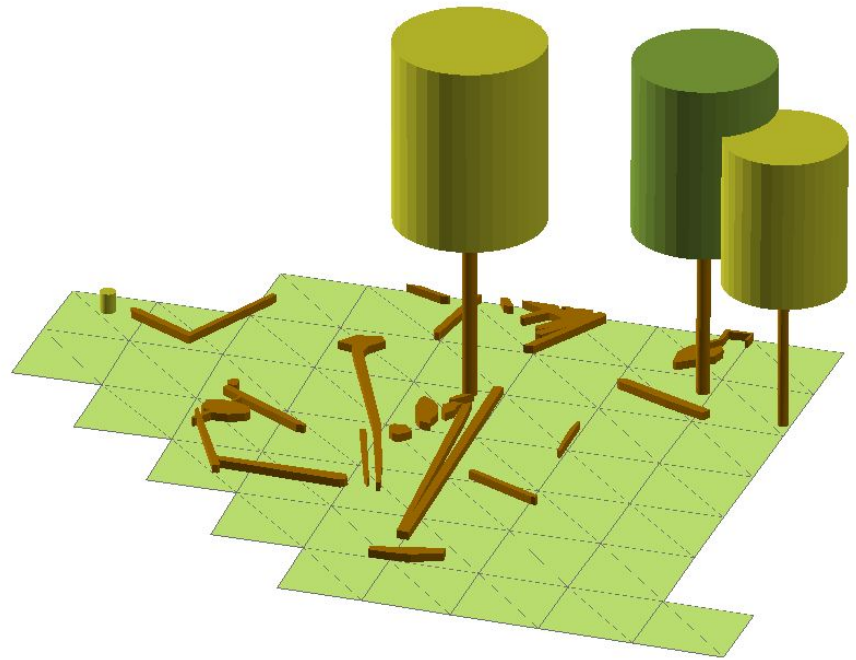
foliar biomass:	65 kg. [1 kg. change from 2011-2012]
aboveground woody biomass:	2064 kg. [34 kg. change from 2011-2012]
coarse root biomass:	510 kg. [8 kg. change from 2011-2012]
total biomass:	2640 kg. [44 kg. change from 2011-2012]

Pines

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



Pines



Ecology:

total stems:	4
total basal area:	5523 cm ²
species richness:	2
shannon index (0 - ~4.6):	0.562
simpson index (0 - 1):	0.625

Biomass:

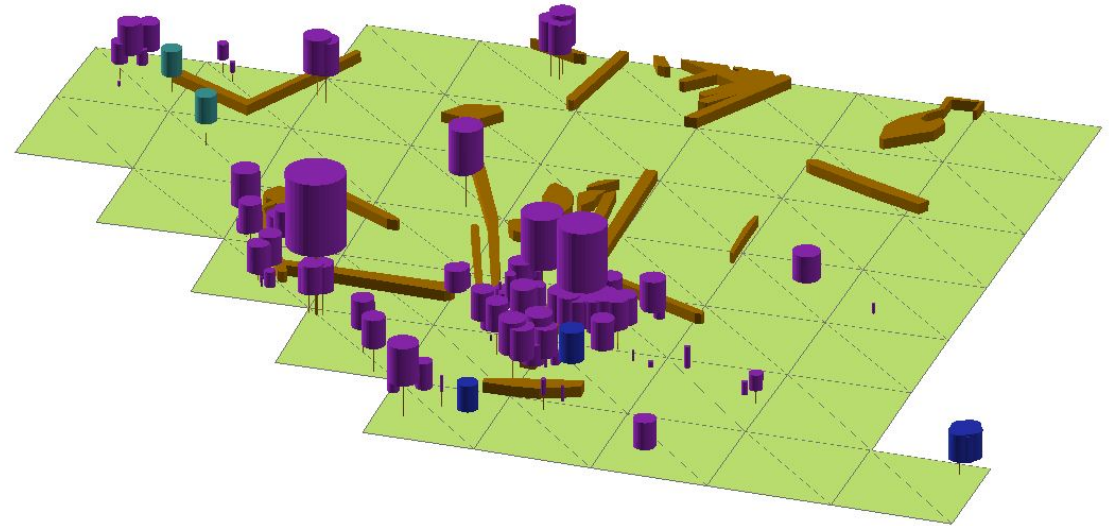
foliar biomass:	173 kg. [0 kg. change from 2011-2012]
aboveground woody biomass:	2227 kg. [0 kg. change from 2011-2012]
coarse root biomass:	647 kg. [0 kg. change from 2011-2012]
total biomass:	3048 kg. [0 kg. change from 2011-2012]

Understory - Buckeye and Viburnum

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



The Understory



Ecology:

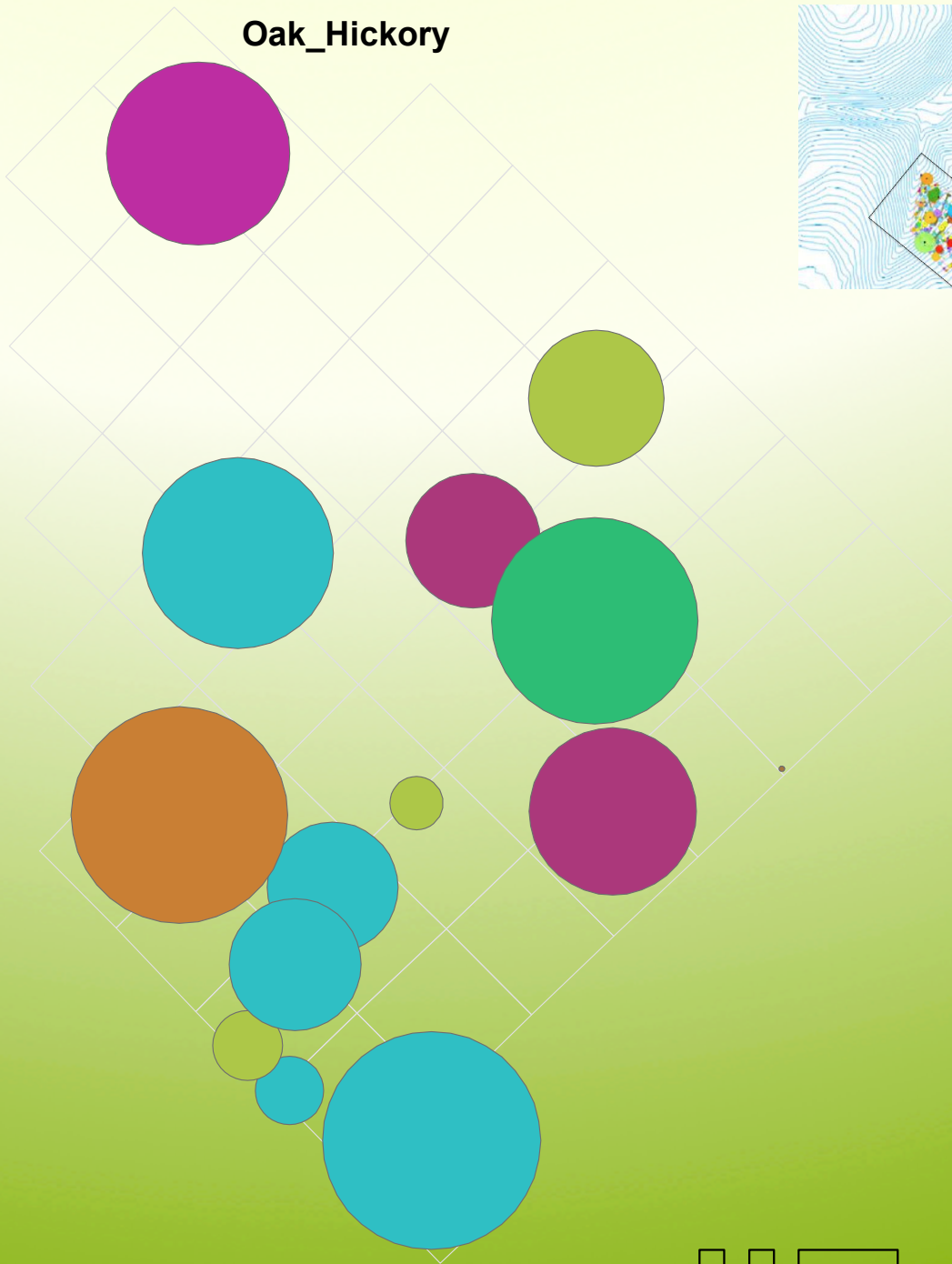
total stems:	134
total basal area:	176 cm ²
species richness:	3
shannon index (0 - ~4.6):	0.303
simpson index (0 - 1):	0.86

Biomass:

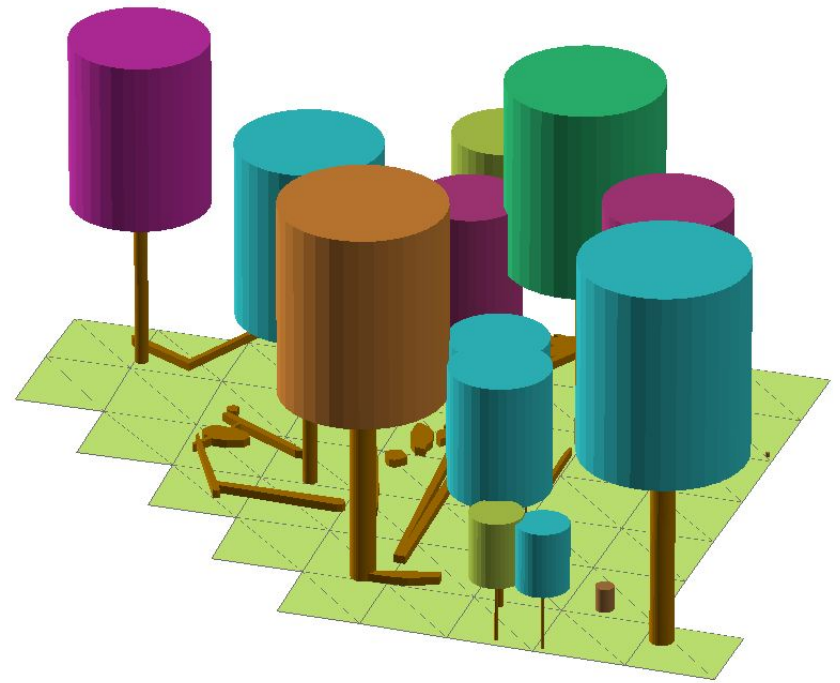
foliar biomass:	1 kg. [0 kg. change from 2011-2012]
aboveground woody biomass:	25 kg. [0 kg. change from 2011-2012]
coarse root biomass:	6 kg. [0 kg. change from 2011-2012]
total biomass:	33 kg. [0 kg. change from 2011-2012]

Oak_Hickory

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



Oak - Hickory



Ecology:

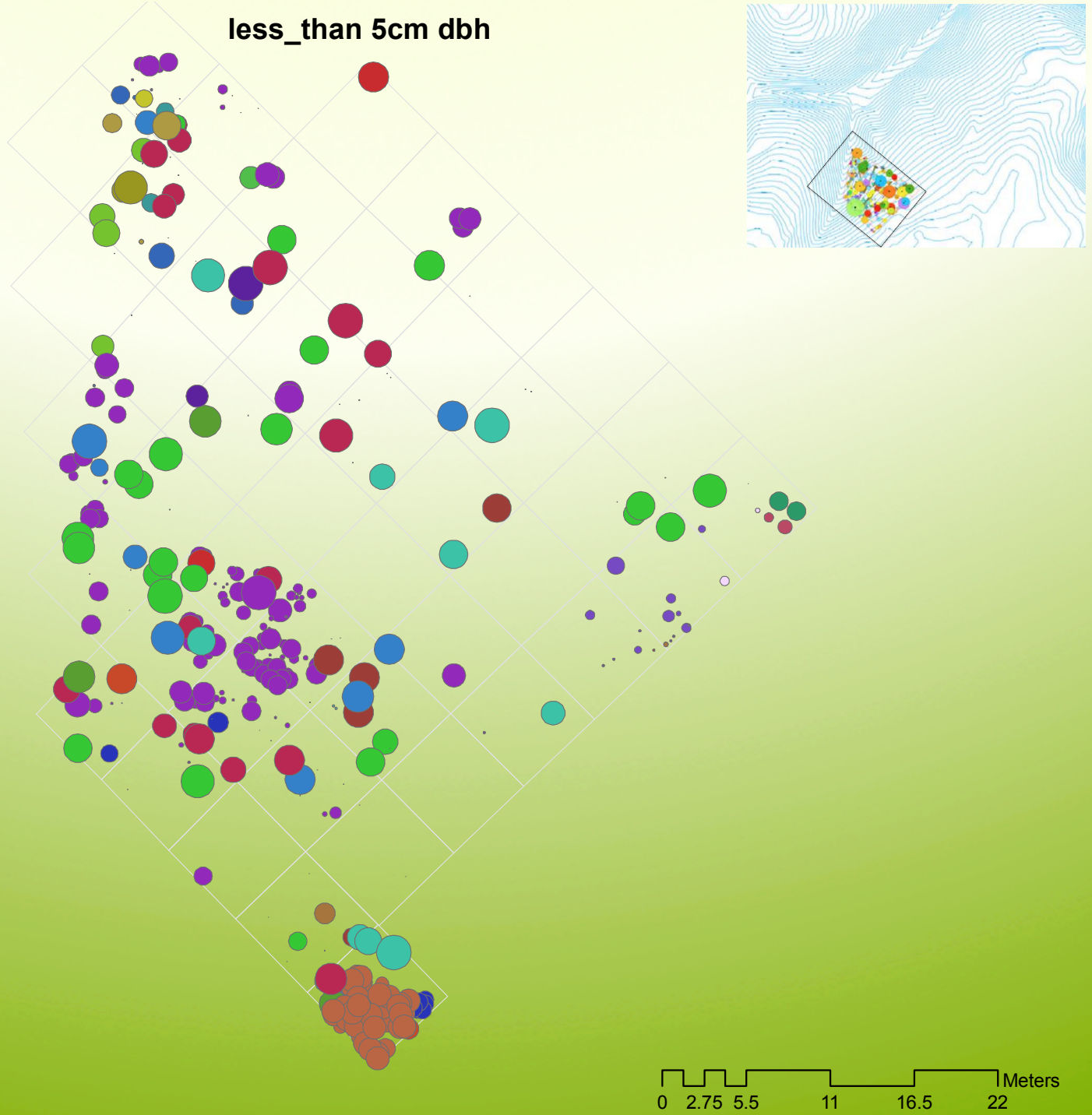
total stems:	15
total basal area:	24550 cm ²
species richness:	7
shannon index (0 - ~4.6):	1.767
simpson index (0 - 1):	0.2

Biomass:

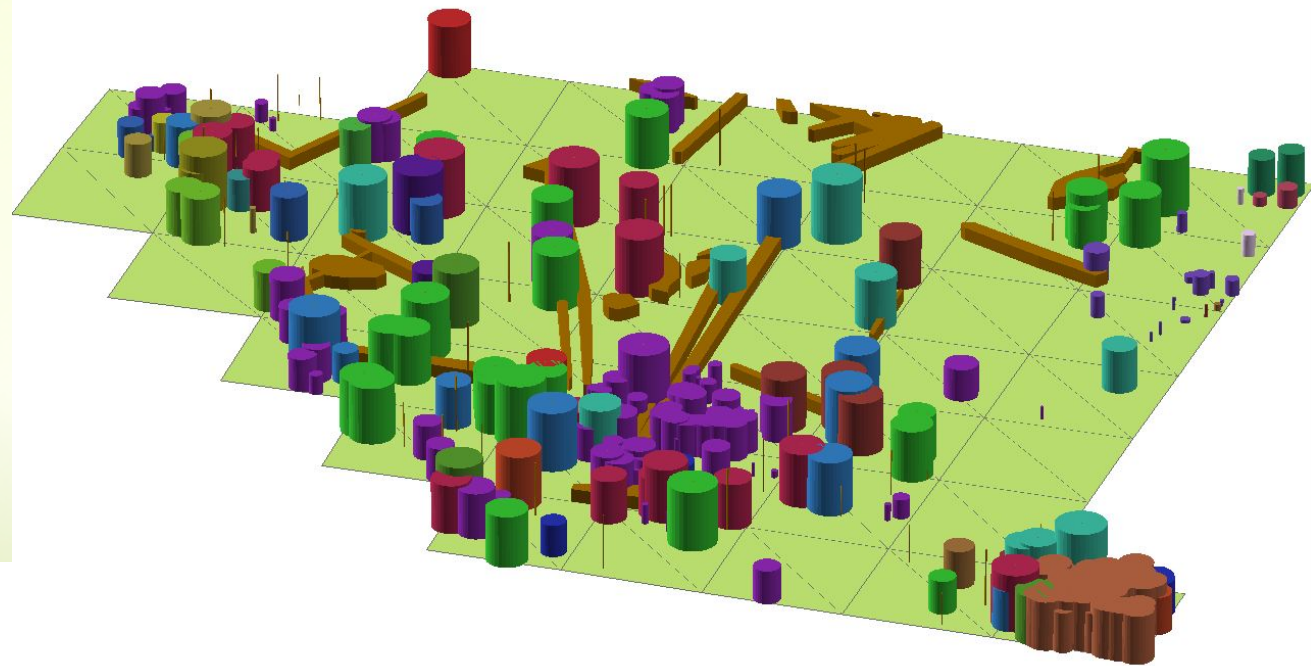
foliar biomass:	481 kg. [10 kg. change from 2011-2012]
aboveground woody biomass:	20646 kg. [462 kg. change from 2011-2012]
coarse root biomass:	4849 kg. [107 kg. change from 2011-2012]
total biomass:	25978 kg. [580 kg. change from 2011-2012]

less_than 5cm dbh

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



Less than 5cm dbh



Ecology:

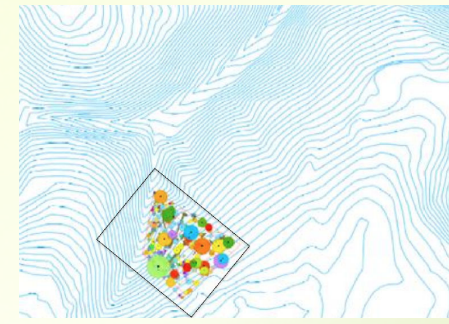
total stems:	359
total basal area:	1374 cm ²
species richness:	35
shannon index (0 - ~4.6):	2.302
simpson index (0 - 1):	0.169

Biomass:

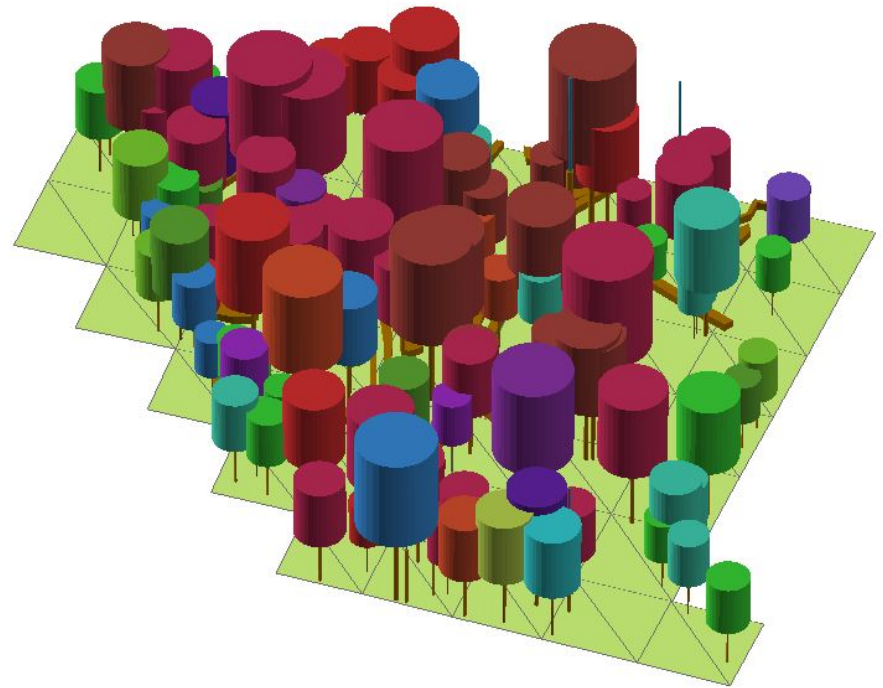
foliar biomass:	20 kg. [1 kg. change from 2011-2012]
aboveground woody biomass:	166 kg. [9 kg. change from 2011-2012]
coarse root biomass:	55 kg. [3 kg. change from 2011-2012]
total biomass:	243 kg. [14 kg. change from 2011-2012]

5_25cm

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



5 – 25cm dbh



Ecology:

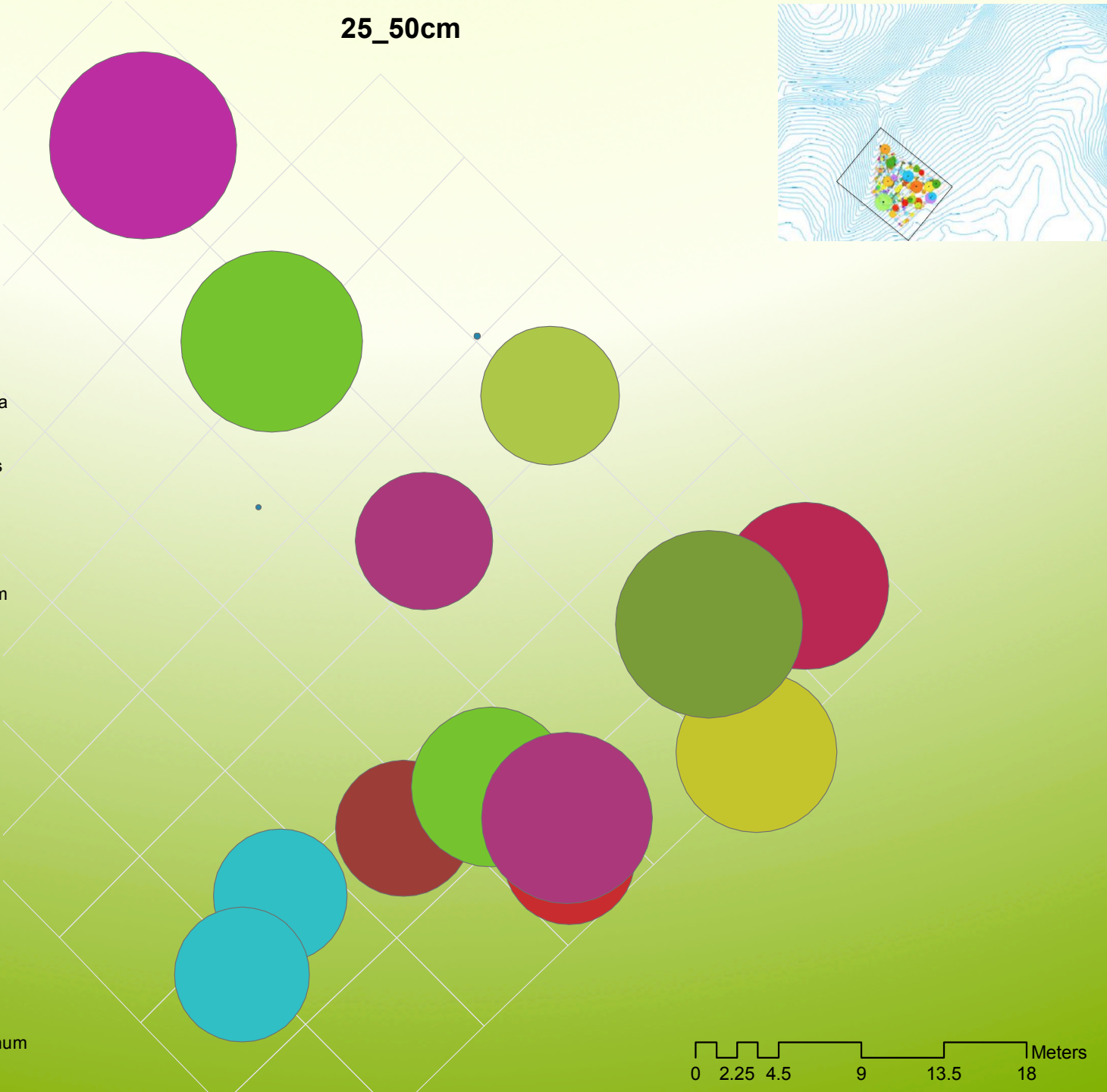
total stems:	122
total basal area:	11491 cm ²
species richness:	36
shannon index (0 - ~4.6):	2.41
simpson index (0 - 1):	0.119

Biomass:

foliar biomass:	129 kg. [4 kg. change from 2011-2012]
aboveground woody biomass:	3704 kg. [166 kg. change from 2011-2012]
coarse root biomass:	937 kg. [40 kg. change from 2011-2012]
total biomass:	4771 kg. [212 kg. change from 2011-2012]

25_50cm

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



Ecology:

total stems:	15
total basal area:	16016 cm ²
species richness:	36
shannon index (0 - ~4.6):	2.338
simpson index (0 - 1):	0.102

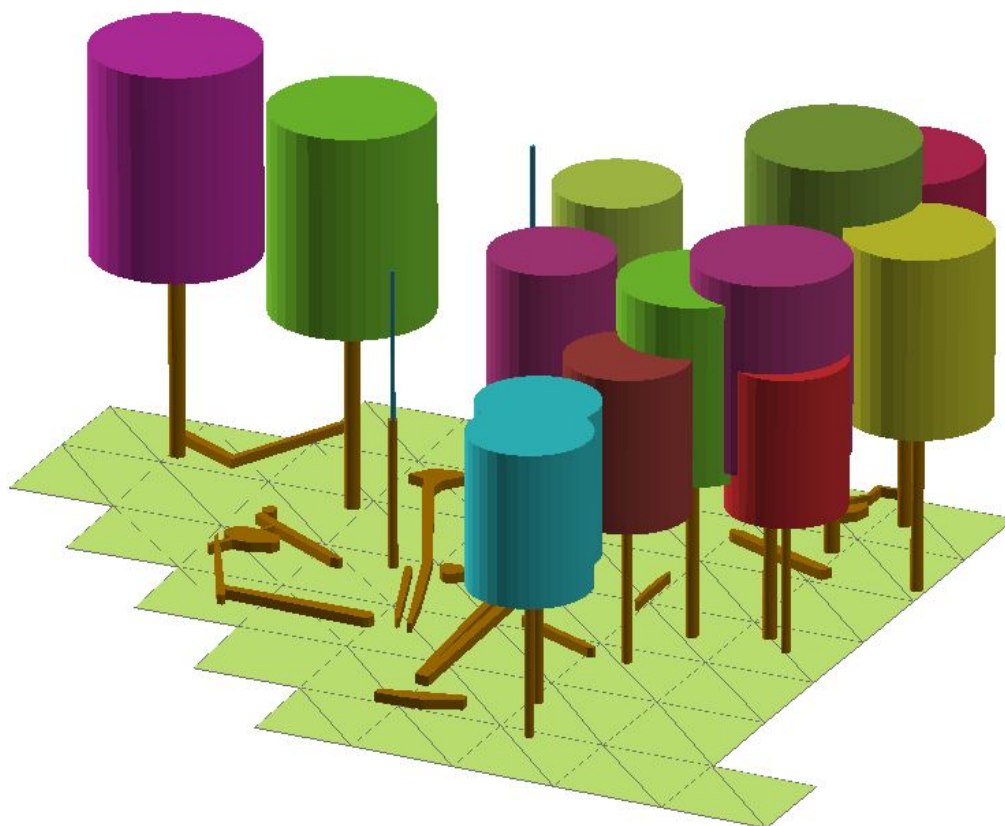
Biomass:

foliar biomass:	276 kg. [3 kg. change from 2011-2012]
aboveground woody biomass:	8551 kg. [141 kg. change from 2011-2012]
coarse root biomass:	2098 kg. [33 kg. change from 2011-2012]
total biomass:	10927 kg. [177 kg. change from 2011-2012]

25 - 50cm dbh

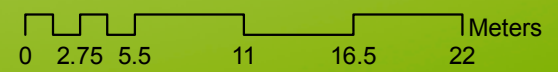
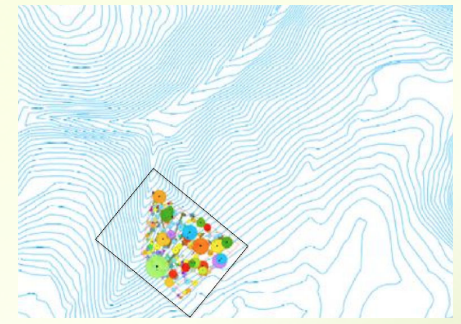
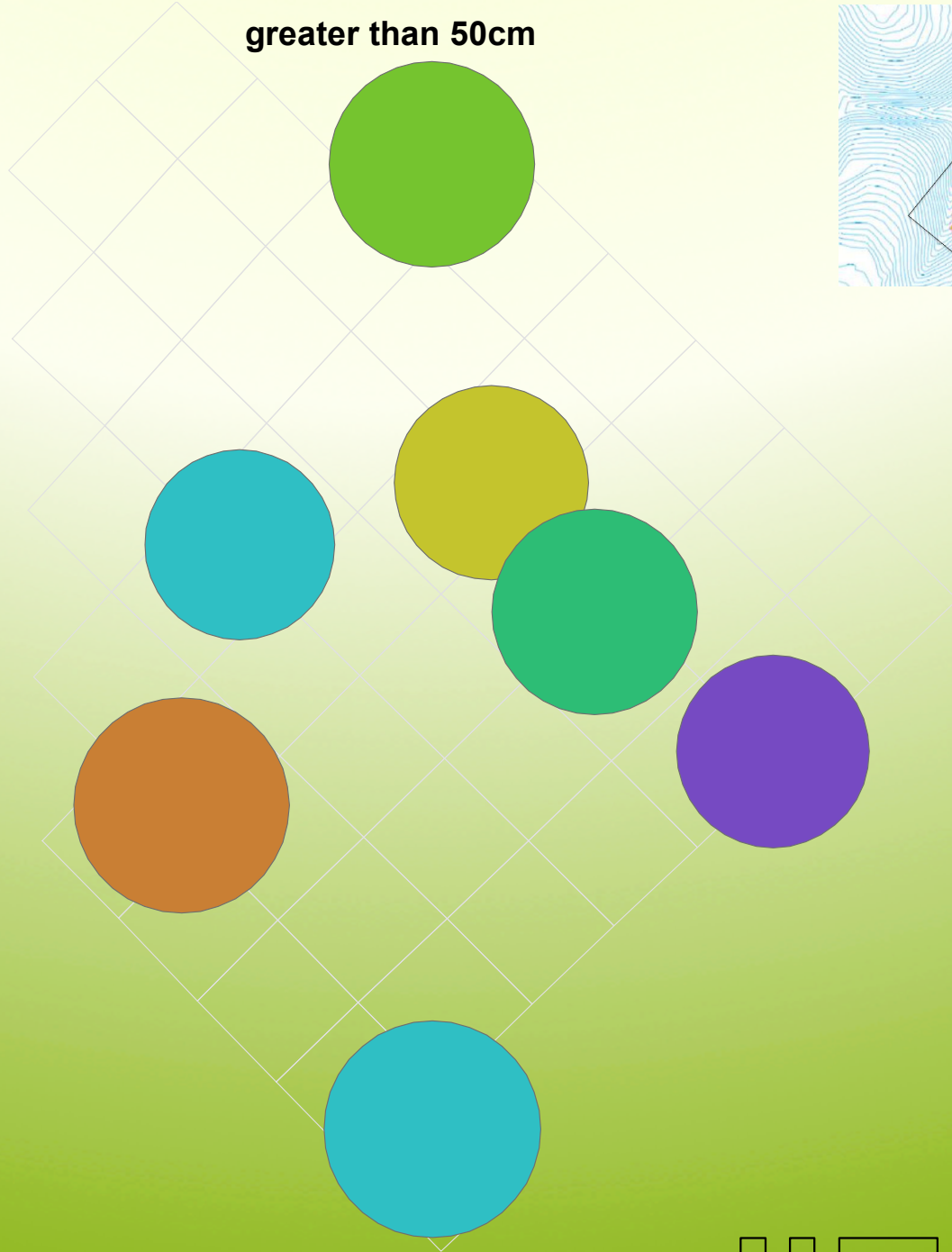
Species List:

Carya_tomentosa
Pinus_taeda
Quercus_alba
Nyssa_sylvatica
Pinus_echinata
Acer_rubrum
Liriodendron_tulipferia
Dead
Quercus_stellata
Ulmus_rubra
Quercus_coccinea

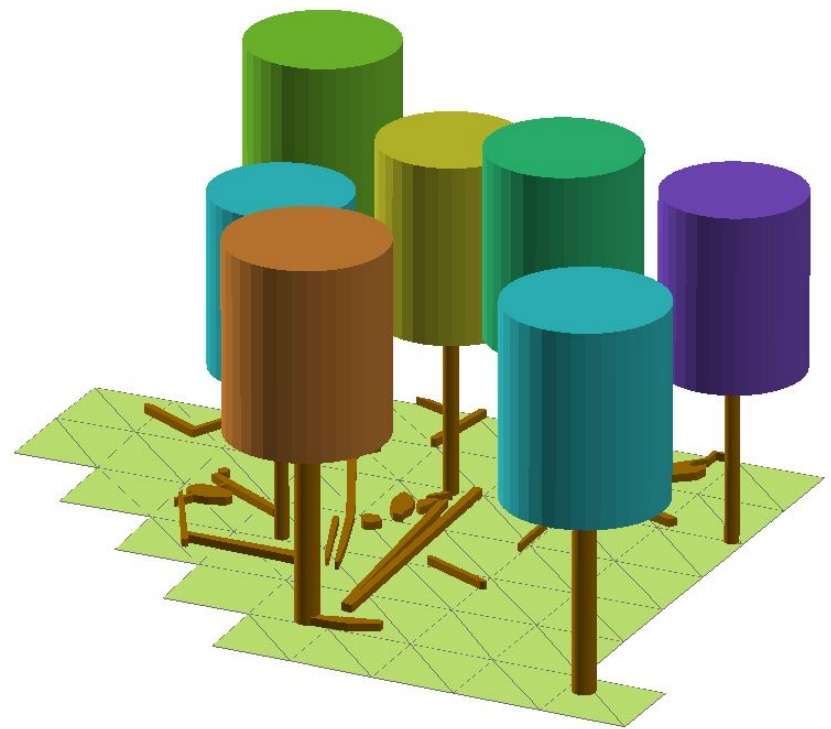


greater than 50cm

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipifera
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia



Over 50cm dbh



Ecology:

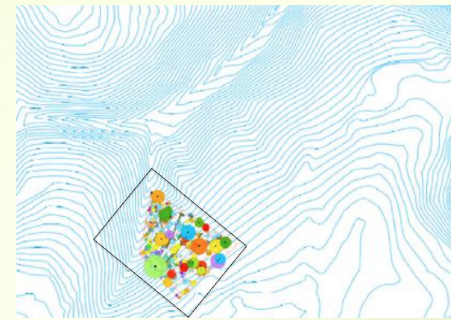
total stems:	7
total basal area:	26409 cm ²
species richness:	36
shannon index (0 - ~4.6):	1.748
simpson index (0 - 1):	0.184

Biomass:

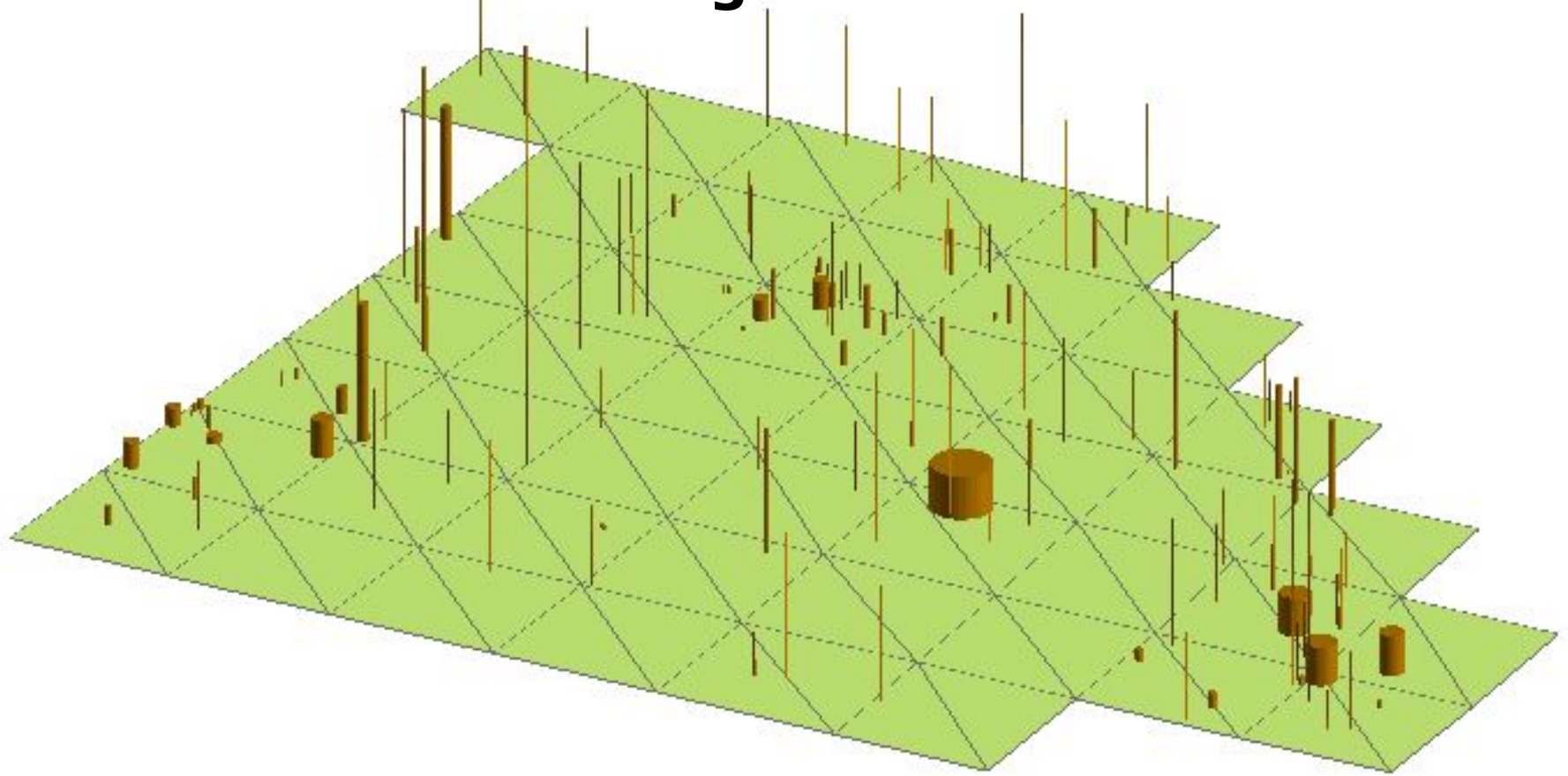
foliar biomass:	542 kg. [8 kg. change from 2011-2012]
aboveground woody biomass:	21151 kg. [374 kg. change from 2011-2012]
coarse root biomass:	5013 kg. [87 kg. change from 2011-2012]
total biomass:	26707 kg. [469 kg. change from 2011-2012]

Total_Change

- Acer_rubrum
- Aesculus_sylvatica
- Camellia_spp.
- Carya_tomentosa
- Cercis_canadensis
- Cornis_florida
- Dead
- Diospyros_virginiana
- Fagus_grandifolia
- Fraxinus_americana
- Ilex_opaca
- Juniperus_virginiana
- Liquidambar_styraciflua
- Liriodendron_tulipferia
- Loropetalum_chinensis
- Magnolia_grandiflora
- Morus_rubra
- Nyssa_sylvatica
- Oxydendrum_arboreum
- Phyllostachys_spp.
- Pinus_echinata
- Pinus_taeda
- Prunus_serotina
- Quercus_alba
- Quercus_coccinea
- Quercus_falcata
- Quercus_rubra
- Quercus_stellata
- Quercus_velutina
- Ulmus_alata
- Ulmus_rubra
- Viburnum_acerfolium
- Viburnum_rafinesquianum
- Vitis_rotundifolia

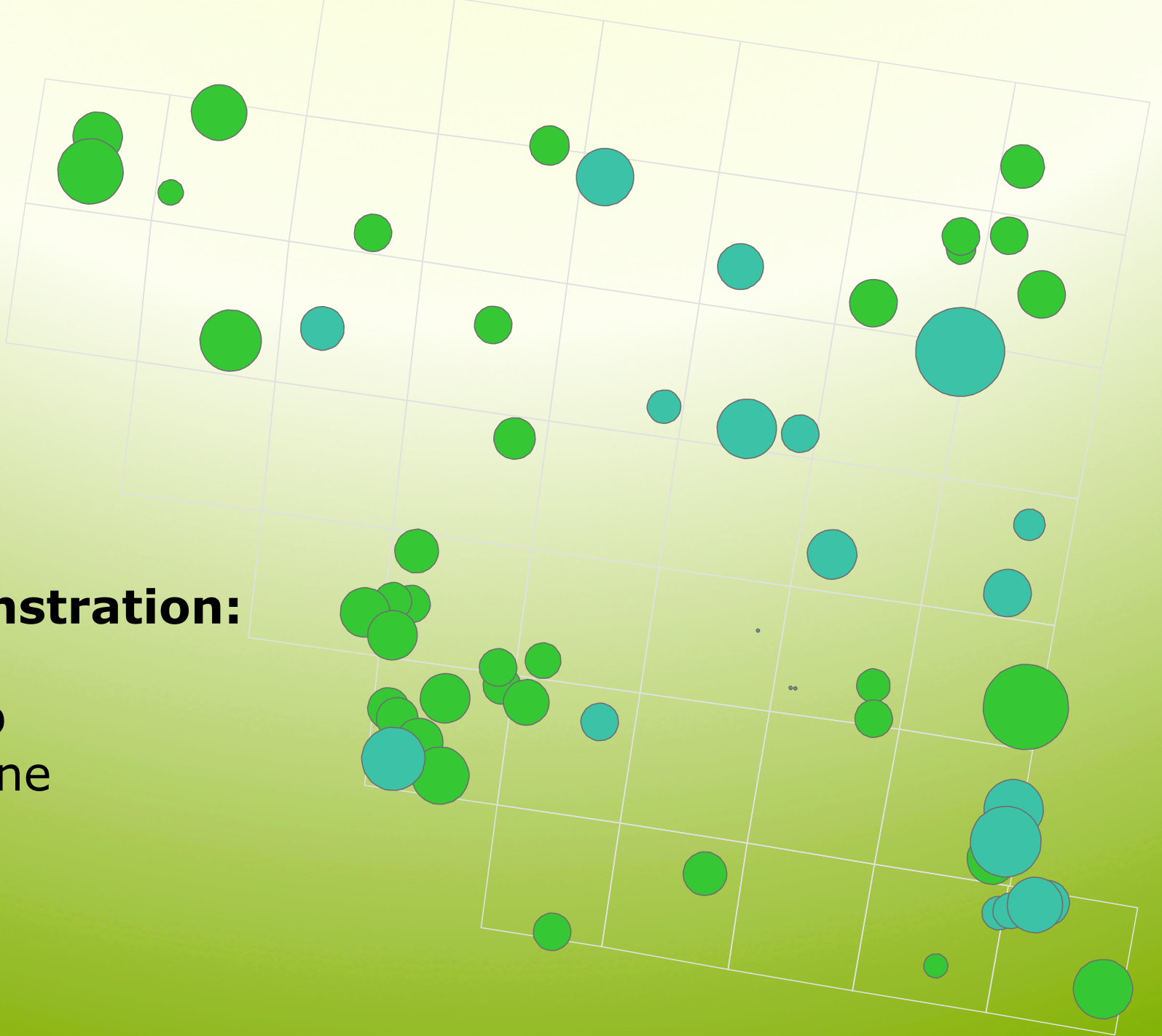


Net change 2011-2012



Biomass:

foliar biomass:	17 kg. change from 2011-2012.
aboveground woody biomass:	692 kg. change from 2011-2012.
coarse root biomass:	164 kg. change from 2011-2012.
total biomass:	874 kg. change from 2011-2012.

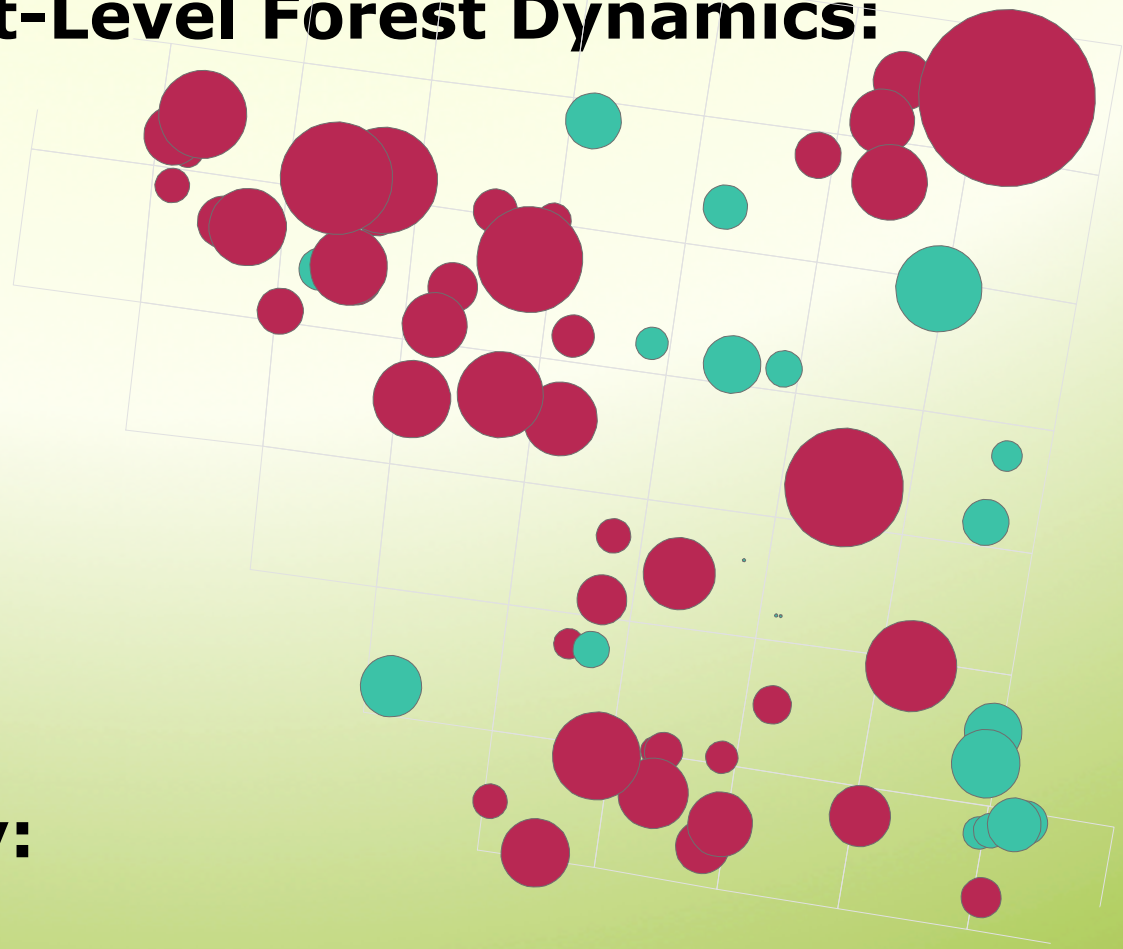


Demonstration:

ArcMap
ArcScene

Spatially Explicit Plot-Level Forest Dynamics: An Interactive Tool

Chris Hakkenberg vG
2012-11-14



- **User Interaction:**

- Fast and flexible

- **Producer simplicity:**

- Requires one txt file with three data points per tree:
 - species type
 - diameter at breast height (dbh)
 - location
- Scales to larger datasets