Emerald Ash Borer:

Monitoring and Management Recommendations for the City of Iowa City, Iowa

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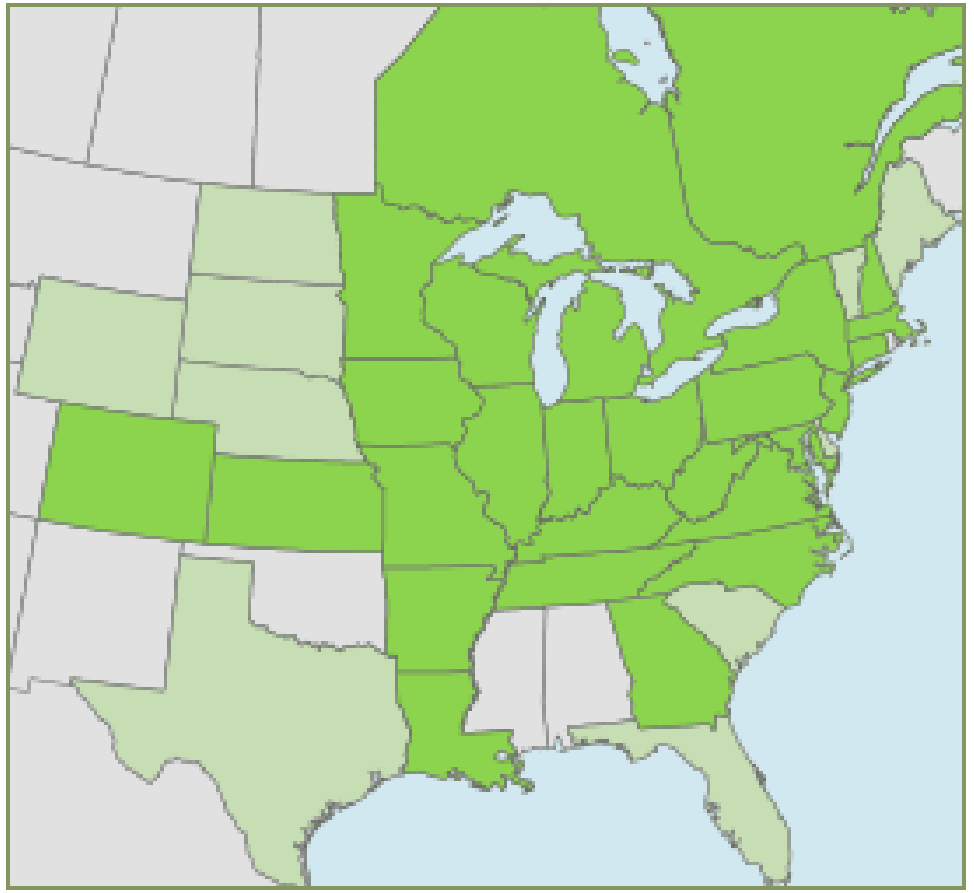
http://www.nyis.info/slideshow_eab/EAB_9000019b.jpg

Introduction

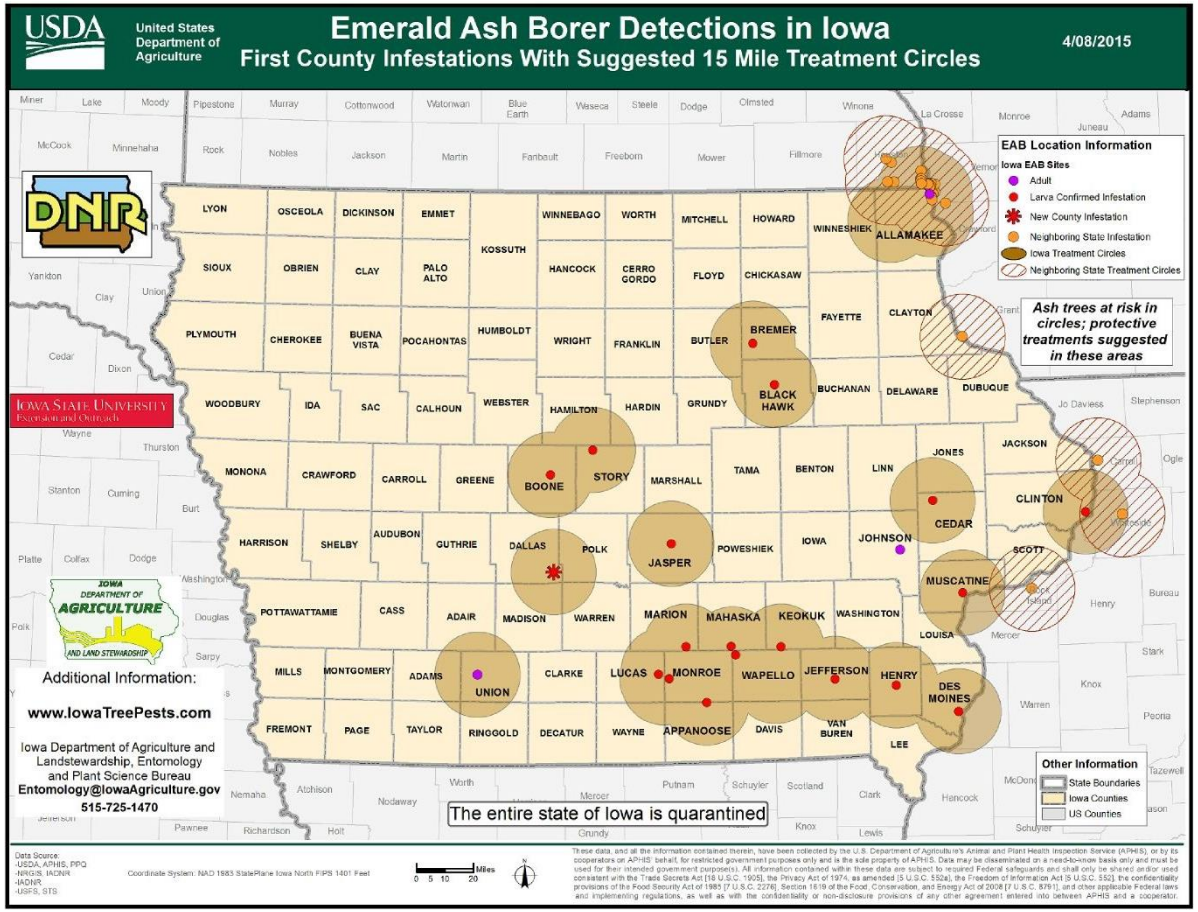
- Emerald ash borer (EAB) is an invasive beetle first detected in the US in 2002
- Inadvertently introduced in the 1990s via contaminated shipping materials
- Rapidly spread to 25 states and 2 Canadian provinces
- Already resulted in the loss of millions of ash trees at a significant cost to governments and private property owners



http://www.emeraldashborer.info/images/homepagemap.gif

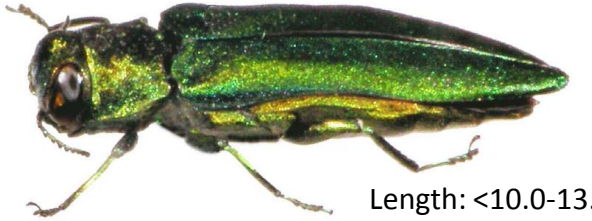
Statement of Purpose

- EAB is expected to arrive in Johnson County in the near future
- Monitoring and management strategies are necessary
- This presentation will assist the City of Iowa City by:
  1) Providing information on the ecology of EAB
  2) Completing an inventory of ash trees in the Iowa City area
  3) Suggesting methods for monitoring EAB
  4) Recommending treatment or replacement options for ash trees



http://www.iowatreepests.com/images/Iowa_Q_Map.jpg

Emerald Ash Borer: Identification



Length: <10.0-13.0 mm

- Adult similar to *Agrilus* species native to North America
  - Larger and brighter green
- Overall metallic green color may include brassy, coppery, or reddish reflections
- Dorsal surface of abdomen is bright metallic coppery-red; most visible when wing covers and wings are raised

dorsal view ventral view

https://datcpservices.wisconsin.gov/eab/images/eabhome.jpg

Length:
26.0-32.0 mm

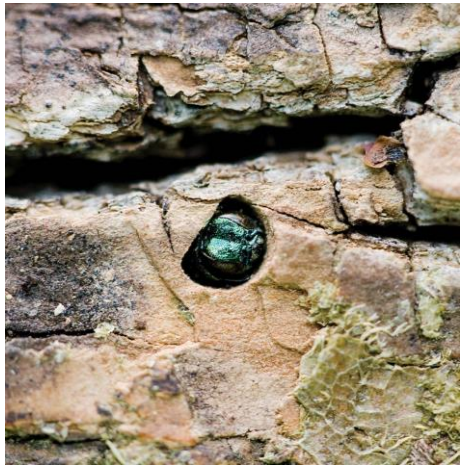
http://static1.squarespace.com/static/502d2cede4b0ab396711e089/t/553e43d3e4b0bfb591520753/1430143960167/

- Larvae are white to cream-colored; head is brown
- Abdomen is flattened rather than round, has 10 segments, brown, pincer-like appendages

Emerald Ash Borer: Ecology

- Complete life cycle in 1-2 years
- Upon hatching, larvae bore through bark of ash tree and feed on phloem in tunnels called galleries
- Feed into the fall, overwinter in bark
- Pupation occurs the following spring
- Adults emerge from distinctive D-shaped holes between May and July
- Live for 3-6 weeks, feeding on leaves but causing little damage
- Following mating females lay eggs on the bark of ash trees

http://www.arinvasives.org/wp-content/uploads/2012/09/5110029-LGPT.jpg



http://mdc.mo.gov/sites/default/files/media/images/2010/08/36.jpg

http://www.nyis.info/images/5428789.jpg

Impacts on Native Ash Trees

- Phloem-feeding beetle
  - This disrupts nutrient and water transport
- Recently infested trees show few external symptoms
- Thinning of canopy and branch die-back occurs as infestation advances
  - Woodpecker flecking is an indicator for EAB
- Epicormic shoots may emerge from trunk or branches
- Trees die within 2-4 years of infestation

http://www.nyis.info/images/EpicormicFraxPen.jpg

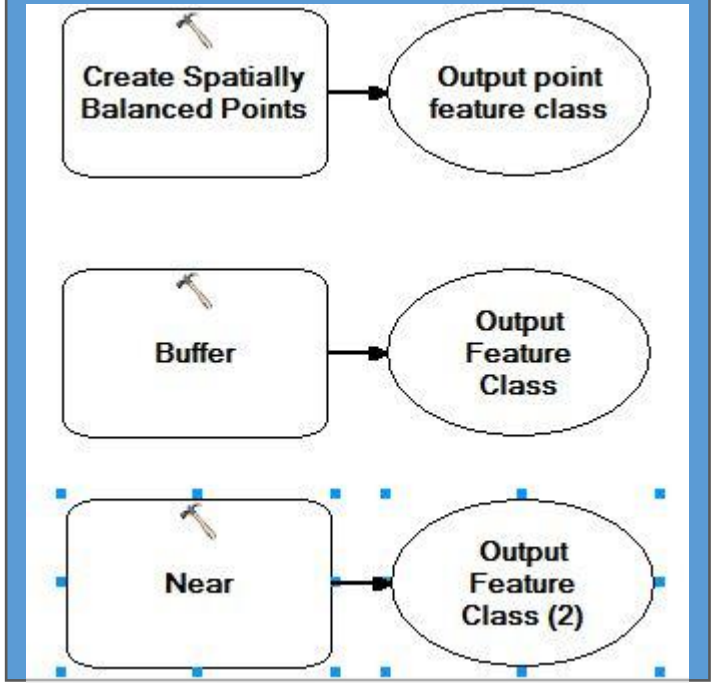
Epicormic shoots on girdled ash.

http://www.greatermichigantimbermanagement.com/yahoo_site_admin/assets/images/ash_003.39121008_std.jpg

Flecking caused by woodpecker damage.

Site Selection Protocols

ArcMap 10.2 GIS Model Builder



This site selection process was performed by UI Graduate Student, Cody Hodson.

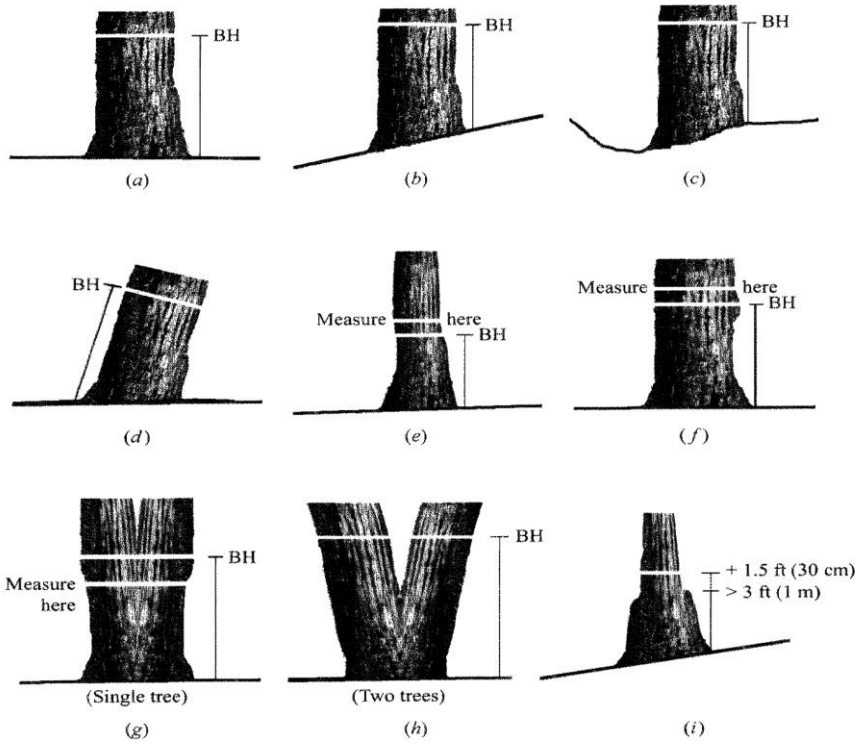
Survey Methodology

- Identify and count ash trees
- Record GPS coordinates
- Measure diameter at breast height
- Measure tree height
- Measure tree's average crown width

https://myfavoritehikes.wordpress.com/2011/08/22/garmin-etrex-venture-hc-gps/

Survey Methodology

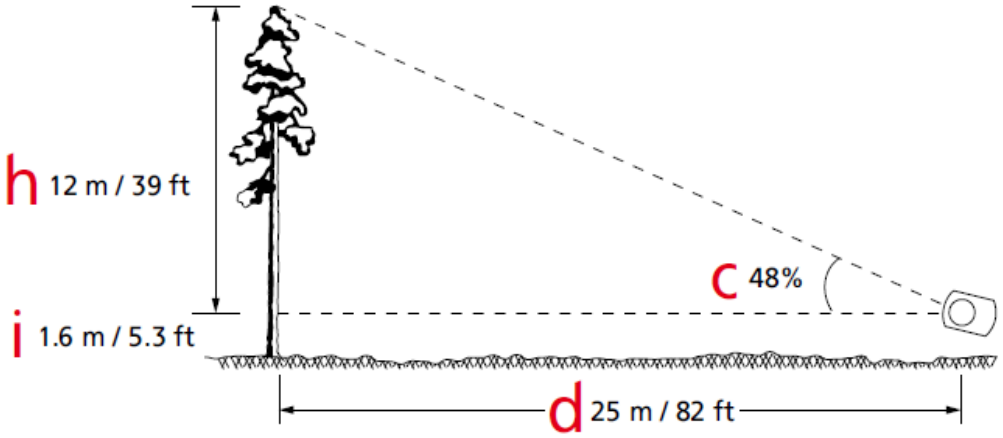
- Diameter at Breast Height
  - Trunk is the best indicator of tree size
  - Measured at 1.37m from ground
  - Data collected in centimeters



Survey Methodology

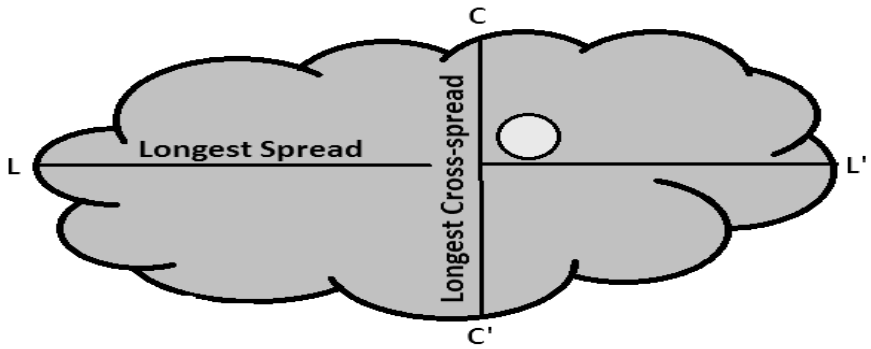
- Tree Height
  - Used clinometer and range finder
  - Measured distance from tree with range finder
  - Clinometer found percentage angle to top of tree
  - Height found by formula CxD+I=H

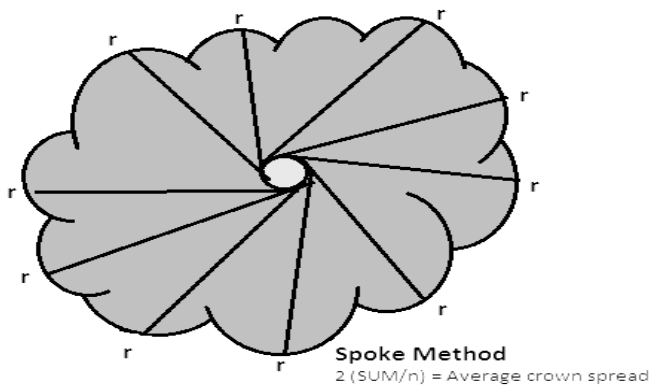
https://honeybros.com/Item/Suunto_Clinometer_PM5-1520



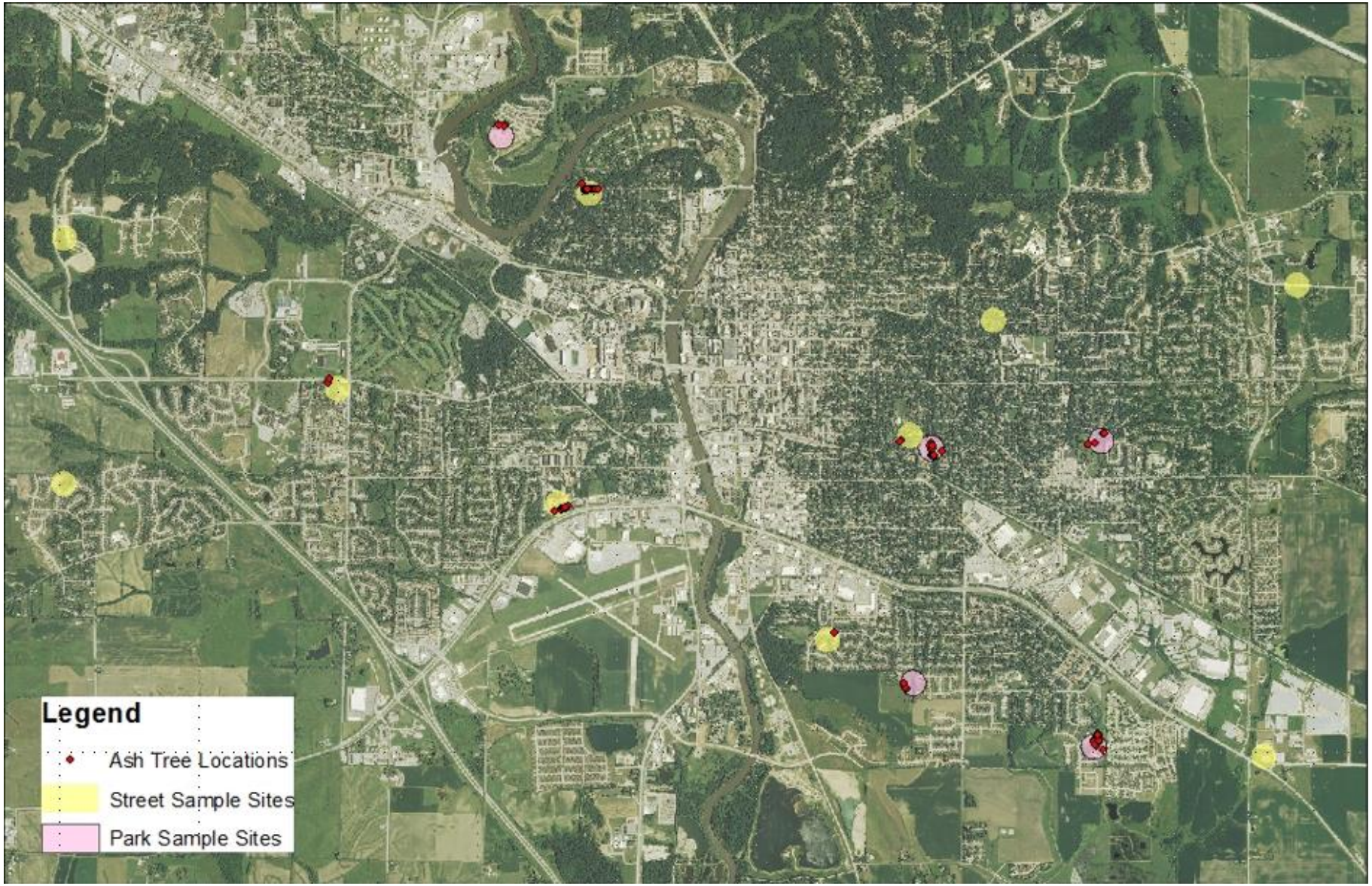
Survey Methodology

- Average Crown Width
  - Measured longest spread by the longest cross-spread
  - Formula for this method is (narrowest length + widest length)/2
  - Spoke method is an alternative





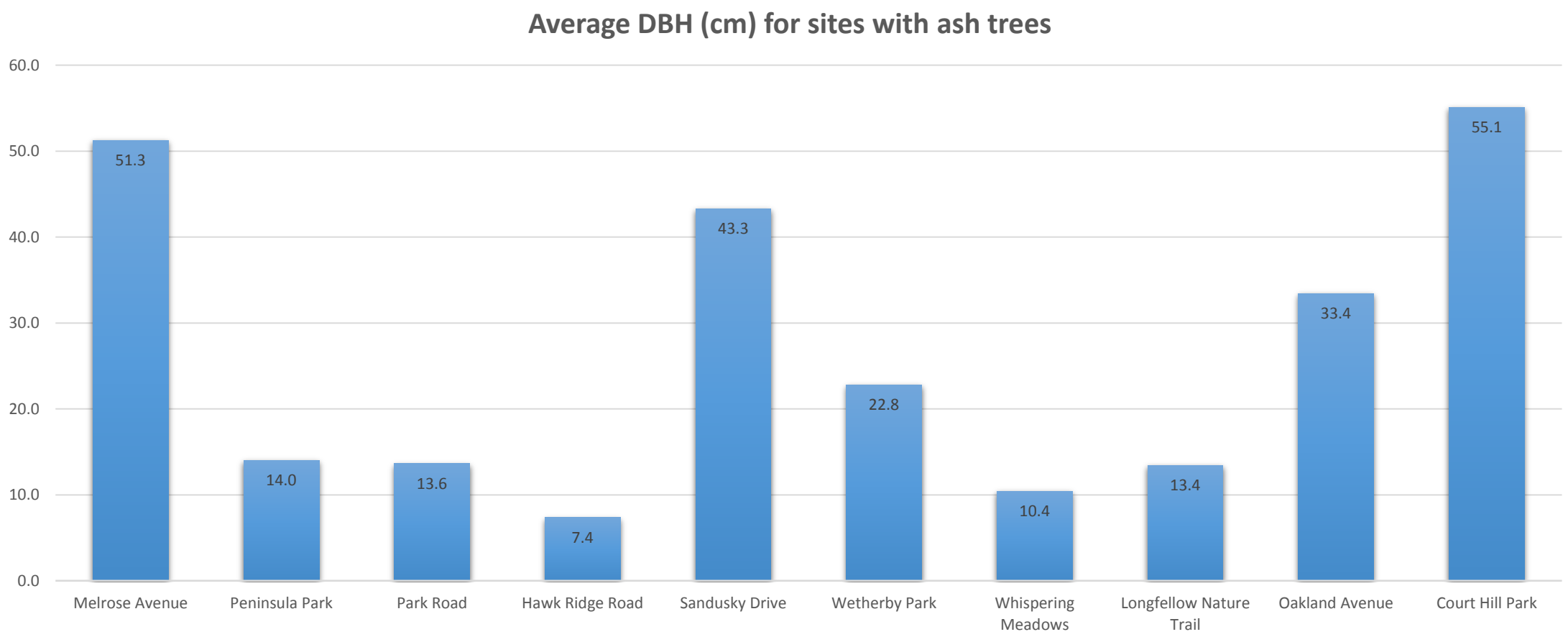
Ash Tree Locations by Site



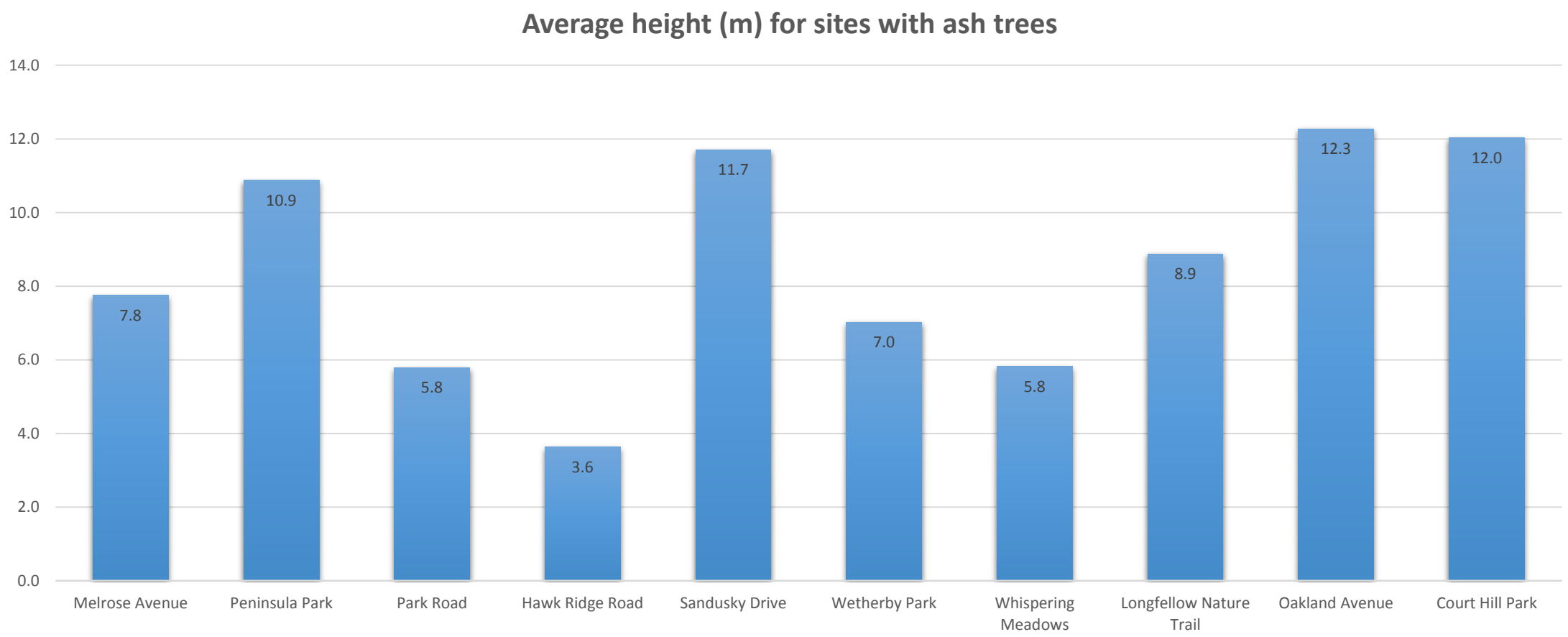
Tree Count Table

Site	Non-ash Trees	Non-Ash Saplings	Ash Trees	All Trees
Santa Fe Drive	11	0	0	11
Ryan Court	0	0	0	0
Melrose Avenue	6	0	2	8
Peninsula Park	229	1104	4	233
Park Road	186	96	24	306
Hawks Ridge Road	49	294	14	357
Mesquakie Park	N/A	N/A	N/A	N/A
Sandusky Drive	10	0	1	11
Wetherby Park	29	0	4	33
Whispering Meadows	93	71	26	190
Commerce Drive	87	44	0	131
Longfellow Nature Trail	234	240	19	493
Oakland Avenue	73	3	3	79
Glendale Road	1	0	0	1
Court Hill Park	284	570	5	859
Scott Park	N/A	N/A	N/A	N/A
Lower West Branch Road	0	0	0	0
Hickory Hill South	N/A	N/A	N/A	N/A
Hickory Hill North	N/A	N/A	N/A	N/A
Shimek Ravine	N/A	N/A	N/A	N/A
Total	1292	2422	102	2712

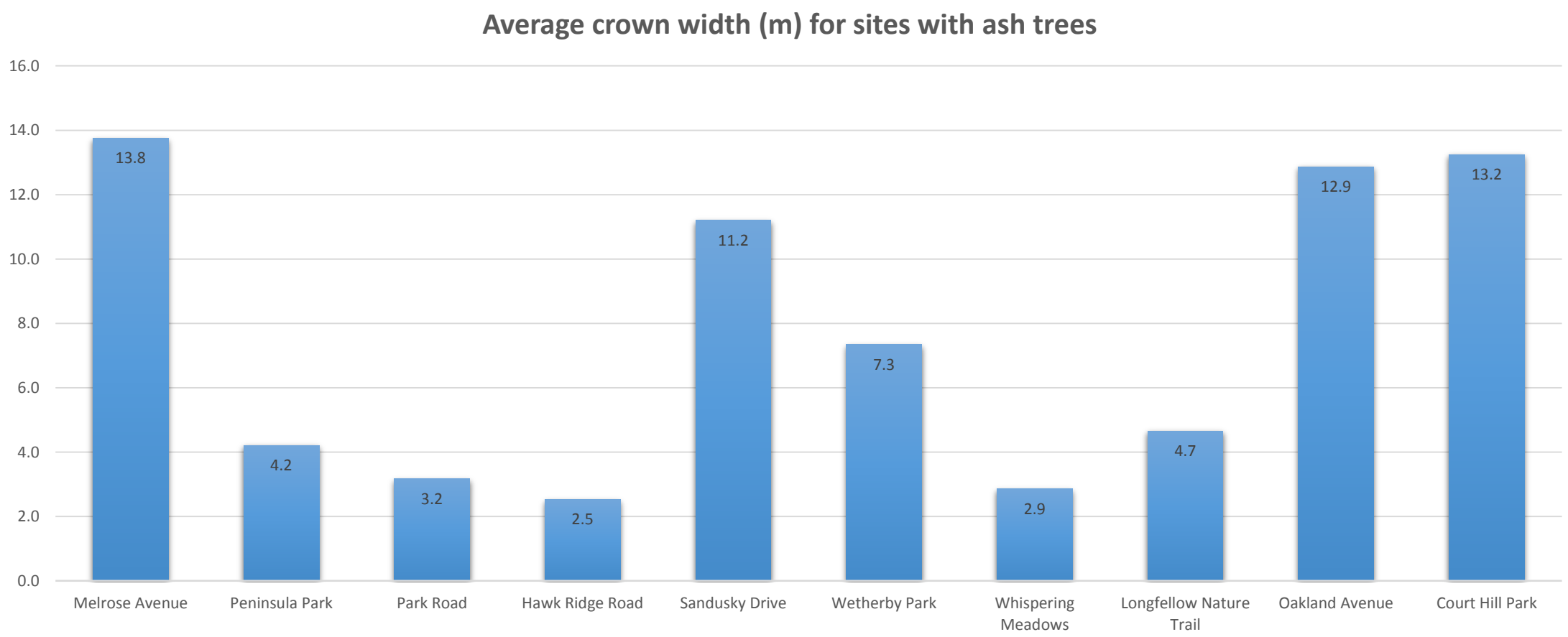
Tree Diameter



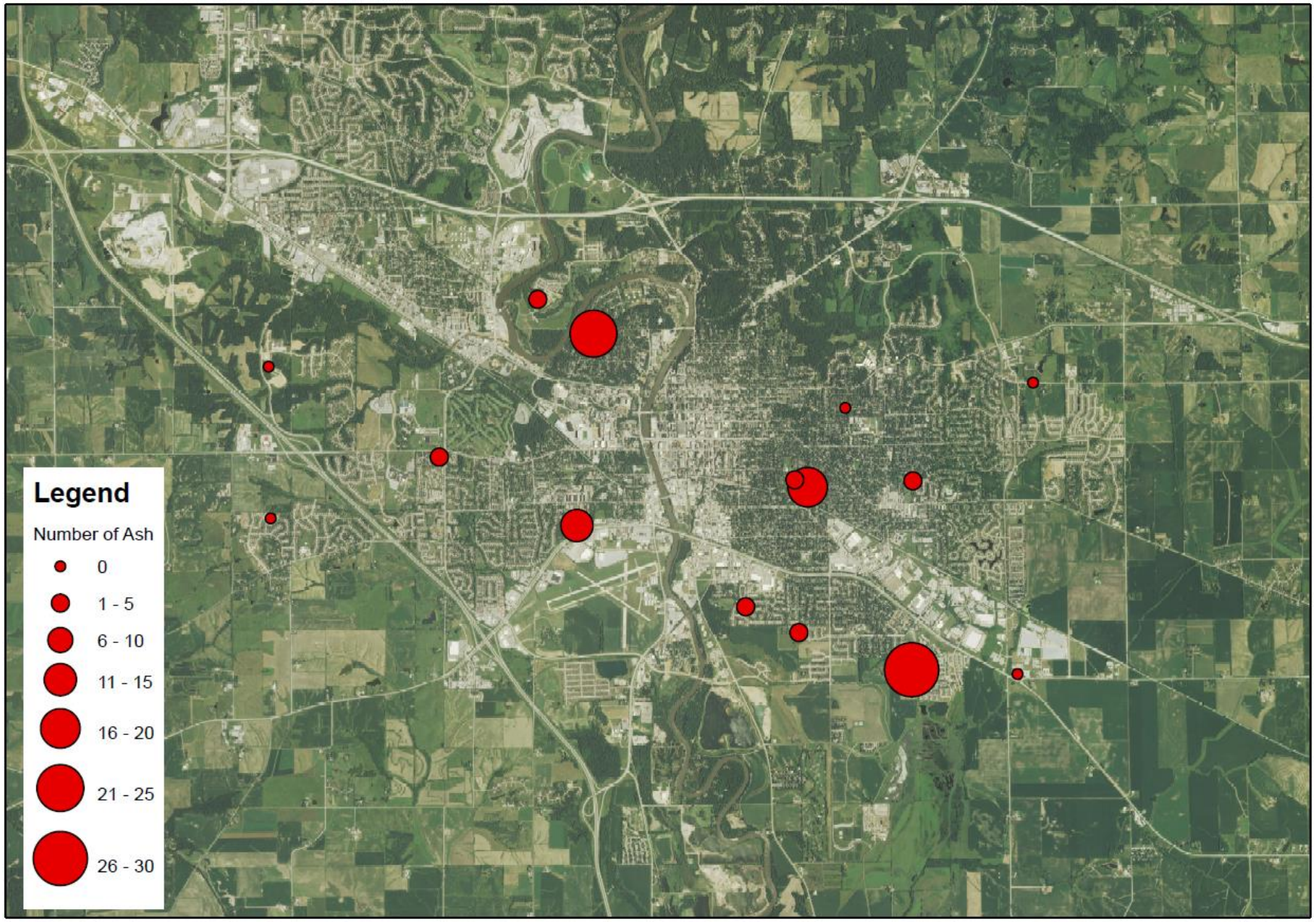
Tree Height


Average height (m) for sites with ash trees
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
7.8
10.9
5.8
3.6
11.7
7.0
5.8
8.9
12.3
12.0
Melrose Avenue
Peninsula Park
Park Road
Hawk Ridge Road
Sandusky Drive
Wetherby Park
Whispering Meadows
Longfellow Nature Trail
Oakland Avenue
Court Hill Park

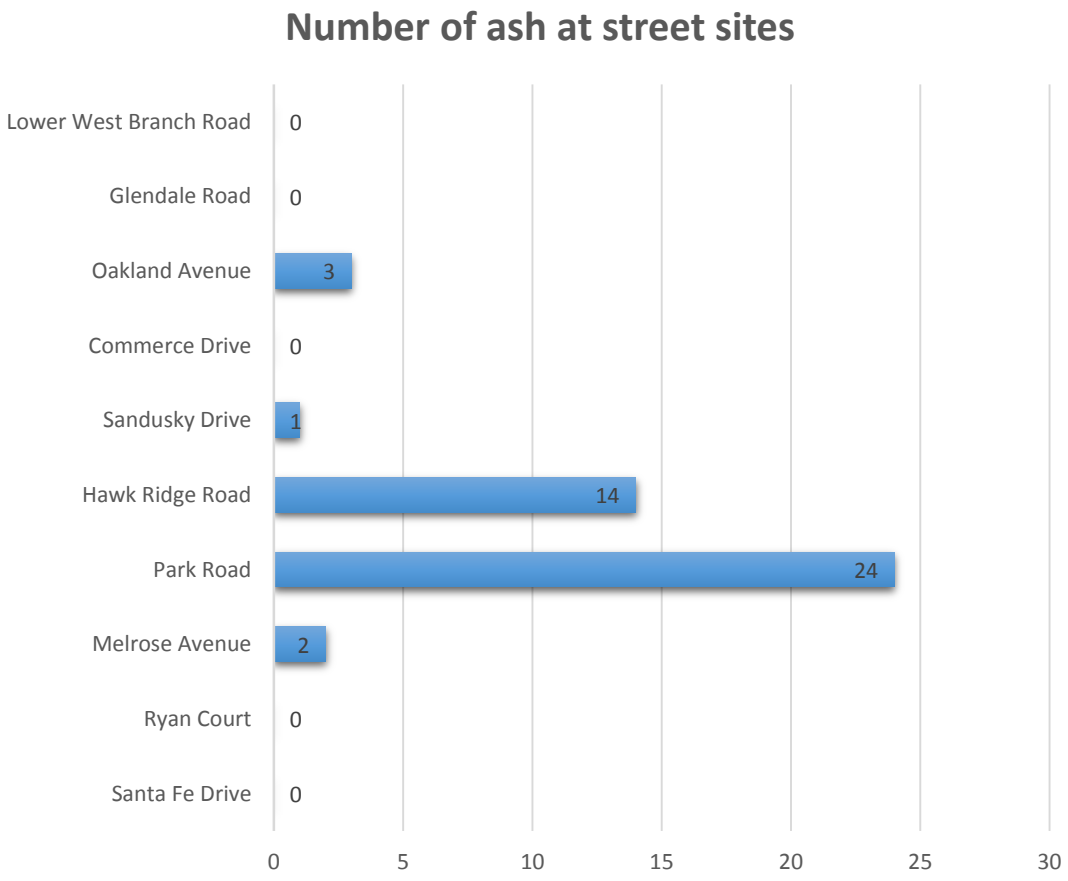
Crown Width

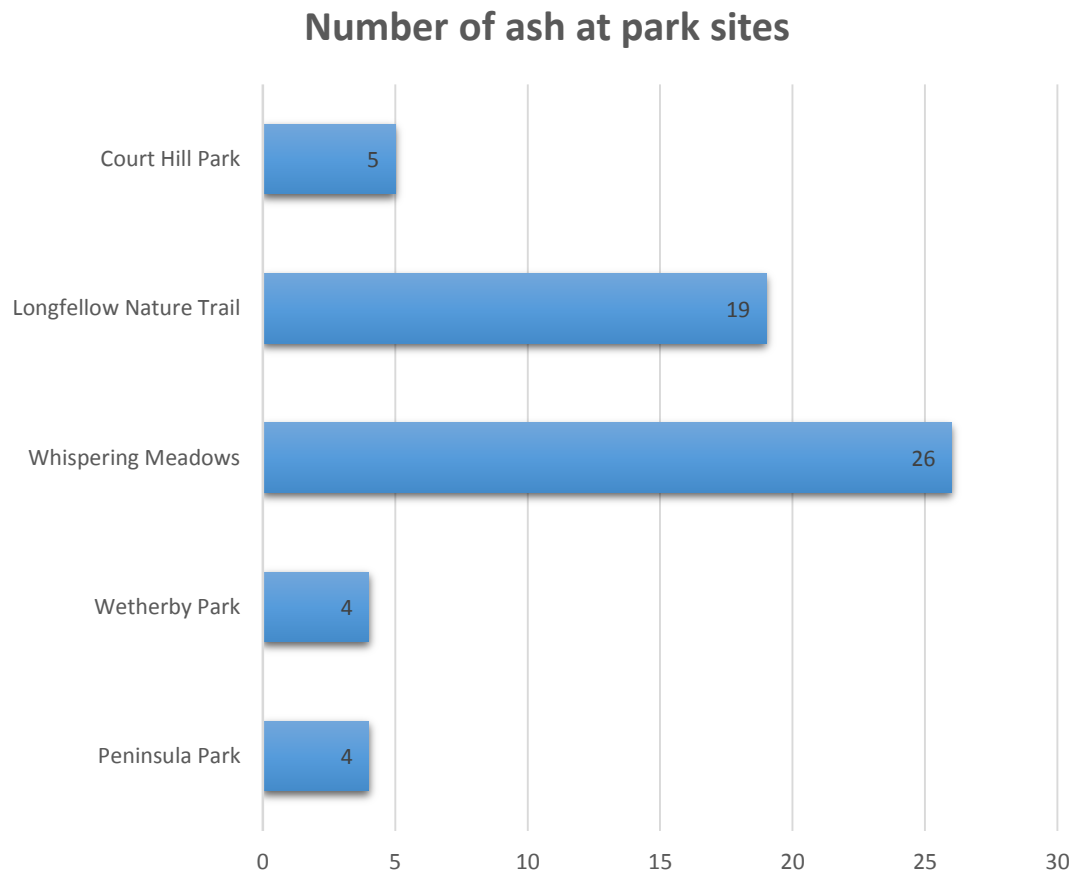

Average crown width (m) for sites with ash trees
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
13.8
4.2
3.2
2.5
11.2
7.3
2.9
4.7
12.9
13.2
Melrose Avenue
Peninsula Park
Park Road
Hawk Ridge Road
Sandusky Drive
Wetherby Park
Whispering Meadows
Longfellow Nature Trail
Oakland Avenue
Court Hill Park

Number of Ash Trees by Site

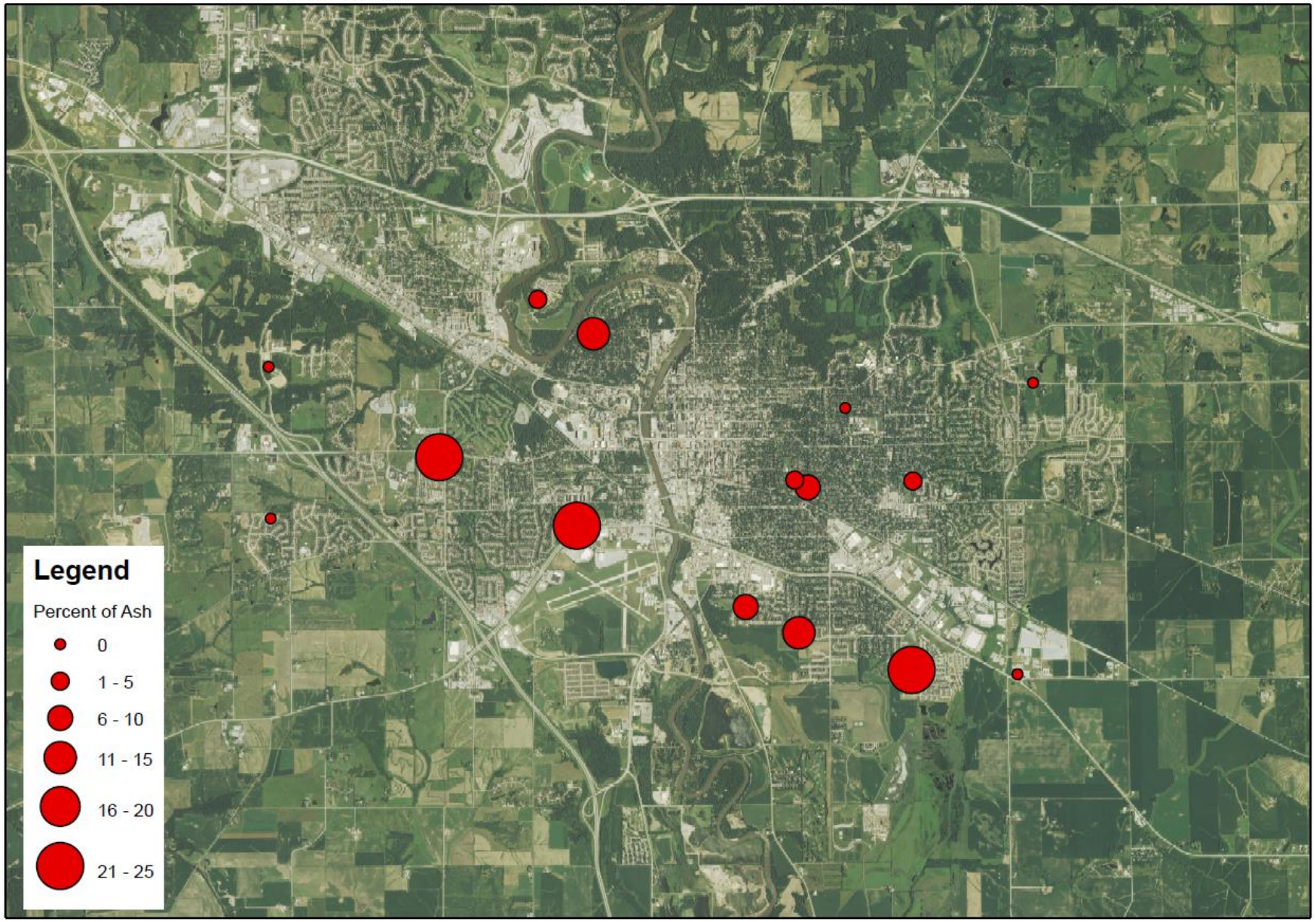


Ash Tree Count

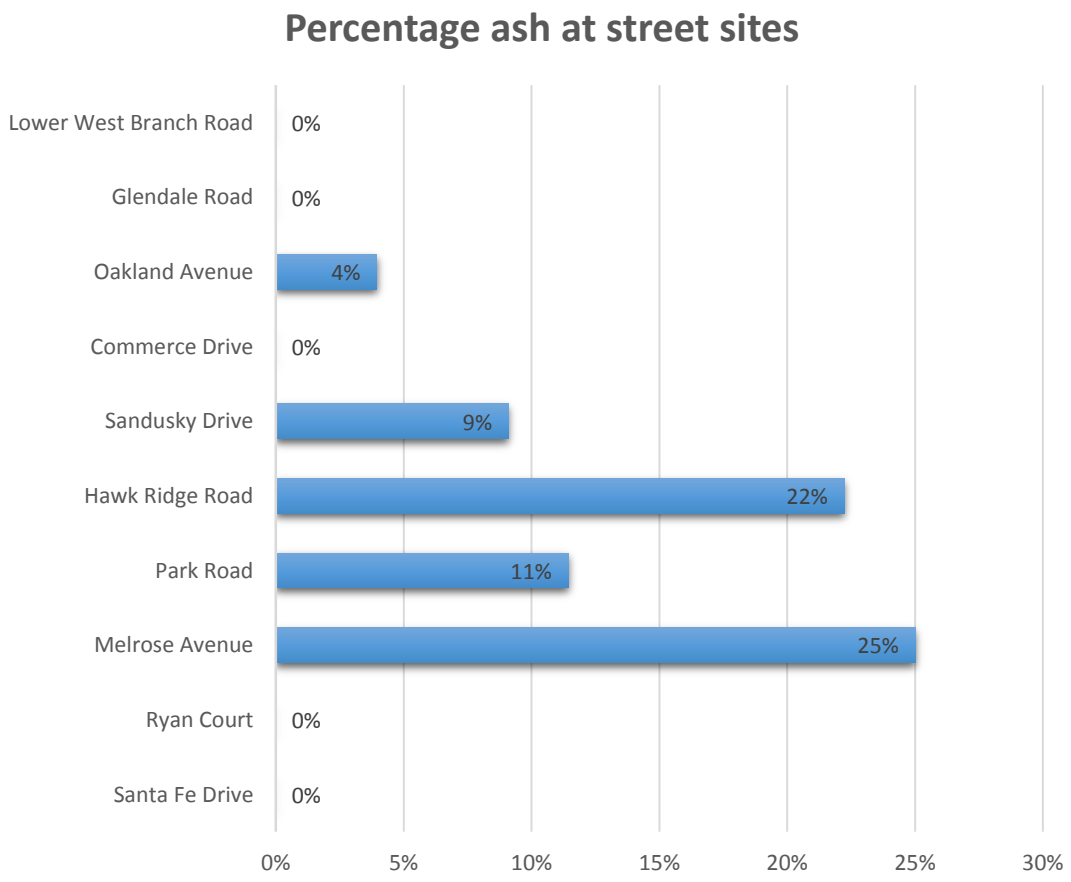


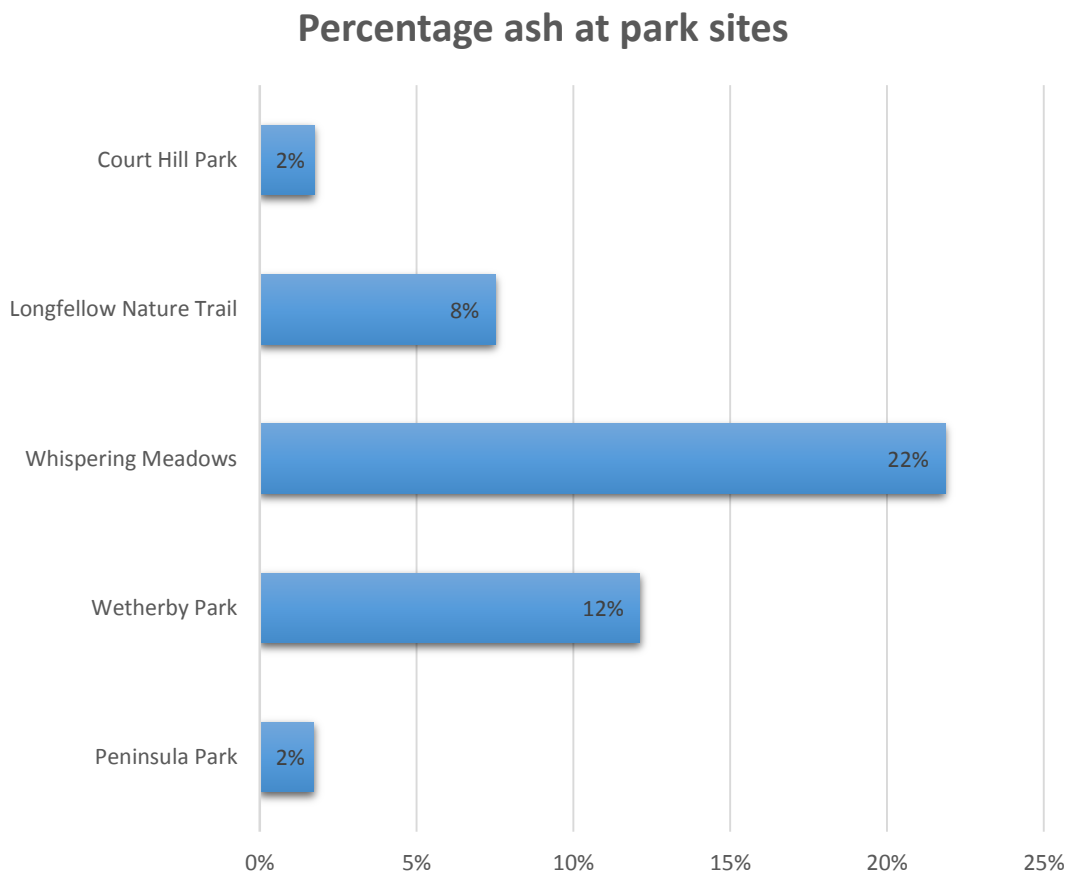


Percentage of Ash Trees by Site



Ash Tree Percentages

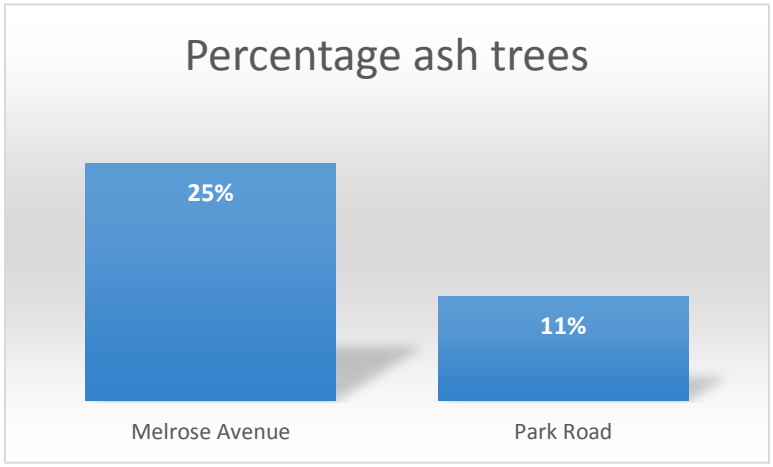




Ash Tree Percentages by Age of Neighborhood

Sites by Decade	1960s	1980s	1990s	2000s
Santa Fe Drive				x
Ryan Court				x
Melrose Avenue	x			
Peninsula Park				x
Park Road	x			
Hawk Ridge Road		x		x
Mesquakie Park			x	
Sandusky Drive		x		
Wetherby Park				x
Whispering Meadows				x
Commerce Drive			x	
Longfellow Nature Trail				x
Oakland Avenue			x	
Glendale Road	x	x		
Court Hill Park				x
Scott Park				x
Lower West Branch Road				x
Hickory Hill South			x	
Hickory Hill North				x
Shimek Ravine			x	

- Dutch elm disease responsible for the death of thousands of elm trees in Iowa in 1963
- Sampled streets sites from 1960's are Melrose Avenue and Park Road
  - Both sites exhibit higher percentages of ash trees (25% and 11.4% respectively)

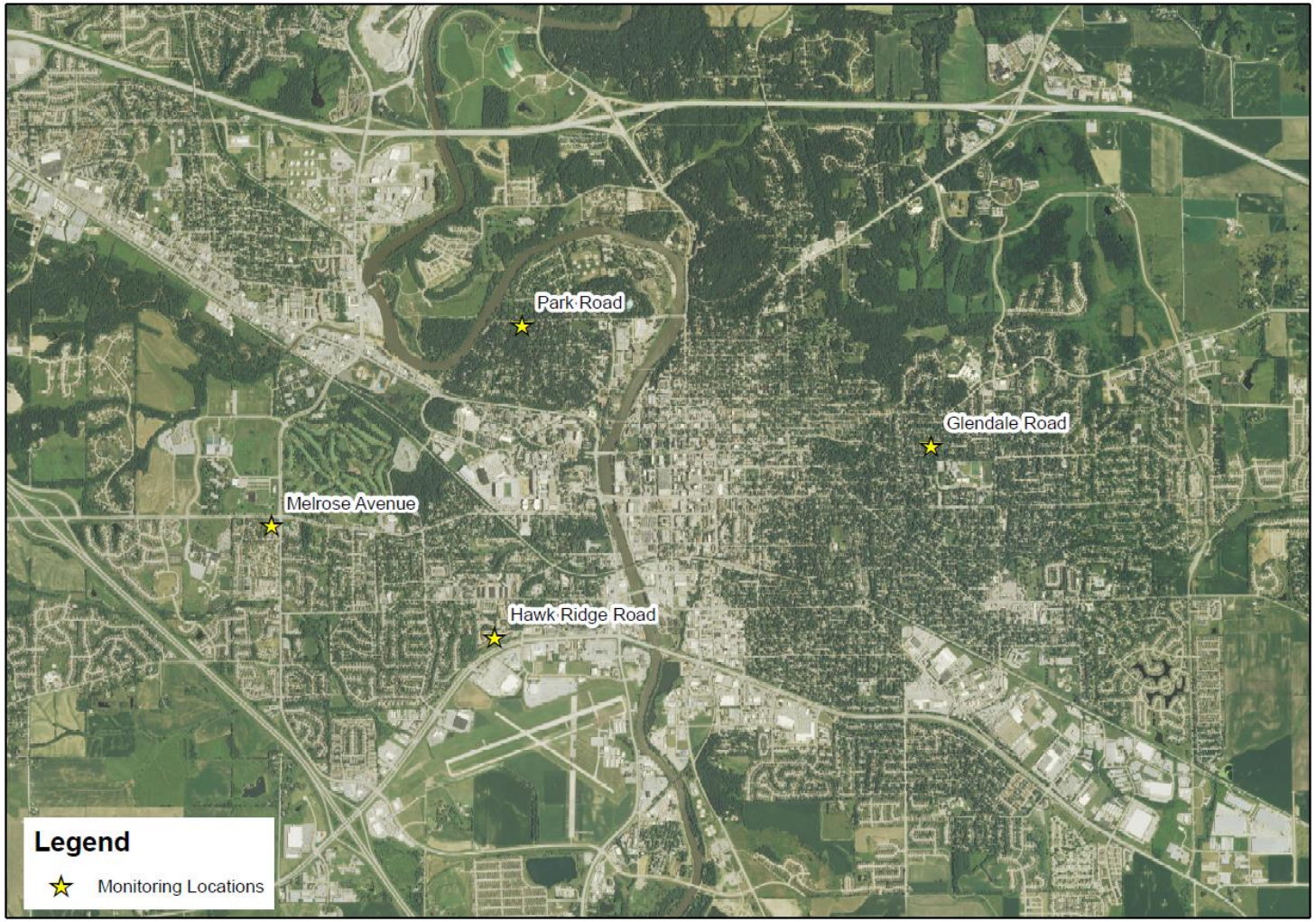


Results

- Based on our sample design, it's possible Iowa City could lose approximately one tenth of its street tree population.
- The sampled park sites had 6.3 percent ash
- The sampled streets sites 9.4 percent ash.
- Combined all trees, 7.3 percent were ash.

Where to Monitor for EAB

- Focus on Street sites
  - Glendale Rd
  - Hawk Ridge Rd
  - Melrose Ave
  - Park Rd
- Park sites are of secondary concern
  - Natural setting, trees not hazards



How to Monitor for EAB

- Canopy traps (PPT and double-decker PPT)
  - EAB attracted to color, baited with oils similar to those found in ash, glue traps beetles
  - Research has suggested that double-decker traps are more effective in areas with low EAB density
- Girdling
  - Low-tech, destructive to tree
    - Not recommended for street trees
- Surveillance
  - Beetle itself
  - Signs of infestation
    - Branch and canopy die-off
    - Epicormic shoots
    - Woodpecker damage

Atanycolus hicoriae

- Study conducted in Michigan
- Parasitoid of the two-lined chestnut borer and bronze birch borer, possibly feeds on EAB
- Small wasp species that develops singly
- Impact is dependent on how well life cycles match; EAB and *A. hicoriae* are not well synced
- EAB on two-year life cycle were more affected by parasitism
- Found higher rate of parasitism than previous studies

http://www.biocontrol.entomology.cornell.edu/images/parasitoids/a_cappaerti1.jpg

Oobius agrilli

- Wasp parasitoid found in China
- Sole host is the EAB
- 53-61% parasitism in July/August
- Preferentially attacks EAB over other species

http://www.ars.usda.gov/SP2UserFiles/Place/80100000/JJDuan/Balchaindica.jpg

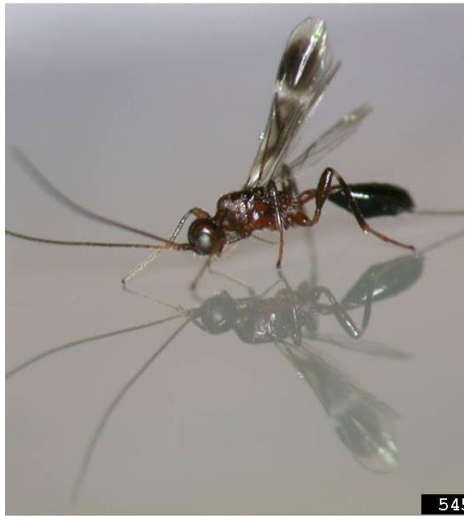
Tetrastichus planipennisi

- Parasitic wasp species of N Asia
- Shown to kill up to 50% EAB larvae
- Can survive winter as larvae inside host- very good at establishing continuous population
- Only host is the EAB
- Only attacks EAB larvae that are actively feeding

http://www.discoverlife.org/IM/I_BUR/0000/mx/Tetrastichus_planipennisi,I_BUR2.jpg

Spathius agrili

- Parasitic wasp species of N Asia
- Small tree host range but highly effective- up to 90%
- EAB is only host species
- Lifecycle of EAB and host coincide well



http://www.insectimages.org/browse/detail.cfm?imgnum=5451604

Cedar Rapids EAB Management Plan

- Around 30% of city street trees are ash trees
- Estimated: 15,000 ash trees
- Slow the spread approach: combining tree removal and insecticide use
  - Limits dispersal of EAB and lessens it impact over a greater timeframe
- Buffers the loss of ash tree canopy so new trees can get larger and form a new canopy
- Allows tree removal crews more time to remove all ash trees

CEDAR RAPIDS

City of Five Seasons®

Ash Tree Treatment

TREE-age Injection (emamectin benzoate)

- $5 per inch of tree diameter ($120 24” DBH tree)
- Treatment lasts 2-3 years
- 90% effective (not guaranteed)

Plans for Treatment

- Create a treatment buffer along infected sites
- Treat sentinel ash trees & well-formed mature ash trees
- City blocks with primarily ash trees: ≈50% will be treated to allow new tree species to grow while minimizing canopy loss

http://www.greenvelvet.com/wp-content/uploads/2012/11/Treeage-Always-Ready-Bottle.jpg

Ash Tree Removal

- Cedar Rapids has removed over 1000 ash trees since 2009
  - (150-300 per year)
- Become more aggressive once EAB infestation occurs
  - Remove 500-1000 trees per year
- Remove all ash trees within 2 block radius of infected tree

Trees to Remove

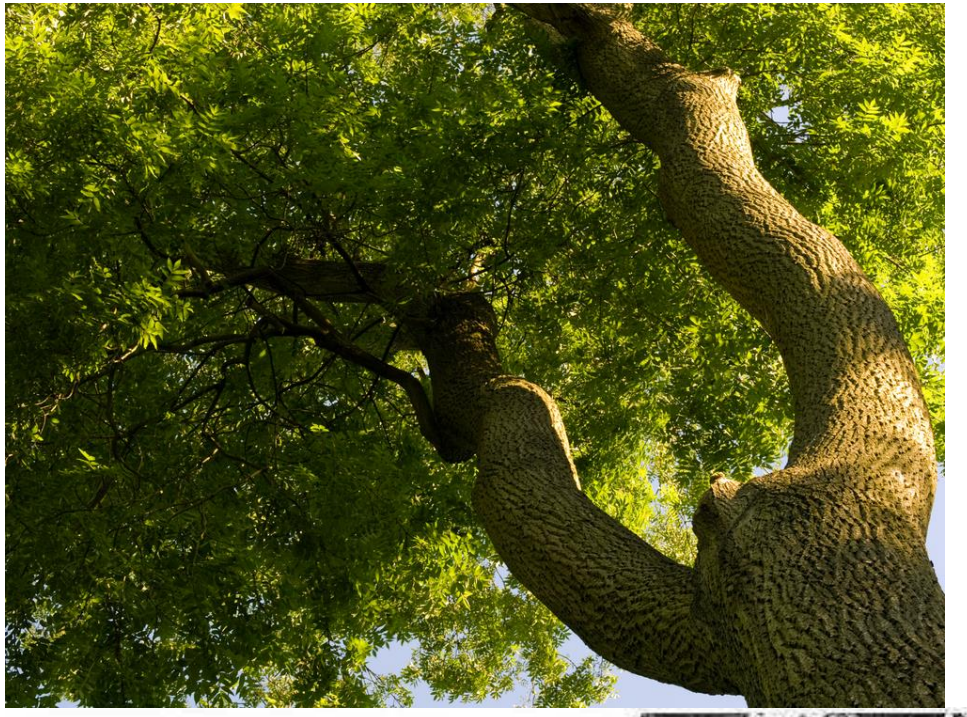
- Poor form
- Safety hazard
- Poor location
- Declining ash tree

Poor location (under power lines)

Examples of Trees to Remove

Declining ash are more prone to storm damage and falling limbs

Ash trees with co-dominant leaders can be more prone to splitting and storm damage



Management Costs

- $400,000 to conduct ash tree survey & identify trees to have

to treat all 15,000 trees:

- $3.15 million for initial treatment
- $20.4 - 26.7 million to treat over a 16 year period (depending on 2-3 yr treatment plan)
- Does not factor in removal of treated trees overcome by EAB

To remove all 15,000 trees:

- $11.25 million to remove within 10 years
- $15.22 million total to remove and replace all ash trees

Middle approach:

- Save some trees and remove some
- $16.1 million over 18 years with chemical treatment every 3 years
- $17.6 million with chemical treatment every 2 years

Cedar Rapids Tree Survivability

- Conducted a tree survey for street trees planted from 2009-2012 (3087 trees)

- Found an average of 82% survivability & 18% mortality rates

Most successful trees were able to handle stress

- Soil compaction
- Road salt
- Reduced groundwater filtration (impermeable surfaces)
- Excessive heat radiation
- Pollution

Best Tree Replacements (From CR Data)

Tree Species	Trees Planted	Trees Alive		Dead/Replaced Trees	
		#	%	#	%
Manchurian Alder	20	20	100.0%	0	0.0%
Amur Corktree	49	47	95.9%	2	4.1%
Black Locust	42	40	95.2%	2	4.8%
Tartarian Maple	15	14	93.3%	1	6.7%
Amur Maple	12	11	91.7%	1	8.3%
Shumard Oak	12	11	91.7%	1	8.3%
Hackberry	179	164	91.6%	15	8.4%
Crabapple	70	64	91.4%	6	8.6%
Japanese Zelkova	66	60	90.9%	6	9.1%
Kentucky Coffeetree	230	208	90.4%	22	9.6%
Horse Chestnut	31	28	90.3%	3	9.7%
Miyabei Maple	121	109	90.1%	12	9.9%
Hybrid Elm	302	268	88.7%	34	11.3%
Swamp White Oak	193	167	86.5%	26	13.5%
Honeylocust	191	165	86.4%	26	13.6%
London Planetree	139	120	86.3%	19	13.7%
Shingle Oak	36	31	86.1%	5	13.9%
Dawn Redwood	13	11	84.6%	2	15.4%
Ginkgo	276	228	82.6%	48	17.4%
Lacebark Elm	63	52	82.5%	11	17.5%
Bald Cypress	112	92	82.1%	20	17.9%
Japanese Tree Lilac	77	63	81.8%	14	18.2%
Sawtooth Oak	11	9	81.8%	2	18.2%
Hills Oak	15	12	80.0%	3	20.0%
Bur Oak	29	23	79.3%	6	20.7%

Worst Tree Replacements

Tree Species	Trees Planted	Trees Alive		Dead/Replaced Trees	
		#	%	#	%
Serviceberry	11	6	54.5%	5	45.5%
Blue Beech	17	10	58.8%	7	41.2%
Japanese Pagodatree	13	8	61.5%	5	38.5%
Tulip Tree	94	58	61.7%	36	38.3%
Black Alder	33	21	63.6%	12	36.4%
Norway Maple	25	16	64.0%	9	36.0%
White Oak	27	18	66.7%	9	33.3%
Sweet Gum	27	19	70.4%	8	29.6%
Goldenraintree	23	17	73.9%	6	26.1%
European Hornbeam	73	55	75.3%	18	24.7%
Black Maple	29	22	75.9%	7	24.1%
Sugar Maple	224	174	77.7%	50	22.3%
Chinquapin Oak	106	83	78.3%	23	21.7%

Summary of Recommendations

- Monitor Street Sites
  - Glendale Rd, Hawks Ridge Rd, Melrose Ave, and Park Rd
- Utilize double-decker prism traps
- Increase surveillance efforts in these areas
  - Insect, secondary signs of infestation
- Treat sentinel and large mature ash trees
- Create quarantine buffers around infested ash when possible
- Replace removed ash trees with emphasis on natives over exotic species

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