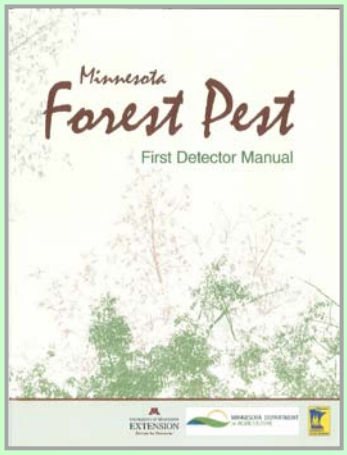
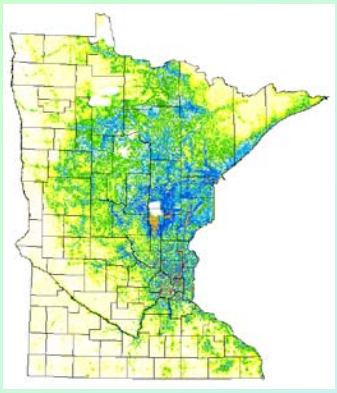
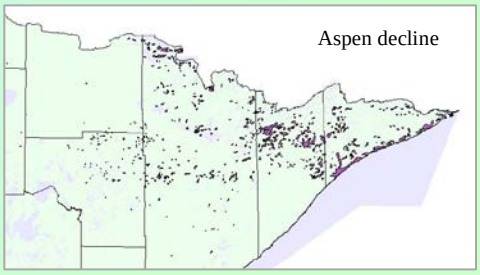
Minnesota Forest Health Annual Report

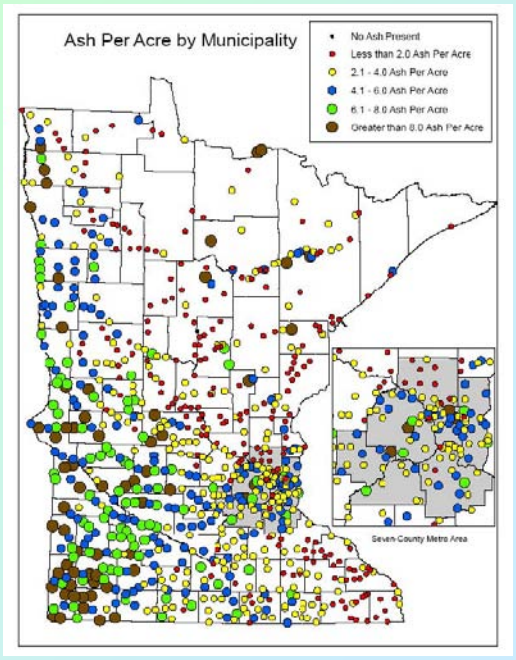
2010

DNR-Forestry
Forest Health Unit









THE FOREST RESOURCES OF MINNESOTA

In Minnesota there are approximately 16.3 million acres of forested land, of which 14.9 million acres are classified as "timberland" or lands capable of producing timber. An additional 960,000 acres are not included in productive timberland due to their inclusion in the Boundary Waters Canoe Area Wilderness or other reserved land category. Forest land ownership is 46% private, 27% state, 14% county, 12% National Forest and 1% other federal ownership. (Source of data is the Minnesota 2001 Eastwide Database provided by the USFS-NCFES.)

Emerald ash borer was found in this St. Paul neighborhood in April of 2009.

Two major industries depend on Minnesota's forested lands: forest industry and tourism. Fforest industry is Minnesota's second largest manufacturing industry, employing more than 55,000 people. The value of forest products manufactured in Minnesota exceeds $7 billion and accounts for 16% of all manufacturing dollars generated in Minnesota. The tourism industry is Minnesota's second largest employer employing over 140,000 people and accounting for a payroll in excess of $3 billion. Gross receipts from tourism exceed $6 billion. Over 70% of people who took at least one spring or summer trip in Minnesota rated "observing natural scenery" as the most important activity of their trip.

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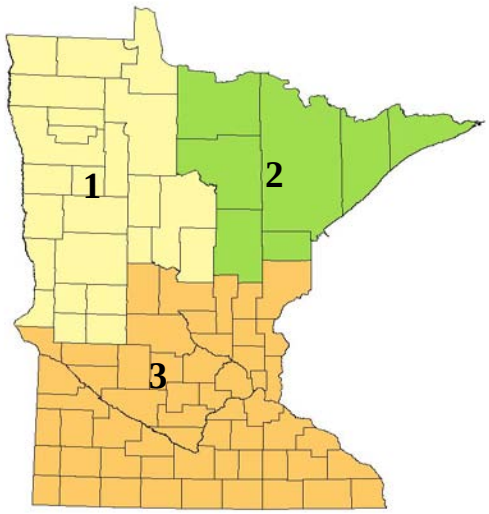

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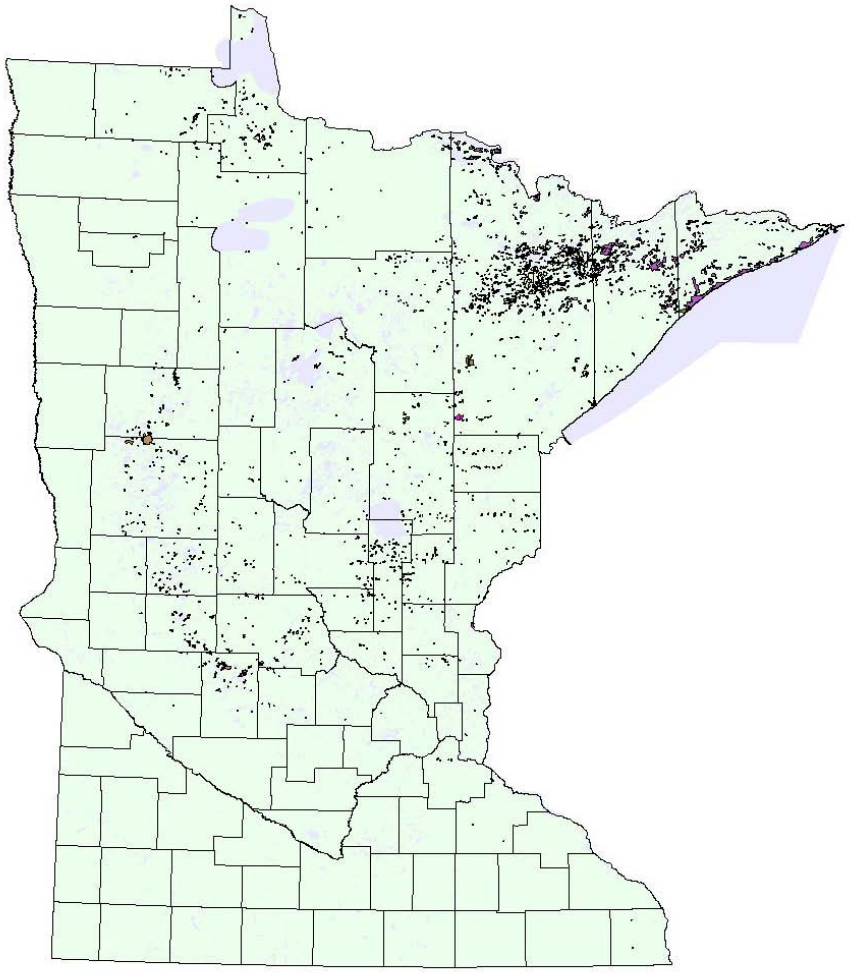
AERIAL SURVEY

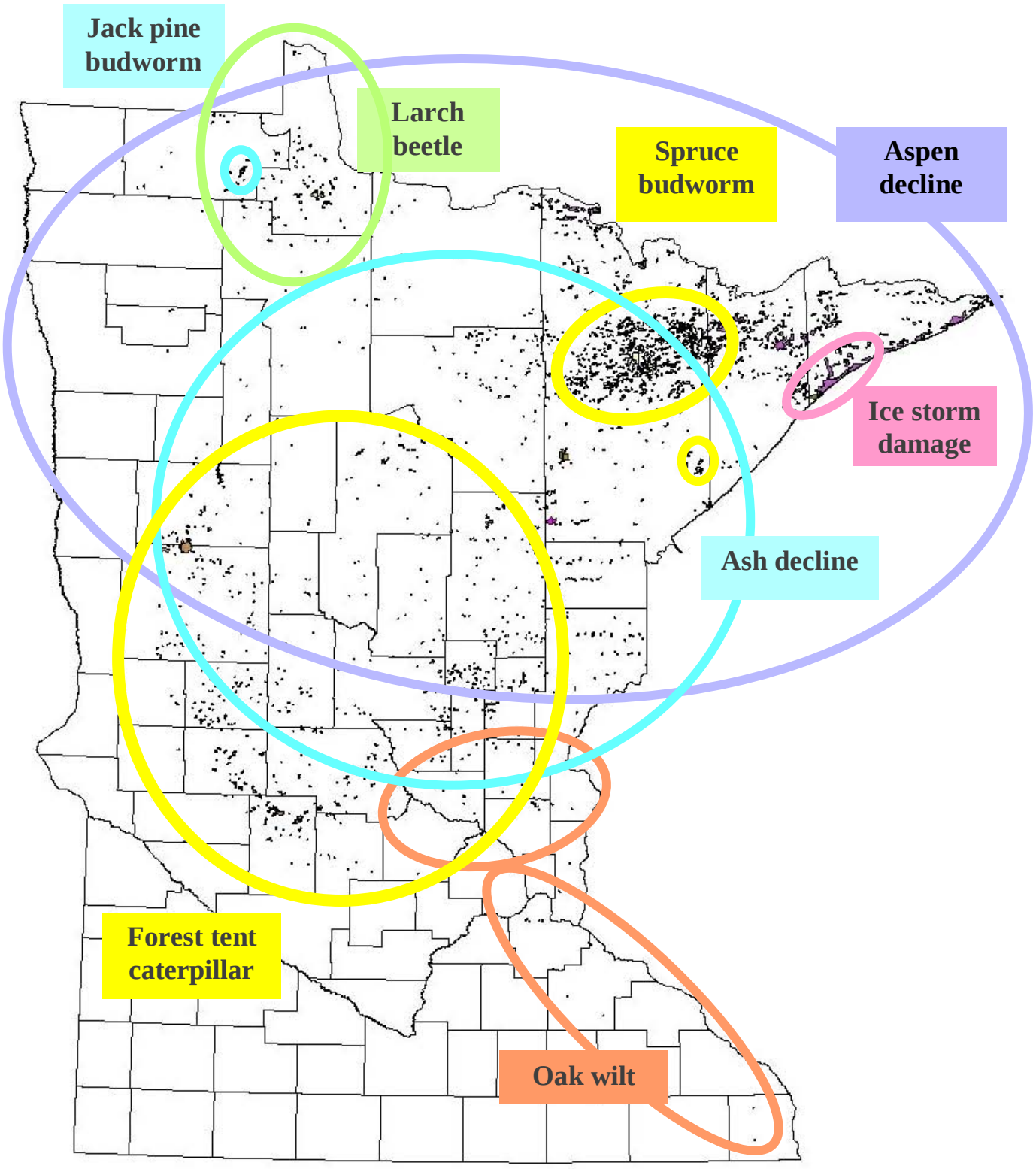


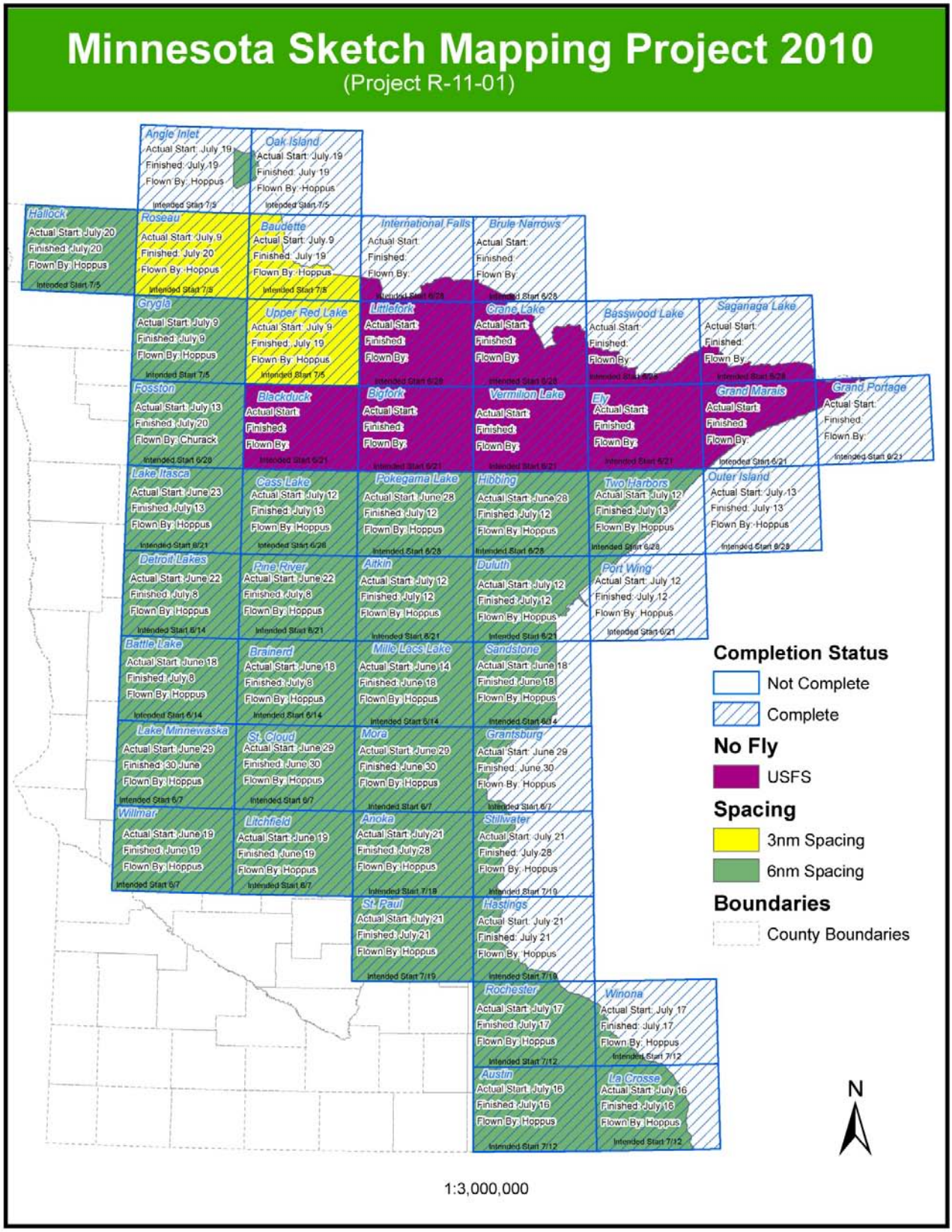
Since the early 1950's, aerial survey has been a valuable tool for monitoring the activities of forest insects and pathogens across the 16 million acres of forest land in Minnesota. For the past fourteen years, these surveys have been accomplished through the collaboration of DNR Forest Health and Resource Assessment Units and USFS, State and Private Forestry. The Forest Health staff plans the scope, timing and intensity of the surveys, trains Resource Assessment staff, provides ground-truthing, analysis and dissemination of survey data. Resource Assessment staff conducts the aerial sketch-mapping, digitizes the data and produces digital shape files. In addition to being used in Minnesota, the survey results are incorporated into the USFS's national database since our procedures and products comply with national standards.

Thanks to Mike Hoppus, Pat Churak and Larry Hoyt, Resource Assessment's sketch-mappers, who accomplished this year's aerial survey. Thanks also to Marc Roberts, USFS-S&PF, for mapping the federal lands and to Quinn Chavez, USFS-S&PF, for post-flight map rectification.

Agent	Number of polygons	Number of acres
Ash decline	566	23,092
Aspen decline	245	68,050
Hardwood decline	499	198,304
Bark beetles	175	1143
Dutch elm disease	532	406
Eastern larch beetle	1648	18,817
Fire	20	753
Flooding	81	478
Forest tent caterpillar	829	70,665
Jack pine budworm	16	1,052
Larch casebearer	105	15,387
Oak wilt	2065	3,397
Snow/ ice damage	16	12,618
Spruce budworm	440	121,370
Two-lined chestnut borer	81	56
Wind damage/ tornado	45	2,007
Winter injury	1	197
Totals	**7364**	**537,792**

Aerial Survey Results 2010




Minnesota Sketch Mapping Project 2010
(Project R-11-01)
Angle Inlet
Actual Start: July 19
Finished: July 19
Flown By: Hoppus
Intended Start 7/5
Oak Island
Actual Start: July 19
Finished: July 19
Flown By: Hoppus
Intended Start 7/5
Hallock
Actual Start: July 20
Finished: July 20
Flown By: Hoppus
Intended Start 7/5
Roseau
Actual Start: July 9
Finished: July 20
Flown By: Hoppus
Intended Start 7/5
Baudette
Actual Start: July 9
Finished: July 19
Flown By: Hoppus
Intended Start 7/5
International Falls
Actual Start:
Finished:
Flown By:
Intended Start 6/28
Brule Narrows
Actual Start:
Finished:
Flown By:
Intended Start 6/28
Grygla
Actual Start: July 9
Finished: July 9
Flown By: Hoppus
Intended Start 7/5
Upper Red Lake
Actual Start: July 9
Finished: July 19
Flown By: Hoppus
Intended Start 7/5
Littlefork
Actual Start:
Finished:
Flown By:
Intended Start 6/28
Crane Lake
Actual Start:
Finished:
Flown By:
Intended Start 6/28
Basswood Lake
Actual Start:
Finished:
Flown By:
Intended Start 6/28
Saganaga Lake
Actual Start:
Finished:
Flown By:
Intended Start 6/28
Fosston
Actual Start: July 13
Finished: July 20
Flown By: Churack
Intended Start 6/28
Blackduck
Actual Start:
Finished:
Flown By:
Intended Start 6/21
Bigfork
Actual Start:
Finished:
Flown By:
Intended Start 6/21
Vermilion Lake
Actual Start:
Finished:
Flown By:
Intended Start 6/21
Ely
Actual Start:
Finished:
Flown By:
Intended Start 6/21
Grand Marais
Actual Start:
Finished:
Flown By:
Intended Start 6/21
Grand Portage
Actual Start:
Finished:
Flown By:
Intended Start 6/21
Lake Itasca
Actual Start: June 23
Finished: July 13
Flown By: Hoppus
Intended Start 6/21
Cass Lake
Actual Start: July 12
Finished: July 13
Flown By: Hoppus
Intended Start 6/28
Pokegama Lake
Actual Start: June 28
Finished: July 12
Flown By: Hoppus
Intended Start 6/28
Hibbing
Actual Start: June 28
Finished: July 12
Flown By: Hoppus
Intended Start 6/28
Two Harbors
Actual Start: July 12
Finished: July 13
Flown By: Hoppus
Intended Start 6/28
Outer Island
Actual Start: July 13
Finished: July 13
Flown By: Hoppus
Intended Start 6/28
Detroit Lakes
Actual Start: June 22
Finished: July 8
Flown By: Hoppus
Intended Start 6/14
Pine River
Actual Start: June 22
Finished: July 8
Flown By: Hoppus
Intended Start 6/21
Aitkin
Actual Start: July 12
Finished: July 12
Flown By: Hoppus
Intended Start 6/21
Duluth
Actual Start: July 12
Finished: July 12
Flown By: Hoppus
Intended Start 6/21
Port Wing
Actual Start: July 12
Finished: July 12
Flown By: Hoppus
Intended Start 6/21
Battle Lake
Actual Start: June 18
Finished: July 8
Flown By: Hoppus
Intended Start 6/14
Brainerd
Actual Start: June 18
Finished: July 8
Flown By: Hoppus
Intended Start 6/14
Mille Lacs Lake
Actual Start: June 14
Finished: June 18
Flown By: Hoppus
Intended Start 6/14
Sandstone
Actual Start: June 18
Finished: June 18
Flown By: Hoppus
Intended Start 6/14
Lake Minnewaska
Actual Start: June 29
Finished: 30 June
Flown By: Hoppus
Intended Start 6/7
St. Cloud
Actual Start: June 29
Finished: June 30
Flown By: Hoppus
Intended Start 6/7
Mora
Actual Start: June 29
Finished: June 30
Flown By: Hoppus
Intended Start 6/7
Grantsburg
Actual Start: June 29
Finished: June 30
Flown By: Hoppus
Intended Start 6/7
Willmar
Actual Start: June 19
Finished: June 19
Flown By: Hoppus
Intended Start 6/7
Litchfield
Actual Start: June 19
Finished: June 19
Flown By: Hoppus
Intended Start 6/7
Anoka
Actual Start: July 21
Finished: July 28
Flown By: Hoppus
Intended Start 7/19
Stillwater
Actual Start: July 21
Finished: July 28
Flown By: Hoppus
Intended Start 7/19
St. Paul
Actual Start: July 21
Finished: July 21
Flown By: Hoppus
Intended Start 7/19
Hastings
Actual Start: July 21
Finished: July 21
Flown By: Hoppus
Intended Start 7/19
Rochester
Actual Start: July 17
Finished: July 17
Flown By: Hoppus
Intended Start 7/12
Winona
Actual Start: July 17
Finished: July 17
Flown By: Hoppus
Intended Start 7/12
Austin
Actual Start: July 16
Finished: July 16
Flown By: Hoppus
Intended Start 7/12
La Crosse
Actual Start: July 16
Finished: July 16
Flown By: Hoppus
Intended Start 7/12
Completion Status
Not Complete
Complete
No Fly
USFS
Spacing
3nm Spacing
6nm Spacing
Boundaries
County Boundaries
N
1:3,000,000

2010 Cheatsheet for Coding Damage Polygons in ArcView

File Names: Store successive shapefile versions as skm10v01.xxx, skm10v02.xxx, etc. in S:\sketchmp\dmg_polys_10

Items coded: Arrange data fields in the following order and format:

Polygon ID: Name of 1:100,000 quad on which polygon is first delineated , plus 3-digit number: e.g. LakeItasca025. Numbering starts at 001 in every quadrangle. Once assigned, this ID will not change. Character field, width 25.

ID No: Only the numerical portion of Polygon ID above. Numeric field, width 3, no decimal.

Damage type code: Use severest type if more than one may apply. Flight map coding may indicate agent only; e.g. FTC = forest tent caterpillar = defoliation, or OW = oak wilt = mortality. Numeric field, width 2, no decimal.

Defoliation (D)	1	Branch breakage (Br)	6
Mortality (M)	2	Stembreak/uproot (St)	7
Discoloration (Dc)	3	Branch flagging (Bf)	8
Dieback (Db)	4	Other damage (0)	10
Topkill (Tk)	5	Old mortality (OM)	11

State severity code: Coding default is L unless otherwise specified. Character field, width 2.

Trace, 5%-25% affected	T	Moderate, 51%-75% affected	M
Light, 26%-50% affected	L	Heavy, > 75% affected	H

Federal severity code: Derived from state severity code. Numeric field, width 2, no decimal.

T, L	1	M, H	2

Pattern code: Coding default is 1 unless otherwise specified. Numeric field, width 2, no decimal.

Where host cover > 50% and damage is:		Where nonhost cover > 50% and damage is:	
Cg = Contiguous	1	C = Continuous	3
P = Patchy	2	Sc = Scattered	4

Agent code: Following are common; see Aerial Survey Handbook for anything else. Coding default = Unknown (90000) where agent is not specified. Numeric field, width 6, no decimal. Based on Aerial survey gis hdbk apx E Revised 11/2007

Bark beetles (BB)	11000	Dutch elm disease (DED)	24022
Larch beetle (LB)	11010	Fire (F)	30000
Large aspen tortrix (LAT)	12037	Porcupine damage	41006
Spruce budworm (SBW)	12038	Abiotic (A)	50000
Jack pine budworm (JPB)	12041	Flooding (~~IF~~, Fl)	50004
Larch casebearer (LCB)	12047	Snow/ice	50011
Forest tent caterpillar (FTC)	12096	Wind damage (WD)	50013
Two-lined chestnut borer (TLC)	15005	Winter injury (WI)	50014
Decline(DC)	24008	Herbicide damage (HD)	70001
Oak wilt (OW)	24021	Unknown	90000

Agent Name: Common name of causal agent exactly as given in Handbook. Character field, width 40.

Host code: Following are common; see Handbook for others. Use Hardwoods, Softwoods (= conifers) or Both if more than one species is involved. Numeric field, width 4, no decimal.

Hardwoods (Hw)	001		Scotch pine	130
Softwoods (Sw)	002		White-cedar	241
Both	003		Birch	370
Unknown	999	(Don't use unless necessary.)	Ash	540
Balsam fir	012		Black ash	543
Tamarack	071		Aspen	746
White spruce	094		Balsam poplar	741
Black spruce	095	(In bogs.)	Oaks	800
Jack pine	105		Willow	920
Red pine	125		Basswood	950
White pine	129		Elm	970

Host name: Common name of host exactly as given in Handbook. Character field, width 40.

Acres: Calculate with Theme-Utilities > Calculate Area/Perimeter/Length in DNR Tools. Numeric field, width 16, 2 decimal places. Delete Area, Perfeet and Perimeter fields, retain Acres only.

FOREST INSECTS

Aspen blotch miner

Phyllonorycter apparella

Hosts	Quaking aspen
Setting	Forest lands
Counties	Across northeastern counties
Survey methods	Ground
Acres affected	Not determined
Narrative	

Aspen blotch miner, sometimes also called aspen leaf blotch miner, was prevalent on quaking aspen throughout NE Minnesota this summer. Larvae of this insect feed inside the leaf between the top and lower surface causing pale round or oval blisters on the leaf that later turn brown. You can visualize this as if the larvae eating the filling out of an Oreo cookie. When full grown in late July or early August they pupate in the leaf. The pupa pushes its way through the lower epidermis of the leaf and the insect emerges as a small moth. The moths find sheltered areas such as beneath bark flakes on conifers to overwinter. The moth folds its wings up and looks kind of like a small grain of wild rice. Birds feed on these overwintering moths and in doing so may flick most of the outer bark flakes off trees.

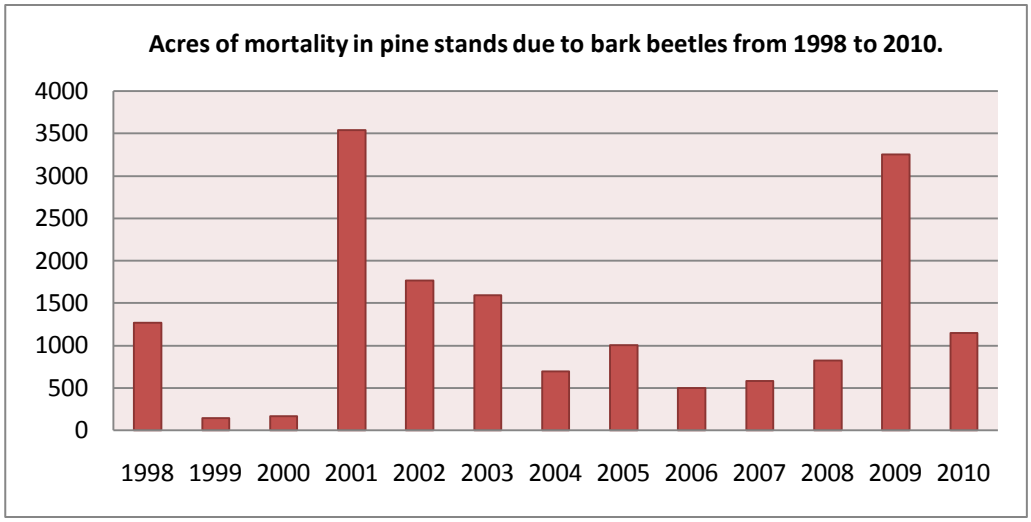
In areas with lots of aspen blotch miner this summer, you might get calls late next winter from people wondering why all the bark appears to have fallen off their jack pines and is laying on the snow at the base of their trees. This doesn't hurt the tree since the birds are only removing the outer bark flakes, but it worries many people. This can make a jack pine tree look like a scotch pine because when the outer bark flakes are removed it reveals the smoother orange colored bark beneath. So remember this later this winter when you start getting calls. The overwintering moth emerges in the spring or early summer and lays eggs on the underside of new leaves. Aspen blotch miner is not considered a serious problem. Most leaves, even ones with many blotches, still have some green tissue between the blotches. It probably has the same effect as light defoliation does on the trees.

Bark beetles

Ips spp. and *Dendroctonus* spp.

Hosts	Red and jack pines
Setting	Rural and urban forests
Counties	See map below
Survey methods	Aerial and ground detection
Acres affected	1,146 ac
Narrative	

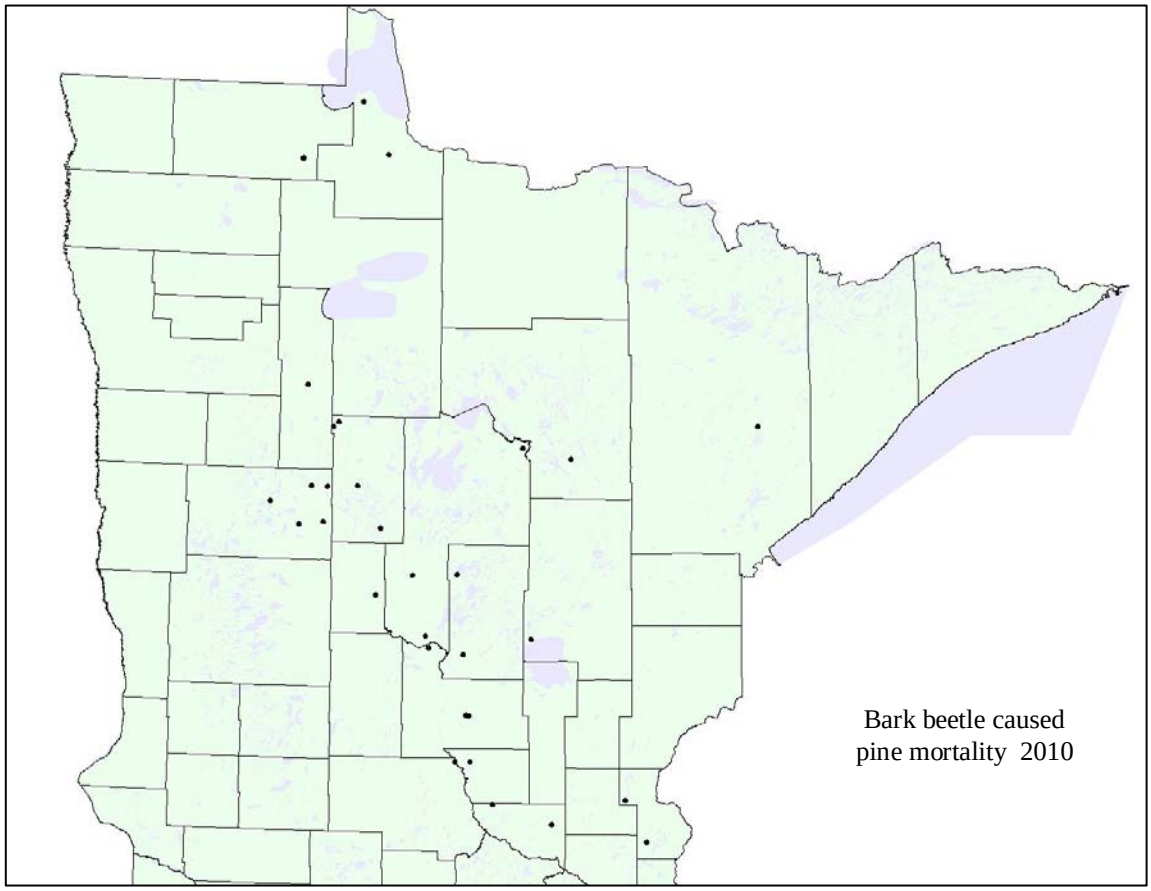
This summer 1,146 acres of bark beetle caused mortality were detected during the aerial survey. See table and map. This was less than a third of the acreage found last year. See table for other comparisons. This decrease can be attributed to the abundant rainfall during the spring and summer in most of the state.



Pine bark beetles continue to be a problem in stressed red pine. The greatest damage due to pine bark beetles was in un-thinned stands and trees with poor site issues. Turpentine beetles killed several Scots pine in Elk River on sandy, droughty soils.

Comparison of bark beetle polygons between 2009 and 2010.

	2009	2010
Number of polygons	218	175
Total acres	3,657 ac	1,146 ac
Average acres per polygon	21.7 ac	6.5 ac
Maximum size of polygons detected	953 ac	70 ac



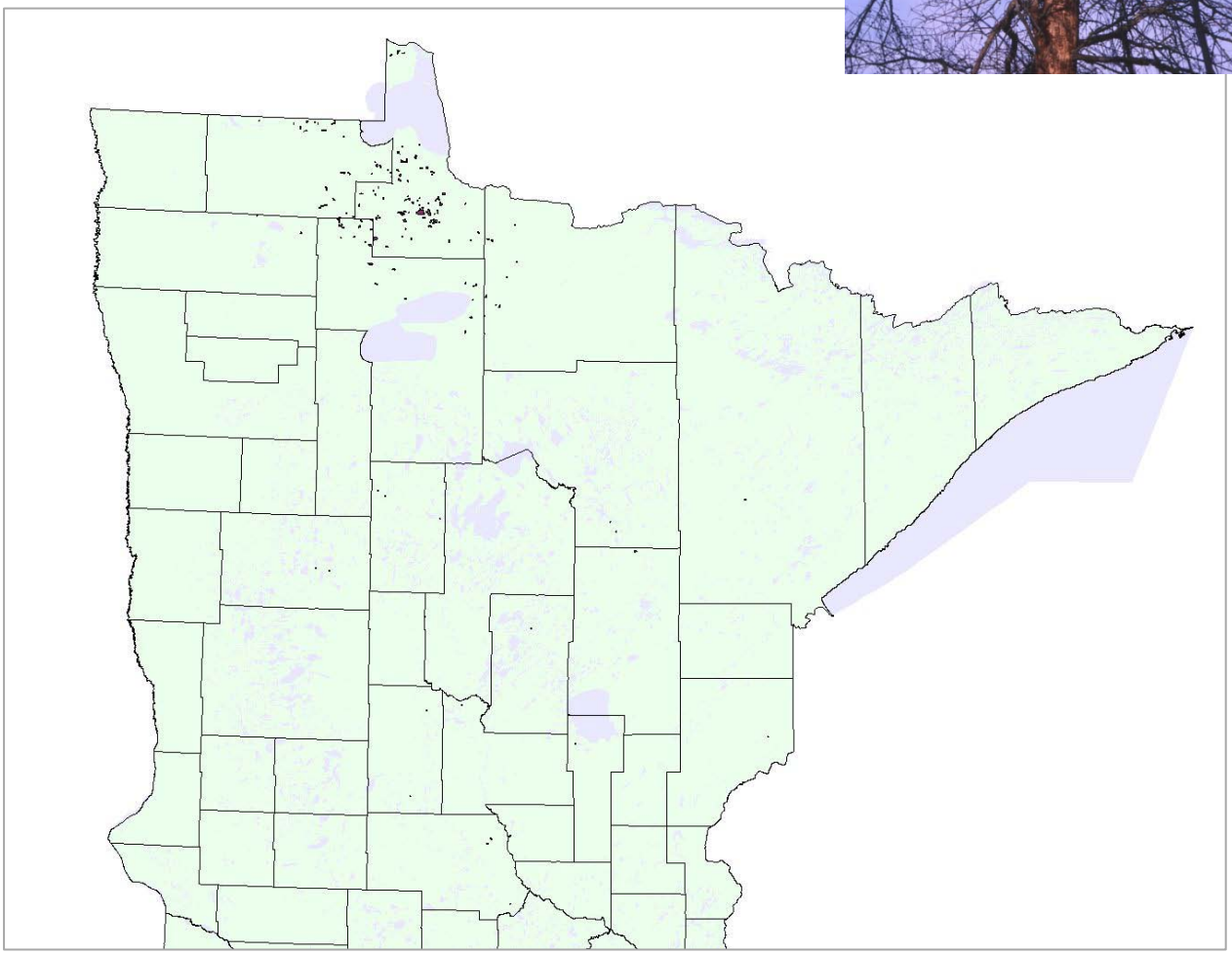
Eastern larch beetle

Dendroctonus simplex

Hosts	Tamarack
Setting	Rural forests
Counties	See map.
Survey methods	Aerial detection
Acres affected	19,126

Narrative

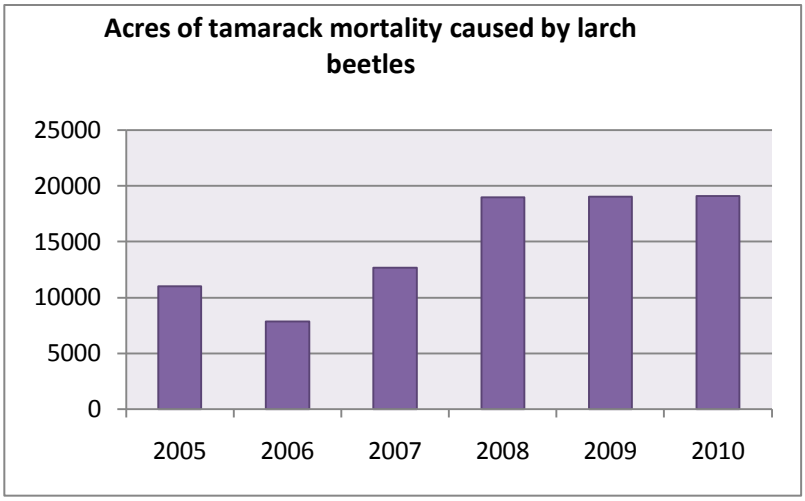
In 2010, an additional 19,126 acres with tamarack mortality were mapped during the aerial survey. This is about equal to the number of acres mapped in 2009. Most of the mortality mapped this year was in northwestern Minnesota in Lake of the Woods, Roseau and Beltrami Counties. Scattered mortality was also found throughout the range of tamarack in the state. See chart and map.



Larch beetle adults, larvae, and pupae, overwinter in attacked trees. Adults emerge in the spring, seek out and bore into suitable live trees or fresh logging slash. There they construct galleries and lay eggs. Larvae hatch from the eggs, feed on the phloem and eventually pupate and change into adults about 4 mm long. There is only one generation per year but female larch beetles may produce up to 3 broods per year.

An outbreak of larch beetle has been occurring in Minnesota since 2000. During this same time period we have also experienced an unusual outbreak of larch casebearer and it has been suggested that the larch casebearer defoliation has been stressing the tamarack leading to attack and mortality from eastern larch beetles. However, this does not appear to be the case in Minnesota. Less than 5 percent of the acres with larch beetle mortality have also been defoliated by larch casebearer.

A number of stress factors are likely contributing to the current mortality. Droughts and resulting fluctuating water levels in 2002-2003 and 2006-2009 are likely involved. Warmer winter temperatures may also be involved. Since the larch beetles overwinter in the above ground parts of the tree warmer winter temperatures appear to allow more to survive the winter building up larger populations resulting in more tree mortality.



Dr Rob Venette, USDA FS NRS and Abby Walter, UMN Graduate student at U of MN, investigated the seasonal changes in supercooling points of the eastern larch beetle and related these to historical winter temperature records in Minnesota. Eastern larch beetle adults, larvae and pupae are freeze intolerant. They survive winters by supercooling. Suprisingly, the larvae were found to be more winter hardy than the adult beetles. In December, larvae supercooled at a lower temperature (-56F) than adults (-43F).

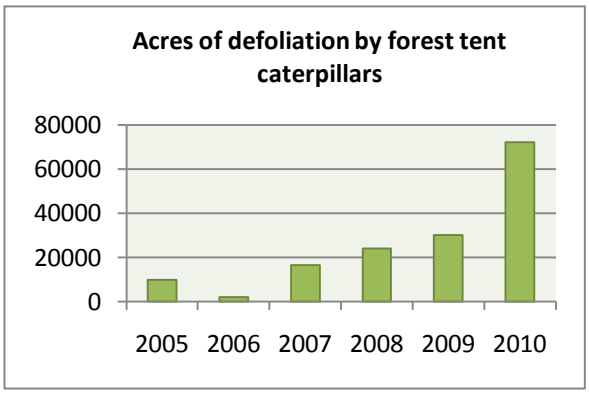
Over the past 40 years, winters have become less severe. Venette and Walter found that the low temperatures in Isle, MN have increased by approximately 0.25C per year from 1964 - 2004. Since eastern larch beetle larvae are extremely cold-tolerant the warming winter temperatures have had very little impact on their overwintering success. However, warming has had a substantial impact on adult overwintering success. They predicted that on average, adult survival has increased by 0.7% per year from 1964-2004. So adult overwintering success in the early 2000's, was predicted to be about 25 to 30% higher than in the mid-sixties. Larger overwintering populations of adult larch beetles could produce larger populations of offspring the following summer that may be able to overwhelm the defenses of tamarack trees and kill them.

While the causes of the eastern larch beetle outbreak in Minnesota are not fully understood, combinations of drought, stand, and site conditions likely contribute to the resulting mortality in individual stands. Warmer winters resulting in greater overwintering success by eastern larch beetle adults may also play a role.

Forest tent caterpillar

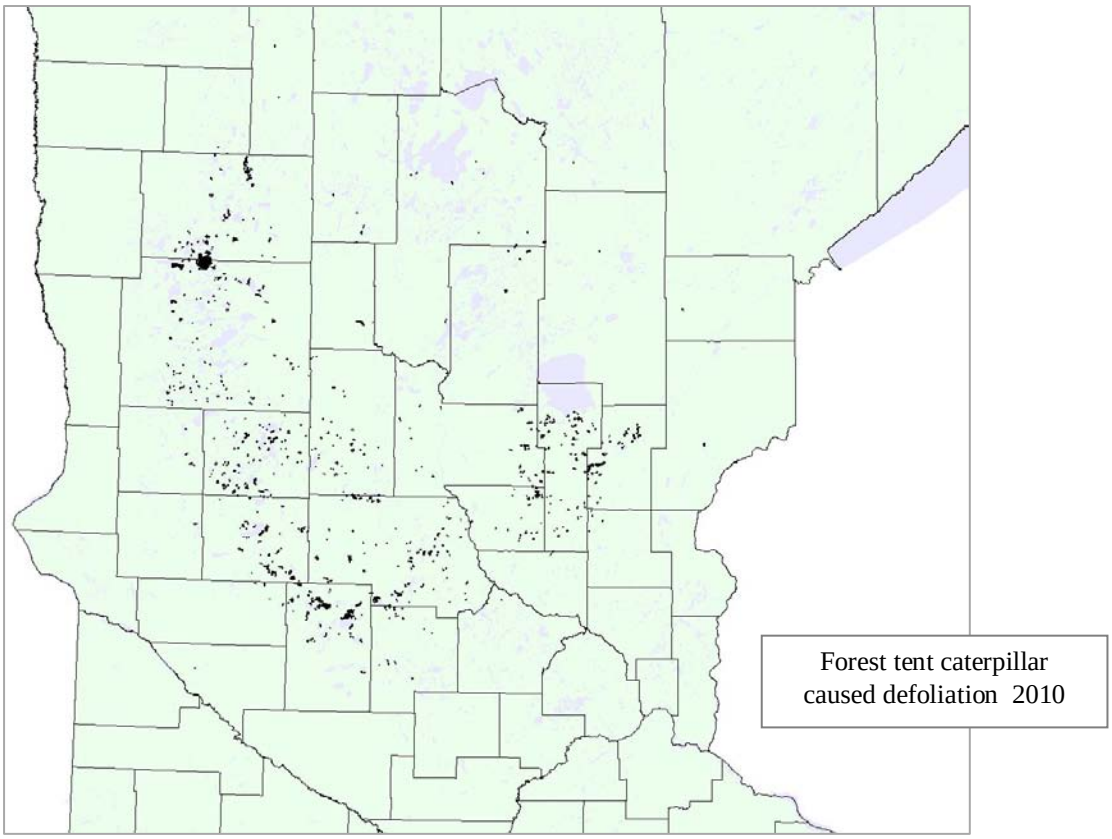
Malacosoma disstria

Hosts	Aspens, oaks, birches and other hardwoods
Setting	Rural forests
Counties	See map
Survey methods	Aerial survey
Acres affected	72,066 ac
Narrative	



During March, 14 egg mass plots were taken in Aitkin, Itasca and St. Louis Counties. No egg masses were found. In May and early June there were many sightings and reports of forest tent caterpillars in the western and central counties of MN and a few new locations to the north were found. Based on defoliation that occurred last year, there are a few noteworthy "outlier" populations that caused noticeable defoliation in 2010 which ranged from trace to severe levels. See map. These occurred in Hubbard County, southern Cass County on the north shore of Gull Lake, in Waukenabo Township in Aitkin County, and in the Twin Cities. Basswood trees along the Mississippi River in the southern part of the Twin Cities metro area were defoliated. FTC populations seem to be intensifying in Ottertail and Kanabec Counties, too.

FTC populations are building in central Minnesota. The number of acres defoliated is climbing steadily with increases being found in all of the central counties. This year, 72,066 acres of aspen and hardwoods were defoliated. See chart. The number of additional sightings of individual caterpillars and small pockets of trace defoliation from the northern counties is also increasing. Taken together, these observations usually portend a north-wide outbreak in the near future.

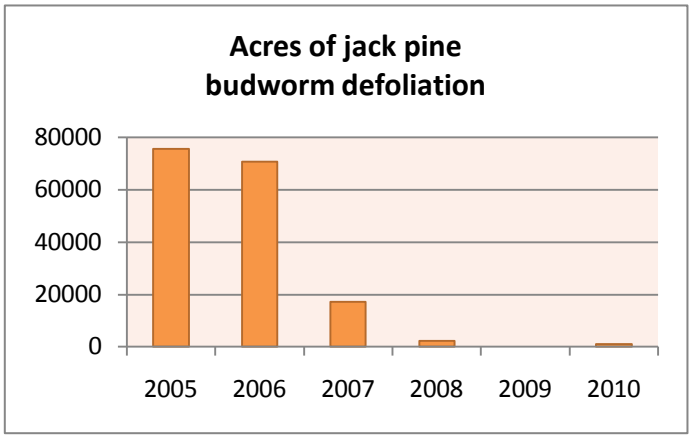


Jack pine budworm

Choristoneura pinus pinus

Hosts	Jack pine; rarely red pine, white pine and white spruce
Setting	Rural forests
Counties	Roseau, Cass and Mahnomen Counties
Survey methods	Aerial survey
Acres affected	1060 acres

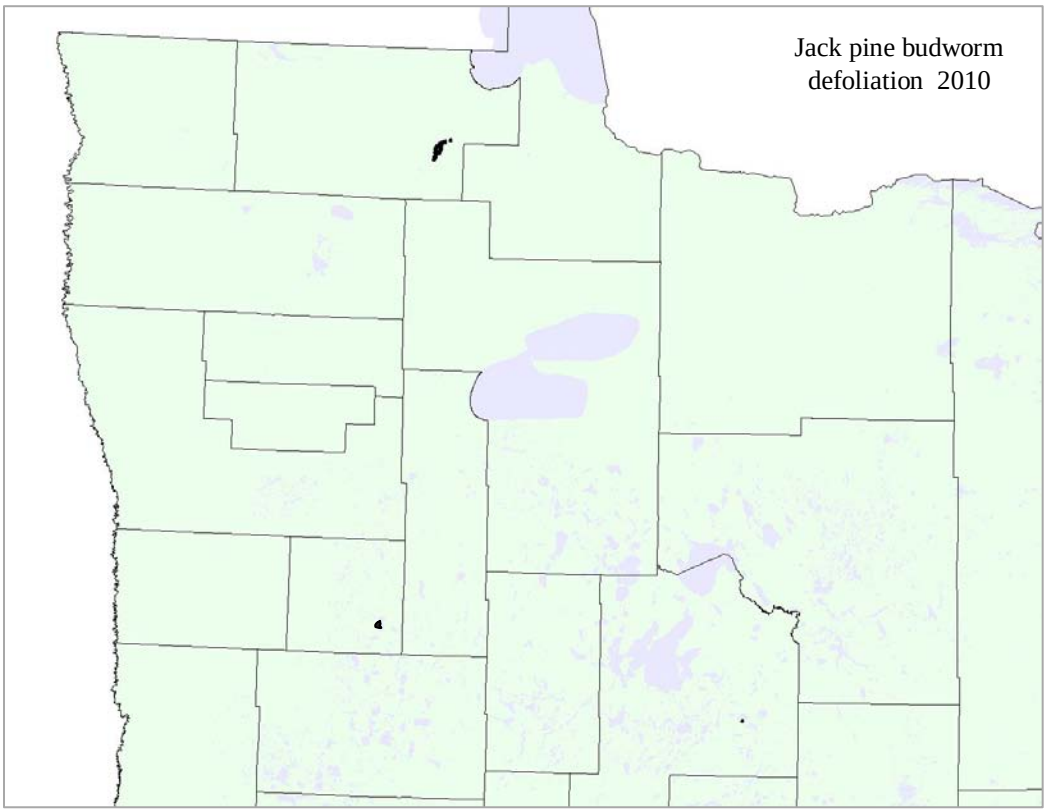
Narrative



After a hiatus lasting one year, jack pine budworm defoliation was observed and mapped on 1,060 acres in northern Minnesota. See chart and map. Two small polygons of defoliation were found in Mahnomen and Cass Counties.

Nine early larvae were found on 6 early larvae plots near Esquagama Lake in St. Louis County but no defoliation was detected during the aerial survey in July. Only one budworm larva was found on 21 sites across the western range of jack pine budworm in Minnesota in early June during the early larval survey. However, during aerial survey, 1052 acres of light to moderate defoliation was found, primarily in Roseau County near Bemis Hill. Interestingly, defoliation was confined to an area of mostly federal lands in the Beltrami Island State Forest. Two egg mass studies were conducted in early August. No egg masses were found on the branches during the formal protocol, but perusal of the remaining foliage on 12 branches (36 inches long) found 8 egg masses. This indicates that budworm larvae will be present in 2011, likely causing less than 25% defoliation of the jack pine in the area. See Survey section for details.

From the ground, jack pine budworm larvae were found damaging red and jack pines in the Sand Dunes State Forest (sec 20 and 29) where similar damage was observed in 2004 and 2005.



Jack pine survey methods and data

Early larval survey* by Roger Hannigan, June 2-9, 2010.					
Township	*Location*	*Number of larvae on vegetative shoots*	*Number of larvae on staminate shoots*	*Estimated pollen shed*	*Notes*
Hubbard County- June 2					
Hendrickson	47 12.771 94 47.851	0/12	0/18	70 %	
White oak	46 56.039 94 43.080	0/8	0/21	Most	
Badoura	46 51.754 94 43.425	0/13	1/17	90%	Second instar. Webbing present.
Badoura	46 51.745 94 41.455	0/6	0/24	Most	
Straight River	46 49.409 95 04.153	0/12	0/18	Most	
Lake George	47 02.625 95 00.038	0/5	0/25	80%	
Lake George	47 12.814 94 59.001	0/6	0/24	70%	
Cass County – June 2					
McKinley	46 46.932 94 42.139	0/4	0/26	Most	Section 11.
McKinley	46 45.616 94 42.204	0/6	0/24	Most	Some webbing and frass on 5 stamin. shoots
Wadena County – June 2					
Huntersville	46 46.693 94 51.041	0/6	0/24	Most	Section 14
Becker County – June 2					
Green Valley	46 51.318 95 12.317	0/15	0/15	Most	Shipman Lake Section 15
Green Valley	46 50.395 95 13.441	0/18	0/12	Most	Blueberry Lake Section 22
Two Inlets	46 58.680 95 15.250	0/0	0/30	Most	Section 32
Two Inlets	47 02.524 95 11.906	0/6	0/24	Most	Section 11
Beltrami County – June 4					
Eckles	47 31.604 94 57.368	0/10	0/20	Most	Section 26
Liberty	47 34.267 94 59.052	0/0	0/30	Most	Section 34
Buzzle	47 35.084 95 03.357	0/6	0/24	Most	Section 36.
Lammers	47 35.084 95 07.145	0/12	0/18	Most	Section 3
Lake of the Woods – June 7					
Unnamed tnshp SW of Norris Camp	48 35.866 95 12.481	0/10	0/20	Most	Some webbing noted on 4 shoots
Roseau County - June 9					
Red Lake Wildlife Headquarters	48 30.534 95 10.764	0/17	0/13	Most	
Clear River Station site	48 43.946 95 19.749	0/6	0/24	Most	Section 29

Early larval survey* by Mike Albers, June 3, 2010.				
Township	*Location*	*Number of larvae on shoots*	*Estimated pollen shed*	*Notes*
St Louis County				
Tnsp 57N, Range16W	SENE Section 5	0	Staminate cones were dry and no longer releasing pollen but all were still attached. Larvae were feeding in these cones.	Larvae ranged from 3/8th to ¾ inches long.
Tnsp 57N, Range16W	NESW S4	2		
Tnsp 57N, Range16W	NENW S9	3		
Tnsp 57N, Range16W	SWNE S16	2		
Tnsp 57N, Range16W	NWSE S15	0		
Tnsp 57N, Range16W	SWSW S9	2		

Methods for early larval surveys: Early larval surveys consists of examining 6 shoots from each 5 separate 15 inch branch samples cut from the mid-crowns of 5 different jack pine trees. One shoot per branch is tallied. A total of 30 shoots is tallied at each site. The rest of the branches are examined for the presence of larvae and other notable findings. Percent pollen shed is noted.

June 25, 2010. Bob Tiplady reports:

Mission Tnsp in Crow Wing Co, SW SW of 29-136-27
1 pupa, few pollen cones, no current defoliation, no previous defoliation.

Jack pine budworm egg mass study* by Jana Albers, Aug. 6, 2010		
Location	*Number of egg masses found on 15 inches of needle bearing twig sample*	*Number of egg masses found on rest of branch*
NE of Bemis Hill on Thompson Rd.in Section 34. 48 43.161 95 25.784	0,0,0,0,0,0	1,0,2,1,0,0
¼ mi from jnct of Thompson and Root Rds. in Section 7. 48 41.738 95 27.903	0,0,0,0,0,0	1,1,0,2,0,0

Location: Southwest of Warroad on Thompson Road and Root Roads. Location was based on aerial detection of 1052 acres JPBW defoliation in 2010. All trees in these stands were young (18 to 22 years) and 30 to 40 feet tall. Defoliation was light to moderate as viewed from the ground. These stands included Stand 189JP12 on 7-160-37 and Stand 650JP23 on 34-161-37 as reported being defoliated by DNR Forester, Shane Delaney.

Methods for egg mass surveys: A single branch from the mid-crown of each of 6 trees per site were cut. Branches were about 36 inches long. 15 inches of living needles were examined on interior twigs of each branch. The numbers of observed egg masses per branch were recorded. All other needles on the branches were tallied and the numbers of observed egg masses per branch were recorded.

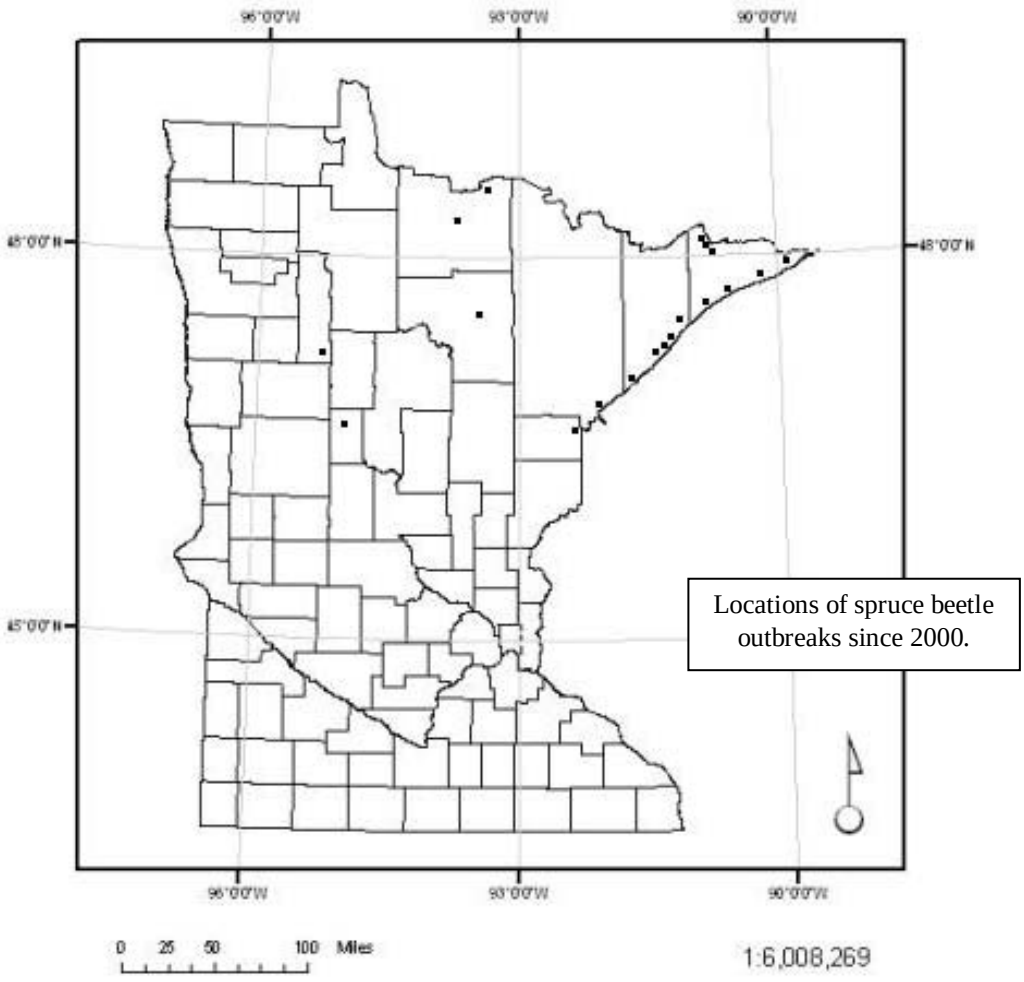
Spruce beetle

Dendroctonus rufipennis

Hosts	White spruce
Setting	Rural forests, campgrounds, windbreaks
Counties	Cook, Lake, St Louis, Carlton, Itasca, Koochiching, Wadena and Clearwater
Survey methods	No surveys were conducted for spruce beetle in 2010. In the past, survey methods used included ground, funnel traps and general observation.
Acres affected	No estimate

Narrative

Spruce beetle occurs naturally in northern Minnesota. Significant mortality has been found in State Parks and campgrounds along the shore of Lake Superior where slightly over 10% mortality was found some years in the early 2000's. Low levels of scattered mortality continue to occur in campgrounds. Significant mortality was found in a couple white spruce plantations in Koochiching County also in the early 2000's. Mortality due to spruce beetle was estimated at approximately 20%. The beetle population was thought to have built up on blown down white spruce and then spread to live standing trees.



Locations of spruce beetle outbreaks since 2000.

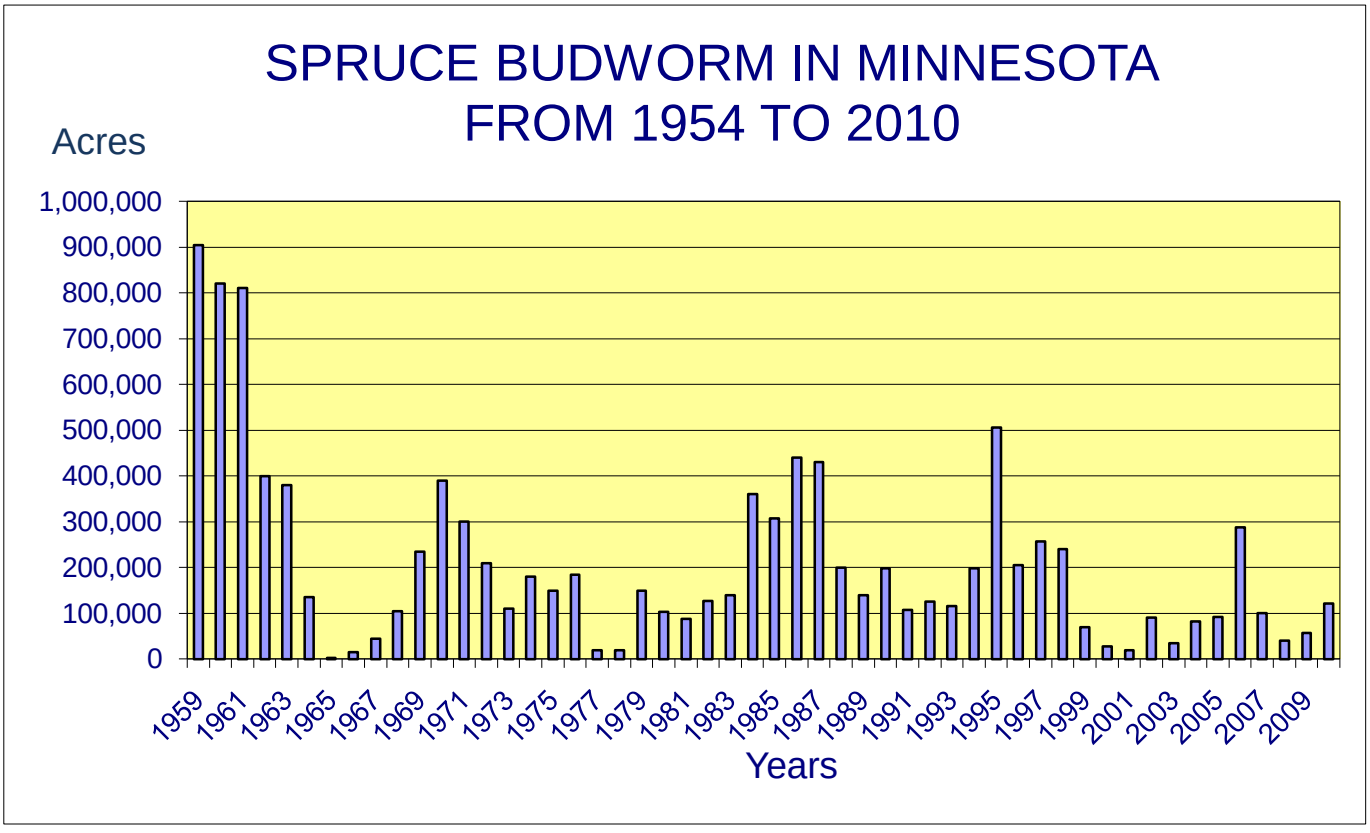
Spruce budworm

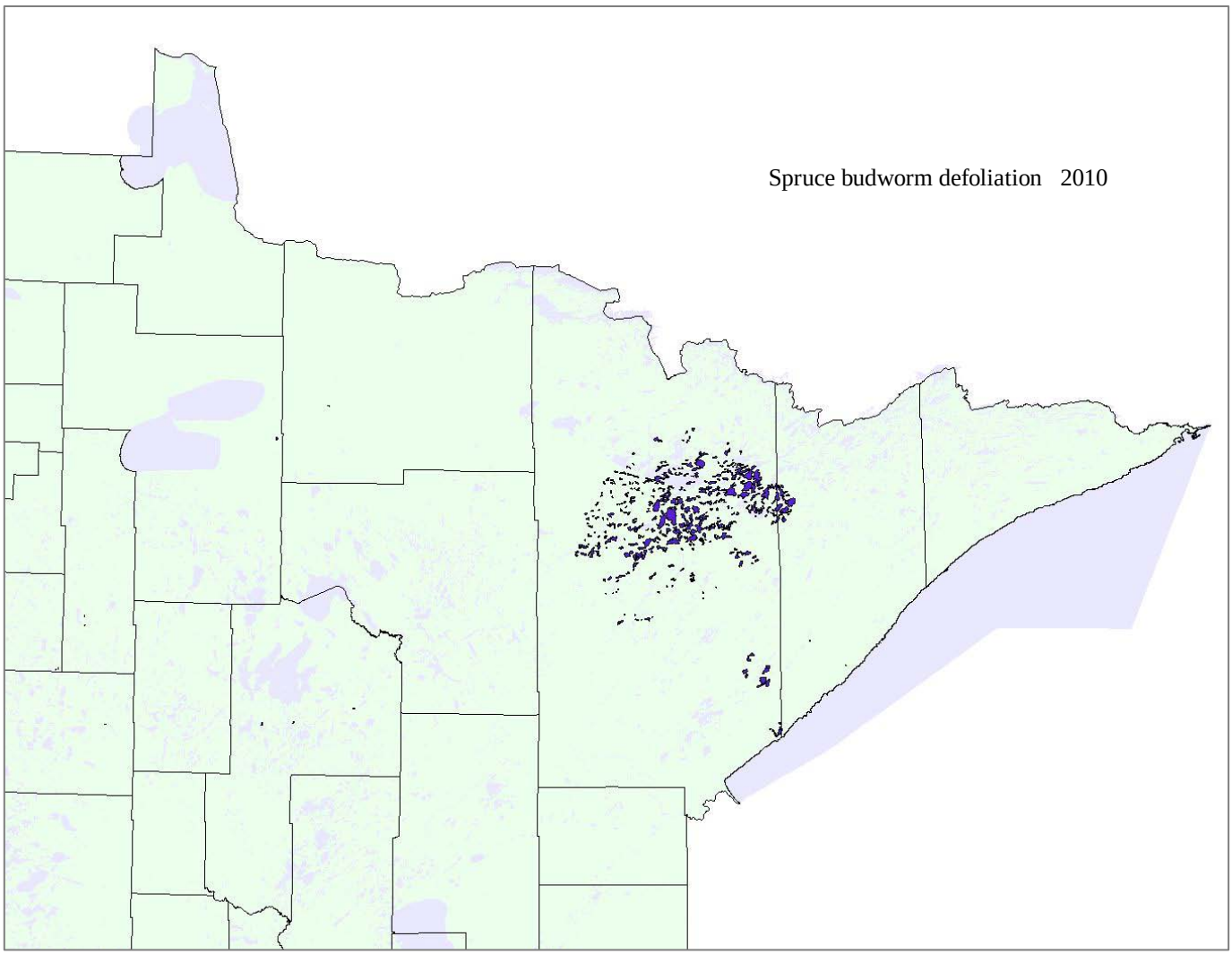
Choristoneura fumiferana

Hosts	Balsam fir and white spruce
Setting	Rural forests
Counties	Koochiching, St Louis, Lake, Beltrami, Clearwater, Hubbard, Cass, Mahnomen, Becker
Survey methods	Aerial survey
Acres affected	121,492

Narrative

Spruce budworm is a native insect in North America. Massive outbreaks periodically occur in spruce-fir forests of eastern Canada and the United States. Since 1954, when annual aerial sketch-mapping began, spruce budworm has caused defoliation of balsam firs and white spruces every year in Minnesota. This year, 121,492 acres of defoliation were observed in northeastern counties. See map. This is slightly more than double last years' defoliation. Defoliation was greater than 50% on 114,800 of the acres. The major area of defoliation has shifted to the east and south and now extends from the western edge of Lake Vermillion to east of Ely into Lake County on the north and from Buhl to Hoyt Lakes on the south. An area of almost 5,000 acres of defoliation showed up near Pequaywan Lake in the Cloquet Valley State Forest in southeastern St Louis County and another 1,200 acres showed up near the Knife River in extreme in southeastern St Louis County. Mortality and topkill begin to occur after 3 to 4 years of heavy defoliation in balsam fir. Defoliation on the western end of Lake Vermillion has been occurring since at least 2003.




Spruce budworm defoliation 2010

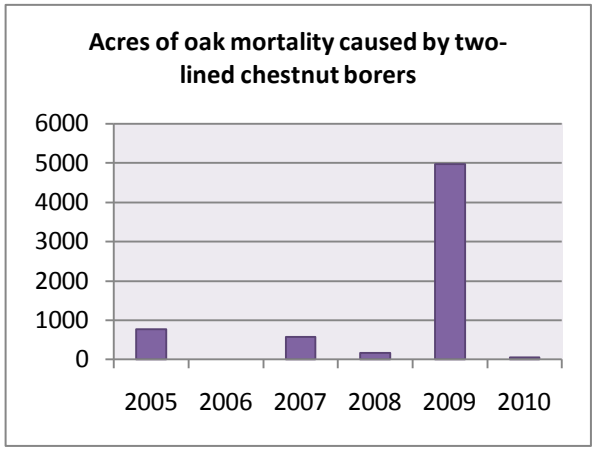
Two-lined chestnut borer

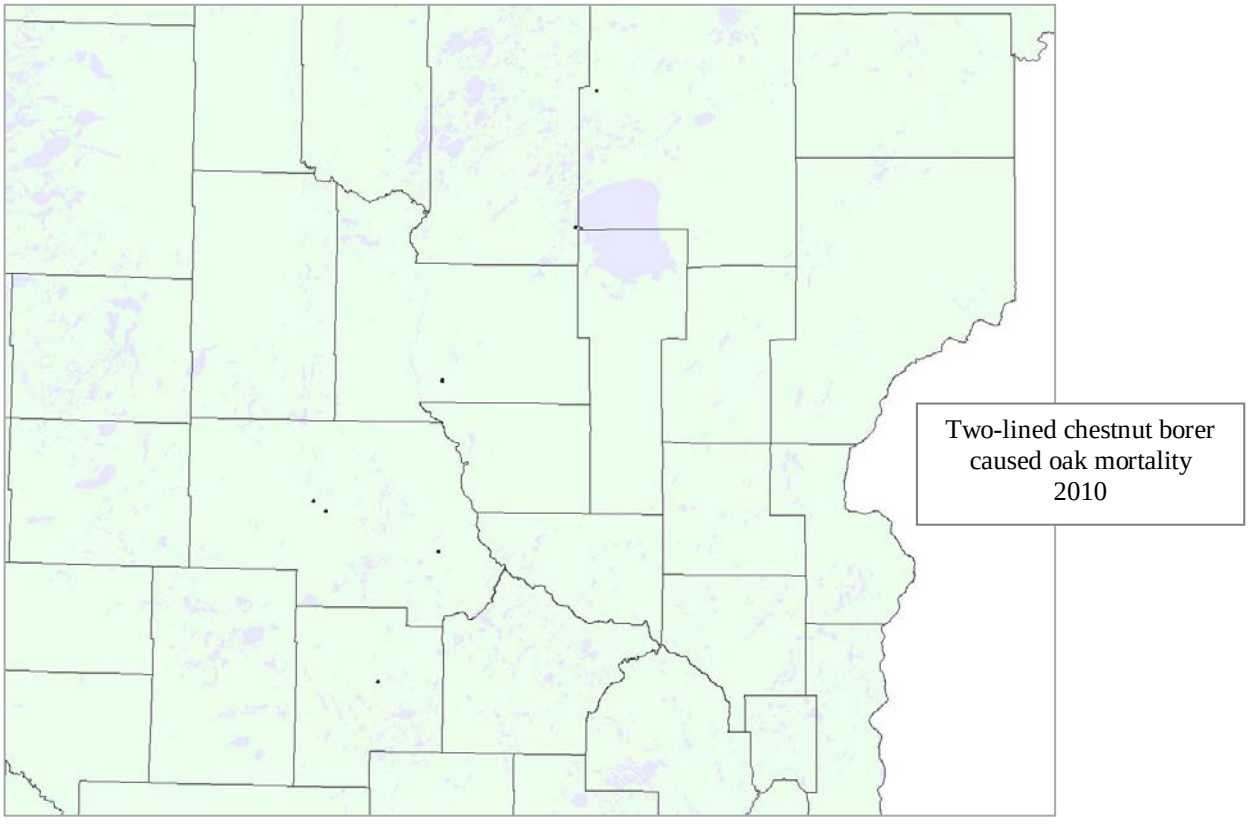
Agrilus bilineatus

Hosts	Oaks
Setting	Rural and urban forests
Counties	See map
Survey methods	Aerial survey
Acres affected	60 ac
Narrative	

This insect has had a fairly constant presence over the last decade, the weather of which has been warmer and drier than most. This year, new damage caused by two-lined chestnut borers was detected on only 60 acres in west-central and central counties. All of the polygons were less than an acre in size.

After three summers of drought and high levels of oak mortality, the spring and summer rains received this summer apparently caused the local populations to collapse. See map and chart.





Willow flea weevil

Rhynchaenus rufipes

Hosts	*Salix* spp.
Setting	Rural forests
Counties	Aitkin, Crow Wing and Itasca
Survey methods	Ground
Acres affected	Not determined
Narrative	

Willow trees with brown leaves were observed in parts of Aitkin, Itasca and Crow Wing Counties. Leaves on these trees appear to have been attacked by the willow flea weevil. Adults of this weevil chew tiny circular holes into the leaves on the underside of the leaves. These holes don't go all the way through the leaf so leaves the upper epidermis intact. If you hold the leaf up to the light you can see pinpoints of light shining through parts of the leaf that are still green (see lower photo). In the brown parts of the leaf, the dark epidermis blocks the light from shining through, but the holes can be seen on the underside of the leaf. Some of the more senior Forest health staff find it necessary to use a hand lens to see the holes.

Balsam poplar leaf diseases

Septoria musciva and *Linospora tetraspora*

Hosts	Balsam poplar
Setting	Rural and urban forests
Counties	North western and north central counties
Survey methods	Ground detection
Acres affected	Not determined
Narrative	

I think I finally know why balsam poplars are called BAM. You start with balsam poplars and some rainy weather, add some fungi, and "BAM" the leaves all fall off the trees.

Two leaf fungi were prevalent on balsam poplars this year. Septoria leaf spot and Linospora leaf blight.
In the picture on the left, the middle leaf has Septoria leaf spot. These infections start as small angular spots that often coalesce into larger spots. The fungus overwinters on fallen leaves where spores form the next spring. These spores are carried by wind and rainsplash to leaves where new leaf infections occur. Severe leaf infection may reduce growth but often occurs late enough in the season that it doesn't have much impact on tree health.

The leaves on the left and right have both Septoria leaf spot and Linospora leaf blight. Lesions caused by *Linospora* can vary in size and shape and can involve the entire leaf. The upper surface of the leaf becomes grayish brown to ashen. Small black spots about 0.5 mm across develop on the lesions. The lesion on the underside of the leaf becomes reddish bronze. This fungus also overwinters on fallen leaves producing spores the next spring that infect the new leaves. Infection by *Linospora* is unlikely to kill trees but again can cause early leaf fall as seen in the picture of trees on the right. This picture was taken near Deer River on Sept 1st.

Bur oak blight

An unnamed species of *Tubakia*

Hosts	Bur oak
Setting	Rural and urban forests
Counties	4 NEW counties: Mille Lacs, Sherburne, Hennepin and Ramsey
Survey methods	Ground sampling
Acres affected	Unknown
Narrative	

The first bonafide case of bur oak blight, confirmed by Dr. Tom Harrington of Iowa State University, has been identified in Minnesota. Previously, symptoms of BOB were reported to occur in portions of southern Minnesota, however, the disease was then called Tubakia leafspot and was cited to be caused by the fungus, *Tubakia dryina*. Since then, Dr. Harrington, Professor at Iowa State University, has completed DNA and pathogencity testing that confirms this disease is caused by a new, and yet unnamed, species of *Tubakia*, and he has named the disease bur oak blight (BOB).

It is not clear if this new species of *Tubakia* is a recent arrival to this region or if a shift in climate (more early-season rain events) have made this disease more noticeable over the last two decades. To date, BOB is known to occur from eastern Nebraska to central Minnesota and southwestern Wisconsin, and it appears to be spread across all of Iowa .

Plant pathologists and arborists have been on the lookout for the new BOB *Tubakia* species in Minnesota, particularly in central and more northern counties. Jill Pokorny, plant pathologist with the US Forest Service located symptomatic bur oak trees in Mille Lacs and Sherburne counties, collected leaf samples, and identified the fungus, *Tubakia*, to be present. To determine if it was the new species of *Tubakia* that causes BOB, she submitted samples to Dr. Harrington for further laboratory testing. The samples tested positive for BOB.

In recent weeks, symptoms of BOB have also been reported on bur oaks located in Hennepin and Ramsey counties. These samples have also been submitted for species-level DNA testing, and we are awaiting test results. Jill Pokorny predicts, “As we continue to investigate symptomatic bur oak trees and more samples are tested, it is expected that BOB will be found in additional Minnesota counties.”

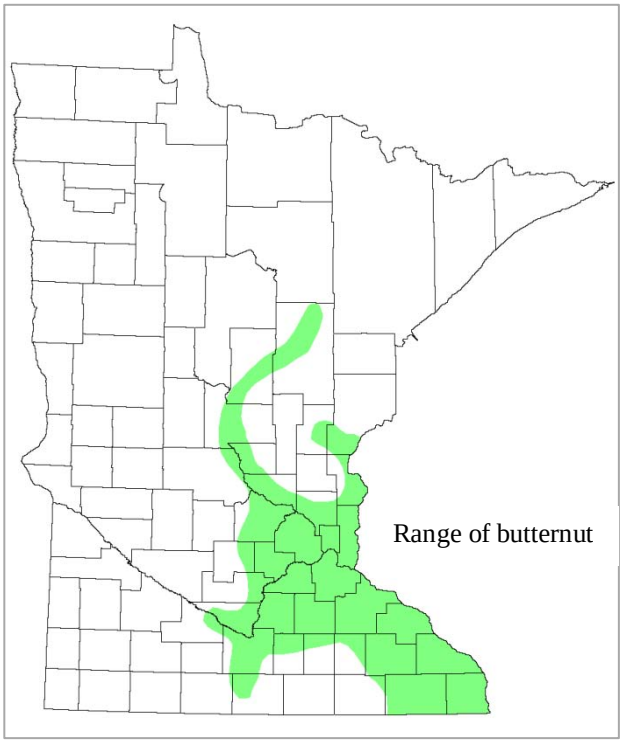
Butternut canker

Ophiognomonia clavigigneti-juglandacearum

Hosts	Butternut
Setting	All
Counties	See attached list.
Survey methods	General observation
Acres affected	Unknown
Narrative	

Butternut canker has spread throughout the range of butternut species in Minnesota, with the exception of a few outlier locations in Aitkin County. It is generally estimated that more than 99% of the trees currently are infected or dead. It is a fatal disease.

In November this year, the fungal species was reclassified to *Ophiognomonia clavigigneti-juglandacearum.* Formerly, it was in the genus *Sirococcus*.



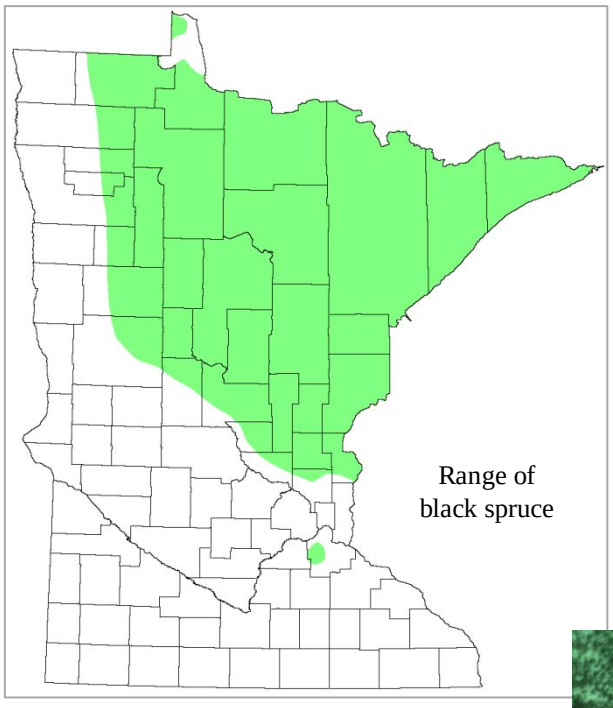
Eastern dwarf mistletoe

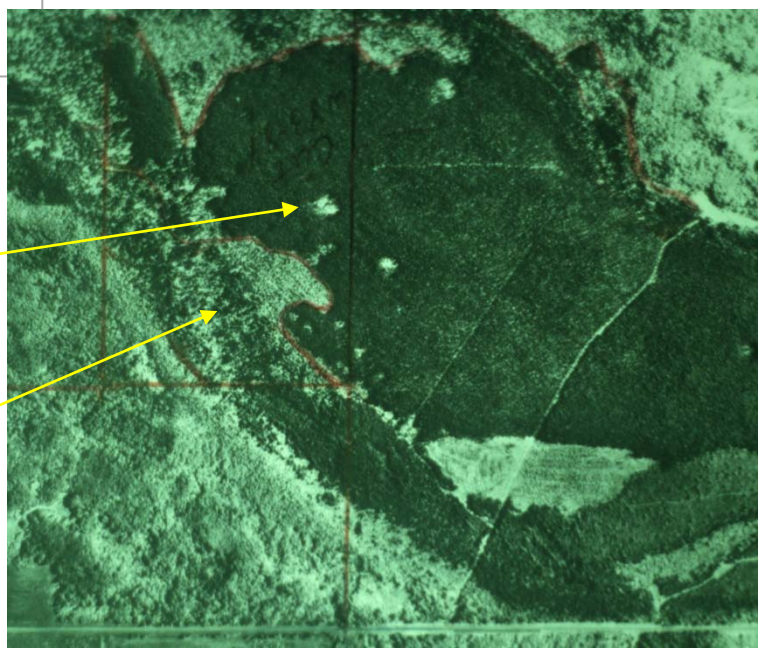
Arceuthobium pusillum

Hosts	Black spruce
Setting	Rural forests
Counties	Range of black spruce; see map below.
Survey methods	General observation and ground survey
Acres affected	Based on NA-TP-01-04, the mortality rate ranges between 0 and 2% per year.

Narrative

Eastern dwarf mistletoe is a native disease and is always fatal. The primary host is black spruce and we have approximately 1,551,000 acres of black spruce in the state (Based on NRS-6). Losses are not spread equally over the forest. Infections can be found in unmerchantible stands and along stand edges where it has been active for decades or centuries and in new infection centers that are roughly circular. Losses range between 0 and 2% annually. According to Anderson (1949) dwarf mistletoe infections have elimated black spruce production on 11% of the black spruce acreage in MN.





Pockets of mistletoe-killed black spruce in even-aged black spruce stand.

Continuous distribution of mistletoe infections in an all-aged black spruce stand that renders the stand unmerchantible.

Hickory decline

Ceratocystis smalleyi and *Scolytus quadrispinosus*

Hosts	Bitternut hickory
Setting	Rural forests
Counties	Fillmore, Houston, Olmsted, Wabasha and Winona Counties
Survey methods	Survey 2006-2008 and research studies on the ground
Acres affected	Unknown

Narrative

UPDATE ON HICKORY DECLINE RESEARCH

Jennifer Juzwik[1], Ji-Hyun Park[2], and Linda Haugen[1]
U.S. Forest Service[1] and University of Minnesota[2], St. Paul, MN
October 2010

Research continued through the 2010 field season on the etiology of hickory decline that is characterized by thinning crowns with small, yellow leaves and hickory bark beetle attack on the upper main stem. This research is part of a larger project initiated in 2006 to assess the distribution and determine the cause(s) of Forest Health Monitoring reported decline and death of hickories in the north central and northeastern regions of the USA.

Pathogenicity trials were conducted in Minnesota and Wisconsin with *Fusarium solani* and *Ceratocystis smalleyi* obtained from actively declining bitternut hickory in those states. The overall goal is to determine the role of selected fungi in the decline and death of hickory. *C.smalleyi* was shown to be a virulent pathogen based on large, elongate cankers found within 14 months of artificial inoculation on poletimber sized bitternut hickory. *F. solani* proved to be a weak pathogen with small cankers produced within 12 months of inoculation.

The interaction between hickory bark beetles (*Scolytus quadrispinosus*) and *C. smalleyi* was investigated. Three actively declining bitternut hickories from two Wisconsin locations were felled and bark stripped from the entire main stem of each. Hundreds of inner bark and sapwood lesions were found on the stems. Over 90% of these were associated with hickory bark beetle attack. The bark beetles emerged from infested trees between late June and late July. *C. smalleyi* was commonly isolated from beetles collected during their construction of entry holes. In contrast, the fungus was seldom (3 of 41) isolated from adults manually collected from bark beetle galleries on declining trees just prior to beetle emergence. Furthermore, the fungus was not isolated from 40 beetles emerged from logs in rearing tubes. Thus, hickory bark beetles are likely involved in initiation of cankers on beetle colonized stems. It is not clear, however, whether bark beetles only provide the entry hole (i.e. infection court) for the fungus or whether they are vectors as well.

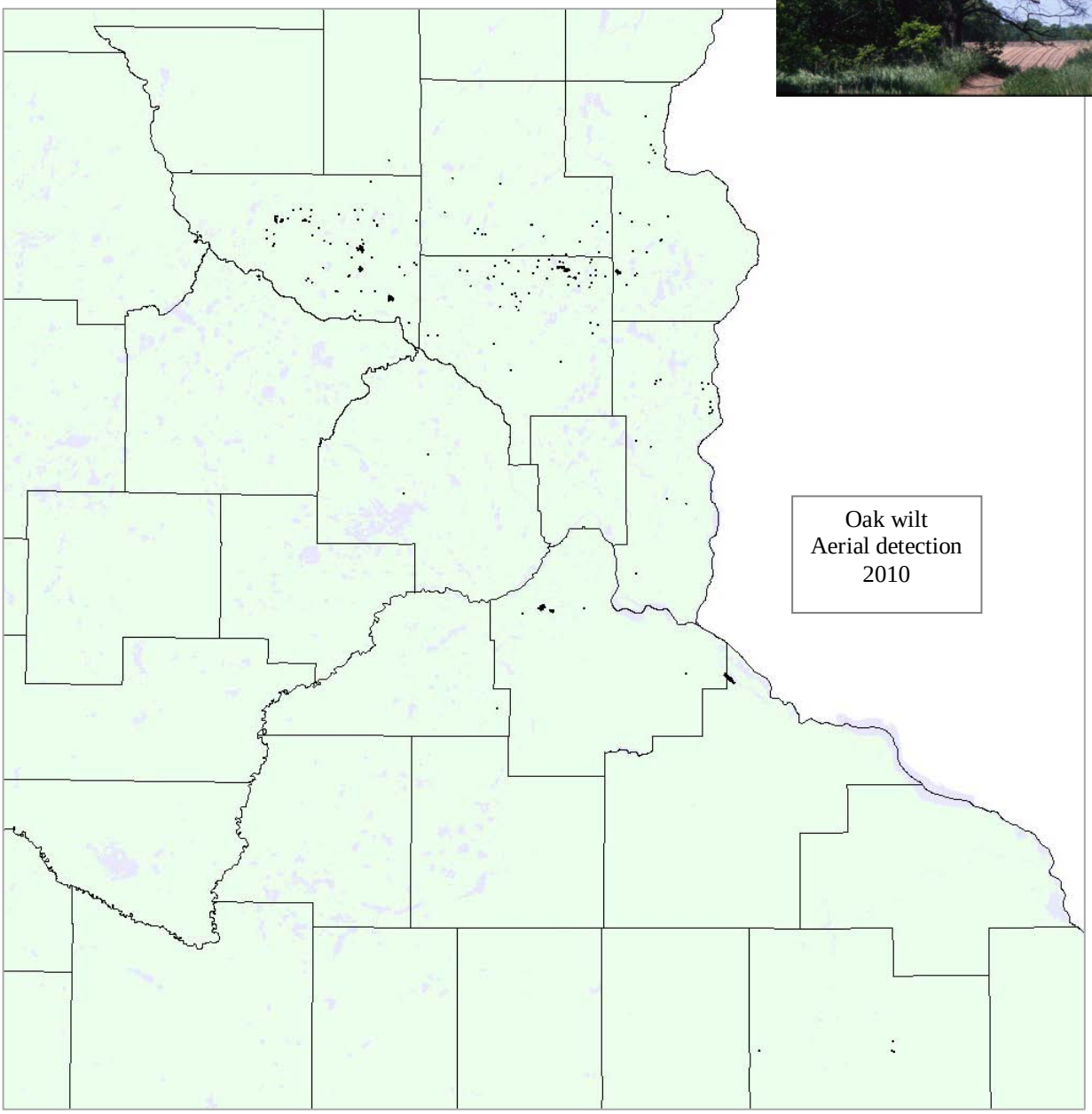
Field studies also were conducted to more precisely determine the role *C. smalleyi* plays in causing hickory decline. The fungus colonizes the sapwood as well as the bark in naturally and artificially inoculated trees. The effect of multiple inoculations (50 per tree between 6 and 12 ft. on main stem) on within tree water transport was evaluated by monitoring sap flow rate and documenting tylose production in the sapwood of trees that had been inoculated 14 months before in two locations. Only one of eight inoculated trees showed any symptoms of decline in the crown when sap flow was monitored; however, extensive, elongate cankers were evident. Bitternut hickory with numerous cankers showed significantly reduced mean sap flow rates compared to non-infected trees ($P = 0.005$) in the 2009 evaluation conducted in southeastern Minnesota (Figure 1). Sap flow rates were inversely related to the extent of inner bark tissue death associated with *C. smalleyi* inoculations ($P < 0.01$) (Figure 2). Lastly, sap flow rates were inversely related to the numbers of tyloses found in xylem vessels of the study trees (Figure 3). A prior anatomical study found that tyloses are produced in response to *C. smalleyi* infection. These preliminary results suggest that multiple stem infections of *C. smalleyi* impair water transport in bitternut hickory. These preliminary findings also support the overall hypothesis that the synergistic interaction of hickory bark beetles and *C. smalleyi* lead to tree decline and mortality.

Oak wilt

Ceratocystis fagacearum

Hosts	Primarily red oaks, white oaks occasionally
Setting	Rural and urban forests
Counties	See map and attached list.
Survey methods	Aerial survey in 2010; see map.
Acres affected	3397 acres
Narrative	

Oak wilt is an invasive fungal disease. During the federally funded oak wilt control program in the Metro area, new infestations "spread" north at about 7 miles per decade and west at 10 to 14 miles per decade. Since the program's end was so recent, we do not have a recalculation of the rates of spread. Control actions are now land-owner initiated and funded, so we expect oak wilt in the currently infested areas to increase in size and abundance and the spread rate to increase.

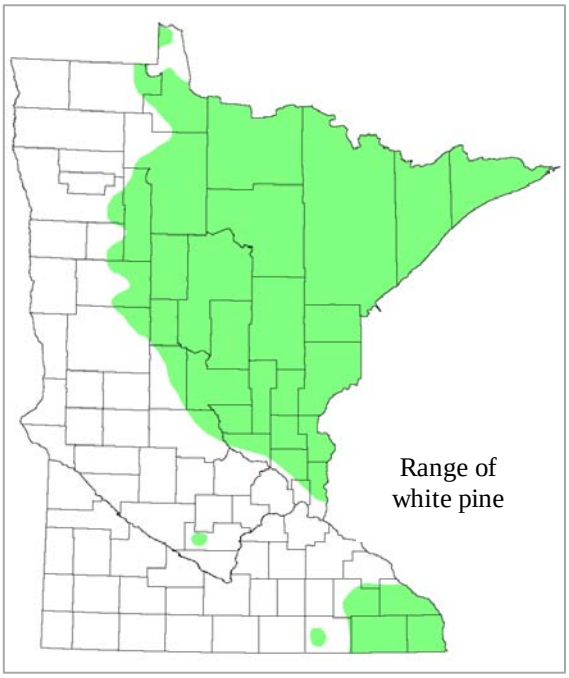


White pine blister rust

Cronartium ribicola

Hosts	White pine; Currants,gooseberries
Setting	All
Counties	All counties in natural range of white pine and wherever planted. See attached list.
Survey methods	General observation
Acres affected	Unknown
Narrative	

An introduced and invasive species, this disease has disrupted and, in some places, crippled natural and artificial regeneration of white pine and caused topkill in mature white pines since the 1930's. If climate change predictions are correct, less white pine blister rust could be expected all across Minnesota in the future.



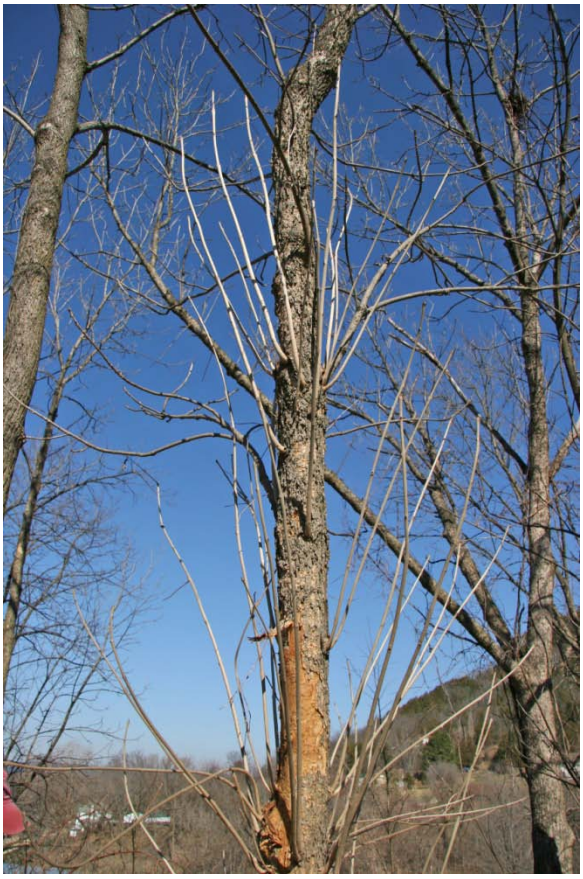
EXOTIC INSECTS AND DISEASES

Emerald ash borer

Agrilus planipennis

Hosts	All ash species
Setting	Urban and rural forests
Counties	Houston (new find), Ramsey and Hennepin Counties
Survey methods	Trapping, girdled trees and general observation
Acres affected	Not determined.

Narrative



As we expected in 2009, the Minnesota Department of Agriculture (MDA) confirmed the presence of emerald ash borer (EAB) in Houston County in late April this year. The infested trees were in the Upper Mississippi River Fish and Wildlife Area, about one mile from the infestation that was found in 2009 in Victory, Wisconsin. Houston County was already under state and federal quarantine because of the expectation it would be found in Minnesota after its discovery in nearby Victory.

To monitor populations of EAB, MDA staff placed 2,840 purple prism traps statewide, with placement in three categories: risk-based, grid-based and quarantine trapping. Risk-based traps were placed at campgrounds, compost or environmental waste sites and at various other locations considered high-risk. See maps that follow. Grid-based traps were placed to monitor the front line of EAB movement in seven counties along the St. Croix and Mississippi Rivers. Traps were placed based on 1.5 square-mile grids covering Anoka, Washington, Dakota, Goodhue, Wabasha, Winona, and Houston counties.

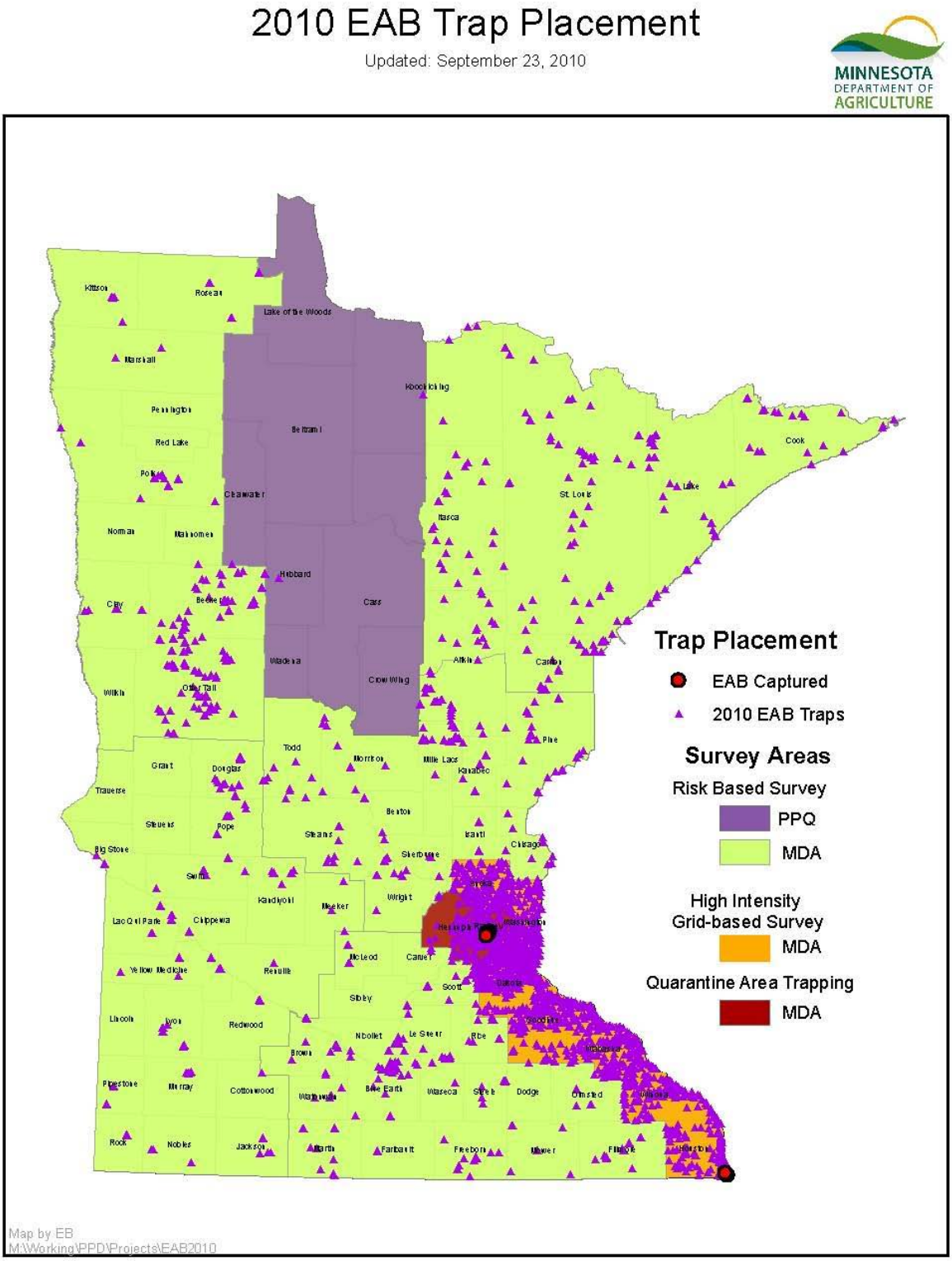
Quarantine trapping in Hennepin and Ramsey counties focused on detecting EAB movement in the known infested areas of St. Anthony Park in St. Paul and Prospect Park in Minneapolis. Using EAB population densities and ash tree inventories provided by the cities of Minneapolis and St. Paul, traps were hung in an attempt to measure how far these infestations have grown so that mitigation strategies can be employed. Traps were also placed in suburbs and in other outlying communities of Hennepin and Ramsey Counties.

Fourteen EAB adults were found on traps throughout the survey season, all from the known infested areas. Four adult beetles were collected from traps placed by MDA: two in Houston County and two in the St. Paul-Minneapolis infested area. Ten beetles were collected from traps placed by U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) staff in the St. Paul-Minneapolis infested area.

In addition, 135 trees found positive for EAB were removed in the St. Paul-Minneapolis infested area.

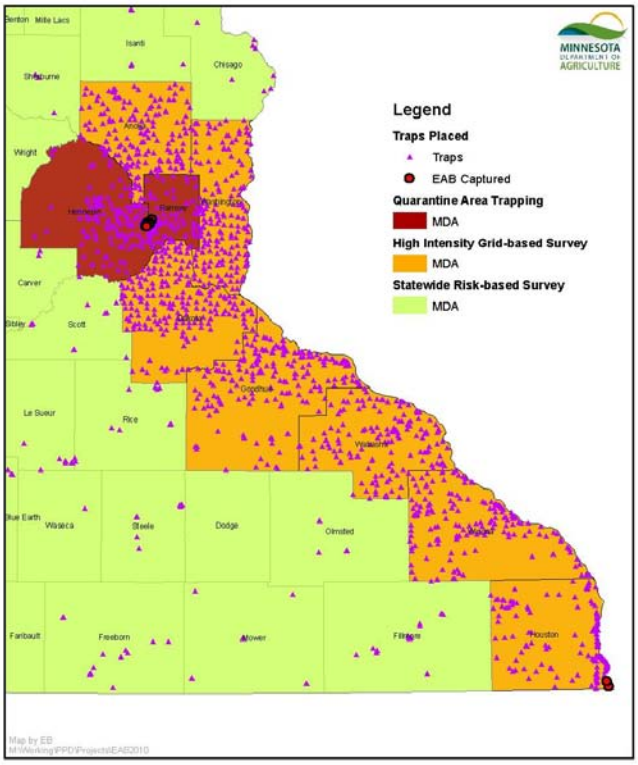
In September, MDA and partners including APHIS, the U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the

Minnesota DNR conducted the state's first release of parasitic wasps as a biological control effort to slow the spread of EAB. The release took place in the infested area of Houston County. See last map. The two species of larval parasites were approved for release and reared by APHIS in Brighton, Michigan. *Tetrastichus planipennisi* adults find and insert their eggs into EAB larvae. With *Spathius agrili* , the wasp eggs and developing wasps are attached to the outside of EAB larvae. The developing wasps feed on and eventually kill the EAB larvae. MDA released the wasps after extensive testing confirmed they will not harm people, other animals or the environment.



2010 EAB MDA High Risk Grid Based Survey Trap Placement

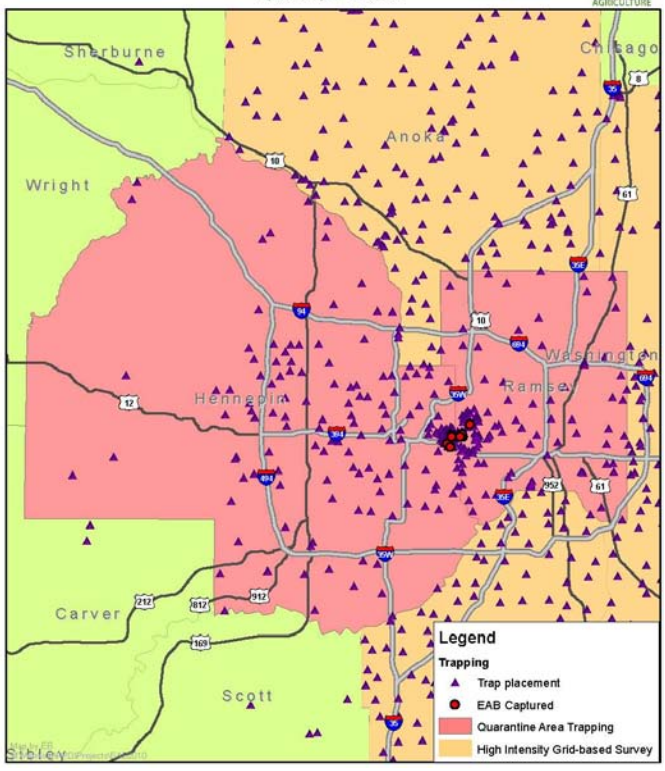
Updated: September 23, 2010

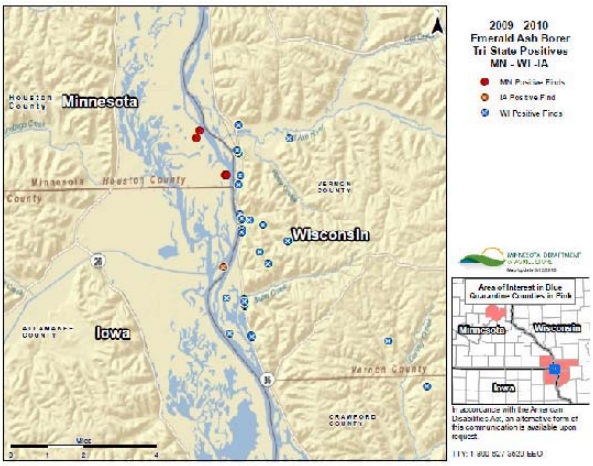


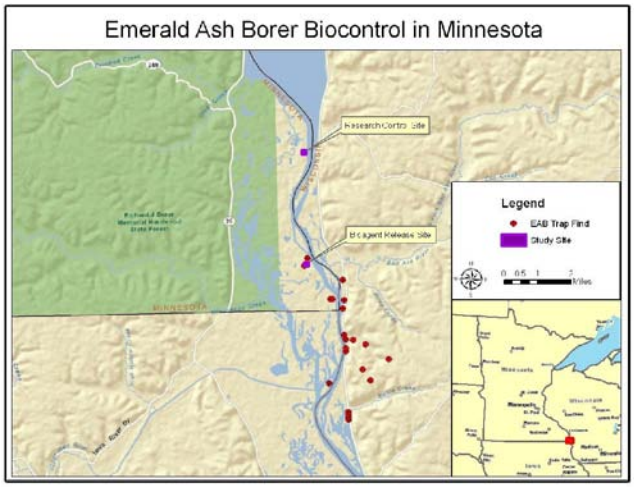
2010 EAB Quarantine Area Trap Placement

MINNESOTA DEPARTMENT OF AGRICULTURE
PLANT PROTECTION

Updated: September 23, 2010







MINNESOTA DEPARTMENT OF AGRICULTURE
PLANT PROTECTION

European pine sawfly

Neopdiprion sertifer

Hosts	Scots and red pines
Setting	Forests
Counties	Anoka and Isanti Counties
Survey methods	Ground
Acres affected	Not determined

Narrative

European pine sawfly was again present in the northern part of the Central Region, particularly on sandy soils in Anoka and Isanti counties. Infestations were not as severe as in 2009 however; emergence was a full two weeks earlier than last year. First hatch occurred on May 11th in 2009 at a site in East Bethel—at the same site young sawflies were emerging on April 26th this year.

PROGRAM OVERVIEW & BACKGROUND

The gypsy moth detection program is a cooperative effort between state and federal agencies including the Minnesota Departments of Agriculture (MDA) and Natural Resources (DNR), the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (APHIS), and the U.S. Forest Service (USFS). The Gypsy Moth Program Advisory Committee (GMPAC) was formed in 1998, consisting of representatives from these cooperating agencies and the University of Minnesota. On a biannual basis, GMPAC meets to discuss issues related to gypsy moth management. It is this cooperative effort that has built a strong gypsy moth program in the state of Minnesota. A strategic plan was prepared by GMPAC members to describe the objectives and administrative structures necessary to manage the gypsy moth in Minnesota. The plan contains a mission statement, a framework for decision making, and outlines the strategies and mechanisms to implement the plan.

Since 2004, Minnesota has been a formal member of the Gypsy Moth Slow the Spread (STS) Foundation. The STS Action Area is moved annually based on trap catch data and to cover areas where moth populations are building. The majority of Houston, Winona, Lake, Cook and portions of Fillmore, Olmstead, St. Louis and Wabasha were included in the 2010 Action Area.

The gypsy moth program relies on Minnesota state general funds as a matching cost share to federal grants. The STS Foundation is the major contributor of funding as they support both trapping and treatment within the STS Action Area. They also finance a portion of the regulatory program in Minnesota. In addition to STS sources, funding was provided by APHIS to conduct delimit and detection surveys as well as trapping on federal lands including national forests and Native American reservations.

GENERAL SURVEY PROGRAM

The MDA has been the lead agency undertaking the annual gypsy moth detection survey since 1973. The trapping survey is the data source for determining where gypsy moth management strategies should be implemented. Gypsy moth survey data from all participating agencies in Minnesota is routed through MDA for inclusion in annual reports.

Program Area

In 2010, MDA filled positions for 33 trapping routes and 6 lead workers to oversee field operations. Trappers were responsible for setting, checking, and removing gypsy moth traps during the field season. All trap data in Minnesota is collected and recorded using STS protocols. To gather comparable data, trapped areas beyond the STS Action Area do not follow the APHIS recommended trap density but rather use equivalent metric grids to achieve similar results. Minnesota's entire eastern border including the metro was trapped this season. The northern trapping grid covering the entire northeastern region, with the westernmost areas extending to central Koochiching County and south to Mille Lacs County. The southern region covered the entire southeastern corner of the state and extended west to cover the St. Cloud and Mankato areas. The entire state is not surveyed every year. Gypsy moth is moving into the state from the east, so trapping in the western portion of the state is typically done on a rotating basis from year to year. This year's western rotation surrounded the Mankato area.

Much of the northern region of Minnesota remains a challenge to survey because of the lack of access roads or road maintenance. As moth numbers rose in the northeast, trapping routes were designed to be hiked rather than driven. Although hiking field staff can only set about 40% of the traps that driving staff can, the extra attention to trapping on a pre-determined grid has enabled the program to gather more complete data on the existence of moth populations across the landscape. Tourism is a large part of the local economy in the north woods and along the

North Shore of Lake Superior, making the area susceptible to artificial introductions of gypsy moth. Popular camping and outdoor recreation sites are still trapped heavily thanks to hike-in trappers.

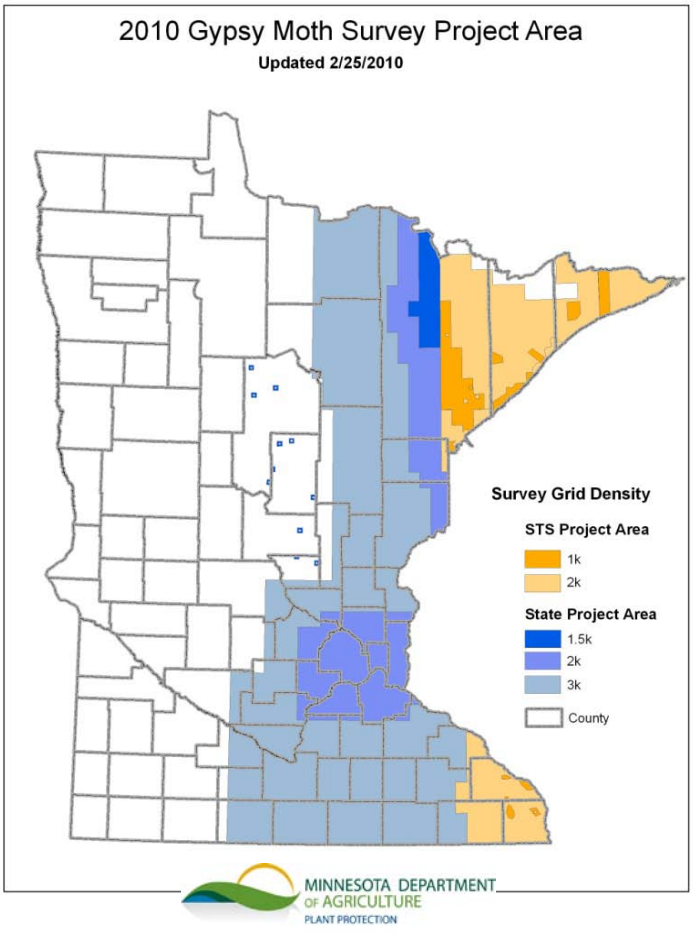
The 2010 survey was designed using prioritized trapping suggestions for each route. First tier traps had target circles intersecting a road and were considered easiest to access. Second tier traps required a short-distance hike (<1/2 mile) to set. Third tier traps were more challenging to reach and trappers were allowed to omit due to time constraints. The system worked relatively well, but because of the shortcomings of GIS road and trail layers, some traps were categorized incorrectly. Field staff valued trap prioritization and were able to achieve higher productivity following the suggestions.

"Milk carton" trapping was introduced to the northeast STS Action Area as a response to high trap catches in the 2009 season. These larger pheromone traps replaced delta traps that had been set in previous years to accommodate more moths per trap. Special safety training was given at northern trapper orientation for proper handling, construction and transportation of these traps due to the pesticide strip they contain.

High-risk sites

A determination of risk for the introduction and establishment of gypsy moth is based on human activity levels, preferred habitat for gypsy moth, and the advancing gypsy moth front heading west from the northeastern states. Wholesale nursery dealers and nursery growers that report stock sources from gypsy moth-quarantined areas or have a history of pest problems are considered high risk. Sawmills and pulp mills are regarded as high risk if it is known or likely that they have out-of-state sources and if they are within 100 miles of counties that trap fifty or more gypsy moths. State Parks, campgrounds, and other sites associated with the movement or sale of firewood and movement of humans and items from infested areas for tourism/recreation are also deemed high risk.

Compliance Agreement (CA) sites are high risk by nature and are trapped at a higher density. CA's for five mills and one nursery in Minnesota were issued or renewed jointly by state and federal officials this year. One CA was cancelled due to a violation and will not be renewed. See Survey Results for more details.



Trapping Grid

Grid densities differ according to the risk of introduction: smaller grid sizes yield higher trap densities which result in higher resolution of actual moth populations. Isolated traps with high moth numbers in 2009 were surveyed intensively in 2010 through site delimitation. This survey technique involves narrowing down a large area to find out if gypsy moth populations are persisting and if treatments should be administered.

The STS Action Area was trapped on a 1-2 kilometer grid. Outside the STS area, standard grid densities ranged from 1.5k to 3k. The map to the right indicates density differentials throughout Minnesota's 2011 survey area. Densities were decreased this year to make up for a loss in program budgets. MDA was able to maintain a similar trapping area as in the past but with fewer overall traps.

There were 106 STS and 28 non-STS delimit sites designated in 2010. Delimit sites were trapped at a grid density varying between 250 and 1000 meters. Urban areas (Twin Cities metro, St. Cloud and

Rochester) outside of the STS Action Area are considered high-risk for gypsy moth introduction due to human movement and were subsequently trapped on a 2k grid.

Asian Gypsy Moth

Trapping for the Asian strain of gypsy moth (AGM) continued in 2010. Traps from pathway sites (ports of entry, warehouses or sites that receive/store containers)**,** and around sites where heterozygous strains were identified previously were sent to OTIS Laboratories for DNA analysis. This year, 117 AGM traps with 259 moths were sent in for analysis. No AGM have been identified in Minnesota at this time.

Research

Sharp increases in moth numbers along the North Shore since 2005 along with noticeable variations in moth size and an unusually long adult flight season led MDA to request further research into the biology and behavior of northerly populations.

- Meteorological data are being analyzed to determine if wind patterns are capable of carrying gypsy moth larvae or adults over Lake Superior from eastern infestations into Minnesota.
- Autotraps were hung along the shoreline to capture and record daily flight patterns as well as seasonal moth activity.
- A sentinel trap grid was established in Minnesota in 2008 on areas of the existing grid along the North Shore to monitor male moth flight patterns. Sentinel traps were set and checked frequently again in 2010.
- To address the question of how temperatures over time affect lure release rates from traps, MDA is participating in a regional lure release study to measure these differences.
- Wing measurement studies started in Minnesota and expanded to include other states for comparison. A random sampling of moths were processed from 2007-2009 for wing measurements for help in determining whether they are resident or immigrant populations. Data collection was complete after the 2009 season, and preliminary results of the research indicate that approximately 20% of the males trapped each year are immigrants from high density populations.

The above research projects were coordinated through the USFS Field Station in Morgantown, WV.

- Around 40 positive traps from St. Louis, Cook, Lake, Carlton, and Itasca Counties were sent to an undergraduate at North Dakota State University for genetic research.

Trapping Schedule

Traps are ideally set just prior to adult moth flight. Trap removal starts once the predicted moth flight is over. A midseason trap check facilitates determinations of moth development and removal timing. It also helps with early detection and regulatory action at regulatory sites. MDA's trapping area was divided into northern and southern regions, as the latitudinal climate range of the state creates a delayed moth emergence in the north and a need for separate trapping schedules. Traps were all set between May 20 and July 15 and removed by September 15 in the south and October 21 in the north.

Survey Results

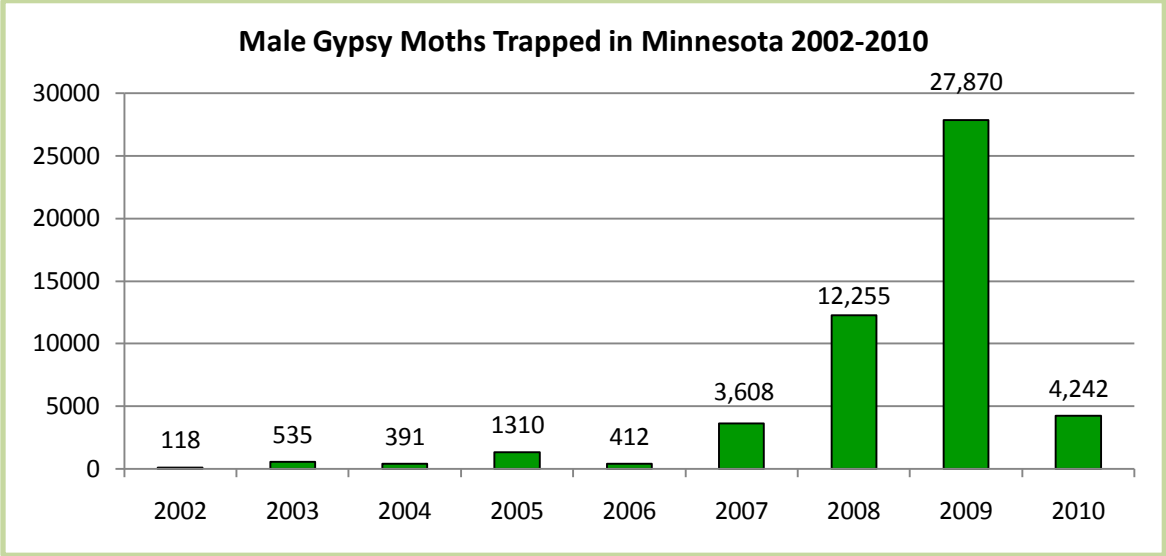
A total of 19,895 gypsy moth traps were set in Minnesota this season, yielding 4,242 moths. MDA set 19,182 traps, capturing 4,239 gypsy moths in 2,618 traps. APHIS coordinated trap placement for 615 traps on several federal and tribal land sites and areas of high risk interest. These areas including the Agassiz, Big Stone and Tamarac National Wildlife Refuges, Pipestone National Monument, Leech Lake Band of Ojibwe Reservation lands, the Upper and Lower Sioux Indian Community lands, and the U.S. Army Corps of Engineer lands in Cross Lake, all of which were outside the boundaries of MDA's program area. Minnesota County Agricultural Inspectors (CAI's) volunteered to set 75 traps outside the MDA trapping area in Clearwater, western Koochiching, and Lake of the Woods counties. Three Rivers Park District, located in the Twin Cities metro area, set 23 traps. Positive traps will be followed up in 2011 according to GMPAC-approved delimitation protocols.

There were 429 traps placed on tribal lands by all cooperators, capturing a total of 117 moths. APHIS funds were used to trap all national forest and tribal lands within MDA's standard trapping grid with the exception of the Grand Portage Reservation, which was trapped using STS funds. Results for federal and Reservation lands that were trapped are listed in the summary table at the end of this report.

The total number of gypsy moths trapped in Minnesota in 2010 decreased by 85% from 2009 levels. By region, a total of 556 moths were trapped in the south and 3,686 were trapped in the north.

The northern region saw an 87% decline in moths caught even as milk carton traps were deployed as a more accurate measure of dense populations. It appears that the 2009 dispersal of male moths in the north was due to a well-timed meteorological event which carried adults farther inland from Lake Superior. Trapping evidence shows that most of these moths were not able to find a mate to reproduce and build a sustainable population. In fact, most of the persistent populations were found to be within 15 miles of the shoreline where human activity is also most prevalent.

The moths trapped in the northern region of Minnesota account for 87% of the statewide 2010 totals. St. Louis County alone accounted for 46% of the statewide moth totals.



MINNESOTA DEPARTMENT OF AGRICULTURE
PLANT PROTECTION

The total number of gypsy moths trapped in the southern region more than doubled since last season as a result of a weak "bulge" of moths pushing in from southwestern Wisconsin. Like the northeast, southeast Minnesota is experiencing widespread but low counts of moths which theoretically will not develop into established populations.

MDA will be working closely with the land stewards in areas where there is a need to align management strategies with increased or perpetuating moth populations. Many of the isolated positive traps will be further delimited and treatments will be proposed for these areas in 2011.

Regulatory Sites

MDA staff set 465 traps at 83 nursery sites in 2010, yielding 6 positive traps and a total of 7 moths recovered from 6 different sites. The substantial outreach campaign MDA promotes has made a huge impact as more nurseries are contacted and informed about proper sanitation of imported stock. MDA continues to work with the industry to minimize their risks of transporting gypsy moth into the state.

Outside of the STS area, there were four nurseries that each yielded a single moth. At three sites, no further action was considered because subsequent trap checks yielded no additional moths. One positive nursery site already had a compliance agreement in place because of previous moth interceptions. The CA was cancelled after the moth was captured. Although no subsequent moths were trapped there, gypsy moth pupae were found upon inspection of stock. The nursery was quarantined by MDA and an order to treat their stock in the spring of 2011 was issued.

MDA staff set 215 traps at 71 mill sites in 2010, yielding 23 positive traps and a total of 27 moths at 15 different sites. Catches at these mills were not investigated for regulatory concerns because the numbers of moths caught there simply reflect the overall high moth population in the larger landscape.

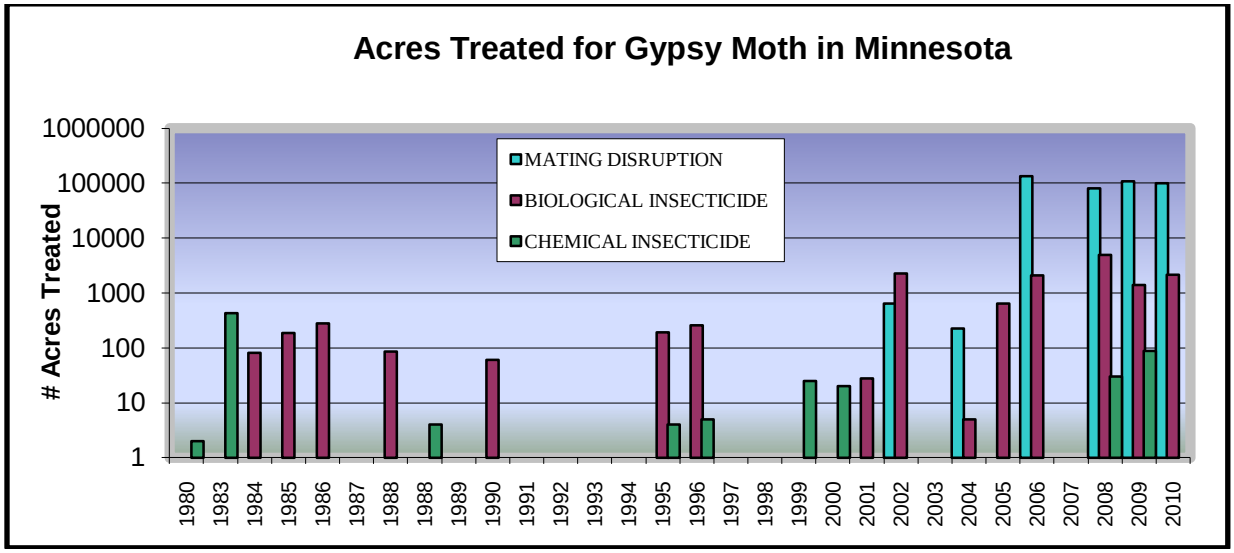
Of Minnesota's 80 State Parks, 45 were covered by the standard grid in 2010 and had an additional 1-2 random traps placed at each. There were 90 traps set at State Parks, yielding 9 positive traps and a total of 16 moths at 6 different sites. Three of the positive State Parks are located in the STS area.

There were 19 other campgrounds and three randomly trapped sites that had positive trap catches. Catches at these sites account for the remaining 57 out of 107 moths that were trapped at all regulatory sites. Regulatory catches in 2010 accounted for 2.5% of the total moth catches in the state.

This year's survey results reflect the success of the Gypsy Moth Program as a whole by identifying start-up populations, tracking population development over time, and monitoring treated areas. Despite the attention to trapping, gypsy moths were found in a record 33 Minnesota counties this year. Even though the overall moth count was extremely low as compared to the exponential growth that has been seen in the state over the last few years, the number of counties gypsy moth is being found in continues to grow. The increase in the overall moth distribution, as well as persistent moth presence in areas that the STS Decision Algorithm still indicates are Potential Problem Areas, is what substantiates the continued need for investment in the detection survey and subsequent eradication and STS treatment efforts. The success comes when the significantly higher costs of management once gypsy moth is established are delayed year after year thanks to fully functioning programs for both trapping and treatments.

GENERAL TREATMENT PROGRAM

Since 1980 the MDA has coordinated and overseen the treatment of more than 437,000 acres to delay, prevent or mitigate the adverse impacts directly or indirectly associated with gypsy moth infestation on our state's natural resources, citizens and industries.



MINNESOTA DEPARTMENT OF AGRICULTURE
PLANT PROTECTION

Slow-The-Spread

This year 100,870 acres were treated within the STS Action Area in St. Louis and Lake Counties northeast of Duluth. An organic formulation of *Btk* was used in the larvicide blocks. Disrupt II was applied to the larger treatment blocks.

An Environmental Assessment was done in conjunction with Superior National Forest and was significant in that it included recommendations for use of Btk on the Forest. The FONSI was signed after no objections were made to the application.

2010 Gypsy Moth Treatments

Site Name	Acres	Product	Application Rate/Acre	Applicator	Application Equipment	Date of Application	Cost/ acre	Project
Ninemile Lake	1,285	Foray 48B	24 CLU x 2	Airborne Custom Spraying	Fixed Wing	6/1/2010	$23.25	STS
Finland	540	Foray 48B	24 CLU x 2	Airborne Custom Spraying	Fixed Wing	6/1/2010	$23.25	STS
Clover Valley	351	Foray 48B	24 CLU x 2	Airborne Custom Spraying	Fixed Wing	6/1/2010	$23.25	STS
Legler Lake	46,852	Disrupt II	6g	Al's Aerial Spraying	Fixed Wing	7/10/2009	---	STS
Knife River	51,842	Disrupt II	6g	Al's Aerial Spraying	Fixed Wing	7/10/2009	---	STS

**No Eradication or Regulatory treatments were required in 2010.*

MINNESOTA DEPARTMENT OF AGRICULTURE
PLANT PROTECTION

Treatment Monitoring

Btk treatments in 2010 and mating disruption treatments in 2009 were evaluated this year. Treatment blocks were analyzed by the STS Decision Algorithm at the conclusion of the 2010 trapping season. The algorithm measures success of treatment, and external gypsy moth colony presence. Ninemile Lake and Finland (both northern Btk blocks) were successful but the colony may be larger than the area treated. The Clover Valley block was embedded in a larger mating disruption area so results are deferred until next year. All 2009 northern mating disruption blocks were successfully treated and, with the exception of Castle Danger block, the colonies were suppressed in 2010. All 2009 southern mating disruption blocks were also successfully treated but widespread low-level catches this year caused the algorithm to declare that the colony may not be suppressed in 2010.

Alternate Life Stage Surveys

In July, a city forester correctly reported a gypsy moth caterpillar in Duluth which led MDA staff to a heavily infested oak tree nearby. In October, egg mass searches were conducted at four sites: Minnetonka, the City of Grant, and Coon Rapids in the metro area and Split Rock Point area on the north shore. Alternate life stages were found at all three metro locations. Planning is underway for 2011 treatments to occur at the sites where gypsy moth alternative life stages were found.

OUTREACH

Recent legislation in Minnesota makes the now-fee-based Tree Care Registry a source of income for the division. The Registry is now housed with the Gypsy Moth Program so program managers will have access to contact information for all registered tree care companies to give updates on invasive species quarantine issues.

Treatment proposals offer many opportunities for outreach and MDA coordinated several events for media, elected officials, and the general public to learn about the program. Visits to businesses with compliance agreements are an annual occasion for employees to reacquaint themselves with the gypsy moth regulatory program.

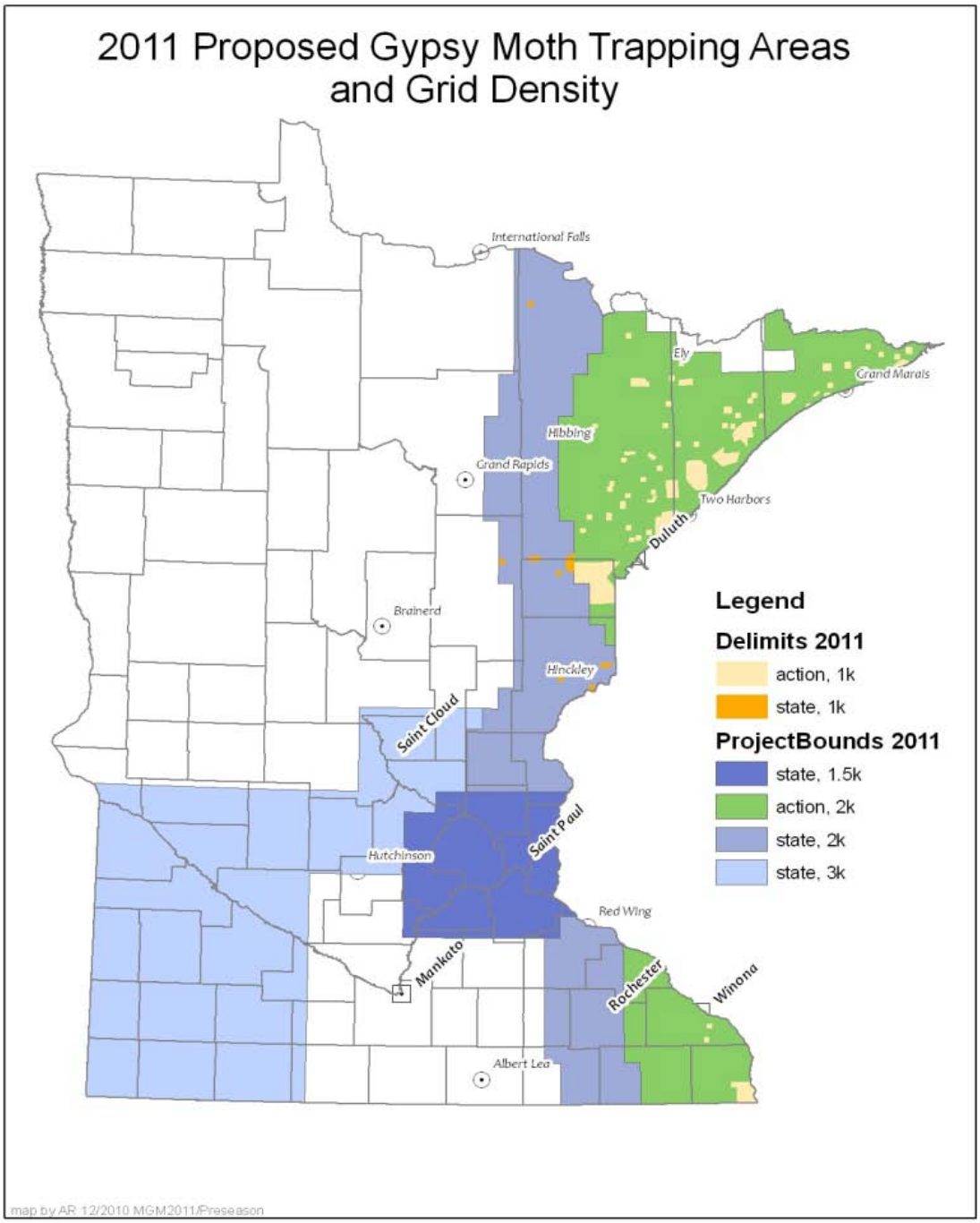
A gypsy moth session was offered at the Minnesota/Wisconsin Invasive Species Conference and a program was given on the Invasive Species Tour hosted by the Minnesota Soil and Water Conservation Districts.

PROGRAM PLANS FOR 2011

The annual survey will continue to focus on the eastern border of Minnesota, with special attention paid to both STS areas and high-risk areas such as the Twin Cities metropolitan. The western rotation in 2011 will include the SW corner of the state. Trapping densities are shown on the map above. It is projected that ~23,000 traps will be

set. Milk carton traps will not be necessary due to the lower numbers of moths so all deployed traps will be of the delta variety.

The enormous state budget deficit impacts all programs that rely on general revenue funds to operate, including the gypsy moth program. Newly elected lawmakers and leaders will alter the political climate needed to maintain invasive species management work in Minnesota. The gypsy moth program is integrated with MDA's mission and we are confident that it has proven itself over the past three decades as a successful, economical, and popular service.



MINNESOTA DEPARTMENT OF AGRICULTURE
PLANT PROTECTION

2010 COUNTY CATCH SUMMARIES

Positive

County	# Traps	# Moths	% of Total
Aitkin	490	72	2%
Anoka	397	85	2%
Benton	185	1	0%
Carlton	640	328	8%
Carver	278	1	0%
Chisago	199	3	0%
Cook	1,230	435	10%
Crow Wing	141	1	0%
Fillmore	538	43	1%
Freeborn	208	4	0%
Goodhue	284	1	0%
Hennepin	581	43	1%
Houston	581	130	3%
Hubbard	36	1	0%
Isanti	148	2	0%
Itasca	625	21	0%
Kanabec	160	12	0%
Koochiching	430	11	0%
Lake	1,242	779	18%
Mille Lacs	131	1	0%
Morrison	59	1	0%
Mower	211	4	0%
Olmsted	530	12	0%
Pine	549	182	4%
Ramsey	131	1	0%
Saint Louis	4,627	1,931	46%
Scott	270	1	0%
Stearns	170	1	0%
Steele	120	1	0%
Wabasha	308	9	0%
Washington	369	80	2%
Winona	591	44	1%
Wright	361	1	0%
# Positive Counties:	**33**		

Negative

County	# Traps
Beltrami	67
Blue Earth	231
Brown	95
Cass	182
Clearwater	44
Dakota	497
Dodge	128
Faribault	208
Lake of the Woods	45
Le Sueur	161
Martin	194
McLeod	136
Meeker	36
Nicollet	133
Renville	69
Rice	183
Roseau	12
Sherburne	183
Sibley	215
Wadena	22
Waseca	124
Watonwan	110

MINNESOTA DEPARTMENT OF AGRICULTURE
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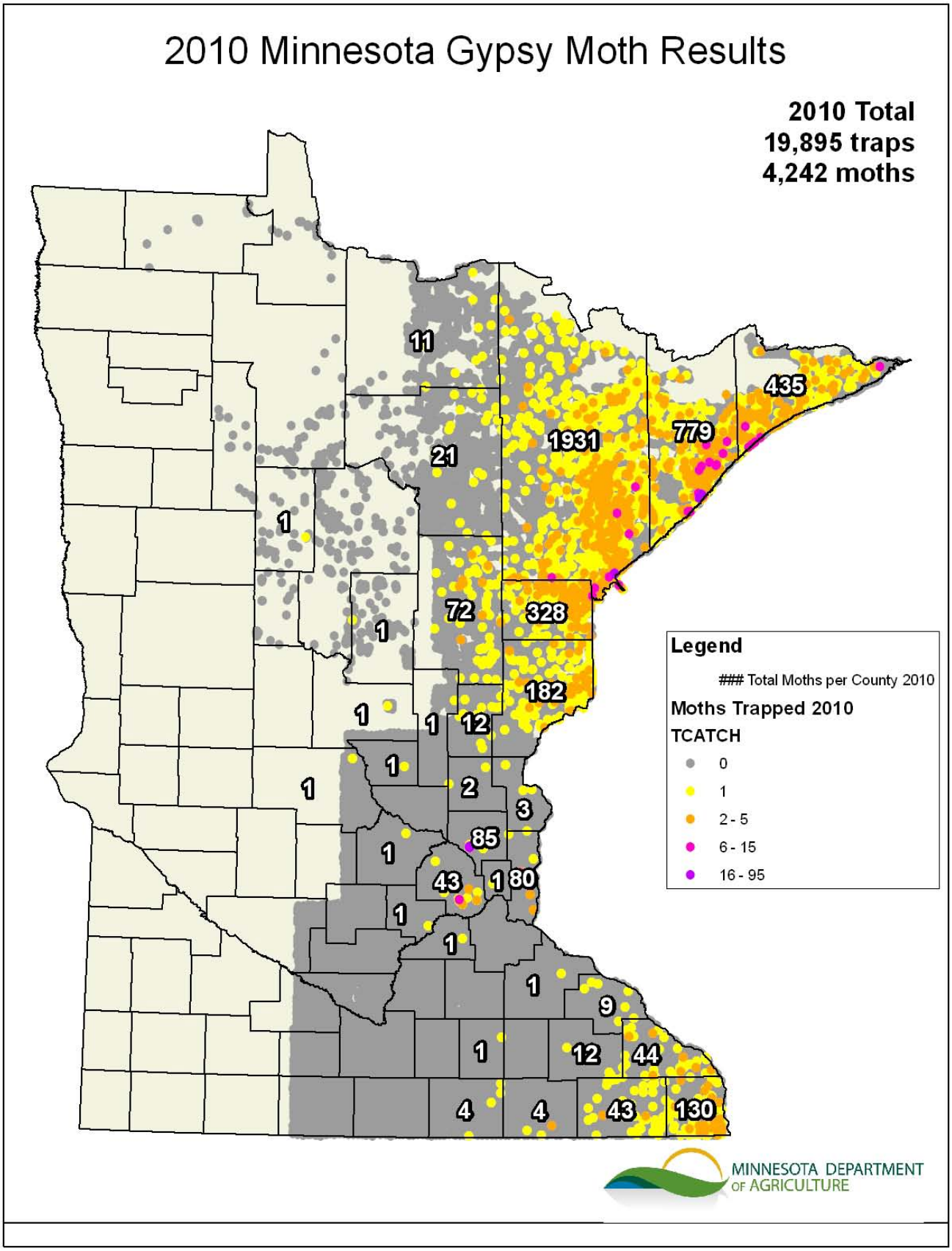
2010 GM Survey Summary Tables:

Management Zones	Total Traps	% of Total Traps	Total Moths	% of Total Moths
Eradication Area	12,529	63%	1,106	26%
STS Action Area	7,366	37%	3,136	74%
TOTAL	**19,895**	**100%**	**4,242**	**100%**
Traps set by agency	**Traps Set**	**Positive Traps**	**Moth Count**	
MDA	19,182	2,618	4,239	
APHIS	615	3	3	
County. Ag. Inspector Volunteers	75	0	0	
Three Rivers Park District	23	0	0	
TOTAL	**19,895**	**2,621**	**4,242**	
Trap Type				
Standard	16,544	2,228	3,346	
Delimit	2,225	302	623	
High Risk Sites	1,126	91	273	
TOTAL	**19,895**	**2,621**	**4,242**	
High Risk Sites	*Note that these figures are spatial and may duplicate trap and moth counts. These numbers are not to be incorporated into totals.*			
Nursery	465	6	6	
Mill	215	23	27	
State Park	90	9	16	
Campground	208	25	37	
Firewood Dealer	9	0	0	
Reactive	35	3	8	
Random	15	8	18	
TOTAL	**1,037**	**74**	**112**	
Urban Areas	*Not all urban areas listed; figures include all types of traps set within the urban boundaries.*			
Duluth	395	178	488	
Twin Cities Metro Area *	2,524	61	211	
Rochester	56	1	1	
St. Cloud	103	0	0	
Winona	24	1	1	
Mankato	5	0	0	
Reservations				
Fond Du Lac	108	59	99	
Grand Portage	109	6	13	
Boise Forte (Vermillion, Nett Lake)	47	4	4	
Leech Lake	160	0	0	
Mille Lacs	1	1	1	
Prairie Island	4	0	0	
TOTAL	**429**	**70**	**117**	
Federal Lands				
Superior National Forest	2,811	709	1,062	
Chippewa National Forest	209	1	1	
TOTAL	**3,020**	**710**	**1,063**	

** Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties*


2010 Minnesota Gypsy Moth Results
2010 Total
19,895 traps
4,242 moths
11
435
1931
779
21
1
72
328
1
182
1
1
12
1
1
2
3
85
1
43
1
80
1
1
1
9
1
12
44
4
4
43
130
Legend
Total Moths per County 2010
Moths Trapped 2010
TCATCH
0
1
2 - 5
6 - 15
16 - 95
MINNESOTA DEPARTMENT
OF AGRICULTURE

Japanese beetle

Popillia japonica

Hosts	Grasses, roses and other shrubs
Setting	Urban forests
Counties	Ramsey, Washington and Hennepin Counties
Survey methods	Ground detection
Acres affected	Not determined

Narrative

Japanese beetle infestations are becoming more numerous in the Metro area. The Japanese beetle was declared a general pest in Minnesota in 2002 by the Minnesota Department of Agriculture and since that time it continues to spread outward from the Metro. Some of the larger infestations are in Ramsey and Washington counties. Many infestations are adjacent to or very near golf courses.

The first adult sighting was on July 9th, 2010 in Maplewood, one block from a golf course. Adults were feeding on Virginia creeper in an Edina yard on July 22nd. An adult was even found on the grounds of the Central Region DNR office on Warner Road. Damage at previously infested sites was less than last year and several golf courses apply insecticides annually for grub control. New infestations are cropping up as evidenced by increased Japanese beetle calls to the Central Region office in 2010.

Sirex woodwasp

Sirex noctilio

Hosts	Pines
Setting	Urban and rural forests
Counties	See table below
Survey methods	Funnel traps
Acres affected	None

Narrative

In Minnesota, USDA-APHIS-PPQ set out Lindgren funnel traps in pine stands and near industrial sites this year. Three traps were set out per site and each trap contained alpha-pinene, UHR ethanol and ipsdienol. Traps were checked periodically through the summer. No Sirex woodwasps have been found.

Sirex woodwasp/ Exotic bark beetles survey 2010 Survey by APHIS-PPQ		
County	*Number of traps*	*Number of sites*
Anoka	6	2
Carver	3	1
Dakota	27	9
Goodhue	6	2
Hennepin	30	10
Olmsted	6	2
Ramsey	21	7
Scott	9	3
Stearns	6	2
Washington	12	4
Totals	*126*	*42*

NOT known to be in Minnesota for 2010 FHH Report.

Asian long-horned beetle
Beech bark disease
Dogwood anthracnose
Fusiform rust
Hemlock wooly adelgid
Laurel wilt disease
Sudden oak death

The Minnesota Department of Agriculture's nursery inspection program inspected and certified 9,221acres of Minnesota nursery stock to facilitate sale of trees, shrubs and perennials within the state, interstate and internationally. A total of 314 nursery stock growers and 2,274 nursery stock dealers were certified in 2010. Along with growers, retail nursery operations are also inspected and MDA audits certification documents for stock originating outside of Minnesota thus assuring that stock offered for sale in Minnesota is free of plant pests. When injurious plant pests are detected, stock is removed from sale pending successful treatment and control. In cases where no effective treatment is available, stock may be ordered destroyed or returned to the shipper.

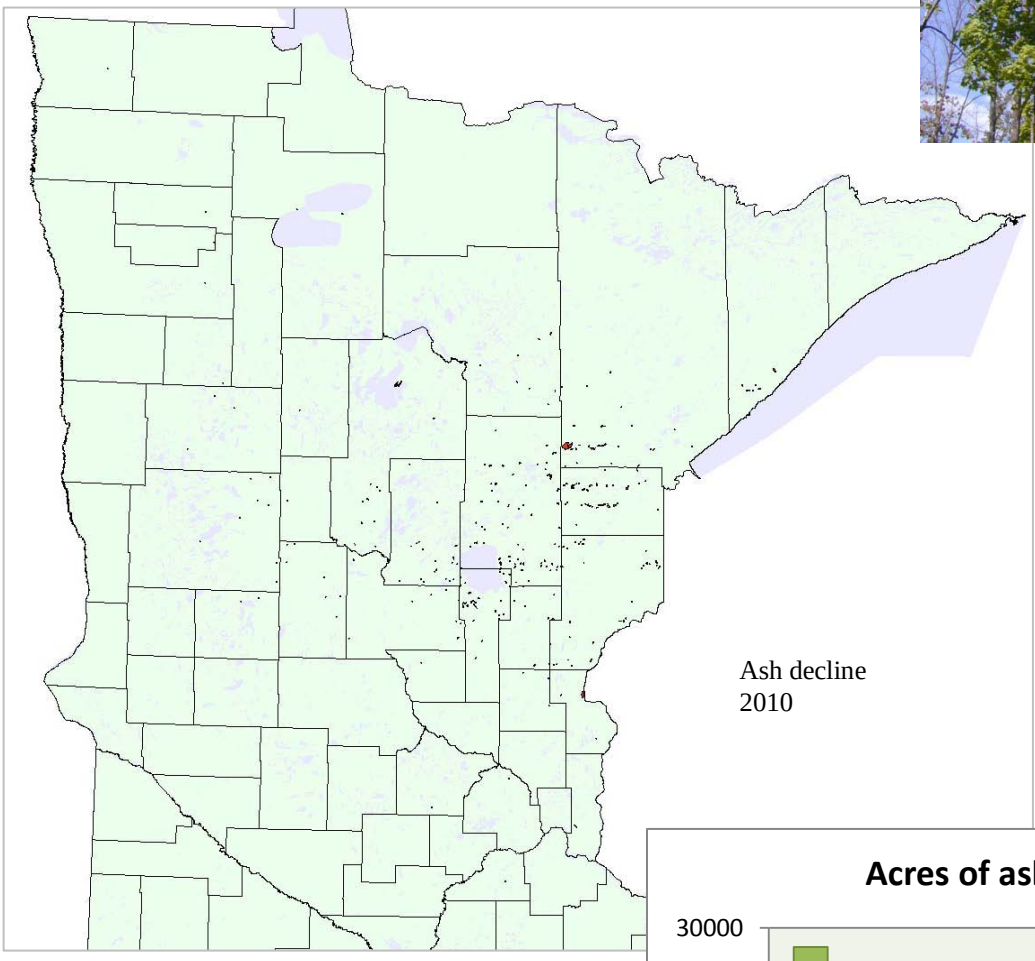
ABIOTIC AGENTS

Ash decline

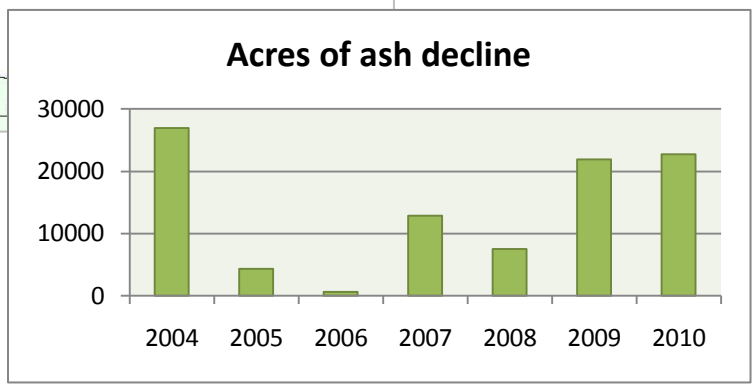
Multiple agents

Hosts	Black ash
Setting	Rural forests
Counties	See map
Survey methods	Aerial detection
Acres affected	23,092 ac
Narrative	

Ash decline occurred in 566 stands and was detected on 23,092 acres in 2010. Acres of ash decline were similar to last year's tally. See map and chart.



Ash decline
2010

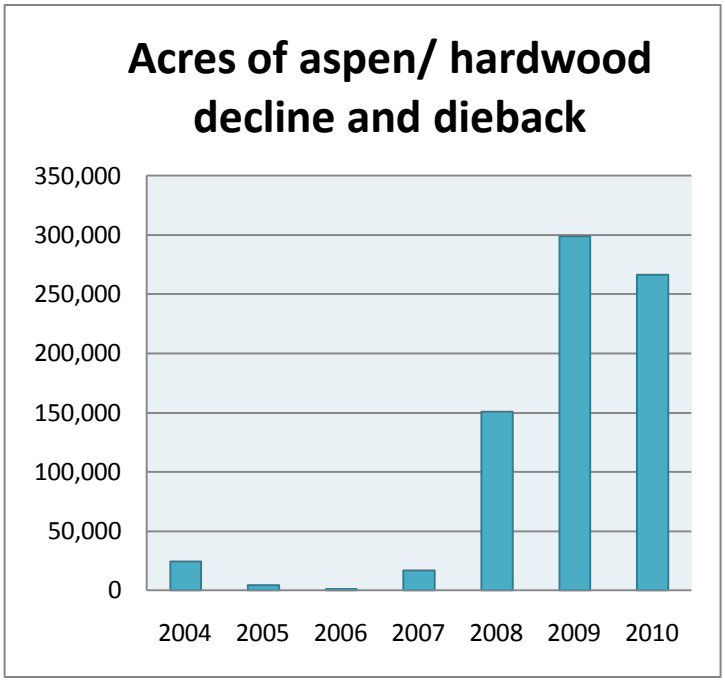


Aspen and hardwood decline

Unknown agent(s)

Hosts	Quaking aspen, some paper birch.
Setting	Rural forests
Counties	See map
Survey methods	Aerial surveys
Acres affected	
Aspen	68,050 ac
Hardwoods	198,304 ac

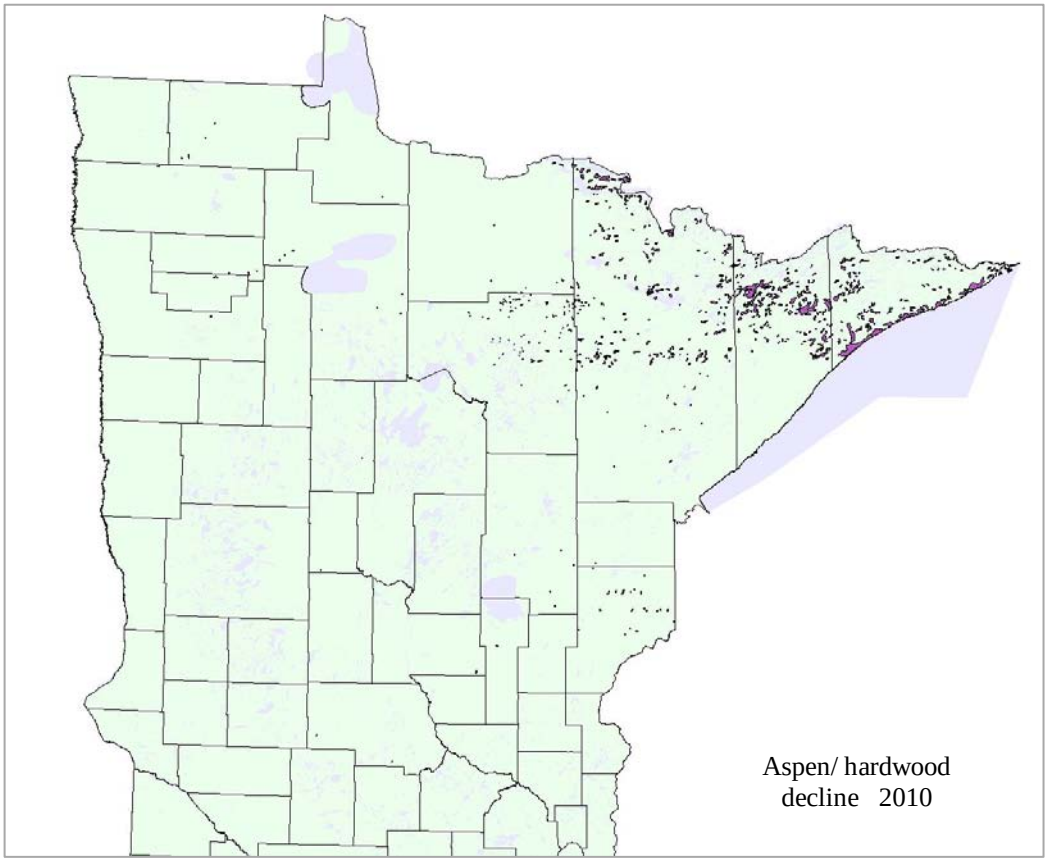
Narrative



Since 2004, aspen with symptoms of decline has been mapped by aerial survey sketch mappers. Symptoms have included combinations of defoliation, discoloration, dieback and/or mortality.

Dieback is the most common symptom but tree mortality has also occurred. Mortallity can vary from scattered trees throughout a stand to patches of 30 to 40 dead trees scattered through stands. Trees with dieback often also exhibit small off color foliage in the live parts of the crown. Ground surveys have found serpentine galleries of bronze poplar borer on dead trees as well as in trees with extensive dieback.

Most of the dieback has been mapped in the northern tier of counties especially in St Louis, Lake and Cook Counties. It is thought that two significant droughts as well as three to four years of heavy forest tent caterpillar defoliation in the past decade stressed the aspen resulting in attack by secondary pests. Some birch decline is also noted among the declining aspen.



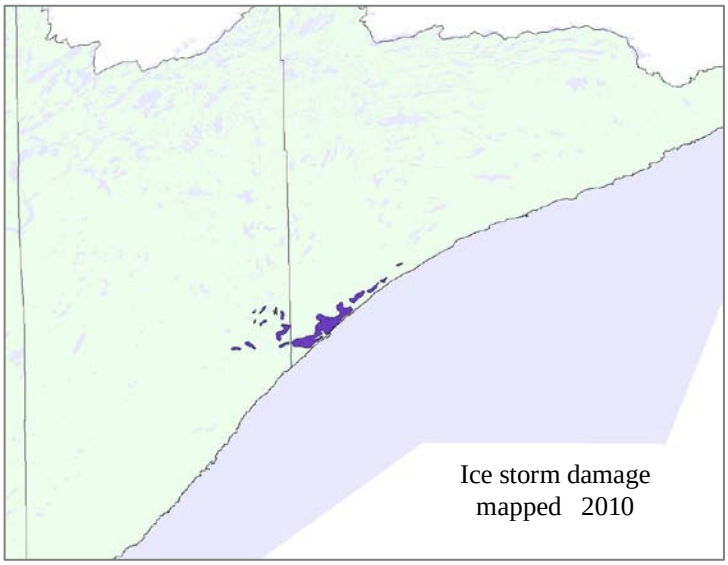
Aspen/ hardwood decline 2010

The map shows 741 polygons of aspen with current symptoms of aspen decline. Most of the polygons in the northern parts of Itasca, St Louis Lake and Cook counties are from the 2009 federal aerial survey map. Aspen decline in these areas were only mapped in 2010 if they were new areas of decline beyond what was mapped in 2009. In those areas, 7,449 acres were newly found in 2010.

Ice storm damage

Hosts	Conifers and hardwoods
Setting	Rural forests
Counties	Lake and Cook Counties
Survey methods	Aerial survey
Acres affected	12,618 ac
Narrative	

On March 16, 2009, Lake and Cook Counties suffered an ice storm that became a federally-listed disaster. All stands in the ice storm area received damage but much of it was to trees scattered throughout the stands. Stands with very light damage, visible from the ground were not easily mapped from the air. The 2010 aerial survey mapped 12,6188 acres where 26 to 50% of the trees had main stem breakage or were uprooted.



Late spring frost

Hosts	Northern red oak and others
Setting	Forests
Counties	Aitkin, Crow Wing and Cass Counties
Survey methods	Ground
Acres affected	Not determined
Narrative	

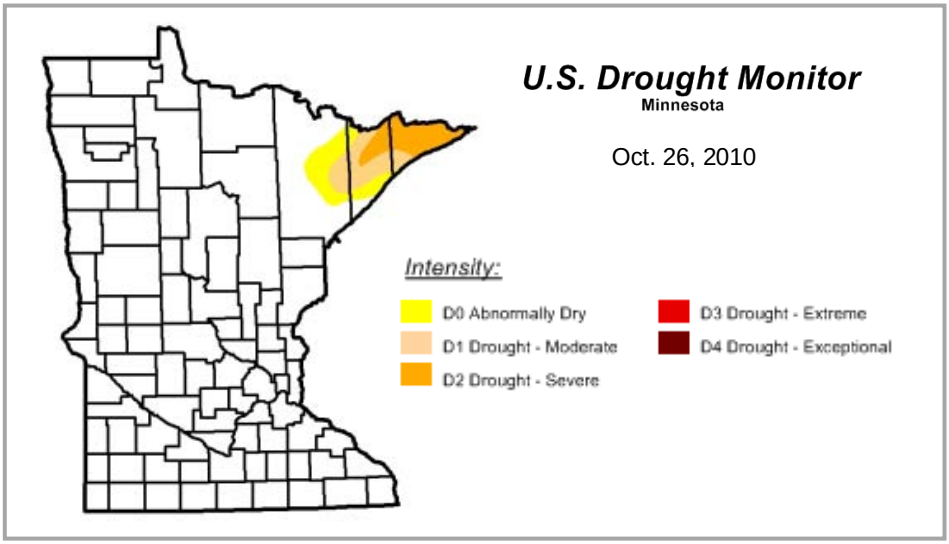
Warmer than normal temperatures, in March and April brought an early spring and leaf out. High temperatures reached 73 F in Grand Rapids on April 1st and weekly highs reached the upper sixties or low seventies throughout April and early May. Pokegama Lake was ice free by April 6th, a new ice out record. This normally does not occur until April 20 or 21. This was followed by over 4 inches of heavy wet snow on May 7th that covered the ground for the next two days and brought a low of 22 F to Grand Rapids on May 9th.

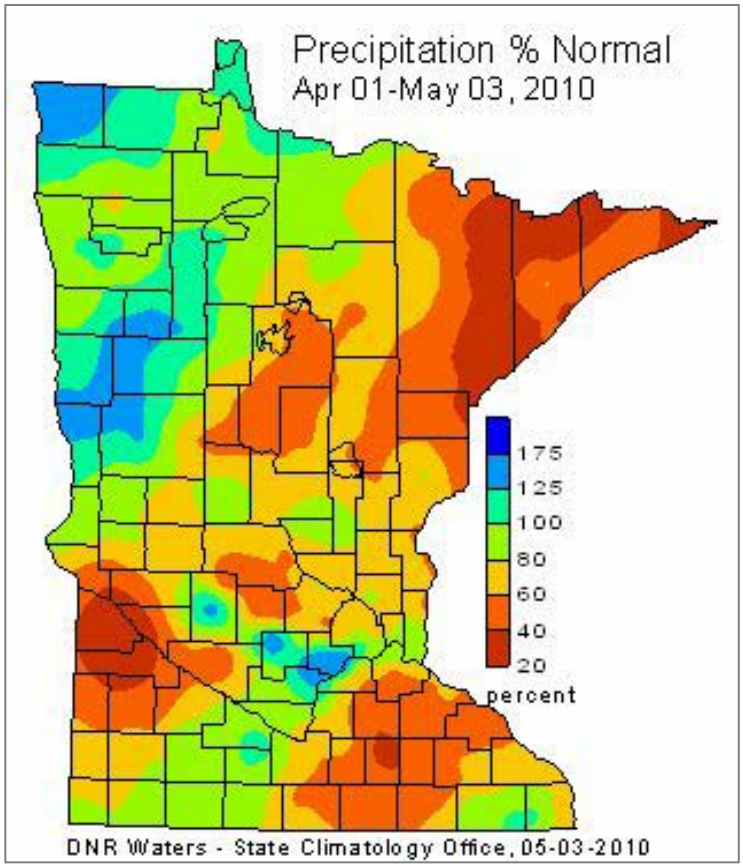
The cold temperatures resulted in frost damage to tender young tree leaves in locations scattered throughout the north. Frost killed half inch long red oak leaves near Brainerd. Red oaks and willows near Cass Lake were also reported to have suffered frost damage. In some locations the new growth on balsam fir and white spruce was also killed by the cold temperatures.

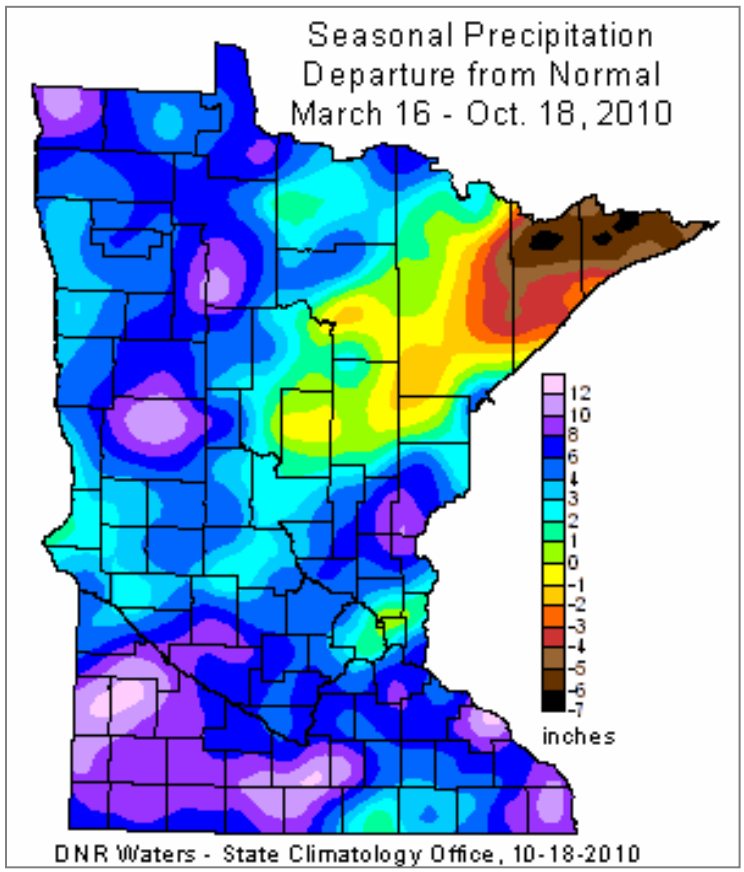
Spring drought and summer deluge

Hosts	All
Setting	All forests
Counties	Statewide
Survey methods	Rainfall and temperature monitoring stations
Acres affected	Entire state
Narrative	

2010 was a welcome change from the previous four growing seasons, although it did start out with a very dry spring and early summer. In the northwest corner of the state, rainfalls were heavy starting on May 3rd. Elsewhere in the state, abundant to heavy rains started during the last week of June and continued until the last weeks of September. See maps on next page. Then, a warm and dry spell lasted until late October. The exception was in the Arrowhead region where severe drought was reported in Cook, Lake and northeastern St. Louis counties during mid-summer and that lasted through October.




Precipitation % Normal
Apr 01-May 03, 2010
175
125
100
80
60
40
20
percent
DNR Waters - State Climatology Office, 05-03-2010


Seasonal Precipitation
Departure from Normal
March 16 - Oct. 18, 2010
12
10
8
6
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
inches
DNR Waters - State Climatology Office, 10-18-2010

PHENOLOGY 2010

Date	*Item*	*Location*
3/ 16	No snow except on a few roadsides. A few pussy willows in bloom. Saw a string of snow geese heading north of Mille Lacs.	Aitkin County
3/ 16	Two to three times more pussy willows blooming. No yard flowers are up yet in Brainerd.	Crow Wing Co.
4/ 15	Dandelions blooming in profusion where heat is reflected from buildings. Several aspen clones have broken bud and appear green. American elder buds are broken and infloresence buds are now visible. Starting to see a few leatherwood blooms.	Itasca Co.
4/ 19	Forest tent caterpillars hatched at Gull Lake. Aspen and basswood twigs have big buds and are beginning to expand.	Cass Co.
4/ 21	Birch catkins are pendant. Leatherwood in full bloom. 1 *Diervilla* bloom spotted. Small white violets in lawn are blooming. Garden: 2 tulips and 1 daffodil in bloom.	Itasca Co.
	FTC from Ottertail Co. hatched. (Egg masses were kept out of doors in GR)	Ottertail Co.
4/ 22	Frost on windshield this morning. Temp was 28 F this morning. Noted many American elder shoots wilting.	Itasca Co.
4/ 24	Rained some. Forsythia in bloom. New leaves on hardwood trees are a chlorotic green color, esp. aspens.	Itasca Co.
4/ 25	Paper birch buds are breaking. Lilac leaves are 1 inch long. *Amelanchier* flower buds appear elongated to the "white" stage and should be blooming tomorrow. Several daffodils are up.	Itasca Co.
4/ 26	Most aspen clones have leaves. Tamarack needles are out. Crabapple leaves are ½ expanded. *Amelanchier* is in early stages of blooming.	Aitkin and Carlton Cos.
4/ 30	First marsh marigolds in bloom. In bloom = short pussy-toes and white with purple violets.	Itasca Co.
5/ 1	Bur oak buds expanding.	Itasca Co.
5/ 7	Snow today. Flowering almond is in full bloom.	Itasca Co.
5/ 8	American elder in full bloom. Nodding Trillium bud enlarging but still closed.	Itasca Co.
5/ 9	White crabapples in bloom.	Itasca Co.
5/ 13	Wake-robin Trillium is up and white sepals are visible.	Itasca Co.
5/ 14	Wild plum is in full bloom. Yellow rocket is all blooming.	Itasca Co.
5/ 14	Male jack pine cones are easily visible. Bigtooth aspen not even budded out while quaking aspen and balm of gilead are almost fully leafed out. Along #2 near Cass Lake, the bigtooth aspen leaves are starting to emerge. Both chokecherry and pin cherry are starting to bloom. Some *Amelanchier* petals still on a tree. Red oaks in bloom. Hoary puccoon blooming in profusion.	Cass Co, northern
	Jack pine candles are 2-4 inches on the smaller trees.	Beltrami Co.
5/ 15	Starting to catch June bugs at outdoor night light.	Itasca Co.
5/ 18	Horsechestnuts in full bloom.	Itasca Co.
5/ 19	In bloom: Red crabapples, *Actea rubra*, starflower and nodding Trillium	Itasca Co.
5/ 21	*Trillium grandiflora* in full bloom.	Itasca Co.
6/ 3	1 lonesome jack pine budworm larva found north east of Badoura Nursery	Hubbard Co.
6/ 14	Leaf rollers on hilltops 5 mile east of Remer causing light defoliation of aspen. Also 1 mile south of Outing.	Cass Co.
6/ 17	Post-peak blooming: Showy ladyslipper, Indian paint brush and oxeye daisy.	Itasca Co.

SPECIAL PROJECTS

Forest Health Program

Development of Division of Forestry guidelines for ash management
Ash management guide for private forest landowners
The Black Ash Symposium, May of 2010
Latent *Diplodia* infection in state nursery seedlings
A GIS model for the risk of emerald ash borer spread in Minnesota
2010 Firewood program update
The First Detector Program
Minnesota issues and strategies: Five year plan. Forest Health section.
Oak wilt accomplishments for 2009.
Creating a GIS model for oak wilt in Minnesota
White spruce thinning project: Data for 2010.

Invasive Plant Species Program

An education plan for Minnesota recreationists
Available on-line only:
Literature Review: The biology of terrestrial invasive species in Minnesota.
Invasive species project: Focus group report, Parts I, II and III.
Literature Review: State of effective educational efforts to reduce the transport of terrestrial invasive species and applications for Minnesota.

Urban and Community Forestry

U&CF grants and projects affiliated with the Forest Health Program
2006 Community Rapid Assessment Survey for ash and elm: Final report.
2010 Community Rapid Assessment Survey for all species. Initial report
MN STAC report on the invasive species threats in Minnesota

Development of guidelines for managing sites with ash to address the threat of emerald ash borer on DNR Forestry-administered lands

The formal start of developing a guideline for managing ash on DNR Division of Forestry administered lands began with a meeting in September 2009. Representatives from DNR Divisions of Forestry, Wildlife and Ecological Resource, Minnesota Department of Agriculture, USDA- APHIS, University of Minnesota, USFS State & Private Forestry and Counties met to develop a framework of ideas to guide the development of the guidelines.

The guideline was developed largely within the Division of Forestry and reviewed by representatives of the landed Divisions in DNR, Chippewa and Superior National Forests, Minnesota Forest Resource Council, Minnesota Forest Resources Partnership, USFS State & Private Forestry and others. Following revisions based on the reviews the guideline document was adopted by the DNR Division of Forestry in July 2010. It will be presented to the Commissioner of DNR and recommended that it be adopted Department-wide in the form of an Operational Order.

The guidelines are based on the current belief that regardless of the type or magnitude of actions taken, emerald ash borer will spread throughout Minnesota and kill the majority of ash trees. Because of the amount of ash in the state efforts, should start now to reduce the amount and size of ash, and to increase species diversity in order to reduce future impacts from emerald ash borer, help keep forested sites forested, and protect the hydrology of sites currently dominated by ash.

Guidelines for Managing Sites with Ash To Address the Threat of Emerald Ash Borer On Forestry-Administered Lands

BACKGROUND

The ash genus (*Fraxinus*) in Minnesota comprises some 900 million trees and is the second most common hardwood tree genus in the state. EAB was discovered in the United States in 2002 and is now present in 13 states and 2 Canadian Provinces. It was found in Minnesota in 2009; currently EAB's only known occurrence within Minnesota is in the cities of St. Paul and Minneapolis. EAB populations can spread rapidly in infested firewood, logs, and ash nursery stock. Therefore, it is assumed that EAB will soon infest Minnesota's forested areas and cause significant impact to the ash resource. Experience from other states has shown that EAB kills 99+% of the ash in a stand once that stand becomes infested. This level of impact is greater than what occurred with American elm following the introduction of Dutch elm disease to Minnesota.

To date there has been no evidence of resistance to EAB within any North American ash species. Resistance does exist in some Asian ash species. Subtle differences in susceptibility to EAB between white, green, and black ash have been reported, but those differences are minor and should not influence management options. All three ash species in Minnesota will likely succumb to EAB attack.

SCOPE

This document applies to:

- Forested stands classified as ash covertype
- Forested stands with an ash component of at least 20% of stand basal area but not typed as an ash covertype. Native plant communities where ash is and can be significant include: FDw44, MHs49, MHw36, MHc47, MHn46, FFs58, FFs59, FFn57, FFn67, WFs57, WFw54, WFn53, WFn55, WFn64.
- Forested stands with ash that are free of EAB occurrence and are greater than 25 miles from the closest known EAB infestation. This distance will allow multiple entries into a stand based on an average, "natural" movement of EAB of ~1/2 mile per year.

ASH MANAGEMENT OBJECTIVES

- Landscape perspective: Manage ash populations in the landscape to protect sensitive wetland ecotypes, reduce outbreak costs, and restrict emerald ash borer introduction and spread without eliminating ash within forest ecosystems.
- Stand perspective: Create conditions that will reduce potential impacts and increase the resiliency of forested stands by
  - Keeping forested sites forested
  - Maintaining an ash component but reducing the size and number of ash in the stand.
  - Increasing tree species diversity.
- Management objectives should focus on ecosystem health and management, not on the emerald ash borer. The intent is to limit habitat attractiveness to EAB.
- The Division of Forestry will work within its nursery program and with other partners for maintaining representative samples of genotypes but not for processing seeds for reforestation.

CAVEATS

- There is a likelihood that the vast majority of ash trees in Minnesota will be killed by EAB regardless of the type or magnitude of actions taken.
- The large extent of the ash resource, particularly black ash, will likely mean that sufficient management actions will not occur in all stands prior to EAB becoming established in Minnesota. Forested sites will be altered or lost.
- Little is known through research and experience how to maintain black ash forested sites as forested communities once the black ash is killed or removed. On-going research and knowledge gained through experience that can be passed along to all managers are critical to meeting long term ash management objectives. Therefore, this document presents interim guidance that will change as knowledge from research and experience is gained.

MANAGING FORESTED STANDS WITH ASH

1. INTERIM DIRECTIVE FOR ALL STANDS WITH ASH

The current scientific evidence does not support investments in artificial regeneration of ash species or management practices implemented to expand or regenerate ash populations. These activities could also compromise efforts to protect sensitive wetland ecosystems through canopy diversification, reduce forest vulnerability and potentially compromise EAB response efforts.

A. Ash species should not be planted on DNR administered lands for ornamental, shade or reforestation purposes. In implementing forest management practices do not structure operations to intentionally favor the regeneration or reestablishment of ash

- Rationale: In order to avoid perpetuating habitat for EAB for future generations, the current objective is to diversify ash dominated plant communities now and into the near future.
- Actions
  - Do NOT plant ash seedlings on state administered lands or recommend ash seedlings for reforestation on private lands.
  - Do NOT use ash seed in the mix for direct seeding on state administered lands or recommend ash seeds for direct seeding on private lands.
  - Create conditions favorable for regeneration of non-ash tree species. Ash regeneration can be aggressive, particularly from stump sprouting; chemical application may be necessary to reduce ash on some sites.

B. Prioritize opportunities to implement management practices in stands with ash immediately irrespective of EAB outbreaks.
- Rationale: Given the magnitude of the ash resource in Minnesota today, forest managers must make ash management a higher priority. The proximity of EAB and the uncertainty of knowing where EAB is currently infesting ash necessitate taking immediate actions to ameliorate some of the negative consequences that have been documented in other states.
- Actions
  a. Ash stands on the annual stand exam list should be scheduled for a management action that addresses the objectives above. Do not defer stands with ash for a later action. Schedule treatment as soon as possible.
  b. Work with the department's planning groups to revise SFRMP objectives and stand selection criteria to address the objectives listed above.

2. GUIDELINES FOR ALL STANDS WITH ASH

A. Reduce the stocking and average diameter of the ash component
- Rationale: Ash phloem is the larval food source for EAB. More phloem can support greater populations of EAB within any given area. The larger the tree, the greater potential to support higher EAB populations. Reducing the ash component may reduce future impacts and may help slow the spread of EAB.
- Actions
  a. Reduce the ash component to no more than 20% of current stand basal area.
  b. Focus on reducing the average diameter of the residual ash component. Focusing on reducing larger trees will be more effective than removing only poles and saplings. However, if scattered larger diameter trees are left to meet leave tree guidelines or wildlife considerations, remove a larger proportion of smaller diameter ash so that the overall average diameter of the residual ash is reduced from the average ash diameter before treatment.
  c. Leave other species as residuals during harvesting or regenerate other, non-ash species to maintain a forested cover.
  d. Use intermediate stand treatments that focus on a dominant thinning technique where larger trees are selected to be cut to reduce the size and amount of ash.
  e. Intermediate stand treatments are often precommercial. The cut material can be left on the forest floor if biomass opportunities are limited or non-existent. EAB will not utilize dead ash trees as host material. Leaving uninfested stems on the forest floor will not create EAB habitat.
  f. Multiple entries may be necessary. When non-ash reproduction is at least 2 - 3 feet in height, consider another ash reduction treatment.

B. Reduce the concentration of ash
- Rationale: A dispersed ash component can lessen the impacts to the stand by reducing the likelihood of EAB killing large areas of ash which may or may not have an understory of other tree species. Work to

create and maintain scattered ash throughout the stand rather than maintaining pure or nearly pure ash areas within the stand.

- Actions
  - **a.** In homogeneous ash areas, focus on thinning dominant and codominant trees where all ash above a prescribed diameter limit are cut resulting in a reduction in the size and number of ash in the stand. See basal area and diameter guidance above.
  - **b.** Use scattered ash in the stand to meet the basal area goal above rather than relying on pure ash areas to meet this goal.

C. Transition sites to a composition that favors non-ash species

- Rationale: Despite all management efforts, current experience seems to indicate that EAB will kill 99% of the ash in the stand regardless of ash tree size and spatial occurrence within the stand. The ultimate strategy must be to move stands away from ash and maintain the forest community by depending on other species.
- Actions
  a. Use the native plant community field guides to determine the growth stage and refer to *Silviculture Interpretation, Table PLS-2, Abundance of trees throughout succession* to identify favorable ingressing species. The DNR web site for ECS information is: http://www.dnr.state.mn.us/forestry/ecs_silv/interpretations.html
  b. Consider the regeneration strategies (tolerance) of non-ash tree species already on the site.
  c. If non-ash species are few or nonexistent, consider artificial regeneration. Try aerial seeding non-ash species as well as underplanting non-ash species even in the absence of any other kinds of stand treatment.
  d. Consider creating canopy gaps through hand felling or girdling to provide light conditions more suitable for the establishment of underplanted or seeded non-ash species. However openings greater than 60 feet in diameter may encourage ash regeneration.
  e. Use the NPC tree table, *Silviculture Interpretation Table R-1, Suitability ratings of trees,* to select non-ash species best adapted to the site.

3. ADDITIONAL GUIDELINES FOR BLACK ASH

A. Protect the hydrologic functions of the site to maintain a tree cover

- Rationale: The guiding principle for all black ash management decisions is to protect the hydrology of the site. Black ash, because of its abundance on some sites, often controls water levels in the stand. If the black ash is cut or die off, water levels often increase and there is a chance sites will convert to wet meadows or become dominated by alder. The greatest concerns are black ash communities classified in the wet forest system (WF).
- Actions
  a. Use the Native Plant Community information along with stand site index to help guide management decisions. The greater the site index, the more flexibility in applying a management treatment that will not cause long-term alteration of the site.
  b. General site index guidance:
    - SI = <45: Avoid all forest management actions. Do not spend resources on these sites.
    - SI = 45-55: These sites may provide limited forest management opportunities. Extreme care must be taken on these sites when trees are harvested. These sites are appropriate candidates for understory planting or direct seeding of non-ash species.
    - SI = >55: Consider management for timber with the cautions listed below for specific NPCs. Ash reduction, salvaging, and regeneration by planting, underplanting, and direct seeding to non–ash species may be appropriate. Use the NPC tree table, *Silviculture Interpretation Table R-1, Suitability ratings of trees,* to select non-ash species best adapted to the site.

c. When working in black ash stands, always monitor treatment results and apply lessons learned to future black ash management opportunities.

B. Precautions for specific native plant communities at risk

The following communities are at risk for hydrologic damage if the tree cover is significantly altered. Generally, management actions should be lightly applied, and follow up monitoring is mandatory.

WFn55 – Northern Wet Ash Swamp

a. When there is substantial aspen or balm of Gilead (bam) in the stand, use partial harvesting techniques such as 2-step shelterwood and strip clearcut, or use dominant thinning when the stand is not merchantable. Suckering aspen and bam will help avoid swamping the site.
b. When substantial aspen or bam is lacking,
- Stands with a site index of 55 or greater, partial harvesting and dominant thinning are possible. However, extreme care should be taken by removing not more than 50% of the basal area at one time.
- Stands with a site index under 55, avoid harvesting and intermediate stand treatment but consider establishing non-ash species.

c. Underplant or aerial seed appropriate species listed in the NPC tree tables, *Silviculture Interpretation Table R-1, Suitability ratings of trees,* to select species alternates to ash. Browse protection will be necessary.
d. In the absence of any harvesting or intermediate stand treatments, consider hand felling or girdling to create gaps for the establishment of non-ash species.

WFn64 – Northern Very Wet Ash Swamp

a. Avoid harvesting or intermediate stand treatments.
b. In lieu of any harvesting, consider underplanting or aerial seeding appropriate species listed in the NPC tree tables, *Silviculture Interpretation Table R-1, Suitability ratings of trees,* to select species alternates to ash. Browse protection will be necessary.
c. Consider creating small gaps by hand felling or girdling when underplanting and seeding.

WFs57 – Southern Wet Ash Swamp

a. This is a rare community often found near springs, mostly in rugged topography of the Blufflands Subsection and along the tributaries of the Minnesota and St. Croix rivers.
b. Avoid any harvesting or intermediate treatments in or immediately adjacent to these communities. Allow other tree species to naturally seed or develop in the understory.

Family Forest Landowners Guide for Ash Management

Educating the public and communities throughout Minnesota about emerald ash borer is a high priority, but educational resources for family forest landowners are lacking at this time. University of Minnesota Extension in a joint effort with other agencies is currently working to develop the Family Forest Landowners Guide for Ash Management.

Project facilitators Angie Gupta and Julie Miedtke using the Delphi process put together an expert panel of 39 knowledgeable representatives from agencies and other stakeholders groups in Minnesota. Three rounds of survey type questions were developed and sent to the members of the expert panel to gather recommendations. The first of these were sent out in November 2010. The third and final round is to be sent out in January 2011. The guide will be developed from these recommendations. Final printing of the guide is planned for June 2010.

Funding for the project is being provided through Renewable Resources Extension Act, Minnesota DNR Division of Forestry and Minnesota Forest Stewardship.

Black Ash Symposium

May 25-27, 2010

From registration web page

Covering more than 959,000 acres, black ash is a major species and forest type in Northern Minnesota, providing an important cultural and ecological resource as well as a variety of products. Black ash is the only native ash species that grows in pure stands. The ecological impact of emerald ash borer (EAB) will therefore be the most dramatic in black ash systems. This symposium will look at black ash from an environmental and cultural context. Latest research findings will be presented. Management strategies of black ash systems prior to, during, and after EAB invasion will be presented. The overall focus will be to address the challenges facing resource managers responsible for the management of black ash forest types. 16 CEU's will be awarded for attendance.

The list of presenters includes Lee Frelich (UMN), Tony D'Amato(UMN), Andrew Storer (UMichigan), Daniel Herms (Ohio State), Louis Iverson (USFS-NRS), Brian Palik (USFS-NRS), Steve Katovich (USFS-SPF), Mike Benedict (BIA), Mark Abrahamson(MDA), Keith Jacobson (DNR) and several more excellent speakers.

The symposium is sponsored by the Minnesota Forest Resources Council, USDA Forest Service, Minnesota Department of Natural Resources and the Minnesota Forest Resources Partnership. It will be held on the campus of Bemidji State University, Bemidji, Minnesota, in the Beaux Arts Ballroom.

Goals of the conference are to increase understanding of:

- Ecology of black ash and it's cultural significance in northern Minnesota
- Anticipated effects and impact of EAB on native plant communities that contain black ash.

- Status of current and ongoing research.
- Range of forest management strategies that can be applied prior to (creating resilience), during (slowing the spread), and after (restoration) invasion by EAB in black ash systems.
- Utilization and markets for various black ash products.
- To provide land managers up-to-date information on EAB and ash management strategies.

Symposium Schedule:

On Tuesday and Wednesday, invited speakers will present their information in lecture format in the Beaux Arts Ballroom at Bemidji State University. Both days will start at 8:00 and finish before 5:00 PM. The optional Tuesday evening session provides an opportunity for further discussion of the day's issues, and hear presentations by Kelly Church and Jennifer Neptune (see agenda) in an informal setting with refreshments.

On Thursday, we will hold an optional field trip to the Chippewa National Forest. There, we will examine silvicultural options for three black ash stands in the morning, and have a panel discussion on management prescriptions by agency representatives after lunch. We will return to Bemidji by 2:30 that afternoon.

Publication:

Following the Symposium, proceedings will be posted on this website, containing papers form authors giving oral presentations.

http://www.fs.usda.gov/wps/portal/fsinternet/!ut/p/c4/04_SB8K8xLLM9MSSzPy8xBz9CP0os3gDfxMDT8MwRydLA1cj72DTUE8TAwjQL8h2VAQAMtzFUw!!/?ss=110903&navtype=BROWSEBYSUBJECT&cid=stelprdb5167294&navid=091000000000000&pnavid=null&position=Not%2520Yet%2520Determined.Html&ttype=detailfull&pname=Chippewa%2520National%2520Forest-%2520Home

Black Ash Symposium: Presenters, titles, and a few notes		
Lee Frelich Director of MN Center for Hardwood Ecology Univ. of Minnesota St. Paul, MN	Ecology and distribution of black ash in Minnesota forests	Distribution and abundance of black ash in MN based on Forest Inventory Analysis (FIA) data. The ecological roles of black ash in temperate and boreal forest ecosystems. Species associated with black ash, including trees, herbaceous plants and wildlife. Potential ecosystem changes that may occur if black ash is removed from forest ecosystems. Growth study: Best black ash growth (ring width) occurs in vernal pools. In black ash lowlands, black ash roots share hummocks with sedges and other forbs. Forbs and shrubs are main competitors, not other black ash. As black ash dies off beware of invasive plants, especially, reed canary grass, glossy buckthorn and hybrid cattails.
Brian Palik Research Ecologist USFS Northern Research Sta. Grand Rapids, MN	Black ash decline in northern Minnesota: Will emerald ash borer really make a difference?	Black ash decline is ongoing and extensive in parts of northern Minnesota. In many stands, there is little evidence for regeneration of healthy black ash or for successional replacement by other tree species. EAB invasion may only further an already severe decline and hasten retrogression to a shrubby or open condition. Black ash is a resource "in crisis"; 18% increase in mortality between 1990 and 2003. Study of 55 stands: 53% healthy, 38% with dieback, 10% dead. More dieback found in wetter stands or older stands or both. Lots less ash regen in stands with dieback, so saplings are not replacing dead and dying ash trees. Silvi recommendations: Choose sites with healthy black ash regen on drier sites to work in. If planting or establishing, work during droughty years (Wisc DNR is having success with this).

Mike Benedict Acting Regional Forester BIA Midwest Regional Office Ft. Snelling, MN	Cultural and economic importance of black ash for native Americans.	Black ash has and continues to be an important part of the culture and economics throughout its range for utility and decorative baskets. Until recently there has been little interest to study or manage this species for either commercial or ecological purposes. However, within the last twenty years, there has been interest by tribes to learn more about black ash's ecology. Their interest is in developing silvicultural guides to better manage dwindling supplies of quality basket logs available locally to basket makers. Best black ash trees for basket making are found in vernal pools (agrees with ecologists). An ideal tree = open grown, on hummocks, rings have thickness of a nickel, min diam is 6", age 40 to 80, recent 10-20 years with good growth and defect free. In MN, very small usage: ranges from 2 to 150 trees/yr/ basket maker.
Louis Iverson Research Landscape Ecologist USFS Northern Research Sta. Delaware, Ohio	What next? Potential species replacements for black ash in northern Minnesota in a changing climate	Current black ash distribution and abundance, along with the other ashes in North America will be reviewed based on USFS Forest Inventory data. Suitable habitat for black ash was modeled for the current time and under various scenarios of climate change for ~2040, 2070, and 2100. These scenarios include two carbon emissions scenarios and three global circulation models. Assessments of potential changes of current co-occurring species and additional species co-occurring with black ash to the south (e.g., Ohio) will also be evaluated, resulting in potential species mixes that will be suited for the area under a changed climate. Models show that, by 2100, acreage suitable for black ash will decrease by 50%. Green ash will have little change.
Steve Katovich Entomologist USFS State & Private Forestry St. Paul, MN	The status of emerald ash borer in North America	Emerald ash borer (EAB) was first reported in North America in the Detroit area in July of 2002. Unfortunately, the initial introduction had likely occurred in that area 8-10 years earlier and by 2002 EAB was already infesting the vast majority of ash trees over an extensive area around the Detroit epicenter. This presentation will chronicle the expanding range of EAB in North America. In addition, the current understanding on the life cycle and basic biology of EAB will be discussed. Signs and symptoms of an infestation will be shown. Insecticides are primarily killing adults as they feed on ash leaves, not the larvae inside the tree. Has implications for treating most of living ash trees in a small area.

Daniel Herms Assoc. Chair of Dept. of Entomology Ohio State University Wooster, Ohio	Ecology of EAB invasion on forest communities: Susceptibility to invasion, ash demography and indirect ecological impacts	Patterns of ash mortality, seed bank dynamics, and regeneration in forests of the Huron River Watershed southeast Michigan since 2004 suggest a highly precarious future for ash. Effects of community composition on susceptibility to invasion reveal little potential for silvicultural approaches to EAB-proofing ash stands. Effects of ash mortality on canopy gap dynamics, course woody debris, and native fauna suggest that indirect ecological impacts of EAB will be pervasive. 38 stands near Detroit along Huron River: Found no potential to use silviculture to prevent EAB establishment and ultimate death of ash trees. Woodpecker predation is about 50%. Normally, ash has "mast years", so a lot of seed goes into seedbank. EAB-killed stands do not have an ash seedbank; need to seed or plant for reestablishment of trees. Established ash saplings will survive for quite awhile, but as they reach 1 inch diam, they are killed by EAB.
Kathleen Knight Research Ecologist USFS Northern Research Sta. Delaware, Ohio	Dynamics of emerald ash borer infestation, ash mortality, succession, and invasive plant species in infested forest ecosystems: What we've learned in Michigan and Ohio	How fast does a forest stand of ash trees die? What replaces them? What spatial and temporal patterns of emerald ash borer infestation and ash mortality occur in ash stands? Models and results from five years of data from ash monitoring plots across Ohio and Michigan provide insights into the potential effects of EAB in Minnesota. AS EAB invades a stand and starts showing dieback symptoms. Percent mortality found at yr=0, year1 = 20% mortality, yr2 = 31%mort, yr3=73%mort, yr4=92%mort, yr5=99% mort. Aftermath of EAB: 99.9% of ash trees killed; 0.1% survive. From these, scion materials have been gathered for research (resistance and genetics-see later talks). To prevent invasive plants, ash stand must have existing mid-canopy of other species, so light cannot get to forest floor. Suggests planting/ creating them.
Andrew Storer Entomologist Michigan Tech. University Houghton, MI	Not beyond hope: EAB survivors in Michigan	In the core area of EAB impact in Michigan, living ash trees with full canopies can be found. This presentation will discuss the possible reasons for their survival and our research into those possibilities. In core area in Detroit, studying 203 trees found as individuals and as clusters. Studying physical and chemical characteristics of these trees. He anticipates keeping these trees in the population for seed production and limited reforestation. Storer feels that EAB is not going to kill 100% of the black/ green ash populations.

Louis Iverson Research Landscape Ecologist USFS Northern Research Sta. Delaware, Ohio	Modeling the risk of spread of EAB: Summer traffic is key	We have developed a model identifying risk levels for EAB infestation for Ohio and Michigan, based on roads and traffic density, human population density, basal area of ash, locations and size of campgrounds and wood products industries, and known locations of EAB. The model has two components, an 'insect flight' model that slowly diffuses EAB out from known locations, and an 'insect ride' model that allows for occasional outbreaks, especially in zones near high-traffic roads. We are creating such a model for Minnesota. Model is spatially explicit, so can be used for tracking and predicting EAB introductions and spread. In Ohio, summer traffic (campers) is key.
Jennifer Neptune Maine Indian Basket Makers Old Town, Maine and Kelly Church Grand Traverse Band of Ottawa Chippewa Hopkins, ME	Black ash basketry: demonstrations	An informal gathering to meet Symposium presenters and discuss EAB and black ash management. There will be a demonstration of black ash basket making and log pounding, as well as a discussion and display of black ash basketry by three Native American basket makers.
Andrew Storer Entomologist Michigan Tech. University Houghton, MI	Tools available for integrated pest management of EAB	An overview of the integrated pest management tools for EAB, including the impact of native parasitoids and the deployment of exotic parasitoids. The Ash Phloem Reduction strategy will be discussed in detail. Chinese parasitoids in China cause 84% mortality of EAB larvae. Current releases I Michigan, Indiana, Ohio and Chicago. North American parasitoids of Agrilus species are beginning to feed on EAB larvae, too. Use of insecticides can keep ash trees in forests and urban for many years. Emmamectin benzoate is best. Ash phloem reduction: can keep a few large trees or many small diameter. Many small diameter ash = maintain genetic diversity, reduces EAB pops and keeps healthy ash in the stands longer.

Tony D'Amato Silviculture and Applied Forest Ecology Lab Univ. of Minnesota St. Paul, MN	Silvicultural options for black ash communities in the face of EAB	This talk focused on outlining silvicultural approaches for managing black ash communities to increase resilience to EAB. In particular, discussions will center on potential alternate tree species to encourage across site types, regeneration methods to minimize hydrological impacts, and the applicability of different silvicultural treatments across the range of site conditions in which black ash is found. Silvi goal is to maintain forest cover by building site-level resistance on lowland sites and reducing EAB spread and impacts on all sites. Ash is keystone species in lowlands – so lots to lose. Focus on maintaining site hydrology. Mgt strategies for even aged mgt: create small gaps for natural regen (no larger than ¾ ac); plant alternate species (increase species diversity - use ECS suitability tables); plant in fall into hummocks and shoulders of existing ash trees; work in WFn55 will be easier than WFn64; try nurse crop with shelterwood approach; develop a mid-canopy of q. aspen, cedar, tamarack and yellow birch; during release tmt, reserve ash stump sprouts, clusters of regen and ash trees with good shoulders; will be expensive. For uneven mgt: use group or patch selection to get mid-tolerants (tamarack in intolerant). Remember that invasives could be a problem. Strongly supports ash phloem reduction; D'Amato cautions land managers that they must plan for and deal with these additional issues: removes the water-pumping trees on the site (hydrological problems will result), removes most vigorous trees (may affect site genetics), has no provisions for ash regen, improving quality, and, preventing invasion by invasives.
Steve Katovich Entomologist USFS State & Private Forestry St. Paul, MN	SLAM – An Integrated Strategy To SL.ow A.sh M.ortality In Emerald Ash Borer Outlier Sites	SLAM is an integrated strategy designed to suppress EAB population growth and delay the onset and progression of widespread ash mortality. Basically SLAM projects are intended to delay the onset and advance of ash mortality, thus buying time for land managers to take proactive steps in dealing with the impending loss of the ash resource. SLAM projects attempt to integrate EAB survey efforts, ash surveys for distribution and amount, population suppression tools and tactics, regulatory activities, data management and evaluation, and outreach and communications. Pilot projects are being evaluated at sites in the Upper Peninsula.

Keith Jacobson Utilization & Marketing MN Dept. Natural Resources St. Paul, MN	Black ash markets in Minnesota	Markets for wood products have a tremendous impact on our ability to manage forest resources. The presentation will give an overview of current black ash markets in Minnesota, along with a look into the "crystal ball" of likely future markets and market opportunities. The presentation will also give an overview of marketing resources available to resource managers and landowners. A U&M plan for MN is being prepared by Keith's group. Marketing and utilization of ash will be a challenge. Also recall that quarantines will have an impact on wood transportation and processing.
Mark Abrahamson EAB Project Manager MN Dept. of Agriculture St. Paul, MN	Impact of state and federal quarantines on forest management	When EAB is discovered in a new area, state and federal quarantines follow closely behind. This presentation will cover the quarantines and regulations that will likely follow the discovery of EAB in northern Minnesota. A "find" is the tip of the icebeg. If find an ash tree with 1 woodpecker "pecks" during the winter, the tree is likely infested and will produce a crop of adults that summer. So, do sanitation removals every year. Keep in contact with MDA and know how to access compliance agreements that loggers must have in order to move the logs, slash or chips across county lines.
Jennifer Koch Research Biologist Northern Research Station Delaware, Ohio	The search for resistance to EAB: Can breeding be used to develop EAB-resistant North American ash species?	Efforts to identify sources of EAB-resistance to be used in breeding programs will be discussed including attempts at developing hybrids with Asian species of ash. The possibility of some level of EAB-tolerance existing in native ash species will also be introduced. Using Storer's 203 trees for research into genetics of tolerance and resistance in green and black ash. Breeding work for the same.
Paula Pijut Research Plant Physiologist USFS Northern Research Sta. West Lafayette, IN	Development and conservation of *Fraxinus* spp. with resistance to the emerald ash borer	Development of adventitious shoot regeneration, micropropagation, rooting, regeneration of plants to the greenhouse and field, and genetic protocols for propagation and conservation of *Fraxinus* spp. with resistance to the emerald ash borer.Using advanced genome technologies to mass produce green and black ash seedlings from freezer stored seed (USFS project-see below) and from Koch's lab (see above). Will be used post-infestation for possible restoration work.

Robert Karffalt Director of National Seed Lab USFS National Seed Lab Dry Branch, GA	Ash seed collection protocols for the National Seed Lab for the preservation and restoration of the species.	The National Seed Laboratory is assembling range wide seed collections of all ash species to preserve genetic diversity for use by ash breeders and researchers seeking solutions to the EAB problem. GIS data mapping of preservation efforts, seed collection, handling, testing and storage protocols will be presented. The work is in cooperation with the Agricultural Research Service, Natural Resource Conservation Service and numerous other partners.
Rick Klevorn Silviculturist MN Dept. Natural Resources St. Paul, MN	During Field trip: DNR Forestry guidance for black ash silviculture	Draft form of Black ash guidance document will be available from the DNR-Silviculture Program. MN DNR will be working on cooperative field studies with USFS and Michigan and Wisconsin DNR's.

Latent *Diplodia* infections in red pine seedlings from Badoura and Gen. Andrews Nurseries in 2010

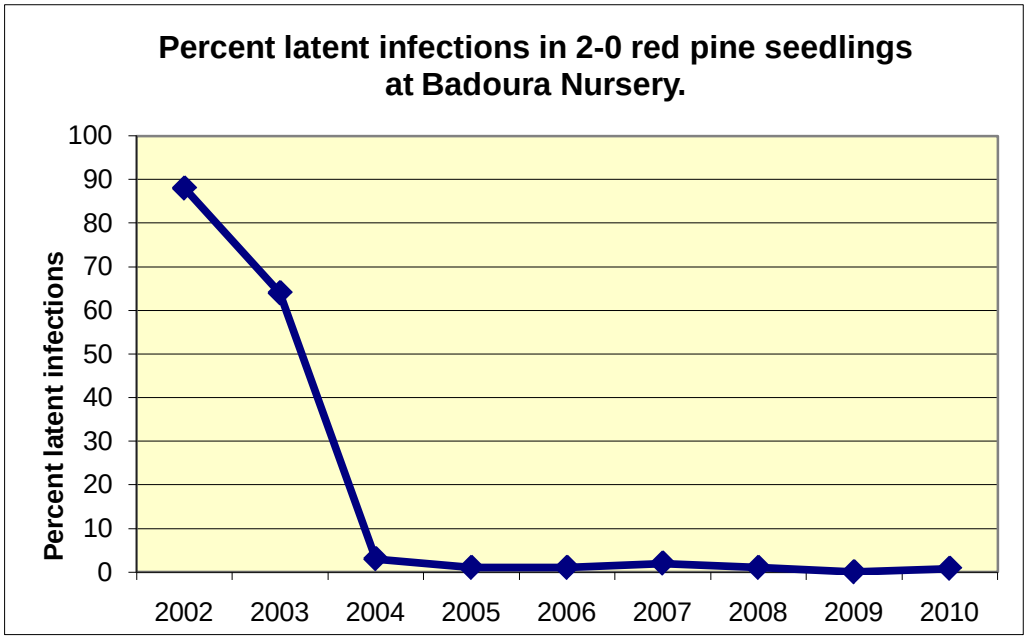
In an effort to monitor the amount of latent *Diplodia* infections that occur in red pine seedlings produced by the State Nurseries, surveys were completed at Badoura and Gen. Andrews Nurseries. The 2-0 and 3-0 seedlings were sampled in a systematic design and were assayed for the presence of *Diplodia* spp. by Dr. Stanosz's lab at the University of Wisconsin.

From Badoura Nursery, 260 seedlings were collected on September 20th .

Badoura	# positive	# sampled	% infected
2-0	1	115	0.8
3-0	3	135	2.2
All RP	4	250	1.6

Badoura Nursery: 250 seedlings collected and assayed

Field	Beds sampled and location in bed	Number of seedlings assayed	Seedling size	Location of positive seedlings	Total # positive	Ave. percent latent infection per seedling size
E-10	9N,10M,11S,13N, 14M, 15S,17N, 18M, 19S	45	2-0		0	0.8 %
F-12	1N,2M,3S,6N 7M,10N, 11M,12S,14N,15M, 17S,18N,19M	70	2-0	8S	1/5	
E-12	1S,4N,6M,7S,15N, 17M,18S,20N	40	3-0	7S	2/5	2.2 %
F-5	8N,9M,10S,12N, 13M,14S,17N, 18M,19S	45	3-0		0	
F-10	6N,7M,8S,10N, 11M,12S,14N,15M, 17S,18N	50	3-0	18N	1/5	

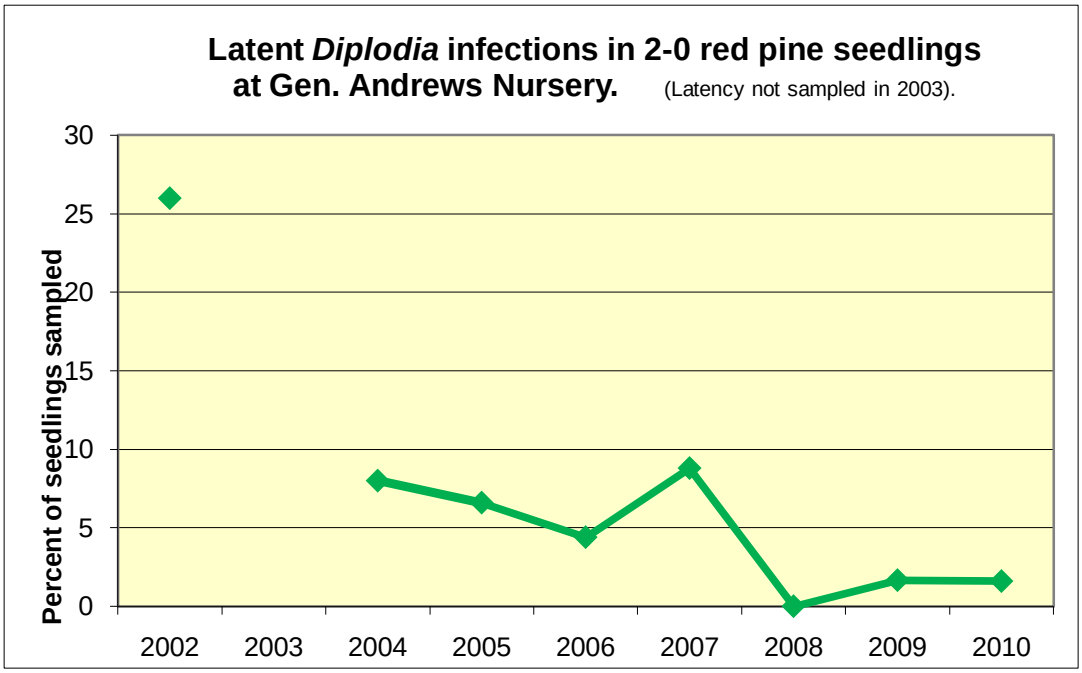


From Gen. Andrews Nursery, seedlings were collected on September 22nd .

Gen. Andrews	# positive	# sampled	% infected
2-0	1	60	1.6
3-0	6	180	3.3
All RP	7	240	2.9

General Andrews Nursery: 240 seedlings collected and assayed

Field	Beds sampled and location	Number of seedlings assayed	Seedling size	Location of positive seedlings	Total # positive	Ave. percent latent infection per field
D-1	25N,26M,27S,29N, 30M,31S,33N,34M, 35S	45	2-0	29N	1/5	1.6 %
D-2	5N,6M,7S	15	2-0		0	
G-2	5E,6M,7W,9E,10M, 13E,14M,15W,17E, 18M,19W,21E,22M, 23W,25E,26M,27W, 29E,30M,31W	105	3-0	18M 22M	1/5 1/5	3.3 %
G3	15E,16M,17W, 19E,20M,21W,23E, 24M,25W,27E,28M, 29W	60	3-0	29W	4/5	
	31E,32M,33W	15	2.5-0		0	



A model for the risk of EAB spread in Minnesota

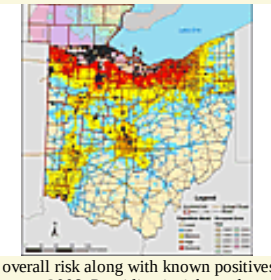
Emerald Ash Borer (*Agrilus planipennis*, EAB), an invasive insect native to Asia, is responsible for killing millions of ash (*Fraxinus*) trees throughout much of the Midwestern USA. It was first discovered near Detroit, Michigan in June of 2002, most likely imported in pallets in the early 1990s. Detection of EAB infestations is difficult when trees are first attacked, showing few signs that EAB is present. However, healthy ash trees are killed in 2-4 years. Outlier colonies also make tracking the natural spread of the insect difficult, since they are often attributed to human activities. Predicting where EAB will likely spread to can be a challenging process as they can use several human assisted means to spread to ash trees in outlier zones beyond its inherent flight capability.

Dr. Louis Iverson and co-authors at the USFS-NRS in Ohio have modeled the risk of spread for EAB in Ohio using a stochastic, spatially explicit cell-based model which incorporates the insect's flight characteristics (Insect Flight Model) and external agents that enable EAB to "hitch a ride" (Insect Ride Model). The Flight Model calculates the risk of spread for any 270m-cell based on the basal area of ash within the cell (ash abundance) and estimates of EAB abundance based on the years since infestation. The model assumes EAB will kill all ash trees within a cell in 10 years after the initial detectable infestation. The Insect Ride Model weights the road network, wood products, population density, and campground information in a GIS and uses an ash abundance multiplier that alters the ash abundance input to the model. We combine both the Flight and Ride Models to yield a map of EAB Risk that is corroborated by detection trees and trees that have been confirmed infested.

Map of risk due to insect flight.

Map of risk due to human -assisted movements.

Map risk of potential spread from EAB flight or riding.



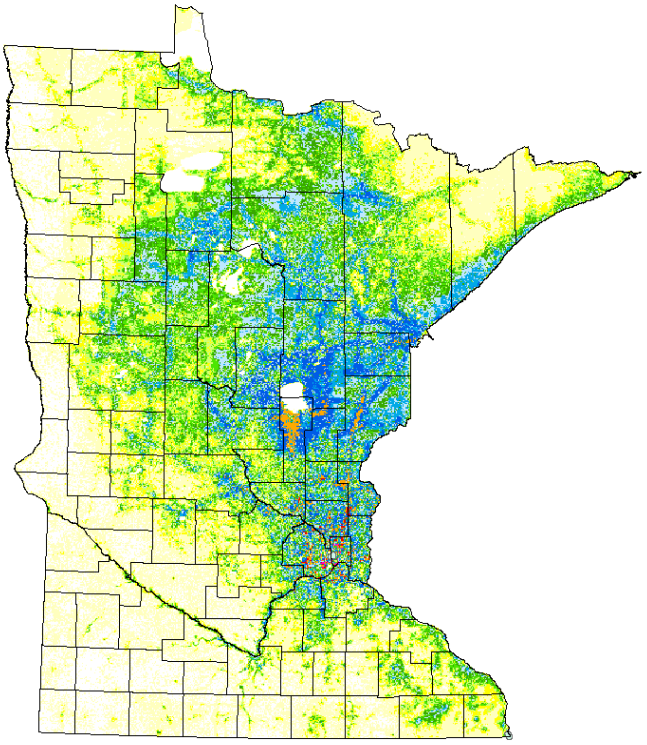
Map of overall risk along with known positives as of January 2008. Providing insight to the mechanisms that create outlier colonies. Road networks are critical.

In 2009, Dr. Iverson and his co-authors agreed to create a similar model for Minnesota if we could provide the basic layers (ARC shapefiles and metadata) that would populate the model. During 2009 and 2010, these layers were created and additional layers were requested by Dr. Iverson. In late 2010, the preliminary model was completed from 10 of the 12 layers needed. See map and list of layers on next page. In early 2011, the last layers, ash abundance in 700 communities based on the 2010 survey and State Park visitors by home zip code, will be created and incorporated into the model. The scale used to develop the data layers will allow us to use the model at multiple spatial scales, from the statewide level down to the township level. We feel that this model will benefit agencies that regulate invasive pests, agencies that manage rural and urban forests, local units of government, public outreach providers and affected landowners.

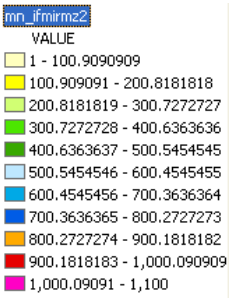
The spread model can be used for three purposes in Minnesota. First, it can be used as a map to track the actual spread of EAB from its points of introduction on an annual basis. Since the model is spatially explicit, it would aid on-the-ground tracking and management of EAB as well as facilitate the study of new EAB introductions. Second, the model can be used dynamically at the multi-township level to determine the locations and areas most at risk from EAB spread whether EAB is currently there or not. We anticipate using this model during inter-agency planning exercises this year to evaluate alternative detection and management strategies for new introductions. Third, as a wave of EAB passes through, managers will begin to formulate rehabilitation plans when the greatest flexibility exists for those activities. Knowing where the losses will occur and how much will be lost will aid forest managers, land owners and city planners in developing reforestation plans and watershed restoration plans.

Text and maps backed in tan are derived from:
http://nrs.fs.fed.us/disturbance/invasive_species/eab/risk_detection_spread/modeling_eab_risk/

Preliminary risk of EAB spread model – 2010.
By Iverson,et al



Note: legend is indexed. Yellow is least risk and magenta is most risk.



Layers and metadata supplied/ needed for Minnesota model	
Layers supplied to Iverson	*Source*
Ash abundance 30m data	Res. Assess. and Ty Wilson-USFS
EAB trap locations 2009	MDA
EAB positive trap locations 2009	MDA
Campground locations – all types of owners	Res. Assess.
Wood product industries using ash	DNR- Utiliz & Marketing
Biomass energy locations	DNR- U & M
Human population density by zip codes	Res. Assess.
Transportation network and traffic densities	Res. Assess.
Locations of declining ash stands	Res. Assess. and For. Health
Firewood vendors by zip codes	Res. Assess. and For. Health
Layers needed to update initial model (Jan.2011)	*Source*
State Park visitors by home zip code	Res. Assess & Ed Quinn, Parks & T
EAB trap locations 2010	MDA- Mark Abrahamson
EAB positive trap locations 2010	MDA-Mark Abrahamson
Municipal ash densities (2010 study)	Res. Assess. In-house data set

Prasad, A., L. Iverson, M. Peters, J. Bossenbroek, S. N. Matthews, D. Sydnor, and M. Schwartz. 32767. Modeling the invasive emerald ash borer risk in Ohio, USA it's mainly about roads. Landscape Ecology. doi10.1007/s10980-009-9434-9

Iverson, Louis R.; Prasad, Anantha M.; Sydnor, Davis; Bossenbroek, Jonathan; Schwartz, Mark W.. 2006. Modeling potential Emerald Ash Borer spread through GIS/cell-based/gravity models with data bolstered by web-based inputs. In: Mastro, Victor, et. al., comps. Emerald Ash Borer research and technology development meeting; 2005 September 26-27; Pittsburgh, PA. FHTET-2005-16. U.S. Department of Agriculture, Forest Service, Animal and Plant Health Inspection Service: 12-13.

Iverson, Louis R.; Prasad, Anantha; Bossenbroek, Jonathan; Sydnor, Davis; Schwartz, Mark. 2006. Modeling potential movements of the emerald ash borer in Ohio. In: Mastro, Victor; Lance, David; Reardon, Richard; Parra, Gregory, comps. Emerald ash borer and Asian longhorned beetle research and technology development review meeting; 2006 October 29-November 2; Cincinnati, OH. FHTET-2007-04. U.S. Department of Agriculture, Forest Health Technology Enterprise Team, Morgantown, WV:

Minnesota DNR Firewood Program Update

The DNR firewood program was established in 2007 after the firewood statute was approved; allowing the DNR to restrict firewood entering DNR administered lands. The goal of the new statute and the firewood program was to 1) reduce the risk of introducing damaging invasive species onto public lands and 2) change public behavior with regard to pathways of spread, in this case firewood.

The poster child for pests accidently moved in firewood is the emerald ash borer (EAB). But many other tree pests can be moved as well, including oak wilt, Dutch elm disease, Asian long-horned beetle, Sirex wood wasp, exotic decay or blue-stain fungi, thousand canker disease of walnut and many more. By enrolling Minnesota residents in the need to buy local or certified firewood, the program aimed to reduce the chance of moving these 'bad bugs' around. And based on staff observations and surveys conducted by the DNR and MDA, it looks like the program has accomplished one of its primary outreach goals – i.e. changing public behavior.

Initial surveys in 2008 indicated that over 40% of park visitors brought firewood with them, most often from home (often many miles from their camping site). A 2010 survey indicated that far fewer now follow that practice (19% of the 1200 recreationists surveyed). So in 2 years we have made great strides in encouraging behaviors among Minnesota recreationists that help sustain healthy forests.

In April 2010, Sue Burks took over as the program lead. Under her watch, program materials were updated and outreach efforts enhanced by revising the firewood webpage and adding several documents, such as detailed on-line instructions and answers to frequently asked questions for firewood vendors. Some internal data management issues were also addressed greatly reducing the number of complaints from firewood vendors, DNR staff and public firewood users.

Heading into 2011, we will be updating the Commissioner's Order that outlines the requirements for approved vendors. Current plans include expanding the list of those able to bring their wood onto DNR lands by including all vendors certified by Minnesota Department of Agriculture (MDA) using any federally approved method of treatment, not just heat treatment. That will expand the market of 'approved' wood and increase the availability of wood in some areas.

We also plan to drop the 'buffer' counties around the known infestations of EAB and rely solely on the EAB quarantine managed by MDA to address the risk of spread. That should greatly simplify the process of becoming a DNR approved vendor in the twin cities area and expand the list of DNR facilities at which wood harvested in those counties can be used.

The last planned change is to reduce the distance untreated wood can be moved from 100 miles to 50 miles. The original recommendation to the legislature back in 2006 was to use 50 miles as the basis of the program in order to keep local pests local. Based on the distribution of forest pests and their rate of spread, it's hard to defend wood moved a 100 miles as being truly 'local'. However, discussions at the time expanded that limit, and in the process reduced the potential to prevent accidental pest introductions. Recent work has clearly demonstrated that a 100 mile limit does not support program goals and that actually a 25 mile limit is more likely to succeed at reducing the risk of introduction. However, a 25 mile limit is likely to reduce wood available for some parks too much, so the plan is to go with a 50 mile radius. The end result will be to enhance the marketability of MDA certified wood which can be moved anywhere in the state, and keep untreated firewood close to home. Once the revised Commissioner's Order has been approved, outreach materials will be developed and vendors notified.

The 'First Detectors' Program

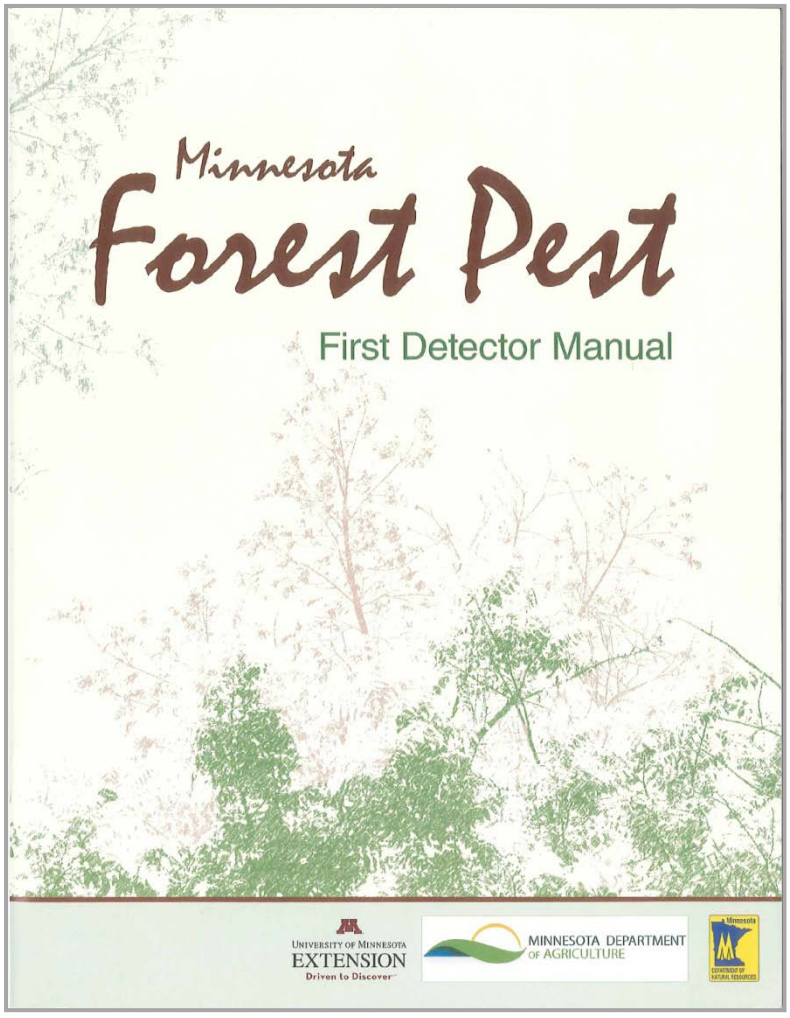
In late February and early March, experts with the Minnesota Department of Natural Resources (DNR), Minnesota Department of Agriculture (MDA), and University of Minnesota Extension offered the third round of workshops to teach tree care workers, community foresters and others the basics of how to tell destructive invasive forest pests from harmless doppelgangers. In the process, the state continued to build its established network of so-called "First Detectors" who help regulators spot infestations early.

The state agency partners offered six one-day workshops in St. Paul, Morris, Albert Lea, Brainerd, St. Cloud and Farmington, to provide in-depth information on identification of invasive tree pests. After completing the training, participants were qualified to serve as volunteers in the state's First Detector Program. The idea behind the First Detector Program is to train people around Minnesota to know what to look for and who to call when they find symptoms of a suspected invasive pest. The sooner new infestations are identified, the better the chance of slowing their spread.

The role of the First Detectors is to serve as public contacts for information about these pests and to help investigate reports of potential infestations. The table below shows the number of calls to MDA's Arrest-the-Pest Hotline and how many of those calls were referred to First Detectors. The jump in calls in 2009 reflects the discovery of emerald ash borer in St. Paul that year in May.

Year	Arrest-the-Pest Calls	First Detector Referrals
2008	116	0
2009	>1800	228
2010	742	505

One hundred forty-four people attended the 2010 workshops (including two attendees from South Dakota), with 83 individuals agreeing to become First Detectors. The total number of individuals signed up to be First Detectors at the end of 2010 is 305, covering 64 out of 87 Minnesota counties.



MN Issues and Strategies for Forest Management-5 year Plan

"The 2008 federal Farm Bill (Title VIII: Forestry) sets out new priorities and planning standards for the USDA Forest Service (USFS) State and Private Forestry (S&PF) program and adjusts cooperative relationships for federal, state, and private forest systems. This effort, referred to as S&PF Redesign was in direct response to increased impacts on the nation's forests and decreased S&PF funds and resources. Under this new S&PF Redesign, all 50 states are required to analyze their forest conditions and trends in a *Statewide Forest Resource Assessment*. The bill recognized the need for forest planning by requiring the 50 states to complete the statewide assessment by June 2010, in order to receive federal funds under the Cooperative Forestry Assistance Act (CFAA).

Further, based on the statewide assessment, a "*Statewide Forest Resource Strategies"* document is also required, which is anticipated to become the foundation for formulating S&PF competitive project proposals and future guiding of S&PF program direction.

The 2008 Farm Bill establishes three new federal priorities for the S&PF program including the following national themes and objectives.

Conserve and Manage Working Forest Landscapes for Multiple Values and Uses
• Identify and conserve high priority forest ecosystems and landscapes
• Actively and sustainably manage forests

Protect Forests From Threats
• Restore fire-adapted lands and/or reduce risk of wildfire impacts
• Identify, manage, and reduce threats to forest and ecosystem health

Enhance Public Benefits From Trees and Forests
• Protect and enhance water quality and quantity
• Improve air quality and conserve energy
• Assist communities in planning for and reducing forest health risks
• Maintain and enhance the economic benefits and values of trees and forests
• Protect, conserve, and enhance wildlife and fish habitat
• Connect people to trees and forests, and engage them in environmental stewardship activities
• Manage trees and forests to mitigate and adapt to global climate change

Under the S &PF Redesign program, national and statewide forest resource assessments and strategies will be used to develop competitive proposals for S&PF funds. To receive these federal funds under the S&PF Redesign program, projects will have to follow the annual direction being developed by the USFS, and address directly one or more of the three national priorities as laid out above. To ensure that future S&PF resources are focused on high priority issues and areas, with the greatest opportunity for measured success, Minnesota continues to work collaboratively with neighboring states and the USFS to identify these key priority areas and identify landscapes where an investment of federal competitive grant funding, (future annual report of use of funds still being developed), can most effectively accomplish forest goals or leverage desired outcomes."

This document is Minnesota Forest Resource Strategies: Positioning the State of Minnesota for Forest Resources Sustainability 2010-2015. The following section can be found at this web address:
http://files.dnr.state.mn.us/forestry/subsection/mnForestResourcestrategies.pdf

The following table shows results for the Issue of Forest Health and Productivity.

Minnesota Issues and Strategies for Forest Management – 5 year Plan

Issue: *Forest Health and Productivity*

Minnesota's forests and trees are critical to the ecological health and financial economy of the state. Ensuring healthy ecosystems, productive forests and quality trees exist well into the future is a collaborative goal between federal, state, tribal and county agencies, and community partners both public and private, throughout the state.

→This issue relates to the USFS National Themes and Objectives: Conserve and Manage Working Forest Landscapes for Multiple Values and Uses; Protect Forests From Threat; Enhance Public Benefits From Trees and Forests

Strategy	Key Stakeholders	Partners	Resources
Identify high-risk, low-volume stands and create prescriptions to increase stocking and health	Public and private forest landowners, tribes	USFS,DNR, counties, industrial landowners, NIPF, U of M, SWCD, BIA, tribal natural resources departments	FMIA, Bonding, LSOHC, LCCMR, FSP
Reduce average age of even-aged managed cover types and promote vigorous young forest stands through harvesting	Public and private forest landowners, tribes	DNR, Counties, USFS, Industrial landowners, NIPF, U of M, SWCD, BIA, tribal natural resources departments	FMIA, Bonding, LSOHC, LCCMR, FSP
Develop and maintain a better balanced and complete age class distribution for plant communities managed primarily with even-aged silvicultural systems, while at the same time allowing some stands to transition to older growth stages	Public and private forest landowners, tribes	USFS,DNR, counties, industrial landowners, NIPF, U of M, SWCD, BIA, tribal natural resources departments	FMIA, Bonding, LSOHC, LCCMR, FSP
Thin overcrowded stands to improve vigor and reduce competition	Public and private forest landowners, loggers, industry, tribes	USFS,DNR, counties, industrial landowners, NIPF, U of M, SWCD, BIA, tribal natural resources departments	FMIA, Bonding, LSOHC, LCCMR, FSP
Match tree species and management techniques to individual sites through use of Ecological Classification Systems (ECS)	Public and private forest landowners, tribes	DNR, Counties, USFS, industrial landowners, NIPF, U of M, SWCD, BIA, tribal natural	FMIA, Bonding, LSOHC, LCCMR, FSP
		resources departments	
Promote species diversity in community and urban plantings	Public and private forest landowners, communities, tribes	DNR, USFS, MnSTAC, U of M, SWCD	Bonding, LSOHC, LCCMR, SWCD, $, technical assistance
Use eradication, suppression, and outreach to respond to new and expanding EAB and gypsy moth populations in the state.	Public and private forest landowners, communities, tribes	DNR, MDA, S&PF, USFS Nat Forests, counties, APHIS-PPQ, SWCD, landowner groups, MFRC and MFRP, GMSTS, Co Ag Inspectors	Bonding, LSOHC, LCCMR, SWCD, $, technical assistance
Identify and develop partnerships with public/private stakeholders and community groups to develop the relationships and infrastructure needed to support integrated early detection and rapid response efforts, a collaborative prevention approach , and a unified outreach effort.	Public and private forest landowners, communities, tribes	DNR, MDA, S&PF, USFS Nat Forests, USFWS, BIA, Tribes, NPS, counties, APHIS-PPQ, SWCD, landowner groups, MFRC and MFRP	USFWS, NEPA, USDA, Bonding, LSOHC, LCCMR, SWCD, $, technical support
Develop new and expand existing markets for ash to provide the means and incentive to manage ash stands ahead of EAB infestation and to address ash mortality when EAB infests stands.	Public forest landowners and managers, wood industry	DNR, USFS, U of M, MFI, MLEP	Bonding, LSOHC, LCCMR, $, technical assistance
Encourage communities and local governments to formally inventory their ash resource on public and private lands so they know what is at risk and more effectively take preventative actions where needed.	Municipalities and private homeowners	DNR, MnSTAC, MDA, USFS, S&PF	Bonding, LSOHC, LCCMR, $, Technical assistance
Work with communities to help develop sanitation and utilization strategies.	Municipalities and private homeowners	DNR, MnSTAC , MDA, USFS, S&PF	Bonding, LSOHC, LCCMR, $, technical assistance
Implement EAB mitigation strategies in ash stands to maintain forested communities in predominate ash types at risk from EAB.	Public and private forest landowners, communities, tribes	DNR, MDA, USFS , S&PF, USFS Nat Forests, USFWS, BIA, Tribes, NPS, counties, APHIS-PPQ, SWCD, landowner groups, MFRC and MFRP, SWCD, MLEP	USFWS, NEPA,USDA Bonding, LSOHC, LCCMR, SWCD, $, technical support
Develop restoration guidelines for both urban and rural lands forests, and modify landowner assistance program to support restoration.	Public and private forest landowners, communities, tribes	DNR, counties, USFS, industrial landowners, NIPF, U of M, SWCD, BIA, tribal natural	FMIA, Bonding, LSOHC, LCCMR, FSP

		resources departments	
Work with private campgrounds, resorts, and other agencies to explore and implement the means to minimize the movement of unregulated firewood.	Resort and campground associations, MN citizens	DNR, MDA, Aphis-PPQ, USFS, NPS	Bonding, LSOHC, LCCMR
Work with public and private nurseries to explore alternatives to growing and planting ash and explore how to replace ash in large blocks of forests	MNLA, other private nurseries	DNR, MDA, USFS S&PF, U of M	Bonding, LCCMR
Explore revenue sources and opportunities to ensure EAB preventative efforts are adequately funded.	Public and private forest landowners, communities, tribes	DNR, MDA, USFS , S&PF, APHIS-PPQ, MnSTAC, MFRC , MFRP, Tribes	USDA, USFS, USFWS, Bonding, LSOHC, LCCMR $, Technical support
Support research into bio-control, chemical control, resistance, and "slowing the spread" for EAB and other threats.	Public and private forest landowners, communities, tribes	DNR, MDA, USFS , S&PF, APHIS-PPQ, USFWS, MnSTAC, MFRC , MFRP, GMSTS	USDA, USFS S&PF, USFWS, Bonding, LSOHC, LCCMR U of M, $, technical assistance
Develop risk assessment for oak wilt in MN and prioritize outreach efforts based on risk.	Public and private forest landowners, communities	DNR, USFS , S&PF, Aphis-PPQ, U of M	USDA, USFS S&PF, USFWS, Bonding, LSOHC, LCCMR U of M, $, technical assistance
Identify high-risk, low-volume stands and create prescriptions to increase stocking and health	Public and private forest landowners, communities, tribes	DNR, USFS, U of M, SWCD	USDA, USFS S&PF, USFWS, Bonding, LSOHC, LCCMR U of M, $, technical assistance

MN 2009 Oak Wilt Suppression & Site Monitoring Report; 349 Treatment Sites.

In 2009 DNR cooperators in 13 Minnesota communities collected efficacy data on 349 oak wilt treatment sites (21 miles of RGB line) treated in both 2007 and 2008. Efficacy results range from 95 to 100%!

Summary; Results and work plans.

Treatment Year/Sites	2007 (126 sites)	2008 (182)	2008 (41), City North Branch
2008	98%		
2009	95% (12 failures/5re-treatments)	98% (8 failures/5re-treatments)	100% (1 failures/1re-treatments)
2010	30% (38 sites to check)	All 182 sites	All 41 + 1st year for 2009
2011		30% (55 sites to check)	30% (2008) all 2009
2012			30% (2009)
RGB line (24+ miles)	37,432'/519 PSPT'S	75,829'/640 PSPT'S	15,276'/51 PSPT'S + 09

In 2008 the MN DNR Division of Forestry began monitoring intensively all of the 2007 treatment year, grant administered, oak wilt suppression projects (126 sites) within 13 Minnesota communities. The MN communities included Andover (Kameron Kytonen), North Oaks (Mark Rehder), Maplewood (Andy Hovland), Ham Lake (Nathan Ashford), Lino Lakes (Marty Asleson), Chicago County Soil and Water Conservation District (Jason Rehm), City of Columbus and Isanti County (Sam Klocksien), Mahtomedi and Lake Elmo (Kathy Widen), and Blaine (Mark Shippee). This field work was done in cooperation with the USDA Forest Service (NA, State and Private Forestry) using their recommended field protocol.

In 2009 we completed the second year of monitoring of the 2007 treatment sites and began monitoring additional treatment sites installed in 2008. In the 2007 treatment sites 37,432 feet (or 7 miles) of RGB (Root Graft Barrier) line was installed and 519 PSPT's trees were removed on time. In the fall of 2008 and with additional funds still available in the grants and with an existing extension of the grants for another year an additional 182 treatment sites were installed. The 2008 participating communities were Andover, Lino Lakes, City of Columbus, City of North Branch, Mahtomedi and Isanti County. This resulted in an additional 75, 829 feet (or 14 miles) of RGB line with an additional 640 PSPT's removed on time. The majority of this 2008 work took place in Isanti County and the City of Columbus (116 sites, Sam Klocksien) and city of North Branch (41 sites, Jason Rehm).

Methods: Inspectors from the above listed communities were trained and instructed to inspect all 2007 treatment sites using U. S. Forest Service field protocol. Infection centers were considered successfully treated if (1) there were no failures in the root graft barrier (RGB) line and (2) all potential spore-producing trees (PSPT's) were properly removed and disposed of.

In 2008 the efficacy data for the 126, 2007 treatment sites was roughly 98% with only a few sites to follow-up on. In 2009 the efficacy data for these 126, 2007 treatment sites was 95% (12 failures/5 re-treatments). The final field checks for 30% of these 2007 treatment sites will be conducted in August –September, 2010.
In 2009 the efficacy data checks for the 182, 2008 treatment sites, was 98% (8 failures/5 re-treatments). The second year field checks for these 182, 2008 treatment sites will be conducted in August –September, 2010, with the final check in 2011.

In 2008 an additional grant was awarded to the City Of North Branch, Minnesota. In this grant the City of North Branch is under contract with the Chicago County Soil and water Conservation District to administer the suppression program. This is a pilot project will attempt to implement suppression activities on an estimated 200 active oak wilt infection centers within the city over a 5-year treatment period. In 2008, 41 sites were treated, 15,276 feet of RGB line was installed and 51 PSPT's were removed on time. In 2009 post treatment evaluations were conducted on the 41 sites. This was the first year of efficacy checks. In 2009 the efficacy data for these 41 sites is 100% (1 failure/1 retreatment). As of December 2009 an additional 39 sites were treated in 2009. An additional 19,225 feet (or 3.64 miles) of RGB line was installed. Efficacy check will begin on these sites in 2010.

All site data is available in spread sheets by community. Contact Ed Hayes with inquiries.

The balance of the oak wilt cost share program to Minnesota communities is now over with the exception of the above City of North Branch which will make their final treatments in 2010 and continue monitoring through 2012.

Creating a GIS model to map oak wilt vulnerability and susceptibility in MN

As part of an effort to assess the effectiveness of oak wilt treatments in North Branch, an oak wilt model was created by Dennis Kepler, DNR-Resource Assessment, and Ed Hayes, Forest Health Unit, in 2009 and 2010. The original goal was to map oak wilt vulnerability in North Branch but that goal was modified to include a map of oak wilt susceptibility. As the model began to take shape, Kepler was also asked to project the model on oak forests occurring on larger blocks of land in south-eastern and east-central Minnesota.

The process and methodology were based on the 2006 National Risk Mapping effort which is documented in www.fs.fed.us/foresthealth/technology/pdfs/FHTET2007_06_RiskMap.pdf.

Vulnerability characterizes the degree to which a forested area may be harmed by oak wilt, given that it is locally established.

Susceptibility characterizes the likelihood of establishment and spread of oak wilt in a forested area where oak wilt is not currently established.

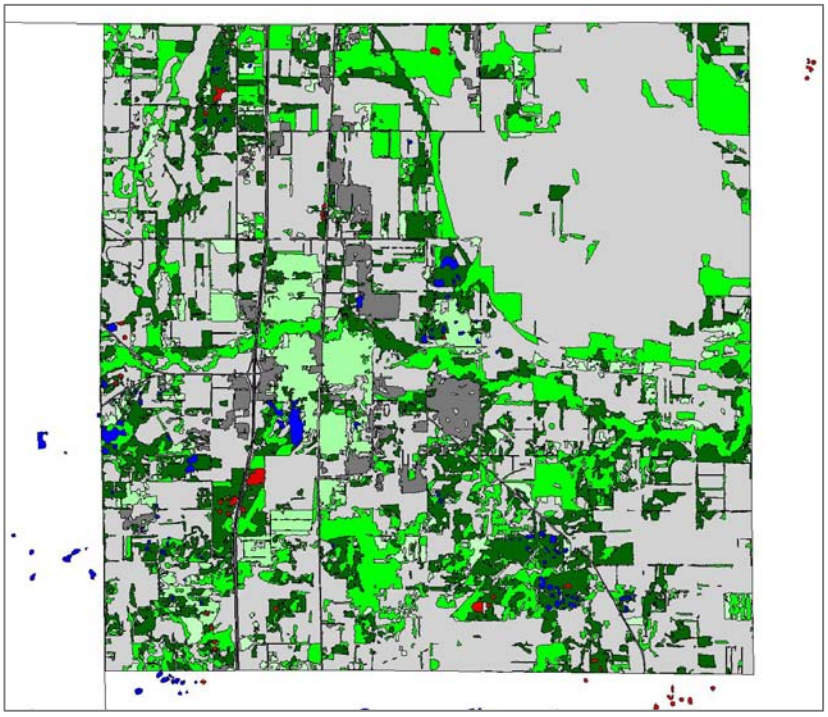
The base layers used include:

- 1991-1995 GAP Analysis data layer.
- 2001 National Land Cover Data canopy layer and deciduous forest layer.
- 1999-2007 Resource Assessment change detection layers for harvested sites.
- North Branch Oak Forest and Urban with trees data layer.
- Statsgo Soils layer for soil types and topography.
- State campgrounds and Metro region sites layers for recreational sites.
- DOT road layers for impervious surfaces.
- 2006 Oak Wilt with treated and untreated oak wilt sites indicated.

The base layer for oak wilt was 2006 Oak Wilt which was created from aerial and ground detection maps that were ground-truthed. Kepler randomly selected half of the 2006 oak wilt sites to be used in the model and other half for accuracy assessment.

The Forest Health Unit identified, ranked and weighed individual criteria that were used to determine the vulnerability and susceptibility to oak wilt. See tables on next page.

The final model was created in ARC-MAP and was distributed to the FHU in digital format. Model output included susceptibility and vulnerability maps for North Branch and southeastern and east-central Minnesota. Several examples can be found on the following pages.



Raw data for North Branch, MN.

Oak wilt 2006
- Active disease
- Treated disease

Covertype and land use
- Oak forest
- Other forest
- Urban forest
- Non-forest with trees
- Non-forest without trees
- Urban with no trees

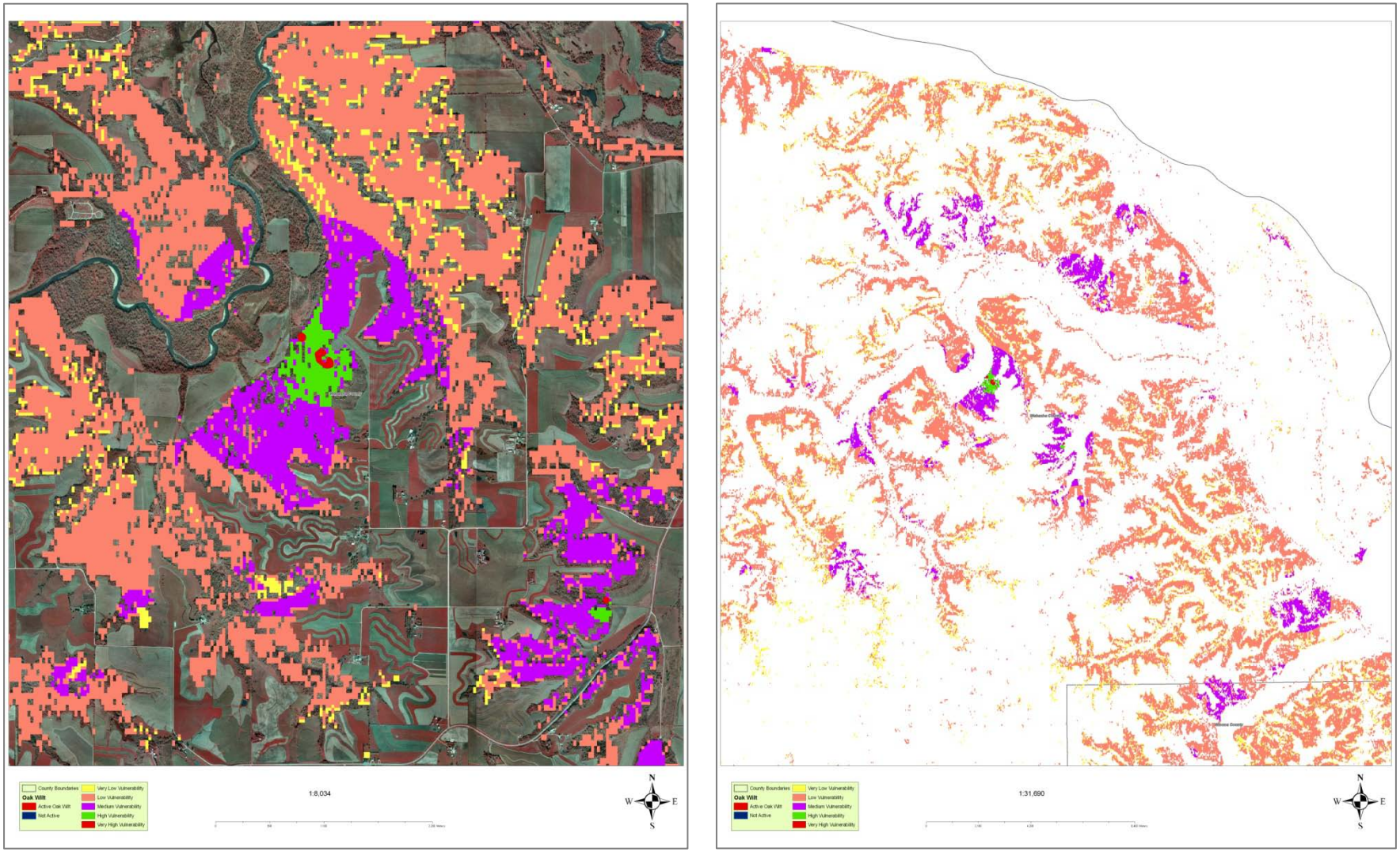
Multi-criteria/multi-objective decisions were used to evaluate the relative importance in determining the weighted values of Oak Wilt factors

Pairwise Comparison Matrix Assessing the Importance of Vulnerability Factors in determining the potential spread of Oak Wilt																	
Vulnerability to Mortality	**Pairwise Comparison Values**								**Weighted Values**								
Proximity to:	**OW**	**R/POak**	**Soils**	**Topo**	**Rec**	**FCDC**	**B/WOak**	**Imperv**	**OW**	**P/Roak**	**Soils**	**Topo**	**Rec**	**FCDC**	**B/WOak**	**Imperv**	**Ave. Weight**
Proximity to Oak Wilt	1.00	3.00	3.00	3.00	7.00	9.00	9.00	9.00	0.43	0.57	0.37	0.28	0.32	0.32	0.19	0.16	***33%***
Proximity to Red/Pin Oak	0.33	1.00	3.00	3.00	5.00	5.00	9.00	9.00	0.14	0.19	0.37	0.28	0.23	0.18	0.19	0.16	***22%***
Proximity to Soils	0.33	0.33	1.00	3.00	5.00	5.00	9.00	9.00	0.14	0.06	0.12	0.28	0.23	0.18	0.19	0.16	***17%***
Proximity to Topo	0.20	0.33	0.33	1.00	3.00	5.00	9.00	9.00	0.09	0.06	0.04	0.09	0.14	0.18	0.19	0.16	***12%***
Proximity to Recreation	0.14	0.20	0.33	0.33	1.00	3.00	5.00	9.00	0.06	0.04	0.04	0.03	0.05	0.11	0.11	0.16	***7%***
Proximity to FCDC Harvest	0.11	0.20	0.20	0.20	0.33	1.00	5.00	9.00	0.05	0.04	0.02	0.02	0.02	0.04	0.11	0.16	***6%***
Proximity to Bur/White Oak	0.11	0.11	0.11	0.11	0.20	0.20	1.00	3.00	0.05	0.02	0.01	0.01	0.01	0.01	0.02	0.05	***2%***
Proximity to Impervious	0.11	0.11	0.11	0.11	0.11	0.11	0.33	1.00	0.05	0.02	0.01	0.01	0.01	0.00	0.01	0.02	***2%***
sum	**2.34**	**5.29**	**8.09**	**10.76**	**21.64**	**28.31**	**47.33**	**58.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	***100%***

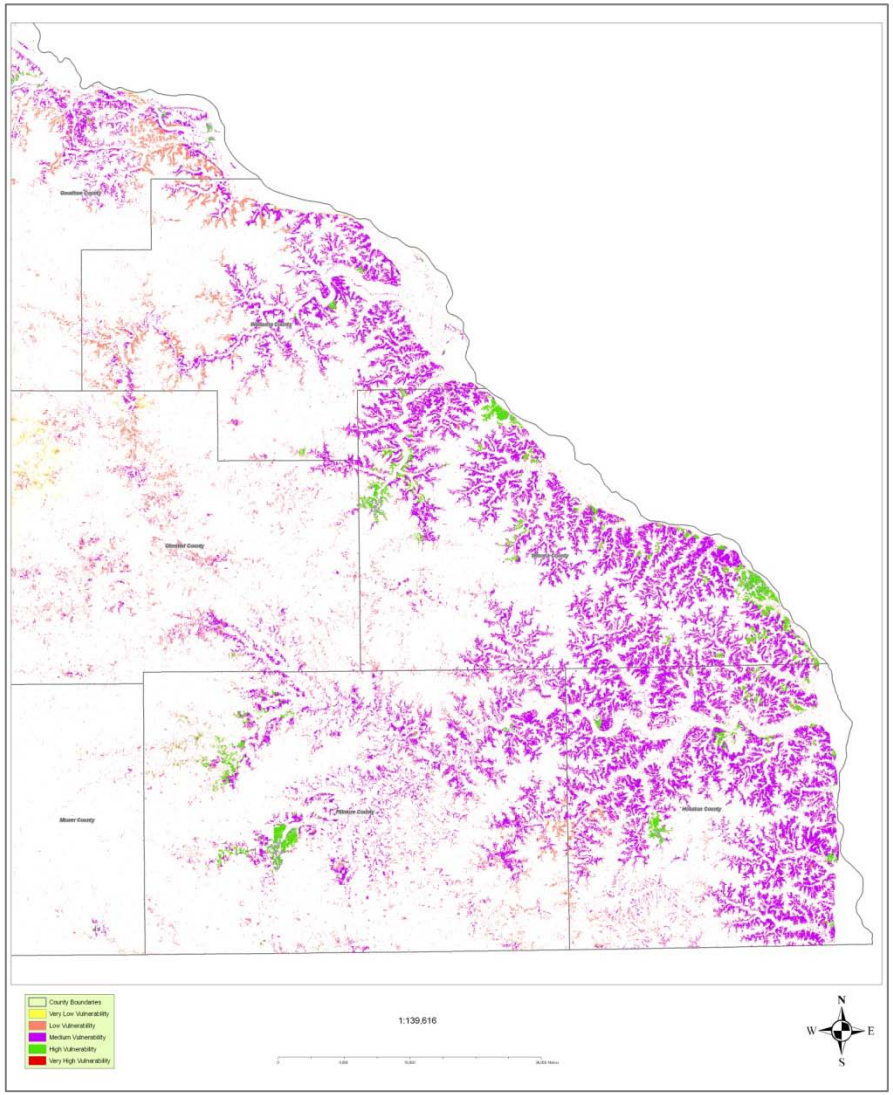
Average Weighted Value is calculated for each factor then used in the Vulnerability Model

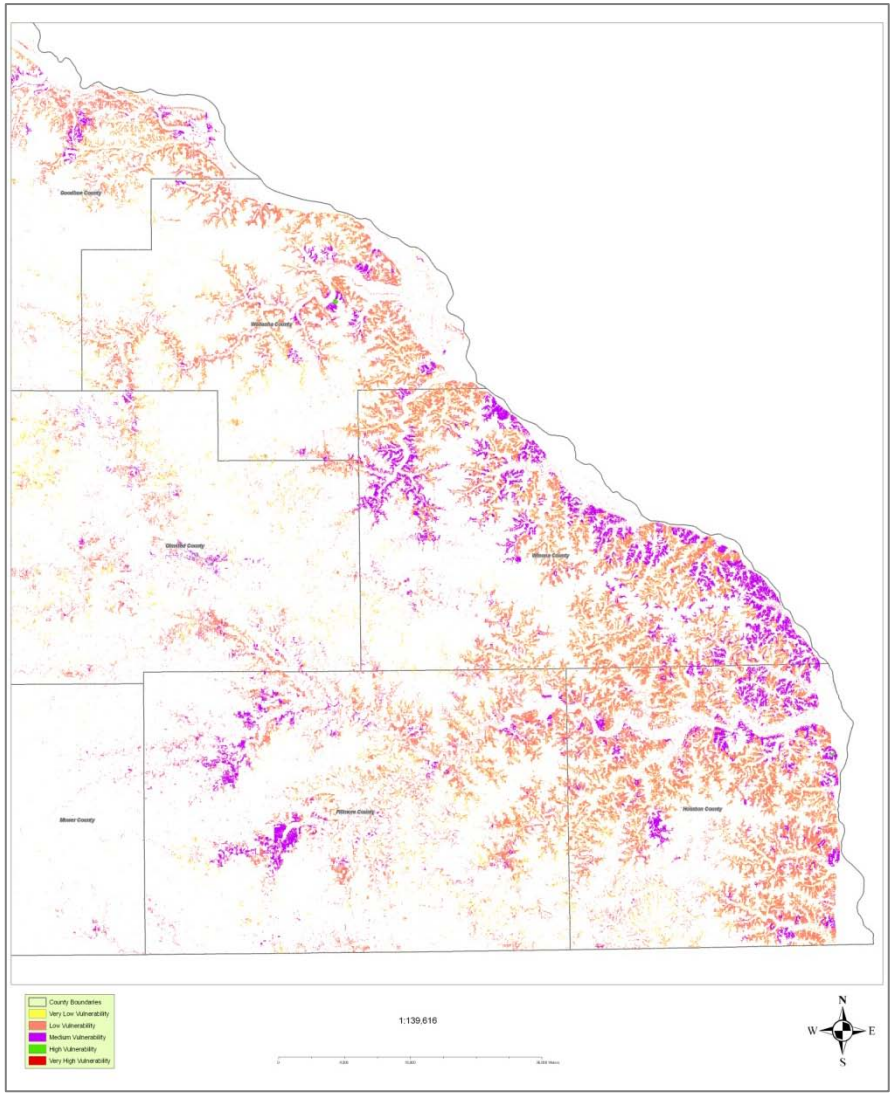
Pairwise Comparison Matrix Assessing the Importance of Susceptibility Factors in determining the potential spread of Oak Wilt													
Susceptibility to Oak Wilt	**Pairwise Comparison Values**						**Weighted Values**						
Proximity to:	**R/POak**	**Soil**	**Rec**	**FCDC**	**B/WOak**	**Imperv**	**P/ROak**	**Soil**	**Rec**	**FCDC**	**B/WOak**	**Imperv**	**Ave. Weight**
Proximity to Red/Pin Oak	1.00	3.00	5.00	9.00	9.00	9.00	0.54	0.63	0.52	0.49	0.31	0.23	***45%***
Proximity to Soils	0.33	1.00	3.00	5.00	9.00	9.00	0.18	0.21	0.31	0.27	0.31	0.23	***25%***
Proximity to Recreation	0.20	0.33	1.00	3.00	5.00	9.00	0.11	0.07	0.10	0.16	0.17	0.23	***14%***
Proximity to FCDC Harvest	0.11	0.20	0.33	1.00	5.00	9.00	0.06	0.04	0.03	0.05	0.17	0.23	***10%***
Proximity to Bur/White Oak	0.11	0.11	0.20	0.20	1.00	3.00	0.06	0.02	0.02	0.01	0.03	0.08	***4%***
Proximity to Impervious	0.11	0.11	0.11	0.11	0.33	1.00	0.06	0.02	0.01	0.01	0.01	0.03	***2%***
sum	**1.87**	**4.76**	**9.64**	**18.31**	**29.33**	**40.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	***100%***

Average Weight Value is calculated for each factor then used in the Susceptibility Model

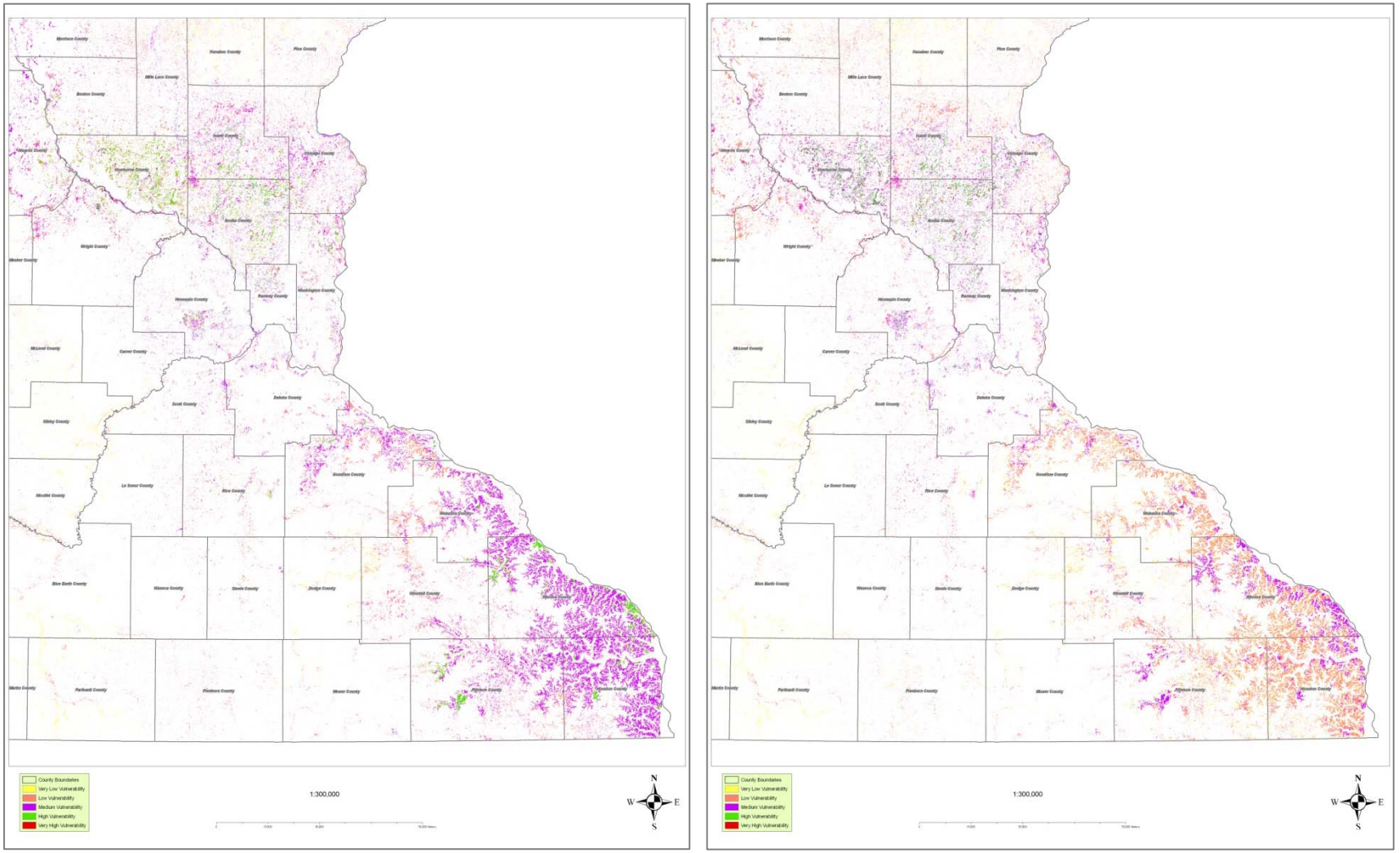


Oak wilt vulnerability model in oak forests applied to a known location of oak wilt in SE Minnesota; 2 views.





Vulnerability model (left) and susceptibility model (right) for oak forests in SE Minnesota.



Oak wilt vulnerability model (left) and susceptibility model (right) for known range of oak wilt in Minnesota.

White spruce thinning study

This study was started in 1998 with a USFS Focus fund Grant, to study white spruce, spruce budworm and thinning. Dr Klaus Puettmann, U of MN was the original principal investigator and Mike Saunders his graduate student at U of MN.

There are 11 stands on State, Federal and Blandin Paper Company lands included in the study. Stands were thinned between 1998 and 2002. A portion of each stand was thinned and a portion left unthinned as a control. Each stand has 6 permanent plots established with rebar as the center points. All stands in the study are visited yearly to evaluate spruce budworm defoliation. Resource Assessment crews collected tree measurements after harvest, 5 growing seasons after harvest and in the winter of 2008 -2009 started the 10 year after harvest re-measurement. The final 10 year measurement was completed on 7 of the sites by May 2010.

Dr Anthony D'Amato is the senior author of a paper titled, "Growth and survival of *Picea glauca* following thinning of plantations affected by eastern spruce budworm. The manuscript has been accepted for publication in the Northern Journal of Applied Forestry.

The locations of stands in this study are shown on the following map.

Name of Site	Label	Date thinned	10 yr measurement d
Aitkin Co	AC	11/1999	4/2010
Johnson Landing	JL	2/2000	4/2010
Larson Lake Salvage	LL	3/2000	4/2010
Plantation Rd	PR	10/1998	2009
Power Line	PL	2/2000	4/2010
Sam Welch's Corner	SWC	7/1999	4/2010
Smith Creek	SC	11/1999	4/2019
Taconite Trail	TT	1/2001	
Warba	WA	1/2002	
White Spruce Alley	WSA	8/2002	
White Township	WT	8/2002	

Spruce budworm defoliation levels are shown in the following table.

White Spruce thinning Project Spruce Budworm Defoliation Rating Data

		Date thinned	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Plantation Road PR	Thinned	Oct-98	L	L	O	O	O	O	O	L	O	O	*1	*1
	Reserved		H	L	L	O	O	O	O	L	O	O	*1	*1
Sam Welch Corner SWC	Thinned	Jul-99	L	L	O	O	O	O	O	O	O	O	O	*1
	Reserved		L	L	L	O	O	O	O	L	O	O	O	*1
Aitkin Co AC	Thinned	Nov-99	O*	O	O	O	O	L	M	L	L	L	O	*1
	Reserved		O*	O	O	O	O	O	L	L	L	L	L	*1
Smith Creek SC	Thinned	Nov-99	L	L	L	H	M	H	M	O	O	O	O	*1
	Reserved		L	L	L	M	M	H	M	O	O	O	O	*1
Johnson Landing JL	Thinned	Feb-00	M	L	O	O	O	O	O	O	O	O	O	*1
	Reserved		M	M	L	O	O	O	O	O	O	O	O	*1
Power Line PL	Thinned	Feb-00	L	L	O	O	O	O	O	L	O	O	O	*1
	Reserved		L	L	O	O	O	O	O	L	O	O	O	*1
Larson Lake Salvage LLS	Thinned	Mar-00		L	L	M	M	L	M	L	O	O	O	*1
	Reserved			L	L	L	L	L	L	O	O	O	O	*1
Taconite Trail TT	Thinned	Jan-01			O*	O*	O*	O	O	O	O	O	O	O
	Reserved				O*	O*	O*	O	O	O	O	O	O	O
Warba WA	Thinned	Jan-02				O*	O	O	O	O	O	O	O	O
	Reserved					O*	O	O	O	O	O	O	O	O
White Spruce Alley WSA	Thinned	Aug-02				O*	O	O	O	O	O	O	O	O
	Reserved					O*	L	O	O	L	O	O	O	O
White Township WT	Thinned	Aug-02				O*	O	O	O	O	L	O	O	O
	Reserved					O*	O	O	O	O	L	O	O	O

* = no defoliation rating done on the ground on this site, rating based on aerial survey data
*1 = no defoliation rating done this year because this site is more than 10 years since thinning
O = no current needles missing, **L** = 1 to 33% defoliation of current year needles
M = 34 to 66% defoliation of current year needles**, H** = 67 to 100% defoliation of current year needles

Invasive Plant Species Program

An education plan for Minnesota recreationists

Available on-line only: http://www.dnr.state.mn.us/treecare/forest_health/annualreports.html
Literature Review: The biology of terrestrial invasive species in Minnesota.
Invasive species project: Focus group report, Parts I, II and III.
Literature Review: State of effective educational efforts to reduce the transport of terrestrial invasive species and applications for Minnesota.

Terrestrial Invasive Species
An Education Plan for Minnesota Recreationists

BACKGROUND
(Taken in part from *Invasive Species Project, Final Analysis*. Pepin Hugunin and Associates. April, 2010)

Defining the problem
Invasive species have been identified by the Chief of the U.S. Department of Agriculture Forest Service (USFS) as one of four significant threats to our nation's forests and rangeland ecosystems referring to invasive species as a "catastrophic wildfire in slow motion because of the seriousness of the problem and its impacts. While only 15% of introduced species become established and only 15% of those become invasive, the impact is substantial. For instance invasive plants invade 1.7 million acres of wildlife habitat annually (NISIC, '09). Costs associated with surveying for invasive species, forest management once infestation has occurred, and losses to industry, recreation and forest and water quality are in the billions of dollars each year. Whole ecosystems are being lost due to the invasion of species with limited options to check their spread. Further, the number and types of species being introduced into the U.S. is increasing exponentially as world trade increases.

Preventing the spread of invasive species has been shown to be far more cost effective than managing the pests after they become permanently established in a new locale. State and Federal agencies have attempted to protect our natural resources by various regulations, primarily on trade. These regulations have had some success but new invasive species are still being introduced each year. Further, in the realm of terrestrial invasive species, existing regulations do not effectively address the movement of invasive species by private individuals – most of whom are totally unaware of the hitchhikers.

The discovery of the emerald ash borer in Michigan in 2002, and the link between firewood used for recreation purposes, highlighted just how important private individuals are to the movement of invasive pests. For the first time, a large number of government agencies and land managers focused on pathways through which terrestrial invasive species spread and found little in the literature to serve as the foundation upon which to design new prevention guidelines. For instance, the literature review completed as a part of this project, found only one paper comparing the relative risk of spread associated with different carriers of the emerald ash borer. It found none comparing the carriers of other terrestrial invasive species. And it found only antidotal evidence to link terrestrial invasive species and recreation, although the correlation between trails and invasive species has long been known.

Based on evidence in the case of firewood and the correlations in the case of terrestrial plants, and the long term impacts terrestrial invasive species have on the state's forest resources, the Forestry Division of the Minnesota Department of Natural Resources (DNR) applied for and was awarded a grant from the United States Department of Agriculture, Forest Service (USFS) to develop an education plan to address and interrupt the pathways of spread of terrestrial invasive species in Minnesota associated with recreational activities.

Process and Pathways
A core team of eight individuals was established to identify the needs and develop an educational plan for the purpose of changing public behavior. Core team members included DNR and Minnesota Department of Agriculture (MDA) staff, USFS State and Private Forestry, and Research staff, and the University of Minnesota (UMN). In addition, an advisory committee of approximately thirty-five people was assembled representing a broad spectrum of organizations and user groups with interest in recreation and Minnesota natural resources and invited to participate in the planning process. Our strategy was to utilize their expertise and understanding of the recreationists they represent to help guide the core team in their efforts.

The core group identified key invasive species and the pathways by which they spread, and evaluated and ranked them based on the relative risk of damage to Minnesota forest resources (Appendix, page 26-27). To do that, a simple matrix was developed, risk criteria identified and expert opinion applied to assess the relative risk of damage based on each criteria (Appendix, page 28-29). Based on that assessment, the decision was made to focus our education efforts on two pathways, firewood and trails along which soil and weed seeds are spread.

Firewood can contain the immature stages (eggs, larvae & pupae) of a number of wood boring insects and/or bark beetles that can later emerge to attack nearby trees. It can also carry a number of disease pathogens, whose spores can be carried by wind, rain or insects to nearby trees. Soil often contains weed seeds, soil-borne pathogens, parasites and the immature stages of insects and worms. Firewood can be carried by recreationists in their vehicles, trailers, RV, strapped to the back of their motorcycle, or even carried in by hikers. Soil can be carried in tire treads, vehicle grills or undercarriages, on the soles of shoes and boots, tents, tarps, poles, lawn furniture, pet's paws and coats, horses' hooves, personal gear, and almost any outdoor piece

of equipment. Because soil is virtually synonymous with the out-of-doors, there really isn't a recreationist who doesn't have at least some potential to move invasive species.

Based on these two major pathways, the core team identified recreation audiences whose activities are closely associated with firewood and/or the use of recreational trails. Excluding winter sport enthusiasts, our primary audience includes campers, hikers, bikers, horse-back riders and riders of two and four wheel off road vehicles.

Measures of success
A key objective of the project was to identify and carry out the means to measure the success of our education campaign. To that end, a baseline survey was conducted to establish the current state of knowledge and the behaviors, attitudes and motivations of our key audience groups (a quantitative understanding of what they know and what they do). The data provides a statistical foundation for comparison later to measure any changes in understanding and/or behavior that may have resulted from the education campaign. In addition to the survey, focus groups were held as part of the project to understand the values and motivations driving the actions of the identified audiences (a qualitative understanding of what they know and how they make recreation decisions).

Toward that end, Pepin Hugunin & Associates (PHA) conducted nine focus group discussions in Minneapolis, Duluth and Rochester, MN, in late September and early October 2009 on behalf of the DNR and USFS. Under the guidance of the core team, a total of 97 individuals participated in the nine discussions. The methodologies used in executing the focus group research are discussed in detail in Part I: Detailed Findings of the Focus Group Report.

A survey of 1,201 Minnesotans was also conducted by PHA in March 2010. The respondents were interviewed via telephone by sub-contractor JEM Research, Valparaiso, IN using a questionnaire developed by PHA under the supervision of the project core team.

The participants in both phases of research are Minnesotans who participate in a variety of at-risk activities—bicycling, camping, hiking, horseback riding, riding motorized vehicles, running and walking—and they are generally representative of Minnesotans as a whole by virtue of geography. The sample population in both studies included nearly 200,000 visitors to DNR facilities, recreationists holding sport licenses (hunting and fishing) and those with trail permits (motorized vehicles, equestrian or cross-county skiing) issued by the DNR during 2008. While cross-country skiing was not considered an at-risk activity, those with skiing permits were considered a reasonable surrogate for our hiking population since no other record of that population exists within the DNR. To supplement our sample of the hiking population, we contacted the Superior and North Country hiking clubs and requested volunteers through their on-line group lists.

I. Do the Survey Results Validate the Focus Group Findings?

The focus group results suggested six "desired beliefs" which, if held to be true by outdoor recreationists, would provide the strongest possible motivations for them to adopt the recommended behaviors relating to the transport of land-based invasive species.

These six desired beliefs include:

1. The spread of land-based invasive species has undesirable consequences.
2. *"I may be contributing to the spread of land-based invasive species."*
3. *"If I eliminate certain risky behaviors, the spread of land-based invasive species can be stopped or delayed."*
4. *"I am ready to do my part to prevent the spread of land-based invasive species."*
5. *"I know what to do."*
6. *"I have the resources to do it."*

Do Minnesotans already share these beliefs as indicated in the survey? Yes, they do. In fact, agreement with these six key, desired beliefs is higher than we would have predicted based on the focus group findings alone.

1. ***The spread of land-based invasive species has undesirable consequences.***
   - 79 percent of survey respondents agree or agree strongly that "Land-based invasive species present a significant threat to the health of the Minnesota environment.
   - 71 percent agree or agree strongly that "Land-based invasive species may hinder our ability to fully enjoy the outdoors, including such activities as camping, hiking and hunting."
2. ***"I may be contributing to the spread of land-based invasive species."***

- 78 percent agree or agree strongly that "In order to prevent the spread of invasive species, Minnesotans should acquire firewood only in the vicinity of where it is going to be burned."
- 64 percent agree or agree strongly that "In order to prevent the spread of invasive species, Minnesotans should clean their outdoor gear before taking it into the outdoors and again before taking it home."

3. ***"If I eliminate certain risky behaviors, the spread of land-based invasive species can be stopped or delayed."***
   - 69 percent disagree or disagree strongly that "What I do doesn't matter, because land-based invasive species are going to spread anyway."
4. ***"I am ready to do my part to prevent the spread of land-based invasive species."***
   - 41 percent disagree or disagree strongly that "Cleaning off my outdoor gear is not how I want to spend my time in the out of doors."
   - Another 25 percent responded in a neutral way to this same statement.
   - 34 percent agree or agree strongly with this statement, however.
5. ***"I know what to do."***
   - 86 percent agree or agree strongly that "I can find a good supply of firewood near where I intend to burn it."
   - 74 percent agree or agree strongly that "I know how to clean up my outdoor gear and equipment to prevent the spread of invasive species."
6. ***"I have the resources to do it."***
   - 69 percent already "acquire firewood in the vicinity of where I'm going to burn it."
   - 91 percent already "clean my equipment and gear," and 29 percent do so "on-site, before leaving for another location."
   - 87 percent agree or agree strongly that they already "remove most of the mud and dirt" from their equipment and gear.
   - 85 percent agree or agree strongly that they already "remove most of the plant matter and weed seeds" from their equipment and gear.

Conclusions Concerning "Desired Beliefs"

- Large majorities make the more "environmentally-friendly" responses to almost every survey question. Minnesotans generally will be receptive to education about land-based invasive species.

- 59 percent do not disagree, however, that "Cleaning off my outdoor gear is not how I want to spend my time in the out of doors." Minnesotans need to know that cleaning off their outdoor gear to prevent the spread of land-based invasive species can be done quickly and easily.

- Generally speaking, some 70 to 80 percent of survey respondents make the more "environmentally-friendly" responses. So, while most Minnesotans will be receptive to messages about land-based invasive species, this also raises the question, who is the target for the education campaign? Is it, indeed, the 70 to 80 percent who are inclined to do the right thing? Or is it the 20 to 30 percent who are not so strongly inclined?

II. Time Barrier – "Cleaning Off My Gear Is Not How I Want to Spend My Time"

Focus group results suggested that "time" was a key obstacle to cleaning up one's gear and equipment.

- "(Cleaning up) takes the fun out of it. I want to relax and have fun."
- "It takes time; you have to think about it."
- "But I don't want to think about it. I'm busy…."
- "I'm not willing to take the time."
- "I'm having fun, and cleaning up isn't fun."

Most of these comments came from non-motorized trail users. As such, we hypothesized that the concern about time relates, first, to the fact that non-motorized trail users are not now spending any significant amount of time on clean-up and, therefore, perceive cleaning up as a new and onerous requirement. Second, we thought that they do not see themselves as transporting any significant amount of dirt, mud or plant matter, nor therefore at risk for spreading invasive species.

Based on focus group results, we hypothesized that those who already spend their time cleaning up their gear and equipment would be more likely to perceive cleaning as easily done, and therefore would be more likely to agree with the survey statement, "Cleaning off my gear and equipment is not how I want to spend my time in the outdoors."

This hypothesis was not entirely validated. Those who already are most likely to clean up their gear on-site and to clean their gear most thoroughly, according to the survey, include campers, those with higher incomes, women and riders of motorized

vehicles. Among these four groups, only women are especially likely to disagree that "cleaning off my gear is not how I want to spend my time."

Most Likely to Say That Time Is an Issue

Those who are most likely to agree that "Cleaning off my outdoor gear is not how I want to spend my time"—most likely, that is, to consider time to be a significant obstacle—are as follows:

- Horseback riders—33.6 percent agree with the statement
- Age 25-44 (younger respondents)—31.6 percent agree
- Northern Minnesotans—31.4 percent agree
- Lower income respondents—31.4 percent agree
- Men—30.2 percent agree
- Higher income respondents—29.8 percent agree
- Bicyclists—29.7 percent agree

Least Likely to Say That Time Is an Issue

Those who are least likely to agree with the statement—and, that is, least likely to consider time to be a problem—include:

- Middle income respondents—26.2 percent agree with the statement
- Southern Minnesotans, women, older respondents (age 45+), hikers and runners are all in the 27 percent range

Survey results for horseback riders and bicyclists (non-motorized trail users) would seem to support the original hypothesis, as do the results for the younger age group, who are more likely to be engaged in non-motorized trail uses such as bicycling and running. On the other hand, the results for hikers and runners refute the original hypothesis. The same is true for the results for Northern Minnesotans, who are disproportionately likely to ride motorized vehicles.

Analysis

So, in short, the survey report does not seem to support any particular hypothesis concerning who regards time to be an issue, and why. It is not surprising that the survey results do not fully explain these differentials, as they are slim—7.4 percent from the highest (horseback riders) to the lowest (middle income households) percent in agreement, or about twice the margin of error.

70 to 80 percent of Minnesotans accept most of the other motivators that point toward the recommended behaviors, but as many as half of these individuals (plus the 20 to 30 percent who do not accept the other various assertions made in the survey; or a total of 60 percent of all survey participants) are not certain that "cleaning off my outdoor gear is…how I want to spend my time." Being so numerous, it should not be surprising that they come from various walks of life.

Representing 60 percent of Minnesota outdoor recreationists, those who regard time as a problem necessarily come from many different walks of life. And the differentials among sub-groups of survey respondents are small. So it is difficult to say that Minnesotans for whom time is an issue come from any particular demographic group. The explanation, then, must be attitudinal.

We posited that Minnesota outdoor recreationists would have to subscribe to a series of six "desired beliefs" in order to be properly motivated to take the recommended actions to stop the spread of land-based invasive species. It follows that any reluctance to adopt the recommended actions might come as a result of skepticism toward these six beliefs.

1. ***The spread of land-based invasive species has undesirable consequences.***
   - 20 percent of survey respondents disagree or disagree strongly or responded neutrally to the statement, "Land-based invasive species present a significant threat to the health of the Minnesota environment."
   - 29 percent disagree or disagree strongly or responded neutrally to the statement, "Land-based invasive species may hinder our ability to fully enjoy the outdoors, including such activities as camping, hiking and hunting."
2. ***"I may be contributing to the spread of land-based invasive species."***
   - 21 percent disagree or agree strongly or responded neutrally to the statement, "In order to prevent the spread of invasive species, Minnesotans should acquire firewood only in the vicinity of where it is going to be burned."
   - 36 percent agree or agree strongly or responded neutrally to the statement, "In order to prevent the spread of invasive species, Minnesotans should clean their outdoor gear before taking it into the outdoors and again before taking it home."
3. ***"If I eliminate certain risky behaviors, the spread of land-based invasive species can be stopped or delayed."***
   - 31 percent disagree or disagree strongly or responded neutrally to the statement, "What I do doesn't matter, because land-based invasive species are going to spread anyway."
4. ***"I am ready to do my part to prevent the spread of land-based invasive species."***
   - 59 percent agree or agree strongly or responded neutrally to the statement, "Cleaning off my outdoor gear is not how I want to spend my time in the out of doors.

5. ***"I know what to do."***
    - 13 percent disagree or disagree strongly or responded neutrally to the statement, "I can find a good supply of firewood near where I intend to burn it."
    - 26 percent disagree or disagree strongly or responded neutrally to the statement, "I know how to clean up my outdoor gear and equipment to prevent the spread of invasive species."
6. ***"I have the resources to do it."***
    - 19 percent "usually…bring firewood with me" when they travel to an outdoor recreation location.
    - 37 percent "clean my equipment and gear" at home or not at all.
    - 12 percent disagree or disagree strongly or responded neutrally to the statement, "When I clean my outdoor equipment and gear, I remove most of the mud and dirt."
    - 14 percent disagree or disagree strongly or responded neutrally to the statement, "When I clean my outdoor equipment and gear, I remove most of the plant matter and weed seeds."

We do not know who these respondents are who responded negatively or neutrally to these statements. They could be the same people for each statement. Or, perhaps a variety of people responded negatively or neutrally to one or two of the statements each. If the latter, there could easily be 60 percent of the sample who does not fully share one or more of the desired beliefs. It is also plausible that a negative attitude on any of these desired beliefs might be enough of a motivator to cause skepticism about adopting the recommended behaviors. For example, if a Minnesota outdoor recreationist does not believe that "Land-based invasive species present a significant threat to the health of the Minnesota environment," then that individual might be less likely to adopt the recommended behaviors and more likely to say that "cleaning off my gear is not how I want to spend my time in the out of doors."

Conclusions Concerning the Time Needed to Successfully Clean Off One's Gear

Two sets of messages, then, suggest themselves as running counter to the concern that cleaning off one's gear and equipment will take more time than one is willing to spend. First is simply to reinforce the various desired beliefs, all of which might provide the motivation to spend a little (more) time cleaning up. The focus groups suggested that two of the desired beliefs were most important.

- The spread of land-based invasive species has undesirable consequences. Land-based invasive species are a significant threat to the health of the Minnesota environment.
- Minnesota outdoor recreationists need to know what to do. What are the behaviors that will help stop the spread of land-based invasive species?

The second message—related to the need to be know what to do—is to stress that cleaning up sufficient to prevent the spread of land-based invasive species can be accomplished quickly and easily.

III. Differential Populations - Horseback Riders

Among all of the sub-groups studied in this project, horseback riders are among the sub-groups that are the least familiar with land-based invasive species. They are most likely to agree (34 percent do so) that "cleaning off my equipment and gear is not how I want to spend my time in the out of doors," and they are slightly more likely to disagree with the assertion that land-based invasive species may hinder our ability to enjoy the outdoors.

They are also significantly more likely than the statewide norm to clean up their outdoor gear and equipment (including horses) at home, rather than on-site, and slightly less likely to acquire firewood near where they intend to burn it.

Analysis

Do horseback riders represent a particular threat to transport land-based invasive species? Yes, but only very narrowly. The differentials on each of these attitudes and behaviors are small, but significant. Thirty percent of horseback riders are familiar with land-based invasive species, for example, versus 40 percent of all respondents. Unfortunately, we had very few horseback riders in the focus groups, so not much additional light is shed on the matter by the focus group results.

It must be considered to be surprising, however, that horseback riders are less familiar with invasive species, because we know from the focus groups that the potential for the transport of land-based invasives in hay has been widely communicated. The Department of Agriculture runs a certification program in which hay is inspected and certified to be free of invasives.

The behaviors concerning firewood is probably related to the fact that horseback riders are less likely to ride at state parks, where there is enforcement of firewood restrictions, and more likely to ride at locations where such restrictions are not generally enforced.

Finally, it should be noted that among the survey respondents, horseback riders are more likely to be female (62 percent versus 52 percent of the total). They are more likely to be non-metro residents (55 percent versus 46 percent of the total). And, horseback riders are more likely also to ride motorized vehicles such as ATVs, ORVs and dirt bikes (43 percent versus 31 percent of the total).

Horseback riders participate in other outdoor activities as well. 87 percent of survey respondents camp, 71 percent hike. Only 57 percent bicycle, ten percent below the statewide norm (among survey respondents).

Conclusions Concerning Horseback Riders

- We know that many horseback riders are aware of the certification program that is in place to help reduce the transport of land-based invasive species in hay for livestock. There is an opportunity to leverage the hay certification program to inform horseback riders about the problems of land-based invasive species generally. Currently, there is a disconnect between the two matters.

- Messaging to riders of motorized vehicles can build on the fact that a vast majority are already cleaning off their equipment and gear. However, most of that cleaning is currently done at home, not on-site. A significant goal of the education campaign may be to shift that cleaning up from after one returns home, to before.

- Currently, much of the awareness of firewood restrictions has been communicated at the state parks. There is an obvious need to inform Minnesotans who frequent state and national forest facilities of these restrictions.

- Any programming designed to reach horseback riders should be cognizant of the fact that they are engaged in other activities that are at risk for the spread of land-based invasive species.

IV. Differential Populations - Riders of Motorized Vehicles

Among all of the sub-groups studied in this project, riders of motorized vehicles are among the least likely to agree to three statements.

- "Land-based invasive species may hinder our ability to fully enjoy the outdoors, including such outdoor activities as camping, hiking and hunting."
- "Some people say that, in order to help prevent the spread of invasive species, Minnesotans should acquire firewood only in the vicinity where that firewood is going to be burned."
- "Some say that, in order to help prevent the spread of invasive species, Minnesotans should clean their outdoor gear, including vehicles, trailers, campers or tents, camping gear, clothing and footwear, before taking it into the outdoors and again before taking it home."

They are also less likely to be familiar with land-based invasive species (34 percent versus 40 percent of all survey respondents). And they are slightly less likely to acquire firewood near where they intend to burn it (more likely to bring it with them from their point of origination).

On the other hand, there is evidence that they take more time to more thoroughly clean off their equipment and gear. (They are no more likely to clean off their gear, but they are more likely to report that they remove all of the mud, dirt, plant matter and weed seeds that may have collected there.)

Analysis
Do riders of motorized vehicles represent a particular threat to transport land-based invasive species? Yes, narrowly, as it relates to firewood. But, according to the survey results, they are probably no more likely to spread land-based invasive species than those who engage in any other activity and perhaps less so.

Their attitudes and behavior concerning firewood are probably related in part to the fact that they do not ride in state parks, where firewood restrictions have been enforced. Rather, they tend to ride in state and national forest facilities and on private property, where such restrictions generally are not enforced.

The major theme that emerged from the focus groups is that riders of motorized vehicles want more trail miles to be developed and made available for their activity. Yet they perceive the whole issue of land-based invasive species as representing a threat,

whether justified or not, of the closure of more motorized trails. (Some see invasives as representing a legitimate threat; others see it as an excuse that is being trumped up by the agencies for the purpose of justifying additional trail closures.)

Finally, it should be noted that riders of motorized vehicles are predominantly male (60 percent versus 52 percent of all survey respondents), and overwhelmingly residents of northern and southern Minnesota (80 percent versus 46 percent of the total). They also participate in other activities similarly to the statewide norm. 87 percent camp, for example.

Conclusions Concerning Riders of Motorized Vehicles

- The education campaign should tread lightly on the issue of trail closures. If the potential for trail closures as a result of land-based invasive species is overstated, the credibility of the DNR and Forest Service will be negatively affected. On the other hand, if this is a real possibility, it is the most powerful consequence and could be highly motivating to riders of motorized vehicles.

- Messaging to riders of motorized vehicles can build on the fact that a vast majority are already cleaning off their equipment and gear. However, most of that cleaning is currently done at home, not on-site. A significant goal of the education campaign may be to shift that cleaning up from after one returns home, to before.

- Currently, much of the awareness of firewood restrictions has been communicated at the state parks. There is an obvious need to inform Minnesotans who frequent state and national forest facilities of these restrictions.

- Any programming designed to reach riders of motorized vehicles should be cognizant of the fact that they are engaged in other activities that are at risk for the spread of land-based invasive species.

V. Summary of Study Conclusions

Conclusions Concerning "Desired Beliefs"

- Large majorities make the more "environmentally-friendly" responses to almost every survey question. Minnesotans generally will be receptive to education about land-based invasive species.

- 59 percent do not disagree, however, that "Cleaning off my outdoor gear is not how I want to spend my time in the out of doors." ***Minnesotans need to know that cleaning off their outdoor gear to prevent the spread of land-based invasive species can be done quickly and easily***.

- Generally speaking, some 70 to 80 percent of survey respondents make the more "environmentally-friendly" responses. So, while most Minnesotans will be receptive to messages about land-based invasive species, this also raises the question, who is the target for the education campaign? Is it, indeed, the 70 to 80 percent who are inclined to do the right thing? Or is it the 20 to 30 percent who are not so strongly inclined?

Conclusions Concerning the Time Needed to Successfully Clean Off One's Gear

Two sets of messages suggest themselves as running counter to the concern that cleaning off one's gear and equipment will take more time than one is willing to spend.

- First is simply to reinforce the various desired beliefs, all of which might provide the motivation to spend a little (more) time cleaning up. ***The focus groups suggested that two of the desired beliefs were most important***:
  - The spread of land-based invasive species has undesirable consequences. Land-based invasive species are a significant threat to the health of the Minnesota environment.
  - Minnesota outdoor recreationists need to know what to do. What are the behaviors that will help stop the spread of land-based invasive species?
- The second message—related to the need to be know what to do—is to stress that cleaning up sufficient to prevent the spread of land-based invasive species can be accomplished quickly and easily (relative to the cleaning that Minnesotans are already doing). This may be particularly true of riders of motorized vehicles, because the evidence suggests that they are most likely to already be doing significant clean-up.

Related to this, however, is the possibly difficult job of convincing Minnesotans to ***shift some of the current cleaning done at home to cleaning done before they leave the site.***

Conclusions Concerning Horseback Riders

- We know that many horseback riders are aware of the certification program that is in place to help reduce the transport of land-based invasive species in hay for livestock. There is an opportunity to ***leverage the hay certification program*** to inform horseback riders about the problems of land-based invasive species generally. Currently, there is a disconnect between the two matters.

- Messaging to riders of motorized vehicles can build on the fact that a vast majority are already cleaning off their equipment and gear. However, most of that cleaning is currently done at home, not on-site. A significant goal of the education campaign may be to shift that cleaning up from after one returns home, to before.

- Currently, much of the awareness of firewood restrictions has been communicated at the state parks. There is an obvious need to ***inform Minnesotans who frequent state and national forest facilities of these firewood restrictions.***

- Any programming designed to reach horseback riders should be cognizant of the fact that they are engaged in other activities that are at risk for the spread of land-based invasive species.

Conclusions Concerning Riders of Motorized Vehicles

- The education campaign should tread lightly on the issue of ***trail closures***. If the potential for trail closures as a result of land-based invasive species is overstated, the credibility of the DNR and Forest Service will be negatively affected. On the other hand, if this is a real possibility, it is the most powerful consequence and could be highly motivating to riders of motorized vehicles.

- Messaging to riders of motorized vehicles can build on the fact that a vast majority are already cleaning off their equipment and gear. However, most of that cleaning is currently done at home, not on-site. A significant goal of the education campaign may be to shift that cleaning up from after one returns home, to before.

- Currently, much of the awareness of firewood restrictions has been communicated at the state parks. There is an obvious need to inform Minnesotans who frequent state and national forest facilities of these restrictions.

- Any programming designed to reach riders of motorized vehicles should be cognizant of the fact that they are engaged in other activities that are at risk for the spread of land-based invasive species.

Other Conclusions

Above, we posed the question: Who is the target for the education campaign? Is it, indeed, the 70 to 80 percent who are inclined to do the right thing? Or is it the 20 to 30 percent who are not so strongly inclined?
Logically, the program must reach out to all Minnesota outdoor recreationists, whether they are inclined to be supportive of our messaging or not. Unfortunately, reaching out to the 20 to 30 percent of possible skeptics and "scofflaws" will be difficult because they are not identifiable through any objective demographic data. ***Rather, they are characterized by certain beliefs and attitudes that we know from the survey to be found within any and all demographic groups.***

This brings us back to the recommendations cited above that are meant to counter the concern that cleaning off one's equipment and gear will take more time than one is willing to spend:

- First is simply to reinforce the various desired beliefs, all of which might provide the motivation to spend a little (more) time cleaning up.
- The second message is to stress that cleaning up sufficient to prevent the spread of land-based invasive species can be accomplished quickly and easily.

MINNESOTA EDUCATION PLAN

I. Education Plan Goals

Terrestrial invasive species (invasive species that live on the land) have significant, negative environmental and social impacts. For example, introduced wilt diseases, bark beetles and wood boring insects can destroy native trees in large numbers. Defoliating insects and leaf diseases can stress native trees and thus contribute to additional tree mortality. Tree mortality can have significant economic consequences such as lost forestry revenues, and the cost of removing diseased trees in private yards and public spaces. Tree mortality also displaces native flora and fauna that depend upon our native tree species. Dead and dying trees reduce human enjoyment and the aesthetic experience of the outdoors.

Invasive plants displace native plants, negatively affecting native fauna that need native plants for food or shelter. Some invasive plants reduce the carrying capacity of pasture lands and otherwise negatively affect agricultural productivity. Others pose health threats to humans.

Attempts to minimize the impact of terrestrial invasive species can also have significant economic, environmental and social consequences. Communities are pushed to spend scarce dollars and private citizens may resort to any means possible to protect their assets. And Land managers may feel compelled to limit access to certain recreation areas to protect the public and/or to help prevent future damage.

People involved in recreational activities may contribute to the spread of invasive species in a number of ways. Two pathways that involve almost all recreationists are:

1. Wood borers, other insects, fungi and viruses spread in firewood used at developed and/or dispersed primitive campsites.
2. Non-native seeds and plant material spread along recreational trails in soil and mud that sticks to recreational and road vehicles, trailers, outdoor equipment and gear, clothing, footwear and pets. Non-native seeds and plant material in hay and therefore manure left along recreational trails can also spread non-native seeds and plant material.

The primary goal of this project was to design an education plan which would enhance protection of Minnesota forest resources by interrupting the link between the recreational activities described above and the spread of terrestrial invasive species by fostering changes in behavior among Minnesota recreationists. To accomplish that goal, our objectives were to:

1. **Guide** outreach and education efforts (1) to provide consistent messaging among partner organizations and (2) to integrate those efforts to maximize the return on dollars spent.
2. **Educate** the target audiences about changes in behaviors that can reduce the likelihood of their spreading invasive species.
3. **Motivate** target audiences to adopt recommended behaviors appealing to potential negative and positive consequences.
4. **Provide** baseline information by which behavioral changes among the target audiences can be identified and assessed to determine campaign effectiveness.

II. Education Audiences

The potential damage posed by invasive species is of such concern, that there are a number of groups involved in addressing invasive species concerns. In Minnesota these groups include among others, the Minnesota Invasive Species Advisory Committee, Governor's Task Force on Forest Protection, Minnesota Gypsy Moth Advisory Council, Emerald ash borer working group and the Inter-agency firewood working group. In addition to these groups, there are a number of sub-committees specifically designed to address the needs for out-reach and public education.

Each of the primary partners involved in these efforts has literature and websites available to the public. These resources provide a wealth of information. They also provide a dizzying array of experts from among whom the public must choose to get their questions answered. The result has been public confusion and minimal success in changing public behaviors at risk of spreading invasive species.

The subject of public behavior and the need to change it comes up again and again. Yet, changing public behavior is a slow process, one not easily undertaken by a single agency. It is also an expensive undertaking and with limited financial resources, state and federal agencies tend to focus on short-term information projects that fail to produce the results needed – in this case a change in how the public thinks about and behaves with regard to their involvement in the movement and spread of invasive species and the subsequent impact on critical resources.

This education plan is meant to be used by partner agencies and organizations to guide and coordinate education efforts to provide consistent messaging, maximize the potential benefits achieved with minimal funding and to measure the success of our efforts over time.

III. Recreation Audiences

As stated above, the target audiences for this education effort are those engaged in outdoor recreation activities with the greatest potential to spread terrestrial invasive species in two primary carriers, firewood and soil. Our audiences include:

Primary audiences

1. Recreational riders of motorized vehicles, such as ATVs, OHVs and motorized dirt bikes, who use recreational trails.
2. Recreationists who participate in non-motorized activities such as, hiking, walking, running, riding mountain bikes or horses on recreational trails.

3. Campers, regardless of the type of shelter they use—e.g. tents, pop-up campers, RVs, etc.

Secondary audiences

4. Children – This is about the future, and children are the future. In addition, research has shown that children can influence the behaviors of their parents and other family members.
5. Anyone who ventures out into undeveloped, or agricultural, or natural lands that may harbor invasive species of plants, including hunters, trappers, and gatherers of non-traditional forest products.
6. Anyone who transports and uses hay for livestock or other activities (such as event organizers for large outdoor gatherings).
7. Retail outlets and distributors of recreational equipment and supplies

IV. Current and Desired Beliefs

While the responses heard from focus group participants are not necessarily representative of the population of Minnesota recreationists, their comments gave us an idea of the range of knowledge and attitudes present. For instance, it is clear that when they do not understand the rationale behind a government program or message, such as the DNR firewood restrictions with our 'Buy Local' slogan, they are likely to make up a reason based on their limited understanding. And the unintended consequences of those assumptions may be contrary to program goals. An example of this is the statement heard from one participant "If EAB were as bad as they say, they would do a better job of enforcing their own rules. So I say it's all a scam to make money off firewood sales." It is also clear that the reasons they have for taking on desirable behaviors may not be the reasons we expect. For instance one woman said she likes the firewood restrictions, because that's one less thing to pack without argument from her husband. So a message encouraging the belief that it's the right thing to do (i.e. protect your resources) may be missing the point (i.e. what matters to her – quality time with her family).

Focus group responses also suggested that some commonly held stereotypes about recreationists do not necessarily hold up. For example, participant responses did not support the belief shared by many that ATV riders don't care about the environment while nature watchers do. Instead motorized the trail users participating in our focus groups were more likely to be aware of their role in protecting the environment and willing to do their part than the non-motorized trail users in our study.

In general focus group participants agreed with one of the following statements:

- It is plausible that I may be contributing to the spread of invasive species.
- It is not plausible that I am contributing to the spread of invasive species, because I don't see any invasives where I go. And they spread by other means, e.g. they blow in the wind.
- It is plausible that I am contributing to the spread of invasive species, but I don't care. The consequences are acceptable, and changing my behavior is too much trouble.

The beliefs we would like to foster include:

- The spread of land-based invasive species has undesirable consequences.
- I may be contributing to the spread of land-based invasive species.
- If I eliminate certain risky behaviors, the spread of land-based invasive species can be stopped or delayed.
- I am ready to do my part to prevent the spread of land-based invasive species.
- I know what to do.
- I have the resources to do it.

V. Current and Desired Recreationist Actions

Our survey results report that:

- 69% of Minnesota recreationists believe that what they do matters
- 63% usually clean their gear at home
- 30% usually clean their gear at their recreation site
- 68% usually acquire their firewood in the vicinity of their recreation site

So most Minnesota recreationists are already taking some variation of the actions we'd like to foster. It's important that we acknowledge and applaud that behavior without implying there's something wrong in what they are doing. At the same time, the reasons they are taking those actions do not necessarily make the link between their actions and the spread of invasives. So

their actions may not be consistent and/or sufficient to prevent the accidental movement of terrestrial invasive species. An example of this is a camper who buys their wood locally, but fails to enquire of the supplier or notice that the label indicates the wood was actually harvested in another state. While regulations can address part of that particular issue, public awareness and personal responsibility is a critical component of the education needed to break the link between recreation and the spread of invasive species.

The actions we would like to foster include:

Before Leaving Home

- Locate a source for approved firewood (check the source).
- Where needed, acquire certified hay or feed.
- Remove dirt and plant material from vehicles, equipment, gear, clothing, footwear and pets before leaving home. Inspect and clean (brush or wash) as needed to remove soil and plant debris.
- Plan ahead. Pack cleaning tools and supplies.

While on Site

- Stay on the trail. By staying on the trail you are less likely to pick-up and move invasive species and you do not create a disturbance where invasives can take hold.
- Acquire firewood at your destination (check the source).

Before Leaving the Site

- Remove dirt and plant material from vehicles, equipment, gear, clothing, footwear and pets before you leaving the site. Inspect and clean (brush or wash) as needed.
- Leave unused firewood on site, or burn it all.

Anytime

- Learn what terrestrial invasive species may be present in the area where you recreate. Learn to identify them and understand the consequences/impacts of those invasive species.
- Advocate behaviors that reduce the spread of invasives to your family members, friends and fellow members of your organization.

VI. Brand personality

Branding is the foundation of everything an organization or campaign does, so it's very important when selecting a contractor to choose an expert in the field. Once the brand is established, it should be communicated at every point of contact with the public - from how the phone is answered to customer service to advertising and publications.
Branding is so much more than designing a logo!

- It is defining the campaign's entire personality—how you want to be perceived by the public—and unique attributes and benefits.
- It also must be something associated exclusively with that campaign. If your "personality" could also describe other programs, your branding efforts may go awry.
- It must be something the public will believe. It doesn't do any good to develop a brand that isn't believable.
- It must convey attributes and benefits that are important to the public—that they care about, what matters to them. For example, an auto manufacturer spent a great deal of money on developing many features (color choices for the interior of the car, etc.) and advertised it like crazy, only to find that consumers didn't care about those attributes. The Fluid Dairy Association touted the health benefits of milk only to have sales continue to decline. Once they understood how people choose to drink milk (it's largely based on what they are eating!) and aligned their message with that ("Got milk?"), sales increased dramatically.
- We want an identity system. With regard to that and a logo, even the choice of colors should convey the personality, appeal to the target market, etc.

The core team, made up of pest managers and educators, are not the experts. Graphic designers and advertisers are not necessarily the experts either. It's critical to have the input of someone who really understands and has a successful track record developing brands.

That being said, the core team and advisory committee discussed images and slogans that may be used in branding our proposed education campaign. We want an image that is easily recognizable and does not imply that recreational activities are bad in and of themselves, instead focusing on the vectors of spread, such as firewood, tire treads, and boot soles.

Three potential icon models discussed:

- Image that represents a mascot or spokes-person (example - Smokey Bear)
- Image that represents the pathways by which invasive species are spread (example – tire treads and the logo used in the "Stop Aquatic Hitchhikers" campaign)
- Image that represents the pest or "bad bug" (example - Mr. Yuck campaign)

The Advisory Committee recommended we build on the national recognition of the Stop Aquatic Hitchhikers campaign (symbolized by the stop sign logo) and the pathways along which terrestrial invasive species spread.

VII. Concepts, Products and Partners for All Audiences

Forty percent of the focus group participants had heard the term "invasive species" and could correctly name a terrestrial species, with buckthorn and the emerald ash borer being the mostly commonly named. However, very few individuals had seen an invasive species in a location where they recreate (among the 'invasives' they had seen were coyotes, possums, ticks, forest tent caterpillars, deer, city folk and poison ivy). Most reported not having seen any. So there is a disconnect between their general knowledge and their experience of invasive species. And much of what they know is hearsay.

About a third of the group who knew what invasives were said they had dead and dying trees on their property due to invasive wood borers or bark beetles. They went on to describe their experience as either an aesthetic or an economic issue because of the cost of removal. Two-thirds said they had been affected by invasives because of the firewood restrictions on DNR lands. A small percent said they had not been affected by invasive species saying things like "We don't have any ash trees." "None of the trails have been closed due to invasives." "I don't think about it much. It's out of my mind. Others are doing that job. I have other things to worry about."

Overall, about two-thirds of the focus group participants thought that invasive species were a concern. At a three to one ratio, motorized trail users were likely to agree invasives were a problem, while only 50% of the campers were likely to agree. A large number of focus group participants stated that controlling invasive species seemed hopeless. "If everything I do is risky, then screw it." "Aren't we just beating a dead horse?" Others asked if invasive species were truly "invasive" or just an annoying part of the normal evolution of things. "What's here now used to be invasive, maybe." "Is this a new thing, why now?" One woman responded, "on a scale of all the things that concern me as a mother of 4, it's a 3 on a scale of 1 to 10. It's not high on my radar." A non-motorized group member said that invasives can be a good thing. "Our state produces wood products and some are not natural. I'm not convinced they're all bad."

When asked how they might help prevent the spread of invasives, many fell back on their familiarity with aquatic species and made the link between those messages and the potential to move plant parts on their clothing, vehicles and dirt bikes. The second most frequently mentioned prevention method was controlling the movement of firewood. However, a number of participants thought that restricting the movement of firewood was a "scam" designed to make money for the state. "If EAB was such a big problem, the DNR would be doing a better job of enforcing their regulations."

A number indicated that it was plausible that they may be moving invasives, but that they were unwilling to make the effort to limit their role. "It makes me a little angry. It's not fair, why do we have to do all of this? It takes the fun out of it." "How do I teach my kids (about nature) if I can't take them out in the woods?" "Yes it makes sense, but it is a very tiny grain of what's going on, because you can't control animals, birds and mudslides." A large number of participants also felt it was unreasonable to expect folks to clean up on-site because there's no easy way to do it, it's often raining, or you're just plain tired.

Overall, most of their experience with terrestrial invasive species has been with the DNR firewood restrictions and the media around the discovery of the emerald ash borer in Minnesota. While experience and responses varied, many did not view the firewood restrictions favorably, complaining about the high price and poor quality of the wood at state parks.

Even with the complaints we heard, there were a number of folks who defended the DNR and other public agencies for what they were attempting to do. One motorized trail user said "It's about time you asked us what's needed." And then later said "What you need to do, is empower us to fulfill the actions you want to see happen." He and another fellow motorized trail user were adamant about the need to educate folks to stay on the trail, pick up their trash and protect the environment.

A. Concepts for all Audiences

While it's clear most Minnesotans are likely to respond favorably to messages aimed at preventing the spread of invasive species, a good number of them do not know how, do not have access to the resources they need to carry out desired actions or aren't completely convinced the desired actions are worth their time. Others are already taking actions we want to foster and if encouraged could serve as advocates for others. So besides conveying these messages, it is important to establish and reinforce social norms so there is an incentive to continue the desired behavior over the long term. Establishing a well accepted social norm is also more likely to succeed in enrolling the 20 percent of individuals who are not currently inclined to do the right thing.

We want to foster the belief "I can easily make a difference in limiting the spread of terrestrial invasive species and it's important that I do so." To support that belief, other concepts to foster include:

- Invasive species = harm to our natural resources, economies and recreational experiences.
- Invasive species can spread in dirt and mud attached to vehicles, clothing, etc.
- Tree killing invasives can be spread in firewood.
- Prevention is effective, cheaper and more likely to succeed than pest control after an. invasive is established in an area.
- It's the right thing to do for our children and our future.

Attitudes and Perceived Barriers to address:

- Cleaning takes too much time away from other priorities.
- I can't get quality wood for a reasonable price at my destination.
- The tools I need, like washing stations, aren't available.
- I'm just one person, my actions don't matter.
- It's a lost cause, so why worry about it.

B. Potential Messages for All Audiences:

- Stop invasive hitchhikers
- Prevention works, stop invasive hitchhikers
- Clean your gear. Kids know it's the right thing do to
- Be smart, buy certified
- Save time packing, buy local firewood
- Protect your investment, clean your gear
- It's easy, just brush/pick and dump (dirt clods and plant debris)

C. **Suggested Products for All Audiences**

Because most recreationists participate in a number of activities, there is considerable overlap in the message and materials individuals may come across. So products aimed at the general public (or in this case, the general population of Minnesota recreationists) ought to broadly address what our role is as individuals and what we can do to prevent accidentally moving of invasive species as we recreate, rather than focusing on any single pathway of spread. Products designed for a particular subset of recreationists can better address those pathways of spread that may involve that particular audience.

- Brand and suggested text for partner organization websites
- "What Can I Do" brochure for distribution at retail outlets and public gatherings
- Branded prevention displays to be used at nature centers, state and county fairs, science museums, etc
- Brand and text for new or revised guide and regulation booklets
- Brand and text for state, federal and tribal use or access permits Brand and text for grants-n-aid contracts
- Brand and text for permits such as special event and fuel wood cutting permits
- Radio PSA on prevention
- Television clip on prevention for use in outdoor programs such as Minnesota Bound and Kent Herbek Outdoors
- Branded message for social media like Twitter and Facebook

D. Partners for All Audiences

Besides the government and tribal entities, it is important to involve retailers and manufacturers early in the education process. If our messages are consistent with their branding, they can be strong advocates and critical partners in reaching our target audiences.

- State, federal and tribal campground & trail managers
- Local units of government

- State universities and colleges
- Private campground & trail managers
- Minnesota Hospitality & Explore Minnesota
- Minnesota Parks & Trail Council
- Youth organizations
- Recreational retailers and manufacturers

E. Opportunities for Exposure:
Because of the number of agencies and organizations already involved in some form of public outreach and education in the invasive species arena, there is a myriad of ways to build on existing partnerships, programs and budgets. Take advantage of the breadth of those efforts to expose as many segments of the Minnesota population as possible to our brand and key messages.

- Look for opportunities to build on existing and/or planned communication and outreach efforts.
- With partner organizations, review upcoming events for communication and outreach opportunities.
- Develop a shared calendar of key events, milestones and occasions that provide opportunities for collaboration and exposure.
- Consider an interagency website on invasive species.

VIII Concepts, Partners and Products for Specific User Groups

Note that in reality user groups cross boundaries because most recreationists participate in a number of different activities. So the concepts presented below are those not already mentioned for all audiences and should be considered to apply more where recreationists might engage in these activities than to specific differences between groups.

Campers

Just about all recreationists camp in one form or another, so dividing campers into a single uniform category of recreationist may be misleading. However on the whole, most Minnesotans seem to be familiar with the firewood restrictions on state and federal lands. While most comply, their experience has not been favorable. As per their comments, wood quality has been poor, the prices high and the rules so varied between agencies that it's difficult to know what to do on a particular site. Enforcement has been inconsistent, the information has been confusing, and park staff have been uninformed or even at times dismissive of the regulations and their intent. Without a clear understanding of what to do and why, many individuals have made assumptions about the risk of spreading invasive pests that are not accurate and not helpful in light of our education goals.
That being said, there does seem to have been a shift in behavior since the DNR firewood restrictions went into effect in 2007. So in spite of the negative impressions, the program has succeeded in its chief goal to discourage actions at risk of spreading invasive species. Most participants report they acquire their firewood at their destination and a few even say they prefer it that way.

Given the wide range of campers and camping experiences, there are several sub-groups within the camping population. The ones of importance to us here are those groups whose interests determine where they are likely to camp (developed or undeveloped site), the kind of vehicles they use (motorized or not and thus their carrying capacity for firewood) and the equipment they are likely to take with them (the likelihood of moving soil and the volume of soil that could be moved). These sub-groups are also important when it comes to specific advertising campaigns and the media used to reach them. So for our purposes, we have identified key sub-groups as follows:

- Developed campground campers (tent and recreational vehicles) who drive to their camp site and may bring large vehicles or trailers with them. Because they are in a developed campground, there are several easy points of contact.
- Disbursed campsite campers who may be hiking, riding a horse or an ATV to get to their camp site. Because they often camp as individuals in undeveloped areas, opportunities for interaction are limited. Retail centers, maps, guidebooks, hunting permit regulations or the like may be a source of contact.
- Cabin owners & renters, who may bring large quantities of firewood with them to use over time. While there are a couple of associations for cabin and second home owners, they have not been among the traditional partners government agencies work with. That may need to change.
- Large event organizers, who may be bringing in large quantities of firewood to use during an event. Again more could be done to identify and build relationships between these organizations.

A. Concepts for Campers

Outside of their experience with firewood discussed above, several of the campers in the focus groups commented on the effect of dead and dying trees on their camping experiences. They clearly indicated that aesthetics is an important factor in choosing where and how they camp. Other values mentioned were: quality time with their family, teaching their kids about nature and relaxing away from the bustle of the cities. So concepts that might appeal them to include:

- Tree killing pests could ruin my favorite camping spot
- Acquiring local firewood could save time packing
- A quick brushing before leaving the site is easy to do
- Cleaning up can be a fun 'teachable moment' with my kids

Implications of risky or no action

- Infested campsites can lose their trees and other desirable vegetation.
- Campgrounds may have to close for safety reasons until dead trees are removed.
- Droppings from defoliating pests could make camping unpleasant.
- Campgrounds may lose their appeal as invasive species out-compete native flowers and shrubs, block trails or pose a health risk for our kids.
- Campsites without shade trees are not fun.
- Our firewood may be confiscated and we may be fined.

Attitudes and Perceived Barriers to Address

- We've got to have a fire, but can't count on finding high quality wood at our destination.
- They didn't ask about our firewood at the last park, so why worry about it this time.
- There are no facilities to clean our gear where we camp.
- Cleaning up takes away from family time.
- Hey it's green and pretty, why should we care?

B. **Potential Messages for Campers**

- Burn it where you buy it
- Pack marshmallows, not firewood
- Save time & space; buy your firewood at your destination
- Support rural development; buy local firewood
- Protect your campsite for next year; stop invasive hitchhikers
- Save time, save space, save the environment; buy local firewood

C. **Suggested Products for Campers** (not mentioned under all audiences)

- Branded brochure for those buying or burning firewood
- Branded firewood alert at check-in stations & on reservation websites
- Branded firewood posters for campground kiosks
- Branded labels and signs for use by firewood vendors

D. **Potential Partners for Campers** (not included above under all audiences)

- Youth camp managers
- Church camp managers
- Event organizers of camping events such as rendezvous, rodeo's, NASCAR, motocross and equestrian gatherings
- State and county fairs with camping facilities
- Campground hosts

Non-motorized Trail Users

Other than horse-back riders and skiers who need a permit to use DNR facilities, non-motorized trail users are difficult to identify and sample. While there are hiking and horse-back riding clubs, their membership is small compared to the large number of recreationists who participate in some form of non-motorized trail use. Since non-motorized activities include walking and hiking, non-motorized trail users include almost everyone. So reliably describing their demographics is nearly impossible. Those who self-identified as non-motorized trail users in our study, tended to be individuals who recreate alone or with their families rather than in clubs or other organized group. As per the UMN Recreation Trail User Survey (2008), runners and mountain bikers are more likely to be young men more interested in the challenge of the trail than aesthetics.

Horse-back riders are likely to be older women wanting to enjoy the scenery. Hikers are likely to be older and more educated than other user groups. Based on these differences and their accessibility through various media (such as riding club materials), critical sub-groups include:

- Hikers/walkers
- Runners
- Horse-back riders
- Mountain bikers

A. Concepts for Non-motorized Trail Users

Given the differences between those who see their activity as a form of exercise and those who see it as a form of recreation, the messages need to be customized to speak to the values of the specific audience in mind. Media outlets need to be to carefully considered as well. For instance, those out walking their dog or taking their morning jog are not likely to check the trail-head kiosk first. The biggest challenge with this audience is just making the connection between their activity and the potential to spread invasive species. After all, almost all of us fit in this group and how many of us think to dump our cuffs before going home? So a few concepts we want to convey include:

- Invasive weed seeds can hitch a ride on my shoes, clothing, horse or dog.
- Cleaning my is gear simple and protects my investment.
- Acquiring and using certified hay or feed is the smart thing to do.
- Doing our part is good public relations for our hiking/riding club/organization.

Implications of risky or no action

- Invasive plants can overgrow trails and forested areas, making walking, hiking, biking or horse-back riding unpleasant and difficult.
- Trails may close more frequently to avoid excessive disturbance during the 'mud' season.
- Trails may lack shade from dead or removed trees.
- Trail scenery may be altered by increased invasive species and less native trees and plants.
- Animals along trails may change or disappear as plant foods change.

Attitudes and Perceived Barriers for non-motorized trail users:

- I don't see them when I'm out, so are they really an issue?
- It's hard enough to find time to exercise without having to clean everything whenever I go out.
- We're not the problem; it's those ATV & dirt bike riders.
- Where I go, it's all buckthorn anyway, so what's the point?
- What am I supposed to do with the burs I pick off my dog?
- Certified hay isn't readily available in my area.

B. Potential Messages for Non-motorized Trail Users

- Keep yourself and your environment healthy
- Buy certified, it's the smart thing to do
- Don't give them a ride; stop Invasive Hitchhikers
- Clean your gear. It's easy. It's the right thing to do
- Clean gear = clean environment. Easy

C. **Suggested Products for Non-motorized Trail Users**

- Branded articles for hiking and riding club newsletters
- Branded "ads" for hiking and riding club newsletters, magazines and websites
- Branded key message for recreationists type to be included on club websites
- Branded presentations to be given at club or association gatherings
- Branded key messages added to all visitor programs, nature walks, and kiosk at trailheads etc.

D. **Potential Partners for Non-motorized Trail Users**

- Hiking clubs such as the Superior Hiking Trail Association
- Minnesota Dept. of Transportation (biking information)
- Metro Transit (biking information)
- Cycling clubs such as Twin Cities Bicycling Club
- Minnesota Horse Council
- Boundary Waters Advisory Council

Motorized Trail Users

Based on the DNR Recreation survey (2004), the number of motorized trail users is rapidly growing, at a time when all other outdoor recreation is on a decline. Other than motorized trail users, people are just getting out less than they used to and that is particularly true of young people these days. So it is notable that motorized trail users are likely to be young family men sharing their love of the sport with their kids (UMN Recreation Trail User Survey, 2008).

Because our funding was limited, we did not separate riders of two-wheeled vehicles from riders of four-wheeled vehicles or off-road trucks in our two studies. However, surveys carried out by those in the industry clearly demonstrate that the type of trails used and how recreationists use them varies dramatically based on the type of vehicle used. Two-wheeled vehicles can go places an ATV can't and an ATV can go places a truck or jeep can't. As such, critical sub-groups who need to be considered when developing any proposed messaging need to include:

- OHV, such as trucks and jeeps
- ATV riders
  Motorcycle & dirt bike riders

A. Concepts for Motorized Trail Users

Based on survey results, motorized trail users were slightly less likely to take the more environmentally friendly approach in answering survey questions. However, that trend was observed in the focus groups. In the focus groups, the motorized trail users were more likely to see the connection between their activities and the movement of invasive species. A couple mentioned that they had noticed seeds sprouting where they had cleaned their bikes. And they were more willing to do their part in preventing the spread of invasive species than the non-motorized trail users we talked to. Most already clean their equipment regularly and quite a few mentioned using the wash stations at those facilities that provide them. The comments suggested that one contributing factor in the difference in awareness was the influence of riding clubs in sharing information and establishing a social norm among their members, while non-motorized trail users tended to recreate as individuals with little contact with one another. An example of that was one motorized trail user who mentioned that word we were doing these focus groups had been passed through local riding circles well before we got there.

Another contributing factor seems to be recent coverage of the controversies surrounding ATV use and subsequent trail closures limiting access to their favorite sport. However, several participants expressed concern that government agencies might use invasive species as another excuse to close more trails, suggesting that using the threat of trail closures might be an outreach strategy that could backfire by creating more upset than support. So concepts we want to convey:

- Invasive species can spoil our riding experience.
- Cleaning our equipment is simple and protects our investment.
- Staying on the trail limits soil disturbance and the opportunity for invasive species to get established.
- Doing our part is good PR for our club or organization.

Implications of risky or no action

- Invasive plants can overgrow trails and forested areas, making riding unpleasant and difficult.
- Trails may close more frequently to avoid excessive disturbance during the 'mud' season.
- Make-shift trails help spread invasive hitchhikers.

Attitudes and Perceived Barriers

- I've heard a lot about cleaning my boat, but no one has said anything about my ATV
- They have closed so many trails, it's difficult to enjoy my sport. And now they're adding a bunch more restrictions, it's just too much.
- Who says it's more important than acid rain or global warming. It's just another excuse to pick on us.
- It's a lost cause, so why bother.
- We're not the problem, there are too many other ways for these things to spread.
- In my area, there are no facilities to clean my machine.

B. Potential Messages for Motorized Trail Users

A potential benefit of the existing social network among motorized users, besides accessibility, is the opportunity to use peer pressure and social norms to foster sustainable behaviors. The clubs also provide an outlet for advocacy like the DNR Trail Ambassador program. Also, because so many of these recreationists are already involved in actions that closely resemble the actions we'd like to foster, there is an opportunity to step things up by building on the values

behind their current actions. For instance, most regularly clean their machines at home. How much more would it take for them to clean their machines before they leave the site?

- Clean your machine, protect your investment
- Kids know, it's the right thing to do
- Teach 'em right, it's their future
- Protect your favorite vacation spots, clean coming and going

C. Products for Motorized Trail Users

- Branded messages for clubs to incorporate into member newsletters and Websites.
- Branded flyer for retailers to distribute to new owners of motorized recreational vehicles.
- Branded logo and tagline to be included in the tab registration information.
- Branded bumper sticker and window sticker.
- Branded posters or kiosks at access points on trails used by motorized recreational vehicles.
- Information on Minnesota DNR Website for OHV Trails: http://www.dnr.state.mn.us/ohv/index.html
- Brochures at highway information centers.
- Add Branded logo and tagline with key messages to all OHV maps.

D. Potential Partners for Motorized Trail Users

- Riding clubs such as Minnesota Off-Road Cyclists and Minnesota Trail Riders Association
- Motorized recreational vehicle retailers and manufacturers such as the Specialty Vehicle Institute of America
- Trail Ambassadors
- Grant-in-Aid trail sponsors

VII. Conclusions

The goal of this project was to design an education plan which would enhance protection of Minnesota forest resources by interrupting the link between recreational activities and the spread of terrestrial invasive species by fostering changes in behavior among Minnesota recreationists. Our objectives were to:

1. **Guide** outreach and education efforts (1) to provide consistent messaging among partner organizations and (2) to integrate those efforts to maximize the return on dollars spent.
2. **Educate** target audiences about changes in behaviors that can reduce the likelihood of their spreading invasive species.
3. **Motivate** target audiences to adopt recommended behaviors appealing to potential negative and positive consequences.
4. **Provide** baseline information by which behavioral changes among the target audiences can be identified and assessed to determine campaign effectiveness.

Two of the most important pathways addressed were those that move weed seeds in soil or manure or soil borne organisms along recreational trails, and those that move forest insect and disease pests in firewood or other plant or wood products. These pathways are closely associated with recreation trail users and campers, (among others not addressed in the context of this plan, such as cabin and second homeowners using firewood for heating purposes). After seeing the results of the recreational focus group study and baseline survey, the advisory committee discussed the current recreational behaviors and attitudes described and the ramifications for our outreach goal. Besides the points described previously in this document, the advisory committee developed two recommendations for participating organizations. The first was to use the *Stop Aquatic Hitch Hikers* model as a guide to build an outreach and education campaign for terrestrial audiences around the slogan "Stop Invasive Hitch Hikers". The second was to develop a unique brand, building on current recognition of the *Stop Aquatic Hitch Hikers* brand utilizing the stop sign image in our logo.

They also recommended that Minnesota state agencies work with partner organizations to update existing outreach materials to incorporate the new brand to the extent possible to collectively reinforce the message that recreationists can make a difference in limiting the spread of terrestrial invasive species.

Products the advisory committee felt were likely to be the most successful in reaching key audiences groups were:

Top priority

- Signs at trail heads and park entrances
- Public website on invasive species with links to other sites

- Brand icon & text to include on partner websites (such as associations, resorts, etc)
- Brand icons & text to go in regulation booklets, tourism guides and maps

Secondary products

- Promotional pieces (such as newsletter articles) for use by partner organizations
- Pamphlets and brochures for specific recreational audiences
- Brand icon & slogan to put on receipts, window clings, etc for use by retail outlets and local businesses

Other products

- Billboards
- Social media, like Facebook and Twitter

The next steps necessary in fulfilling our education goals include:

1. Obtain funds to develop and test a brand for our Stop Invasive Hitchhikers campaign. Toward that end, the DNR has dedicated a small amount to start the initial branding work.
2. Identify what public resources already exist and which products can be addressed in the context of existing budgets. Partner agencies are beginning those discussions.
3. Identify critical gaps in agency budgets and outreach materials, and pursuing funds to fully execute an outreach campaign for Minnesota recreationists.
4. Three years after executing the outreach campaign, repeat the baseline survey as designed in this project to describe the level of success in enhancing behaviors that limit the spread of terrestrial invasive species

X Appendices

Potential Carriers of Terrestrial Invasive Species Associated with Recreation

	Issue	Who moves it (Recreationists)	Points of Introduction
Firewood	Firewood can contain the immature stages (eggs, larvae & pupae) of a number of wood boring insects and/or bark beetles that can later emerge to attack nearby trees. It can also carry a number of disease pathogens, whose spores can be carried by wind, rain or insects to nearby trees. Examples include EAB, ALB, Sirex wood wasp, oak wilt and Dutch elm disease	• Cabin & 2nd home owners • Campers (campground and dispersed campers) • Campground & resort owners/managers • Recreation organizations (scouts, riding clubs, NASCAR, etc) • Cultural organizations (pow wows & rendezvous')	• State parks • County & regional parks • Private campgrounds & resorts • Lakeshore & woodland homes & adjacent natural areas
Landscape plants	Landscape plantings can themselves be invasive species whose seed is spread by wind or animals to adjacent areas. Or they can carry invasive species on their leaves or bark or in the soil they're grown in. Examples include Amur maple, buckthorn and Asiatic weevils and Japanese beetles which are moved as grubs in the potting soil	• Cabin & 2nd home owners • Campground & resort owners • Recreation organizations w/ permanent facilities (like scout & church camps)	• Adjacent natural areas • Adjacent rights-of-way • Nearby trail systems
Hay, seed and other feed	The species of hay can be an invasive plant itself. Or weeds mixed in with the hay can produce viable weed seeds. Many seeds easily survive passing through grazing animals and are thus spread in their manure.	• Horseback riders • Recreation organizations (scouts, riding clubs, NASCAR, etc) • Cultural organizations (pow wows & rendezvous')	• Trails • Group campsites • Outdoor event locations
Bait	Fishing bait often contains a mixture of worms, none of which are native to Minnesota. When excess bait is dropped on the ground, the worms can survive to spread into adjacent natural areas.	• Anglers	• Woods adjacent to lakes, boat landings & piers
Logs, pallets & building materials including mulch & gravel	Logs used for log homes and pallets used for transporting household goods (like appliances) can contain insects and pathogens much like the firewood described above. If fresh, mulch can also contain insects and pathogens. But it also can contain weed seeds. Gravel is another source for weed seed.	• Campground & resort owners/managers • Cabin & 2nd home owners • LUG natural centers	• Trails • Cabin & 2nd home sites • Nature Ctr & recreation facilities • Adjacent natural areas • Adjacent rights of way

	Issue	Who moves it (Recreationists)	Points of Introduction
Vehicles (those associated with recreation	Besides carrying goods that may carry invasive species, such as logs, hay, landscape plants, etc, vehicles themselves may have egg masses or other life stages attached to them, or have mud containing weed seeds caught in their tires and grills. Off-road vehicles can also disturb natural areas leaving them open to invasion.	All recreationists	• ATV & bike trails • Parking areas • Campsites • Adjacent natural areas • Adjacent rights of way • Trail Maps
Soil	Soil often contains weed seeds, soil-borne pathogens, parasites and the immature stages of insects and worms. Examples include garlic mustard, night crawlers, sudden oak death pathogen, and Japanese beetles	All recreationists	• Trails – all types • Parking areas • Campsites • Adjacent natural areas • Adjacent rights of way
Personal gear & belongings (boots, clothing, packs, lawn furniture, etc)	Personal belongings can contain weed seeds and in some cases the immature life stages of some insects, such as the gypsy moth.	All recreationists	• Trails – all types • Parking areas • Campsites • Adjacent natural areas • Adjacent rights of way
Horses & pets	Horses & pets may have seed or parasites attached to their coats. They may have mud & soil containing additional other invasive species on their hooves or paws. Horses can also disturb natural areas leaving them open to invasion.	• Hikers • campers • Dispersed land users (hunters & gatherers) • Horseback riders	• Trails – all types • Parking lots • Campsites • Adjacent natural areas • Adjacent rights of way

Relative Ranking of
Terrestrial Invasive Species Carriers

Rank each carrier relative to each other on a scale of 1 to 9 (no duplicate rankings), with 1 = least potential and 9 = most potential

Criteria	Notes on criteria	Firewood	Land-scape Plants	Feed & Seed	Bait	Logs & bldg materials	Vehicles	Soil	Personal gear	Horses & pets
Potential to move invasive species	Consider the number of different types of pest species involved	7	6	4	1	9	5	8	2	3
	Consider the potential number of insects or propagules involved	7	6	5	1	9	3	8	2	4
	Consider their source and distribution	7	5	4	1	6	8	9	2	3
	Consider the likelihood of further spread.	8	5	4	2	7	6	9	1	3
Potential to impacts natural resources	Consider their (spp above) potential to cause NR damage	8	5	4	2	7	6	9	1	3
	Consider the impt of the resource being impacted.	6	5	3	4	9	7	8	1	2
	Consider the potential for economic impacts	8	5	4	2	9	6	7	1	3
	Consider the potential for social impacts	9	6	4	1	5	7	8	2	3
Potential for outreach to key **recreation** audiences	Consider the number of different types of audiences involved	6	4	2	1	5	8	9	7	3
	Consider the number of individuals involved	6	5	2	4	3	8	9	7	1
	Consider the types of outreach venues available to reach those audiences	9	4	2	5	3	7	9	6	1
	Consider the number of outreach venues specific to those audiences	9	8	2	6	4	5	7	3	1

Criteria	Notes on criteria	Firewood	Land-scape Plants	Feed & Seed	Bait	Logs & bldg materials	Vehicles	Soil	Personal gear	Horses & pets
Potential for assessment and/or measurement of success	Consider the **means** of **qualifying** audience behaviors & motivations	6	4	2	1	5	8	9	7	3
	Consider the **ease** of **qualifying** audience behaviors & motivations	5	9	7	8	3	2	4	1	6
	Consider the **means** of **quantifying** audience behaviors & motivations	6	4	2	1	5	8	9	7	3
	Consider the **ease** of **quantifying** audience behaviors & motivations	5	9	7	8	3	2	4	1	6
Potential to build on previous work	Consider the volume of existing materials available	9	8	5	6	7	3	2	1	4
	Consider their effectiveness at changing public behavior	5	7	9	6	3	2	4	1	8
	Consider the ease of adapting materials to fit our needs	5	9	7	8	3	2	4	1	6
Average Score		6.9	6.0	4.2	3.6	5.5	5.4	7.2	2.8	3.5

In lieu of hard evidence in the form of peer reviewed papers, a system of relative ranking using expert opinion was used to identify pathways to target in this project.

XI. References

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2. Pepin Hugunin and Associates. Invasive Species Project, Focus Group Report, Part I. Detailed Findings. October, 2009
3. Pepin Hugunin and Associates. Invasive Species Project, Focus Group Report, Part II. Summary and Analysis. November, 2009
4. Pepin Hugunin and Associates. Invasive Species Project, Survey Report. April, 2010
5. Pepin Hugunin and Associates. Invasive Species Project, Final Analysis. April, 2010
6. Schuweiler, Andrea, M.S. and Schneider, Ingrid, PhD. State of Effective Educational Efforts to Reduce the Transport of Terrestrial Invasive Species and Applications for Minnesota (a literature review). June, 2009

The cited references 1,2,3 and 6 can be found on the DNR Forest Health Webpage: http://www.dnr.state.mn.us/treecare/forest_health/annualreports.html

Urban and Community Forestry

U&CF grants and projects affiliated with the Forest Health Program
2006 Community Rapid Assessment Survey for ash and elm: Final report.
2010 Community Rapid Assessment Survey for all species. Initial report
MN STAC report on the invasive species threats in Minnesota

Community Forestry Program's grants and projects that are affiliated with the Forest Health Program

Here are the Community Forestry projects that are affiliated with the Forest Health Program.

1. Grants and Contracts Administration

- MN Community Forest Bonding grants: 2008-2011, $500,000 (15 projects)
- MN Community Forest Bonding grants: 2010-2014, $3,000,000 (24 projects to date)
- USFS competitive grant for Rapid Assessment of Community Forests, $362,000
- 2 USFS competitive grants for Community EAB Preparedness, $306,000
- Professional and Technical contract for Initiating Greater MN Model Communities EAB Preparedness Program

2. Community Forest Bonding Grants

2008 to 2011 Grant Program. A total of 15 communities were awarded $450,000 of state bonding funds for projects in 2008 through 2011. These grants were made for the removal, disposal and replacement of dead or dying shade trees located on publicly owned land that are lost to forest pests or disease. As the name implies, these grant projects are financed using state general obligation bond dollars, authorized by the 2008 Minnesota State Legislature. The use of these funds is specifically restricted to activities of a capital nature and must be conducted on publicly owned land.

2010 to 2014 Grant Program. The 2010 Legislature appropriated an additional $3,000,000 of bond funds for a 4 year period, for grants to local governments "**to plant native trees to replace trees lost to forest pests, disease or storm; or to establish a more diverse community forest better able to withstand disease and forest pests, and to remove and replace ash trees infested with Emerald Ash Borer.**" Compared to the previous bonding grants program, the emphasis now shifted from replacing trees lost to all forest pests to replacing EAB infested trees and planting a much greater variety of trees, in order to increase the diversity of community forests. The appropriation is being allocated in 2 rounds of grants, $1.5 million was offered in November 2010, for work through spring 2012, and the remaining $1.5 million is expected to be offered in summer 2012, for work through spring 2014, during which time new EAB infestations are expected to be discovered.
For the initial grant round, a total of 23 local government units were awarded $559,000 of state bonding funds for projects in 2011 through 2012.

3. Community Rapid Assessment Projects

Both of these projects were funded by a Competitive USFS Grant. See reports on following pages.

4. Minnesota GreenCorps

The Pollution Control Agency , DNR and MDA completed a very successful pilot year for the Minnesota GreenCorp Program in 2009 to 2010. Urban Forestry GreenCorps members were hosted by the cities of Duluth, St. Paul, Woodbury and Rochester.

All GreenCorps members completed at least partial city street tree inventories, provided EAB outreach, and planned Arbor Day ceremonies. In Rochester, they helped install a gravel bed system for temporary holding of nursery stock, a key component of that city's efforts as part of the University of Minnesota's EAB Rapid Response Community Preparedness research project. In St. Paul, the program helped survey neighborhoods to determine outreach needs and developed a new St. Paul Street Tree Planting Master Plan. Woodbury's UTC project has spurred similar projects in Minneapolis and St. Paul. All 4 GreenCorps members initiated or improved their city's EAB Preparedness Plans.

2006 Rapid Assessment of Ash and Elm Resources in Minnesota Communities

By Resource Assessment Unit, Forestry Division

Minnesota Dept. of Natural Resources

The full report can be found on the following website: http://files.dnr.state.mn.us/assistance/backyard/treecare/forest_health/ash_elmRapidAssessment/rapidassessment_AshElm.pdf

Introduction

In the early 21st Century, resurgence of Dutch elm disease *(Ophiostoma ulmi)* put populations of elms (*Ulmus* spp.) in Minnesota towns at the greatest risk since the epidemic infections of the 1970s and 1980s. The U.S. Forest Service has attributed the renewed outbreak to decreasing community vigilance, together with buildups of insect vectors and host trees in the wild (Haugen 1998). All native elm species are susceptible to some extent.

The same period saw the introduction of a new urban forestry threat in the shape of emerald ash borer *(Agrilus planipennis)*, a beetle introduced from Asia, larvae of which kill ash trees (*Fraxinus* spp.) by feeding on the inner bark (McCullough and Katovich 2004). The insect has destroyed millions of trees in Michigan, Ohio, Indiana, Illinois and southern Ontario, in the face of costly eradication and quarantine efforts since its establishment around 2000. All native Minnesota ash species are susceptible, though the borer has not, as of 2006, been detected in the state.

Efforts to combat such urban forestry threats often involve inventories to assess the size and distribution of the populations at risk or under actual attack. Bloniarz *et al.* (2003) describe applications of modern geographic information system (GIS) and Global Positioning System (GPS) technology in the context of urban forest inventory. Public and private agencies as far apart as Washington D.C. and Alberta have used these and more traditional tools to inventory and map threatened elms (see web accounts at http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/prm4494, http://www.cps-scp.ca/pathologynews/dutchelmdisease.htm, and http://www.caseytrees.org/pdfs/ElmFactSheet061406L.pdf describing these and similar elm inventories.)

In response to emerald ash borer infestation, Michigan investigators in 2005 undertook inventories of threatened and attacked *Fraxinus* species (http://www.forestprod.org/smallwood06weatherspoon.pdf.) The states of Illinois (http://dnr.state.il.us/conservation/forestry/urban/IAA_1020_06.htm) and Ohio (http://www.dnr.state.oh.us/forestry/eab/pdf/EABmanagement_plan032406.pdf) include inventories of threatened species in their community action plans. Researchers at a recent U.S. Forest Service conference on ash borer management in the U.S. and Canada (Adams and Sapio 2004), describing inventory requirements for establishing an extensive "reduced ash zone" to inhibit spread and impact of the pest, remark that conventional Forest Inventory and Analysis (FIA) data are of limited utility in urban forestry applications:

> Urban areas or areas classed as “non-forest” are currently not well-represented in FIA, creating a need to capture additional information on ash density where FIA plots do not exist.

In particular, any economic analysis of potential ash and elm impacts comparable to that performed by Nowak *et al.* (2001) on the possible toll of the comparatively omnivorous Asian longhorned beetle *(Anoplophora glabripennis)* would require more specific and better-localized data than FIA provides.

Objectives

Many smaller communities in Minnesota have little or no information on species composition and health of street and yard trees. In 2006 we undertook a project intended to characterize at low cost the abundance, size and condition of the *Ulmus* and *Fraxinus* resource in residential and commercial areas of Minnesota municipalities. We conducted on-the-ground sample surveys of more than 750 separate communities across the entire state to gather the data.

Methods

General: Field survey was obviously necessary to accomplish the aim; no available remote technique would provide the required discrimination of tree genera, or detect trees in the sapling (1-5" diameter) class. Three two-person crews with vehicles were deployed to conduct a "windshield" survey during summer 2006. Residential and business streets were used as our sampling frame: crews would drive a specified distance along streets in each municipality, visually tallying all ash and elm individuals within one chain (66') of the pavement edge in the following classes in the table.

Genus	Ash	*Fraxinus* spp.
	Elm	*Ulmus* spp.
Size class	Sapling	1-5" diameter breast high
	Pole	5-12" diameter
	Sawtimber	>12" diameter
Condition	Healthy	< 30% visible crown damage
	Discoloration	>30% of crown affected
	Dieback	>30% of crown affected
	Dead	

Delineating Areas of Interest: The survey was intentionally confined to residential neighborhoods and main business corridors within municipalities. Primary interest lay in street and yard trees in these areas, not in woodlot trees in areas of low population density. This meant that legal limits of municipalities could not be relied on to define the area under study, as in many rural communities these encompass a great deal of land and water remote from residential/commercial neighborhoods. In each of the 789 communities to be sampled, street maps were overlaid on 2003 aerial photography, and a GIS was used to delineate a study area boundary including only roaded residential and business areas as far as they could be distinguished. Sample results would be expanded to the area enclosed by this boundary.

Sampling intensity: Time and resources precluded a complete census of all residential streets in all communities. Instead, the sample was proportioned to the total street mileage in each town:

Total street mileage	***Percentage sampled***
< 1 mile	100%
1-2 miles	75%
2-4 miles	50%
4-6 miles	33%
6-10 miles	25%
10-15 miles	20%
15-20 miles	15%
20-30 miles	12%
30-45 miles	10%
45-75 miles	7%
75-200 miles	5%
200-350 miles	4%
350-1000 miles	3%
>1000 miles	2%

Street miles to be surveyed were calculated on this basis for each of 789 municipalities. An orthophoto road map of the study area was prepared for each, and distributed to field crews. A general map of the communities surveyed appears as Figure 1 below, and a sample municipal orthophotomap surveyed appears as Figure 2.

Field methods: Crews drove their assigned street mileage in each community, recording all ash and elm trees observed within 66 feet from either edge of the street. The data form used appears as Figure 3 below.

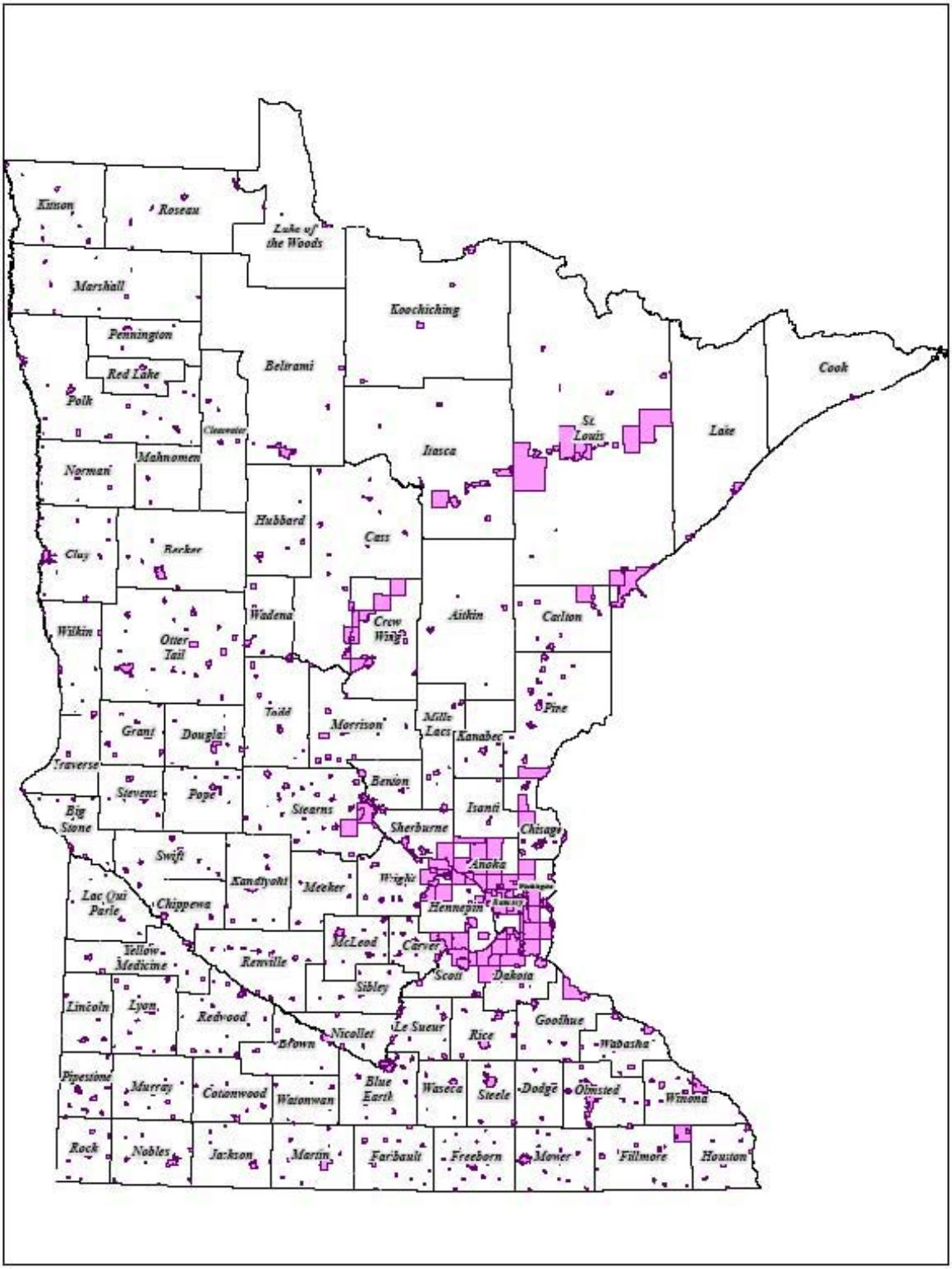


Figure 1. Map of communities surveyed. Outlines show legal boundaries.

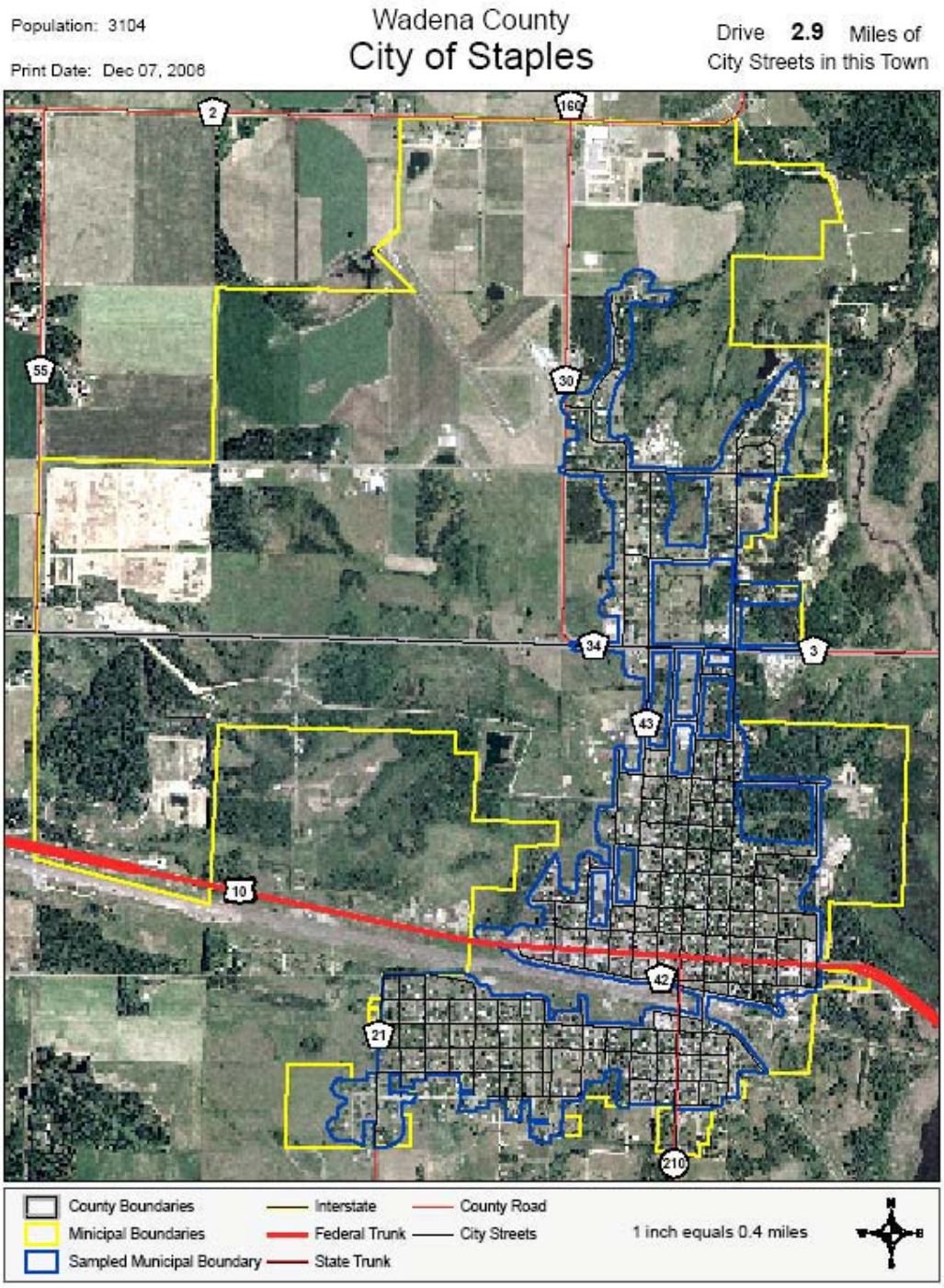


Figure 2. Orthophotomaps like this were the primary navigational tool used by field crews in making the survey. The yellow outline represents the legal boundary of the municipality; the blue outline delineates the residential-commercial area of interest, to which sample data were expanded.

LUG:	Date:	Miles Surveyed:	Crew:

	# Elm					% Elm in LUG:
	Healthy	Stressed			Dead	Remarks
		Dieback	Discoloration	Dieback & Discoloration		
Saplings (1 – 5 inch)						
Pole (5 – 12 inch)						
Sawtimber (12 inch plus)						
Total						

	# Ash					% Ash in LUG:
	Healthy	Stressed			Dead	Remarks
		Dieback	Discoloration	Dieback & Discoloration		
Saplings (1 – 5 inch)						
Pole (5 – 12 inch)						
Sawtimber (12 inch plus)						
Total						

Figure 3. Field tally sheet used to record tree observations.

Data quality control: A blind check of crews' survey results was run in 69 of the 789 communities surveyed. Crews other than those who gathered the original data, including supervisory personnel, conducted the checks. The checks uncovered substantial differences in crews' ability to distinguish and count target trees. One crew's communities were resurveyed on account of discrepancies identified in field checks.

Results

At an approximate cost of $75 for fieldwork and $65 for office work per community, basic data on presence, size, and condition of ash and elm trees in residential areas of nearly 800 highly diverse municipalities across Minnesota were generated. These data are presented in map form in Figures 4-9 on the following pages. Statewide summary data appear in Tables 1-4 at the end of this report. A complete tabulation of ash and elm in all communities in each county is given in a separate Appendix.

Field checks indicated that ash were undercounted by 14 percent and elm by 33 percent statewide, taking field-check counts as the basis (Table 4.) Most of the variation occurred in the sapling (1-5" diameter) class. Excluding this class, statewide ash field check totals differed from the initial count by 1 percent, while elms were underestimated by 18 percent. We had hoped that community-by-community field check figures would be within 30 percent of original count data in two-thirds of cases; ash counts met this goal in 68 percent of communities, but elm counts did so in only 43 per cent.

Preliminary calculations using benefit-cost tables from the USDA *Midwest Community Tree Guide* (McPherson *et al.* 2005) suggest that the elm population identified in this survey provided approximately $29 million, and the ash population $20 million, in net public benefits in the year 2006 (D. Mueller, MN DNR Community Forestry Partnership Coordinator).

Discussion

The survey achieved its primary objective: cost-effective field estimates of the distribution, size and condition of two at-risk tree genera in a large number of communities. The results represent the most thorough estimate of residential ash and elm ever attempted in Minnesota; they will be of value in evaluating future tree health measures relating to these genera, and will facilitate communication with legislators and policymakers considering investments to protect urban trees.

This type of survey could be conducted on a continuous basis, and its scope expanded to include all major tree genera in Minnesota communities. Costs per municipality could be expected to rise to approximately $330, amounting to about $272,000 statewide, or $68,000 annually for a four-panel continuous program.

This survey was designed and implemented at short notice, and improvements were made as work progressed. Some gaps and inadequacies in the survey became evident by the time of completion:

Target recognition: Field checks revealed larger than expected between-crew differences in ability to discern and identify trees of the target genera. One crew's work was re-done as a result of field check data. Better pre-survey training in tree identification is indicated.

Tree count: Counts of target trees became more variable in high-density areas; this was compounded by crews' differing ability to estimate, from the street, the 66-foot width of the sample strip. Future surveys should probably be conducted on foot rather than from vehicles, and laser rangefinders employed to help define transect width. Use of portable data recorders or PDA devices to replace data forms would streamline data flow.

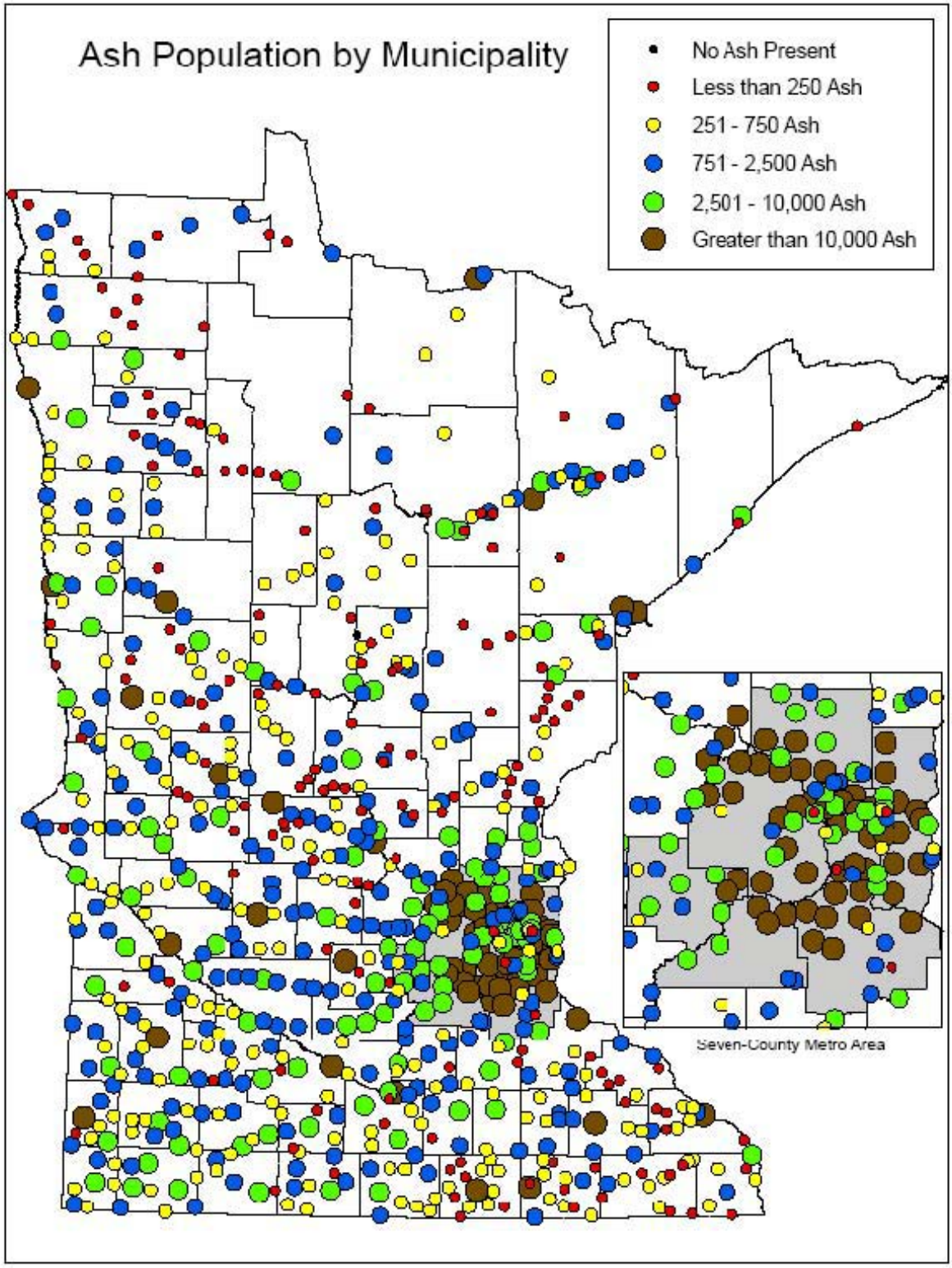


Figure 4. Ash populations in Minnesota municipalities, all tree-size classes. (Inset shows Minneapolis-St. Paul metropolitan area at enlarged scale.)

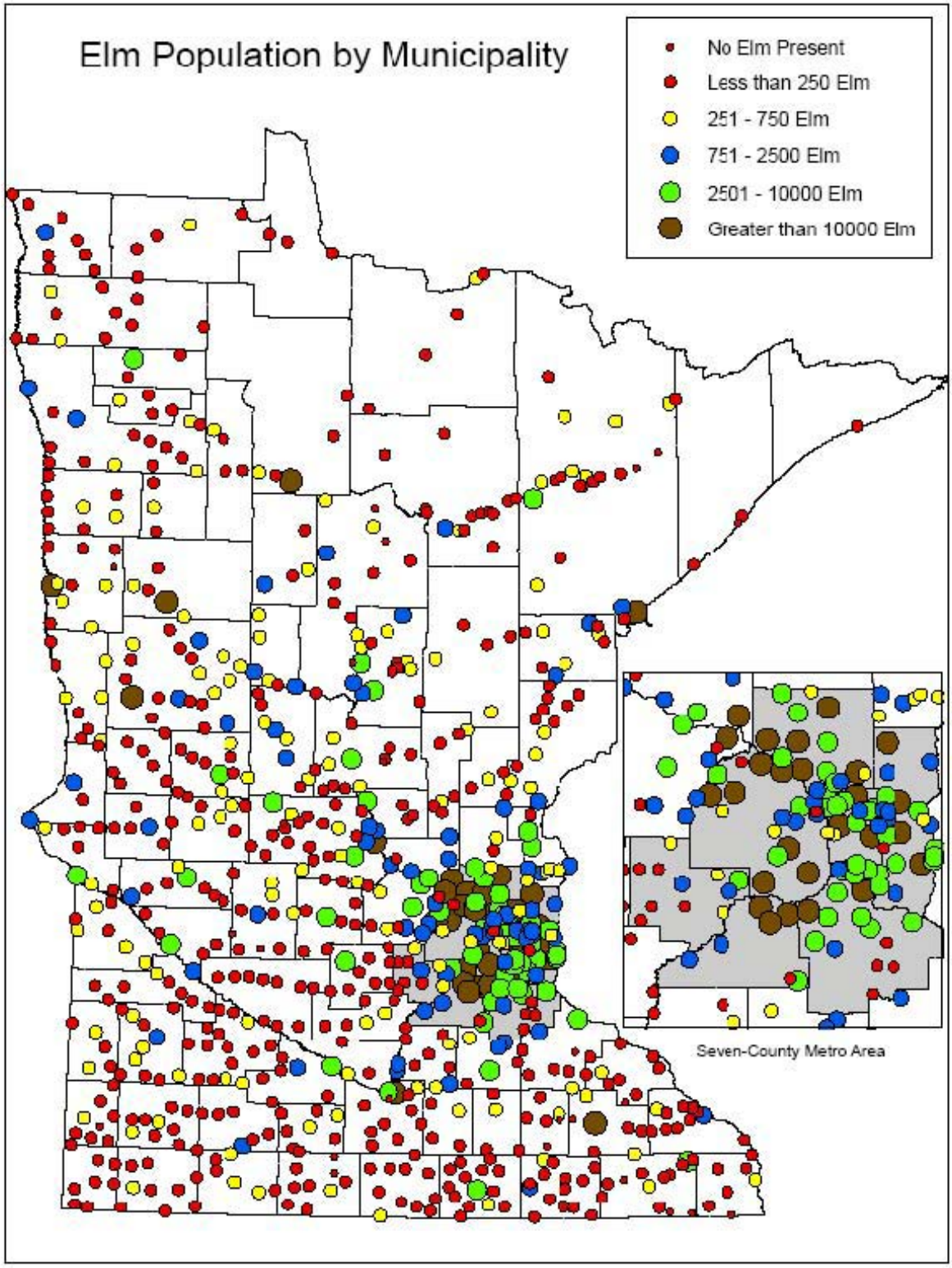
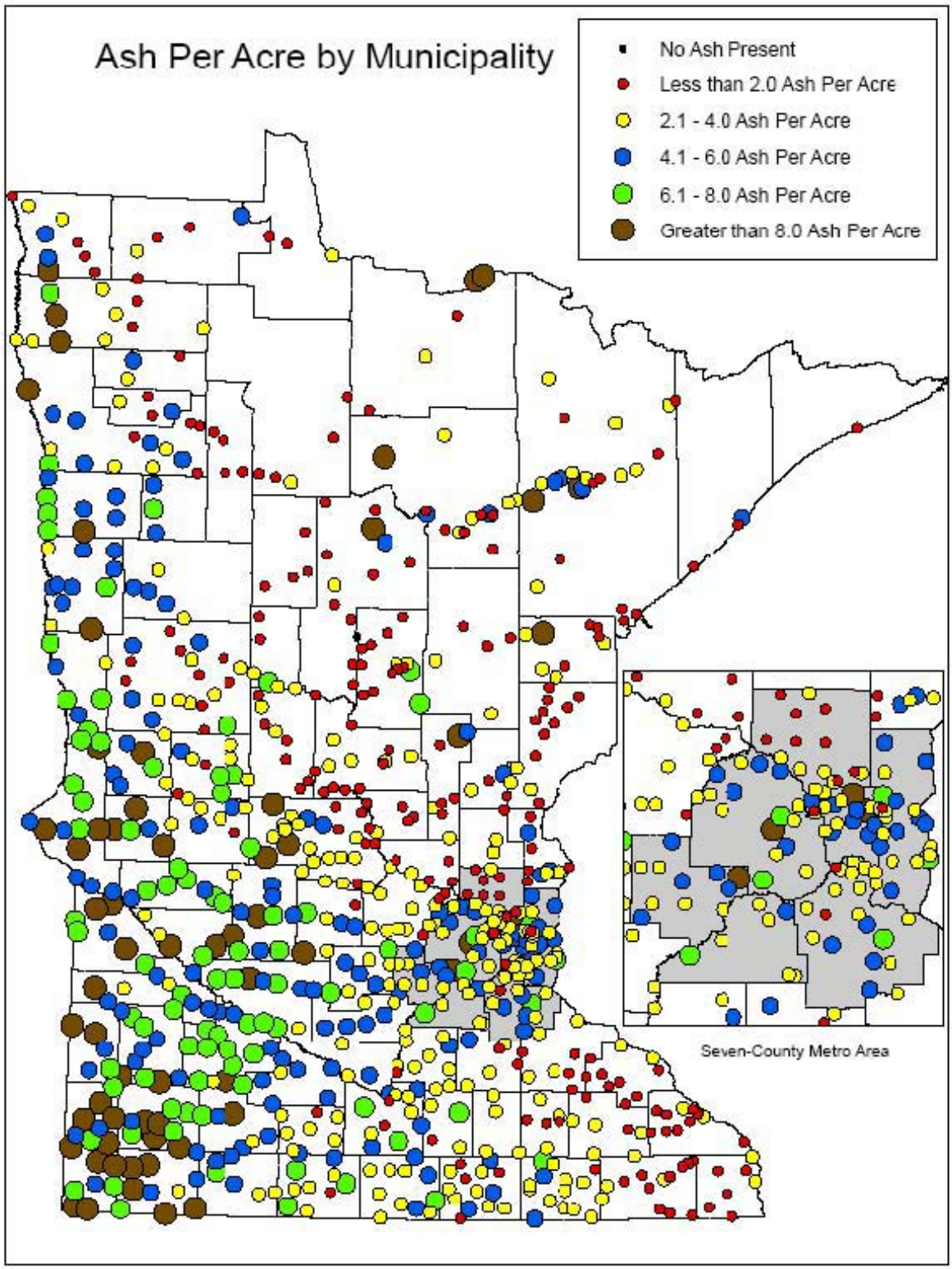
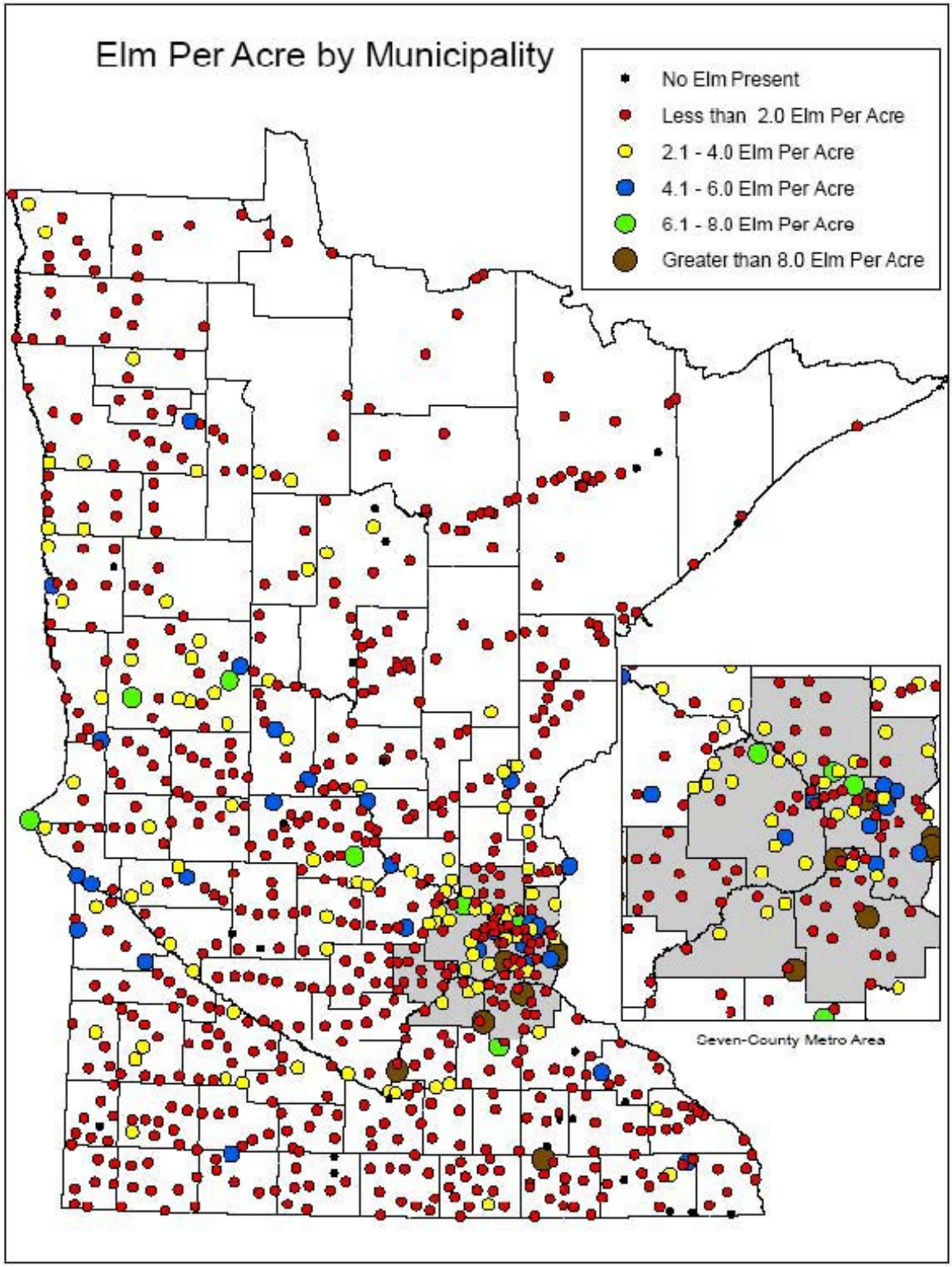


Figure 5. Elm populations in Minnesota municipalities. *Figure 6.* Ash density in Minnesota municipalities. *Figure 7.* Elm density in Minnesota municipalities.


Ash Per Acre by Municipality
No Ash Present
Less than 2.0 Ash Per Acre
2.1 - 4.0 Ash Per Acre
4.1 - 6.0 Ash Per Acre
6.1 - 8.0 Ash Per Acre
Greater than 8.0 Ash Per Acre
Seven-County Metro Area



Sample strip location: Within each community, crews chose the particular street segments they would survey, and

marked them on the orthophotomap. From the orthophotomap the routes were visually transferred to GIS for measurement and recording. It would probably have been better to pre-designate the street segments on the orthophotomaps, and use GPS to locate start and end points. This would have eliminated ambiguity, and facilitated field checks.

Dieback and discoloration thresholds: A tree was to be tallied in the dieback or discoloration column if 30 percent of its crown was affected. Field checks showed wide discrepancies in interpretation of this threshold value. Unless a higher level of training can be achieved, the threshold should be done away with, and crews instructed to put all trees with any level of dieback or discoloration into the affected columns.

Relative stocking of ash/elm and other trees: Tabulations include estimates of the percentage of total residential/commercial tree stocking represented by ash and elm in each locality. These are purely ocular estimates unsupported by actual enumeration. If this information is desired from a future survey, provision should be made for a tally of all trees in some proportion of the sample strips.

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Acknowledgements

Funding for this survey was provided by the Forest Health Protection program of State & Private Forestry, USDA Forest Service, and by the Division of Forestry, Minnesota Department of Natural Resources.

2010 Rapid Assessment of Community Forests Project

A project similar to the 2006 Rapid Assessment of Community Forests was created and expanded to cover all tree species in 2010. It was funded by a Competitive USFS Grant. DNR Forestry Resource Assessment survey crews finished inventorying all common genera of trees, in public and private ownerships, for 700 communities statewide. Survey protocol had been refined since the 2006 survey of elm and ash. Data entry is completed and staff are currently creating individual reports for each community. Complete analysis and a final report are expected in spring 2011. DNR survey accuracy is being checked against inventory results from the U of M's "EAB Rapid Response Community Preparedness Project" model communities.

2011 Legislative Considerations:

MnSTAC supports:

- Government programs that will preserve and protect the state's tree and community forest resources, as well as programs that provide for removal and replacement of diseased or infested trees
- Funding for municipal EAB planning and response efforts
- Maintaining the roles and responsibilities that the DNR and MDA each have relative to community forest health management and invasive species, and maintaining funding for invasive species and forestry programs at MDA and DNR so that federal funds can continue to be leveraged
- LCCMR's recommendation to fund biological control of EAB using three species of stingless wasps to kill developing EAB eggs and larvae
- Funding the successful, statewide ReLeaf Program, and tree-planting and protection as a stormwater mitigation Best Management Practices.

Failure to leverage federal funds for tree pest rapid response and management programs will place a greater long-term burden on the state and effectively create a new unfunded burden on local governments.

Minnesota Shade Tree Advisory Committee
The Minnesota Shade Tree Advisory Committee (MnSTAC) was established in 1974 to address the health and well-being of Minnesota's community forests, initially focusing on Dutch elm disease. Today, MnSTAC has a diverse membership of over 420 individuals, representing a broad spectrum of green-industry interests. MnSTAC is recognized throughout Minnesota and the nation for its expertise, innovation, counsel, coordination, and support related to a variety of shade-tree issues.

A coalition of organizations supports these considerations:

Minnesota Shade Tree Advisory Committee (MnSTAC)
Minnesota Nursery & Landscape Association (MNLA)
Minnesota Society of Arboriculture (MSA)
Tree Trust

For More Information

Minnesota Shade Tree Advisory Committee –
www.mnstac.org
Minnesota Society of Arboriculture –
www.msa-live.org
Minnesota Nursery & Landscape Association –
www.mnla.biz
MN Dept of Agriculture –
www.mda.state.mn.us
MN Dept. of Natural Resources –
www.dnr.state.mn.us
Tree Link –
www.treelink.org
Tree Trust –
www.treetrust.org
USDA Forest Service –
www.na.fs.fed.us
USDA Forest Service's Center for Urban Forest Research –
www.fs.fed.us/psw/programs/cufr/
University of Minnesota –
www.myminnesotawoods.umn.edu/category/urban-natural-resources/community-forestry/

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Minnesota Trees Are Under Attack

New pests of mass destruction pose the greatest threat ever faced by Minnesota trees.

Residents consistantly rank trees as the 1st or 2nd priority for improving their neighborhoods. Source: Minneapolis Neighborhood Revitalization Program Surveys.

- **Emerald Ash Borer (EAB)** has destroyed millions of ash trees in the Midwest and has now begun to destroy trees in Minnesota, which affects the timber industry as well as family and community forests.
- **Gypsy Moth,** which already has a toe-hold in Cook and Lake counties, defoliates whole forests, year after year, slowing growth which affects all Minnesota forests.
- **Asian Longhorned Beetle (ALB),** not yet in Minnesota, bores into maples, elms, and willows. Once this pest has invaded an area, every maple, elm, and willow may be lost.
- **Dutch Elm Disease** remains a threat, with over 56 communities around the state reporting an alarming increase in the number of sick elms.
- **Oak Wilt** continues to fester in many suburban and rural communities of the Twin Cities and SE Minnesota.

Response to EAB will require difficult management decisions at the local level. Considerations must be made for increased energy costs, increased stormwater runoff, removal and replacement costs, loss of habitat and decreased property values resulting from tree loss.

West California Avenue in St. Paul was covered in a canopy of ash trees. *(MPR Photo/Jeffrey Thompson/November 2009)*

This is the same street after the decision was made to cut down all ash street trees, to slow the spread of EAB and spread tree removal costs over time. *(MPR Photo/Jeffrey Thompson/November 2009)*

Financially strapped cities and homeowners must pay the staggering costs to remove dead and dying trees and restore canopy cover.

The Minnesota Shade Tree Advisory Committee was established in 1974 by the Minnesota Legislature to address the health and well-being of Minnesota's community forests.

MnSTAC 2011 REPORT TO THE STATE OF MINNESOTA

Minnesota Shade Tree Advisory Committee

Trees pay us back

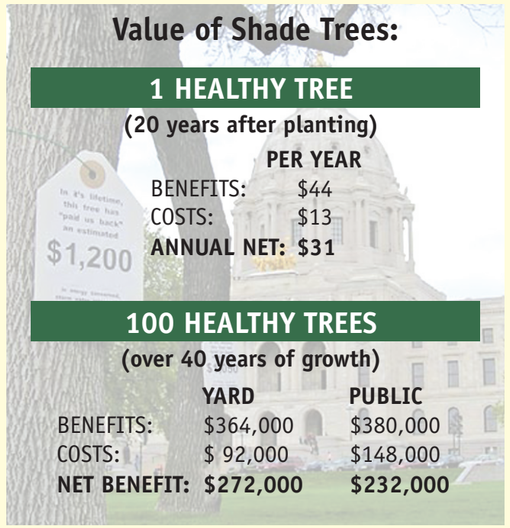
Properly cared for, they are capital—and growing—assets ***worth three times their investment.**** Trees increase in value as soon as they are planted and continue to appreciate as they mature.

**Based on a 2004-05 tree study, U.S. Forest Service.*

Beyond removal and replanting costs...

St. Paul's South St. Anthony Park neighborhood is "ground zero" for EAB in Minnesota.

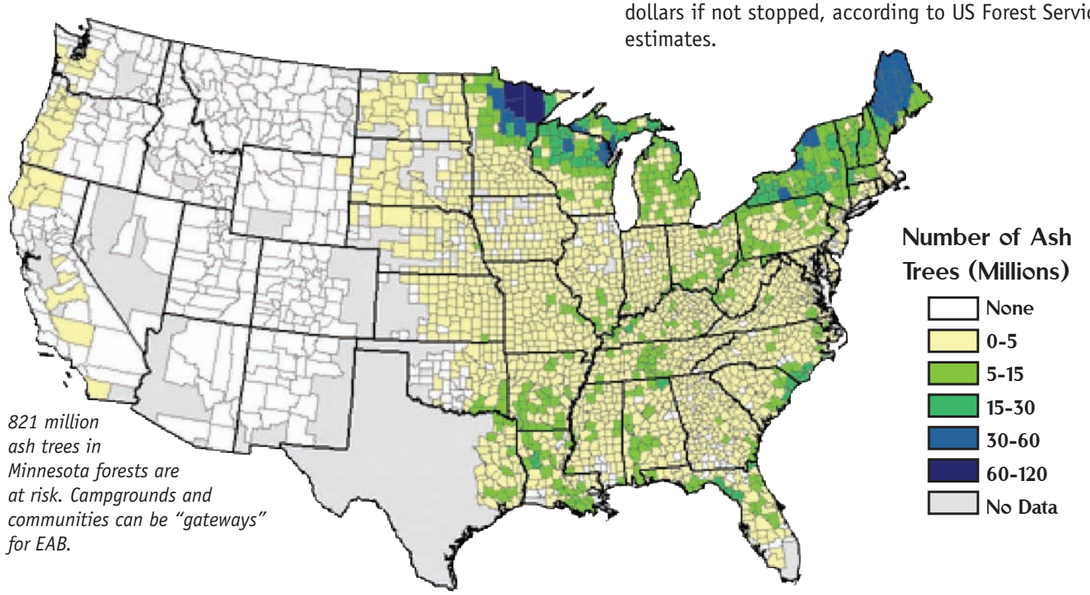
A recent study shows that their 484 ash street trees provide benefits worth over $56,000 every year. This is in an area that is only 4% of St. Paul. Furthermore, public trees typically represent only 10% of a community's forest, so the benefits provided by private property trees are 10 times greater than benefits provided by public trees.



Current threats:

Gypsy Moth, Emerald Ash Borer, and Asian Longhorned beetles travel like hitch-hikers — in shipping crates, firewood, logs, nursery stock, and even on car bumpers across state and national borders. High-risk points-of-entry include campgrounds, sawmills, nurseries, and urban areas. If we do not stop them there, they will spread to forests and the countryside, with devastating results.

- **EAB management will cost** municipalities, property owners, nursery operators, and forest-product industries tens of millions of dollars. Minnesota has over 821 million ash trees in forests, communities and agricultural areas throughout the state.
- **Gypsy Moth** - It costs one-third as much to slow the spread of Gypsy Moth as to treat it once established.
- **Asian Longhorned Beetle** alone could destroy 1.2 billion trees in the U.S. at a value of $669 billion dollars if not stopped, according to US Forest Service estimates.



821 million ash trees in Minnesota forests are at risk. Campgrounds and communities can be "gateways" for EAB.

Minnesota responds:

State agencies and the University of Minnesota have teamed up for a coordinated response. The Minnesota Department of Agriculture (MDA) monitors and responds to the introduction of exotic and invasive plant pests. The Minnesota Department of Natural Resources (DNR) has overall forest management responsibility and, with University of Minnesota researchers, assists local governments and landowners to restore forest resources and utilize the large volume of wood and brush being cut down.

They work closely to:

Assess and monitor tree resources, resulting in:

- Annual monitoring of 20,000 gypsy moth traps and 3,000 EAB purple traps
- Training a statewide network of monitors:
  - 1,028 DNR field staff
  - 850 Certified Tree Inspectors in over 500 communities
  - 350 Forest Pest First Detectors in 70 of 87 counties
  - A Certified Arborist found the first EAB infestation in Minnesota
- A statewide survey of 700 community forests that will assess risk posed by new forest pest invaders.

Slow the spread of invasive pests:

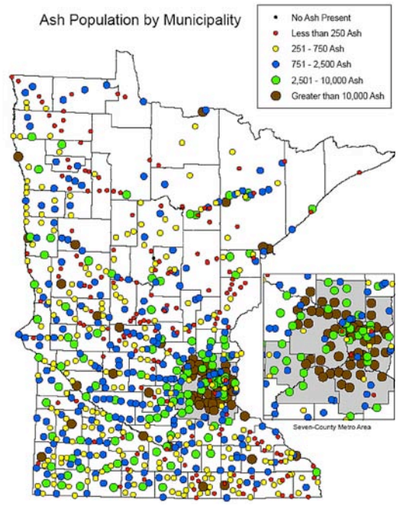
- Establishing quarantines and management programs in Hennepin, Ramsey, and Houston counties to contain the spread of EAB
- Dispersing biological controls of tree pests
- Successfully treating and suppressing gypsy moth populations in Northeast Minnesota and the metro area.

Help communities and residents to prepare and react:

- Establishing the "EAB Front Door" – a one-stop Web site for Best Practices and advice for residents
- Educating community leaders and residents in town-hall meetings and preparedness workshops.
- Developing model pest-management ordinances for communities.

State Financial Assistance:

The State responded in 2009 with legislative appropriations of $1.875 million in Forest Protection Reserve Grants from the Outdoor Heritage Fund to prevent and respond to EAB, and $3 million in Community Forest general obligation bonds to plant native trees and remove infested trees.



Recently completed tree assessments in 700 communities will help determine threats to our forests and the need to plant a greater variety of trees.

But the need is great:

- **MN ReLeaf Grants stopped.** From 1990 to 2007, $7.6 million* in grants leveraged $9 million in local match, helping over 330 communities start up or expand tree planting, care and protection efforts. MN ReLeaf funding stopped in 2007. (* $7.6 = $2.9 federal + $4.7 state)
- **Fewer Tree City USAs.** In 2009, 98 Minnesota cities qualified, down from 134 in 1997. This program suffers from a shortage of DNR staff to promote and administer. This means local programs lose recognition and community support.
- **EAB Grants fall short.** $1.875 million from the Outdoor Heritage Fund supported 18 local EAB projects and for community preparedness outreach and training, but 58 worthy city and county applicants went unfunded.
- **Budget Cuts.** DNR urban and community forestry staff reduced from 2.0 to 1.2 FTE positions. City budgets are being severely cut.
- **Professional Services.** Communities need professional assistance to support tree programs.

Decision makers have a role...