Minnesota's Line-note Database

What Ecologists can learn from Surveyors

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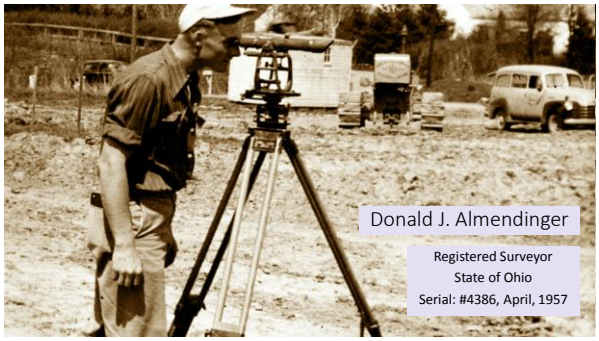
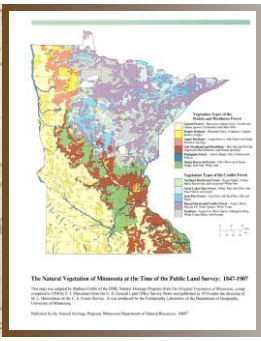


A rocky start with methods … but consistent documentation of resources

- Because land would be purchased sight-unseen, the GLO recognized the need to systematically describe the land and likely natural resources … the first natural survey of Minnesota
- Under the 1855 instructions that includes: intersections of line by land objects, intersections of line of water objects, land surface, soil, timber, bottom lands, springs, lakes and ponds, improvements, coal, roads and trails, rapids, precipices, and natural curiosities … all things that in one way or another are the interest and charge of the Department of Natural Resources

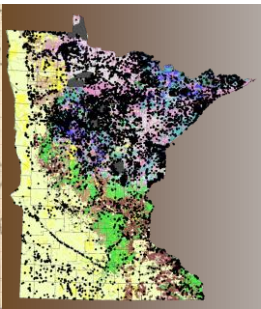
Why turn to the Public Land Survey?

- There are no systematic assessments of pre-settlement natural resources in the fields of ecology (1915) or forestry (1900) … our governing societies didn't exist
- In Minnesota forestry no archives of timber cruising except for the first inventory of School Trust Lands
- In National forestry there are no pre-settlement archives, but the Forest Inventory Analysis inventory on all ownerships has been monitoring forests since the mid-1900's, but data are only easily obtained for the 4th cycle (1977) and successive cycles
- The first systematic inventory on Minnesota's geologic and natural resources occurred between 1872 and 1898, with N. H. Winchell in charge throughout but no original data exist with resolution finer than a county



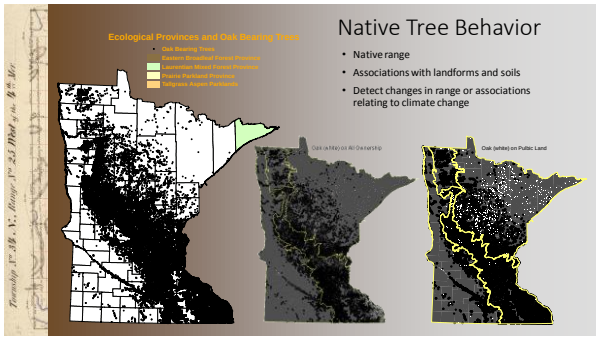
Make Pre-settlement Maps of Vegetation

- Created by Francis J. Marschner, an Austrian emigrant working for the USDA Bureau of Agricultural Economics, in the winter of 1929 and 1930
- Marschner never set foot in Minnesota nor left any details of his methodology, other than that the map was made from the original township plats and corresponding field notes
- Marschner's map was transferred to a large 1:500,000 base map of Minnesota by hand.
- The map was presented to Raphael Zon, a former co-worker of Marschner and director of the Lake States Forest Experiment Station
- The original was lost, but a hand-copy was rescued at the Experiment Station by Miron Heinselman, who annotated the legend and published the map for foresters and natural resource managers



Make New Pre-settlement Maps of Vegetation

- Minnesota County Biological Survey has surveyed the remnants of what Marschner mapped
- We have over 20,000 quantitative point observations used to classify our Native Plant Communities (NPCs)
- Field Guides are used to train most resource professionals in the state
- We need a map legend that matches the field guides
- We still need the survey notes to fill-in lands that no longer have native vegetation



Native Tree Behavior

- Native range
- Associations with landforms and soils
- Detect changes in range or associations relating to climate change

	Sugar maple present	Sugar maple absent
Basswood present	1065	500
Basswood absent	373	3752

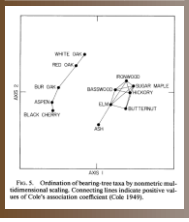
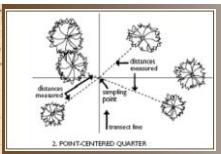


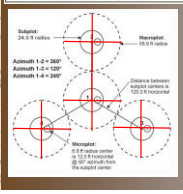
Fig. 5. Ordination of bearing-tree taxa by nonmetric multidimensional scaling. Connecting lines indicate positive values of Cole's association coefficient (Cole 1949).

How Trees Associate with Each Other

- 5,692 PLS survey corners where sugar maple or basswood occurs
- The coefficient of association is calculated based upon joint presence, joint absence, and the two cases of one occurring without the other
- The coefficient of association is 2092, by far the strongest in the state
- This is highly significant in a Chi square test

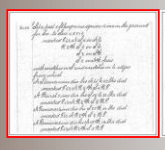
Graphic from Grimm, E.C., Ecological Monographs 1984

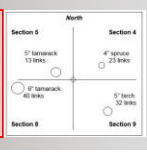


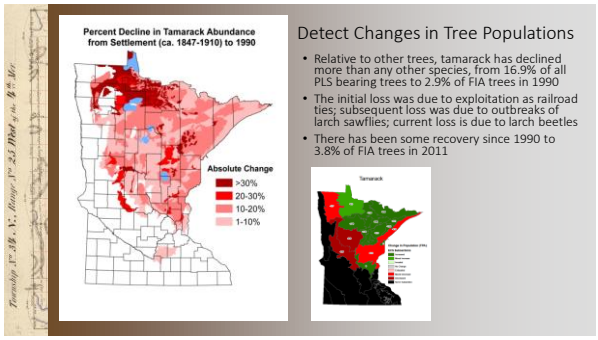


Detect Changes in Tree Populations

Point-centered quarter sampling in forestry, FIA subplots, and PLS section corners share in common a record of trees, their diameter, azimuth, and distance from a point!

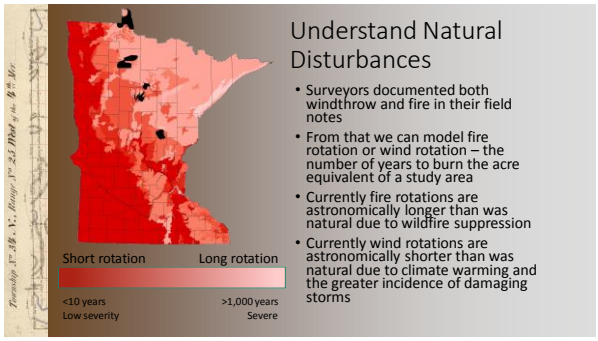






Detect Changes in Tree Populations

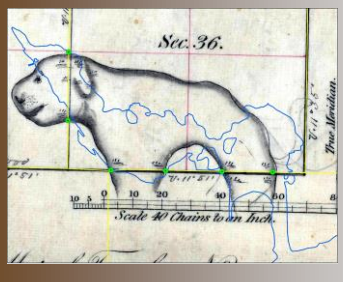
- Relative to other trees, tamarack has declined more than any other species, from 16.9% of all PLS bearing trees to 2.9% of FIA trees in 1990
- The initial loss was due to exploitation as railroad ties; subsequent loss was due to outbreaks of larch sawflies; current loss is due to larch beetles
- There has been some recovery since 1990 to 3.8% of FIA trees in 2011



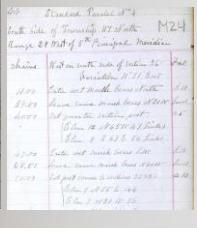
Understand Natural Disturbances

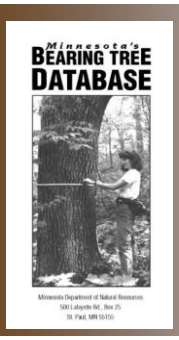
- Surveyors documented both windthrow and fire in their field notes
- From that we can model fire rotation or wind rotation – the number of years to burn the acre equivalent of a study area
- Currently fire rotations are astronomically longer than was natural due to wildfire suppression
- Currently wind rotations are astronomically shorter than was natural due to climate warming and the greater incidence of damaging storms

Reconstruct Historic Surface Water Resources



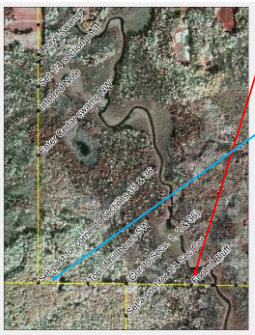
Township 117N R28W





Minnesota DNR PLS Linenote Database

- Construction of a PLS geodatabase for ecological applications began in 1987 to support the efforts of the Minnesota Biological Survey.
- By 1996, all bearing tree records were completed and the database was made public.
- A few years later it was decided that all points of reference along survey lines were of interest: meander trees, line trees, changes in vegetation, trails, notable features, etc.
- As of today 2,520 of 2,534 townships are complete … and it took only 30 years



The Point Layer

Town: 53
Rang: 26
Rdir: 0 (West of PM)
Dir: W
Nodetype: TF
Distance: 49
Note: Foot of Bluff
Summary: Land hilly 2nd rate Timber Pine good Cedar Maple Birch Fir @
LT_type:
LT_dia:
MT1_type:
MT1_dia:
MT1_dist:
MT1_az:
… up to 4 meander trees
BT1:
BTDIAM1:
BTDIST1:
BTDIR1:
… up to 4 bearing trees

Town: 53
Rang: 26
Rdir: 0 (West of PM)
Dir: W
Nodetype: SC
Distance: 17.79
Note: Set post for corner to sections 35 & 36
Summary: Surface hilly. Soil 2nd rate. Timber Wh pine Sugar Ash Aspen Birch Ironwood & Cedar
BT1: WP
BTDIAM1: 18
BTDIST1: 8
BTDIR1: N68E
BT2: IR
BTDIAM2: <null>
BTDIST2: 44
BTDIR2: N46W

The Line Layer

Town: 53
Rang: 26
Rdir: 0 (West of PM)
Dir: W
Boundry: N
Between: 2 & 36
Note: Set post for corner to sections 35 & 36
Summary: Surface hilly. Soil 2nd rate. Timber Wh pine Sugar Ash Aspen Birch Ironwood & Cedar
SPECIES1: WP
DIAM1: 18
DIST1: 8
DIR1: N68E
SPECIES2: IR
DIAM2: <null>
DIST2: 44
DIR2: N46W
… up to 8 witness trees

VEGTYPE: F
NOTETREE1: <null>
NOTETREE2: <null>
SUMTREE1: WP
SUMTREE2: SU
SUMTREE3: AH
SUMTREE4: AS
SUMTREE5: BI
SUMTREE6: IR
SUMTREE7: CE
UNDTREE1: <null>
UNDTREE2: <null>
UNDTREE3: <null>

Accuracy: I wish I had …

- Started with a more accurate geodatabase of section corners
  - Doesn't match current DNR Lands & Minerals
  - Doesn't match County parcels
  - Neither matches where the surveyors really were
- Calculated residual distances rather than rubber-sheeting
- Preserved the starting point and closing point of each survey
- Identified corners with clean provenance from the original monument

Usefulness: I wish I had …

- Recorded the deputy surveyor and year of survey
- Kept the images of the field notes, both the State and GLO copies so that they can be joined to the lines and compared
- Recorded the general descriptions as a join table
- Preserved the meanders in their own database

T61N R10W Albert T. Armstrong

The memory of a man in the relentless grasp of a pack sack loaded with 100 pounds of provisions and camp plunder, on a June day, midst myriads of mosquitoes, deer and moose flies and no see'ems is sufficient to drive a man to the depths of perdition in search of comfort.

At the corner of secs. 16, 17, 20 and 21, my last camp, there stands a 12' X 14 wall tent. One 10' X 12' wall tent stands. Cooking utensils and bedding valued at $60, all of which any examiner of surveys is welcome to, to do as he wishes with.

At the township corner, NE. corner of section 1, there are three canoes in good condition besides 300 pounds of flour, 100 pounds of beans, 50 pounds of sugar, and all camp supplies, all of which I am most heartily glad to be relieved of and cheerfully donate to anyone who wishes to carry them around the country on his back.

What can or should be done?

- Accuracy
  - Moving corners to fit what?
  - Move points verbatim and calculate residuals
  - Create line features corresponding to the beginning and closing of a survey
  - Investigating corner provenance
- Usefulness
  - Add deputy surveyor and year of survey as line attributes
  - Attach images of the field notes
  - Create join table of general descriptions
  - Create a meander geodatabase
- New ideas?


Thanks Dad!
Thank You Surveyors!
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