

Vegetation Dynamics on a Remnant Prairie: Difficulties Measuring Rates of Colonization and Extinction

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Inventory

- “A detailed list of things in one’s view or possession, esp. a periodic survey of all goods and materials in stock.”
- Implicit assumption of boundary and time. Inventories have more long-term value as the boundaries and time are more explicit.

Value of inventory

- Value is determined by the **goal(s)**.
- The goal I am most interested in is estimating colonization and extinction rates of plant species at preserved sites.
- Other goals of inventories are possible:
 - Quality of site.
 - Quantity that can be harvested.
- **Change** is inferred from comparing two or more lists.

Transformations

- From a list of species to a statistic
 - **SR**, species richness
 - **NSR**, native species richness
 - **FQI**, floristic quality index
 - Other attributes that can be calculated by associating variable 'states' with species.
 - Height
 - Odor
 - Color



Comparing Plant Inventories

- What are boundaries of area inventoried?
 - The more poorly the boundaries are described the more ambiguity in comparing lists.
- Species names were determined how?
 - Different authorities delimit species differently.
 - Taxonomy progresses and changes continually.



Peacock/Woodworth Inventories

- Paintin 1926, 1927 published 1929
- Betz and Cole 1966 published 1969
- Apfelbaum & Rouffa 1979, 1980
 published in 1981
- Nyberg & Masters 1995, 2000
 published in 2001

Lengths of the Woodworth Lists

- Paintin's 1929 list had 153 names
- Betz and Cole's 1969 list had 139 names
- Apfelbaum and Rouffa's 1981 list had 215 names
- Nyberg and Masters' 2001 list had 198 names
- Since 2000 268 taxa have detected, but no year has all. New taxa discovered in every year thru 2007.

Events between inventories

- Between 1927 and 1966 the east edge became Greenwood Ave., a road, the prairie was sold to a developer and 4 northern acres were developed.
- Between 1966 and 1981 UIC got ownership of the prairie, and Interpretation Center and parking lot were built. It is probable that contractor brought in soil from another prairie.

Events between inventories

- In 1979 a 10 meter grid system was established on north/south and east/west lines. Marker stakes were placed at the intersect of the lines.
- Inventories of the square meter surrounding the grid marker were begun.
- The first part of this talk focuses on 'meander' inventories of entire site.



Peacock/Woodworth Prairie in 1949



Changes when comparing lists

- Five Types of sources of differences
 - Trivial
 - Taxonomic progress
 - Mistakes in identification
 - Detection efficiency
 - New species within boundary or species disappears from within boundary
- Only the last category is a 'real' event of interest to population biologist.



Trivial Problems

- Examples of “trivial” differences between lists
 - Kalmii versus kalmii
 - pratensis versus pratense
 - buabaumii versus buxbaumii
- With electronic copying and spell checking such differences should decline in frequency.

Taxonomic diversity and progress Problem

- We learn more about populations and the knowledge results in taxonomic changes.
- I assert one must accept a **single** taxonomic authority to provide a list of legitimate names.
 - If more than one authority is used, one is forced to 1) become a taxonomic authority oneself, or 2) generate artificially high rates of 'extinction' & 'colonization'.



Mistakes in Identification Problem

- Observers have diverse levels of expertise and attention to taxonomic authorities.
- Mistakes occur.
- The traditional approach to this problem is to collect voucher specimens.
- Digital photographs and freezing bits of tissue should alleviate the voucher collection discrimination against rare species.

Mistakes in Identification Problem

- What information is useful in deciding identification mistakes?
 - Abundance information (on both lists)
 - Presence of other species in genus on list
 - Distribution information (County level)
 - Subtly of species differences (of course subtly varies with observer, so knowing the identifier is always important)
- I concluded 33 misidentifications on JWP lists.

Detection Efficiency Problem

- Distance sampling explicitly recognizes the efficiency of detection varies. What kinds of information increase the capacity to make inferences about efficiency?
- Name of observer(s)
- How much time was spent and on what dates?
- How clearly are boundaries specified?
- **Future: GPS tracking of meanders**



Colonization & Extinction Rates

- Deliberate introductions of species are a problem as one presumably means 'natural' colonization when one is estimating the colonization rate.
- At the James Woodworth Prairie eleven species are known/said to have been deliberately introduced. These eleven have been excluded from all calculations of rates of colonization and extinction.

238 taxa on the four lists are accepted as having been present at the prairie

- For each accepted taxa there is a sequence of four present /absent entries
- There are 15 different sequences
 - e.g. PPPP, PPPO, OOPP, POPO, ETC
 - All of the 15 possible patterns applies to one or more of the 238 taxa
 - **PO sequence is extinction**
 - **OP sequence is colonization**

Numbers of each Presence Pattern

- PPPP 93
- PPPO 10
- PPOP 4
- POPP 14
- PPOO 8
- POOP 4
- POPO 1
- POOO 6
- OPPP 13
- OPPO 3
- OPOP 2
- OOPP 44
- OPOO 1
- OOPO 11
- OOOO 24

Species continuously present

- The 93 species present on each inventory, PPPP, included 7 exotics, 14 natives and 72 prairie species
 - 14 natives are listed to the right

Ambrosia artemisiifolia elatior
Bidens frondosa
Equisetum arvense
Glyceria striata
Juncus balticus littoralis
Lactuca canadensis
Lycopus americanus
Potentilla simplex
Prunella vulgaris lanceolata
Solidago canadensis
Solidago graminifolia
Typha latifolia
Verbena hastata
Viola sororia

Changes between consecutive lists


➤ These are the numbers of new taxa and the number of previously detected taxa that were not seen in the succeeding inventory

- 1926 to 1966 +19 -25
- 1966 to 1980 +70 -15
- 1980 to 2000 +34 -25
- 2000 to 2004 +53 -9

- 53 includes 29 new taxa new to site and 24 that were on an earlier list.
- 9 losses include 6 species that are now being reintroduced via garden.

Extinction and Colonization Rate

- A literal estimate assumes the data set is completely accurate, every $P \rightarrow O$ change is extinction & every $O \rightarrow P$ a colonization.
- The overall rate of colonization is 123 taxa in 74 years = 1.66 colonists per year to site.
- The overall literal rate of extinctions is 65 in 74 years or 0.88 taxa lost per year from site.



Surprise! There have been more Colonizations than Extinctions

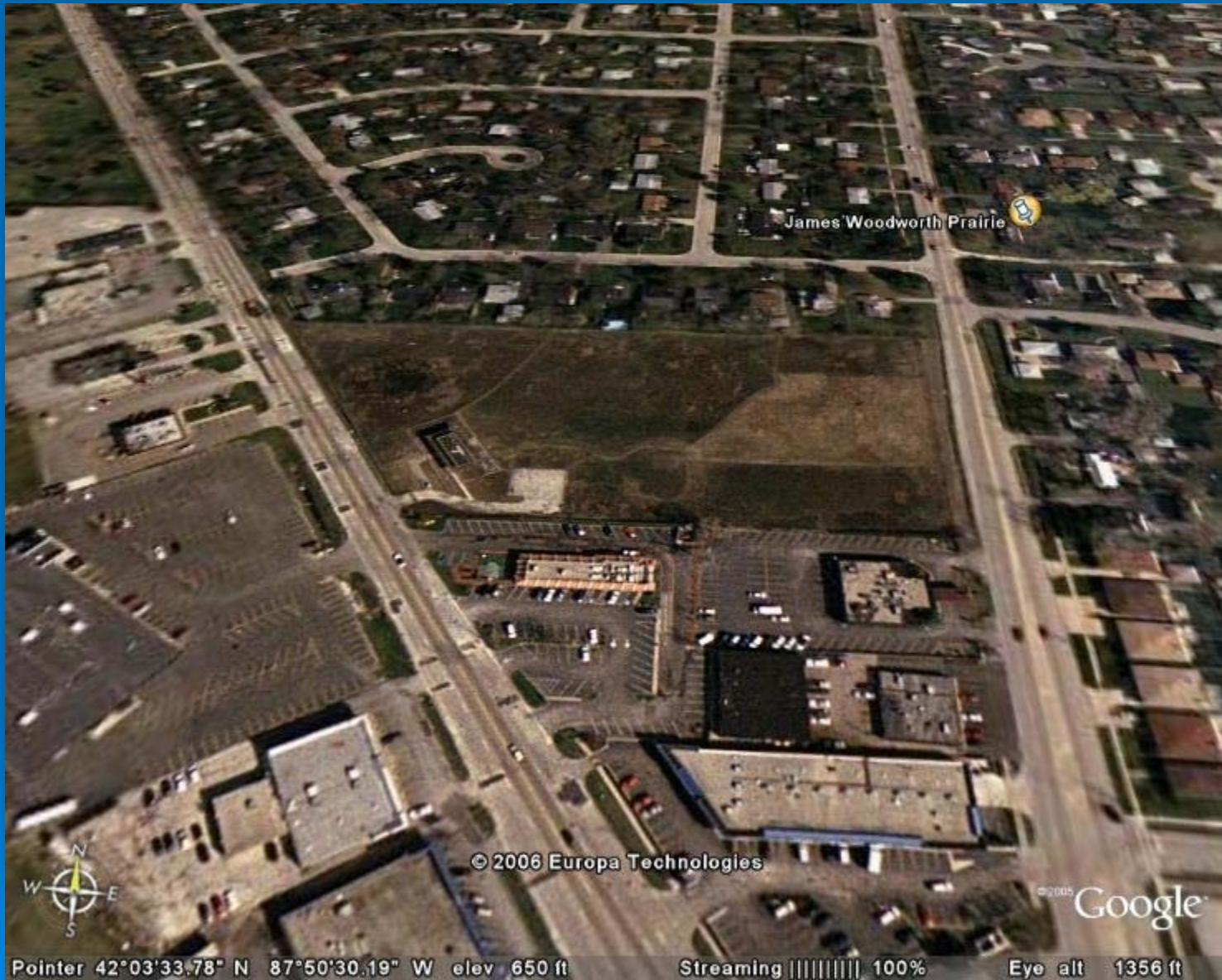
- Are the large number of colonization events mostly non-native and weedy native species?
- How will the rates change if we use more than pairs of lists and convert POP sequences to PPP?

Prairie Plant Colonists

- Of the 19 colonists in the 1926 to 1966 period, 15 were prairie species = 0.375 y^{-1}
- Of the 70 colonists in the 1966 to 1980 interval, 10 were prairie species = 0.71 y^{-1}
- Of the 34 colonists in the 1981 to 2001 interval, 5 were prairie species = 0.25 y^{-1}

Categories of colonizers

- New colonizers in last two intervals (**OOOP** and **OOPP**) have included 33 exotic species and 28 native (non-prairie) species, so rate for these types are high,
- But the last intervals had 7 new prairie species colonize, so even on this small preserve surrounded by residential and commercial property new prairie species continue to show up.



Pointer 42°03'33.78" N 87°50'30.19" W elev 650 ft

Streaming ||||| 100%

Eye alt 1356 ft

Prairie Species Colonists

- Since 2000 four prairie species that never appeared on the previous lists have been detected. Specifically,
 - *Carex bicknellii*
 - *Cypripedium candidum*
 - *Liatris pycnostachya* (probably same population as *L. spicata*)
 - *Physalis virginiana*
- Ten prairie species 'extinct' on the 2001 list have been detected since 2000 and six others have been deliberately introduced.



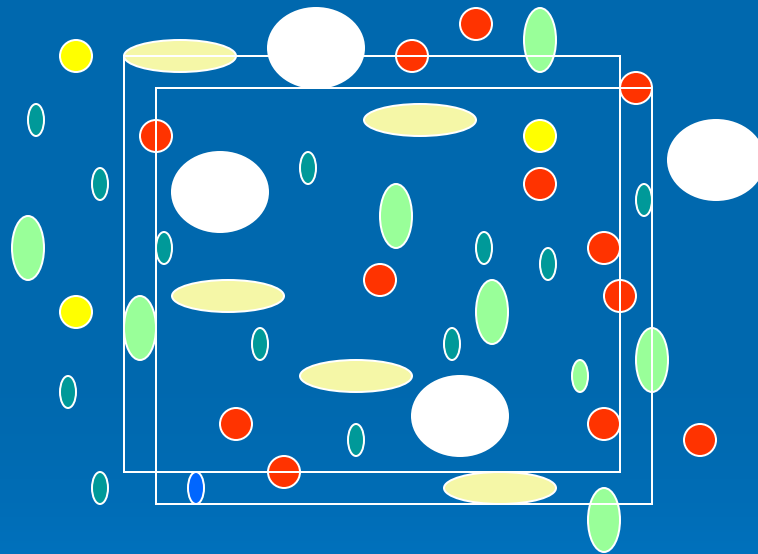
Fixing probable Detection Errors

- If we convert every POP sequence to PPP, we eliminate
 - 6 of 48 colonizations by exotics
 - 11 of the 46 colonizations by native –non-prairie
 - And 6 of the 29 colonizations by prairie species
- Leaving 100 colonizations in 74 years, not much lower than original estimate

Quadrat Studies

- Can quadrat studies solve the 'boundary' problem?
- Any plot whose boundary is a line will always have problems of inclusion/exclusion.
 - Difference is location of lines
 - Movement of individual plant with respect to the line

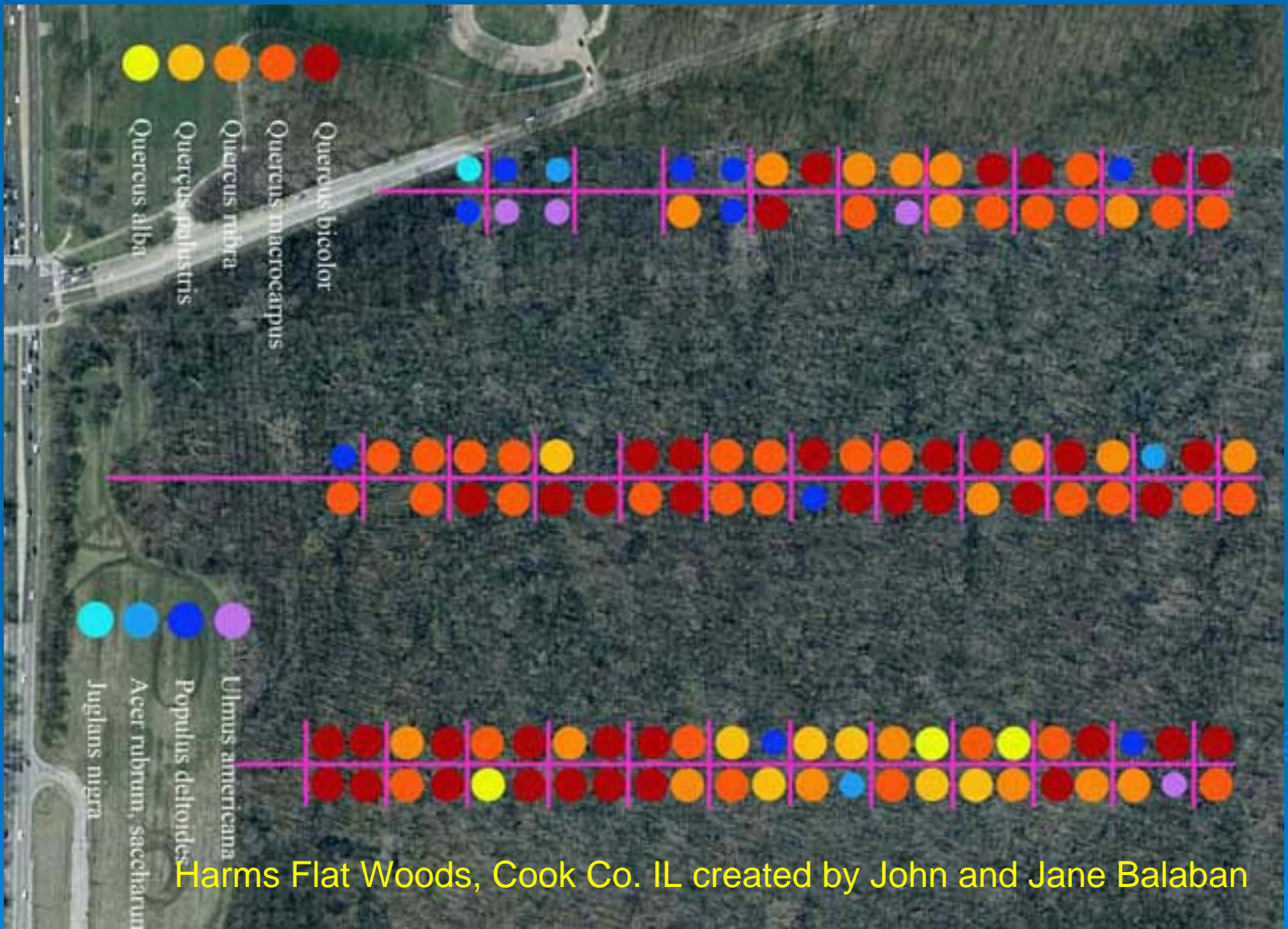
Slight shifts in quadrat boundaries result in list changes



- In 1995 an inventory of the square meter around the grid stakes was done by Linda Masters and Gerould Wilhelm.
- In 2005 an inventory of a $\frac{1}{4}$ square meter touching the grid marker in a corner was done by Erin Haase.
- 7 exotic, 7 native and 6 prairie species detected in 2005, that were not detected in larger area in 1995. Probably not all additions were actual colonization, but it is very difficult to separate real from procedural.

How can we make the science of detecting ecological change better?

- Focus should be on place and abundance.
 - Statistical techniques deal with abstractions that have no position/place. All members are equal and dimensionless. Life is intrinsically spatial. We now have the computer capacity to store spatial details. (next slide is example)
 - The tail of species density distribution is long and most difficulties in measuring change pertain to species represented by few individuals.



Harms Flat Woods, Cook Co. IL created by John and Jane Balaban



Improving Inventories

- PLACE = mapping
- ABUNDANCE = focus on populations
- DETAILS



Improving Inventories - Place

- GPS locations and tracking have dramatically increased spatial specificity.
- Google Earth is another resource of and to store spatial information.
- Every inventory list should include a map of the boundaries.
- Attention to spatial issues raises questions about how extinction & colonization rates should be measured.



Improving Inventories - Abundance

- Information on abundance is very informative in deciding probable origin of change – legitimate or illegitimate.
- Conservation is (or should be) about populations with births and deaths and genetic change. Species with populations have a much greater conservation value than those with non-offspring producing individuals. Describing population size is very informative.

Improving Inventories - Details

- Details of effort should be available for every published inventory
 - Observer(s),
 - Taxonomic authority providing key
 - Dates & hours
- Other useful information
 - GPS tracks of meanders
 - Weather info

Concluding Remarks

- Inventories are done for diverse goals. Inventories done by others can be useful, but a variety of problems make measuring change uncertain.
- There are diverse, **easily recorded** details that should be included with inventories that will improve the future ability to interpret change.
- An important new approach is to use **mapping** of species locations rather than lumping all info into a homogeneous sample.

Concluding Remarks -JWP

- Paintin's 1929 inventory has been used as a management goal since 2000.
- Many species on Paintin's list that are rare (or not detected) at JWP are being grown in the garden that surrounds the Interpretation Center. Hopefully seeds from that garden will colonize the prairie. Thus rates of change are no longer 'natural'.