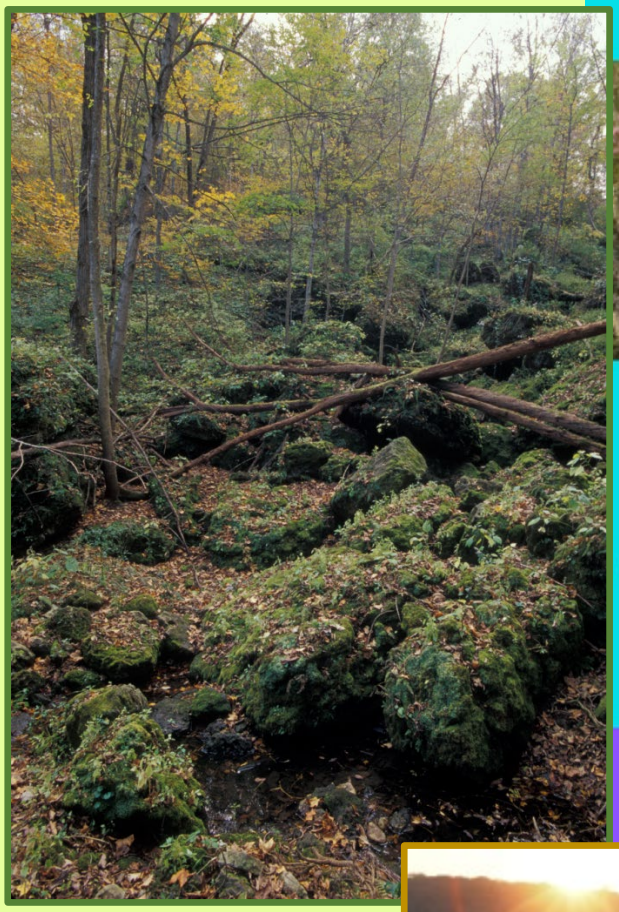
Bixby State Preserve



GOLDEN HILLS RC&D presents

COEFFICIENT OF CONSERVATISM

Online class via Zoom

Monday, March 29

7:00-8:00pm

Learn about plant conservatism and its use in evaluating the quality of plant communities. Moreover, see how to obtain a professional evaluation of the conservation value of ecosystems.

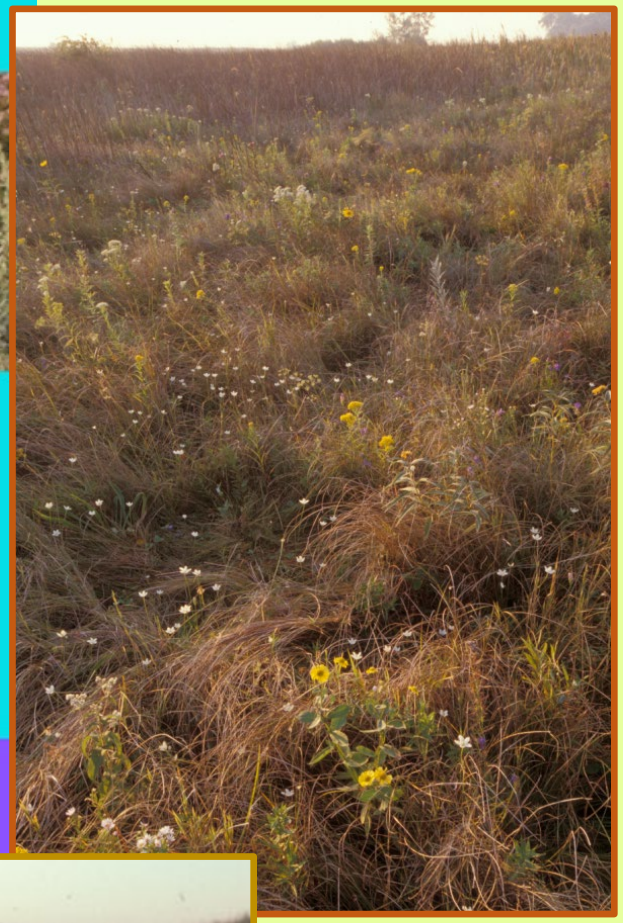
Open to the public. Pre-registration required. $5 registration fee.

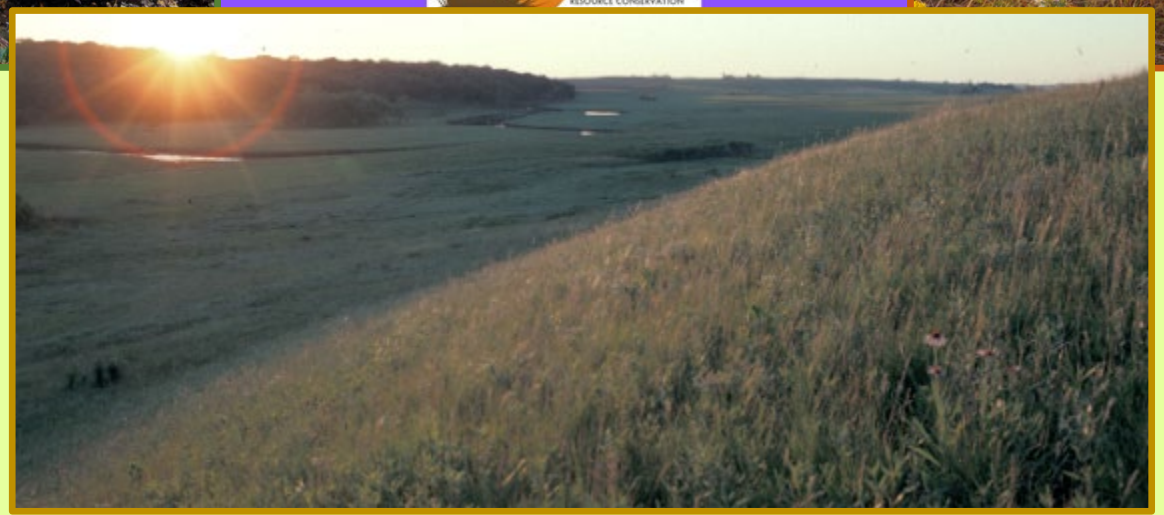
Learn more and sign up at

goldenhillsrcd.org/plantID

GOLDEN HILLS RESOURCE CONSERVATION

Kauten Fen





Freda Hafner Kettlehole State Preserve

Biodiversity Imperiled

Conservation of the Earth's biodiversity is increasingly becoming vitally important and challenging to accomplish

- pressure for economic development
- habitat degradation, fragmentation and loss H
- debilitating effects of invasive species I
- dwindling conservation dollars
- inadequate management
- pathogens and pollution P
- unsatisfactory and ill-conceived policy
- human population pressure P
- over consumption (harvests and hunting) O
- general environmental illiteracy
- more science

bunchberry

upland sandpiper

Natural resource managers and conservationists must embrace efficient, adaptive and comprehensive strategies

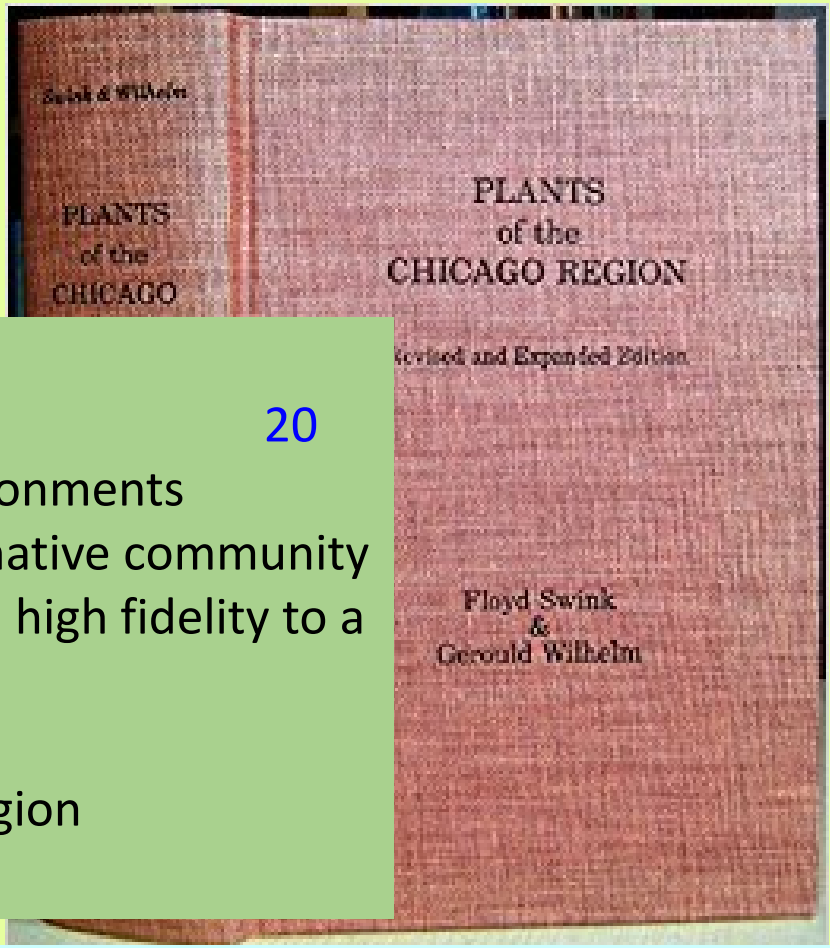
1: Identify conservation targets
2: Collect information and identify information gaps
3: Establish conservation goals
4: Assess existing conservation areas
5: Evaluate ability of conservation targets to persist
6: Assemble a portfolio of conservation areas
7: Identify priority conservation areas

Groves et al. 2002. Planning for biodiversity conservation: Putting conservation science into practice. BioScience 52(6):499-512

Plant Conservatism

Gerould Wilhelm and Floyd Swink , 1979

Wilhelm, 1977. Ecological assessment of open land areas in Kane County, Illinois.



Native species:

0 1 2 3 4 5 6 7 8 9 10 15 20

0 - mostly ubiquitous in a broad range of environments

5 - typify an advanced successional phase of a native community

10 - represent stable, near climax communities; high fidelity to a narrow range of environments

15 - a 10 species that is also fairly rare in the region

20 - locally threatened or endangered

Non-native species:

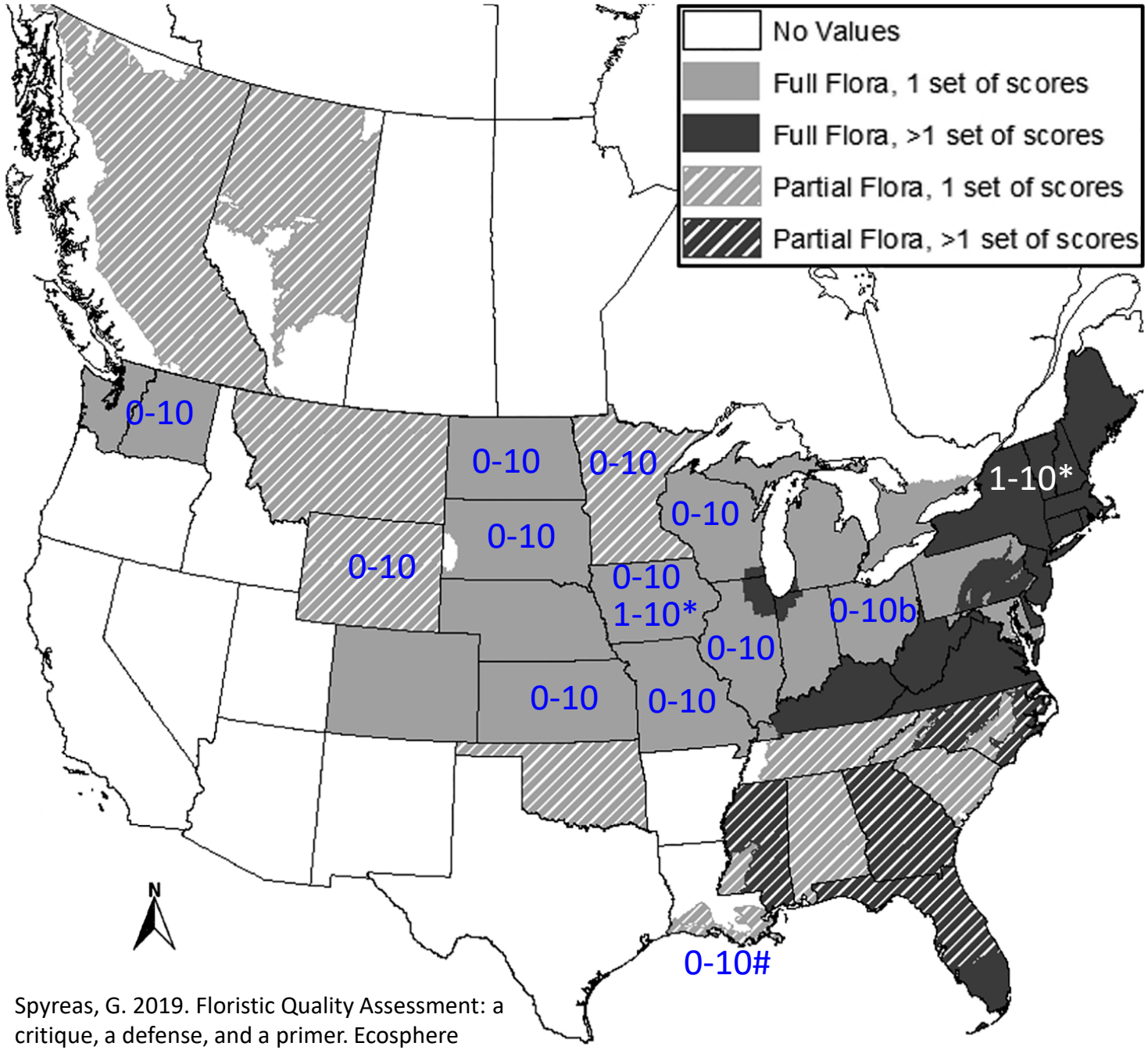
-3 -2 -1 0 1 2

< 0 - species that undermine quality, are poisonous/illegal, exhibit preemptive roles

0 - have little or no impact on the ecology of extant communities

> 0 - exhibit important roles in succession of novel communities, as wildlife food, or are interesting or showy

Plant Conservatism



Spyreas, G. 2019. Floristic Quality Assessment: a critique, a defense, and a primer. Ecosphere

Plant Conservatism

A conservative species is defined as: “a species almost always restricted to intact ecosystems where ecological processes, functions, composition, and structure have not been (or minimally so) degraded/modified by human stressors.”

An intact ecosystem is defined as: “an ecosystem in which the composition, structure, function, and ecological processes are within their historic range of variability (i.e. historic = pre-Euro-Asian settlement).”

Rocchio and Crawford 2013 (Floristic Quality Assessment for Washington Vegetation)

Does plant conservatism work?

- plants are strongly tied to environment

- plant species composition of a community in an ecosystem reflects its condition (degraded or pristine)

- plants have evolved life history strategies that best serve them in their environment

- plant conservatism is beset by circularity

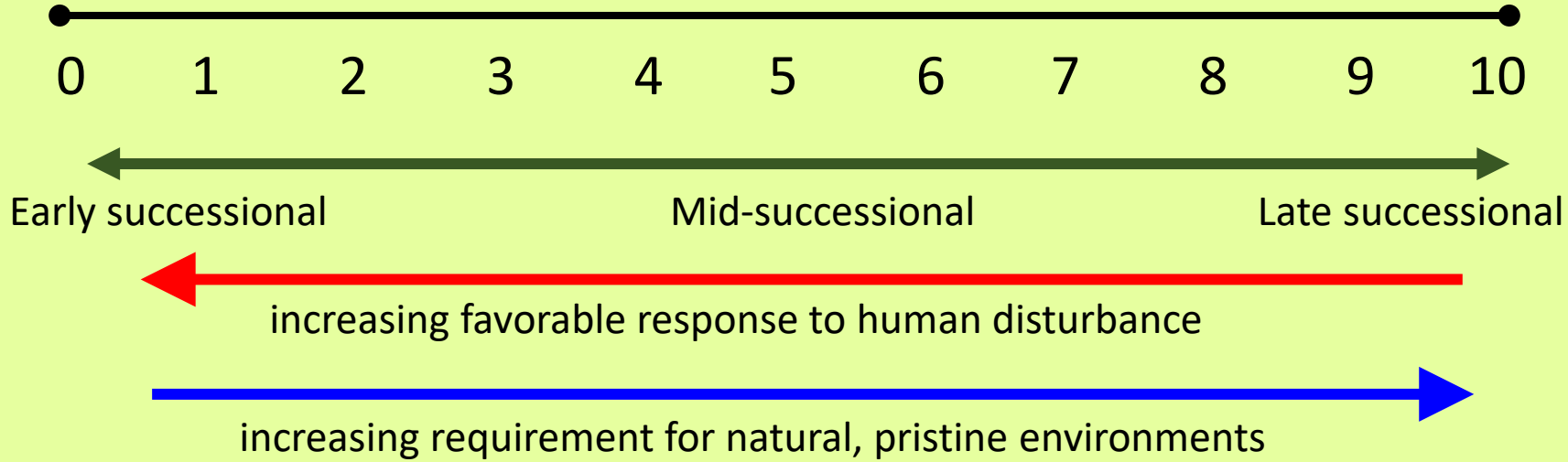
- plant conservatism is subjective

- rare species are biased toward high C-values

- species C-values are imprecise
  * acclimation

Spyreas, G. 2019. Floristic Quality Assessment: a critique, a defense, and a primer. Ecosphere

Ecology of Plant Conservatism



Given C-value = 3 → the presence of this species ≈ 30% probability the community where observed is a natural, pristine ecosystem

Anthropogenic disturbances	vs.	Natural disturbances
agricultural fields		**secondary succession**
right-of-ways		- fire
lawns		- windthrow
parking lots		- bare soil (wallows, dens, gopher mounds)
livestock yards		- floods
overgrazed pastures		**primary succession**
		- sand dunes
		- paleosols

Ecology of Plant Conservatism

https://www.flickr.com/photos

Grime's Triangle (Grime 1977)

http://delawarewildflowers.org

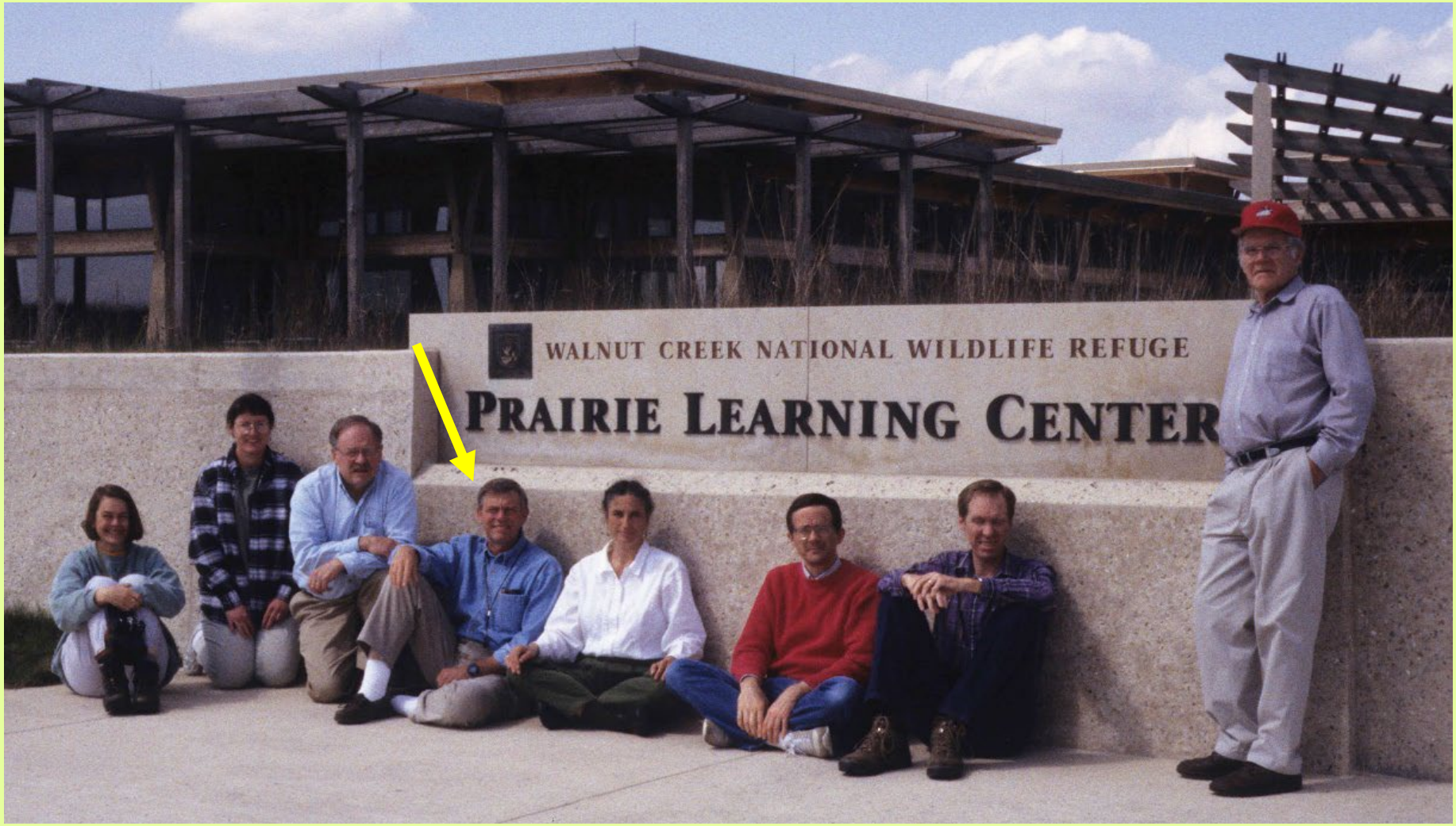
R-selected → strategy is to colonize relatively fertile, disturbed sites, often early secondary successional environments

C-selected → strategy is to compete in relatively fertile, late successional sites

S-selected → strategy is to survive in stressful environments, often primary successional environments such as those stressed by abiotic factors such as low fertility, high temperature, or low moisture

Iowa Original Coefficients List Meeting Dates (4 days)

April 9th – 12th, 1999



1999 participants (l-r): Diana Horton, Deb Lewis, Daryl Smith, Gerould Wilhelm, Pauline Drobney, Mark Leoschke, John Pearson and Dean Roosa

Flora of Iowa Working Group

Iowa CC Revision
14 days May 2014 to March 2018

Deb Lewis, Dean Roosa, Mark Widrlechner, Daryl Smith, Tom Rosburg, and John Pearson; Pauline Drobney (absent)

4 expert reviewers:
William Norris, Beth Lynch, Brian Hazlett, Michaeleen Golay

<u>Native vs. Non-native ?</u>
Original list → many native ruderals = 0
non-native species = 0 (by default)

All native species have more value than non-native species
→ native species ≥ 1

<u>Reevaluate the fidelity of species to pristine habitats</u>
check vouchers, research databases

<u>Assign a measure of confidence to each C-value</u>
low, medium, high

<u>Separate and discount observations from reconstructions</u>

Iowa Coefficients of Conservatism

Name (FNA)	Common name	Old CC	New CC	Confidence
Euphorbia marginata	Snow-on-the-mountain	0	4	H
Lythrum alatum	Winged loosestrife	3	6	H

Iowa Coefficients of Conservatism

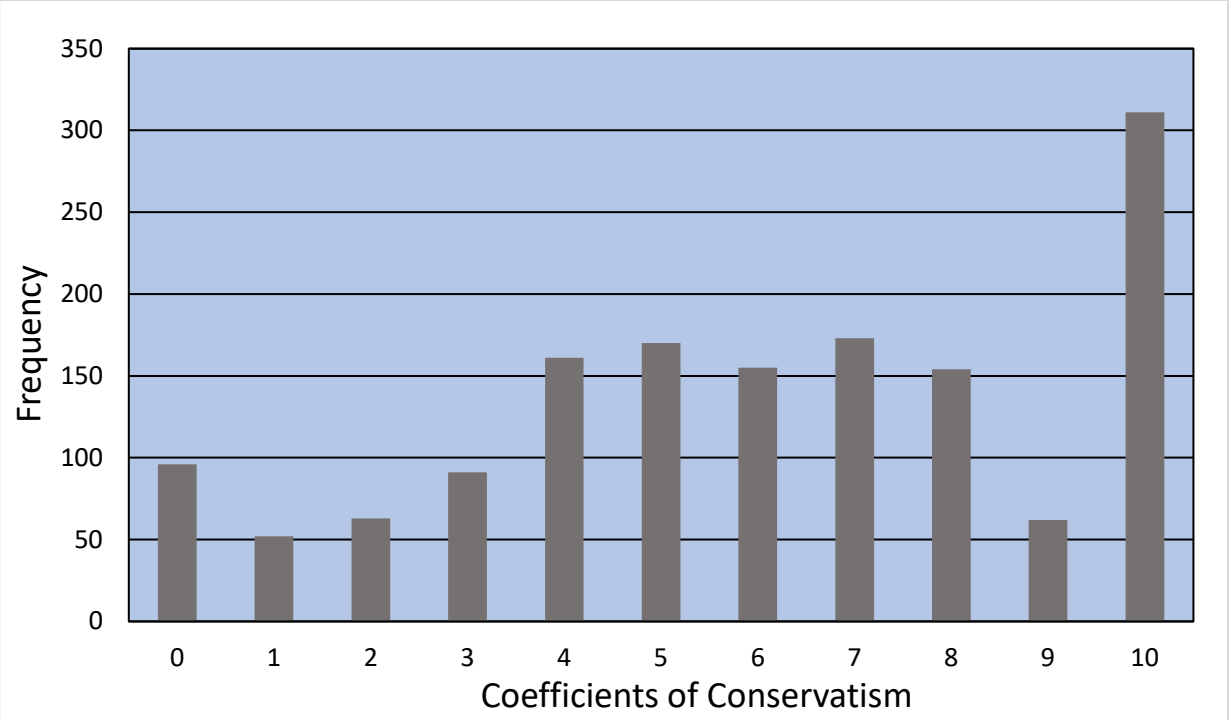
Name (FNA)	Common name	Old CC	New CC	Confidence
Carex frankii	Frank's sedge	8	5	L
Galium triflorum	Sweet-scented bedstraw	7	5	H

https://www.marylandbiodiversity.com/index.php

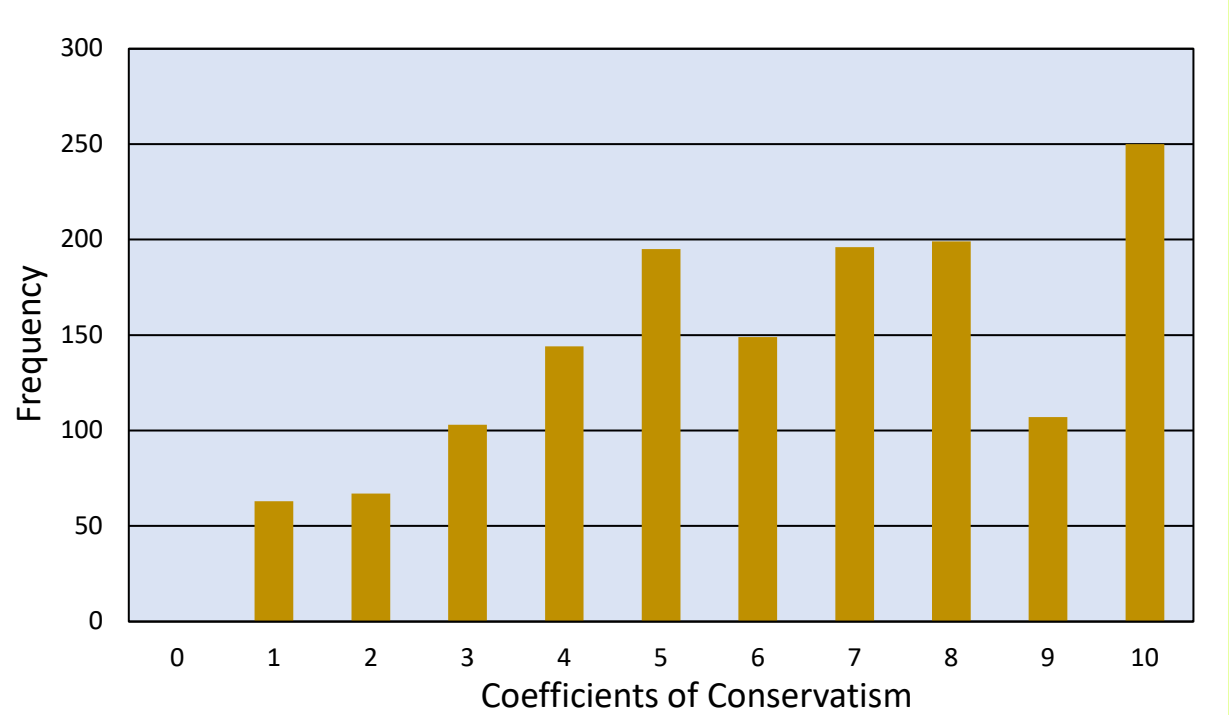
https://www.minnesotawildflowers.info/

Distribution of Iowa Plant Species C-values

Original C-values
n= 1,488
$\bar{y}$ = 6.04

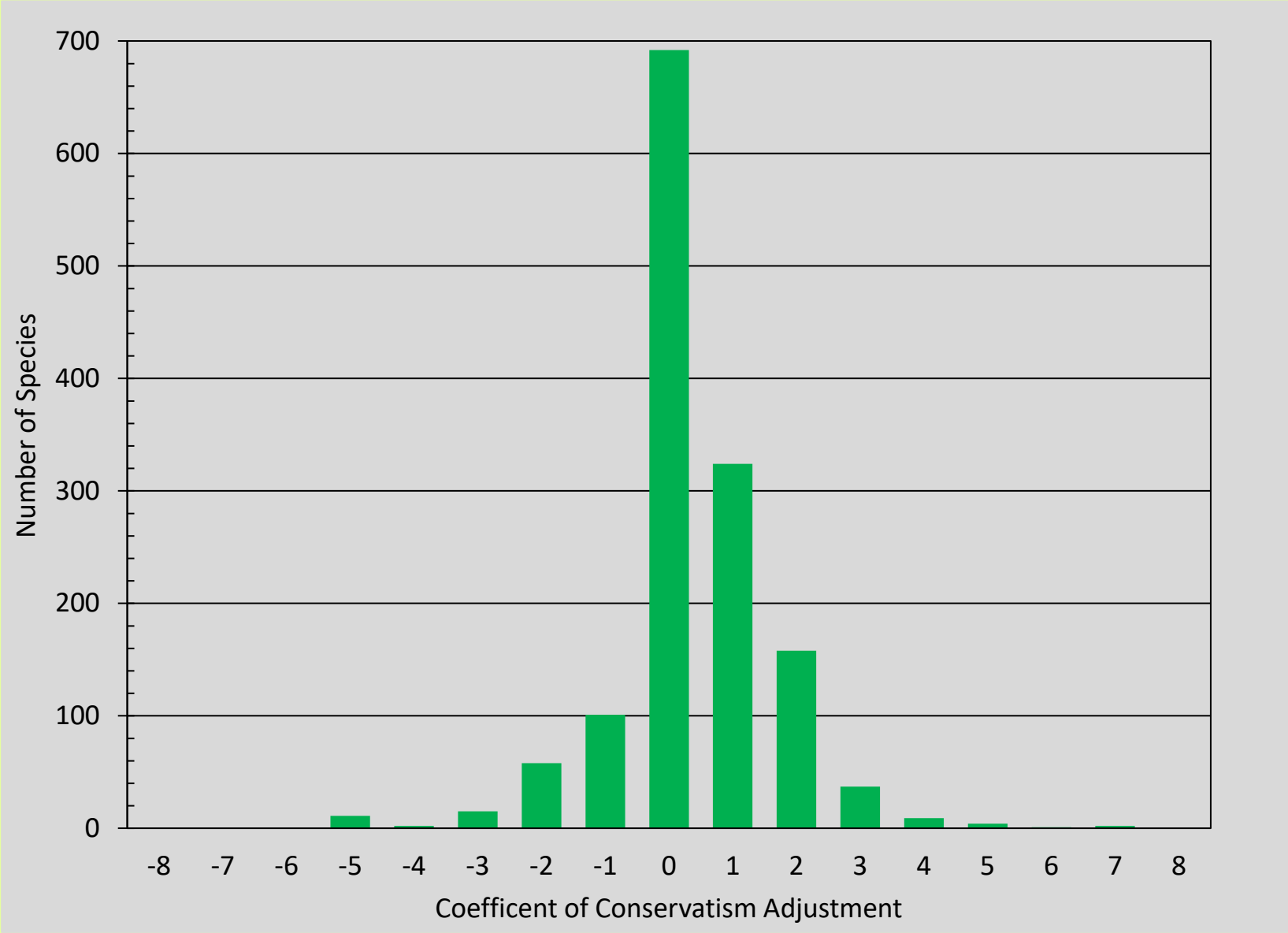


Revised C-values
n= 1,473
$\bar{y}$ = 6.37



Distribution of Adjustments made to Plant Species Conservatism

n = 1,414 species $\bar{y}$ = 0.355



Application of Iowa Coefficients of Conservatism

Story County Sensitive Areas Inventory

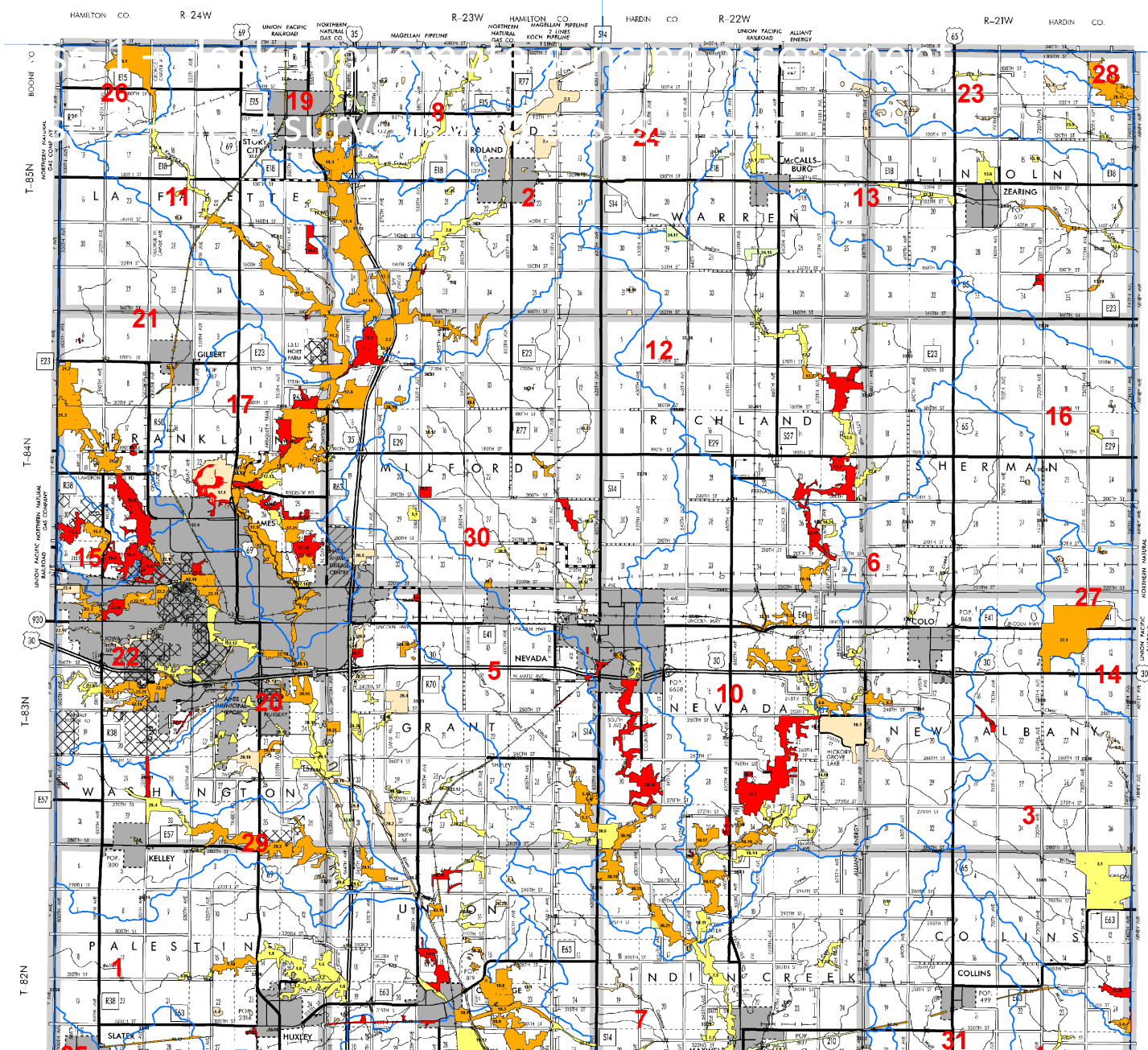
1) Conduct field research on high and medium priority sites to delineate, map and identify extant ecosystems – a goal of 10,000 acres
2) Identify the plant species composition of ecosystems by compiling a quantitative list of the vascular plants (abundance with frequency)
3) Obtain data to characterize community structure and successional status of the ecosystems mapped (plant growth forms and sizes of woody plants)
4) Report anecdotal observations of other organisms, including fungi, invertebrates, and vertebrates
5) Map locations of imperiled and high conservative plant species
6) Provide assessment of ecosystem/vegetation conservation value
7) Assemble a Geographic Information System (GIS)

* extant vegetation/ecosystems	* topography	* soils
* native vegetation/ecosystems	* historic land use	* GLO vegetation

Story County Sensitive Areas Inventory – Quick Numbers

- field research 2017 to 2020 (most sites surveyed during a single visit)
- 1,450 hours of research (Tom Rosburg and Bill Norris)
- 138 sites surveyed, 717 plant communities/ecosystems mapped and inventoried
- 34,455 observations of plant species abundance in a specific community/ecosystem
- 800 plant species in 106 plant families
- 65 community variables calculated to convey measures of community/ecosystem condition

Macrosite and Sites For Field Survey in Story County, Iowa (2017-02-23)



Potential Natural Areas Organized by Macros

Legend
Biodiversity Site Bound

Survey Priority: High, Me Special (Restorable) and

- H = High Survey Priority
- M = Medium Survey Prior
- L = Low Survey Priority,
- S = Special Area - Restor
- U = Quality to Be Determ

POTENTIAL NATURAL AREAS FOR FIELD SURVEY
ORGANIZED BY MACROSITES AND SITES

Story County Conservation Board (SCC) contracted Scott C. Zager, Wildlands Ecological Services, to develop a strategy to inventory the Story County of its remaining natural areas, which are comprised of Native Plant Communities (NPC): e.g., forests/woodlands, savannas, prairie, wetlands, etc. The Story County Natural Areas Inventory is to be conducted in two phases: 1) Phase one is the identification of potential natural areas using remote sensing (air photos) along with previously collected data (rare species occurrences, previous natural areas surveys (Norris 1995), USDA Soil Surveys, Iowa Geological Survey, etc.). 2) Phase two is the ground survey to visit sites identified in Phase 1 and evaluate the Quality of Naturalness and Biodiversity within these sites. This map represents the results of Phase 1.

Biodiversity Site Boundaries
Site boundaries were determined primarily using air photos that were photographed along flight lines spanning the county. These pictures were digitized and then combined into a mosaic that completely canvassed the county. Photo mosaics were then rectified into electronic maps used in Geographical Information System (GIS) software as a theme layer (ESRI ARCMAP). These rectified mosaics, known as rasters, became the base layers that were then overlain by other Theme Layers, such as, rare species inventories, soil surveys and surficial geology. Past natural areas surveys, such as that completed by W. R. Norris for his Master's Dissertation at Iowa State University, helped identify areas of known quality. The photographic signatures of these areas were used to extrapolate the potential natural quality of other areas with similar signature patterns. Using this general methodology sites were identified and delineated using a combination of themes, primarily in this order: 1) Vegetation patterns (from air photos), 2) Surficial Geology Landscapes, 3) Soil Type (including hydrology, texture, etc.), and 4) Topographic position and aspect. Existing data was incorporated into the attribute fields associated with Site Shapefiles. These attributes include the "Survey Priority Categories: High, Medium, Low, Special (Restorable) and Unknown or Undetermined quality".

Potential Survey Sites are organized by small watersheds, which I have called Macrosites. These are numbered on the map from 1 to 31. In the attribute table, I have given these Macrosite Names based upon the predominate waterway segment. Sometimes the sites cross boundaries so the Macrosites may have a different name from the HU12 watershed as given by the Iowa Geological Survey. In addition, I have allocated maps/shapes of miscellaneous sites into Macrosites. For instance, Railroads and Bike Trails are all within Macrosite 32 (individual sites are randomly numbered throughout the entire county). Roadsides are within Macrosite 33. In addition, I have included native grass plantings and restorations into Macrosite 34. Likewise, all of these plantings are uniquely numbered (sometimes as clusters of polygons nearby) and these are found randomly throughout the county.

There are 409 sites recognized in Phase 1. Sites are uniquely color coded in this map by their potential natural quality. The sites are labeled by a combination of Macrosite Number and Site Number, (e.g., 17.1 to 17.25). While digitizing site boundaries native plant community boundaries within the sites were also delineated, therefore you may see several polygons within a site. Each polygon is labeled according to the Site Label. I expect that Natural Plant Community (NPC) polygons will be refined following field survey and eventually each NPC polygon will have it's own unique number within the site.

Some ecological data observed within the site were added the shapefile attribute table. Sometimes an area was a pre-existing name which was retained. However, most sites have not been uniquely named and will need so for conservation purposes. SCC will have to add these names as data is collected and more is known about the areas and the property owners.

Ecological Criteria for Evaluation (Norris 1995)
Only ecological criteria were considered for evaluation of natural areas in Story County, Iowa. Other criteria such as aesthetic quality, potential use as an outdoor teaching laboratory, ownership (public or private), availability for acquisition and potential for future development were excluded from consideration.

Diversity
Measures of species diversity can be obtained from at least three sources: species richness indices, parameters associated with species rank-abundance models, and diversity indices that attempt to combine species richness and relative abundance concepts.

Structural Diversity
The number of strata into which foliage is distributed in a community strongly influences its suitability for wildlife. In temperate forests of North America, for example, a woodland with four distinct foliage layers (canopy, sub canopy, shrub, and herbaceous) would possess more breeding bird species than a grazed woodland with shrub and herbaceous layers largely removed. It can be inferred that animal species richness directly from a measure of foliage stratification of vegetation in his index of ecological quality for evaluating the countryside.

Naturalness
Most definitions of naturalness refer to freedom from - or lack of - impact by humans. Many of the term have arisen during evaluations of landscapes severely altered by the hand of mankind, and thus naturalness is negatively correlated with alien or introduced species. Consequently, the predominance of natural vegetation has often been the barometer used to measure naturalness. One would be hard pressed to point to any vegetation community in Iowa that is entirely natural. The effects of fire suppression, logging, grazing, and drainage are evident wherever one looks closely at Iowa's remaining prairies, woodlands and wetlands. Thus, naturalness should be thought of as a continuum within which communities have recovered after human disturbance are especially appropriate in the context of the Story County Natural Areas Inventory.

Representativeness
Representativeness refers to the range of variation occurring on a regional scale. Norris (1995) recognized two interpretations of this term, referred to as typicalness and inclusiveness. Typicalness is concerned with usual species assemblages in an area, especially the commoner and more widespread species. Inclusiveness refers to the entire range of variation in an area, encompassing not only typical communities (characterized by mostly common species) but also unique communities containing rare species. Representativeness has been used as a component of natural area evaluation (e.g., classification/prioritization of natural communities in a wide region for comparison with areas to be evaluated), the concept is perhaps more naturally applied in the selection of biological reserves. Many of the reasons given in support of diversity and naturalness as evaluation criteria can be used to justify consideration of representativeness in evaluation of natural areas.

Area
Many schemes for natural area evaluation consider area as one criterion. However, area determinations are not always straightforward, particularly in fragmented landscapes (such as those found throughout Iowa) where wooded tracts are often connected by narrow corridors that follow river drainages. The strong positive relationship between area of a natural resource and the species richness of many groups of organisms is an established tenet of ecology.

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Field Methods

Plant species abundance

Frequency assigned in the field	Numerical absolute frequency
Sparse	**5**
Locally Occasional	10
Sparse/Occasional	13
Occasional	**20**
Locally Frequent	30
Occasional/Frequent	33
Frequent	**45**
Locally Very Common	60
Frequent/Very Common	63
Very Common	**80**

Woody structure

Structural Class	Size
Seedling/Sprout	< 50 cm height
Shrub	50 to < 200 cm height
Sapling	≥ 200 cm height and < 5 cm DBH
Tree	≥ 5 cm DBH, record DBH to nearest 5 cm

green ash 20 sdl, shb, sap, 5, 20, 25, 45
bur oak 20 60, 70, 75, 90, 100, 120, 130

Plant Conservatism

-3 -2 -1 0 1 2 3 4 5 6 7 8 9 10

Revised scale of plant conservatism to incorporate the negative effect of invasive, non-native species to community quality.

Plant Conservatism Variables

1) Native Forb Mean Conservatism
2) Native Graminoid Mean Conservatism
3) Native Woody Mean Conservatism

4) Native Herbaceous Weighted Mean Conservatism
5) Native Woody Weighted Mean Conservatism
6) All Herbaceous Weighted Mean Conservatism
7) All Woody Weighted Mean Conservatism

8) Native High Conservative Richness (C-value ≥ 7)
9) Native Low Conservative Richness (C-value ≤ 2)
10) Percentage (%) Low Conservatism Native Ruderals

11) Exotic Herbaceous Negativity Index

$$= (\text{Nat Herb WM Cons} - \text{All Herb WM Cons}) * \sqrt{\text{Total Exotic Herb Rich}}$$

12) Exotic Woody Negativity Index

$$= (\text{Nat Wood WM Cons} - \text{All Wood WM Cons}) * \sqrt{\text{Exotic Wood Rich}}$$

13) FQI Native Species
14) Weighted FQI All Species

$$\text{FQI} = \text{mean conservatism} \times \sqrt{\text{richness}}$$

Plant Richness Variables

1) Native Forb Richness
2) Exotic Forb Richness

3) Native Graminoid Richness
4) Exotic Graminoid Richness

5) Native Woody Richness
6) Exotic Woody Richness

7) IA Native/Story Exotic Richness

8) Total Native Richness
9) Total Exotic Richness
10) Total Richness

11) Native Richness Index

$$= \frac{(\text{total native richness})}{(\text{total exotic richness})}$$

12) Native Forb/Graminoid Richness Index

Plant Frequency Variables (Abundance)

1) Total Absolute Frequency % Native Forbs
2) Total Absolute Frequency % Exotic Forbs
3) Total Absolute Frequency % Native Graminoids
4) Total Absolute Frequency % Exotic Graminoids
5) Total Absolute Frequency % Native Woody
6) Total Absolute Frequency % Exotic Woody
7) Total Absolute Frequency % IA Native Story Exotic
8) Total Absolute Frequency % All Species
9) Percentage Relative Frequency % Native Forbs/All Native Herbs
10) Percentage Relative Frequency % Native Herbs/All Herbs
11) Percentage Relative Frequency % Native Woody/All Woody
12) Total Absolute Frequency % Native Annuals & Biennials
13) Total Absolute Frequency % Exotic Annuals & Biennials
14) Percentage Relative Frequency % All Herb Ruderal/All Herbs

15) Native Forb Frequency Index

$$= \frac{(\text{total native forb frequency})}{(\text{total exotic forb frequency})}$$

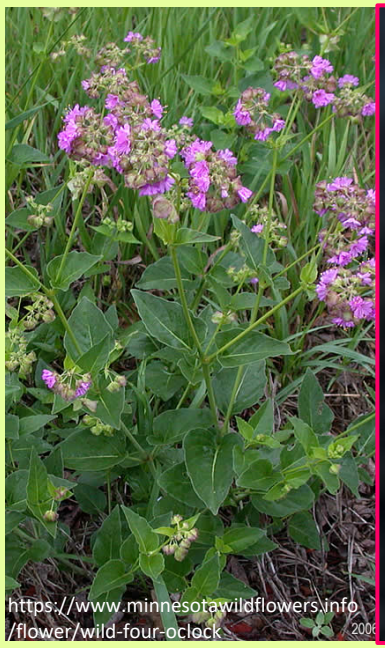
16) Native Graminoid Frequency Index

$$= \frac{(\text{total native graminoid frequency})}{(\text{total exotic graminoid frequency})}$$

Prairie Indicator Variables

0	1	2	3	4	5
poor	somewhat	fair	good	very good	excellent

1) Prairie Indicator Richness
2) Percentage Relative Frequency (%) Prairie Indicator Richness
3) Total Prairie Index
4) Prairie Index Score %



Wetland Affinity Variables

1) Mean Native Forb Wetland Affinity

2) Mean Native Graminoid Wetland Affinity

3) Mean Native Woody Wetland Affinity

4) Mean Exotic Wetland Affinity

5) All Species Weighted Mean Wetland Affinity

Affinity Status	Occurrence in Wetlands within the Region	Numeric Value
Obligate wetland	99% or more of the time	-5
Facultative wetland	67-98% of the time	-3
Facultative	34-66% of the time	0
Facultative upland	2-33% of the time	3
Obligate Upland	1% or less of the time	5

Woody Structure Variables

1) Total Native Shrub Frequency
2) Total Exotic Shrub Frequency
3) Relative Percentage % Exotic Shrub Frequency/All Shrub Frequency
4) Total Shrub Frequency/Total Native Herb Frequency Index

5) Native Understory Richness-Structure
6) Exotic Understory Richness-Structure
7) Total Understory Richness-Structure
8) Native Understory Richness-Structure Index

9) Old Growth Index - Upland Dry-mesic Forest/Woodland
10) Old Growth Index - Upland Wet-mesic Forest/Woodland
11) Old Growth Index - Upland & Lowland Mixed Forest/Woodland
12) Old Growth Index - Floodplair
13) Total Native Old Growth Index
14) Old Growth Index - Exotic spe

DBH (diameter at breast height) classes in cm	Index Value
$50 \leq$ DBH < 75	1
$75 \leq$ DBH < 100	2
$100 \leq$ DBH < 125	3
$125 \leq$ DBH < 150	4
$150 \leq$ DBH < 175	5
$175 \leq$ DBH < 200	6
$200 \leq$ DBH < 250	7
$250 \leq$ DBH	8

Old Growth Index

Species	DBH measurements		
Silver maple	55, 60, 90, 140	1+2+4 = 7	Floodplain Forest = 7
Hackberry	75	2	Mixed Forest = 5
Am elm	35, 45	0	
Honey locust	40, 65, 80	1+2 = 3	
Basswood	80, 90	2	Upland Rich Forest = 2

Total Old Growth Index= 14

DBH (diameter at breast height) classes in cm	Index Value
$50 \leq$ DBH < 75	1
$75 \leq$ DBH < 100	2
$100 \leq$ DBH < 125	3
$125 \leq$ DBH < 150	4
$150 \leq$ DBH < 175	5
$175 \leq$ DBH < 200	6
$200 \leq$ DBH < 250	7
$250 \leq$ DBH	8

Overall Biodiversity Conservation Score

10 variables previously described are integrated to create a score standardized to a perfect score of 100

1) Percentage low conservatism (0 to 10)

2) Percentage of the abundance (absolute frequency) of native herb species relative to the total abundance of all herbs (0 to 10)

3) Native richness index (0 to 10+)

4) High conservatism (0 to 10+)

5) FQI for native species (-0 to 10+)

6) Weighted FQI for all species (0 to 10+)

7) Total exotic shrub frequency (-0 to 10)

8) Prairie quality score (0 to 10+)

9) Native old growth (0 to 10+)

10) Wetland score reflecting the abundance of all wetland plants (0 to 10)

Overall Biodiversity Conservation Scores

Comparison among 5 communities at 5 different sites

	Doolittle Prairie	CS Grassland	Recon Prairie	Up Mix Forest	Wet Swale
1) Percentage low conservatism	9.0	4.1	7.2	8.0	7.8
2) Percentage abundance native herb species	8.9	2.3	8.9	9.8	8.2
3) Native richness index	4.9	0.4	1.4	5.8	1.5
4) High conservatism	16.0	0.0	4.0	0.0	0.7
5) FQI for native species	17.3	3.9	8.8	8.7	6.3
6) Weighted FQI for all species	9.6	-2.2	5.3	4.4	3.1
7) Total exotic shrub frequency	10.0	8.5	10.0	6.7	10.0
8) Prairie quality score	11.8	0.4	3.5	0.0	0.4
9) Native old growth	0.0	1.2	0.0	1.6	0.0
10) Wetland score	4.4	2.5	2.9	3.8	8.5
Total Conservation Score	**91.7**	**21.1**	**52.1**	**48.8**	**46.4**

Highlights of Story County SAI Results

Growth Form	Native	Native to Iowa but not Story Co	Non-native	Total
Forb, Vine, Pteridophyte	380	11	108	499
Graminoid	146	3	34	183
Woody (Shrub, Liana, Tree)	75	6	37	118
Total	601	20	179	800
	75.1%	2.5%	22.4%	

1) 49 plant species not included in Eilers and Roosa
   * 35 ecological
   * 12 taxonomic

2) 24 plant species represent new Story County records
   * 11 native (but 2 likely planted)
   * 8 native to Iowa but not Story County (poorly designed reconstructions)
   * 5 non-native

3) 9 plant species considered historic rediscovered
   * 8 native (but 2 may have been planted)
   * 1 non-native

4) 16 plant species on Iowa imperiled species list (E, T, SC)
   * 1 endangered (but clearly planted, blue giant hyssop)
   * 15 special concern (but 11 are insignificant, 4 ecologically important)

Prairie remnant

- *Helianthemum bicknellii*
- *Cyperus filiculmis*

Sedge meadow remnant

- *Lysimachia terrestris*
- *Carex conoidea*

Oak-basswood forest

- *Actaea pachypoda*
- *Juglans cinerea*