APPENDIX B
CORRESPONDENCE

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
New York Natural Heritage Program
625 Broadway, 5th floor, Albany, New York 12233-4757
Phone: (518) 402-8935 • **FAX:** (518) 402-8925
Website: www.dec.state.ny.

Denise M. Sheehan
Commissioner

April 7, 2006

Frank LaVardera
Clough Harbour & Associates
111 Winners Circle
Albany, NY 12205

CHA # 12206

Dear Mr. LaVardera:

In response to your recent request, we have reviewed the New York Natural Heritage Program database with respect to an Environmental Assessment for the proposed Expansion of the Rapp Road Landfill, area as indicated on the map you provided, located in the City of Albany, Albany County.

Enclosed is a report of rare or state-listed animals and plants, significant natural communities, and other significant habitats, which our databases indicate occur, or may occur, on your site or in the immediate vicinity of your site. The information contained in this report is considered sensitive and may not be released to the public without permission from the New York Natural Heritage Program.

The presence of rare species may result in this project requiring additional permits, permit conditions, or review. For further guidance, and for information regarding other permits that may be required under state law for regulated areas or activities (e.g., regulated wetlands), please contact the appropriate NYS DEC Regional Office, Division of Environmental Permits, at the enclosed address.

For most sites, comprehensive field surveys have not been conducted; the enclosed report Ponly includes records from our databases. We cannot provide a definitive statement on presence or absence of all rare or state-listed species or significant natural communities. This information should not be substituted for on-site surveys that may be required for environmental impact assessment.

Our databases are continually growing as records are added and updated. If this proposed project is still under development one year from now, we recommend that you contact us again so that we may update this response with the most current information.

Sincerely,

Charlene Houle Jr

Charlene Houle, Information Services
NY Natural Heritage Program

Enc.
cc: Reg. 4, Wildlife Mgr.
Peter Nye, Endangered Species Unit, Albany

USERS GUIDE TO NY NATURAL HERITAGE DATA

New York Natural Heritage Program, 625 Broadway, 5th Floor, Albany, NY 12233-4757 phone: (518) 402-8935

NATURAL HERITAGE PROGRAM: The NY Natural Heritage Program is a partnership between the NYS Department of Environmental Conservation (NYS DEC) and The Nature Conservancy. Our mission is to enable and enhance conservation of rare animals, rare plants, and significant communities. We accomplish this mission by combining thorough field inventories, scientific analyses, expert interpretation, and the most comprehensive database on New York's distinctive biodiversity to deliver the highest quality information for natural resource planning, protection, and management.

DATA SENSITIVITY: The data provided in the report are ecologically sensitive and should be treated in a sensitive manner. The report is for your in-house use and should **not** be released, distributed or incorporated in a public document without prior permission from the Natural Heritage Program.

EO RANK: A letter code for the quality of the occurrence of the rare species or significant natural community, based on population size or area, condition, and landscape context.

A-E = Extant: A=Excellent, B=Good, C=Fair, D=Poor, E=Extant but with insufficient data to assign a rank of A-D.
F = Failed to find. Did not locate species during a limited search, but habitat is still there and further field work is justified.
H = Historical. Historical occurrence without any recent field information.
X = Extirpated. Field/other data indicates element/habitat is destroyed and the element no longer exists at this location.
U = Extant/Historical status uncertain.
Blank = Not assigned.

LAST REPORT: The date that the rare species or significant natural community was last observed at this location, as documented in the Natural Heritage databases. The format is most often YYYY-MM-DD.

NY LEGAL STATUS – Animals:

Categories of Endangered and Threatened species are defined in New York State Environmental Conservation Law section 11-0535. Endangered, Threatened, and Special Concern species are listed in regulation 6NYCRR 182.5.

E - Endangered Species: any species which meet one of the following criteria:
- Any native species in imminent danger of extirpation or extinction in New York.
- Any species listed as endangered by the United States Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.

T - Threatened Species: any species which meet one of the following criteria:
- Any native species likely to become an endangered species within the foreseeable future in NY.
- Any species listed as threatened by the U.S. Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.

SC - Special Concern Species: those species which are not yet recognized as endangered or threatened, but for which documented concern exists for their continued welfare in New York. Unlike the first two categories, species of special concern receive no additional legal protection under Environmental Conservation Law section 11-0535 (Endangered and Threatened Species).

P - Protected Wildlife (defined in Environmental Conservation Law section 11-0103): wild game, protected wild birds, and endangered species of wildlife.

U - Unprotected (defined in Environmental Conservation Law section 11-0103): the species may be taken at any time without limit; however a license to take may be required.

G - Game (defined in Environmental Conservation Law section 11-0103): any of a variety of big game or small game species as stated in the Environmental Conservation Law; many normally have an open season for at least part of the year, and are protected at other times.

NY LEGAL STATUS – Plants:

The following categories are defined in regulation 6NYCRR part 193.3 and apply to NYS Environmental Conservation Law section 9-1503.

E - Endangered Species: listed species are those with:
- 5 or fewer extant sites, or
- fewer than 1,000 individuals, or
- restricted to fewer than 4 U.S.G.S. 7 ½ minute topographical maps, or
- species listed as endangered by U.S. Dept. of Interior, as enumerated in Code of Federal Regulations 50 CFR 17.11.

T - Threatened: listed species are those with:
- 6 to fewer than 20 extant sites, or
- 1,000 to fewer than 3,000 individuals, or
- restricted to not less than 4 or more than 7 U.S.G.S. 7 and ½ minute topographical maps, or
- listed as threatened by U.S. Department of Interior, as enumerated in Code of Federal Regulations 50 CFR 17.11.

R - Rare: listed species have:

- 20 to 35 extant sites, or
- 3,000 to 5,000 individuals statewide.

V - Exploitably vulnerable: listed species are likely to become threatened in the near future throughout all or a significant portion of their range within the state if causal factors continue unchecked.

U - Unprotected; no state status.

FEDERAL STATUS (PLANTS and ANIMALS): The categories of federal status are defined by the United States Department of the Interior as part of the 1974 Endangered Species Act (see Code of Federal Regulations 50 CFR 17). The species listed under this law are enumerated in the Federal Register vol. 50, no. 188, pp. 39526 - 39527. The codes below without parentheses are those used in the Federal Register. The codes below in parentheses are created by Heritage to deal with species which have different listings in different parts of their range, and/or different listings for different subspecies or varieties.

(blank) = No Federal Endangered Species Act status.
LE = Formally listed as endangered.
LT = Formally listed as threatened.
C = Candidate for listing.
LE,LT = Formally listed as endangered in part of its range, and as threatened in the other part; or, one or more subspecies or varieties is listed as endangered, and the others are listed as threatened.
LT,PDL = Populations of the species in New York are formally listed as threatened, and proposed for delisting.

GLOBAL AND STATE RANKS (animals, plants, ecological communities and others): Each element has a global and state rank as determined by the NY Natural Heritage Program. These ranks carry no legal weight. The global rank reflects the rarity of the element throughout the world and the state rank reflects the rarity within New York State. Infraspecific taxa are also assigned a taxon rank to reflect the infraspecific taxon's rank throughout the world. ? = Indicates a question exists about the rank. Range ranks, e.g. S1S2, indicate not enough information is available to distinguish between two ranks.

GLOBAL RANK:

G1 - Critically imperiled globally because of extreme rarity (5 or fewer occurrences), or very few remaining acres, or miles of stream) or especially vulnerable to extinction because of some factor of its biology.

G2 - Imperiled globally because of rarity (6 - 20 occurrences, or few remaining acres, or miles of stream) or very vulnerable to extinction throughout its range because of other factors.

G3 – Vulnerable: Either rare and local throughout its range (21 to 100 occurrences), or found locally (even abundantly at some of its locations) in a restricted range (e.g. a physiographic region), or vulnerable to extinction throughout its range because of other factors.

G4 - Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.

G5 - Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.

GH - Historically known, with the expectation that it might be rediscovered.

GX - Species believed to be extinct.

NYS RANK:

S1 - Critically imperiled: Typically 5 or fewer occurrences, very few remaining individuals, acres, or miles of stream, or some factor of its biology making it especially vulnerable in New York State.

S2 – Imperiled: Typically 6 to 20 occurrences, few remaining individuals, acres, or miles of stream, or factors demonstrably making it very vulnerable in New York State.

S3 - Vulnerable: Typically 21 to 100 occurrences, limited acreage, or miles of stream in New York State.

S4 - Apparently secure in New York State.

S5 - Demonstrably secure in New York State.

SH - Historically known from New York State, but not seen in the past 15 years.

SX - Apparently extirpated from New York State.

SxB and SxN, where Sx is one of the codes above, are used for migratory animals, and refer to the rarity within New York State of the breeding (B)populations and the non-breeding populations (N), respectively, of the species.

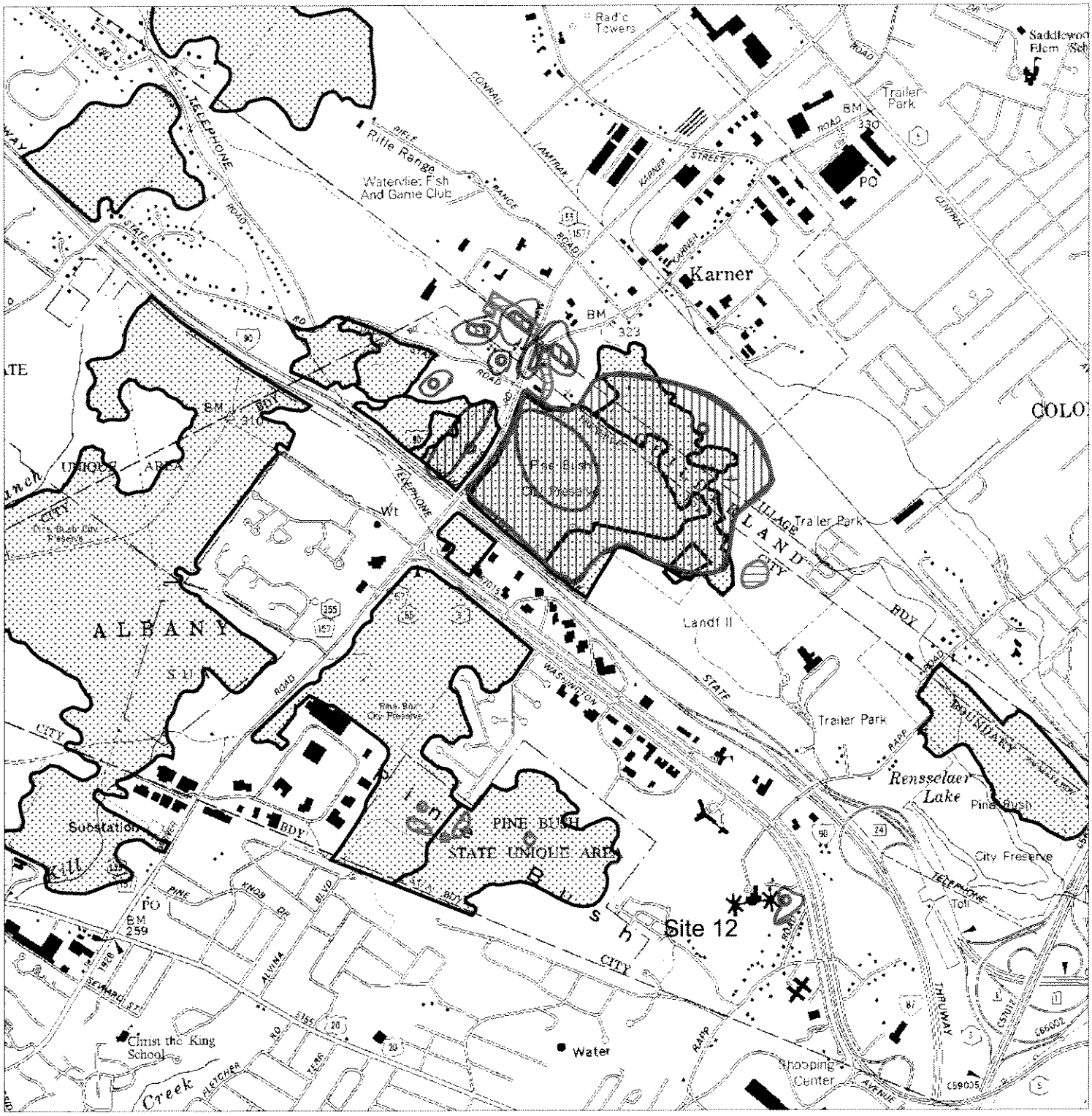
TAXON (T) RANK: The T-ranks (T1 - T5) are defined the same way as the Global ranks (G1 - G5), but the T-rank refers only to the rarity of the subspecific taxon.

T1 through T5 - See Global Rank definitions above.

Q - Indicates a question exists whether or not the taxon is a good taxonomic entity.

Natural Heritage Map of Rare Species and Ecological Communities

Prepared April 3, 2006 by the NY Natural Heritage Program, NYS DEC, Albany, NY



New York Natural Heritage Program Database Records

Map Overview

- Animal Assemblage
- Community
- Animal
- Plant

Scale: 1:24,000

0.4 0 0.4 Miles

N

*The locations that are displayed are considered sensitve and cannot be released to the public without permission. We do not provide map locations for all records. Please see report for details.

Natural Heritage Report on Rare Species and Ecological Communities

NY Natural Heritage Program, NYS DEC, 625 Broadway, 5th Floor,
Albany, NY 12233-4757
(518) 402-8935

* Records that are also mapped

~This report contains **SENSITIVE** information that may not be released to the public without permission from the NY Natural Heritage Program.
~Refer to the User's Guide for explanations of codes, ranks and fields.
~Location maps for certain species and communities may not be provided if 1) the species is vulnerable to disturbance, 2) the location and/or extent is not precisely known, and/or 3) the location and/or extent is too large to display.

BUTTERFLIES and SKIPPERS

Callophrys henrici

Henry's Elfin

*

Office Use: 412 S ESU

NY Legal Status: Unlisted, Special Concern
NYS Rank: S2S3; Imperiled
Global Rank: G5; Demonstrably secure
Last Report: **
EO Rank: **
County: Albany
Town: Colonie
Location: Karner Barrens East, Albany Pine Bush
Directions: Albany Pine Bush; northeast part of the city preserve.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Callophrys irus

Frosted Elfin

*

Office Use: 7827 ESU

NY Legal Status: Threatened
NYS Rank: S1S3; Critically imperiled
Global Rank: G3; Vulnerable
Last Report: **
EO Rank: **
County: Albany
Town: Colonie
Location: Kings Road Barrens East, Apollo Drive
Directions: From the junction of Route 155 and Washington Avenue Extension, go north on 155 about 0.6 miles to apollo drive. Turn west on apollo drive. The butterflies are inside a horseshoe along the road on the north side very near Route 155.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Callophrys irus

Frosted Elfin

*

Office Use: 9329 ESU

NY Legal Status: Threatened
NYS Rank: S1S3; Critically imperiled
Global Rank: G3; Vulnerable
Last Report: **
EO Rank: **
County: Albany
Town: Guilderland, City Of Albany, Colonie
Location: Karner Barrens East, Albany Pine Bush
Directions: Albany Pine Bush, city preserve. Entrance off Route 155, includes Route 155 dune cut. City Preserve is bounded by landfill to the west, railroad to the north, Route 155 to the west and New York State Thruway to south.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

BUTTERFLIES
and SKIPPERS

Callophrys irus

Office Use

Frosted Elfin

NY Legal Status: Threatened
NYS Rank: S1S3; Critically imperiled
Global Rank: G3; Vulnerable
EO Rank: **

3091
ESU

Last Report: **
County: Albany
Town: Guilderland, City Of Albany
Location: Kings Road Barrens East, Apollo Drive South
Directions: From the junction of Old State Road and Route 155 just south of apollo drive, turn west onto Old State Road and pull off on the north side at a cleared out area. Take a trail through the woods a short distance north to an open sandpit area with an old chimney. Lupine and butterflies are on Old State Road side of dune.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Erynnis martialis

Office Use

Mottled Duskywing

NY Legal Status: Unlisted, Special Concern
NYS Rank: S1S2; Critically imperiled
Global Rank: G3G4; Vulnerable
EO Rank: **

6735
ESU

Last Report: **
County: Albany
Town: Guilderland
Location: Kings Road Barrens East
Directions: From Guilderland, follow Route 155 north. Approximately 100 meters after passing through the intersection with Old State, turn east onto VFW Drive. Park just after turning. The specimen was collected from an open area to the south of VFW Drive.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Lycaeides melissa samuelis

Office Use

Karner Blue

NY Legal Status: Endangered
Federal Listing: Endangered
NYS Rank: S1; Critically imperiled
Global Rank: G5T2; Imperiled
EO Rank: **

2621
S
ESU

Last Report: **
County: Albany
Town: City Of Albany
Location: Willow Street Barrens, Madison Ave/Point-Of-Woods
Directions: From Route 155, go west approximately 0.1 mi on Washington Avenue Extension in the Albany Pine Bush area. Butterflies are located just south of the road.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

BUTTERFLIES
and SKIPPERS

Lycaeides melissa samuelis

Karner Blue

Office Use

NY Legal Status: Endangered
NYS Rank: S1; Critically imperiled
8349

Federal Listing: Endangered
Global Rank: G5T2; Imperiled
S

Last Report: **
EO Rank: **
ESU

County: Albany

Town: City Of Albany, Guilderland

Location: Blueberry Hill, Se Quad Row Number 2, Velina Driver Burn

Directions: The butterflies are in the Albany Pine Bush area. [West of Rapp Road, east of Route 155, north of Route 20].

General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Lycaeides melissa samuelis

Karner Blue

Office Use

NY Legal Status: Endangered
NYS Rank: S1; Critically imperiled
2092

Federal Listing: Endangered
Global Rank: G5T2; Imperiled
S

Last Report: **
EO Rank: **
ESU

County: Albany

Town: City Of Albany

Location: Blueberry Hill, Se Quad

Directions: Albany Pine Bush area. South and east approximately 0.7 mi of the junction of Route 155 and Washington Avenue.

General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Lycaeides melissa samuelis

Karner Blue

Office Use

NY Legal Status: Endangered
NYS Rank: S1; Critically imperiled
9646

Federal Listing: Endangered
Global Rank: G5T2; Imperiled
S

Last Report: **
EO Rank: **
ESU

County: Albany

Town: City Of Albany

Location: Pine Lane Woods, Frontage Road Southeast

Directions: From the junction of Rapp Road and Frontage Road south, northwest 0.05 mi. Butterflies are on small dune on front lawn of daughters of sarah nursing home.

General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

BUTTERFLIES
and SKIPPERS

Lycaeides melissa samuelis

Karner Blue

Office Use

NY Legal Status: Endangered
NYS Rank: S1; Critically imperiled
10090

Federal Listing: Endangered
Global Rank: G5T2; Imperiled
S

Last Report: **
EO Rank: **
ESU

County: Albany
Town: City Of Albany
Location: Kings Road Barrens East, Apollo Drive South
Directions: The site is just north of Old State Road, south of Apollo Drive and west of Route 155 (New Karner Road). Park on Old State Road in pull-off on the north side just west of Route 155. Walk on a trail north through woods to an open sandpit with a huge duneand an old chimney. Lupine is on the south side of a dune and on a low dune that runs parallel to Old State Road.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Lycaeides melissa samuelis

Karner Blue

Office Use

NY Legal Status: Endangered
NYS Rank: S1; Critically imperiled
1055

Federal Listing: Endangered
Global Rank: G5T2; Imperiled

Last Report: **
EO Rank: **
ESU

County: Albany
Town: Colonie
Location: Kings Road Barrens East, Apollo Drive
Directions: From the junction of Route 155 and Washington Avenue Extension, go north on Route 155 about 0.6 miles to Apollo Drive. Turn west onto Apollo Drive. The butterflies are inside the horseshoe along the north side of Apollo Drive and east of Kings Road.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Lycaeides melissa samuelis

Karner Blue

Office Use

NY Legal Status: Endangered
NYS Rank: S1; Critically imperiled
6301

Federal Listing: Endangered
Global Rank: G5T2; Imperiled

Last Report: **
EO Rank: **
ESU

County: Albany
Town: City Of Albany, Colonie, Guilderland
Location: Karner Barrens East, Albany Pine Bush
Directions: The butterflies are at the Albany Pine Bush City Preserve near Karner which is east of Route 155, north of the NYS Thruway, south of the railroad tracks, and west of the landfill. Look for a sign on the east side of Route 155.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

BUTTERFLIES
and SKIPPERS

Phyciodes batesii batesii

Tawny Crescent

Office Use 9758 ESU

NY Legal Status: Unlisted, Special Concern
NYS Rank: SH; Historical
Global Rank: G4T1; Critically imperiled
EO Rank: **

Last Report: **
County: Albany
Town: Guilderland, City Of Albany, Colonie
Location: Karner
Directions: Albany Pine Bush.
General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

Satyrium edwardsii

Edwards' Hairstreak

Office Use 10331

NY Legal Status: Unlisted
NYS Rank: S3S4; Vulnerable
Global Rank: G4; Apparently secure
EO Rank: Extant

Last Report: 1987-07
County: Albany
Town: City Of Albany, Colonie, Guilderland
Location: Albany Pine Bush
Directions: The hairstreaks were observed in the Albany Pine Bush between the city of Albany and the city of Schenectady, north and south of I-90, east of Carman Road (Route 146) and northwest of I-87, and east and west of Route 155 (Karner Road).
General Quality and Habitat: The hairstreaks were found in pitch pine-scrub oak barrens.

MOTHS

Catopyrrha coloraria

Broad-lined Catopyrrha *

Office Use 8394 S

NY Legal Status: Unlisted
NYS Rank: S2S3; Imperiled
Global Rank: G4; Apparently secure
EO Rank: Extant

Last Report: 1979-SU
County: Albany
Town: City Of Albany
Location: Karner Barrens West, Albany Pine Bush
Directions: The moths were observed in the Albany Pine Bush city preserve just west of Route 155 on Ceanothus along the trail.
General Quality and Habitat: Pitch pine scrub oak barrens.

MOTHS

Catopyrrha coloraria

Office Use

Broad-lined Catopyrrha **NY Legal Status:** Unlisted **NYS Rank:** S2S3; Imperiled 2930

Global Rank: G4; Apparently secure S

Last Report: 1979-SU **EO Rank:** Extant

County: Albany

Town: City Of Albany

Location: Karner Barrens East, Albany Pine Bush

Directions: Albany Pine Bush city preserve east of Route 155, south of the railroad tracks, and west of the landfill. Adults were on Ceanothus throughout.

General Quality and Habitat: Pitch-pine scrub oak barrens.

Cerma cora

Office Use

Bird Dropping Moth **NY Legal Status:** Unlisted **NYS Rank:** S1S3; Critically imperiled 5875

Global Rank: G3G4; Vulnerable

Last Report: 1990 **EO Rank:** Extant

County: Albany

Town: City Of Albany, Colonie, Guilderland

Location: Albany Pine Bush

Directions: The Albany Pine Bush is between the city of Albany and the city of Schenectady, north and south of I-90, east of Carman Road and northwest of I-87, and east and west of Route 155. The moths occur throughout the Albany Pine Bush.

General Quality and Habitat: The moth was found in pitch pine-scrub oak barrens.

Chaetaglaea cerata

Office Use

A Noctuid Moth **NY Legal Status:** Unlisted **NYS Rank:** S1S2; Critically imperiled 1773

Global Rank: G3G4; Vulnerable

Last Report: 1990 **EO Rank:** Extant

County: Albany

Town: City Of Albany, Colonie, Guilderland

Location: Karner Barrens East, Albany Pine Bush

Directions: The moths were found at the Albany Pine Bush City Preserve that is east of Route 155 (Karner Road) and north of the NYS Thruway in pine barrens habitat.

General Quality and Habitat: The moths were found in pitch pine-scrub oak barrens.

MOTHS

Chaetaglaea cerata

Office Use

A Noctuid Moth

NY Legal Status: Unlisted

NYS Rank: S1S2; Critically imperiled

10140

Global Rank: G3G4; Vulnerable

S

Last Report: 1986

EO Rank: Good

County: Albany

Town: City Of Albany

Location: Karner Barrens West, Albany Pine Bush

Directions: The moths are in the Albany Pine Bush city preserve. From the junction of Route 155 and Washington Avenue, go north on Route 155 for 0.4 mi. Park and walk 0.3 mi northwest to the moths.

General Quality and Habitat: Pitch pine scrub oak barrens.

Chytonix sensilis

Office Use

A Noctuid Moth

NY Legal Status: Unlisted

NYS Rank: S1S3; Critically imperiled

8841

Global Rank: G4; Apparently secure

Last Report: 1990

EO Rank: Extant

County: Albany

Town: City Of Albany, Colonie, Guilderland

Location: Albany Pine Bush

Directions: The moths were collected in the Albany Pine Bush someplace between the city of Albany and the city of Schenectady, north and south of I-90, east of Carman Road (Route 146) and northwest of I-87, and east and west of Route 155 (Karner Road).

General Quality and Habitat: The moths were found in pitch pine-scrub oak barrens.

Hemileuca maia maia

Office Use

Inland Barrens Buckmoth

NY Legal Status: Unlisted, Special Concern

NYS Rank: S1; Critically imperiled

4909

Global Rank: G5T5; Demonstrably secure

Last Report: **

EO Rank: **

ESU

County: Albany

Town: Colonie, Guilderland, City Of Albany

Location: Albany Pine Bush

Directions: The moths are in the Albany Pine Bush. The core area is habitat around the junction of Route 155 and I-90. Nine sample sites were surveyed between 1991 and 2002.

General Quality and Habitat: **For information on the population at this location and management considerations, please contact the NYS DEC Regional Wildlife Manager or NYS DEC Endangered Species Unit at 518-402-8859.

MOTHS

Itame sp. 1 nr. inextricata

Barrens Itame

Office Use: 2664 S

NY Legal Status: Unlisted
NYS Rank: S1; Critically imperiled
Global Rank: G3G4; Vulnerable
Last Report: 1979-07-28
EO Rank: Fair
County: Albany
Town: City Of Albany
Location: Karner Barrens West, Albany Pine Bush
Directions: The site is in the Albany Pine Bush city preserve. From Route 155 and Washington Avenue, go north on Route 155 approximately 0.3 mi and walk west to the moths.
General Quality and Habitat: Pitch pine scrub oak barrens.

Macrochilo bivittata

A Noctuid Moth

Office Use: 7051

NY Legal Status: Unlisted
NYS Rank: SU; Unrankable
Global Rank: G3G4; Vulnerable
Last Report: 1990
EO Rank: Extant
County: Albany
Town: City Of Albany, Colonie, Guilderland
Location: Albany Pine Bush
Directions: The moth was found in the Albany Pine Bush in pine barrens habitat.
General Quality and Habitat: The moths were taken from sites in pitch pine-scrub oak barrens.

Zanclognatha martha

Pine Barrens Zanclognatha

Office Use: 9628

NY Legal Status: Unlisted
NYS Rank: S1S2; Critically imperiled
Global Rank: G4; Apparently secure
Last Report: 1990
EO Rank: Excellent or Good
County: Albany
Town: Guilderland, Colonie, City Of Albany
Location: Albany Pine Bush
Directions: The moths were found in several areas of the Albany Pine Bush.
General Quality and Habitat: The population is persistent and in good habitat. The moths were found in pitch pine-scrub oak barrens.

DRAGONFLIES and DAMSELFLIES

DRAGONFLIES
and
DAMSELFLIES

Williamsonia lintneri

Office Use

Ringed Boghaunter

NY Legal Status: Unlisted

NYS Rank: SH; Historical

Global Rank: G3; Vulnerable

4808
M

Last Report: 1874-05-27

EO Rank: Historical, no recent information

County: Albany

Town: Colonie

Location: Karner

Directions: Center (Karner).

General Quality and Habitat: Most of the Karner area has been developed; the wetlands which remain do not seem to meet the descriptions of occupied sites and are probably not suitable. Could be considered extirpated instead, but available wetlands should be checked first. Sandy pine woods region.

VASCULAR
PLANTS

Agrimonia rostellata

Office Use

Woodland Agrimony

NY Legal Status: Threatened

NYS Rank: S2; Imperiled

Global Rank: G5; Demonstrably secure

3205
M

Last Report: 1927-09-04

EO Rank: Historical, no recent information

County: Albany

Town: Guilderland

Location: Guilderland

Directions: Woods near Guilderland.

General Quality and Habitat: Woods.

Botrychium oneidense

Office Use

Blunt-lobe Grape Fern

NY Legal Status: Endangered

NYS Rank: S2S3; Imperiled

Global Rank: G4Q; Apparently secure

9915

Last Report: 1929-10-16

EO Rank: Historical, no recent information

County: Albany

Town: Guilderland

Location: Guilderland

Directions:

General Quality and Habitat:

VASCULAR
PLANTS

Carex cumulata

Clustered Sedge

Office Use: 1175 M

NY Legal Status: Threatened
NYS Rank: S2S3; Imperiled
Global Rank: G4?; Apparently secure
EO Rank: Historical, no recent information

Last Report: 1919-07-07
County: Albany
Town: Colonie
Location: Karner
Directions:
General Quality and Habitat:

Cyperus schweinitzii

Schweinitz's Flatsedge

Office Use: 7426 S

NY Legal Status: Rare
NYS Rank: S2S3; Imperiled
Global Rank: G5; Demonstrably secure
EO Rank: Fair

Last Report: 1996-08-16
County: Albany
Town: City Of Albany
Location: Albany Landfill, Albany County Dump
Directions: Take the red trail from the "Discovery Center" [formerly the crerdit union] east into the Pine Bush. Stay left on an unmarked trail where the red trail veers to the right. Stay left at the next fork until you reach a mitigation pond on the north side. Take a dirt car track to the right just before the pond. The plants are in clearings on the right before the top of the dune.
General Quality and Habitat: Fair population on threatened site. Sand-mined area and adjoining pine barrens running into Albany Pine Bush preserve to west. Associated species: Melilotus alba, Saponaria officinalis, Centaurea maculosa.

Cyperus schweinitzii

Schweinitz's Flatsedge

Office Use: 749 S

NY Legal Status: Rare
NYS Rank: S2S3; Imperiled
Global Rank: G5; Demonstrably secure
EO Rank: Excellent

Last Report: 1997-07-08
County: Albany
Town: City Of Albany
Location: Blueberry Hill
Directions: From the end of Pitch Pine Drive West, continue down Sand Road. The plants are in 4 groups. Group one is located on exposed sand on the west face of a dune half way down Sand Road. Group two is located at the junction of an east-west sand road, northwest corner. Group three is located in an exposed sand pit down a sand road to the west, on the north side of the road. Group four is located on the top of Blueberry Hill where trails meet.
General Quality and Habitat: 1-2000 plants in protected area. Disturbed slope of dune faces and edges of sand road. Associated species: Lespedeza capitata, Schizachyrium, Centaurea, Monarda, locust seedlings.

VASCULAR
PLANTS

Cyperus schweinitzii

Office Use

Schweinitz's Flatsedge

NY Legal Status: Rare

NYS Rank: S2S3; Imperiled — 5242

Global Rank: G5; Demonstrably secure — S

Last Report: 1996-08-16

EO Rank: Excellent or Good

County: Albany

Town: Guilderland, Albany

Location: Kings Road Karner Barrens East, Apollo Drive South

Directions: Take Route 155 north of Route 20, over the NYS Thruway bridge to a credit union building on the east side of Route 155. Park in the credit union parking lot. The plants are in group 1 along southeast to a northwest Sand Road between the credit union andthe next building to the north (insurance centers). The plants are in group 2 along north side of Apollo Drive south loop from Route 155 west about 0.3 mile to a chain link fence on the south side of the road. Some plants are on the south side of the dri

General Quality and Habitat: Over 2000 plants but threatened and not protected. A sand area of an old mined area in pitch pine-scrub oak barrens. Associated species: Populus deltoides, Centaurea maculata, cycloma, Lupinus, Schizachyrium, Panicum virgatum, Conyza canadensis, Monarda punctata, Bromus inermis, Andropogon gerardii, Cenchrus longispinus, Comptonia.

Desmodium ciliare

Office Use

Little-leaf Tick-trefoil

NY Legal Status: Threatened

NYS Rank: S2S3; Imperiled — 7998

Global Rank: G5; Demonstrably secure — M

Last Report: 1910-PRE-08

EO Rank: Historical, no recent information

County: Albany

Town: Colonie

Location: Karner

Directions: Karner, Albany County.

General Quality and Habitat:

Malaxis bayardii

Office Use

Bayard's Adder's-mouth Orchid

NY Legal Status: Endangered

NYS Rank: S1; Critically imperiled — 9939

Global Rank: G1G2; Critically imperiled — S

Last Report: 1997-07-08

EO Rank: Excellent or Good

County: Albany

Town: City Of Albany

Location: Blueberry Hill

Directions: From Washington Avenue Extension and Route 155, go east to the first right turn on to the Frontage Road that leads to The Dunes development. Take Pitch Pine Drive west to the end and park by the gate to the Pine Bush. Walk south on a sand road west of Blueberry Hill. When it turns to the west, go straight into the Pine Bush along the trail that eventually leads to the east side of the old sand pit. The plants are under pines on north and northwest side of sand pit. They are hard to see so be careful not

General Quality and Habitat: There was only one plant in good habitat during a very dry summer. Plants are likely to return to higher population numbers with a wetter summer. A small area of moist pitch pine scrub oak barrens dominated by black cherry and black locust. There are a few pitch pine evident and some bigtooth aspen. Associated species: Lonicera sp., Lysimachia quadrifolia, Rubus sp. The area was burned in 1992.

VASCULAR PLANTS

Onosmodium virginianum

Office Use

Virginia False Gromwell

NY Legal Status: Endangered
NYS Rank: S1; Critically imperiled — 1820
Global Rank: G4; Apparently secure — M
Last Report: 1923-08-26
EO Rank: Failed to find but search more
County: Albany
Town: Colonie
Location: Karner
Directions: Karner, northwest of Albany.
General Quality and Habitat: Proper habitat present, but no plants found. Open, sandy woods.

Polygonum careyi

Office Use

Carey's Smartweed

NY Legal Status: Threatened
NYS Rank: S2; Imperiled — 508
Global Rank: G4; Apparently secure — M
Last Report: 1955-09-18
EO Rank: Historical, no recent information
County: Albany
Town: Colonie, City Of Albany
Location: Karner Road
Directions: The specimen label says "Open mud, swamp along Karner Road, Pinebush".
General Quality and Habitat: The specimen label says "Open mud, swamp".

Scleria triglomerata

Office Use

Whip Nutrush

NY Legal Status: Threatened
NYS Rank: S2; Imperiled — 5086
Global Rank: G5; Demonstrably secure
Last Report: 1937-08-24
EO Rank: Historical, no recent information
County: Albany
Town: City Of Albany, Guilderland
Location: Blueberry Hill
Directions: The plants were collected from the sand plains south of Karner.
General Quality and Habitat: Sand plains.

COMMUNITIES

COMMUNITIES

Pitch pine-oak forest

Office Use

This occurrence of Pitch Pine-Oak Forest is considered significant from a statewide perspective by the NY Natural Heritage Program. It is either an occurrence of a community type that is rare in the state or a high quality example of a more common community type. By meeting specific, documented significance criteria, the NY Natural Heritage Program considers this occurrence to have high ecological and conservation value.

NY Legal Status: Unlisted **NYS Rank:** S4; 8107

Global Rank: G4G5;

Last Report: 2001-05-17

County: Albany

Town: Guilderland, Colonie, City Of Albany

Location: Albany Pine Bush

Directions: Take Interstate 87 south to Western Avenue (Route 20), turn right (west), go four miles to Willow Street, turn right (north), go 1 mile to the end of Willow Street and to the Pine Barrens Parking lot (stay right at forks in Willow Street). From the townof Colonie, take Route 5 northwest to Route 155, turn left (southwest) and travel 1.3 miles to Kings Road. Turn right (northwest) and travel to a three-way stop, about 0.6 miles, and turn right (northwest). Travel 1.2 miles to the entrance of "The Farm",

General Quality and Habitat: The forest is relatively large with several invasive species and in a landscape that is fragmented by development. A relatively large community consisting of 9 patches. The forest is rather young and there are some invasive species. The forest is partially protected in a fragmented and developed landscape. There are numerous roads separating the various patches and residential and commercial development on approximately 65% of its perimeter. The pitch pine-oak forest forms a mosaic with pitch pine-scrub oak barrens, Appalachian oak-pine forest, and successional northern hardwoods.

Pine barrens vernal pond

Office Use

This occurrence of Pine Barrens Vernal Pond is considered significant from a statewide perspective by the NY Natural Heritage Program. It is either an occurrence of a community type that is rare in the state or a high quality example of a more common community type. By meeting specific, documented significance criteria, the NY Natural Heritage Program considers this occurrence to have high ecological and conservation value.

NY Legal Status: Unlisted **NYS Rank:** S2; 10299

Global Rank: G3G4;

Last Report: 2001-05-15

County: Albany

Town: Colonie, Guilderland

Location: Albany Pine Bush

Directions: In the town of Colonie, take Central Avenue (Route 5) northwest to Route 155, turn left (southwest) and travel 1.3 miles to the Albany Pine Bush trailhead on the left (south) side of Route 155. Follow the blue trail for about 260 yards to the red trail and left (north) on to the red trail. Follow the red trail for about 175 yards to the junction with the yellow trail and turn left (northeast) onto the yellow trail. Continue on the yellow trail to the junction with the white trail and turn right (southea

General Quality and Habitat: The pond is moderate sized in a protected landscape in excellent condition. A moderate sized wetland in a protected landscape in excellent condition. The pond is seasonally flooded and nearly dry in late summer. The wetland lies in a depression between sand dunes and is bordered by pitch pine-oak forest to the southwest and hardwood forest to the northeast. The vernal pond is within a 270-acre roadless natural area.

COMMUNITIES

Pitch pine-scrub oak barrens

This occurrence of Pitch Pine-Scrub Oak Barrens is considered significant from a statewide perspective by the NY Natural Heritage Program. It is either an occurrence of a community type that is rare in the state or a high quality example of a more common community type. By meeting specific, documented significance criteria, the NY Natural Heritage Program considers this occurrence to have high ecological and conservation value.

Office Use 4632

NY Legal Status: Unlisted **NYS Rank:** S1;

Global Rank: G2;

Last Report: 2001-05-15

County: Albany

Town: Guilderland, City Of Albany

Location: Albany Pine Bush

Directions: From the town of Colonie, take Central Avenue (Route 5) northwest to Route 155, turn left (southwest) and travel 1.3 miles to the trailhead on the left (south) side of Route 155. Follow the blue trail through a narrow band of trees to the barrens.

General Quality and Habitat: The barrens is moderate sized with excellent physiognomic diversity in a fragmented landscape. A moderate sized pitch pine-scrub oak barrens in excellent condition in a fragmented landscape. There are four patches ranging in size from 35 to 93 acres. The pine barrens are on rolling sand dunes and form a mosaic with and grade into pitch pine-oak forest, which is a more mature stage of pitch pine-scrub oak barrens. A mosaic such as this allows for excellent diversity and ecosystem function across the landscape and is more desirable than one homogenous community type. The pitch pine-scrub oak barren

39 Records Processed

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New York Field Office
3817 Luker Road
Cortland, NY 13045
Phone: (607) 753-9334 Fax: (607) 753-9699

March 6, 2006

We have received your request to review your project for potential presence of Federally-listed threatened or endangered species or critical habitat. Due to the loss of two-thirds of our endangered species staff to retirement, there will likely be significant delays in our response to your request. We are presently unable to determine the length of this delay and appreciate your patience and understanding during this time. For additional information on Federally-listed species, please visit our website at http://www.fws.gov/northeast/nyfo/es/esdesc.htm. We are planning to update our endangered species pages to provide additional technical assistance to applicants, consultants, and other Federal agencies in the near future.

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New York Field Office
3817 Luker Road, Cortland, NY 13045
Phone: (607) 753-9334
Fax: (607) 753-9699

Long Island Field Office
3 Old Barto Rd., Brookhaven, NY 11719
Phone: (631) 776-1401
Fax: (631) 776-1405

Endangered Species Act List Request Response Cover Sheet

This cover sheet is provided in response to a search of our website* for information regarding the potential presence of species under jurisdiction of the U.S. Fish and Wildlife Service (Service) within a proposed project area.

Attached is a copy of the New York State County List of Threatened, Endangered, and Candidate Species for the appropriate county(ies). The database that we use to respond to list requests was developed primarily to assist Federal agencies that are consulting with us under Section 7(a)(2) of the Endangered Species Act (ESA) (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*). Our lists include all Federally-listed, proposed, and candidate species known to occur, as well as those likely to occur, in specific counties.

The attached information is designed to assist project sponsors or applicants through the process of determining whether a Federally-listed, proposed, or candidate species and/or "critical habitat" may occur within their proposed project area and when it is appropriate to contact our offices for additional coordination or consultation. You may be aware that our offices have provided much of this information in the past in project-specific letters. However, due to increasing project review workloads and decreasing staff, we are now providing as much information as possible through our website. We encourage anyone requesting species list information to print out all materials used in any analyses of effects on listed, proposed, or candidate species.

The Service routinely updates this database as species are proposed, listed, and delisted, or as we obtain new biological information or specific presence/absence information for listed species. If project proponents coordinate with the Service to address proposed and candidate species in early stages of planning, this should not be a problem if these species are eventually listed. However, we recommend that both project proponents and reviewing agencies retrieve from our online database an *updated* list every 90 days to append to this document to ensure that listed species presence/absence information for the proposed project is *current.*

Reminder: Section 9 of the ESA prohibits unauthorized taking** of listed species and applies to Federal and non-Federal activities. For projects not authorized, funded, or carried out by a Federal agency, consultation with the Service pursuant to Section 7(a)(2) of the ESA is not required. However, no person is authorized to "take**" any listed species without appropriate authorizations from the Service. Therefore, we provide technical assistance to individuals and agencies to assist with project planning to avoid the potential for "take**," or when appropriate, to provide assistance with their application for an incidental take permit pursuant to Section 10(a)(1)(B) of the ESA.

Additionally, endangered species and their habitats are protected by Section 7(a)(2) of the ESA, which requires Federal agencies, in consultation with the Service, to ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. An assessment of the potential direct, indirect, and cumulative impacts is required for all Federal actions that may affect listed species.

For instance, work in certain waters of the United States, including wetlands and streams, may require a permit from the U.S. Army Corps of Engineers (Corps). If a permit is required, in reviewing the application pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended;16 U.S.C. 661 *et seq.*), the Service may concur, with or without recommending additional permit conditions, or recommend denial of the permit depending upon potential adverse impacts on fish and wildlife resources associated with project construction or implementation. The need for a Corps permit may be determined by contacting the appropriate Corps office(s).*

For additional information on fish and wildlife resources or State-listed species, we suggest contacting the appropriate New York State Department of Environmental Conservation regional office(s) and the New York Natural Heritage Program Information Services.*

Since wetlands, ponds, streams, or open or sheltered coastal waters may be present in the project area, it may be helpful to utilize the National Wetlands Inventory (NWI) maps as an initial screening tool. However, they may or may not be available for the project area. Please note that while the NWI maps are reasonably accurate, they should not be used in lieu of field surveys for determining the presence of wetlands or delineating wetland boundaries for Federal regulatory purposes. Online information on the NWI program and digital data can be downloaded from Wetlands Mapper, http://wetlands.fws.gov/mapper_tool.htm.

Project construction or implementation should not commence until all requirements of the ESA have been fulfilled. After reviewing our website and following the steps outlined, we encourage both project proponents and reviewing agencies to contact our office to determine whether an accurate determination of species impacts has been made. If there are any questions about our county lists or agency or project proponent responsibilities under the ESA, please contact the New York or Long Island Field Office Endangered Species Program at the numbers listed above.

Attachment (county list of species)

*Additional information referred to above may be found on our website at:
http://www.fws.gov/northeast/nyfo/es/section7.htm

** Under the Act and regulations, it is illegal for any person subject to the jurisdiction of the United States to ***take*** (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import or export, ship in interstate or foreign commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any endangered fish or wildlife species and most threatened fish and wildlife species. It is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. "Harm" includes any act which actually kills or injures fish or wildlife, and case law has clarified that such acts may include significant habitat modification or degradation that significantly impairs essential behavioral patterns of fish or wildlife.

Albany County

Federally Listed Endangered and Threatened Species and Candidate Species

This list represents the best available information regarding known or likely County occurrences of Federally-listed and candidate species and is subject to change as new information becomes available.

Common Name	Scientific Name	Status
Bald eagle	*Haliaeetus leucocephalus*	T
Bog turtle *(historic)*	*Clemmys muhlenbergii*	T
Indiana bat (W/S)	*Myotis sodalis*	E
Karner blue butterfly	*Lycaeides melissa samuelis*	E
Shortnose sturgeon[1]	*Acipenser brevirostrum*	E

E=Endangered T=Threatened P=Proposed C=Candidate

W=Winter S=Summer

[1]Primarily occurs in Hudson River. Principal responsibility for this species is vested with the National Oceanic and Atmospheric Administration/Fisheries.

Information current as of: 6/28/2007

Long-term Response of Woody Vegetation to Repeated Burning in an Eastern Sand Savanna Landscape

Alan Haney[1], Marlin Bowles[2], Steven Apfelbaum[3], Emily Lain[1], and Tom Post[4]

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University of Wisconsin-Stevens Point
Stevens Point, WI 54481

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Brodhead, WI 53520

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Indiana Department of Natural Resources

Abstract

Little information is available on how eastern sand savanna responds to fire restoration management. We examined initial and 20-year fire effects on woody vegetation of the Tefft Savanna, a 197 ha remnant of the eastern sand savanna landscape, located in northwest Indiana. Based on Public Land Survey notes, pre-settlement vegetation was primarily black oak (*Quercus velutina*) and white oak (*Q. alba*) barrens and pin oak (*Q. palustris*) savanna, with total density of about 50 trees per hectare and basal area of 4m^2/ha. In 1986, we identified black oak, white oak and pin oak cover types, which occurred sequentially along a dry to wet moisture gradient determined by topography. For trees > 15 cm dbh, which approximates the PLS data, the black oak cover type had 230 stems/ha and 11.3 m^2/ha. The white oak and pin oak cover types had about 50 % less density and volume. However, density for stems > 5 cm dbh was more that twice as high. We sought to determine the extent that initial burning at low and high fire intensities could restore woody structure, and how low intensity burning over 20 years at 3 fires/decade might further modify vegetation. Initial low intensity burns in the black oak cover type reduced tree cover and shrub layer density. In the white oak cover type, low intensity burns reduced shrub layer cover and density, while high intensity burning reduced cover of trees and shrubs. Continued burning with low intensity fires over 20 years had little effect on tree cover and basal area, but reduced lower size class densities of black oak, white oak and pin oak. This promoted an increase in shrub layer stem densities, primarily as a result of post-fire sprouting of oaks from smaller size classes. Black oak was more fire-sensitive that white oak as it lost significantly more stems in smaller size classes. For stems above 15 cm, the black oak cover type decreased to 195 stems/ha but basal area increased to 16.2 m^2/ha. The white oak and pin oak cover types were more stable. Time since fire was critical in regulating the shrub layer, with a return to high cover and density within three years of burning. These results suggest that burning with low fire intensities at 3 fires/decade for 20 years will only partially restore eastern sand savanna structure and may promote increased woody stem densities in the shrub layer.

Greater fire frequency appears necessary to maintain low shrub layer cover and density however, mechanical thinning, also may be needed to further reduce canopy cover and achieve more open savanna conditions.

Introduction

Open-structured oak savannas in the Midwest were maintained as a result of recurring fire from lightning and burning by Native Americans (Wolf 2004, Abrams 2000, Anderson et al. 1999, Taft 1997, Heikens and Robertson 1994, Olsen 1991, Grimm 1984, Henderson and Long 1984, Vogl 1970). Oak savannas are one of the most endangered and altered ecosystems in North America because of post-settlement fire suppression and cultural development (Anderson et al. 1999, Nuzzo 1986, Bowles et al. 1994, Bowles and McBride 1994, Szeicz and MacDonald 1991, Packard 1988). Fine-textured, deep-soil savannas have suffered the greatest losses; Sand savannas are the most extensive remaining savanna type in eastern North America (Faber-Langendoen 1995, Will-Wolf and Stearns 1998, 1999, Haney and Apfelbaum 1990)because of their low fertility and greater susceptibility to fire (Anderson and Bowles 1999). .

Eastern sand savanna extended from Iowa through Illinois, Indiana, Michigan, and Ohio into Ontario (Figure 1). This vegetation type differs in species composition from northern sand savanna (Will-Wolf & Stearns 1999), and large remnants may contain a wide floristic gradient including dominance by black oak (*Quercus velutina*) on well drained uplands, white oak (*Q. alba*) on more mesic sites, and pin oak (*Q. palustris*) on poorly drained habitats (Brewer & Vankant 2006, 2004; Haney and Apfelbaum 1990). Little specific information is available on how fire processes structured original sand savannas. This vegetation was commonly called "barrens" (Will-Wolf and Stearns 1999), where poor tree growth and form were thought to result from excessively drained, sterile soils (Homoya 1994). However, frequent fire likely contributed to poor form (Bowles and McBride 1994, Anderson & Bowles 1999). Frequent or intense fire apparently maintained sand savannas prior to settlement (Henderson & Long 1984) since surviving savannas developed greater canopy cover with fire exclusion (Abella et al. 2001, Nielsen et al. 2003, Pavlovic et al 2006).

Fire regime has been shown to greatly influence structure and composition of savannas, with increasing fire frequency or intensity causing a decrease in canopy cover and limiting oak recruitment (Faber-Langendoen and Davis 1995), thereby increasing diversity of light-dependent ground-layer vegetation (Bray 1958, Bowles and McBride 1998). Oak wilt (Collada and Haney 1998), and summer drought also may play an important role in this process by increasing flammability of fuel, as well as stressing trees and increasing probability of woody plant mortality (Faber-Langendoen and Tester 1993, Anderson and Bowles 1999). Despite interest in conservation of savannas, only one other long-term burning experiment has been reported. After 30 years of prescribed fire in a northern sand savanna in east-central Minnesota, a minimum of 3 low intensity fires (<1 m flame height)/decade were thought to stabilize woody vegetation as they prevented development of a sapling layer, as well as ingrowth by the dominant tree, Hill's oak (*Q. ellipsoidalis*) (Peterson and Reich 2001). It was also reported that more frequent burning may not sustain Hill's oak, but will favor bur oak (*Q. macrocarpa*) and development of oak grubs. The differential effects on Hill's oak and bur oak may reflect differences in response of the red oak (*Erythrobalanus*) and white oak (*Leucobalanus*) subgenera to frequent fire, where the

latter are expected to be more fire-resistant as a result of greater bark thickness (Loomis 1973, Hengst and Dawson 1994, Huddle and Pallardy 1996).

We examined long-term effects of fire in a 197 ha sand savanna landscape that contains black oak, white oak, and pin oak cover types corresponding to a topographic moisture gradient ranging from well drained upland habitat to poorly drained wetlands. We evaluated response of woody vegetation to initial low and high intensity fires followed by 20 years of low intensityy burns repeated at 3 fires/decade. We examined the following questions that have implications for restoration and management of sand savannas by prescribed fire:

1) How is modern eastern sand savanna vegetation organized across a topographic moisture gradient in comparison to presettlement vegetation?
2) How do initial fires of different intensities affect vegetation structure across this gradient?
3) Does subsequent burning at 3 fires/decade eliminate or prevent saplings and stabilize ingrowth as reported in northern sand savanna (Peterson and Reich 2001), and does this differ among dominant oak species in the eastern sand savanna?
4) Do repeated low intensity prescribed fires produce results similar to initial high intensity fires, and do they stabilize vegetation patterned by initial fires?
5) Does sensitivity to fire vary by cover type primarily because of variation in fire sensitivity by species, or because of variation in fuel characteristics? We have no fuel measures unless Steve can find the original data

Study Area

Our study was conducted at Tefft Savanna Nature Preserve, a remnant of eastern sand savanna located in Jasper Co, Indiana (Figure 1). This 197 ha (480 acre) natural area is located in the "prairie peninsula" (Transeau 1935) at 41^{o}10' N latitude and 86^{o}58' W longitude, within the 3239 ha (8000 acre) Jasper-Pulaski State Fish and Wildlife Area. Oakville fine sand, Newton loamy fine sand and Morocco loamy sand comprise 80 % of soils in the study area, and are developed in Kankakee River outwash and lacustrine sands in the Northwestern Prairie and Wetlands Natural Division of Indiana (Homoya et al. 1985). These sands have been worked into eolian dunes and imbedded wetlands, with elevation ranging from about 210-256 m (700-750 feet) above sea level (Figure 2). Climate is continental, with average temperatures ranging from -4.5 C^{o} in January to 23.2 C^{o} in July, and 93 cm annual precipitation, 52 per cent of which falls during the May through September growing season (Smallwood and Osterholz 1990). Unpredictable summer drought, as well as dry fall and early spring conditions, favored fire and predominance of prairie and savanna vegetation in this region, especially on drought-prone sandy soils (Anderson 1983, Anderson 1991).

Data from the Public Land Survey (PLS) provide a coarse-grained description of pre-European settlement vegetation of the study area. In 1833, Sylvester Sibley and in 1834, A.E. Van Ness surveyed five section lines bounding the study area. Their notes indicate the area was predominantly "barrens" with black and white oak timber occupying poor sandy soil on gently rolling terrain, although about 25 % was wet prairie and marsh (at elevations below 215 m). Based on modified point-center-quarter analysis (Cottam & Curtis 1956) of bearing trees at nine corners, tree density was 49.2 (+7.0 se) trees/ha, with 3.93 m^2/ha basal area. "B. oak" (*Quercus*

velutina) and "W. oak" (*Q. alba*) were recorded as bearing and line trees, and did not differ in size, averaging 15.1 (+0.01se) cm dbh. Black oak was most abundant, with over 70 % relative density and basal area. Several "B. oak" bearing trees in wet prairie may have been pin oak, and a single bearing tree recorded as "Y. oak" may have been Hill's oak, as this species has yellowish inner bark compared to the orange inner bark of black oak.

Modern woody vegetation in the study area probably represents the original floristic gradient, but with modified composition and structure resulting from restricted fire. Black oak- and white oak-dominated savanna and woodland occupy well drained sites, while poorly drained sites support pin oak- dominated woodland, as well as wet prairie and sedge meadow. In 1986-88, when we initiated this study, density of trees > 15 cm dbh in black oak-dominated stands was 230 stems/ha, with 11.3 m^2/ha basal area, several times greater than estimated from the PLS. For stems > 5 cm dbh, density was even greater, reaching 500-650 stems/ha in black oak and white oak stands Apparently fire suppression led to greater canopy cover of upland oaks, as well as increases in big-toothed aspen (*Populus grandidentata*), black cherry (*Prunus serotina*), and development of pin oak, black gum (*Nyssa sylvatica*) and red maple (*Acer rubrum*) woodland in poorly drained areas, which were not mentioned in the PLS. To restore more open savanna similar to presettlement conditions, the Indiana Department of Natural Resources (DNR), Division of Nature Preserves, began prescribed burning in 1982, using either spring or fall dormant season fires.

Methods

Fire treatments

The study area was divided into ten contiguous 16.2 ha (40 acre) management blocks separated by fire breaks (Figure 2). Fire intensities varied with topography and annual burning conditions. We used scorch height to gauge fire intensity because of its predictive relationship to tree mortality based on dbh (Loomis 1973). Data from 250 trees among three blocks in 1986-88 were skewed, with 95 % of all samples having < 3 m scorch height, and a median height of 1.25 m. Prior to 1986, four management blocks that had not burned for 30 or more years were held as controls for initial burns. Three others received at least one burn with scorch heights < 2 m, and three received at least one wildfire in which scorch height reached 3-6 m and caused wide spread mortality of canopy trees. After initial sampling, all blocks were burned randomly, each receiving $\bar{x}$ = 5.7 ($\pm$ 0.28 se) burns over a 20-year period. This corresponds to a rate of 3 fires/decade, and a $\bar{x}$ = 2.84 ($\pm$ 0.12 se) year fire-free interval. During this period, most fires were within the range of conditions measured in 1986-88, and none reached the intensities achieved by the initial wildfires. In the statistical analyses performed in this paper, we refer to burns with scorch heights exceeding 3 m as high intensity fires, as they have > 95 % probability of causing mortality to $\leq$ 30 cm dbh black oak (Loomis 1973), which includes 90 % of all black oak stems sampled in 1986-88. All other scorch height classes are referred to as low intensity, where the median scorch height (1.25 m) has > 95 % probability of killing < 7 cm black oak, which includes < 40 % of all black oaks sampled.

Data collection

Vegetation in each block was sampled by five to ten random 50-m transects that extended east or west from north-south fire-breaks. All transects were permanently marked with steel conduit stakes. Thirty-six transects were first surveyed in 1986, with 15 located in 3 unburned blocks. All of these transects had received at least one prescribed fire by 1988. At that time 23 additional transects, including 10 unburned, were sampled, for a total of 59. Six transects were largely in sedge meadows, and are not included in our analyses for this paper.

Each transect was used as a line intercept to estimate tree canopy cover of all woody species with stems > 5 cm dbh (diameter breast height) and shrub layer cover of woody species with stems < 5 cm. dbh and > 1 m tall. The diameters of living trees rooted within 1 m of each transect were also recorded by species, resulting in a 100 m-sq sampling area. All shrub stems rooted within 1 m of the south side of each transect were tallied by species, resulting in a 50 m-sq sampling area. Black oak and pin oak were clearly identifiable as species occupying opposite elevation extremes in the study area. However, introgression of these species with a third *Erythrobalanaus* oak species, Hill's oak (*Quercus ellipsoidalis*), may have occurred at mid-elevations. We did not attempt to separate Hill's oak, but recorded individuals as black oak or pin oak based on which parent they most clearly resembled.

Each 50-meter transect served as a replicate for statistical analysis. Canopy cover of tree and shrub layer species was expressed as a percentage of the transect length measured to the nearest 0.1 m. These measures were also summed to represent total cover, which often exceeded 100 %. Tree numbers in 10-cm size classes and shrub numbers in transect plots were converted to numbers per hectare.

Data analysis

To examine how woody vegetation was organized across topographic gradients, transects were ordinated using the Bray-Curtis technique with a Sorenson distance measure, and then clustered using Ward's method and a relative Euclidean linkage. The metric used for these analyses was tree species cover averaged for each transect using 1986 and 1988 data. These analyses were conducted on PCORD software (McCune and Mefford 2006). They produced black oak (N = 21), white oak (N = 21) and pin oak (N = 11) dominated groups (see results), hereafter referred to as cover types for statistical analysis. To determine whether ecological factors affected the species gradient, all transects were digitized over USGS quadrangle maps and analyzed for average slope and elevation using 3 m resolution digital elevation models on ARCVIEW software (ESRI 1998). Regression analysis was used to test whether slope and aspect measures were significantly related to the first and second axis scores of each of the three cover types. We also digitized vegetation types described by the PLS and used digital elevation modeling to determine elevation of barrens and wet prairie/marsh vegetation.

To address fire effects on cover and density, we used repeated ANOVA in a General Linear Model (GLM), as well as t-tests. The initial treatments for these tests differed among cover types. Black oak stands had low fire intensity and unburned treatments, white oak stands had high and low fire intensities, as well as an unburned treatment, and pin oak stands had high and low fire intensities but no unburned treatment. These treatments also differed over time, as no cover type had consistent high or low intensity fire, nor unburned treatment after the initial treatments. Percent cover and density were heavily skewed, and therefore arcsin and square root

transformed, respectively, for analysis following Zar (1984). All cover data were reduced to a maximum of 100 % required for the arcsin transformation. Because fire treatments differed over time for some replicates, use of repeated ANOVA to test whether initial high and low fire intensities differed from a control (unburned) is invalid. To compensate, in the 1986-88 data set we used t-tests to compare between treatments in the black oak and pin oak cover types, and a one-way ANOVA to compare the three treatments in the white oak type. The repeated ANOVA provides a valid test of whether cover and stem density differed over time. It also provides an interaction term indicating the probability of whether repeated burning alters cover or density compared to initial treatments. This term should be interpreted with caution as it may be confounded by application of different fire treatments over time. The interpretation of unburned controls is also limited in this study, as no preburn data were collected on initially burned transects, and the initially unburned transects were burned over time after 1986.

We also used a one-way ANOVA to determine effects of time since fire on the cover and density of shrub layer vegetation in 2006. A preliminary ANCOVA revealed that 1986-88 data did not significantly affect the results. For the analysis we pooled cover types, as similar responses occurred among each cover type (unpublished data). Replicates for this analysis were transect data collected in 2006 partitioned by groups based on the number of years since their last fire. These times ranged from 0-years (sampled in the first growing season after fire) to 3-years (sampled in the fourth growing season after fire). Sample sizes were unbalanced, and ranged from N = 5 (third growing season after fire) to N = 20 (second growing season after fire). As above, cover and density data were arcsin and square root transformed, respectively.

To further understand long-term changes in vegetation structure, we compared the size class distributions of the three dominant oak species over time, as well as the distribution of basal area among all tree species over time. For the shrub layer we also partitioned species into three groups: *Quercus* species, stems of other potential canopy trees, and stems of true shrub species. We then compared abundance of these groups over time among the three stand cover types in relation to whether they were initially burned or unburned prior to sampling. Chi-square analysis in contingency tables was used to test changes in size class distributions.

Because blocks represented fire management units in this study, our analysis at the transect level (N = 5/block) constitutes pseudo-replication. We used transects as replicates because stand cover types varied within blocks and the number of blocks in the study area was insufficient to sample variance among stand cover types. As a result, this application limits statistical inference (Hulbert 1984). This necessity is often difficult to overcome in long-term fire studies because of the difficulty of repeatedly conducting burns in a replicated design (McGee et al.1995, Luken and Shea 2000, van Mantgem et al. 2001, Taft 2003, Sutherland et al. 2003).

Results

Species and cover type distribution

Ordination and cluster analysis produced three primary stand cover types (Figure 3). The first ordination axis was associated with decreasing abundance of black oak and increasing abundance of white oak. First ordination axis scores had a significant negative relationship with elevation ($r^2 = 0.37$, $P < 0.001$) and slope ($r^2 = 0.25$, $P < 0.001$). The second ordination accounted for less than half of the variation in the first axis, and was associated with increasing abundance of pin

oak, as well as red maple, and black gum. It also had a significant negative relationship with elevation ($r^2 = 0.09$, $P = 0.03$) and slope ($r^2 = 0.10$, $P = 0.022$). With about 37% information remaining, Ward's cluster analysis produced three species groups corresponding to the ordination, with each group dominated by either black oak (87 % relative cover), white oak (48 % relative cover), or pin oak (68 % relative cover). In the white oak group, black oak and pin oak equally shared an additional 37 % relative cover. In the pin oak group, black gum had 19 % and red maple had 5.5 % relative cover, respectively.

Initial fire effects on vegetation structure across the moisture gradient.
In the black oak cover type, tree cover averaged over 88 % in unburned transects, and was significantly lower in transects treated with low intensity fire, reaching about 50 %. However shrub cover did not differ between treatments, remaining at about 20 % in each. (Figure 4). In contrast, shrub density reached about 775 stems/ha with low intensity fire, a marginally significant ($P = 0.07$) difference compared to over 2000/ha stems in unburned transects.

In the white oak cover type, tree cover averaged 97 % in unburned transects. It was significantly lower with high intensity fire, reaching about 20 %; however, unlike black oak, the low intensity fire treatment did not differ from unburned (Figure 5). There was also a significant effect on shrub cover, which reached only 5 % with high intensity fire, compared to about 15 % with low intensity fire and 40 % in unburned transects. Shrub density tended to be lower ($P = 0.0516$) in transects with low intensity fire than in either unburned or high intensity burned transects.

There were no significant differences between low and high intensity burns in pin oak stands, where tree cover averaged about 35 %, shrub cover about 15 %, and shrub density about 1600 stems/ha (Figure 6).

Effects of burning on cover types over time
Tree cover did not change over time in the black oak cover type, with initially burned transects remaining lower in cover than initially unburned transects (Figure 4). However shrub cover diverged, tending to increase in previously unburned transects and to decrease in previously burned transects. Shrub density increased significantly in either treatment, reaching about 7000 stems/ha. Shrub layer cover and stem density were also significantly correlated ($r^2 = 0.336$, $P = 0.006$) in 2006, but not in 1986.

In the white oak cover type tree cover was significantly lower after 20 years. However, this decrease was caused only by a decrease in transects that had initial low intensity fire, as other treatments remained unchanged (Figure 5). Shrub cover had a marginally significant decline ($P = 0.056$), primarily as a result of a drop in cover in transects that had previous high intensity burns, as well as in previously unburned transects. Shrub density increased significantly to about 35,000 stems/ha in transects that had previous low intensity fires, but remained unchanged in other transects. Shrub layer cover and stem density were also significantly correlated ($r^2 = 0.302$, $P = 0.010$) in 2006, but not in 1986.

Tree cover did not change over time in pin oak stands (Figure 6). However, shrub cover and density both diverged over time by tending to increase in transects with initial low intensity fire and to decrease in transects with previous high intensity fire. Shrub layer cover and stem density

were also significantly correlated in both 1986 and in 2006 ($r^2 = 0.558$, P = 0.001 for combined years).

Change in oak size class distribution and basal area

At the species level, all three dominant oak species exhibited similar changes in size class distribution by increasing below 5 cm dbh, decreasing in mid size classes, and increasing in the largest larger size class (Figure 7). For stems <5 cm, black oak increased from about 440 to over 800 stems/ha, white oak stems from about 300 to 700 stems/ha, and pin oak from 50 to 125 stems/ha. This apparently resulted from post-fire sprouting of oak stems in >5-10 and >10-15 cm size classes, which dropped from between 100-200 stems/ha to < 50 stems/ha. Black oak and pin oak stems up to about 30 cm also were reduced, while white oak stems above 15 cm suffered little loss. As a result, decline in stem numbers below 35 cm was significantly greater for pin oak and black oak than for white oak ($X^2 = 12.651$, P = 0.002). Larger stems increased because of ingrowth from surviving smaller stems. None of the changes in stem numbers above 35 cm were significantly different among species ($X^2 = 3.289$. P = 0.194). The slight increase in larger stem numbers of black and white oak caused their basal area to increase from 6.3 to 7.1 m^2/ha, and from 1.75 to 2.4 m^2/ha, respectively, while basal area of pin oak dropped from 2.0 to 2.6m^2/ha.

At the cover type level, total stem densities of all species >5 cm dbh also decreased, while basal area tended to increase dbh (Table 1). In the black oak cover type, stem densities dropped from about 500 to 300 stems/ha, while basal area increased from 13.1 to 16.9 m^2/ha. In the white oak cover type, stem densities dropped from 650 to 266 stems/ha, with basal area increasing from 9.7 to 11.2 m^2/ha. In the pin oak cover type, stem densities dropped from 230 to 150 stems/ha m densities; however, basal area dropped from 7.5 to 7.4 m^2/ha. Most subdominant tree species tended to increase slightly in basal area (Table 1). Black cherry and black gum increased across all stands. Sassafras declined in black oak stands but increased in white oak stands, while red maple increased in white oak and pin oak stands.

For stem densities above 15 cm, which approximates the PLS data, the black oak cover type decreased from 230 to 195 stems/ha, with basal area increasing from 11.2 to 16.2 m^2/ha. For the white oak cover type, these densities increased slightly from 143 to 157 stems/ha, while basal area increased from 6.7 to 10.5 m^2/ha. There was less change in pin oak stands, which remained at 90 stems/ha and increased from 6.7 to 6.9 m^2/ha.

Change in shrub layer structure

Time since fire had a significant effect on shrub layer cover and density (Figure 8). Cover was lowest in the growing season immediately after fire, averaging only 1.2 %. It remained below 15 % until the fourth growing season, when it reached about 80 %. Density was also lowest in the first growing season after fire, averaging 600 stems/ha. It increased to 10,000 stems/ha the following season, dropped to 2,300 stems thethird season and increased back to 10,000 stems.

Temporal change in densities of oak, non-oak and shrub functional groups varied with cover type and with initial burn treatments (Table 2). In the black oak cover type, all groups had greater densities in initially unburned transects in 1986-88. This pattern did not change over time, as

densities increased in both initially burned and unburned transects. Black cherry, sassafras, and black oak dominated the shrub layer and had the greatest contribution to increases over time in the black oak cover type. In the white oak cover type, oaks had greater densities in initially burned transects, while non-oaks and shrubs, primarily winterberry (*Ilex verticillata*) andblack gum, had greater densities in unburned transects. Over time, oaks tended to decrease in initially burned transects, while non-oaks and shrubs, primarily sassafras and American hazelnut (*Corylus Americana*) increased in unburned transects. Stems of all functional groups increased in pin oak stands, which had no unburned transets. Chokeberry (*Aronia melanocarpa*) had the greatest increase in pin oak stands, and was followed by winterberry, white oak, pin oak, and sassafras.

The changes in functional groups also affected their relative abundance (Figure 9). In black and white oak cover types, functional groups were stable over time in transects that were initially unburned. However, in stands burned prior to 1986, the patterns changed over time, with oaks becoming more abundant in black oak stands, and shrubs becoming more abundant in white oak stands. In pin oak stands, all of which were burned before sampling, relative dominance in the shrub layer shifted as oaks decreased while shrubs and non-oaks increased.

Discussion

Savanna vegetation organization across an ecological gradient

Our analysis indicates that slope and elevation, and their effect on drainage, are critical environmental factors affecting the landscape distributional of woody vegetation at Tefft Savanna. These factors correspond to habitat preferences of species, with black oak being more common on excessively drained sites, while white oak grows poorly on upland sandy soils, and pin oak is largely restricted to poorly drained habitats (Burns and Honkala 1990). The lower abundance of white oak may be related to its restriction to transitional sites between black oak and pin oak stands as opposed to its optimal site preference which is finer textured soil (Burns and Honkala 1990). The sub-dominance of black gum and red maple with pin oak also corresponds to their tolerance for poorly drained conditions, although both grow more poorly when drainage is impaired (Burns and Honkala 1990). Fire tolerance is clearly a factor, as well. Lower areas are commonly wet or have standing water when spring fires occur, and therefore burn less frequently and less intensely, on average.

The first ordination axis representation of black oak and white oak appears to represent the primary woody vegetation gradient present at Tefft Savanna prior to Euro-American settlement. Vegetation in the early 1800's appears to have been structured with low densities of small black and white oaks. The second axis could correspond to post-settlement increases in pin oak, black gum and red maple at lower elevations where fire is most excluded. However, the significant correlation of slope and elevation with the second axis and presence of "B. oak" bearing trees in wet prairie suggests that pin oak savanna was also an infrequent component of the original landscape. Brewer & Vankant (2004) also reasoned that pin oak was present in at lower elevations in pre-settlement oak barrens and wet prairie in northwest Ohio, even though it was not recognized as a species by the PLS in 1817-1832. Nevertheless, pin oak was recorded from wetland habitats by three different surveyors between 1821-1834 PLS in southern Cook and Will counties in Illinois adjacent to the Indiana (Bowles & McBride 2007). Pin oak now occurs at Tefft above the 214 m elevation of marsh and wet prairie. With fire suppression, pin oak may have developed larger stands from isolated trees, and spread into the least well-drained white oak

habitat. Unfortunately, there is no evidence from the PLS of occurrence of black gum and red maple, and their origin remains more problematic than that of pin oak.

Effects of initial fire intensity and repeated burning on vegetation structure

Through comparison of burned and unburned transects, our data suggest that burning at both high and low fire intensities can cause immediate reduction of tree canopy cover, as well as shrub layer cover or density, in black and white oak sand savanna that has had a history of fire exclusion. Although low intensity fire could not be compared with high intensity fire in the black oak cover type, high intensity fire reduced cover in the white oak type. Our data also suggest that repeated burning with low intensity fire, in most circumstances, will not further reduce tree canopy cover or basal area. It is most likely that the persistence of canopy cover after initial fire reflects the inability of repeated low intensity fires to impact larger diameter canopy oaks over about 30 cm dbh, a common effect in oak forests and savannas (Nielsen et al. 2003). Initial fires probably caused an additional reduction of cover by consuming extremely heavy woody fuel loads that had accumulated over time, thus eliminating a substantial amount of woody cover and preventing further reduction by subsequent burning.

Our data indicate that fire-caused changes in woody shrub layer species and functional groups are complex and interact with effects on larger size classes as well as cover type. Our results suggest that initial burning can significantly reduce shrub-layer density and cover and may shift dominance toward oaks by promoting sprouting after top-killing of larger individuals. However, this structural shift may not be stable over time, as it returned to original conditions in white oak stands as a result of an increase in shrubs, but not in black oak stands. Also, recovery of original cover and density is dependent upon time since fire, largely occurring within three years. These shifts also may be species dependent among cover types. For example, the increase in shrubs in white oak stands involved*Americana* American hazelnut, which was infrequent in other stand types.

Despite the apparent stability of tree canopy cover, repeated burning has altered woody vegetation structure by reducing densities of smaller trees. However, the 3 fires/decade burning rate at Tefft, has not stabilized sapling and shrub layer vegetation nor prevented ingrowth, as reported by Peterson and Reich (2001) in northern sand sanvanna. Our data indicate that 4 fires/decade are needed to stabilize shrub layer cover and density. The more dynamic temporal response of stem density following fire may reflect delayed mortality from fire (A. Haney, pers. obs). However, the significant correlations between shrub layer cover and density suggest that these variables respond similarly to fire. Differences between Tefft and Cedar Creek (Peterson and Reich 2001) may result from different oak species, as well as the additional decade of burning at Cedar Creek. Black oak appears to have thicker bark, which would impose greater fire resistance that Hill's oak, and greater fire frequency may be required to control this species. Nevertheless, our data indicate that it has less fire resistance that white oak, which fits our expectations for comparisons between members of the black and white oak groups. It is unknown whether continued low intensity burning at 3 fires/decade at Tefft will eventually reduce shrub layer vegetation.

Fire effects clearly differed across an environmental gradient, and may have interacted with fuel

loadings in a feedback process. Our data suggest that tree and shrub cover tend to be greater in black oak and white oak stands than in pin oak stands, but pin oak stands may be less prone to burn . However, we make this judgment without benefit of a control comparison for pin oak stands. Nevertheless, the impacts of most burns in pin oak stands were reduced by standing water or damp fuels. We agree with Brewer and Vankant (2004) who suggested that fire during late-season might have been more effective in pin oak stands. Tree size also appears to be a critical factor in reducing the effectiveness of fire (White 1983), with oaks above 25-30 cm becoming fire resistant, a threshold also observed by Loomis (1973). Continued growth of these stems offset to various extents the losses of smaller diameter stems.

Restoring presettlement structure: goals vs realism

Targeting presettlement vegetation structure as a strict management goal may not be realistic for smaller habitat remnants in which many scale-dependent features must compete for survival, nor may it represent expected vegetation structure in a changing climate (Pickett et al. 1992). However, reference information is needed to establish a context for community restoration (Aronson et al. 1995). Stand structural data from the Tefft PLS represent a coarse-grained but critical context for contrasting and comparing the effects of management. In this case, after 25-years of fire management, the stand density and basal area in black and white oak stands at Tefft remain about four times greater than conditions thought to exist before European settlement.

The inherent stability in these stands with repeated low frequency fire suggests that use of less frequent high intensity fire followed by repeated low to moderate intensity maintenance fires may be a better management approach to achieve and stabilize desired woody structure in eastern sand savannas. Longer-term treatment and monitoring is needed to test this hypothesis. Frequent low to moderate fires with occasional high intensity fires may be more similar to the pre-settlement fire regime that maintained open savanna communities (Henderson & Long 1984). Evidence for periodic intense fire also is suggested by the presence of distinct age-class cohorts of trees in sand savannas (Haney and Apfelbaum 1990). Reaching presettlement conditions, especially for the black oak cover type, also may require mechanical thinning (Nielsen et al. 2003), especially on smaller savanna fragments where implementation of high intensity fire is problematic. The continued presence of woody species associated with more fire-protected habitats, such as red maple and black gum, remains problematic and linked with the inability to conduct optimum prescribed burns in the pin oak cover type.

Conclusions

In the absence of fire for even a decade or two, Midwest oak savannas undergo conversion to woodlands with an increase in mesic woody species and loss of herbaceous diversity (Anderson and Bowles 1999, Bowles and McBride 1998, Bray 1958). A 50% canopy level has been widely used as a general guide for defining the difference between oak woodlands and savannas (Wilcox et al. 2005). A tree density of about 50 trees/ha is often used to interpret differences between savanna and woodland using PLS data (Bowles et al. 1994). After 25 years of repeated burning, canopy cover of the black oak and white oak cover types at Tefft has been reduced to about 50 %, indicating that it is approaching savanna structure. Nevertheless, tree density remains about four times higher than desired , and shrub-layer cover and density also remain quite high. Our results also indicate that black oak stem densities are somewhat higher than those of white oak, an unexpected result given the drier site conditions occupied by black oak. The current

management regime, of about 3 fires/decade appears inadequate to restore open sand savanna structure unless supplemented by infrequent high intensity fire. Analysis of time since fire also indicates that 4 fires/decade are required to stabilize shrub layer vegetation. Even greater fire frequencies may be needed to maintain diversity of groundlayer vegetation. In dry sand savanna in Minnesota, vascular plant species richness peaked on sites burned about every two years (Faber-Langendoen and Davis 1995). White (1983) reported increased herbaceous diversity in northern pin oak savanna burned every year for 13 years. Increasing fire to these frequencies will require a tradeoff with management for birds and insects unless unburned refugium habitats are maintained (Swengel and Swengel 2006).

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Table 1. Species level (> 5 cm dbh) and cover type changes in basal area (m^2/ha) and stem density/ha by cover type.

	Cover type					
	Black oak		White oak		Pin oak	
Species	1996	2006	1996	2006	1996	2006
Quercus velutina	10.55	13.23	2.22	2.44	3.99	2.16
Quercus palustris	1.39	2.08	2.64	0.41	3.22	3.69
Quercus alba	0.70	0.92	3.17	4.95	0.18	0.00
Nyssa sylvatica	0.11	0.40	0.01	0.58	0.11	1.33
Prunus serotina	0.04	0.23	0.88	0.99	0.00	0.14
Sassafras albidum	0.39	0.07	0.68	1.02		
Acer rubrum			0.00	0.78	0.03	0.08
Populus grandidentata			0.10	0.00		
Total BA > 5 cm dbh	13.18	16.93	0.00	0.00	7.54	7.40
Density/ha > 5 cm dbh	508.70	300.00	657.14	266.67	230.00	150.00
BA > 15 cm dbh	11.27	16.23	6.72	10.46	6.68	6.94
Density/ha > 15 cm dbh	230.43	195.65	142.86	157.14	90.00	90.00

Table 2. Stem densities/ha for shrub layer groups arranged by stand cover type. **UB** indicates transects were unburned prior to initial sampling. **B** indicates transects were burned prior to initial sampling.

Black oak stands

Treatment	Oaks/ha	NonOaks/ha	Shrubs/ha	Total/ha
UB-86	440	1047	880.000	2367
B-86	250	500	25.000	775
UB-06	1454	4001	2025.000	7480
B-06	4475	1575	1875.000	7925

White oak stands

Treatment	Oaks/ha	NonOaks/ha	shrubs/ha	Total/ha
UB-86	680	2300	3120.000	6100
B-86	1801	1291	326.000	3418
UB-06	960	2180	3060.000	6200
B-06	680	2087	6888.000	9655

Pin oak stands

Treatment	Oaks/ha	NonOaks/ha	shrubs/ha	Total/ha
B-86	800	740	80	1620
B-06	1100	2000	1120	4220

Appendix I. Mean (+std. err.) percent cover of canopy tree species by initial burn treatment and cover type. UB = unburned, B = burned.

		Quercus velutina	*Quercus alba*	*Quercus palustris*	*Populus granditentata*	*Nyssa sylvatica*	*Acer rubrum*	*Prunus serotina*	*Sassafras albidum*	Total
Black oak cover type										
1986-88 UB	**mean**	**74.75**	**1.57**	**0.00**	**0.00**	**0.45**	**0.00**	**5.11**	**6.84**	**88.72**
	st.err.	4.23	0.81	0.00	0.00	0.45	0.00	2.56	3.13	7.22
1986-88 B	**Mean**	**38.70**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**	**38.78**
	st.err.	12.75	0.00	0.00	0.00	0.00	0.00	0.00	0.08	12.78
2006 UB	**mean**	**61.26**	**6.67**	**0.00**	**0.00**	**2.64**	**2.53**	**0.75**	**0.07**	**73.91**
	st.err.	8.34	4.62	0.00	0.00	1.92	1.54	0.75	0.07	9.38
2006 B	**mean**	**22.65**	**2.40**	**2.70**	**0.00**	**3.05**	**0.00**	**1.33**	**0.00**	**32.13**
	st.err.	9.17	2.40	2.70	0.00	3.05	0.00	1.33	0.00	9.43
White oak cover type										
1986-88 UB	**mean**	**24.96**	**44.32**	**9.12**	**1.34**	**1.90**	**0.98**	**4.58**	**10.20**	**97.40**
	st.err.	7.00	5.67	3.79	0.94	1.35	0.98	1.70	4.50	6.79
1986-88 B	**mean**	**5.49**	**18.55**	**13.24**	**0.98**	**2.87**	**0.00**	**0.00**	**0.71**	**41.84**
	st.err.	2.24	6.48	5.99	0.98	1.73	0.00	0.00	0.71	14.24
2006 UB	**mean**	**30.08**	**31.50**	**3.14**	**0.00**	**3.90**	**7.82**	**2.28**	**0.02**	**78.74**
	st.err.	7.80	7.33	1.87	0.00	1.76	4.78	1.73	0.02	9.42
2006 B	**mean**	**4.24**	**11.22**	**7.35**	**1.29**	**4.24**	**0.85**	**0.00**	**0.49**	**29.67**
	st.err.	2.18	4.85	3.80	0.90	2.82	0.85	0.00	0.49	11.14
Pin oak cover type										
1986-88 B	**mean**	**1.68**	**1.00**	**27.22**	**0.86**	**8.06**	**0.92**	**0.00**	**1.26**	**41.00**
	st.err.	0.82	0.52	8.90	0.63	3.97	0.78	0.00	1.26	12.38
2006 B	**mean**	**2.66**	**4.70**	**16.12**	**0.00**	**8.58**	**0.74**	**0.00**	**0.00**	**32.80**
	st.err.	1.78	2.49	7.27	0.00	5.15	0.74	0.00	0.00	8.77

Appendix II. Mean (+ std.err.) percent cover of shrub layer species by iniital burn treatment and cover type. UB = unburned, B = burned.

Black oak cover type		*Acer rubrum*	*Aronia melano.*	*Ceanothus americ.*	*Cornus racem.*	*Ilex verti.*	*Lonicera tatarica*	*Nyssa sylvatica*	*Populus grand.*	*Populus trem.*	*Prunus serotina*	*Prunus virgin.*	*Quercus alba*	*Quercus velutina*	*Rhus copall.*	*Rhus radicans*	*Rubus allegh.*	*Rubus occid.*	*Sas alb*
1986-88 UB	**Mean**	**0.11**	**0.00**	**2.32**	**0.00**	**6.51**	**0.00**	**2.40**	**0.15**	**0.00**	**1.91**	**0.00**	**0.51**	**5.83**	**0.29**	**1.72**	**0.00**	**0.00**	**2**
	st.err.	0.11	0.00	1.44	0.00	2.21	0.00	1.70	0.15	0.00	0.80	0.00	0.39	2.51	0.21	1.12	0.00	0.00	1
1986-88 B	**mean**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.58**	**0.68**	**0.00**	**1.30**	**11.73**	**0.00**	**0.30**	**0.15**	**0.00**	**0**
	st.err.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.58	0.68	0.00	0.73	10.69	0.00	0.30	0.15	0.00	0
2006 UB	**mean**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.58**	**0.68**	**0.00**	**1.30**	**11.73**	**0.00**	**0.30**	**0.15**	**0.00**	**0**
	st.err.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.58	0.68	0.00	0.73	10.69	0.00	0.30	0.15	0.00	0
2006 B	**mean**	**0.00**	**0.68**	**0.00**	**2.32**	**5.09**	**0.33**	**0.00**	**7.80**	**1.84**	**5.41**	**0.07**	**0.51**	**4.19**	**0.35**	**0.05**	**0.71**	**0.35**	**2**
	st.err.	0.00	0.68	0.00	1.44	1.93	0.27	0.00	3.85	1.42	1.88	0.07	0.39	1.63	0.26	0.05	0.52	0.24	1

White oak cover type		*Acer rubrum*	*Aronia melano.*	*Corylus americ.*	*Cornus racem.*	*Eleagnus umbell.*	*Gaylussacia bacatta*	*Ilex verticellata*	*Lonicera tatarica*	*Nyssa sylvatica*	*Populus grand.*	*Populus trem.*	*Prunus serotina*	*Quercus alba*	*Quercus palustris*	*Quercus Velutina*	*Rhus copllina*	*Rhus radicans*	*Sas alb*
1986-88 UB	**mean**	**0.38**	**0.00**	**6.50**	**0.46**	**6.00**	**0.14**	**2.54**	**0.52**	**4.16**	**0.00**	**0.00**	**8.66**	**2.64**	**2.94**	**0.96**	**0.04**	**1.48**	**3**
	st.err.	0.38	0.00	4.29	0.46	4.38	0.14	1.72	0.52	2.36	0.00	0.00	3.95	1.29	1.67	0.66	0.04	1.02	2
1986-88 B	**mean**	**0.31**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**4.31**	**0.75**	**0.00**	**0.29**	**1.35**	**0.44**	**0.18**	**0.00**	**0.44**	**0**
	st.err.	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.97	0.75	0.00	0.19	1.35	0.44	0.12	0.00	0.44	0
2006 UB	**mean**	**0.06**	**0.92**	**0.98**	**0.00**	**0.26**	**0.00**	**3.20**	**0.64**	**1.26**	**0.00**	**0.56**	**0.86**	**0.34**	**0.10**	**0.58**	**0.10**	**0.20**	**4**
	st.err.	0.06	0.92	0.98	0.00	0.26	0.00	2.28	0.43	1.17	0.00	0.39	0.45	0.34	0.07	0.45	0.10	0.16	3
2006 B	**mean**	**0.00**	**2.95**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.45**	**0.53**	**0.00**	**0.00**	**0.29**	**0.18**	**0.00**	**0.00**	**0.13**	**0.00**	**0**
	st.err.	0.00	2.04	0.00	0.00	0.00	0.00	0.00	1.42	0.38	0.00	0.00	0.00	0.18	0.00	0.00	0.09	0.00	0

Pin oak cover type		*Aronia melano.*	*Ilex verticellata*	*Nyssa sylvatica*	*Quercus alba*	*Quercus palustris*	*Quercus velutina*	*Acer rubrum*	*Sassafras albidum*	Total
1986-88 B	**Mean**	**1.08**	***0.00***	***7.28***	***1.24***	***1.24***	**0.24**	***0.00***	**0.94**	***12.02***
	st.err.	9.16	0.00	37.01	8.71	11.75	2.40	0.00	9.40	49.92
2006 B	**Mean**	**2.52**	**1.78**	**1.12**	**2.40**	**2.56**	**0.26**	**1.34**	**0.00**	**11.98**
	st.err.	16.97	17.80	10.14	24.00	17.44	2.60	13.40	0.00	67.48

Appendix III. Mean (+ std.err.) density/ha of shrub layer species by iniital burn treatment and cover type. UB = unburned, B = burned.

Black oak cover type		*Aronia melano.*	*Cornus racem.*	*Ilex verti.*	*Lonicera tatarica*	*Prunus serotina*	*Prunus virgin.*	*Nyssa sylvatica*	*Rhus copall.*	*Rubus occid.*	*Rubus allegh.*	*Populus grand.*	*Quercus alba*	*Quercus palustris*	*Quercus velutina*	*Acer rubrum*	*Salix spp.*	*Sass. albidum*	*Vitis spp.*	Total
1986-88 UB	**mean**	**0.00**	**53.33**	**786.67**	**0.00**	**286.67**	**0.00**	**240.00**	**40.00**	**0.00**	**0.00**	**0.00**	**53.33**	**0.00**	**386.67**	**0.00**	**0.00**	**506.67**	**0.00**	**2366.67**
	st.err.	0.00	31.56	657.01	0.00	96.93	0.00	179.38	29.90	0.00	0.00	0.00	31.56	0.00	135.06	0.00	0.00	201.39	0.00	690.16
1986-88 B	**mean**	**25.00**	**0.00**	**0.00**	**0.00**	**75.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**50.00**	**75.00**	**0.00**	**175.00**	**0.00**	**0.00**	**0.00**	**0.00**	**400.00**
	st.err.	25.00	0.00	0.00	0.00	75.00	0.00	0.00	0.00	0.00	0.00	50.00	36.60	0.00	103.08	0.00	0.00	0.00	0.00	119.52
2006 UB	**mean**	**0.00**	**173.33**	**0.00**	**0.00**	**1146.67**	**0.00**	**106.67**	**200.00**	**0.00**	**0.00**	**0.00**	**106.67**	**0.00**	**1306.67**	**0.00**	**0.00**	**506.67**	**0.00**	**2366.67**
	st.err.	0.00	84.65	0.00	0.00	444.09	0.00	110.41	139.54	0.00	0.00	0.00	96.53	0.00	622.80	0.00	0.00	201.39	0.00	690.16
2006 B	**mean**	**0.00**	**0.00**	**0.00**	**0.00**	**875.00**	**400.00**	**25.00**	**1175.00**	**0.00**	**150.00**	**0.00**	**2575.00**	**125.00**	**1775.00**	**0.00**	**150.00**	**675.00**	**0.00**	**7925.00**
	st.err.	0.00	0.00	0.00	0.00	403.44	400.00	25.00	790.51	0.00	105.22	0.00	1031.25	0.00	710.57	0.00	150.00	316.09	0.00	2236.69

White oak cover type		*Acer rubrum*	*Aronia melano.*	*Corylus americ.*	*Cornus racem.*	*Gayluss. bacatta*	*Ilex verti.*	*Lonicera tatarica*	*Prunus serotina*	*Nyssa sylvatica*	*Rhus copall.*	*Rubus occid.*	*Rubus allegh.*	*Rhus radicans*	*Populus grand.*	*Populus tremul.*	*Quercus alba*	*Quercus palustris*	*Quercus velutina*	*Sass. albidum*	*Vitis spp.*	*Salix spp.*	Total
1986-88 UB	**mean**	**20.00**	**60.00**	**580.00**	**80.00**	**0.00**	**2280.00**	**0.00**	**500.00**	**1040.00**	**20.00**	**0.00**	**0.00**	**20.00**	**0.00**	**0.00**	**360.00**	**200.00**	**120.00**	**720.00**	**80.00**	**20.00**	**6100.00**
	st.err.	20.00	60.00	345.70	80.00	0.00	1438.89	0.00	231.42	509.29	20.00	0.00	0.00	20.00	0.00	0.00	145.45	111.55	67.99	292.42	61.10	20.00	1595.34
1986-88 B	**mean**	**163.64**	**90.91**	**0.00**	**0.00**	**0.00**	**72.73**	**0.00**	**200.00**	**490.91**	**0.00**	**0.00**	**0.00**	**0.00**	**18.18**	**490.91**	**854.55**	**54.55**	**890.91**	**90.91**	**0.00**	**0.00**	**3418.18**
	st.err.	96.55	90.91	0.00	0.00	0.00	72.73	0.00	126.49	414.61	0.00	0.00	0.00	0.00	18.18	342.57	489.22	39.00	379.82	73.18	0.00	0.00	918.68
2006 UB	**mean**	**60.00**	**940.00**	**1440.00**	**0.00**	**0.00**	**0.00**	**60.00**	**300.00**	**80.00**	**140.00**	**260.00**	**120.00**	**20.00**	**0.00**	**0.00**	**800.00**	**0.00**	**160.00**	**1800.00**	**20.00**	**0.00**	**6200.00**
	st.err.	42.69	917.99	883.33	0.00	0.00	0.00	60.00	152.75	80.00	94.52	179.01	80.00	20.00	0.00	0.00	572.71	0.00	102.42	886.44	20.00	0.00	1856.88
2006 B	**mean**	**0.00**	**5163.64**	**0.00**	**0.00**	**181.82**	**836.36**	**0.00**	**272.73**	**109.09**	**163.64**	**0.00**	**0.00**	**0.00**	**945.45**	**0.00**	**727.27**	**145.45**	**727.27**	**290.91**	**0.00**	**90.91**	**9654.55**
	st.err.	0.00	3778.77	0.00	0.00	181.82	836.36	0.00	235.52	62.46	128.82	0.00	0.00	0.00	945.45	0.00	494.53	126.75	416.28	290.91	0.00	90.91	5419.03

Pin oak cover type		*Acer rubrum*	*Aronia melano.*	*Ilex verti.*	*Nyssa sylvatica*	*Populus tremul.*	*Prunus serotina*	*Lonicera tatarica*	*Quercus alba*	*Quercus palustris*	*Quercus velutina*	*Salix spp.*	*Sass. albidum*	Total
1986-88 B	**mean**	**60.00**	**20.00**	**0.00**	**480.00**	**20.00**	**160.00**	**220.00**	**20.00**	**560.00**	**20.00**	**40.00**	**20.00**	**1620.00**
	st.err.	134.99	63.25	0.00	989.72	63.25	386.44	345.77	63.25	1146.20	63.25	84.33	63.25	1620.56
2006 B	**mean**	**100.00**	**1820.00**	**700.00**	**160.00**	**0.00**	**0.00**	**560.00**	**340.00**	**200.00**	**0.00**	**0.00**	**340.00**	**4220.00**
	st.err.	253.86	4254.62	2213.59	337.31	0.00	0.00	1184.34	874.58	498.89	0.00	0.00	1075.17	7852.78

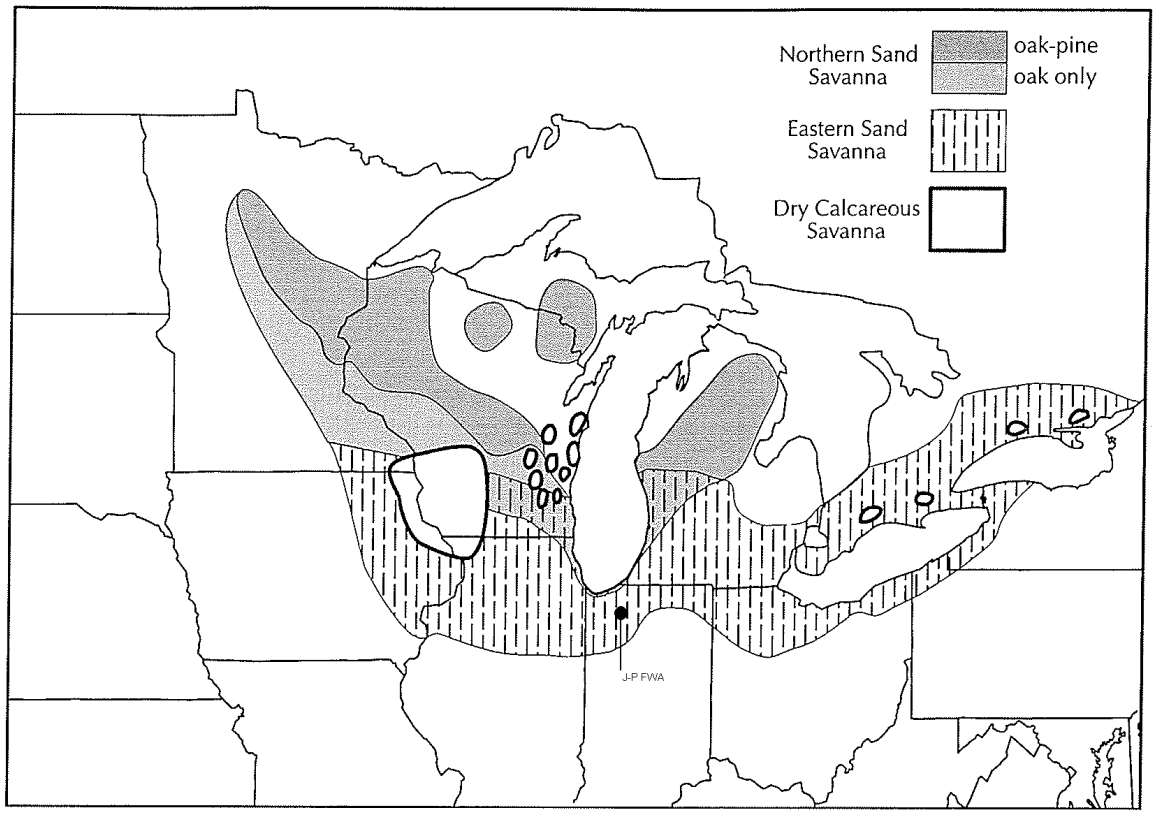


Figure 1. Location of Jasper-Pulaski Fish & Wildlife Area (J-P FWA) within Eastern Sand Savanna (Will-Wolf & Stearns 1999) in northwest Indiana.

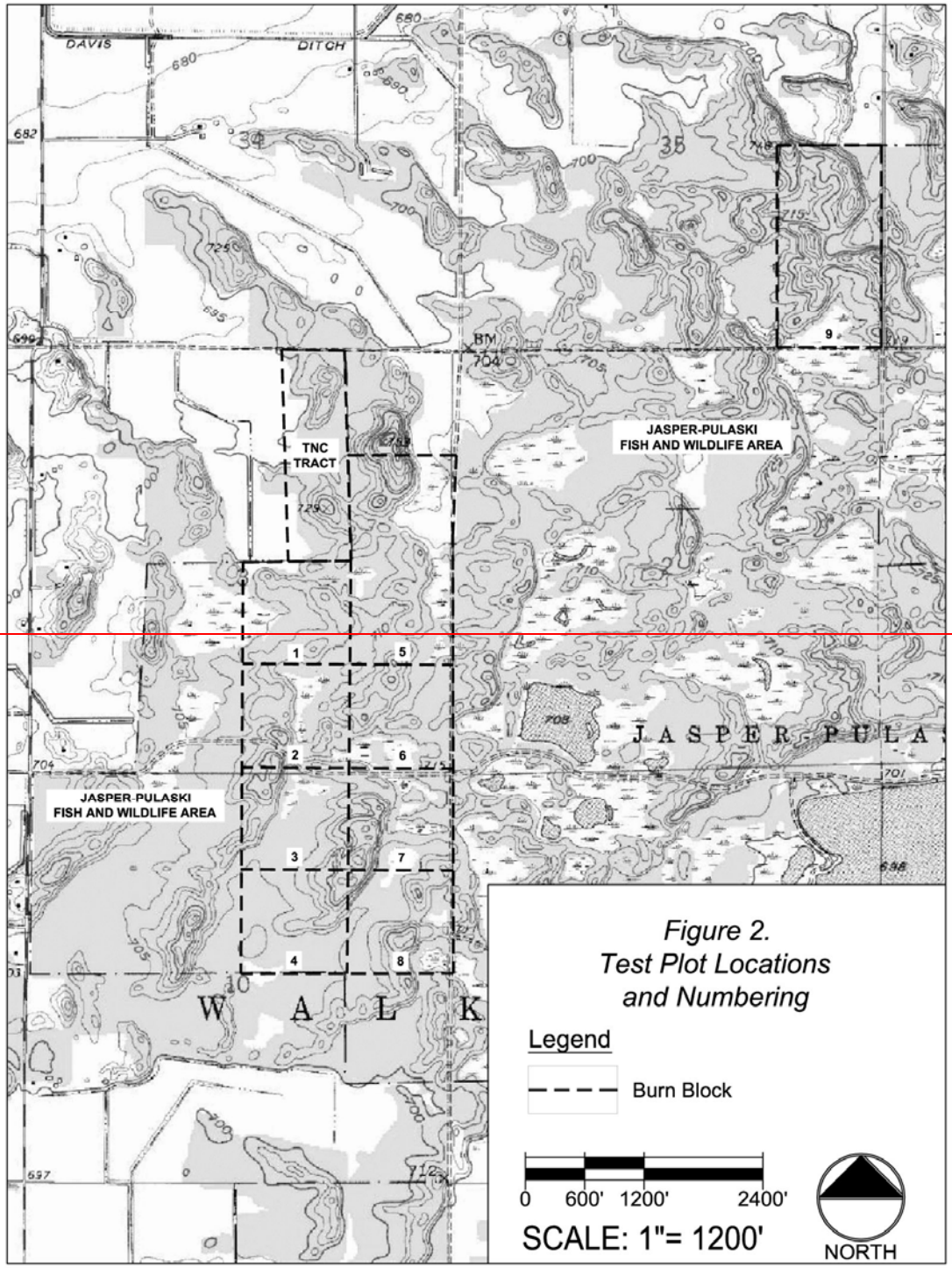


Figure 2. Location the Tefft Savanna Nature Preserve and Management Blocks on the San Pierre, Indiana USGS Quadrangle, Map.

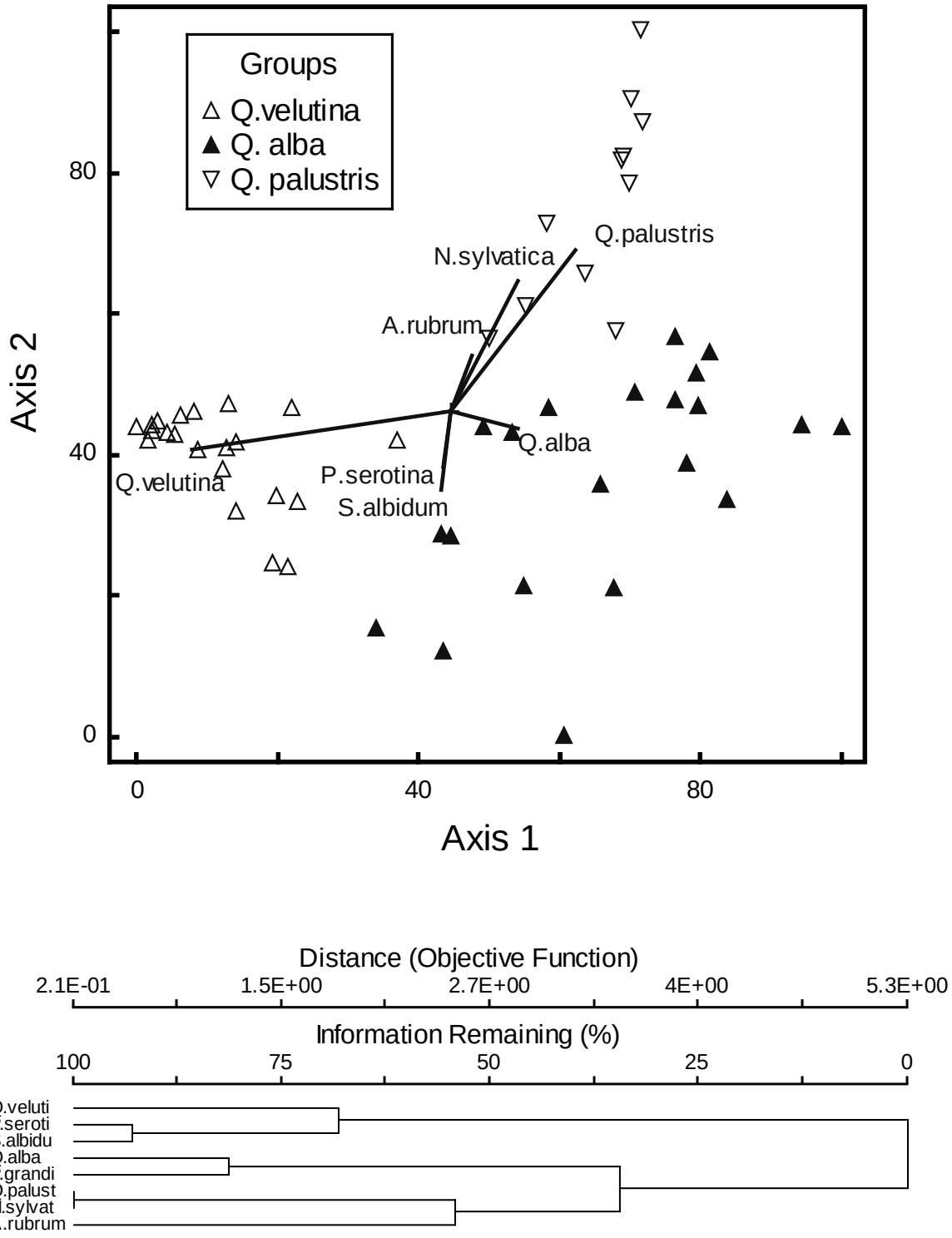


Figure 3. Bray-Curtis ordination (upper) and Ward's Cluster Analysis (lower) of Tefft Savanna woody vegetation. Ordination: cumulative r^2 between ordination distances and original distances = 0.38 (Axis I), 0.548 (Axis II). Cluster analysis: 9.09 % chaining. Angle and length of joint plot vectors indicate strength of relationship with ordination axes.

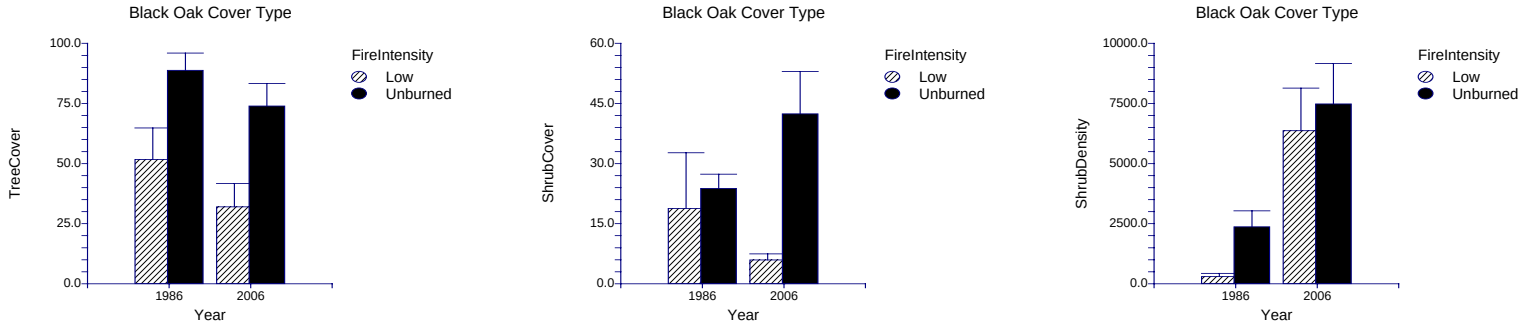


Figure 4. Temporal change in tree cover, shrub cover and shrub layer stem density in the black oak cover type in relation to initial fire intensity and repeated burning. Fire intensity = intensity of fire treatment occurring before initial sampling in 1986-88. Year indicates condition of vegetation after treatment in 1986-88, and in 2006 after repeated fire. Tree cover: T-test (1986) t = -2.8078, P = 0.01123; Repeated ANOVA (Year) F = 2.32, P = 0.1440; (Intensity x Year), F = 0.26,P = 0.6141. Shrub cover: T-test (1986) t = -1.1418, P = 0.2677; Repeated ANOVA (Year) F = 0.11, P = 0.742977; (Intensity x Fire) F = 1.85, P = 0.1898. Shrub density: T-test (1988) t = -1.8934, P = 0.0736; Repeated ANOVA (Year) F = 29.42, P < 0.0001; (Intensity x Year) F = 1.19, P = 0.2898.

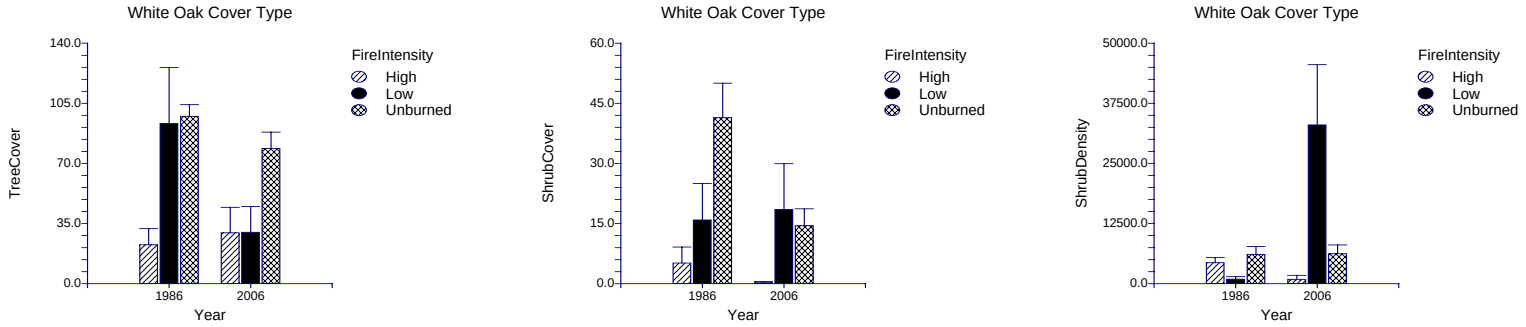


Figure 5. Temporal change in tree cover, shrub cover and shrub layer stem density in the white oak cover type in relation to initial fire intensity. Fire intensity = intensity of fire treatment occurring before initial sampling in 1986-88. Year indicates condition of vegetation after treatment in 1986-88, and in 2006 after repeated fire. Tree cover: One-way ANOVA (1986) $F = 17.95$, $P < 0.0001$; Repeated ANOVA (Year) $F = 8.61$, $P = 0.0089$; (Intensity x Year) $F = 4.04$, $P = 0.0355$. Shrub cover: One-way ANOVA (1986) $F = 9.50$, $P = 0.0015$; Repeated ANOVA (Year) $F = 4.18$, $P = 0.0559$; (Intensity x Year) $F = 2.42$, $P = 0.11745$. Shrub density: One-way ANOVA (1986) $F = 3.51$, $P = 0.0516$; Repeated ANOVA (Year) $F = 5.97$, $P = 0.0250$; (Intensity x Year) $F = 15.40$, $P = 0.0001$.

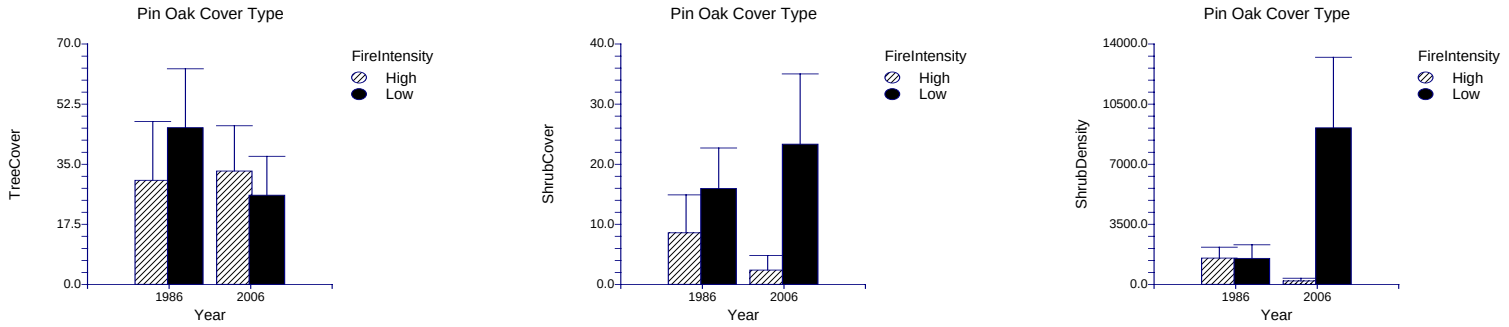


Figure 6. Temporal change in tree cover, shrub cover and shrub layer stem density in the pin oak cover type in relation to initial fire intensity. Fire intensity = intensity of fire treatment occurring before initial sampling in 1986-88. Year indicates condition of vegetation after treatment in 1986-88, and in 2006 after repeated fire. Tree cover: T-test (1986) t = -0.5738, P = 0.5738; Repeated ANOVA (Year) = 0.53, P = 0.4841; (Intensity x Year) F = 1.70, P = 0.2249. Shrub cover T-test (1986) t = -1.2104, P = 0.2570; Repeated ANOVA (Year) F = 0.22, P = 0.6491; (Intensity x Year) F = 0.98, P - 0.3470. Shrub density: T-test (1986) t = -0.0193, P = 0.9850; Repeated ANOVA (Year) F = 3.08, P = 0.1129; (Intensity x Year) F = 19.69, P = 0.0016.

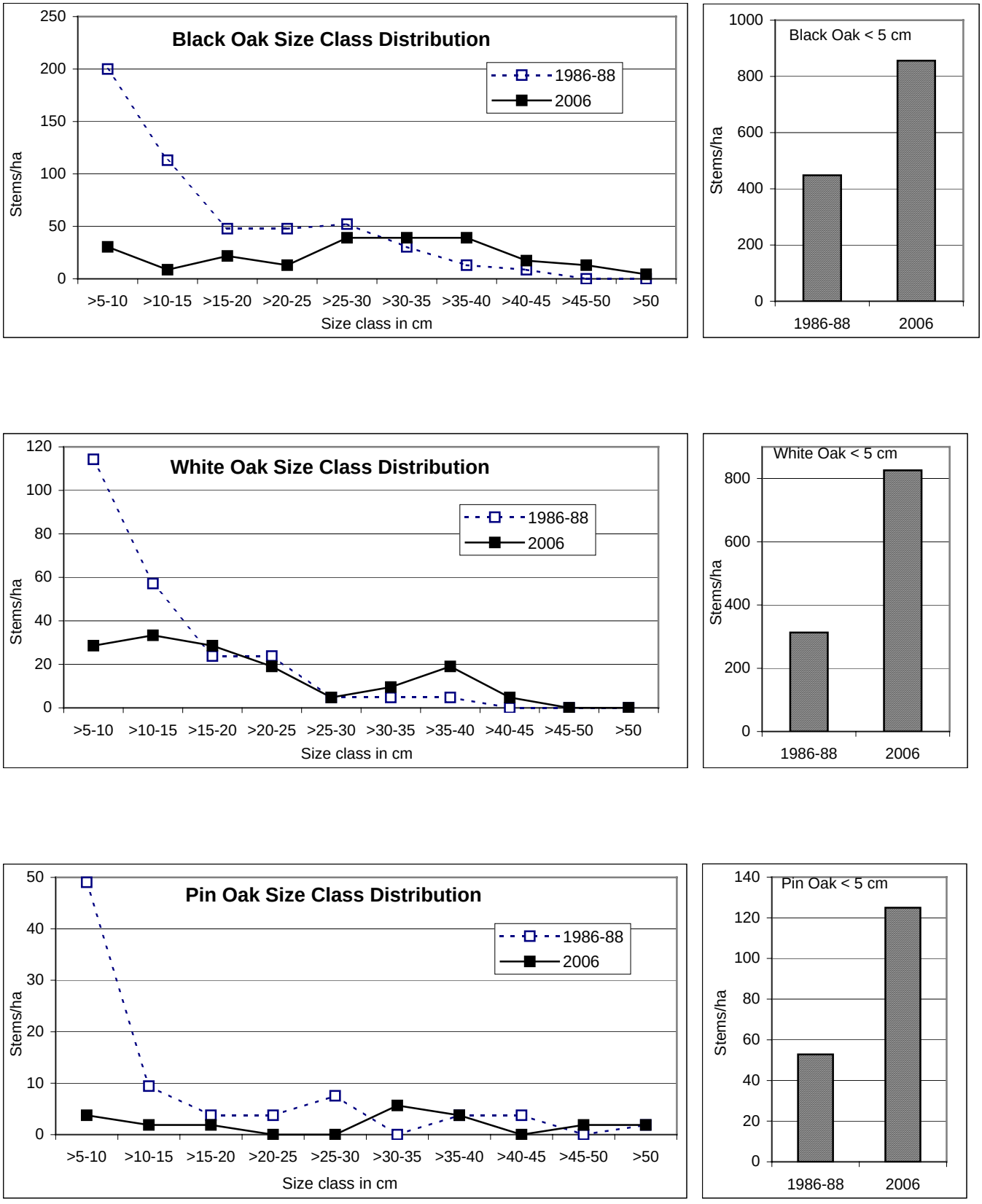


Figure 8. Temporal change in size class distribution of black oak, white oak, and pin oak. Left panels: size classes > 5 cm for black oak and white oak. Right panels: size classes < 5cm.

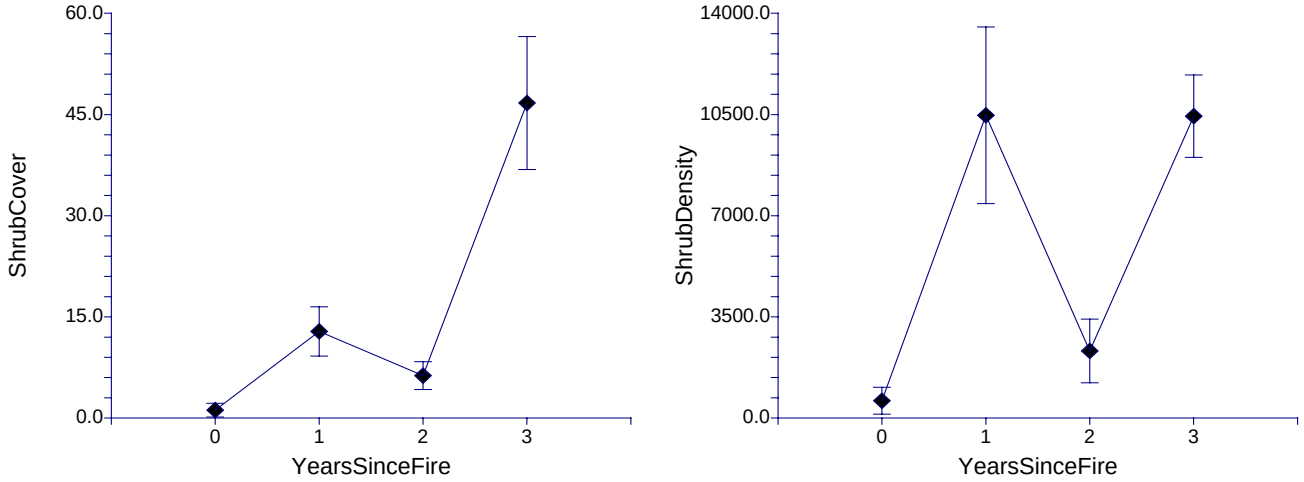
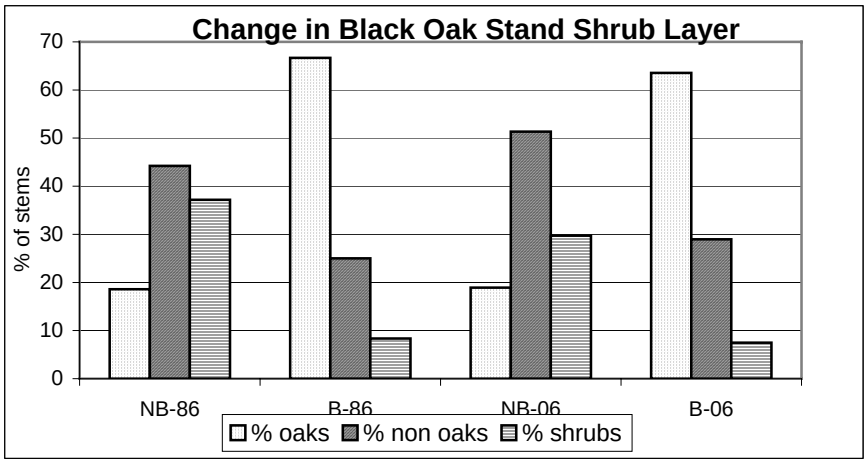
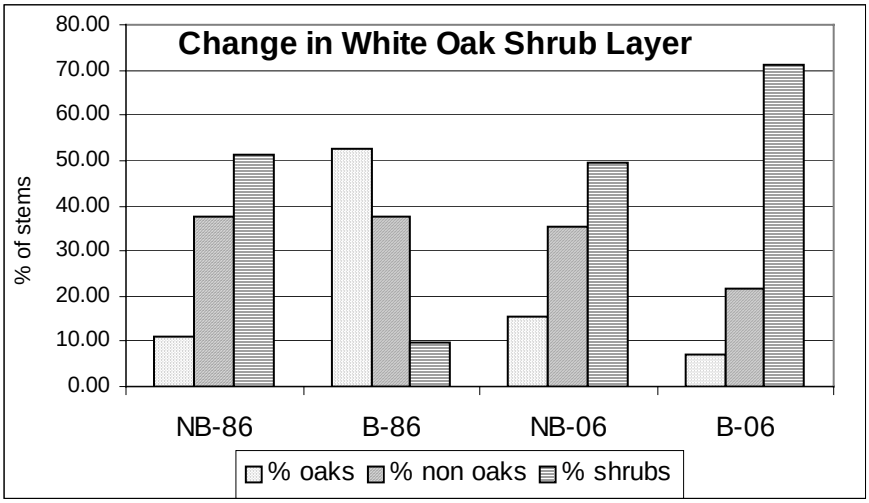


Figure 8. Effects of time since fire on shrub layer cover and density. Years: 0 = first growing season following fire., 1 = second growing season following fire, 2 = third growing season following fire, 3 = fourth growing season following fire. Cover: One-way ANOVA $F = 15.17$, $P < 0.0001$; Tukey-Kramer test, group 3 different from groups 0, 1, & 2. Density: One-way ANOVA $F = 12.05$, $P < 0.0001$. Tukey-Kramer test, group 0 different from groups 1 & 3.





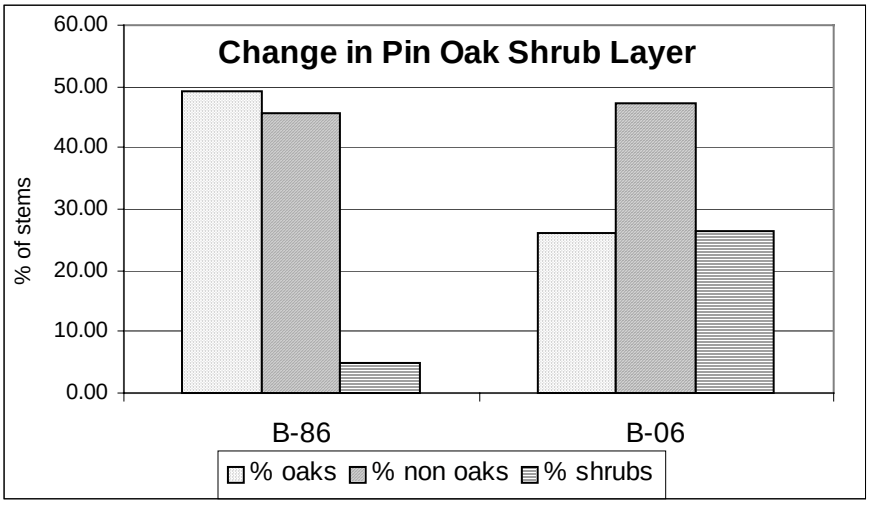


Figure 9. Temporal change in proportional abundance of oaks, non oak tree species, and shrubs in the shrub layers of black oak, white oak and pin oak cover types. B-86 = burned before initial sampling in 1986-88, UB-86 = unburned before initial sampling in 1986-88. B-06 = condition of stands in 2006 that were burned before initial sampling. UB-06 = condition of stands in 2006 that were burned before initial sampling. All stands were burned between 1986-88 and 2006.

cw:11:95192:111795

PLANTING PLAN AND SPECIFICATION

FOR THE

FT. MCCOY NATIVE PLANT SPECIES

RESTORATION/REVEGETATION RESEARCH

AND DEMONSTRATION PROJECT,

FT. MCCOY, WISCONSIN

APPLIED
ECOLOGICAL
SERVICES
INC.

17921 Smith Road
P.O. Box 256
Brodhead, WI 53520-0256

cw:11:95192:111795

PLANTING PLAN AND SPECIFICATION

FOR THE

FT. MCCOY NATIVE PLANT SPECIES

RESTORATION/REVEGETATION RESEARCH

AND DEMONSTRATION PROJECT,

FT. MCCOY, WISCONSIN

Prepared by:

Steven I. Apfelbaum and John L. Larson Ph.D.
APPLIED ECOLOGICAL SERVICES, INC,
17921 Smith Road
P. O. Box 256
Brodhead, Wisconsin 53520-0256
(608) 897-8641

Submitted to:

Kevin McAleese
Executive Director
The Sand County Foundation
201 Waubesa Street
P. O. Box 3037
Madison, Wisconsin 53704

October 1995

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PLANTING PLAN AND SPECIFICATION FOR THE FT. MCCOY NATIVE PLANT SPECIES RESTORATION/REVEGETATION RESEARCH AND DEMONSTRATION PROJECT, FT. MCCOY, WISCONSIN

LANDSCAPING

ARTICLE 1. GENERAL

This general outline provides plans and specifications for the installation of native vegetation within portions of Ft. McCoy, Wisconsin.

1.01 Description

A. The Contractor shall work with an ecological consultant firm, to provide both the materials, labor, and consulting, for the creation of native vegetation at Ft. McCoy, Wisconsin.

1.02 Site Conditions

A. Do not work soil when moisture content is so great that excessive compaction will occur, nor when it is so dry that dust will form in the air or that clods will not break readily. Apply water, if necessary, to bring soil to an optimum moisture content for tilling. Do not work soil when muddy or frozen.

1.03 Regulatory Requirements

A. Perform work in accordance with applicable laws, codes and regulations required by authorities having jurisdiction over the work.

B. Provide for inspections and permits required by Federal, State and local authorities in furnishing, transporting and installing materials.

1.04 Product Delivery, Storage and Handling

A. Furnish standard products in unopened manufacturer's standard containers.

B. Seed analysis shall be attached to outside as well as inside container, showing species, germination, purity, name of certified testing agency and date of test. Native wildflower seeds should have a miminum purity of 90%. No seed will be accepted unless test date is within 12 months of planting date.

C. Wildflower seed for which no standard seed testing is available shall be labeled and cleaned to meet Association of Official Seed Analysis (AOSA) standards: Rules for testing seeds, journal of seed technology, 1991 edition.

D. Ship and store seed with protection from weather or other conditions which could damage or impair the effectiveness of the product. Items that have become wet, moldy or otherwise damaged in transit or storage will be rejected.

1.05 Warranty

A. The warranty period for grasses and wildflowers shall be two years from substantial completion.

B. Plants shall be free of dead or dying patches and areas shall show foliage of normal density, size and color.

C. Delays in completion of planting operations which extend the planting into more than one planting season shall extend the warranty period correspondingly.

D. Coverage: Warrant growth and coverage of plants to the following standard:

1. Acceptance of the work will be determined by the ecological consultant (i. e. Dr. Alan Haney) using a time meander search completed for each planting zone. The search will be conducted at the end of each full growing season. The search will randomly sample at least 20% of the area of each zone that was seeded. The time meander search will record all new plant species observed in one minute increments. When no new species are observed for 5 consecutive minutes the search can be terminated.

   If the following criteria are met by the growth of acceptable species, then the work will be accepted.

2. Acceptance of the work will be determined by the ecological vonsultant (i. e. Dr. Alan Haney) using permanently established transects in each planting zone. Along each transect, at 10 meter intervals, a one meter square quadrat will be sampled. Within each quadrat the cover of each species will be recorded. Data on plant frequency and cover will be converted to relative values, the sum of which will be the importance value of that species.

E. Planting Performance Standards:

1. Year 1 (End of first full growing season):
   Seedlings of 3 dominant prairie or savanna grasses and 2-3 forbs are found

2. Year 2 (End of second growing season)
   5% cover of prairie or savanna grasses
   5% cover of prairie or savanna forbs
   20% of forb and grass species planted should be found

3. Year 3 (End of third growing season)
   30% cover of prairie or savanna grasses
   20% cover of prairie or savanna forbs
   40% of forb and grass species planted should be found

F. As soon as weather conditions permit, reseed without cost to the Owner, areas of dead plants and areas where plants are not in a vigorous, thriving condition, which do not meet the Planting Performance Standards during and at the end of the warranty period. Apply the requirements of this specification to replacement.

G. Contractor shall not be held responsible for failure due to neglect by the Owner, vandalism or acts of God during the warranty period.

ARTICLE 2. PRODUCTS

2.01 General

A. All necessary plants and seed should be ordered immediately to insure availability of desired species. If proof is submitted that any seed specified is not obtainable, a proposal will be considered for use of the nearest equivalent variety with a corresponding adjustment to the Contract price. The Contractor shall provide such proof in writing 30 days after award of the Contract. A partial list of supplies of native seed and plants is provided.

Prairie Nursery
P. O. Box 306
Westfield, WI 53964
(608) 296-3679

Prairie Ridge Nursery
RR 2, 9738 Overland Road
Mt. Horeb, WI 53572
(608) 437-5248

Country Wetlands Nursery
Box 126
Muskego, WI 53150
(414) 679-1268

High Meadow Farm
Tom & Molly Murray
Rt. 3, Box 155
Mt. Horeb, WI 53572
(608) 798-4419

Little Valley Farm
Rt. 3, Box 287
Snead Creek Road
Spring Green, WI 53588
(608) 935-3326

Milaeger's Gardens
4838 Douglas Avenue
Racine, WI 53402-2498
(414) 639-2371

Kester's Wild Game Food Nurseries, Inc.
P. O. Box V
Omro, WI 54963
(414) 685-2929

Prairie Moon Nursery
Rt. 3, Box 163
Winona, MN 55987
(507) 452-1362

Reeseville Ridge Nursery
P. O. Box 171
309 South Main Street
Reeseville, WI 53579
(414) 927-3291

Prairie Seed Source
P. O. Box 83
North Lake, WI 53064
(414) 674-7166

Applied Ecological Services, Inc.
17921 Smith Road
P. O. Box 256
Brodhead, WI 53520
(608) 897-8641

Prairie Restorations, Inc.
P. O. Box 327
Princeton, MN 55371
(612) 389-5733

Prairie Future Seed Co.
P. O. Box 644
Menominee Falls, WI 53052
(414) 246-4019

Olds Seed Company
2901 Packers Avenue
Madison, WI 53707
(608) 249-9291

B. The above provisions shall not relieve the Contractor of the responsibility for obtaining specified seed in advance if special growing conditions or other arrangements must be made in order to supply the specific materials.

2.02 Materials

A. The ecological consultant reserve the right to observe seeds and plant material, either at the place of growth or at site before planting, for compliance with requirements for name, variety, size, quantity, quality and mix proportion.

B. Seed:

1. Refer to mix requirements (2.02(E))
2. Seed shall be blended by the vendor and ratio shall be guaranteed by the vendor in writing to be as specified by proper labeling. All seed shall be true to species and to be 90% pure seed by weight, unless otherwise approved by Ft. McCoy Natural Resource personnel or their ecological consultant.
3. Seeds shall be stratified and/or scarified to break seed dormancy for planting.
4. Legumes shall be inoculated with proper rhizobia prior to planting.
5. Origin of native seed should be a close to the site as possible. All native seed should have it genotypic origin within 200 lineal miles of the project site.
6. Native grass seed shall be provided as pure live seed (PLS).

C. Plants, Tubers, Root Stock; and Trees:

1. Provide freshly dug tubers root stocks or provide potted plants. Do not use materials which have been in cold storage for longer than 45 days.
2. Deliver plant material after preparations for planting have been completed and plant immediately. If planting is delayed more than six hours after delivery, set plants in shade, protect from weather and mechanical damage and keep moist and cool.
3. Do not remove container grown stock from containers until planting time.
4. Label at least one plant of each variety in each planting area with a securely attached waterproof tag bearing legible designation of botanical and common name.
5. Plants shall be free from insects and diseases and must show appearance of normal health and vigor.
6. Plants shall be true to their name as specified.
7. All plant material, including collected stock, shall comply with State and Federal laws with respect to inspection for plant disease and insect infection.
8. Each species shall be handled and packed in the manner approved for that plant, having regard to the soil and climatic conditions at the time and place of digging and delivery. All precautions that are customary in good trade practice shall be taken to unsure the arrival of plants in good condition.

9. Plants shall be packed in such a way as to insure adequate protection against damage while in transit.
10. When shipment is made by enclosed vehicle, that vehicle shall be adequately ventilated to prevent "heating" in transit.
11. Depending on environmental conditions the ecological consultant may use seed to supplement the planting.
12. Species to be planted shall be those specifies in this specification. All plant material should have a genotypic origin within 200 lineal miles of the project site. Any substitution or change shall be approved in writing by the ecological consultant.

D. Hay or threshed straw of wheat, rye, oats or barley may be used for erosion control. Hay and straw shall be free of weed seeds. Straw will be applied at the rate of 2,000 lbs./acre on bare areas and slopes equal to or greater than 4:1.

E. Mix requirements:

TABLE 1. SPECIES AND QUANTITIES OF SEED FOR REVEGETATION OF PRAIRIE AREAS AT FT. MCCOY

Species	Common Name	Rate/1,000 ft.^{2} (ounces) Low	Medium	High
Andropogon gerardi(PLS)	*Big bluestem*	*1.00*	*2.00*	*4.00*
Andropogon scoparius(PLS)	*Little bluestem*	*1.00*	*2.00*	*4.00*
Asclepias verticillata	*Whorled milkweed*	*0.10*	*0.20*	*0.40*
Aster ericoides	*Heath aster*	*0.10*	*0.20*	*0.40*
Helianthus occidentalis	*Western sunflower*	*0.05*	*0.10*	*0.20*
Lespedeza capitata	*Bush clover*	*0.20*	*0.40*	*0.80*
Lolium multiflorum	*Annual rye grass*	*5.00*	*10.00*	*20.00*
Lupinus perennis	*Lupine*	*0.10*	*0.20*	*0.40*
Monarda punctata	*Sand bergamot*	*0.05*	*0.10*	*0.20*
Rudbeckia hirta	*Black-eyed Susan*	*0.25*	*0.50*	*1.00*
Sporobolus cryptandrus	*Sand drop seed*	*0.25*	*0.50*	*1.00*

TABLE 2. SPECIES AND QUANTITIES OF SEED FOR REVEGETATION OF SAVANNA AREAS AT FT. MCCOY

Species	Common Name	Rate/1,000 ft.^{2} (ounces) Low	Medium	High
Andropogon gerardi(PLS)	*Big bluestem*	*1.00*	*2.00*	*4.00*
Andropogon scoparius(PLS)	*Little bluestem*	*1.00*	*2.00*	*4.00*
Aster sagittifolius	*Arrow-leaved aster*	*0.20*	*0.40*	*0.80*
Helianthus laetiflorus	*Showy sunflower*	*0.05*	*0.10*	*0.20*
Lespedeza capitata	*Bush clover*	*0.20*	*0.40*	*0.80*
Lolium multiflorum	*Annual rye grass*	*5.00*	*10.00*	*20.00*
Lupinus perennis	*Lupine*	*0.10*	*0.20*	*0.40*
Monarda punctata	*Sand bergamot*	*0.05*	*0.10*	*0.20*
Solidago nemoralis	*Early goldenrod*	*0.10*	*0.20*	*0.40*
Sporobolus cryptandrus	*Sand dropseed*	*0.25*	*0.50*	*1.00*
Tradescantia ohiensis	*Spiderwort*	*0.20*	*0.40*	*0.80*

ARTICLE 3. EXECUTION

3.01 Drill Seeding Of Grasses and Wildflowers

A. A minimum of four inches of topsoil is necessary in planting areas prior to planting.

B. Prior to starting work, calibrate and adjust seeding equipment to sow seeds at the proper seeding rate. Equipment shall be operated in a manner to insure complete cover of the entire area to be seeded.

C. Do soil repair and finished grading work where the cover crop has been disturbed. This includes small rills and gullies.

D. Drill-seed across the slope, parallel with the contour, not up and down the slope.

E. Drill wildflower seed and grasses no deeper than 1/2 inch depth.

Experimental Plots and Treatments

TEST SITE(S)
SOIL PREPARATION

SEEDING RATE	Broadcast	Broadcast/Disc	No-Till Seed
Low	Low	Low	Low
Medium	Medium	Medium	Medium
High	High	High	High

With this study layout, an analysis of the best method(s) for establishment of native wildflower planting can be quantitatively tested. Testing of the relationship between seeding rates, and soil preparation/seeding method will be undertaken by the Natural Resources staff and an ecological consultant (i. e. Dr. Alan Haney). **AES** will assist the Natural Resources staff in the selection of suitable control and experimental sites. Four of these demonstration test sites (9,000 ft.^{2} each) will be seeded by **AES**. Four areas (3,000 ft.^{2} each) will serve as controls. No seeding or soil preparation will occur in control areas.

Description of variables to be tested:

SEEDING RATE - Three rates of seeding of two specified mixes will be finalized under Task 1. Under this proposal, 3 rates; low (L), medium (M), and high (H) rates of seed application will be tested.

The listing of species for prairie and savanna areas includes an annual grass cover crop that will provide protection against erosion (see Section 2.02F for species lists).

SOIL PREPARATION AND SEEDING METHOD - Three methods of seeding will be tested. Included are two methods of broadcasting seed one method after discing, and a second method without any soil preparation. A third method of planting will involve use of a no-till drill to plant seeds without additional soil preparation.

3.02 Planting Schedule

A. Seeding to occur from April to June 15th or after October 15th until ground freezes as a dormant seeding. Immediately follow seeding with mulching.

B. Plant materials to be installed between May 1st and June 15th.

OFFICE OF PARKS · RECREATION · HISTORIC PRESERVATION
NEW YORK STATE

David A. Paterson
Governor

Carol Ash
Commissioner

New York State Office of Parks,
Recreation and Historic Preservation

Historic Preservation Field Services Bureau • Peebles Island, PO Box 189, Waterford, New York 12188-0189
518-237-8643
www.nysparks.com

23 September 2008

Mr. Christopher Einstein
Clough Harbour & Associates, LLP
3 Winners Circle
P.O. Box 5269
Albany, NY 12205

Re: CORPS, DEC
Albany Landfill Expansion Project
City of Albany, Albany County
06PR01161

Dear Mr. Einstein:

The State Historic Preservation Office (SHPO) has reviewed the information submitted for this project (letter from Corey McQuinn, Hartgen Archeological Associates, Inc., dated 22 September 2008). Our review has been in accordance with Section 106 of the National Historic Preservation Act and relevant implementing regulations.

The above-referenced submission includes proposed site protection zones for the Albany Landfill Alternative 3 Precontact Site (A00140.004700). Although this site has not been fully evaluated regarding its eligibility for listing on the National Register of Historic Places, SHPO has previously recommended that the site may be eligible and that it should be protected or subjected to a Phase II investigation.

The proposed protection zones consist of 50- and 100-foot radius circles centered on the original shovel test (#364) by which the site was first identified. SHPO recommends that the 100-foot radius protection zone should be employed for this site. This recommendation is based on the finding that the actual site limits were not established during the Phase I investigation. Based on the 50-foot-interval Phase I shovel test grid, the site boundary may be less than 50 feet from the apparent center, but how much less is unknown. Furthermore, given that the 50-foot-interval Phase I shovel test grid represents only a very small sample of the site's vicinity, it is possible that portions of the site extend farther than 50 feet from its point of initial discovery. Therefore, the 50-foot radius protection zone might provide little or no actual protective buffer.

As an alternative to the 100-foot-radius protection area, SHPO recommends that additional testing could be conducted to more precisely determine the site's actual

boundary. Based on this additional information, the appropriateness of a 50-foot-radius protection area could be given further consideration.

Given that this project falls under federal jurisdiction, any treatment of this site may be subject to Native American consultation, at the discretion of the federal agency.

If you have any questions please don't hesitate to contact me.

Sincerely,

Philip A. Perazio, OPRHP
Phone: 518-237-8643 x3276; FAX: 518-233-9049
Email: Philip.Perazio@oprhp.state.ny.us

Cc: Corey McQuinn, HAA
Heidi Firstencel, ACOE

OFFICE OF PARKS, RECREATION & HISTORIC PRESERVATION
NEW YORK STATE

New York State Office of Parks, Recreation and Historic Preservation

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2 October 2008

Mr. Christopher Einstein
Clough Harbour & Associates, LLP
3 Winners Circle
P.O. Box 5269
Albany, NY 12205

Re: CORPS, DEC
Albany Landfill Expansion Project
City of Albany, Albany County
06PR01161

Dear Mr. Einstein:

The State Historic Preservation Office (SHPO) has reviewed the information submitted for this project (Email from Angelo Marcuccio, Department of Environmental Conservation, dated 2 October 2008, including map showing 100-foot buffer surrounding the Albany Landfill Alternative 3 Precontact Site (A00140.004700). Our review has been in accordance with Section 106 of the National Historic Preservation Act and relevant implementing regulations.

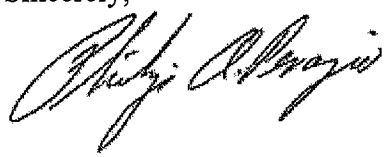
Based on the information provided, SHPO recommends that the planned project will have No Adverse Effect on historic properties listed or eligible for listing on the National Register of Historic Places provided that the following conditions are met. The 100-foot protective buffer shown in the above-referenced email shall be maintained both during and subsequent to construction. The buffer area will be delineated with orange safety fence during construction. Signs indicating "Sensitive Area, No Entry" will be placed at 25-foot intervals along the fence. The protected area will be marked off on all relevant construction plans. Contractors will be instructed that there is to be no entry into this area. Finally, the protected area will be maintained in perpetuity, with no ground disturbance of any kind to be undertaken within its limits without prior consultation with SHPO.

These comments are those of the Field Services Bureau and relate only to Historic/Cultural resources. They do not include potential environmental impacts to New York State Parkland that may be involved in or near your project. Such impacts must be considered as part of the environmental review of the project pursuant to the State

Environmental Quality Review Act (New York Environmental Conservation Law Article 8) and its implementing regulations (6 NYCRR Part 617).

If you have any questions please don't hesitate to contact me.

Sincerely,



Philip A. Perazio, OPRHP
Phone: 518-237-8643 x3276; FAX: 518-233-9049
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Cc: Angelo Marcuccio, DEC
Corey McQuinn, HAA
Heidi Firstencel, ACOE