RECOMMENDED FORESTRY MANAGEMENT PRACTICES

PINELANDS FORESTRY ADVISORY COMMITTEE
Final Report

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Acknowledgments

In recognition of their participation, cooperation and support, sincere thanks are extended to the members of the Forest Advisory Committee, whose names and affiliations (at the time of their appointment to the Committee) are noted below:

Michael Catania, Chairman ..... Conservation Resources Inc.

James Barresi ..... State Forester, New Jersey Department of Environmental Protection

Troy Ettel ..... New Jersey Audubon Society

Robert Zappalorti ..... Herpetological Associates

Marc Matsil ..... Assistant Commissioner for Natural and Historic Resources, New Jersey DEP

Jon Wagar ..... New Jersey Conservation Foundation

Robert Williams ..... Land Dimensions Engineering

Tom Bullock ..... New Jersey Forestry Association

George Zimmermann ..... Stockton State College

Introduction

On February 13, 2004, Pinelands Commission Chairman James J. Florio announced a series of new appointments to the Pinelands Forestry Advisory Committee. He also established a new charge for this reactivated Committee by directing it to review, clarify and refine the forestry provisions of the Pinelands comprehensive management plan. In particular, the Committee was directed to recommend practices designed to ensure that forestry practices conducted in the Pinelands are consistent with the commission's mandate to protect and maintain the Pinelands environment while ensuring that forestry remains a viable economic and cultural resource in the Pinelands. The comprehensive management plan for the Pinelands specifically recognizes, inter alia, that:

"The Pinelands forests are an important cultural, ecological, scenic, and economic resource. Proper management of this resource will ensure its maintenance and result in greater economic returns on the harvested timber… the Commission's policies state that the natural resources of the Pinelands must be preserved, protected, and enhanced, and that "opportunities for traditional lifestyles that are related to and compatible with the overall ecological values of the Pinelands" must be maintained…The Commission's forestry program is intended to meet the objectives of these policies by providing opportunities for the continuing uses of the region's forest resources which are compatible with the maintenance of the Pinelands environment…This will be accomplished by ensuring proper management of the forests through the application of sound management techniques, and through public education."

It is well documented that forest product use of many types has played a major role in the economic and cultural history of the Pinelands. Throughout the last 300 years, Pinelands forests were harvested several times over to provide fuel and raw materials for a series of industries ranging from iron forges, charcoal making, glassblowing and shipbuilding. Hundreds of small sawmills dotted the pinelands landscape, producing wood products ranging from timber to cedar shakes. Traditional forest activities, as well as the gathering and harvesting of forest products, such as pine cones and sphagnum moss, played a major role in a subsistence lifestyle that endured for several centuries and formed an essential element of Pinelands culture.

Forestry as the science, art, and practice of creating, managing, using, and conserving forests was brought to the Pinelands region in the early 20th century. The Forest Park Reservation Commission was created by the state legislature in 1905 and land for the first State Forest, Bass River, was purchased that same year.

By the beginning of the 21st century, however, forestry activities had dwindled dramatically throughout the state, including the Pinelands. Only a handful of sawmills are still in operation here now, and the practice of subsistence through seasonal forestry and related activities is now very much the exception rather than the general rule.

The impacts of this decline in Pinelands forestry are numerous. In addition to the obvious changes to the traditional Pinelands economy and culture, the decline of forestry has also however, had serious ecological implication for the nation's first National Reserve. Scientists now realize that forest use has played a major role, along with fire and other human activities, in shaping and creating the Pinelands. Simply stated, wildfires and forest use have been the principal sources of the very disturbances which have created a mosaic of habitats where a wide variety of rare, threatened and endangered species and natural communities now thrive.

Less obvious is the fact that maintaining the diversity of the Pinelands, by definition, also involves allowing, if not encouraging, continued disturbances which are needed to maintain the dynamic nature of pinelands habitats. Yet the natural fire cycle and the significant wildfires of yesteryear are now largely controlled in order to protect the ever-increasing number of people and structures found throughout the

Pinelands. In this new reality, allowing and promoting appropriate forestry can take on an even more critical role in perpetuating the Pinelands. As such, continued and expanded forestry activities within the Pinelands are now more than merely permissible – they have now become critical in order to promote ecological values, as well as economic and cultural values.

In its deliberations, the Committee has become aware that there has been a growing concern in recent years that Pinelands forests might be converted to huge plantations of sterile monocultures, as forestry is now practiced in some other regions of the country, particularly in the southeastern United States. However, it is apparent to us that this type and scale of forestry is simply not appropriate or even feasible for the Pinelands, due to the nature of Pinelands soils, the ecological importance of protecting the pristine water quality and critical habitat for a wide variety of threatened and endangered species, as well as the strict regulatory system which has been in place here for the last 25 years. Rather, the Committee envisions that future Pinelands forestry can and should be a relatively small-scale, niche industry, which uses and perpetuates native forest types and species.

Forestry activities undertaken here by farmers and other private landowners, public agencies, and non-profit conservation organizations can provide wood and forestry products while also promoting better stewardship and enhancing the ecological integrity of Pinelands resources. The native forests of the Pinelands can once again be managed in a way that helps achieve the public policy objectives that serve as the underpinning of both federal and state laws to protect this unique area. Forestry, if practiced in accordance with sound management practices, can provide wood and wood products, and insure the protection of water quality and critical habitats for wildlife as well as a way of life and culture that will otherwise soon vanish. It is in this spirit that the Forestry Advisory Committee offers the following report.

It is recommended that the Pinelands Commission periodically review, on a 5-year interval, and refine as needed, the provisions of the Forestry Management Practices and the Comprehensive Management Plan regulations that may be in effect that guide the application of these Practices.

This report is broken into three sections and five appendices. Section I sets out what the Forestry Advisory Committee believes should be the broad goals for forestry activity in the Pinelands. Section II suggests ways to make forest management planning better on both private and state-owned properties. Section III describes generally recommended silvicultural practices for the Pinelands. Appendix I sets out recommended silvicultural practices when threatened and endangered animals may be present. Appendix II provides technical definitions of Native Pinelands Forest Types and more specific recommended silvicultural practices for rare types. Appendix III provides a recommended monitoring protocol. Appendix IV contains definitions of terms used in this report and Appendix V contains all the sources and citations for this report.

Section I: Forestry Goals

Maintain Native Pinelands Forest Types

Chapter One of the Pinelands Comprehensive Management Plan describes the three factors that contribute to the essential character of the Pinelands: the physical features of the landscape (relief, soils and hydrology); the living organisms (Pinelands plants and animals); and ecosystem processes, the dynamic interrelationships among and between these living organisms and their particular habitat elements. Chapter one also recognizes that "fire has greatly influenced the development of present patterns of plant and animal species distribution in the Pinelands." Forestry practices should maintain general patterns of native species and ecological communities on the landscape, particularly globally rare types, yet allow for the normal range in post-disturbance dynamics typical for various sub-regions of Pinelands. The goal of forestry in the Pinelands should be to maintain these broad patterns of native species and communities on the landscape by mimicking the historic and prehistoric fire and cutting disturbance regimes that created these patterns, while conducting forestry for commercial, stewardship, ecological and hazard reduction goals. The development of landscape-scale management plans is encouraged to address these large-scale patterns of biological diversity and ecosystem processes in the Pinelands. Forestry practices that encourage natural regeneration to maintain locally native forest types, species and genotypes are encouraged in the Pinelands, although planting of native, locally-derived species should also be permitted in most settings. Forestry techniques should avoid introducing invasive species or facilitating their spread. Forestry practices should also avoid significant permanent conversion from one native forest type to another as well as maintain an understory of native plants.

Mimic historic influences

Forest management should be ecologically-based and mimic the fire and cutting histories that created the Pinelands ecosystem, in order to maintain the distribution of cover types, species, fuel structure, and soil structure patterns on the landscape. Forestry practices that mimic historic disturbance patterns can be defined by: return interval (the average time between occurrences of disturbances in a given stand); severity (the amount of vegetation and root system killed, and the type of growing space made available for new plants); landscape pattern (distribution of disturbance patch mosaic effects); the size and timing of fire; cover types; age classes; and the demands, pressures and benefits placed upon forests by the human environment.

Encourage multiple-use forestry

Forest management should be designed to promote commercial forestry, wildfire hazard reduction and forest stewardship while providing for the long-term environmental integrity of the Pinelands, but avoiding any irreversible adverse affect on habitat critical to the survival of any threatened or endangered plant or animal species in accordance with sections 7:50-6.27 and 7:50-6.31 through 6.34 of the Pinelands Comprehensive Management Plan and the recommendations outlined in "Forestry and Threatened or Endangered Species" memorandum incorporated herein as Appendix I. Integration of ecologically-based forestry and prescribed fire management should be encouraged to achieve ecological and wildfire hazard reduction goals. Sustaining and maintaining habitat for endangered, threatened, and rare plant and animal species through forestry should also be encouraged.

Section II: Management Planning

Because of the unique nature of the Pinelands Forest Resource, the Forestry Advisory Committee agreed that forestry applications should continue to be held to a higher standard than plans required under the Farmland Assessment Act. The FAC recommends minor changes to the standard template to take into account the unique challenges and opportunities in managing forests in the Pinelands. These changes are detailed below.

One of the first challenges of the FAC was to develop a coordinated way to describe the mosaic of Native Pinelands Forest Types found on the landscape. In its deliberations, the Committee learned of various methodologies used to describe unique patterns of Pinelands forests ranging from "plant communities" to "ecological communities" to "forest stands". After much deliberation, the Committee agreed to recommend using the NJDEP Division of Parks and Forestry definitions, based in part on Classification of Vegetation Communities of New Jersey by Breden et al. Native Pinelands Forest Types are described in more detail in Appendix II. All forest management plans in the Pinelands shall use these new Native Forest Type descriptions. The FAC expects that as more research is conducted on these Native Forest Types descriptions will change.

Forestry in the Pinelands should maintain these broad Native Pinelands Forest Types on the landscape scale, while allowing flexibility to mimic natural dynamic changes. Since the primary natural disturbance factor - wildfire - is effectively suppressed in many areas, maintenance of Native Pinelands Forest Types in many cases will require *more* forestry on the landscape. Some vegetation patterns in the Pinelands have been relatively stable for centuries due to frequent fire, such as the distribution of pine plains and barrens documented for at least 200 years in the largest, most fire-prone firesheds. However, many less frequently burned Native Pinelands Forest Types are not nor have ever been static plant communities – by their very nature they change over time. For example, portions of what was an Oak-dominated Native Forest Type could change to a Pine-dominated Native Forest Type over time and vice versa due to local variations in the average disturbance regime of a fireshed. The FAC recognized this fact and feels that localized, ecologically-appropriate conversions from one Native Forest Type to another through forestry should be viewed in this dynamic context.

The committee also recognized that there is a difference in management planning on private and public lands. Whereas private landowners are typically driven to conduct forestry solely for financial interests, public lands, by their very definition, need to be managed for multiple objectives. Maintaining Native Forest Types on the landscape should largely be the responsibility of the NJDEP since they are by far the largest landowner in the Pinelands. Plans on public lands should incorporate landscape-wide considerations only possible on large tracks of lands. These plans should explain how Native Forest Types will be sustained on the landscape and integrate lands owned by the different NJDEP Land Management Agencies – NJDEP Division of Parks and Forestry, NJDEP Division of Fish and Wildlife, and the Natural Lands Trust.

The Forestry Advisory Committee Recommends that all Forest Management Plans should be designed to:

- Avoid any irreversible adverse affect on habitat critical to the survival of any threatened or endangered plant or animal species in accordance with sections 7:50-6.27 and 7:50-6.31 through 6.34 of the Pinelands Comprehensive Management Plan.
- Support, on an overall landscape scale, the soil structure and ground layer, shrub layer and canopy structure and composition, and the complete range of species of living organisms of the Pinelands through practices that mimic established historic disturbance patterns.
- Sustain and perpetuate Native Forest Types and rare and endangered plants and animals (if present).

All forestry applications for projects 25 acres or more in size shall be subject to review by the Forestry Advisory Committee. Commission staff should also have the option of asking the FAC to review smaller

projects. The Committee may also wish to review some smaller projects of an experimental or non-traditional nature.

Depending on site conditions and proposed activity, the Forestry Advisory Committee, the NJDEP, or the Pinelands commission staff may require a threatened or endangered plant or animal survey for forestry applications on public or private lands.

In addition to the information listed in Section 7:50-6.43 of the Pinelands Comprehensive Management Plan, all Forest Management Plans should clearly identify the existing conditions of the subject parcel and include a statement of the short- (5 years) and long-term (20 years) objectives for any and all proposed silvicultural techniques that will be used to manage the site.

At a minimum, Forest Management Plans should include detailed maps and photographs of each stand showing the location of the Native Pinelands Forest Types. The application should also be accompanied by detailed information, in a narrative form, which describes the following:

1. Native Forest Type Inventory – Native Forest Types broken into "stands" and including information on type/size/volume by species
2. Stand cohort composition
3. Stocking table
4. Basal area
5. Percent cover
6. Age of representative trees
7. Understory and ground layer structure and composition
8. Soil type
9. Wildlife habitat consideration
10. Threatened and Endangered species and ecological communities documented on site or in the immediate vicinity by the Pinelands Commission, the New Jersey Natural Heritage Database, and the NJDEP Endangered and Nongame Species Program Landscape Project and statement of how proposed forest management activities will impact rare species and communities (can be a positive impact). If Endangered Animals are found on the site, the recommendations shall use the Endangered Animals guidelines in Appendix I.
11. Management objectives
12. Projections of future stand characteristics at 10, 20, and 40-year intervals
13. Silvicultural treatment alternatives
14. If planting, seed sources records if available
15. Implementation instructions
16. A provision to prevent the potential spread of invasive species into wetlands. For example before entering wetlands with forestry equipment, clean all equipment of invasive species, and thoroughly clean all dirt and detritus from equipment before it is brought to a forestry site either through power washing or steam cleaning, to prevent introduction of mud containing invasive plant seed, or wood debris containing insect pests.
17. Additional Information:
    a. An applicant must certify that they have not received notice of violation of any past forestry permit or, if they have received notice of violation relative to any past forestry permit, must present evidence that such violation has been resolved.
    b. Certification by the applicant and the forester that the proposed forestry activity is consistent with these Management Practices

18. Monitoring (see Appendix III for specific examples of monitoring protocols)
    a. Monitoring is a required component of all plans conducted by state entities
    b. Monitoring is optional on plans for private landowners, but anything deemed to be experimental in nature by the FAC shall be required to have a monitoring component.
19. Additional Requirements for Management Plans for Public Lands

- The Forest Advisory Committee recognized that Forest Management plans on Public Lands will have different goals and objectives than private lands. Whereas financial objectives may drive management planning on private property, forest management on public property will be driven by diverse goals from commercial forestry to enhancing public access to increasing the habitat for rare and endangered plants and animals and improving forest health

- Forest Management Plans on Public Lands should be broad-scale in nature (eg. Capturing entire functional ecosystems or natural landscape units such as with firesheds or watersheds) and set out a clear vision for public lands. The committee agreed that forestry activity conducted on state lands should be done in accordance with a landscape-level forest management plan. Adjoining lands owned by the different NJDEP Land Management Agencies – NJDEP Division of Parks and Forestry, NJDEP Division of Fish and Wildlife, and the Natural Lands Trust – should be incorporated into the same plan. The Committee felt that landscape-level plans would provide invaluable information for forest planning on adjoining private lands.

- The FAC recommends that the Governor, New Jersey State Legislature and the New Jersey Department of Environmental Protection, budget and appropriate adequate funds so that a comprehensive Forest Management Plan for each State Park, State Forest and Wildlife Management Area located within the pinelands area is completed and adopted within 5 years of the adoption of the Recommended Forestry Management Practices.

Section III – Recommended Silvicultural Practices

The following section describes the entire range of practices that are currently in foresters' land management "tool box". Although all practices are possible, the Forest Advisory Committee has found that many are only appropriate under certain specific conditions. The following is a detailed description of each of the practices as well as a description of where and how there should be restrictions on each particular practice.

Note about Best Silvicultural Practices

All of the recommendations in this report are meant to serve as strict guidelines. If a good case can be made for experimental silvicultural techniques that are not recommended in this report, then the FAC should be permitted to review the proposal with the NJ Division of Parks and Forestry and provide recommendations to the Pinelands Commission after the applicant has been consulted.

Herbicide Guidelines

More data documenting some of the long-term ecological impacts of the use of herbicides may be needed. In particular, it was noted during the discussions that there is a great deal of uncertainty concerning the long-term environmental risk of certain surfactants used in herbicides. Consequently, it is recommended that the Pinelands Commission work with the New Jersey Department of Environmental Protection, Division of Science and Research, to evaluate research projects/risk assessments evaluating herbicide/pesticide applications in the Pinelands.

Due to the need for more data, noted above, it is recommended that the Pinelands Commission and the Forest Advisory Committee periodically review, on a 3-year interval, and refine as needed, the provisions for herbicides below.

- Follow Integrated Pest Management principles when applicable.
- Secure appropriate state and federal permits and follow all state and federal laws regarding proper use or disposal as well as the following;
    - Use herbicides only as directed on the label.
    - Refer to Streamside Management Zone best practice recommendations regarding use in these areas.
    - Do not apply when wind conditions may increase the possibility of significant drift.
    - Avoid application when temperatures are high and relative humidity is low.
    - Base pesticide selection on site factors and pesticide characteristics.
    - Locate mixing and loading areas where residues will not enter streams or other water bodies.
    - Do not rinse equipment into wetlands or open waters.
    - Do not store containers on site.
    - Must demonstrate conformance with sections 7:50-6.27 and 7:50-6.31 through 6.34 of the Pinelands Comprehensive Management Plan for use in the presence of any documented occurrence of a threatened and endangered species and may only be used in presence of rare and endangered amphibians and invertebrates where application is necessary for perpetuation of such species.
- "Tank mixes" (mixes of several different pesticides in the same application) shall be prohibited unless they are approved by the EPA.
- Shall not be used in any forest type where natural succession is the objective except as may be necessary to ensure generation of cedar, or where deemed necessary to retain a particular Native Forest Type.
- On pine restoration sites, spot treatment of herbicide to control hardwood species in direct competition with pine plantings is recommended.

Aerial

- Buffer size shall be depended on manufacture's recommendations and type of aircraft used. Plan shall spell out recommendations and be incorporated as a practice.

Ground

- Can be used to control competing or invasive species when there is no reasonable alternative.
- Backpack.
- When used for cedar restoration wait until end of growing season – in uplands, wait until after 1 to 2 growing seasons.
- May be useful to control invasive exotics, consistent with labeling requirements.

  Special Herbicide Restrictions for Particular Native Forest Types

  - Pine-shrub Oak Native Forest Types – avoid broadcast herbicide applications that significantly reduce tree or shrub oak resprouting or cover.

Fire Management Practices

Prescribed fire should be encouraged as a site preparation method and as a general hazard reduction treatment to reduce wildfire risk in some cases, such as in upland sites dominated by pine or in pitch pine lowland sites. In certain circumstances, it provides an alternative to drum chopping, root raking and disking and is potentially much less disturbing to mineral soils, roots, and underground snakes. Fire has the added benefit of providing a capability to stimulate natural regeneration among serotinous pitch pine seed trees where present.

A trained crew must be used to plan and execute a prescribed burn, as required by NJDEP. It shall only occur when the soil and fuel moisture is sufficient and weather conditions are favorable.

The Pinelands Commission and the New Jersey Fire Service should confer to seek flexibility in forest fire regulations and to expand opportunities to use ecological burning as a management tool. Growing season fires should be considered on a small-scale, experimental basis and only after proper buffering by thinning or a burned perimeter by dormant season burning.

The Forest Advisory Committee should study the possibility of increasing the use of prescribed fire in the Pinelands. There are certain instances where extensions of the season for prescribed burning could be extremely beneficial. For example, growing season burning after thinning in pitch pine lowlands can be used to reduce shrub cover and fire hazard and encourage rare grass-dominated Native Forest Types such as pitch pine-reedgrass savanna, to the benefit of wildlife and rare species. Growing season burning in uplands can be used to facilitate native grass colonization during the creation of upland savanna or grassland where ecologically appropriate (see Appendix II, Upland Savanna and Grassland Native Forest Type).

General Fire Management Restrictions for Particular Native Forest Types

- Oak Dominated Native Forest Types – Intense (mature tree-killing) prescribed burning shall not be permitted in Oak Dominated Native Forest Types that are dominated by oak-pine-holly and oak-hardwood-holly combinations, except in wildland-urban interface or other special circumstances.
- Can be used in all other Native Forest Types.

Site Preparation/ Regeneration Methods

Site preparation techniques typically employ manual, mechanical and/or chemical procedures and are often used to help maintain or produce local spatial heterogeneity, treat and/or prevent weeds, and when applicable, to break up the surface root mat. Site preparation techniques are also occasionally required to establish a new stand of trees. Site preparation techniques require some manipulation of dead organic debris on the soil surface. A decision to use any site preparation technique or combination of techniques is

highly site specific and requires a complete evaluation of existing conditions. Site preparation techniques can achieve the following objectives:

- Ameliorate soil characteristics to enhance seedling establishment;
- Allow newly established seedlings to get a growing head start over potentially competing vegetation;
- Allow early successional species such as herbs and grasses to become established, as per management goals and objectives;
- Improve access for planting, and create additional planting micro-sites;
- Clear sites of logging debris.

All site preparation/regeneration methods shall be designed and applied in a manner that avoids harm to threatened and endangered species of plants and animals, in accordance with the guidelines specified in Appendix I and Appendix II. Site preparation techniques should also be designed to prevent soil erosion and maintain water quality. On slopes of greater than 10%, a natural buffer strip of 25 feet or more should be retained along roadways during site preparation to catch soil particles. With the exception of recently abandoned agricultural lands, natural drainage should be maintained and groundwater or surface water hydrology should not be disturbed in wetlands.

Broadcast Scarification

Description/General Guidelines

- To temporarily reduce surface brush, litter and humus and to enhance the reforestation of a site. Can be used in lieu of disking, root raking or drum-chopping to avoid mineral soil disturbance and associated root damage, and thus assure oak re-sprouting, as well as to avoid impacts to rare snakes hibernating underground, especially in pine-shrub oak types.
- Scarification of the surface brush, litter and humus layers shall be permitted where the goal is to greatly reduce surface fuel loads and enhance ground layer heterogeneity and biological diversity.

Broadcast Scarification Restrictions for Particular Native Forest Types

- Can be used in all Native Forest Types per guidelines above.

Disking

Description/General Guidelines

- Used to stimulate regeneration in areas where tree growth is impeded due to thick turf.
- Disking is usually only needed on upland sites with extensive hardwood competition, a dearth of seed trees, extremely dry sites, or those with hard-to-regenerate species.
- When slopes are discernible, disking should follow land contours.
- Where the intent is to restore cedar, disking should be limited to shrub-dominated sites and recently abandoned agricultural land.

Disking Restrictions for Particular Native Forest Types

- Pine-Shrub Oak Native Forest Type - disking shall not be permitted.
- Pine Plains Native Forest Type – disking shall not be permitted.
- Disking shall be allowed in all other Native Forest Types, per guidelines above.

Root Raking

Description/General Guidelines

- Do not pile debris in wetland areas.
- Where the intent is to restore cedar, root raking should be limited to shrub-dominated sites and recently abandoned agricultural lands.

Root Raking Restrictions for Particular Native Forest Types

- Pine-Shrub Oak Native Forest Type – Root Raking shall not be permitted.
- Pine Plains Native Forest Type – Root Raking shall not be permitted.
- Root Raking shall be allowed in all other Native Forest Types, per guidelines above.

Bedding

Description/General Guidelines

- Land prepared before planting in the form of small mounds. The prepared land concentrates topsoil and elevates the root zone of seedlings above temporary standing water.
- Bedding is not a common practice in the Pinelands.

Bedding Restrictions for Particular Native Forest Types

- May only be used in recently abandoned, cultivated wetland with no established Native Forest Type.

Drum Chopping

Description/General Guidelines

- Use to create bare mineral soil and provide site preparation for seed germination and planting of trees and other plants.
- Maintain local spatial and species heterogeneity.
- Chop up and down the slope so the depressions made by the cleats and chopper blades are located on the contour of the land to help reduce the occurrence of channeled surface erosion.
- Drum chop perpendicular to a wetland or a water body.
- Where the intent is to restore Atlantic white cedar, drum chopping should be limited to shrub-dominated sites and recently abandoned agricultural lands.
- Avoid drum chopping in wetland buffers where rare species, wildlife or cultural resource artifacts tend to be concentrated and follow the New Jersey Forestry and Wetlands Best Management Practices Manual.
- Avoid 180-degree turns at the end of each straight pass which cause more severe soil and root disturbance and greater potential for erosion.
- Shall only be allowed in dormant season if using an unfilled drum.
- Can be used in growing season with a filled drum (note Appendix I).
- Types of Drum Chopping

  Single pass and Double pass

  - Use to create bare mineral soil for seed germination of trees and other plants.

  Repetitive passes

  - May be used on an experimental, small-scale basis (up to 10 acres) in some ecological communities to evaluate long-term effects of the practice, or to create upland savannas in ecologically appropriate sites outlined in the Upland Savanna and Grassland Native Forest Type (see Appendix II)

Drum Chopping Restrictions for Particular Native Forest Types

- Pine-Shrub Oak Native Forest Type – single or double pass drum-chopping shall only be allowed in dormant season, or shallow vertical disking in dormant season, if applied in a manner which minimizes disturbance to roots in the mineral soil (eg. by using a drum which has not been filled with water).

- Pine Plains Native Forest Type – Drum chopping shall not be permitted except for road shoulder fuelbreaks 25-feet wide using single, double or repetitive passes.
- Shall be permitted in all other Native Forest Types.

Mechanical Weeding

Description/General Guidelines

- Used to influence species composition.
- Girdle.
- May be used to control invasive plants.
- Permitted for pre-commercial activity.
- Used for thinning. Slash trees to promote decomposition.
- Used to remove fire hazard.

Mechanical Weeding Restrictions for Particular Native Forest Types

- Can be used in all native forest types per guidelines above.

Prescribed burning

Description/General Guidelines

- Used to temporarily remove surface litter, slash and brush to promote tree regeneration.
- Used to expose mineral soils.
- Used to stimulate serotinous pitch pine seed release in seed trees.

Prescribed Burning Restrictions for Particular Native Forest Types

- Can be used in all Native Forest Types per guidelines above.

Regeneration Systems (Harvesting Techniques)

The act of renewing tree cover by establishing young trees.

Clearcutting

Description/General Guidelines

- Removal of an entire stand in one cutting, reproduction is obtained artificially, or by natural seed, or from advanced regeneration. This method typically involves the removal of all woody vegetation from the site in preparation of establishment of new trees but depending on the management objective may or may not have reserve trees left to attain goals other than regeneration.
- Shall be limited to 300 acres in size or 5% of parcel, whichever is greater.
- There shall be a 10-year interval between successive clearcuts.
- The following provisions shall apply for clearcutting at all sites, regardless of parcel size:
  - A minimum 50-foot buffer should be retained at the property boundary.
  - A minimum 300-foot wide buffer should be retained between successive clearcuts.
  - The interval between cuts on contiguous parcels should be a minimum of 10-years.
  - Dead snags, at least 10 inches dbh and at least 6-feet in height, should be left on the site.
  - The site should have contoured edges.

Clearcutting Restrictions for Particular Native Forest Types

- Clearcutting shall not be permitted in Pine Shrub Oak Native Forest Type.

- Clearcutting shall not be permitted in the Pine Plains Native Forest Type.
- Clearcutting can be used in all other Native Forest Types per guidelines above.

Coppice

Description/General Guidelines

- Producing stands originating from vegetative sprouting by the trees that are harvested (stump sprouts, root suckers, and naturally rooted layers). This method usually involves short rotations with dense stands of short trees. Trees resulting from sprouts are almost never as good as trees of the same species originating from seed, although producing sprout growth is the goal when maintaining dwarf pitch pine stands in pine plains and hydric pine plains communities.
- For harvests up to 500 acres in size where goal primarily is asexual (sprout) reproduction.
- Dead snags, at least 10 inches dbh and at least 6 feet in height, should be left on-site.
- For all sites, regardless of parcel size, a minimum 50 foot buffer should be retained at the property boundary, a 300 foot wide buffer should be retained between successive cuts.
- The site should have contoured edges.
- The interval between cuts on contiguous parcels should be a minimum of 10-years.

Coppice Restrictions for Particular Native Forest Types

- Coppice can be used in all Native Forest Types per guidelines above.

Seed Tree

Description/General Guidelines

- Removal of old stand in one cutting, except for a small number of trees left singly, in small groups or narrow strips, as a source of seed for natural regeneration. An even-aged method
- Shall be limited to 500 acres in size or 10%, whichever is greater.
- The following provisions shall apply for seed tree at all sites, regardless of parcel size:
  - A minimum 50-foot buffer should be retained at the property boundary.
  - A minimum 300-foot wide buffer should be retained between successive seed tree.
  - The interval between cuts on contiguous parcels should be a minimum of 5-years.
  - Dead snags, at least 10 inches dbh and at least 6-feet in height, should be left on the site.
  - The site should have contoured edges.
- Retain dominant residual seed trees at a distribution of at least 7 to 12 trees acre.
- Distribute residual seed trees evenly throughout the site.
- Seed tree cuts applied with repeated drum chopping or other shrub-removing techniques to create upland savanna should only be used at wildland-urban interface and ecologically appropriate sites, in accordance with the Upland Savanna and Grassland Native Forest Type description in Appendix II.

Seed Tree Restrictions for Particular Native Forest Types

- Seed Tree can be used in all Native Forest Types per guidelines above.

Shelterwood

Description/General Guidelines

- Establishment of a new, essentially even-aged stand from release, typically in a series of cuttings, of new trees started under the old stand. The new stand is established before the old stand is removed. An even-aged method.

- No size limit.
- The new stand is established before the old stand is removed. Shelterwood cutting can take an irregular or uniform form and can be laid out in groups or strips.

Shelterwood Restrictions for Particular Native Forest Types

- Shelterwood can be used in all Native Forest Types per guidelines above.

Group Selection

Description/General Guidelines

- Uneven-aged silvicultural system in which a group of trees are periodically selected to be removed from a large area so that age and size classes of the reproduction are mixed.
- The width of the group is typically twice the height of the mature trees with smaller openings providing microenvironments suitable for tolerant regeneration, but widths can be bigger.
- Generally used for uneven-aged management.

Group Selection Restrictions for Particular Native Forest Types

- Group Selection can be used in all Native Forest Types per guidelines above.

Individual Selection

Description/General Guidelines

- Uneven-aged silvicultural system in which single trees are periodically selected to be removed from a large area so that age and size classes of the reproduction are mixed.

Selection Restrictions for Particular Native Forest Types

- Can be used in all Native Forest Types.

Propagules/Planting Guidelines

Natural Regeneration

Description/General Guidelines

- Encouraged in most silvicultural treatments. Required in pine plains and where endangered and threatened plants are present.
- Regeneration methods can include seed tree cuts (trees retained to provide seeds) and shelterwood cuts (retaining a number of seed and shade trees to provide sufficient shade to promote a new age class).

Natural Regeneration Restrictions for Particular Native Forest Types

- Natural Regeneration can be used in all Native Forest Types per guidelines above.

Artificial Regeneration

Artificial Regeneration may be used where the forest management plan designates acceptable forest regeneration objectives and is designed to maintain Native Pinelands Forest Types. Hybrid[1] and non-native species shall not be permitted.

[1] The FAC held a special meeting to investigate the threat of hybrid species in the Pinelands, specifically hybrid pitch pine/loblolly pine. Dr. John Kuser from Rutgers University was interviewed by the Committee and a significant amount of literature on the subject was provided by Dr. George Zimmermann. The FAC concluded pitch pine/loblolly pine hybrids are unlikely to thrive in the Pinelands because of their reduced tolerance to fire and increased susceptibility to fungal disease. The risk of genetic drift – the chance of loblolly pine genes getting into the population of native pines – was less conclusive. It was also noted that non-hybrid native trees, if properly managed, can attain growth rates equivalent to hybrid species. The FAC concluded that hybrids should not be permitted in the Pinelands. The FAC should periodically review the pine hybrid issue and

Seed Description/General Guidelines

- Hybrid and non-native species shall not be permitted.
- NJDEP State Tree Nursery in Jackson should be encouraged to collect and distribute a genetically diverse stock of native seeds for use in reforestation. The provenance of these seeds should be well documented so that reforestation efforts can use the most locally adapted varieties. When the State Tree Nursery has done this, these seeds shall be the only ones permitted to be used for reforestation.

Seed Restrictions for Particular Native Forest Types

- Pine Plains Native Forest Type – Shall only be used to restore drastically disturbed (e.g. bulldozed or mined) pine plains sites and only if using seeds from the immediate vicinity collected from local, genetically similar sources.
- Permitted in all other Native Forest Types.

Cuttings Description/General Guidelines

- Hybrid and non-native cuttings shall not be permitted unless it can be demonstrated that the cutting is from a locally native, naturally occurring hybrid.
- Cuttings shall be collected to ensure genetic diversity.

Cuttings Restrictions for Particular Native Forest Types

- Cuttings can be used in all Native Forest Types per guidelines above.

Seedlings Description/General Guidelines

- Hybrid and non-native seedlings should not be permitted.
- NJDEP State Tree Nursery in Jackson should be encouraged to collect and distribute a genetically diverse stock of native seedlings for use in reforestation. The provenance of these seeds should be well documented so that reforestation efforts can use the most locally adapted varieties.
- Encouraged for restoration of sand mines, agricultural fields or other drastically disturbed sites lacking rare species.

Seedlings Restrictions for Particular Native Forest Types

- Pine Plains Native Forest Type – Shall only be used to restore drastically disturbed (e.g. bulldozed or mined) pine plains sites and only if using seeds from the immediate vicinity collected from local, genetically similar sources.
- Permitted in all other Native Forest Types as per guidelines above.

Post Treatment

Slash

Description/General Guidelines

- Can be retained in piles.
- Can be distributed throughout the site.
- Can be removed or burned.

Slash Restrictions for Particular Native Forest Types

- Guidelines shall be applied in all Native Forest Types.

encourage additional research. Research should focus on the fate of existing hybrid trees and the potential of genetic drift/contamination into surrounding native pines.

Deer Deterrents

Description/General Guidelines

- Woven fences, electric fences, hunting and tree protectors are all acceptable methods.

Deer Deterrent Restrictions for Particular Native Forest Types

- Can be used in all Native Forest Types.

Intermediate Treatments Guidelines

Intermediate treatments are any forestry practice not done during regeneration (pre or post harvest) and not related to salvage or protection. These treatments can influence, among other things, stand composition, density, growth and spatial heterogeneity.

- Intermediate treatments shall maintain an understory of native plants.

Thinning

Description/General Guidelines

- A tree removal practice that reduces tree density and competition between trees in a stand.
- Pre-commercial thinning can be used to maintain an open canopy
- Thinning is strongly encouraged in pine-shrub oak types and pitch pine lowlands if dense planting or natural regeneration occurs which closes the pine canopy, in order to avoid shading the understory, loss of rare species habitat, and increased wildfire hazard
- Heavy thinning (10-50% residual) is strongly encouraged in long unburned pine-shrub oak and pitch pine lowland communities to reduce wildfire hazard, restore an open canopy structure and rare species habitat, and increase the growth rate of residual trees.
- Low-density thinning (50-70% residual) can be used to hasten diameter growth and stimulate understory development to benefit wildlife habitat
- The extent of thinning on commercial sites (i.e. high, low, selection, geometric or free) depends on the management objectives for the site.

Thinning Restrictions for Particular Native Forest Types

- Can be used in all Native Forest types.

Cleaning

Description/General Guidelines

- Used to influence species composition and used to encourage a more vigorous growth of remaining stand.

Cleaning Restrictions for Particular Native Forest Types

- Can be used in all Native Forest Types.

General Salvage/Protection Guidelines

Description/General Guidelines

- Salvage is removal of dead trees or trees that have been damaged or are dying because of injurious agents other than competition such as fire, storm, and insect infestation like Southern Pine Beetle.
- Response to critical insect infestation or storm damage should be comprehensive in nature and undertaken as soon as practicable.
- Tree salvage practices should be limited to dead or damaged trees only.

Cleaning Restrictions for Particular Native Forest Types

- Salvage and Protection can be used in all Native Forest Types.

Appendix I – Endangered Animals

The Forestry Advisory Committee was asked to review two memos titled Forestry and Threatened or Endangered Animal Species from Dr. Robert A. Zampella dated October 17, 1996, and a memo from Kim J. Ladig from June 16, 1998. The Forestry Advisory Committee felt that species accounts and silvicultural practices outlined therein are still applicable except for a few minor exceptions.

The memos recommended conducting all drum chopping during the dormant season. In general, the FAC believes that drum chopping can occur during *both* the growing season and the dormant season. If conducted during the growing season, the FAC recommends a biologist or trained forester lead the drum chopper looking for snakes and other reptiles. If he/she encounters an animal it could be physically moved to another part of the site out of the way of the drum chopper. During the dormant season, drum chopping shall be permitted but only if the chopper is not filled with water. This will reduce the chances of the chopper crushing a den.

The memos are largely reproduced verbatim below.

To ensure the long-term viability of native Pineland animal populations, it will be important to develop silvicultural management regimes that promote *all* of our native wildlife. The FAC encourages the development of silvicultural prescriptions for the entire suite of species dependent on early successional Pinelands habitats, endangered or not. For instance, early successional species like ruffed grouse are all but gone from the Pinelands.

Red-headed Woodpecker (Melanerpes erythrocephalus)

State threatened. Prepared by Lawrence Torok

Species Description

The red-headed woodpecker is a fairly small (8.5-9.5 in) bird with an entirely red head and throat coupled with white underparts, rump, and in-flight wing patches (Peterson 1980, Short 1982). Eggs are laid in late May or June with young fledging by mid-August (DeGraffet al. 1980).

Habitat Characteristics

The species may breed in a variety of habitats including river bottom forests, wood swamps, beaver ponds, open deciduous groves, orchards, and agricultural areas (Wilson 1970, Reller 1972). Habitats used by the species are characterized by scattered mature trees with an open or herbaceous understory or forest edge associated with nearby open areas (Conner 1976, Hardin and Evans 1977). Tree species used for nesting in New Jersey include red maple (Acer rubrum), oaks (Quercus spp.) and pitch pine (Pinus rigida) (Cromartie 1982). A study area in a Texas bottomland forest contained 27 snags/ac and 237 hardwoods/ac (Conner et al. 1994). Canopy trees in this area averaged 9.4 in diameter and 109 ft in height.

Graber et al. (1977) reported red-headed woodpeckers to nest in a bottomland forest characterized by oaks, hickories (Carya spp.), elms (Ulmus spp.), and hackberry (Celtis spp.). Wander and Brady (1980) reported the species to nest in a forest stand characterized by scattered pitch pines with an understory of oak sprouts, and a sparse ground cover of low bush blueberry (Vaccinium vacillans) and huckleberry (Gaylussacia spp.) in the Pinelands. They also identified a "probable" nest site in a roadside utility pole. A wetland nesting site in Sussex County is characterized as a seasonally flooded sedge meadow featuring numerous standing dead trees interspersed and bordered by hardwood forest (pers. observation). Nest cavities are usually in dead trees or, less frequently, dead limbs in living trees (Reller 1972). Red-headed woodpeckers prefer vertically facing cavities and limbs without bark. Nest cavities are usually excavated from existing indentations or cracks (Reller 1972, Jackson 1976). Nests are typically located 23-40 ft above the forest floor, though they have been documented as high as 80 ft. (Bull 1975).

The study on woodpecker foraging characteristics in a Texas bottomland forest indicated that red-headed woodpeckers favored dead trees over live trees foraged largely on tree trunks and did not vary foraging heights when changing between live trees and dead trees (Conner et al. 1994). This study also showed a significant preference for oak species over all other tree species in the forest for foraging. The presence of mast-producing trees (e.g. acorns) has also been suggested as an important component to wintering habitat for the red-headed woodpecker (Kilham 1958).

Little is known about the home range requirements for the red-headed woodpecker. Documented densities of nesting pairs may provide the best indicator of the species spatial requirements. Graber et al. (1977) recorded 9-12 birds per 100 ac in their Illinois bottomland forest site. Twenty-eight birds were documented in a 100 ac shrub area also in Illinois (Graber and Graber 1963). Woodlots used for nesting in Virginia varied in size from 1.2-50 ac (Connor 1976).

Forestry Impacts

Cutting and intermediate practices that create an open or sparse understory with scattered overstory trees and which preserve snags of suitable size for nesting can benefit red-headed woodpeckers. Clearcutting can have a negative impact on the habitat of this species depending on the amount of available suitable habitat and the proportion of that area being cut over. The cutting of nest trees or potential nest trees can adversely affect occupied habitats. Planting pines and oaks may have a long-term beneficial effect by re-establishing Pinelands habitats associated with red-headed woodpeckers, especially if intermediate practices create stand characteristics favorable to the species. Acorns have been documented to serve as a winter food source for the red-headed woodpecker. Practices which preserve or create suitable snag or dead limb nesting habitat are encouraged.

Planting

Planting practices which create oak-pine or oak dominated communities can lead to the creation or habitat for the red-headed woodpecker.

Site Preparation

No major concerns.

Intermediate practices

Intermediate practices, such as thinning, cleaning, or prescribed burning can create and maintain habitat suitable for this species provided that they are conducted to create a sparse tree stand and to maintain a low or open understory. Creating large dead standing trees through selective girdling would enhance red-headed woodpecker habitat.

Harvesting

In general, any cutting regimen which results in the removal of large snags or trees with dead limbs has the potential to adversely impact this species. Specifically, salvage or sanitation cuts have the potential to greatly reduce the suitability of occupied habitats. Small clearcuts are less likely to result in negative impacts than larger cuts. Cutting practices in occupied habitats, such as shelterwood or seed tree cuts, minimize short-term impacts if nest trees and snags are retained, but largely mimic clearcuts over time. When using seed tree cuts, clearcuts, and/or the final stage of a shelterwood cut, adjacent suitable habitat should be available or developed when possible. Single tree or group selection cuts are unlikely to result in negative impacts provided that nest trees and some snags are left. In unoccupied habitat, shelterwood, single tree selection or group cuts can result in the sparse or "parklike" canopy tree community favored by this species for at least some period in the cutting cycle.

Barred owl (Strix varia)

State threatened. Prepared by Kim J. Laidig

Species Description

The barred owl is a medium-sized owl with a relatively large round head, no ear tufts, and dark brown eyes. Plumage is laterally barred with buffy white and brown on the head, neck and upper breast and streaked vertically on the lower breast and flanks. The general color of wings and tail is brown with transverse spots or bands of white to pale brown (Johnsgard 1988). Barred owls are most easily identified by their distinctive vocalization, usually transcribed "who cooks for you, who cooks for you all." Egg dates for this species in New Jersey extend from late February to mid April (Johnsgard 1988).

Habitat Characteristics

Barred owls are closely associated with mature forest varying from upland woods to lowland swamps throughout their wide North American range (Johnsgard 1988). In New Jersey, barred owls occur in substantial numbers only in the extreme northwest (Bosakowski et al. 1987, 1989) and south (Sutton and Sutton 1985, Sutton 1988) which are the only regions that still provide extensive tracts of relatively undisturbed broad-leaved or mixed forest. In southern New Jersey, important habitat consists of mature hardwood swamps, Atlantic white cedar (Chamaecyparis thyoides) swamps, and mixed cedar swamp-pitch pine (Pinus rigida) lowlands (Sutton and Sutton 1985, Ladig and Dobkin 1995). Trees suitable for nesting are large (diameter usually greater than approximately 20 in) and may be alive or dead (Johnsgard 1988). Barred owls generally nest in cavities or hollow tree stubs 30 ft or more above the ground (Devereux and Mosher 1984), but occasionally utilize abandoned hawk nests (Bent 1938). Barred owls exhibit a high degree of nest-site tenacity; nests are typically used year after year (Johnsgard 1988).

The relationship of barred owl occurrence and forest openings is inconclusive. Devereux and Mosher (1984) found that nest sites (eight total) in Maryland were located closer to forest openings (defined as trails, roads, fields) than randomly selected non-nesting sites, which would indicate a positive relationship between owl occurrence and openings. Alternatively, barred owls in northern New Jersey avoided areas with extensive clearings (defined as percent cleared area within 328 ft radius of owl sighting) relative to eastern screech (Otus asio) and great horned owls (Bubo virginian us) (Bosakowski et al. 1987). Based on their data, Bosakowski et al. (1987) argue that the creation of cleared areas (through forest cutting) will favor the invasion of the larger, more aggressive great homed owl.

Barred owls cover large areas of habitat relative to most other species of concern. Based on comprehensive radio-telemetry tracking research at a Minnesota location, home range sizes ranged from 213 to 912 ac for nine individuals (Nicholls and Warner 1972) and 309 to 1903 ac for four individuals (Fuller 1979). For the 13 barred owls combined, the average home range was 677 ac (Nicholls and Fuller 1987). In Virginia, Hegdal and Colvin (1988) determined the average home range of four radio-tracked individuals to be 1403 ac (range 640 to 2421 ac). In Michigan, Elody and Sloan (1985) found home ranges averaged 697 ac (no range) based on seven radio-tracked birds.

While mature upland or wetland forests are considered important habitat throughout their North American range, radio-telemetry studies indicate barred owls use other habitat types as well, albeit to a lesser degree. In Minnesota, Nicholls and Warner (1972) recorded barred owl usage of the following habitats, listed in descending order of importance: oak (Quercus spp.) woods, mixed hardwoods and conifers, northern white cedar (Thuja occidentalis) swamps, oak savannas, alder (Alnus spp.) swamps, marshes, and open fields. They suggested that lower barred owl use of northern white cedar and alder swamps was due to high stem densities in these habitats, among other reasons. Similarly, McGarigal and Fraser (1984) suggest that low stem densities resulting in an unimpeded subcanopy flying space is an important reason for barred owl preference for mature forests in Virginia.

Forestry Impacts

Since the presence of substantial numbers of barred owls in New Jersey is associated with large tracts of mature forest, management practices should promote the preservation and protection of existing forest stands important to barred owls. In southern New Jersey, mature hardwood, Atlantic white cedar and

pitch pine swamps are considered important barred owl habitat. Harvest type and size are the most significant forestry practices relative to barred owls.

Planting

No major concerns.

Site Preparation

No major concerns.

Intermediate Practices

Intermediate cuttings (thinning) in young stands may eventually benefit barred owls by promoting the growth of larger trees and increasing subcanopy flying space. Creating large dead standing trees through selective girdling would enhance barred owl habitat.

Harvesting

Clearcutting can have a negative impact on this species depending on the size of the harvested area. The size of clearcuts should be small. Single-tree selection cutting is preferable to clearcutting assuming a number of mature trees are left intact Group selection cutting is also preferable to clearcutting if target groups comprise small areas. Nest trees and mature trees (dead or live) with sizable cavities should not be cut. Because of this species' high nest-site tenacity and to avoid disturbance to breeding birds, forestry activities in the vicinity of a nest site should be avoided.

Pine Barrens treefrog (Hyla andersonii)

State endangered. Prepared by John F. Bunnell

Species Description

The body of the Pine Barrens treefrog is a rich, emerald green bordered by white with a lavender or plum color that extends from the white border down onto the belly. The concealed surface of the hind legs is yellow to orange. The average snout-vent length of this species is 1.1-1.7 in (Conant and Collins 1991). Pine Barrens treefrog vocalizations can be described as a series of nasal "honks".

Habitat Characteristics

In New Jersey, Pine Barrens treefrogs have been reported to occur in a variety of habitat types including wet areas in pitch pine (Pinus rigida) lowlands, small pools in sphagnaceous bogs (Noble and Noble 1923), intermittent streams (Zappalorti and Johnson 1982), slow moving streams surrounded by heavy shrub growth (Gosner and Black 1957), backwater areas along streams, seeps, borrow pits, small isolated ponds, vehicle ruts, cranberry bogs, Atlantic white cedar (Chamizecyparis thyoides) swamps (Freda and Morin 1984), and roadside ditches (Hulmes et al. 1981). Of these habitats, treefrogs prefer early successional bogs, seeps, and ponds dominated by shrub and herbaceous vegetation (Freda and Morin 1984). Hydrology, water quality, and the structure of the vegetation community have been identified as the most important variables determining breeding habitat. Treefrogs typically call from vegetation that is less than 8.2 ft in height (Davis 1907, Noble and Noble 1923). The water is usually shallow, dilute, and acidic (ranging in pH from 3.88 to 5.53) (Hulmes et al. 1981, Freda and Morin 1984, Freda and Dunson 1986).

In New Jersey, Pine Barrens treefrogs breed and deposit eggs during May and June and the larva metamorphose into adults in July and August (Zappalorti and Johnson 1982). One study found that the majority of treefrogs remain within 230 ft of the breeding site throughout the breeding season, but one individual was found calling from a distance greater than 328 ft (Freda and Gonzalez 1986). As the breeding season wanes, treefrogs move and call from stations further away from the breeding site (Freda and Morin 1984, Freda and Gonzalez 1986). The suitability of individual breeding sites from one year to

the next is often a factor of annual rainfall, rate of vegetational succession, and wildfire occurrence (Freda and Morin 1984). Little is known about treefrog habits during the non-breeding season.

Forestry Impacts

For the purpose of discussing forestry impacts, the treefrog breeding water body can be defined as a pond or ponded area with distinct boundaries. Forestry activities that physically or chemically alter the breeding water body and adjacent vegetation used by Pine Barrens treefrogs can have a detrimental effect on the species. An inner no activity buffer (e.g., 100 ft) surrounding the water body can prevent direct physical disturbance of breeding habitat. Some forestry activities can occur within an outer buffer (e. g., extending 100 to 300 ft from the water body). Continuity between the adjacent forest and the breeding habitat should be maintained by leaving a portion of the outer buffer uncut. Because no activity should occur in the inner buffer, the forestry activities and potential impacts listed below pertain only to the outer buffer.

Planting

No major concerns.

Site Preparation

Major soil disturbances, such as drum chopping, should be avoided.

Intermediate Practices

The creation of slash piles causes no major concern and may even benefit the treefrog by providing protection against desiccation and predators. Application of chemicals such as soil amendments or pesticides should be avoided entirely.

Harvesting

The impact to treefrogs from harvesting within the outer buffer and beyond the outer buffer is probably minimal. Because treefrogs spend time in the adjacent forest during the non-breeding period, continuity should be maintained between the surrounding forest and the breeding water body by leaving a portion of the outer buffer uncut.

Northern pine snake (Pituophis melanoleucus melanoleucus)

State threatened. Prepared by David Jenkins

Species Description

The pine snake is a relatively large (48-68 in) black and white snake. Blotches are dark toward the front of the body but may fade to brown near and on the tail. The background color is dull white to yellowish or light gray. Scales are keeled. The pine snake is known for its noisy hiss. It is a ground dwelling snake, rarely climbing vegetation. Since this species is secretive and fossorial, it can easily go undetected even where it is common.

Habitat Characteristics

In New Jersey, the pine snake occurs exclusively within Pinelands habitats of the outer coastal plain. This population of pine snake is disjunct and distant from populations in other parts of this species' range which includes the western Appalachians of Virginia, North Carolina, southern Kentucky, Tennessee, northern Alabama, northern Georgia, as well as the Piedmont of southern North Carolina, and nearly all of South Carolina (Conant and Collins 1991). Throughout its range the pine snake nearly always occupies dry upland forests usually comprised of pines (Conant and Collins 1991).

While the general distribution and habitat associations of pine snakes in New Jersey have been known for some time, only recently have researchers begun to investigate their more specific habitat requirements in this state (Zappalorti et at. 1983, Zappalorti and Burger 1986, Burger and Zappalorti 1986, 1988, 1989, Burger et al. 1988). In general, these studies have confirmed that habitats required by pine snakes in New

Jersey are provided primarily within dry pine-oak forest types growing on very infertile sandy soils such as Lakehurst or Lakewood sands (Burger and Zappalorti 1988, 1989).

Within these generalized habitats, pine snakes select open sandy clearings with little ground cover for nesting. Summer den sites are also typically located in clearings near fallen logs. Winter hibernacula are located in nearby areas providing more vegetation cover and leaf litter (Burger and Zappalorti 1986, Burger et al. 1988). Clearings used for nesting and denning have ranged in size from 0.30 ac to 4,900 ac, although only the edges of large clearings appear to be used (R. Zappalorti, pers. comm., July 1996). Sandy, infertile soil not only provides for persistent openings in disturbed sites, but may also be important because pine snakes are the only snakes known to dig hibernacula and summer dens. Both human-caused and natural disturbances (e.g., agriculture, forestry, and fire) are probably involved in creating the types of openings important for nesting and basking.

Telemetry studies conducted by Herpetological Associates (Zappalorti et al. 1992. R. Zappalorti. pers. comm., July 1996) have attempted to quantify daily and seasonal movement patterns of pine snakes. Snakes equipped with radio transmitters for periods of up to three years have moved over areas ranging in size from 54.9 ac to 450 ac. In general, larger activity ranges are associated with longer tracking periods. Pine snakes tend to be most active after emergence from hibernation (mid-April to mid-June), a period which includes nesting activity, and again as they move to winter hibernacula in the fall (mid-September to early November).

Clearings used for hibernacula and denning sites are frequently located near nesting areas and may have a higher concentration of snakes than the surrounding forest at virtually any time of year. Operation of heavy machinery in the vicinity of known or potential denning areas should be avoided. Over the long-term, cutting practices that tend to favor pine over oak and that produce an open canopy and partial shrub layer can maintain or create favorable pine snake habitat. Cutting that produces or favors an oak cover type probably diminishes habitat suitability for pine snakes. Practices that over time result in a closed canopy or that produce a dense shrub layer probably diminish habitat value for pine snakes.

Ways to enhance habitat for snakes include leaving a few large standing dead trees on site; Not chipping the unwanted tree limbs and branches, instead make large brush piles along the North edge of the field; Leaving several large stumps in the ground for snakes; and make small open fields that measure 300 feet long by 100 feet wide within every 25 acre clear-cut. These actions will go a long way to provide suitable habitat patches for snakes and other wildlife.

Forestry Impacts

Forestry practices that increase the extent of pine-oak forests or maintain that cover type can generally benefit pine snakes. To provide suitable nesting and denning areas, management practices must also provide or maintain scattered, bare sandy openings containing only scattered trees and shrubs. Such openings may also be important for foraging.

Planting

Planting of large recently logged areas or other large clearings is probably beneficial when a pine-oak cover will result. Planting that will favor oak or that will increase oak cover is probably not beneficial. Planting in sandy openings that may be used for nesting or denning may reduce habitat suitability. A dense cover or closed canopy is not typical of described habitat but the importance of canopy closure to habitat quality is not known.

Site Preparation

Site preparation activities that create bare sandy openings may increase available nesting or denning sites for the short period before they are replanted or become naturally revegetated. Use of any heavy equipment in areas of confirmed pine snake habitat could result in direct mortality to individual snakes. Mowing, disking/harrowing, drum chopping, root-raking, and bulldozing are best performed during the

late spring, summer, and early fall months when the snakes are active. When snakes are active, they can move away from disturbance and vibration, and may avoid the work areas. A drum chopper should not be filled with water anytime during the year where critical pine snake habitat exists in order to minimize accidental killing of snakes and other wildlife. Reducing the weight of the metal roller by not filling it with water will substantially reduce the possibility of crushing snakes in their dens. Likewise, only one pass over the site should be made during site preparation.

Site preparation activities that may disturb hibernacula or denning sites can cause direct mortality and lower habitat quality. Stump holes and rotted root holes comprise the natural denning/hibernation sites that have been identified to date. Human-created sites used for denning include brush and dirt piles, railroad ties, building foundations, and constructed hibernacula.

Intermediate Practices

Slash piles provide good cover for prey. When covered with dirt they can provide sites for hibernation and denning. Practices such as weeding and cleaning, thinning, and herbicide use are probably of nominal importance with respect to pine snakes. Reptilians have shown wide ranging sensitivity to organochlorine pesticides (Hall 1980). Field applications of some organochlorine pesticides have produced mortality and poisoning in some snakes. Sub-lethal effects are less well documented, but some studies suggest that oviparous snakes may suffer reproductive effects similar to those seen in birds. Effects of more widely used organophosphate and synthetic pyrethroids are not well studied.

Prescribed burning can cause direct mortality to snakes. However, since current burning policies restrict prescribed burning to the winter months when snakes are hibernating, the risk to snakes is low. The long-term habitat impacts of prescribed burning are unclear. Prescribed burning can probably produce both beneficial and harmful habitat changes. Sandy openings suitable for nesting and denning can be produced by extremely hot bums that remove nearly all organic material in the soil. Removal of all or nearly all of the ground cover or shrub layer from large areas, on the other hand, will probably reduce habitat suitability.

Harvesting

Heavy equipment used in harvesting operations may present an immediate threat to individual pine snakes or several individuals concentrated in hibernacula or dens. The risk to hibernating snakes is greatest during the period extending from November to April. Conversely, the risk to individual active snakes is greatest during the periods of highest activity (i.e., mid-April through June and September through October).

Timber rattlesnake (Crotalus horridus)

State endangered. Prepared by Kim J. Ladig

Species Description

The timber rattlesnake (Crotalus horridus) is a heavy-bodied snake with a short, black tail, rattle, keeled scales, facial pits, and small dorsal head scales (Brown 1.993). Body coloration is highly variable. Of the four major color morphs recognized, only the yellow and black variations occur in northern populations (Conant and Collins 1991). The yellow variation consists of dark, sometimes V-shaped, crossbands on a yellow or brown background color. In the black variation the crossbanding pattern is less evident due to the black or dark brown background color. This species ranges in size from 36 to 60 inches in total length (Conant and Collins 1991),though individuals are seldom as long as 52 inches in most areas (Brown 1993).

Habitat Characteristics

Timber rattlesnakes are forest floor ambush predators (Reinert et al. 1984) that occupy forested habitats in mountainous to coastal plain regions from south-central New Hampshire to northern Florida, and west to

southeast Minnesota and central Texas (Conant and Collins 1991). In New Jersey, disjunct populations occur in the northwest (Stechert 1992) and south in the Pinelands (Zappalorti and Reinert 1992). Timber rattlesnake populations are believed to be declining over most of its range largely from human exploitation through bounty hunting, commercial collecting, and sport hunting (Martin 1992, Brown 1993).

Because timber rattlesnakes occupy different habitats due to migrations to and from overwintering sites, both winter den (hibernaculua) and summer range habitat are described. In the Pinelands, documented rattlesnake hibernacula consist of stump holes and burrows in or along the edge of Atlantic white cedar (Chamaecyparis thyoides) swamps near streams (Burger 1934, Reinert and Zappalorti 1988a and 1988b). Hibernating snakes typically coil around tree roots at or near the water table (Reinert and Zappalorti 1988b, Zappa1ortiand Reinert 1992). Unlike colder zones where a single den site is critical to the survival of an entire snake population, large communal aggregations are not apparent in the Pinelands (Brown 1993, Reinert and Zappalorti 1988a). Pinelands rattlesnakes generally return to the same area and, occasionally, the same burrow to hibernate (Burger 1934, Reinert and Zappalorti 1988b). Timber rattlesnakes typically overwinter in hibernacula from mid-to late October through late April to mid-May (Zappalorti and Reinert 1992).

Radiotelemetry research conducted in the Pinelands by Reinert and Zappalorti (1988b) indicated that the area and type of summer range habitat occupied by timber rattlesnakes varies according to individual sex and reproductive status. Gravid (pregnant) females dispersed the shortest distances from winter dens and centered their activity in limited areas before returning to hibernacula. They occupied sites characterized by approximately 25% canopy closure, relatively warmer microclimate conditions, and logs and woody debris in the understory. Gravid females spent much of their time basking in open areas, such as along the edge of sand roads. Non-gravid females were intermediate in distances traveled from hibernacula and activity range sizes. Males traveled the greatest distances from den sites and occupied the largest activity ranges. Both non-gravid females and males occupied sites with canopy closure greater than 50% and dense surface vegetation cover (>75%). These patterns are similar for the timber rattlesnake in other parts of its geographic range (Keenlyne 1972, Brown et al. 1982, Reinert 1984). Total activity ranges for snakes monitored over complete active seasons averaged 55 ac (n = 2) for gravid females, 103 ac (n = 3) for non- gravid females, and 513ac (n = 2) for males. Similarly, gravid females, non-gravid females, and males dispersed an average of 2,461 ft, 3,740 ft, and 1,796 ft respectively, from the den site. Habitat maps (Reinert and Zappalorti 1988b) and descriptions of snake movements (Reinert and Zappalorti 1988a) indicate that individual snakes may utilize all major Pinelands forest types inc1uding pitch pine lowland, hardwood swamp, cedar swamp, and pine-oak and oak-pine upland.

Forestry Impacts

Forestry practices which minimize the amount of large-scale tree canopy and shrub understory removal at known timber rattlesnake localities are most beneficial to this forest dwelling species. To avoid disturbance to dens, forestry activities should not occur within a minimum physical buffer zone (e.g., 100 ft) surrounding known hibernacula. In areas of documented rattlesnake occurrence (i.e., areas with known den locations or areas where rattlesnakes have been frequently encountered), forestry activities in cedar swamps, conducted during .the period when snakes have dispersed away from dens (June through September), will reduce the potential for impacts to snakes in or near hibernacula.

Planting

Since timber rattlesnakes may utilize the full range of native Pinelands forested habitats at some point in their seasonal cycle, the tree species used for replanting does not represent a major issue. Planting which leads to a dense (75% closure) canopy cover endpoint is favorable to male snakes whereas a somewhat open (25% closure) canopy is preferred by gravid females. If a somewhat open canopy cover endpoint is chosen, location of the harvest site relative to hibernacula and summer range habitat may be important (see Zappalorti and Reinert 1992 and comments under Harvesting). Understory cover endpoints leading to dense cover correspond to habitat used by males and non-gravid females.

Site Preparation

Mowing, disking, harrowing, drumchopping, root-raking, and bulldozing may cause direct mortality to individual snakes. Site preparation conducted in areas outside of cedar swamps during the overwintering period (November through April) will minimize this risk. In areas of documented rattlesnake occurrence, site preparation in cedar swamps should be conducted during the period when snakes have migrated away from dens (June through September). Site preparation should be avoided entirely within a buffer zone (e.g. 100 ft) surrounding known hibernacula to reduce the possibility of collapse or disturbance of dens.

Intermediate Practices

Slash piles may be beneficial by providing cover for prey species.

Experimental evaluations of the effects of environmental chemicals on reptiles are lacking (Hall and Henry 1992). Numerous field reports, summarized in Hall (1980), indicate reptiles have been killed by organochlorine pesticides through direct exposure as non-target organisms and by secondary poisoning resulting from the consumption of contaminated prey. The susceptibility of reptiles to most pesticides, including the cholinesterase inhibitor class of pesticides currently in greatest use, is virtually unknown (Hall and Henry 1992). Due to the lack of information on pesticide and herbicide impacts, no recommendation is given.

Prescribed burning, other than temporarily reducing the coverage of understory vegetation, probably has little direct effect on timber rattlesnakes. In research conducted on the eastern diamondback rattlesnake (Crotalus adamanteus) a congener of the timber rattlesnake, mortality due to prescribed bums in Florida outer coastal plain habitat was low and limited to those individuals in mid-ecdysis (molting), a period in which a snake's visual and infrared perception is severely limited (Means and Campbell 1981). Limiting prescribed burning to the overwintering period (November through April) will minimize potential risk to snakes.

Harvesting

Large tree harvests may cause short-term alteration to male summer range habitat by opening up the dense canopy cover that it prefers (Brown 1993). In the summer range of a rattlesnake population, single tree and small group selection regeneration cuts, and small scattered clearcuts are preferable to large-scale clearcutting to retain suitable, high canopy cover habitat small salvage and sanitation cuts should not pose a major threat to habitat suitability in summer range habitat. All types of tree harvest within a buffer zone (e.g., 100 ft) surrounding known den sites should be avoided to prevent den disturbance by machinery and changes in forest structure. In areas of documented rattlesnake occurrence, cedar harvests conducted during the period when snakes have dispersed away from dens (June through September) will reduce the potential for impacts to snakes in or near hibernacula. In stands where there are no documented hibernacula, cedar harvests that are minor in scope (e.g., sapling or small pole size extraction using light equipment limited to existing access roads) should not pose a major threat to snakes, regardless of the season.

Zappalorti and Reinert (1992) recommended clearcutting forested areas to form small fields between den sites and sand roads to benefit gravid females. This recommendation was intended to provide basking site alternatives to sand roads of high snake mortality. This may be considered a technique with limited applicability at certain sites especially those with no canopy openings other than sand roads but not as an overall management strategy.

Appendix II – Native Forest Types

Introduction to Pinelands Native Forest Types

The Forestry Advisory Committee agreed on a common definition of ten broad-scale Native Forest Types of the Pinelands. The FAC choose to use the best available scientific definition of Native Forest Types provided by the NJ DEP Division of Parks and Forestry Forest Service and Office of Natural Lands Management and based partially on Breden et Al, Classification of Vegetation Communities of New Jersey. These ten broad-scale Native Forest Types generally occur on thousands of acres across the broad Pinelands landscape.

The FAC learned that these broad-scale Native Pinelands Forest Types have been recognized since qualitative and qualitative ecological observations started to be collected in the Pinelands. In fact, the FAC views Breden et al.'s work as a modern refinement of the broad vegetation patterns observed and described by Pinelands botanists and Forest Ecologists such as Harshberger in 1916, McCormick in 1970, and pioneering forester Silas Little, who published from the 1940s to the 1980s.

As described in presentations to the FAC by Pinelands ecologists and foresters, the broad patterns of Native Forest Types on the landscape correlate to frequency of wildfire and past land use. The Committee found that disturbances caused by silviculture superficially mimic disturbances caused by wildfire and past land use practices. More study is needed to understand the differences between silviculture and fire in the Pinelands. All silvicultural recommendations made in this document are in the context of the Native Forest Types.

Uplands Native Forest Types

Oak-dominated Native Forest Type

Technical Definition

Represented by several tree-oak dominated forest alliances and associations in Breden et al. 2001, known as oak-pine forest, oak-pine-holly forest, oak-hardwood-holly forest, and oak-heath forest.

- Tree-oak cover is 50-100 percent. Oak species can include various combinations of white oak, scarlet oak, black oak, chestnut oak, and post oak throughout the Pinelands, plus southern red oak, willow oak and swamp chestnut oak in peripheral and southern parts of the Pinelands, especially mesic sites.
- Pine cover (pitch pine, shortleaf pine and rarely Virginia pine) is typically under 50 percent, and often under 5 percent.
- Hickory, mesophytic hardwoods (red maple, sweet gum, beech, tulip poplar, flowering dogwood) and holly can be present in small amounts in peripheral or southern parts of the Pinelands, especially mesic sites.
- Total canopy cover is typically 75-100 percent, but less canopy cover can occur.
- Shrub oak cover (blackjack oak, scrub oak) is absent or under 5 percent.
- Shrub cover is dominated by black huckleberry and lowbush blueberry, as well as dangleberry, mountain laurel, sweet pepperbush or inkberry in more mesic sites.

General Description

The Oak-Dominated Native Forest Type is one of the most common Native Forest Types in the Pinelands. They are found throughout the Pinelands in sites where fires were naturally infrequent, such as broad uplands with loamy soil, mesic coastal sites, the Pinelands periphery, or in the lee of wetland firebreaks. They form critical habitat for many rare and declining bird species and provide natural strategic fuel breaks, such as downwind of extreme fuel hazard areas or upwind of major developments. Oak mast (acorns) is also a very important food source for wildlife and game species.

Intense prescribed burning should not be permitted in oak-pine-holly and oak-hardwood-holly forests, except in wildland-urban interface or other special circumstances.

Pine-Dominated Native Forest Type

Technical Definition

Mostly equivalent to the *Pinus (rigida, echinata)-Quercus coccinea* Forest Alliance in Breden et al. 2001, which includes pine-oak forest and pine-oak upland types. Pine uplands were generally not documented in Breden et al. 2001, although one type of pine upland, pitch pine-sedge upland (*Pinus rigida* / *Carex pensylvanica* Woodland) was described under the *Pinus rigida* Woodland Alliance.

- Pine cover (pitch pine, shortleaf pine, rarely Virginia pine) is typically over 50 percent in most types. Pine cover can be as low as 25 percent in some open canopy forms of pine upland.
- Tree-oak cover ranges from 25-50 percent in pine-oak forest, 5-25 percent in pine-oak upland and under 5 percent in pine upland, depending on stand history. Oak species can include black oak, post oak, scarlet oak, chestnut oak, white oak and southern red oak.
- Total canopy cover is typically 75-100 percent, but less canopy cover can occur.
- Shrub oak cover is absent or under 5 percent.
- Low shrub cover is dominated by black huckleberry and lowbush blueberry in most types.
- One pine upland type, pine-sedge upland, is often associated with old clearings and has a more open pine canopy, minimal shrub cover and a ground cover dominated by Pennsylvania sedge or grasses and serve as pine snake nesting areas.

General Description

Pine-dominated forests are found in central Pineland sites where fire ranged from infrequent to moderately frequent, or where a cutting or clearing history favored regeneration of pine over tree-oak. Most pine uplands occur in geometric patches associated with old fields or scrapes, but some occur on xeric paleodunes in small-scale patches.

Pine-Shrub Oak Native Forest Type

Technical Definition

Mostly equivalent to the *Pinus rigida* Woodland Alliance in Breeden et al. 2001, which includes pitch pine-shrub oak barrens {*Pinus rigida / Quercus (marilandica, ilicifolia) / Pyxidanthera barbulata* woodland} and several related types with shrub oak strata.

- Pine cover (pitch pine, shortleaf pine) is over 25 percent and typically 50-75 percent.
- Tree-oak cover is absent or under 5 percent in most pine-shrub oak “barrens” types, and 5-25 percent in pine-oak-shrub oak “woodland” types. If present, tree-oak species often include black oak, post oak, arborescent blackjack oak, and scarlet oak, and rarely chestnut oak, white oak and southern red oak.
- Shrub oak cover (blackjack oak, scrub oak) is over 5 percent, and is typically 25-100 percent.
- Low shrub cover is dominated by black huckleberry and lowbush blueberry.
- Ground cover often includes early successional species such as bearberry, pyxie moss, pine barrens hudsonia, sandwort, Pennsylvania sedge, little bluestem, and lichens, especially where an open pine canopy is maintained.

General Description

The pine-shrub oak Native Forest Type is found in the large, frequently burned firesheds of the central Pinelands, or on low sandy terraces adjacent to pitch pine lowlands or other wetlands of the central Pinelands. It supports unique combinations of northern and southern plant species, many rare or endemic insect and vertebrate species, and represents the world’s largest, most stable occurrence of extant Pine Barrens habitat. This forest type is also vulnerable to loss from fire exclusion and some standard forestry methods, such as severe root disturbance during site preparation, or dense pine planting without prompt

follow-up thinning to reopen the canopy, either of which can eliminate the shrub oak stratum. Forestry practices applied within this forestry types should be explicitly designed to ensure its preservation and perpetuation.

Seed tree and/or shelterwood cuts in large areas of pine-shrub oak that leave 10%-50% residual pine, ideally mixing a range of percent canopy-cover densities, is required. Permitted site preparation methods after cutting in pine-shrub oak types are mixed intensity prescribed burning, brush mowing followed by prescribed burning or broadcast scarification via dragging cut trees. These site preparation methods do not disturb the mineral soil, or the roots and hibernating snakes within the mineral soil, providing a less severe site preparation approach compared to drum chopping, disking or root raking. The methods also more closely mimic natural fire processes in uplands, where roots and root collars in the mineral soil are insulated from fire and allow sprout regeneration in most species.

Forestry practices within pine-shrub oak types should preclude all site preparation techniques that would result in severe root disturbance and destruction of the shrub oak stratum (such as by repeated, drum chopping, or any severe disking and root raking). Somewhat severe site preparation methods which are acceptable in pine-shrub oak types include single or double pass drum-chopping in dormant season, or shallow vertical disking in dormant season, if applied in a manner which minimizes disturbance to roots in the mineral soil. Single (non-overlapping) straight passes in dormant season with an unfilled drum are recommended for a "low severity" drum chop treatment, to minimize blade penetration into the mineral soil and associated impacts to roots or underground rare snake. Be sensitive to spatial heterogeneity when applying site preparation or harvest.

Natural regeneration methods are encouraged, with follow-up burning or thinning to maintain an open pine canopy. If plantings are used, seed should be from local, genetically similar sources since local serotiny is a characteristic of trees found there.

Thinning is required if dense planting or natural regeneration occurs which closes the pine canopy in order to; avoid the shading the understory; avoid the loss of rare species habitat; increase the growth of remaining trees; and to avoid increased wildfire hazard.

If used, dense pine plantings that would establish a closed canopy should be minimized in extent and followed by thinning within 10 to 15 years, to avoid loss of shrub oak cover and the increased wildfire hazard from a closed pine canopy.

Pine Plains Native Forest Type

Technical Definition

Equivalent to the *Pinus rigida* Shrubland Alliance in Breden et al. 2001, which includes dwarf pitch pine-blackjack oak pine plains {*Pinus rigida / Quercus marilandica / Corema conradii* shrubland} and related types with dwarf pitch pine and shrub oaks. (See also hydric pine plains under Palustrine Shrubland.)

- Dwarf pitch pine cover dominates the shrubland canopy and is typically over 50 percent, but may drop below 50 percent for a few years after top killing fire. Heights are typically 1-4 m but can reach 5-6 m at ecotones. Serotiny is near 100 percent.
- Shrub oak cover (i.e. blackjack oak, scrub oak) is over 5 percent, and usually 25-50 percent.
- Arborescent pine cover over 6 m tall and tree-oak cover is absent or rare.
- Low shrub cover is dominated by black huckleberry and lowbush blueberry.
- Ground cover includes early successional species such as bearberry, pyxie moss, pine barrens hudsonia, Pennsylvania sedge, little bluestem, and lichens; also broom crowberry locally in sandy openings.

General Description

The pine plains Native Forest Type of the New Jersey Pinelands support unique combinations of northern and southern plant species, and many rare or endemic insect and vertebrate species. Pine plains are only found at the most frequently burned centers of the largest firesheds in the central Pinelands core. Its limited worldwide distribution makes it vulnerable to extinction. These communities are vulnerable to loss from fire exclusion and some standard forestry methods. Forestry practices applied within this Native Forest Type should be explicitly designed to ensure its preservation and perpetuation.

The Pine Plains Native Forest Type is characterized by a dense sprout-growth of dwarf serotinous pitch pine often less than 6 feet tall. To preserve these forest types it is necessary to maintain an open canopy shrubland form in most of the landscape and allow for frequent top-killing fire. One of the most unique aspects of the Pine Plains is the adaptation to frequent top-killing fires. This fire pressure has created highly serotinous dwarf pitch pine variety found only in a few places in the world.

Prescribed fire would be the best way to maintain the Pine Plains. Practices such as frequent, intense burning; or coppice cutting followed by burning where excessive fuel loads or an urban wildfire interface make initial fire control and smoke management difficult, are encouraged. In certain circumstances, other experimental silvicultural practices need to be tested to help perpetuate the Pine Plains Native Forest Type. For example, in old pine plains stands unburned for over 50 years where intense burning or coppice cutting may not produce enough dwarf pine sprout and seed regeneration, other methods such as heavy thinning, shelterwood or group selections cuts followed by burning may need to be used experimentally.

Clearcutting shall not be permitted in the Pine Plains Native Forest Type. Coppicing is the preferred cutting method in dwarf pine stands young enough to resprout from root stools (i.e., with stems under 40-60 years old) since it most closely mimics the effects of wildfire. Seed Tree, Shelterwood, Group Selection, and Individual Selection methods are all acceptable for experimental usage to regenerate very old stands of pine plains, but these methods have never been tested before.

Prescribed burning and broadcast scarification are the only acceptable site preparation practices in the Pine Plains Native Forest Type for large scale applications. Drum chopping, disking and root raking are prohibited for large scale applications. Creation of small (under 2 acres) widely scattered successional habitats for broom crowberry, or for road shoulder fuelbreaks under 25 feet wide is acceptable, using either single, double pass or repeated drum chopping.

Natural regeneration shall be the only permitted regeneration technique in the Pine Plains Native Forest Type except to restore drastically disturbed (e.g. bulldozed or mined) pine plains habitats lacking rare plants, and only if using the same dwarf pine genotypes from the immediate vicinity. Large scale artificial regeneration would destroy dense sprout-growth that characterizes dwarf pines and could interfere with the unique genetic makeup of the pitch pine trees that make up the Pine Plains.

Upland Savannas and Grassland Native Forest Type

Technical Definition

Upland savanna and grassland are not recognized in Breden et al. 2001 as naturally occurring ecological communities, since they are only documented in New Jersey as successional communities following severe man-made disturbance. Classification is still in progress, but upland savannas and grasslands will likely be placed in a general category called Successional Uplands.

- Most upland savanna and upland grassland cover types in the Pinelands are the product of succession after severe man-made disturbance such as agriculture.
- Ground cover is dominated by native grasses, especially little bluestem, switchgrass, panic grasses, broomsedge, wiregrass and/or Pennsylvania sedge.

- Shrub cover is absent to less than 25 percent, and can include sweetfern, black huckleberry and lowbush blueberry.
- Upland savannas have an open tree stratum of pine or oak with about 5-25 percent cover, although greater cover may be possible.

General Description

Upland savanna/grassland creation should be limited to old sand mines, abandoned agricultural fields, post-disturbance forests with a grass understory already established, pine-shrub oak types but only in clearings under 5 acres in size, in linear fuelbreaks under 100 feet wide along some power lines, road shoulders and the immediate wildfire/urban interface for the protection of major development and in isolated pine-dominated or oak-dominated forest stands under 100 acres in size associated with and fragmented by development, agriculture or sand mines.

Creation of upland savanna/grassland should rely on natural colonization of native grasses, or sowing native grass seed. If the treatment calls for sowing native grass seed, the applicant shall be required to use locally derived sources if a source becomes available. These areas should be maintained with burning or mowing at 1-3 year intervals.

Wetlands Native Forest Types

Atlantic white cedar Native Forest Type

Technical Definition

Equivilent to *Chamacyparis thyoides* saturated forest alliance and *Chamacyparis thyoides-Acer rubrum* saturated forest alliance in Breden et al. 2001, (commonly called Atlantic white cedar swamp, and Atlantic white cedar-hardwood swamp, respectively).

- Atlantic white cedar sometimes dominates a closed canopy alone, but varying combinations of Atlantic white cedar, red maple, black gum, sweetbay and pitch pine usually codominate the canopy.
- A shrub stratum is dominated by saturation-tolerant species, such as highbush blueberry, fetterbush, sweet pepperbush, swamp azalea, dangleberry, inkberry, and leatherleaf.
- Ground cover is dominated by sphagnum moss.
- Found on flood plains with seasonally saturated to slightly flooded muck soils.

General Description

Cedar forestry practices should be based upon the management practices outlined in Atlantic White-Cedar, Ecology and Best Management Practices Manual, incorporated herein by reference, in addition to the management practices described in these Forestry Management Practices. In accordance with the Atlantic White-Cedar, Ecology and Best Management Practices Manual, where the intent is to restore Cedar, drum chopping, root raking and disking should be limited to shrub-dominated sites and recently abandoned agricultural lands. Cedar restoration is encouraged, but not limited, to sites where a preexisting cedar stand and degradation are evident (e.g., hardwood pine swamp, mixed hardwood-cedar swamp, mixed pine-cedar swamp, successional palustrine shrublands with remnant cedar, agricultural wetlands known to have displaced cedar). Cedar restoration in rare wetlands types, such as in pitch pine lowlands, palustrine grasslands, and some palustrine shrublands is not permitted. Furthermore, until documented information on the effects of their application becomes available, the use of fertilizers should be restricted to research and monitoring projects (see Part 6, Section 3). Before entering wetlands with heavy equipment, use special precautions to clean all equipment of invasive species (e.g., mud containing invasive plant seed, wood debris containing insect pests).

Hardwood /Pine swamp Native Forest Type

Technical Definition

Equivilent to *Acer rubrum-Nyssa sylvatica* saturated forest alliance and *Pinus rigida-Acer rubrum* saturated forest alliance in Breden et al. 2001, (commonly called red maple-black gum swamp or hardwood swamp, and pitch pine-red maple swamp, respectively).

- Swamp hardwood cover (red maple, black gum, sweetbay) is 25-100 percent.
- Pitch pine cover can be under 25 percent, to 25-100 percent, depending on stand history.
- A shrub stratum is dominated by saturation-tolerant species, such as highbush blueberry, fetterbush, sweet pepperbush, swamp azalea, dangleberry, inkberry, and leatherleaf.
- Found on flood plains with muck or mineral soils.

General Description

On the landscape level, the Hardwood/Pine Native Forest Type provides forest interior habitats critical to neo-tropical migrating songbirds, raptors and other rare species. Therefore, this Native Forest Types should be maintained *at the landscape level*. However, silviculture practices shall not be prohibited in these types. There are many reasons why silvicultural practices may be appropriate in Hardwood/Pine Swamp Native Forest Types. For example, there are many areas of Hardwood/Pine Swamp that would be appropriate for Atlantic white cedar restoration. There may also be stands of Hardwood/Pine swamp where silvicultural practices that release understory vegetation would be beneficial to other species of wildlife.

Before entering wetlands with heavy equipment, use special precautions to clean all equipment of invasive species (e.g., mud containing invasive plant seed, wood debris containing insect pests).

Pitch Pine Lowlands Native Forest Type

Technical Definition

Equivilent to *Pinus rigida* saturated woodland alliance in Breden et al. 2001, commonly called pitch pine lowland, which includes several ecological community types based on hydrology and the dominant shrub or ground cover species.

- Pitch pine cover dominates the canopy and is often 50-100 percent, but some types persist indefinitely with only 5-25 percent pine cover.
- Swamp hardwood cover (red maple, black gum, sweetbay, shadbush) is typically under 5 percent, but ecotonal or successional forms occasionally occur with 5-25 percent hardwood cover.
- Shrub oak cover (blackjack oak, scrub oak) is absent or rare.
- Shrub cover varies along hydrologic and fire gradients and can be dominated by various combinations of leatherleaf, highbush blueberry, fetterbush, inkberry, dwarf huckleberry, dangleberry, sheep laurel, black huckleberry or sand myrtle.
- Ground cover can be dominated by sphagnum moss in seasonally flooded sites, or by pine barrens reedgrass, panic grasses, peanut grass, pine barrens gentian, turkey beard and pyxie moss in seasonally flooded to saturated sites, with the greatest grass and herb cover after tree and shrub cover is greatly reduced by severe turf fire or disturbance.
- Found in somewhat to very frequently burned parts of the central Pinelands, often within large fire-prone firesheds dominated by pitch pine lowland or pine-shrub oak barrens, as well as sites adjacent to less fire prone uplands and swamps.
- Several pitch pine lowland types are recognized, mostly on the basis of the dominant shrub or ground cover species. An undifferentiated “system” type is also recognized where multiple pitch pine lowland communities form too complex a mosaic or gradient to separate all types at the map scale used, especially where closed canopy stands dominate that are difficult to distinguish on aerial photography.

- Pitch pine lowland types dominated by leatherleaf, pine barrens reedgrass or sand myrtle often maintain an open canopy for prolonged periods due to seasonal flooding and/or a severe fire or disturbance history.

General Description

All types are rare or globally rare, and provide critical habitats for many rare Lepidoptera. Many also have inclusions of intermittent ponds, swales and bogs supporting other rare communities and rare species habitat, such as palustrine grasslands and shrublands.
All pitch pine lowlands require disturbance to keep hardwood trees in check and many types in fire-prone sites support serotinous pitch pine and fire-dependant herbs and insects, requiring that fire be incorporated into the management regime. Some pitch pine lowland types require growing season fires, particularly those with pine barrens reedgrass or successional palustrine grassland stages. The fire and/or forestry management approaches used should reflect landscape context, wildfire and disturbance history and rare species needs, including the use of prescribed growing season surface fires in some habitats. There are several globally rare types of pitch pine lowland with a very limited extent and a high diversity of rare species (New Jersey Natural Heritage Database), and ecologially-based forestry will be critical to their survival. Avoid most silvicultural activities such as low severity drum chopping, disking, root raking and tree planting *in these very rare types*, although stand thinning and/or fire management may be appropriate in some cases for maintenance. These very rare pitch pine lowland types include pitch pine-reedgrass savanna, pitch pine-sand myrtle lowland, pitch pine-leatherleaf lowland, and successional palustrine grasslands (i.e., temporary grasslands produced by a severe summer fire or disturbance event in pitch pine lowlands). Hydric pine plains are a related group of globally rare communities mostly associated with pitch pine lowland sites in the pine plains region, which are best maintained by intense dormant season fires. Frequent dormant and growing season surface fires are needed to maintain pitch pine-reedgrass savannas, although turfing or drum chopping in adjacent relatively common pitch pine lowland types may be appropriate to expand these savannas.

In the more widespread types of pitch pine lowland (i.e., dominated by a mixture of heath shrubs or inkberry), low severity, single pass drum chopping is acceptable for site preparation in clearcuts or seed tree cuts, to partially break up the turf and enhance natural pine regeneration. High severity, repeated drum chopping, disking, root raking or turfing may also be appropriate on a limited scale to mimic severe summer fires that consume humus and roots and create successional palustrine grassland/savanna. Natural regeneration methods are most encouraged, with follow-up burning or thinning to maintain an open pine canopy. Before entering wetlands with heavy equipment, use special precautions to clean all equipment of invasive species (e.g., mud containing invasive plant seed, wood debris containing insect pests).

If used, dense pine plantings that would establish a closed canopy should be minimized in extent and followed by thinning, to avoid the loss of ground cover diversity and the increased wildfire hazard of a closed pine canopy.

Follow-up burning or thinning is recommended to maintain an open pine canopy.

Palustrine Shrubland Native Forest Type

Technical Definition

Most palustrine shrublands are equivalent to three saturated shrubland alliances in Breden et al. 2001, the *Vaccinium corymbosum* saturated shrubland alliance, the *Chamaedaphne calyculata* saturated dwarf-shrubland alliance and the *Vaccinium macrocarpon* saturated dwarf-shrubland alliance. Hydric pine plains is a recently described palustrine shrubland type in the *Pinus rigida* Saturated Shrubland Alliance.

- Tree cover is absent or under 5 percent, due to frequent fire history, season flooding, or severe fire/disturbance events.

- Hydric pine plains communities occur in frequently burned, seasonally flooded to saturated sites similar to pitch pine lowlands, but with dwarf pitch pine and wetland shrubs or pine barrens reedgrass co-dominating.
- Palustrine shrubland communities occur in seasonally flooded to saturated sites, where wetland shrubs dominate the community, such as cranberry, leatherleaf, highbush blueberry, inkberry, sheep laurel or other heaths.

General Description

More stable palustrine shrubland types associated with seasonally flooded or saturated sites are somewhat rare and support rare species. Successional palustrine shrublands can occur after an intense fire or clear cut removes tree cover but does not trigger tree regeneration. Hydric pine plains are very rare, often provide critical habitat for many rare species, and are associated with wet spots with and near the Pine Plains. Most palustrine shrubland types occur as relatively small patches within a matrix of forested wetland types, particularly within pitch pine lowlands.

Avoid severe drum chopping (double and repetitive pass), disking, root raking, or tree planting in these ponded types (See also management recommendations under pine barrens treefrog, which breed in these ponded habitats). Selectively remove invading trees if needed to maintain these palustrine shrublands. Successional palustrine shrublands created in agricultural wetlands or from degraded cedar stands may be acceptable for cedar restoration, unless rare species are present.

Palustrine Herbaceous Vegetation Native Forest Type

Technical Definition

Palustrine herbaceous vegetation is classified within several seasonally flooded or saturated alliances and associations under the herbaceous vegetation class of Breden et al. 2001. There are also many new and recently described types. Five broad categories are noted below.

- Tree and shrub cover is often absent due to seasonal to semi-permanent flooding or saturation, although sparse to limited cover of pitch pine, hardwoods, Atlantic white cedar, or shrubs can be present in some types.
- Several types of palustrine herbaceous vegetation are recognized based on ground cover species and hydrologic processes.
- **Palustrine grasslands** have ground cover dominated by perennial grasses tolerant of dormant season flooding, such as with Torrey's smoke grass, switchgrass, bushybeard bluestem or pine barrens reedgrass. Habitats include seasonally flooded depressions and swales or the edges of some intermittent ponds.
- **Palustrine herblands** have sedge, rush and forb ground cover tolerant of groundwater flooding during some or all of the growing season, such as brown-fruited rush, twigrush, woolgrass, Walter's sedge, Virginia chain fern, pipeworts, and water lily.
- **Coastal plain intermittent ponds** are regularly flooded ecosystems dominated by annual (or annual-mimicking) seedbanking species and aquatic/emergent perennial species**.**
- **Pine barren riverside savanna** occurs in permanently saturated parts of floodplain terraces and is dominated by herbaceous vegetation tolerant of continuous groundwater seepage, such as sphagnum moss, bog asphodel, golden crest, pitcher plant, sundews, cottongrass, Torrey's smoke grass, twigrush, beaked-rushes, sedges or rushes.
- **Successional palustrine grasslands** can occur temporarily after severe mechanical disturbance or severe turf fire destroys most trees, shrubs, roots and humus in forested wetlands.

General Description

Virtually all types of palustrine herbaceous vegetation are rare and provide critical habitat for many rare plant and animal species. Most palustrine herbaceous vegetation types are small-scale communities under several acres in size, and are found within a matrix of forested wetland such as cedar swamp or pitch pine

lowland. Most types are very to somewhat stable on the landscape, but successional palustrine grasslands are very ephemeral.

Drum chopping, disking, root raking, or tree planting in all palustrine herbaceous vegetation types shall be prohibited (See also management recommendations under pine barrens treefrog, which breed in these ponded habitats). Selectively remove invading trees and shrubs if needed to maintain rare types and critical habitats.

Small unique plant associations

The Forestry Advisory Committee acknowledges that some scientists remain uncomfortable at this time classifying some of the smaller-scale plant community types identified in Breden et al. as Native Pinelands Forest Types because of their small size and the differing opinions about the statistical methodology used to define these communities. Furthermore, the ecological dynamics that produced these small unique communities are not well understood making these classifications not applicable to forest management at this time. The FAC looks forward to reviewing additional research and refinement by the NJDEP Division of Parks and Forestry on these smaller communities and potentially incorporating these into forest management planning. The FAC may consider developing Best Silvicultural Practices for these small communities after more is known about the ecological dynamics that produced them on the landscape. The FAC also understands that many of these smaller plant communities are currently mapped as Natural Heritage Priority sites.

Although the FAC did not consider many “alliances and associations” in Breden et. al as Native Forest Types for these recommendations, the Committee does believe that these unique assemblages of species are important to maintain, as many of them contain habitat for threatened and endangered plant and animal species. Any silviculture in these small Native Forest Types shall only be done on an experimental basis.

According to Breeden et. al. small-scale ecological communities which are rare and provide critical rare species habitat include one type of pine upland (pine-(shrub oak)-sedge paleodune upland), three types of pitch pine lowland (i.e., pitch pine-reedgrass savanna, pitch pine-sand myrtle lowland, pitch pine-leatherleaf lowland), all palustrine shrubland types, and all palustrine herbaceous vegetation types. Any silviculture in these smaller community types should be done with consideration of the rare and unusual plants and animals contained within them and with strict consultation with the NJDEP Office of Natural Lands Management and the NJ Forest Service.

In addition to the broad Native Forest Types identified by the FAC and described above, there are potentially many smaller associations of plants that are important to maintain, enhance, and create on the landscape.

The following list of small plant associations was provided by the NJDEP Division of Parks and Forestry. They are mostly found in patches under 20 acres in size, and most provide critical rare species habitat. Any type of silvicultural management in these communities should be done on an experimental basis as the ecological (disturbance) dynamics that lead to these communities are not well understood.

Pine-dominated Native Forest Type (1 of several types):
- Pine-(shrub oak)-sedge paleodune uplands

Pitch Pine Lowland Native Forest Type (3 of several types)
- Pitch pine-reedgrass savanna
- Pitch pine-leatherleaf lowland
- Pitch pine-sand myrtle lowland

Palustrine Shrubland Native Forest Type – all types

Ericaceous palustrine shrubland – 5 types
Successional palustrine shrubland – several types
Hydric pine plains – 7 types

Palustrine Herbaceous Vegetation Native Forest Type – all types
Palustrine grasslands – 4 types
Palustrine herblands – several types
Coastal plain intermittent ponds – 15 types
Pine barren riverside savanna – 6 types
Successional palustrine grassland – several types

Appendix III – Research and Monitoring

Data documenting the effects of many of the silvicultural techniques described in the foregoing sections of this management practices manual, and particularly drum chopping and herbicide application, is limited and their long-term impacts within the Pinelands have not been extensively identified and evaluated. Consequently, short- and long-term monitoring that provides detailed and specific accounts of the ecological impacts of forestry management practices are encouraged, including the use of techniques that might otherwise be prohibited except for those that have significant ecological impact. Applicants proposing any forestry techniques not explicitly addressed in these Forest Management Practices shall conduct research and monitoring on small plots (10 acres or less) to demonstrate the implications of such techniques prior to Commission approval on larger areas. The FAC recommends that monitoring be a required component of any forest management plan on State Lands and only be required on private lands if the management practice is deemed to be experimental in nature.

Research and monitoring programs shall be designed to be consistent with protocols established by the Commission. At a minimum, a research and monitoring project should be based on an appropriate experimental design for a specific forest and soil type that would entail mapping the test site, which should be subdivided into uniform test plots. Replicate "control" plots should be reserved to enable comparison of the tested practice to "no action". A detailed description of the characteristics of the test plots, with measurements of canopy, understory, and ground layer structure and composition before and after the research experiment should be developed and submitted with a research and monitoring project proposal.

While the bulk of the monitoring will be with changes in the general vegetation- it may be necessary to monitor other forest ecosystem components. These include but are not limited to herbicide residues and their fate, soil characteristics, animal populations, landscape changes, water table chemistry and depth, fire intensity and frequency, etc. It is felt that some form of funding may be needed to insure this is done properly and maintained in the years ahead or the uncertainties faced now will only be exacerbated. It is hoped the State (i.e., DEP Office of Science, Research and Technology), in conjunction with the Pinelands FAC and Pinelands science staff can develop monitoring protocols for non-vegetative parameters that will serve as a general but good index of impacts not included in this appendix.

The monitoring protocol outlined below is meant to serve as a general guideline for scientific vegetation monitoring, but may not answer ALL the questions that might come up when reviewing a Forest Management Plan. For example, in order to understand forestry impacts on bird communities different measures of understory heterogeneity may need to be developed. In these instances, the FAC will advise the applicant on how to develop a science-based monitoring program.

Introduction to General Vegetation Monitoring

General Vegetation Monitoring is used to assess the efficacy of a restoration over time. It is a way to systematically monitor manipulation, succession or mortality of plants due to animal predation, fire, vandalism and disease, as well as the establishment of desirable species and sustenance of globally rare and threatened plant communities. Following this FAC process, it was apparent how little we know about the intricacies, complexities and trends of the Pinelands forest. Forest manipulations, anthropogenic and natural influences, global warming, and invasive pathogens influence the health, genetic integrity and natural diversity of this globally important resource. Sound forest management practices must support short and long-term monitoring--to gauge success of potential restoration, disturbance regimes, and outside influences. Funding should be dedicated for this purpose to support forest monitoring. This could be accomplished through nominal funding (supported from potential mitigation funds) utilizing ecology students and faculty at nearby Stockton College, in coordination with the Pinelands Commission and NJ DEP.

- Desired functions of the Pinelands ecosystem include:
- Varied plant structural and species composition

- Adequate regeneration of desired species
- Control of invasive and/or exotic species
- Stabilization of soil mantle

Monitoring Protocols

Forest/habitat restoration protocols will differ depending on the level of detail required. Protocols should monitor seedling survival and forest and soil structure. It is important to determine the goals of each monitoring regime prior to any on-site work. Once these goals have been established, it is critical to choose the correct method of monitoring, which will depend on site-specific parameters. A combination of methods may be required. For all monitoring, a comprehensive monitoring plan should be developed, including monitoring parameters and any site-specific modifications to the protocol, before any on-site work is performed. Area specific considerations outlined in Appendix 2 (ie: pine plains, pine-shrub oak, cedar, etc) should incorporate monitoring that records the specific restoration practice (drum chop, disk, root rake, fire--prescribed, natural, vandal, etc), percent of canopy, and specific management tools/practices (ie: fencing, planting).

Forest restoration monitoring for seedling survival should be established immediately after a planting. Monitoring for regeneration and forest structure should begin prior to any on-site work to establish baseline data. Monitoring for both protocols should be performed once a year for a minimum of five years. Reference sites on which no restoration work is performed should be identified in ecologically similar areas and monitored identically. The number of plots and transects will depend on several variables, including overall restoration area, planting variability, variability in site conditions (e.g., shade and aspect), and time and labor constraints.

Seedling Survival

This method follows the success or failure of tree plantings. It is important to install plots soon after the planting (or habitat manipulation) is finished so that planted specimens are easily distinguished from volunteers.

Equipment required

- compass or GPS (when appropriate)
- tape measure (100m)
- diameter breast height (dbh) tape (metric)
- clinometer (for obtaining percent slope)
- seedling locator form (1 per plot)
- tree measurement form (1 per plot)

Plot Placement

The number of plots should be based on the following formula:

Planting Area [m^2 (acres)]	**# of plots**
>2400 (>0.6)	3
<1200 (<0.3)	1
1200-2400 (0.3-0.6)	2

If the planting area is unknown, a rough estimate can be made by measuring the distances between several seedlings (given that the seedlings are spaced relatively uniformly). Take the mean of these distances, square it, and multiply by the number of seedlings planted.

Plot size should be 36 m^2 (6m on a side). Each plot is to be randomly located within the planting. Start by locating a single point within the planted area. This will be the starting corner point of the plot. Identify at

least one witness tree (a tree with a distinguishing feature, for example) and record the distance and azimuth (degrees from north) from the starting point to the center of the witness tree. Use the magnetic north, rather than setting the declination on the compass. Mark the base of this tree with a small dot of spray paint to facilitate relocation. This starting corner may also be marked, either with a metal survey shiner or a flagged stake. Metal shiners must be relocated using a metal detector, but will draw less attention to the plot.

Using the tape measure, lay out a line 6m in length in a random direction, recording the azimuth on a Seedling Locator Form. Place a second survey shiner or flagged stake at this point. Set the compass at 90 degrees from this line and measure another 6m for the third corner. Repeat this step to get the forth and final corner point. It is helpful to place grid lines at 1m intervals through the plot, creating 36 $1m^2$ sections.

Measurements

Note the slope and aspect (e.g., northwest facing) of the plot using the clinometer and record on the Tree Measurement Form.

Using the Seedling Locator Form, start at one end and work through the plot, $1m^2$ section by $1m^2$ section, recording the location of every tree seedling. Record the corresponding information for each seedling on the Tree Measurement Form. Species name can be abbreviated by using the four letter scientific abbreviation (the first two letters of the genus and species).

Tree height is to be measured from root collar (where the tree stem meets the ground) to the tip of the tallest branch, excluding foliage, to the nearest 0.5cm. Record these data on the Tree Management Form.

DBH can be substituted for trees that are too tall to measure. Measurements are taken at 1.37m (4.5ft) above the ground using a metric diameter tape. Record dbh to the nearest 0.1cm.

Note any animal browse/herbivory, top dieback, mortality, vandalism, or other comments on the Tree Measurement Form. These data will provide mean seedling height, mean annual growth increment, and survival and indicate problems with predation or vandalism.

Monitoring for Forest Structure/Regeneration *(adopted from Stewart, 1988 and Penn State REGEN Model)*

This method tracks trends in forest development, such as natural regeneration, the presence of groundcover vegetation, and vertical structure. Monitoring should be implemented prior to any on-site work to complete data on conditions prior to restoration of the site.

This protocol combines two sampling methods. The first is used to determine the regeneration state of desirable species on the site. The second is used to determine understory species composition and canopy cover. The combination of methods provides a comprehensive view of the overall health and vigor of the restoration area. As with the Seedling Survival protocol, reference sites should be identified in ecologically similar areas and monitored identically for each of the techniques outlined below.

Equipment required:

- Compass
- Tape measure
- Spherical densiometer
- Clinometer (for obtaining % slope)
- Forest Regeneration Data Sheet (1 per plot)
- Understory Monitoring Data Sheet (1 per plot)

Natural Regeneration Monitoring

This method is used to track natural regeneration of the major desirable tree species delineated in this plan. "Desirable", defined as all commercial tree species native to the region, also includes ecologically desirable species of the Pinelands. Desirable species are divided into two categories Fast and Slow Growth. Recordings of specific management tools used including drum chop, root rake, disk, prescribed burn, herbicide, etc should be recorded. Notation of additional disturbances including browse, vandalism, dieback, mortality should be included (these things can be included on a Tree Measurement Form).

Plot size should be $4m^2$. Randomly locate an initial point within the study area as the starting point for the first transect. Plots should be randomly spaced along this and each additional transect. Individual transects should be at least 10m apart if possible. Using either a prefabricated frame or a tape measure lay out the 2m x 2m plot. Mark each of the four corners of the plot w/either a metal survey shiner or a flagged stake. There should be no more than 50 such plots per restoration site.

Measurements

Note the slope and aspect (eg: northwest facing) of the plot using a clinometer and record on the Forest Regeneration Data Sheet (FRDA). Note all tree species within this plot on the FRDA using the 4-letter scientific name abbreviation. Tally the number of seedlings of each species falling into three distinct size classes: seedlings 2.5-30cm (1-12in), seedlings 30-137cm (1-4.5 ft), and saplings 2.5-7.6 cm dbh (1-3 in. dbh).

Heights should be taken from the root collar (where the tree stem meets the ground) to the tip of the tallest leader excluding foliage (a pole graduated at 30cm and 137 cm is helpful). DBH is taken at 1.37m (4.5 ft) above the ground, to the nearest 0.1 cm. Also note the presence and heights of any shrug species within the plot and record on the FRDA. These data can be used to track forest structure through time.

Understory Monitoring

This method is typically employed with the Natural Regeneration Monitoring technique.
It is useful in tracking understory development through each stage of forest maturation, from early succession to closed canopy. It also follows trends in herbaceous plantings and succession over time. Plots should be established concurrently with Natural Regeneration Monitoring protocol and prior to any on-site restoration work to complete baseline data of the site. Notation of management tools utilized and disturbances specified in a. Natural Regeneration Monitoring above, should be entered on an Understory Monitoring Data Sheet.

Measurements

Plot size is $1m^2$. Randomly choose one of the four 1m x 1m plots within each $4m^2$ plot of the Natural Regeneration model. Record which plot is used on the data sheet to facilitate relocation. A mean densiometer reading should be taken at each plot to estimate the light conditions of the site. Take 4 densiometer readings per plot, one in each of the four cardinal directions, using the center of the 4m2 plot as your pivot point. Record these readings on the data sheet. Within each 1m x 1m plot, record the presence of each herbaceous species. It may be sufficient to record only vegetation families (i.e.: graminoids). Visually estimate the total cover of each of these species and place them into % cover classes of <1%, 1-5%, 5-25%, 26-50%, 51-75%, and 76-100%. Record this information on the Understory Monitoring Data Sheet.

These data will provide species diversity, overall ground cover, and species transition for the site. As with the other monitoring protocols, bring a camera and record photographic visuals.

Soil Measurements

If experimental soil amendments such as fertilizers are proposed to be used, the FAC shall require the applicant to conduct monitoring of soil chemistry, structure and microorganisms. Furthermore, monitoring of effects of herbicides and pesticides on soil characteristics shall also be required when the FAC deems that the use of such chemicals may be ecologically detrimental. If required, soil measurement protocols shall be developed by the applicant and included in the Forest Management Plan.

Appendix IV – Definitions

Artificial Regeneration: The establishment of tree cover through direct or supplemental seeding or planting

Bedding: Raising mounds approximately 6 inches in height in potentially wet areas with a plow on which seedlings are planted to elevate seedlings above the water table. Used for cedar restoration and/or where micro-site hydrology needs to be encouraged

Broadcast Scarification: Dragging cut trees or other objects across a site to remove or reduce above-ground shrub cover, debris, leaf litter and humus, without disturbance to mineral soil horizons and associated roots, in order to mimic natural fire processes of uplands that enhance early successional species and natural pine regeneration without impact to deep root sprouters like oaks.

Cleaning: a release treatment in an age class not past the sapling stage to free favored trees from less desirable individuals of the same age class that overtop them or are likely to do so (weeding)

Clearcutting: The removal of an entire stand in one cutting, reproduction is obtained artificially, or by natural seed, or from advanced regeneration. This method typically involves the removal of all woody vegetation from the site in preparation of establishment of new trees but depending on the management objective may or may not have reserve trees left to attain goals other than regeneration. An even-aged method

Conversion: changing the pattern, distribution and range of living organisms, the soil structure and ground layer, shrub layer, and canopy structure and composition from one type to another

Coppice: Producing stands originating from vegetative sprouting by the trees that are harvested (stump sprouts, root suckers, and naturally rooted layers). This method usually involves short rotations with dense stands of short trees. Trees resulting from sprouts are almost never as good as trees of the same species originating from seed, although producing sprout growth is the goal when maintaining dwarf pitch pine stands in pine plains and hydric pine plains communities.

Disking: Drawing one or more heavy, round, concave, sharpened, freely rotating steel disks, which are either vertical to cut through the soil and roots with minimal disturbance, or angled to cut and turn a furrow over an area.

Drum Chopping: Drawing a large cylindrical drum, which may be partially filled with water for weight, with cutting blades mounted parallel to its axis, across a site to break up slash and crush scrubby vegetation prior to burning and/or planting. A rolling drum chopper also chops up and disturbs the organic turf and roots in the upper foot of soil, including roots of trees and shrub oaks in the upper mineral soil. Severity of the soil and root disturbance increases by a) chopping in growing season, b) increasing the number of passes, c) increasing the weight of the drum by adding more water, and d) using tight curving passes (especially on a 180 degree turn) that torque and pivot the blade while underground.

Fireshed: a fire-influenced landscape unit within the Pinelands dominated by vegetation types with a similar dominant species composition and/or species of similar fire tolerance, flammability and fire response, often with a similar physical environment and a similar long term average fire history.

Girdle: To make more or less continuous incisions around a living stem, thorough at least both bark and cambium, generally with the object of killing the tree, includes chemical, frill and mechanical girdling.

Group Selection: Trees are removed, usually in groups, and new age classes are established in small groups, usually 1/10 to 2/3 acre in size but sometimes up to 1 to 2 acres on large properties

Herbicide: Pesticides used for killing or controlling the growth of plants. Chemical sprays may be used to create seedbeds but are usually applied to ensure growing space. Herbicides usually retard sprout development long enough for regeneration to become established

Individual Selection: Large individual trees are removed to enable the establishment of new age classes. Intended to maintain a continuous crown

Mechanical Control: The deliberate control of pests by mechanical means such as hoeing weeds or constructing barriers

Natural Regeneration: The establishment of a plant or a plant age class from natural seeding, sprouting, suckering, or layering

Prescribed Burn: The controlled application of fire to forest fuels for public safety, wildfire control, ecological, silvicultural, agriculture, or natural resource management purposes, under specified environmental conditions and by following appropriate precautionary measures which cause the fire to be confined to a predetermined area, so as to accomplish planned land management objectives. Prescribed burning is a good tool for improving wildlife habitat and to restore ecologically rare communities. It stimulates sprouting, seed germination, and growth of herbaceous plants. It makes seed more available to birds by removing litter accumulations

Propagules: Plant parts that allow a plant species to reproduce, either vegetatively (such as from rhizomes, sprouting root fragments, rooting stem fragments or cuttings) or sexually from seeds and spores.

Root Raking: Drawing a set of tines, mounted on the front or trailed behind a tractor, over an area to thoroughly disturb tree and vegetation roots and/or to collect stumps and slash. Used in areas with a thick turf layer (deep leaf litter, etc.) and/or where large stumps are remaining. Used to push all of the vegetation on a site into windrows. Leaves the site completely clean with bare mineral soil exposed everywhere but in the windrows.

Savannah: Strong dominance of grasses to the exclusion of woody shrubs

Seed Tree: Removal of old stand in one cutting, except for a small number of trees left singly, in small groups or narrow strips, as a source of seed for natural regeneration. An even-aged method

Shelterwood: Establishment of a new, essentially even-aged stand from release, typically in a series of cuttings, of new trees started under the old stand. The new stand is established before the old stand is removed. Shelter wood cutting can take an irregular or uniform form and can be laid out in groups or strips. An even-aged method.

Single Tree Selection: Individual trees of all size classes are removed more or less uniformly throughout the stand, to promote growth of remaining trees and to provide space for regeneration-synonym individual tree selection

Silviculture: the art and science of controlling the establishment, growth, composition, health and quality of forests and woodlands to meet diverse needs and values of landowners and society on a sustainable basis

Slash: Residue (tree tops, branches) left on the ground after logging or accumulating as a result of storm, fire, girdling, or de-limbing

Stand: a contiguous group of trees sufficiently uniform in age-class distribution, composition and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit

Stand Cohort Composition: the age structure of a stand typically represented as follows:

Single-Cohort: even aged stand

Two-Cohort: a growing area with trees of two distinct age classes separated in age by more than ± 20 percent of the rotation

Multi-Cohort: a stand with trees of three or more distinct age classes, either intimately mixed or in small groups

Thinning: removal of competing trees to favor certain species, sizes and qualities of trees

- ***Free***: the removal of trees to control stand spacing and favor desired trees, using a combination of thinning criteria without regard to crown position
- ***Low***: the removal of trees from the lower crown classes to favor those in the upper crown classes
- ***Selection***: the removal of trees in the dominant crown class in order to favor the lower crown classes
- ***Geometric***: thinning of trees in either even- or uneven-aged stands, involving removal of trees in rows, strips, or by using fixed spacing intervals
- ***High***: the removal of trees from the dominant or co-dominant crown classes in order to favor the best trees of those same crown classes. Synonym: crown thinning, thinning from above.

Turfing: Removal of the humus or upper organic soil horizon and its associated shallow roots by mechanical methods or burning, in order to mimic severe growing season fire, expose mineral soils, enhance early successional species, and encourage natural pine regeneration. Most typically applied in pitch pine lowlands having a thick humus layer densely interwoven with heath shrub roots.

Weeding: A release treatment in stands not past the sapling stage that eliminates or suppresses undesirable vegetation regardless of crown position

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