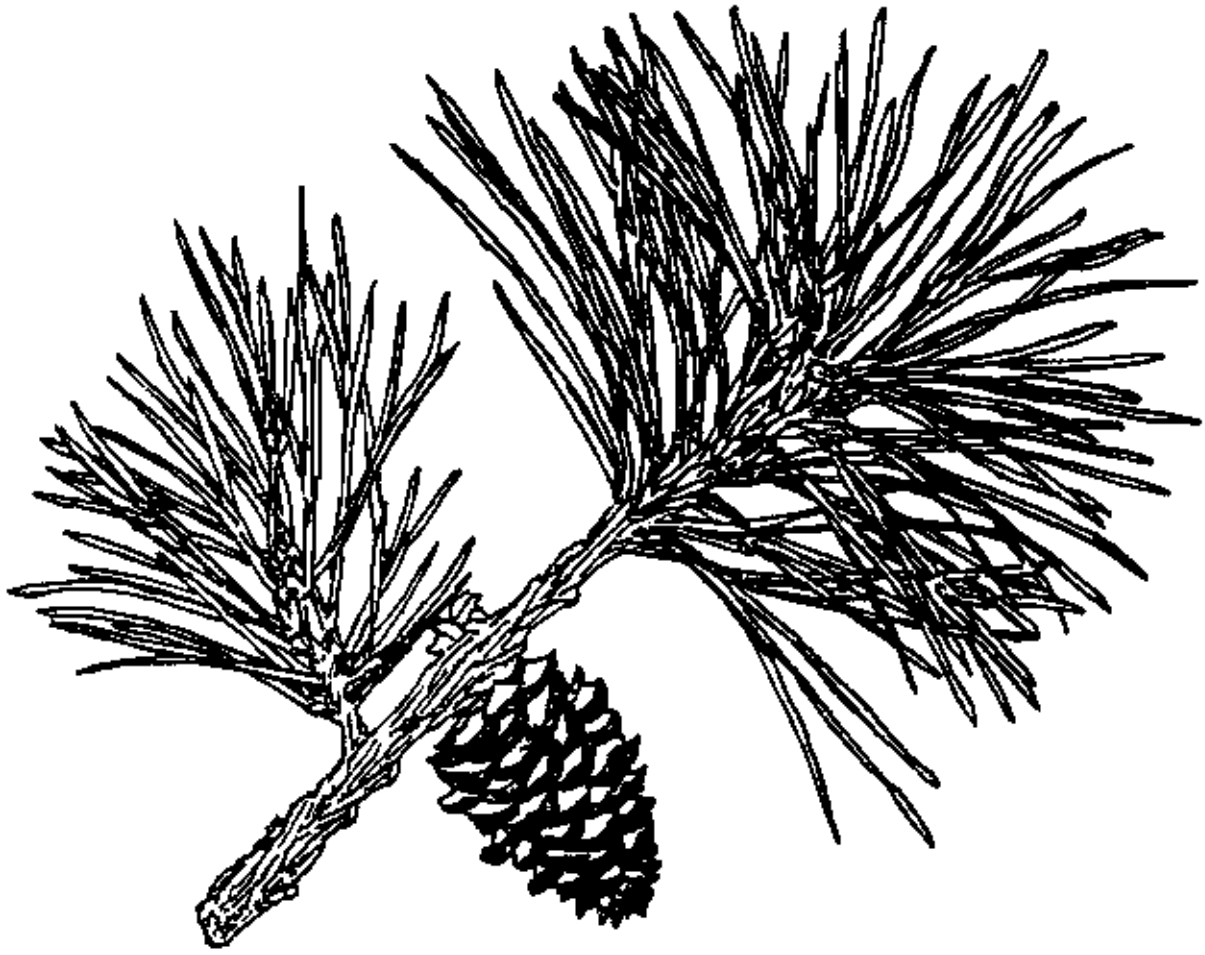
NEW JERSEY
PINELANDS



CRITICAL AREAS STUDY

Rogers, Golden & Halpern

1980

CRITICAL AREAS STUDY FOR THE PINELANDS

Prepared for the

NEW JERSEY PINELANDS COMMISSION

By

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CONTENTS

PAGE

Introduction 1

Report Organization 2

Definitions of Critical Areas and Criteria 4

Ecological Critical Areas 7

Perceptual and Cultural Critical Areas 13

Scenic Areas
Recreation Areas
Archaeological/Historic/Architectural Areas
Cultural Areas

Resource Production Critical Areas 14

Agricultural Lands
Timber Production Areas
Mineral Extraction Areas

Natural Hazard Critical Areas 17

Fire Hazard Areas
Flood Prone Areas
Critical Air Areas

Sources of Nominations for Critical Areas 19

Sources of Nominations from Consultants and the Literature

Ranking Ecological Critical Areas 29

The Scaling Technique
Assumptions and Results

Criteria for Critical Area Protection and Acquisition 38

Future Research Needs 40

Appendix A - Literature Review A-1

State and Federal Critical Area Programs and Methods

New Jersey Critical Area Programs

Appendix B - Public Participation Workshops B-1

Appendix C - Ecological Critical Area Data Sheets C-1

Glossary Glossary-1

References References-1

TABLES AND FIGURES

PAGE

Table 1 Sources of Nominated Ecological Critical Areas 23

Table 2 Ranking of Criteria for Ecological Critical Areas 36

Table 3 Importance Values of Criteria for Ecological Critical Areas . . . 37

Table 4 Summary of Data Availability by Watershed 43

Figure 1 MAP--Numbered sub-drainage basins/map units 31

Figure 2 MAP--Ecological Critical Area Importance Values. 34

INTRODUCTION

This study on critical areas is part of a larger effort on the part of Rogers, Golden & Halpern to help coordinate scientific and land planning activities for the Pinelands Commission in developing regulatory standards and the Comprehensive Management Plan. The objective of the critical areas study is to develop and execute a method for establishing a ranked list of critical areas in the New Jersey Pinelands. The areas designated as critical should be acquired or protected. To accomplish this objective, Rogers, Golden & Halpern performed the following tasks:

1. Reviewed critical areas and environmental ranking literature;
2. Developed nomenclature and concepts for use in critical area method;
3. Identified criteria to be used to evaluate an area's significance;
4. Developed a system for ranking ecological critical areas;
5. Conducted Public Participation Workshops;
6. Transferred Public Participation Workshop conclusions to the land management technique component of the work plan;
7. Coordinated the identification of lands to be acquired;
8. Identified data and future research needs.

A basis for defining critical areas can be found in the National Park and Recreation Act of 1978 (NPRA) and the New Jersey Pinelands Protection Act (PPA). Critical areas in the Pinelands are areas containing resources necessary to maintain the "essential character" (PPA, sec. 8b) of the existing Pinelands environment. The identification of critical areas should include "natural, ecological, agricultural, scenic, cultural, and recreational resources" (PPA, sec. 2) of significant value, as well as "natural hazard" (PPA, sec. 7) areas. On the basis of this interpretation, **critical areas** are defined for this report as geographic areas which contain one or more significant natural or cultural resources that could be degraded or lost as a result of uncontrolled or incompatible development and as natural hazard areas in which incompatible development may result in the loss of life or property.

Critical areas management is a component of the Pinelands Comprehensive Management Plan. Recognition of these areas is vital to land use planning because they must be managed in ways which protect identified resources and enhance the areas' value. The significant resources of concern in a critical area must be explicitly identified so that appropriate environmental protection strategies can be applied. The degree of protection and the restrictions placed on activities within these areas will, of course, depend upon the sensitivity of the resources to various amounts and types of activities. In addition, certain areas are prone to natural hazards. Restrictions must be enforced in these areas because of the threat of damage to life or property.

Critical areas data are useful in several land management functions. These include:

- Policy Planning
- Land Use Planning
- Public Facility Planning
- Land Use Regulation

- Land Acquisition
- Environmental Impact Assessment.

Once compiled, data on these areas are of value to local, regional, state and federal levels of government, as well as to developers, landowners, and residents. These groups will then be able to take critical areas into account when planning, developing and/or living in the Pinelands.

REPORT ORGANIZATION

The Critical Areas Study is organized into five sections:

- Definitions of Critical Areas and Criteria
- Sources of Nominations for Critical Areas
- Ranking Ecological Critical Areas
- Criteria for Critical Area Protection and Acquisition
- Future Research Needs

Definitions of Critical Areas and Criteria

Definitions of Critical Areas and Criteria presents the basic definitions and a discussion of the four classes of critical areas and their related criteria. The criteria for evaluating ecological critical areas were compiled by Rogers, Golden & Halpern, while the criteria for selecting other critical areas came from consultant reports prepared for the Pinelands Commission. They are all compiled in this report in order to provide a convenient reference for all criteria relating to critical areas in the Pinelands.

Critical areas are grouped into the following classes:

Ecological Critical Areas

Perceptual and Cultural Critical Areas

- Scenic Areas
- Recreation Areas
- Archaeological/Historic/Architectural Areas
- Cultural Areas

Resource Production Critical Areas

- Agricultural Lands
- Timber Production Areas
- Mineral Extraction Areas

Natural Hazard Critical Areas

- Fire Hazard Areas
- Flood Prone Areas
- Critical Air Areas

Among the four classes, ecological critical areas are emphasized in this study because both the National Park and Recreation Act of 1978 and the New Jersey Pinelands Protection Act emphasize the importance of existing natural resources in the Pinelands. The PPA stresses the necessity of "maintaining the overall

ecological values" (PPA, sec. 7a.) of the Pinelands. It notes that development poses an immediate threat to the ecological resources of the Pinelands, "especially to the survival of rare, threatened and endangered plant and animal species and the habitats thereof, (and) to maintenance of the existing high quality of surface and ground waters" (PPA, sec. 2). Both Acts state that "A map...to delineate major areas within the boundary (of the Pinelands National Reserve) which are of critical ecological importance" (PPA, sec. 2; NPRA, sec. 502f) is a necessary component of the Comprehensive Management Plan of the Pinelands. The emphasis in the Acts on the "ecological integrity of the Pinelands" (PPA, sec. 7a) and on areas of "critical ecological importance" provides a basis for establishing the ecological critical areas as being paramount in the hierarchy of critical areas classes.

Within the context of land management strategies for the Pinelands' critical areas, resources that distinguish and define ecological critical areas take precedence over other resources. Factors considered in the identification of other classes of critical areas may geographically overlap with critical ecological resources. This may enhance the value of a critical area if potential uses of the distinguishing significant resources are compatible. For example, a headwater drainage area may be identified as an ecological critical area. A portion of this same area may be identified as being culturally critical as well, on the basis of the presence of an historic site. The management strategies employed to protect these two resources may be compatible, and the overlap may be seen as enhancing the importance of this area. If the intensive recreational practices associated with the historic site would impair the critical ecological function of the headwater, then the ecological criticality of the area would preempt the use of the area for recreation, and management strategies would be applied to protect the headwater's ecological function as opposed to promoting recreation.

Sources of Nominations for Critical Areas

Sources of Nominations for Critical Areas contains all the sources used in developing the criteria for the different critical area classes, along with all the site nominations for critical areas. The sources include resource assessment reports which were contracted by the Pinelands Commission, relevant literature, and public workshops on critical areas. Public workshops were held to help set priorities for protection of ecological critical areas. Policy will be set by the Commission to establish the disposition and management of other critical resources; however, before final decisions are made, these policies will be discussed at further public workshops to ensure public involvement in policy making with regard to all classes of critical areas.

Ranking Ecological Critical Areas

Ranking Ecological Critical Areas presents the method used to rank ecological critical areas based on inherent resource values. This section describes the scaling method used, ranks ecological critical areas, and discusses the assumptions implied in the ranking method. Critical areas selection was begun with general definitions and classifications, with the final selection of critical areas occurring at the sub-drainage basin level. Sub-drainage basins are a logical geographic unit for delineation because the quality, quantity, and drainage pattern of surface water within them have a significant effect on the integrity of a natural ecological system. Before final delineations are made for the purpose of implementing management strategies, site visits will confirm the status of the resources and precise boundaries vis-a-vis the proposed strategies.

Criteria for Critical Area Protection and Acquisition

The section on Criteria for Critical Area Protection and Acquisition discusses additional criteria which must be addressed after ranking in the decision-making process for acquisition.

Future Research Needs

The final section, Future Research Needs, discusses the data relevant to the selection of critical areas. The state of the art of resource assessment is unevenly advanced across the different disciplines. In some cases predictive models have been developed to assess resources, while in other disciplines only existing data can be used. Data gaps and future research needs will be outlined in the final section of this report.

DEFINITIONS OF CRITICAL AREAS AND CRITERIA

Critical areas are defined as geographic areas which contain one or more significant natural or cultural resources that could be degraded or lost as a result of uncontrolled or incompatible development and as natural hazard areas in which incompatible development may result in the loss of life or property. A basis for defining critical areas can be gleaned from the National Parks and Recreation Act of 1978 and the New Jersey Pinelands Protection Act. In these Acts, Congress and the State Legislature recognize that the Pinelands area contains significant resources which have special values, and that these may be lost or degraded by incompatible development. The New Jersey Legislature, in writing the Pinelands Protection Act, "...declares that the Pinelands area comprises pine-oak forests, cedar swamps, and extensive surface and groundwater resources of high quality which provide a unique habitat for a wide diversity of rare, threatened and endangered plant and animal species and contains many other significant and unique natural, ecological, agricultural, scenic, cultural and recreational resources; that the continued viability of such area and resources is threatened by pressures for residential, commercial, and industrial development; that the protection of such area and resources is in the interest of the people of this State and of the Nation" (PPA, sec. 2).

Both Acts imply that the entire Pinelands area is an environmentally critical area. One of the purposes of the section in the National Parks and Recreation Act that addresses the Pinelands is to "protect, preserve and enhance the significant values of the land and water resources of the Pinelands area" (NPRA, sec. 502b), and the New Jersey Pinelands Protection Act states that "the object, design and purpose of this act being the protection of the Pinelands area and the resources thereof, this act shall be liberally construed" (PPA, sec. 28). Clearly the ubiquitous nature of many of the resources in the Pinelands, including groundwater, plants, wildlife, scenic, cultural, and recreational resources argues for the designation of the entire Pinelands as a critical area.

However, within the entire Pinelands area, specific areas can be identified and mapped as being of more critical environmental importance than other areas based upon the presence of significant resources and the areas' susceptibility to damage from uncontrolled or incompatible development. The sizes of critical areas differ, since the determining factor is the amount of land needed to preserve and protect the significant resources. The selection of critical areas is the first

step toward protection through either strict protective regulations or acquisition, two techniques which cannot be applied to the Pinelands as a whole.

To avoid confusion, it is necessary to distinguish the critical areas discussed in this report from two other areas "of critical importance." The first comprises areas designated as critical for sewage purposes. These are areas in which sewage disposal practices would be likely to contaminate the groundwater. The consideration of the properties of soils in relation to sewage disposal is not addressed in this report. The second area of critical importance is the Preservation Area, a core area within the Pinelands National Reserve which the Acts have designated as being most important to protect. Since the Preservation Area has been less disturbed by man than the Pinelands as a whole, many critical areas are identified within the Preservation Area. However, the focus of this report is on the inherent qualities of specific areas, and no special weight is given to critical areas within the Preservation Area.

In order to identify critical areas, it is necessary to further define "significant natural or cultural resources." Natural resources are the abiotic elements of air, water, and soil and the biotic elements of individuals, species, populations, communities, habitats, and ecosystems. Cultural resources consist of archaeological or historic sites of national, State, or local importance, as well as sites which are of value to the local community's way of life. Significant resources are natural or cultural resources that are identified as being necessary to maintenance of the essential character and integrity of the existing Pinelands environment. Significant resources are recognized as being valuable to the public in terms of one or more of the following values: economic, public-health, safety, recreational, aesthetic and scenic, research, and educational. Additionally, some resources are of value to the local community's cultural way of life. These values are somewhat general; a specific resource may embrace more than one, and values may change according to proposed use of resources.

Critical areas criteria are related to the quality--or, in a sense, to the degree of significance--of natural or cultural resources. They may also be related to natural hazard areas. Derived from the consultant reports, the Pinelands Technical Advisory Committee, the literature on critical areas, and the public, through public participation workshops, these criteria are standards used to select critical areas. In the case of ecological critical areas, they are further employed to rank subdrainage basin areas. Listed below are the classes of critical areas and their related criteria.

Ecological Critical Areas

- Linkage or corridors
- Unique or exceptional ecosystems
- Pristine aquatic communities
- Headwater
- Nationally endangered and threatened plant or animal species
- Diversity of vegetation types within a given area
- Nationally proposed or under review plant or animal species
- State endangered, threatened, declining, or undetermined plant or animal species (this list has no official status for plants)
- Representative vegetation types

- Outliers, disjuncts, or relict species

- Species at the limits of their range - N, S, E, W
- Restricted and endemic species
- Breeding areas -- nesting, spawning
- Overwintering concentrations
- Migratory stopover areas
- Areas of scientific interest and research
- Oldest, largest, or exceptional individuals

Perceptual and Cultural Critical Areas

- Scenic Areas
  - Study to determine criteria is in progress under contract to Pinelands Commission
- Recreation Areas
  - Study to determine criteria is in progress under contract to Pinelands Commission
- Archaeological/Historic/Architectural Areas
  - Site potentially eligible for inclusion on the Register of Historic Places
  - Site containing potentially significant archaeologic or historic artifacts
  - Buildings potentially eligible for inclusion on the Historic American Building Survey
- Cultural Areas
  - Areas essential to the cultural lifestyle of local residents

Resource Production Critical Areas

- Agricultural Lands
  - Prime farmland
  - Unique farmland
  - Additional farmland of statewide importance
- Timber Production Areas
  - Suitability of area for timber production, both existing and potential
- Mineral Extraction Areas
  - Suitability of area for sand and gravel extraction

Natural Hazard Critical Areas

- Fire Hazard Areas
  - Potential for wildfire
- Flood Prone Areas
  - Potential for flooding
- Critical Air Areas
  - Class I air areas.

Some criteria for the four classes of critical areas may conflict with each other. This will occur if the uses of significant resources are incompatible. For example, the maintenance of habitats for rare or threatened species may conflict with lumbering practices. In general, ecological critical areas are considered the most important. All conflicts will have to be considered as part of the Comprehensive Management Plan.

Following are definitions of critical areas and the criteria in the order of the above outline.

Ecological Critical Areas

Ecological critical areas are defined as geographic areas which contain one or more significant natural resources that could be degraded or lost as a result of uncontrolled or incompatible development. Ecological critical areas are based on resource quality, scarcity, or the role the resource plays in the ecosystem. Used wisely, these natural resources provide many cost-free amenities and services to the public and to private landowners. Maintaining the natural system helps to provide flood control, water purification, water supply, pollution abatement, energy conservation, wildlife diversity, and a pleasing and visually diversified landscape. These areas provide sites for outdoor education, scientific study, and agricultural production of cranberries and blueberries, as well as being of psychological or philosophical value to those who gain comfort from knowing that open semi-wilderness areas and rare and endangered species and habitats still exist.

Unnecessary disturbance or pollution may destroy the natural ecological balance and may curtail natural functions or reduce their usefulness. Once lost, these resources and benefits are extremely difficult to replace. Moreover, many of these resources could be permanently lost.

Criteria for Ecological Critical Areas

Linkage or Corridors. Genetic diversity is important to maintaining the biological stability of the Pineland ecosystem. The maintenance of a diversity of biological communities and populations will be ensured by establishing genetic corridors which link populations of species. Such areas provide continuity for dispersal and genetic exchange among populations of organisms. According to Robichaud (1980), "the purpose of ...critical corridor areas is to provide protected natural corridors for dispersal and migration of native animals and plants so as to ensure optimum living and migratory space for animals and genetic exchange potential among plants in the Pinelands area and between the Pinelands and neighboring forests.... It is recognized that existing developments and infrastructures, highways particularly, prevent the establishment of an ideal corridor network for the Pinelands critical areas."

The ability of individuals to immigrate or emigrate is crucial to maintaining populations over a wide area. Fragmented populations of a species are less stable than populations linked to areas containing the same species. If an isolated population is destroyed, its chances of reestablishing itself may be poor because new colonizers may not be able to travel between areas.

The Pinelands area is unique for the number of species which reach either the northern or southern limits of their range within the Pinelands. Establishing a migratory corridor would ensure that the normal range extension for each species is maintained. The locations of protected critical areas become important for the establishment of migratory genetic corridors. A corridor along a North-South axis is essential, as well as corridors within specified watersheds from upland areas to estuaries.

Land currently in public ownership is not located in a manner that will ensure an adequate migratory corridor for genetic exchange. This is particularly true for the southern portion of the Pinelands area.

Unique or Exceptional Ecosystem. An ecosystem unit that has outstanding characteristics is referred to as a unique or exceptional ecosystem. In the Pinelands the dwarf pine forests, or pine plains, qualify as such an area because of the unusually low stature of the trees (usually less than 11 feet), unique floral composition, and closed cone habit of the pines. The two largest areas are the East Plains and the West Plains, located along the Ocean-Burlington County line near Warren Grove. The Spring Hill Plains is a smaller tract on the northern border of Penn State Forest. Although the plains vegetation is not unique (there are dwarf pitch pine forests near Albany, N.Y., and on Long Island, N.Y.), it certainly is exceptional, and it is the only example of its kind in New Jersey.

Another ecosystem unit that is considered exceptional is any Atlantic white cedar swamp that exhibits regeneration (generally after logging or fire). White cedar is not shade-tolerant; it requires bare soil and open sunlight to germinate and grow; and, unlike pitch pine and oak, it is not able to root sprout. Browsing pressure from deer also hinders the regeneration of cedar stands. Regeneration is critical to ensure the existence of white cedar swamps in the future, particularly since cedar stands have been rapidly depleted by logging in recent years. Areas where the conditions for regeneration are met and where regeneration is taking place should be protected in order to preserve this relatively rare vegetation type. Thirty-two such areas have been identified by the consultant on forest vegetation (Andropogon Associates, 1980).

Pristine Aquatic Communities. Biological systems that are free from disturbance by man are referred to as pristine. Within the Pinelands area, no biological system is truly unaffected by man because all areas have been exposed to man's effects on climate as evidenced by acid rain, ozone level changes, etc. In the Pinelands, "pristine" is applied to aquatic communities that have been exposed to the least amount of disturbance by man and that most closely resemble the original character of the Pinelands' aquatic communities.

The interactions between chemical, physical, and biological factors are responsible for the unique character of pristine aquatic communities. In general, pristine aquatic communities within the Pinelands are characterized by acidic water (pH 4.0-6.0), low nutrients, sluggish and darkly stained waters from humic acid, and species that have uniquely adapted to these conditions and successfully survived the process of competition among species. When the aquatic conditions are modified, the distribution and number of characteristic species are changed. These species tend to be eliminated or reduced in numbers and replaced by nontypical species that are either peripheral or introduced.

As an operational definition, pristine aquatic communities in the Pinelands are identified by fifteen fish species which occur repeatedly in undisturbed streams. The data are sufficient to designate aquatic communities in four streams or portions of the streams as pristine. Ten other streams or portions thereof are designated as potentially pristine due to insufficient data. Since man's effects on aquatic communities are largely as a result of activities on adjacent lands, entire watersheds containing streams with pristine or potentially pristine aquatic communities are mapped.

Headwater. Headwaters are the portions of a river system from which surface waters initially flow. These stream areas are biologically important

because they provide much of the food base for aquatic communities downstream. Headwater streams in the Pinelands typically are heavily vegetated. The vegeta tion canopy provides shade and leaf litter (detritus) which sustain detritus-feeding organisms. These organisms break down large particles of detritus into smaller particles which provide the food base for filter-feeding organisms located down-stream (Vannote, 1975). In the headwaters there is a high retention of leaf litter due to obstructions and less intense flow rates, allowing biotic activity during every month of the year.

The natural vegetation of headwaters should be undisturbed, and no nonpoint or point sources of pollution should be allowed to violate it. All headwater streams should be left tree-covered where possible, as the foliage shades the stream and helps maintain stream temperature which, in turn, helps maintain oxygen levels. At the same time, organic material is provided for the aquatic foodchain.

Protection of headwaters is particularly important to bogs in the Pinelands, for several reasons. The plant and animal life in bogs are adjusted to the low pH levels, low total dissolved solids, low suspended solids, and low nutrient levels typical of Pinelands streams. If the levels of any of these parameters are elevated substantially, the species pool will change. Many bogs contain rare plant and animal species that are either sensitive to changes in water quality or would be unable to compete successfully with other species that would begin to appear if the water quality were altered.

Headwaters are mapped as all sub-drainage basins located at the upper reaches of the main trunk of the stream and all sub-drainage areas containing bogs.

Nationally Endangered and Threatened Plant or Animal Species. Most of the federally listed endangered species for New Jersey are oceanic species of fish and turtles. However, the endangered bald eagle (Haliaeetus leucocephalus) overwin-ters in the Pinelands, and these wintering areas are considered. A program to reintroduce the endangered peregrine falcon (Falco peregrinus) is being carried out under the New Jersey Endangered and Nongame Species Program, and the current and proposed release sites are included in the critical area evaluation. No plants are included in the most recent list for New Jersey, although a number of plants are expected to be re-proposed in the near future (Hogan, 1980. Personal communication).

Diversity of Vegetation Types within a Given Area. Eight natural vegetation types are delineated for the Pinelands. They are: pine-oak forests, oak-pine forests, hardwood swamps, cedar swamps, pitch pine lowlands, bogs, inland marshes, and coastal marshes. Both the consultant report on forest vegetation (Forest Vegetation of the Pinelands, Andropogon Associates, 1980), and A Concep-tual Framework for Pinelands Decision Making (Robichaud, 1980) describe the patterns of vegetation types in the Pinelands as a mosaic that reflects moisture gradients from lowland to upland. The intricate patterns of distribution character-istic of much of the Pinelands create a rich variety of habitats for animals because, in general, different habitats are associated with different species.

A sub-drainage basin exhibiting five of the eight vegetation types was considered to have sufficient diversity of vegetation types to warrant special consideration under this criterion.

Nationally Proposed or under Review Plant or Animal Species. Before a species is added to the national list of endangered or threatened species, it must first undergo a review by the U.S. Fish and Wildlife Service Office of Endangered Species and then be proposed for inclusion in the national list. Although there is no official list of species being considered for national listing, in-house consideration is currently being given to the Pine Barrens treefrog (Hyla andersoni), which is already listed as endangered in Florida (Hogan, 1980. Personal communication).

State Endangered, Threatened, or Otherwise Jeopardized Species. All federally listed species are also included on the state list; however, since these species were considered in the above criteria, they will not be considered under this criterion.

The osprey (Pandion haliaetus) is listed as endangered in New Jersey, although it is not federally listed. Known nest sites were considered in critical areas identification. Coastal islands used for breeding by colonial nesting birds, such as the state listed endangered least tern (Sterna albifrons) and black skimmer (Rynchops niger), the state-listed declining yellow crowned night heron (Nyctanassa violacea) and common tern (Sterna hirundo), were considered, as were known rookeries of the state-listed threatened great blue heron (Ardea herodius). Areas where state endangered and threatened reptiles and amphibians have been sighted since 1970 were considered where information was available. Finally, both known and probable habitats for endangered plants (Caiazza and Fairbrothers, 1980) were considered.

Representative Vegetation Types. Areas which contain high quality examples of any of the eight natural vegetation types (oak-pine, pine-oak, hardwood swamps, cedar swamps, pitch pine lowlands, bogs, inland marshes, or coastal marshes) are considered as representative vegetation types. Selection of these areas has been carried out by consulting the literature, members of the scientific community, and the public. In some cases, assemblages of vegetation types, such as lowland complexes containing representative cedar swamps, hardwood swamps, and pitch pine lowlands, were found as a unit. Because of the fine-grained nature of the pattern of distribution, they were not separated into distinct stands of each type.

Outliers, Disjuncts, or Relict Species. The distribution of plant and animal species generally falls within distinct geographical areas. The area of distribution of a species is referred to as its range.

Some plants and animals at the limits of their ranges may be isolated groups separated from the main population of their species. These species are referred to as disjuncts or outliers. Sometimes these disjunct populations are remnants of a distribution that was more widespread in the past, reflecting a change in geologic or climatic conditions. Such remnant populations are referred to as relicts.

Several plant species found in the Pinelands are disjunct species. Examples of these include false asphodel (Tofieldia racemosa) and Pyxie moss (Pyxidanthera barbulata), both southern coastal plain species that reach their northern limit in the Pinelands, and turkey beard (Xerophyllum asphodeloides), a southern species that has its major distribution in the Appalachian Mountains (Fairbrothers, 1979).

Two disjunct plant species in the Pinelands are considered by some botanists as relict species. These are curly grass fern (Schizaea pusilla) and broom crowberry (Corema conradii), both northern species reaching their southern limit in the Pinelands (Fairbrothers, 1979). Some herptile species found in the Pinelands are considered to be relict species . An example of this is the bog turtle (Clemmys muhlenbergii) (Conant, in Forman, 1979).

Species at the Limits of their Range--North, South, East, and West. At the edge of its geographic range, an animal or plant generally encounters the most extreme environmental conditions under which it can survive. Individuals found at the edges of their ranges (at the northern, southern, eastern, or western limits) are functioning at the limits of their adaptations and may be less able to cope with environmental stresses than would be the case at the center of their range under optimal conditions.

A large number of species, both common and rare, reach the limits of their ranges in the Pinelands. For example, 13.5% of all the types of Pinelands flora are southern species that reach their northern limits in the Pinelands, while 1.8% reach their southern limit there (McCormick, 1970). Notable among the plants reaching their southern limits are the curly grass fern (Schizaea pusilla) and the broom crowberry (Corema conradii). The numerous southern plant species reaching their northern limits include turkey beard (Xerophyllum asphodeloides), false asphodel (Tofieldia racemosa), and Pyxie moss (Pyxidanthera barbulata) (Fairbrothers, 1979). Herptiles reaching the northern edges of their ranges include common species such as the rough green snake (Opheodrys aestivus) and the southern leopard frog (Rana sphenocephala), and less common species such as the northern pine snake (Pituophis m. melanoleucus), the corn snake (Elaphe g. guttata), and the Pine Barrens treefrog (Hyla andersoni) (Conant, in Forman, 1979). Some birds that breed in the Pinelands region are at the limits of their ranges in New Jersey. For example, the chuck-wills-widow (Caprimulgus carolinensis), the red-bellied woodpecker (Centurus carolinus), and the Acadian flycatcher (Empidonax virescens) approach the northern limits of their breeding ranges in the Pinelands region. The willow flycatcher (Empidonax brewsteri), the least flycatcher (Empidonax minimus), and the bobolink (Dolichonyx oryzivorus) reach the southern limits of their breeding ranges. The horned lark (Eremophila alpestris) and several duck species that are primarily prairie state breeders, have recently extended their breeding ranges eastward, including the Pinelands area (Brady, 1980).

For critical areas identification, only the rarer species were considered, based on documentation in the consultant reports. These included the Pine Barrens treefrog, the northern pine snake, the corn snake, the southern gray treefrog (Hyla chrysoscelis), and a number of endangered and threatened plants.

Restricted and Endemic Species. The evolutionary extreme of the relict condition is known as endemism. A population isolated for a long period can develop so differently from its relatives that it becomes a separate species genetically distinct from the species from which it originated.

There are two plant species that are considered endemic to the Pinelands region (McCormick, 1970). These are Pickerings morning glory (Breweria pickeringii var. caesariensis) and sand myrtle (Leiophyllum buxifolium var. buxifolium). Two plants found only in the Pinelands and in nearby Delaware are blazing star

(Liatris graminifolia var. lasis) and Knieskern's beakrush (Rhynchospora knieskernii).

Breeding Areas--Nesting, Spawning. Many species of animals concentrate in areas to breed. Migratory birds and fish are especially notable in this respect. Large concentrations of waterfowl breed in the marshes of the Pinelands region, and large numbers of herons and other colonial nesting birds concentrate in island breeding areas along the coast and in marshes further inland. Other areas which contain a diverse population of breeding bird species were also considered (Brady, 1980).

There are historical records of four migratory fish--blueback herring (Alosa aestivalis), alewife (A. pseudoharengus), Atlantic shad (A. sapidissima), and striped bass (Morone saxatilis)--which ascend Pinelands streams in the spring to spawn. The blueback herring and alewife are known to spawn in Pinelands streams. Recent reports of American shad spawning runs are unconfirmed (Zich, 1978); and striped bass used to be found in the Lower Mullica, but there are no recent confirmed records. The streams and adjacent nursery areas were considered in identifying critical areas.

Amphibians concentrate in wetlands to breed. Known locations of such concentrations, particularly of endangered and threatened species, were considered in critical areas evaluation.

Overwintering Areas. Large numbers of waterfowl congregate in the marshes of the Pinelands in the winter. Since overwintering species tend to move about, primarily in response to food availability, it is difficult to consistently pinpoint overwintering areas at any given time. Nevertheless, some areas, particularly those managed for waterfowl, tend to have predictably high concentrations from year to year.

Another type of overwintering area used as a criterion for critical areas is the deer yard. Deer tend to congregate, or "yard up," in sheltered areas that also provide a food supply, particularly during harsh winter weather. In the Pinelands, these areas are usually in pitch pine lowland swamps, cedar stands, and hardwood swamps.

Migratory Stopover Areas. The Pinelands region is located along the Atlantic flyway, a broadly defined north-south oriented route along which birds migrate in the spring and fall. Certain areas, particularly along the shoreline, serve as resting and feeding areas for shorebirds, birds of prey, and passerines flying north or south during migration. Such areas, where known, were considered in critical area evaluation.

Areas of Scientific Interest and Research. The Pinelands is an unusually well-studied area, with many areas that are important for scientific research and are well-documented by scientific investigations. These areas contain examples of different types of biologic communities and natural features. Inclusion as critical areas will ensure their availability for research and educational use.

Many of these areas were identified by consulting the literature and members of the scientific community. Areas of botanic and herpetological interest, areas of wildlife and forestry research, and water quality and land use study areas are included.

Oldest, Largest, or Exceptional Individuals. In the Pinelands, oldest, largest, or exceptional individuals refers specifically to champion trees--trees which have grown to an exceptionally large size. The New Jersey Bureau of Forestry keeps a list of the largest trees of a number of species. Thirty-five of these trees grow in the Pinelands. They include both native species (e.g., a white cedar, Chamaecyparis thyoides, with a 9'2" circumference) and exotic species (e.g., Chinese chestnut, Castanea mollissima, also with a 9'2" circumference).

Perceptual and Cultural Critical Areas

Perceptual and Cultural Critical Areas are defined as geographic areas which contain one or more significant scenic, recreational, archaeological, historical, or cultural resources that could be degraded or lost as a result of uncontrolled or incompatible development. Perceptual and Cultural Critical Areas are areas having unique combinations of features: e.g., access and proximity to water, special vegetation cover, features conducive to special types of recreation, sites or buildings possessing significant historic or archaeologic resources, land use patterns or cultural areas.

Criteria for Perceptual and Cultural Critical Areas

Scenic Areas. Criteria for scenic critical areas are being developed by a study which is being prepared for the Pinelands Commission.

Recreational Areas. Criteria for recreational critical areas are being developed by a study which is being prepared for the Pinelands Commission.

Archaeological/Historic/Architectural Areas. Archaeological/historical/architectural areas include the following: (1) sites either included or potentially eligible for inclusion (as deemed by experts) in the New Jersey State Register of Historic Places and the National Register of Historic Places; (2) a site, related to a complex of other sites, which contains significant artifacts that have yielded or are likely to yield information considered by qualified professionals in archaeology and history as important to pre-history and history; (3) buildings displaying architecture that is an outstanding example of a particular style or were designed by an important architect as identified by the Historic American Buildings Survey, Office of Archaeology and Historic Preservation, Heritage Conservation and Recreation Service, U.S. Department of the Interior.

Cultural Areas. Cultural critical areas are areas with qualities that field investigators have identified as being essential to the lifestyle of local residents. The areas have scenic or recreational value: activities such as hunting, fishing, gathering, or pleasure driving may take place there. The areas which are important to the cultural lifestyle of Pinelands residents are large contiguous forests, streams, elevated areas, pine plains, coastal waters and shorelines, and

historic sites which are commonly known and visited by local residents (Berger, 1980, and Sinton, 1980. Personal communication).

Resource Production Critical Areas

Resource Production Critical Areas are geographic areas which provide essential products supporting either the local economy or economies of a larger scale. The significant resources can be either the essential products (e.g., lumber from forests, vegetable or fruit crops, sand and gravel) or the resources necessary for the production of such essential products (e.g., soil, water). These resources are primarily economically valuable; however, secondary values may include recreational values or cultural or life support values associated with local communities (e.g., large contiguous forests). These resources can be renewable, as in the case of timber and agricultural crops, or nonrenewable, as in the case of mineral resources.

Criteria for Resource Production Critical Areas

Agricultural Lands. (This section is in part quoted from and in part adapted from U.S. Department of the Interior, Soil Conservation Service, Land Inventory and Monitoring Memorandum-NJ-1, September 11, 1978.) The criteria for critical agricultural lands are based on the U.S. Department of Agriculture Soil Conservation Service (SCS) classification system. The new system used by SCS, as pertains to New Jersey, includes prime farmland, unique farmland, and additional farmland of statewide importance. Prime farmland and farmland of statewide importance correspond to Capability Classes I, II, and III, while unique farmland was formerly classed by New Jersey's Department of Agriculture as soils for special crops.

Prime Farmland

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses (the land could be cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water). It has the soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, including water management, according to acceptable farming methods. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding. Examples of soils that qualify as prime farmlands (in the Pinelands) are Sassafras sandy loam, 2 to 5 percent slopes, and Mattapeake silt loam, 0 to 2 percent slopes.

Terms used in the following section are defined in USDA publications: "Soil Taxonomy, Agriculture Handbook 436"; "Soil Survey Manual, Agriculture Handbook 18"; "Rainfall-Erosion Losses from Cropland, Agriculture Handbook 282"; "Wind Erosion Forces in the United States and Their Use in Predicting Soil Loss, Agriculture Handbook 346"; and "Saline and Alkali Soils, Agriculture Handbook 60."

Criteria for Prime Farmland

Prime farmlands meet all the following criteria.

1. The soils have:

   a. Aquic, udic, ustic, or xeric moisture regimes and sufficient available water capacity within a depth of 40 inches (1 meter), or in the root zone (root zone is the part of the soil that is penetrated or can be penetrated by plant roots) if the root zone is less than 40 inches deep, to produce the commonly grown cultivated crops (cultivated crops include, but are not limited to, grain, forage, fiber, oilseed, sugar beets, sugar cane, vegetables, tobacco, orchard, vineyard, and bush fruit crops) adapted to the region in seven or more years out of ten; or,

   b. Xeric or ustic moisture regimes in which the available water capacity is limited, but the area has a developed irrigation water supply that is dependable (a dependable water supply is one in which enough water is available for irrigation in eight out of ten years for the crops commonly grown) and of adequate quality; or,

   c. Aridic or torric moisture regimes and the area has a developed irrigation water supply that is dependable and of adequate quality; and,

2. The soils have a temperature regime that is frigid, mesic, thermic or hyperthermic (pergelic and cryic regimes are excluded). These are soils that, at a depth of 20 inches (50 cm), have a mean annual temperature higher than 32° F (0° C). In addition, the mean summer temperature at this depth in soils with an O horizon is higher than 47° F (8° C); in soils that have no O horizon, the mean summer temperature is higher than 59° F (15° C); and,

3. The soils have a pH between 4.5 and 8.4 in all horizons within a depth of 40 inches (1 meter) or in the root zone if the root zone is less than 40 inches deep; and,

4. The soils either have no water table or have a water table that is maintained at a sufficient depth during the cropping season to allow cultivated crops common to the area to be grown; and,

5. The soils can be managed so that, in all horizons within a depth of 40 inches (1 meter) or in the root zone if the root zone is less than 40 inches deep, during part of each year the conductivity of the saturation extract is less than 4 mmhos/cm and the exchangeable sodium percentage (ESP) is less than 15; and,

6. The soils are not flooded frequently during the growing season (less often than once in two years); and,

7. The product of K (erodibility factor) times percent slope is less than 2.0, and the product of I (soils erodibility) times C (climate factor) does not exceed O; and,

8. The soils have a permeability rate of at least 0.06 inch (0.15 cm) per hour in the upper 20 inches (50 cm) and the mean annual soil temperature at a depth of 20 inches (50 cm) is less than 59° F (15° C); the permeability rate is not a limiting factor if the mean annual soil temperature is 59° F (15° C) or higher; and,

9. Less than ten percent of the surface layer (upper 6 inches) in these soils consists of rock fragments coarser than three inches (7.6 cm).

Unique Farmland

Unique farmland is land other than prime farmland that is used for the production of specific high-value food and fiber crops. It has the special combination of soil quality, location, growing season, and moisture supply needed to produce sustained high-quality and/or high yields of a specific crop when treated and managed according to acceptable farming methods. Examples of such crops are citrus, tree nuts, olives, cranberries, fruit, and vegetables.

Criteria for Unique Farmland

1. It is used for a specific high-value food or fiber crop.

2. It has a moisture supply that is adequate for the specific crop. The supply is from stored moisture, precipitation, or a developed irrigation system.

3. It combines favorable factors of soil quality, growing season, temperature, humidity, air drainage, elevation, aspect, or other conditions, such as nearness to market, that favor the growth of a specific food or fiber crop.

Additional Farmland of Statewide Importance

Additional farmland of statewide importance is land, in addition to prime and unique farmlands, that is of statewide importance for the production of food, feed, fiber, forage, and oilseed crops. Criteria for defining and delineating this land are to be determined by the New Jersey State soil scientist. Generally, additional farmlands of statewide importance include those that are nearly prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. Some may produce as high a yield as prime farmlands if conditions are favorable. In some states, additional farmlands of statewide importance may include tracts of land that have been designated for agriculture by State law.

Timber Production Areas. Many environmental factors, such as topography, soil types, depth to groundwater, ground cover, and soil acidity, determine the types of trees that are suited to New Jersey Pinelands sites. If the soil series recognized by the U.S. Soil Conservation Service are separated into groups of similar soils, generally certain forest stands grow on one series or another. It must be emphasized that the mapped line separating soil series may not coincide with the forest stand boundary of a specific site. The suitability of a site for timber production is based on

- The quality of the existing stand and
- The potential of the site, primarily based on soils.

The drainage characteristics of soils are particularly important in determining forest stand suitability. For example, muck soils are suitable for cedar, poorly drained soils such as the Atsion series are suitable for pitch pine or lowland hardwoods (e.g., red maple, black gum), and well-drained soils such as the Woodmansie series are suitable for oaks and pines.

Mineral Extraction Areas. Mineral extraction areas include deposits of sand and gravel. The suitability of areas for sand and gravel is based on three criteria that relate to soil characteristics and economic feasibility:

- Soils with a seasonal high water table greater than 1.5'
- Soils with at least a 3' depth of suitable material
- Soils not having excessive amounts of fine material, as defined in the Unified Soil Grouping System (U.S. Department of Defense, 1968). The texture classes that are suitable for sand and gravel excavation are SE, SM, SP, SC, GW, GM, GP, GC.

Natural Hazard Critical Areas

Natural Hazard Critical Areas are geographic areas in which incompatible development may result in the loss of life and property. In the Pinelands these areas include fire hazard and flood prone areas, as well as Class I air quality areas. In this case, critical areas are seen from a negative point of view: high flood waters and forests with a high kindle point are dangerous to man's health and safety.

Criteria for Natural Hazard Areas

Fire Hazard Areas. The behavior of wildfire is influenced by fuels, topography, and weather. Fuels consist of vegetation. A wildfire's rate of spread and resistance to control are determined by size, compactness, and continuity of fuels. Topographic effects in the Pinelands are limited to the degree of slope. Weather is the most important factor in determining fire behavior. Wind, temperature, and humidity are the important weather factors in the Pinelands.

Delineation of fire hazard areas is based on the Wildfire Hazard Classification System. The system classifies areas by fuel types as low, moderate, high, extreme, and variable. These ratings, based on rates of fire spread of the vegetation and its resistance to fire suppression activities, are applied to the Pinelands vegetation types, as follows:

1. Low
    a. Atlantic White Cedar
    b. Hardwood Swamps

2. Moderate

    a. Pine-oak or oak-pine greater than 20' tall and less than 20' spacing

    b. Non-Pinelands forest

    c. Prescribed burned areas

3. High

    a. Pine-oak or oak-pine greater than 20' tall and greater than 20' spacing

4. Extreme

    a. Pine-oak and oak-pine, immature

    b. Pitch pine lowlands, all size classes

    c. Plains type vegetation

    d. Old field grasses

    e. Fresh marshes

    f. Salt marshes

5. Variable (low to extreme)

    a. Cranberry bogs--hazard rating depends on growing stage and presence or absence of drought conditions.

Flood Hazard Areas. Delineation of flood hazard areas has been or is in the process of being carried out for the Federal Emergency Management Agency (FEMA) for most Pinelands municipalities. The product of these efforts are Flood Hazard Boundary Maps (FHBM) and Flood Insurance Rate Maps (FIRM). Exceptions to this are Shamong, Tabernacle, and Barnegat Townships and Chesilhurst Borough, for which flood hazard areas are not yet mapped. Most of these maps appear to be made using "approximate" methods (BCM, 1980). More accurate mapping using alluvial soils, wetlands, bogs, and waterbodies has been provided by the U.S. Soil Conservation Service.

The available mapped information is as follows:

- All areas mapped as Flood Hazard Areas on FEMA Maps (FHBM & FIRM, as available)--using "approximate" methods.

- All areas mapped as alluvial soils, wetlands, bogs and waterbodies by the Soil Conservation Service.

Critical Air Areas. The Federal Clean Air Act of 1977 provides requirements for the prevention of significant deterioration (PSD) of air quality, imposing strict allowable increments of sulfur dioxide and particulate concentrations and protect-

ing visibility in the area. Most of the Pinelands is designated as Class II. Under this classification, increases in sulfur dioxide or particulate concentrations greater than a specified increment cannot be allowed. Designation of an area as Class I imposes stricter limits, requiring that any new major source of sulfur dioxide or particulates in southern New Jersey be evaluated for its potential contribution to air quality, both in the Class I area and in its own immediate area. This criterion is satisfied if an area is designated as a Class I area. The only such area in the Pinelands is the Brigantine National Wildlife Refuge.

SOURCES OF NOMINATIONS FOR CRITICAL AREAS

Sites or locations which may qualify as critical areas were identified from a number of sources. The information collected included general background materials on the Pinelands, resource assessment reports, information from numerous government agencies and scientists, and information solicited from the public at public participation workshops.

Several reports furnished background information that was helpful in identifying critical areas and issues for the Pinelands. These include the Pinelands Technical Advisory Committee paper Goals and Actions for the Pinelands Preservation and Land Acquisition Program, Leland Merrill, et al.'s A Plan for a Pinelands National Reserve, Pine Barrens: Ecosystem and Landscape, edited by R.T.T. Forman, and Jack McCormick's, The Pine Barrens: A Preliminary Ecological Inventory.

The assessment reports contracted by the Pinelands Commission provided the most comprehensive information. These reports (indicated with an asterisk in Sources of Nominations from Consultants and the Literature, listed below) identified significant resources; cited, or in some cases mapped, their locations; and identified other considerations for protecting these resources. The reports dealt with air quality, surface water quality and quantity, aquatic ecology, birdlife, game mammals, birds and small mammals, reptiles and amphibians, threatened and endangered plants, forest vegetation, soils, forestry, and fire management.

State and federal agencies, notably the New Jersey Green Acres Program, the New Jersey Nongame and Endangered Species Project, the Fish and Wildlife Service Office of Endangered Species, and the U.S. Heritage Conservation and Recreation Service, provided much useful information, both general and site-specific, for selecting critical areas.

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Nominations for ecological critical areas were solicited from the public in a series of three public participation workshops held in Burlington, Atlantic, and Ocean Counties. Each nomination was considered in our assessment of potential critical areas. Nominations elicited from these workshops, as well as public nominations received from personal communications, are presented in Appendix B, Public Participation Process.

As an aid in cataloging sources of nominations, the following table (Table 1) was drawn up. Nominations from all sources are listed and are keyed to their

TABLE 1

Sources of Nominated Ecological Critical Areas

Nominated Ecological Critical Areas	Sources								
	National Natural Landmark--potential	National Natural Landmark--registered	National Wild & Scenic River--inventoried	National Recreational River--potential	New Jersey Natural Area--designated to System	New Jersey Natural Area--registered	Critical Area--recommended by Pinelands consultant	Critical Area--identified by public on nomination form	Critical Area--identified by public by letter, personal contact, etc.
Absecon Bay							•		
Absegami Trail Natural Area					•				
Apple Pie Hill								•	•
Area between Rt. 54 and Pinelands boundary								•	
Area between Rt. 542 and Ridgeway Boulevard								•	
Area between Lower Bank and Wading River									•
Area between Soos Place and Chatsworth-Tabernacle Rd., Rt. 563, and Southbank Rd.								•	
Area between Wrangle Brook, Ocean County Air Park, and Rt. 530 in Berkeley Township								•	
Atlantic City Reservoir							•		•
Atlantic Goose Ponds	•					•	•		
Atsion area								•	
Atsion and south of Atsion Lake							•		
Bamber Lake							•	•	
Barnegat Bay	•								
Barnegat Bay--west shore							•		
Barnegat National Wildlife Refuge	•								
Bass River State Forest									•
Batona Trail									•
Batsto Natural Area--Wharton State Forest					•				
Batsto River--north of Wharton State Forest								•	
Batsto River--lower reaches							•		•
Batsto River--from Mullica River to Hampton			•						
Batsto River--near Indian Mills and Tabernacle							•		
Batsto River--from Batsto to Indian Mills Lake							•		
Basin-tail bay areas							•		
Bear Swamp--near Red Lion Circle									•
Block 6208, Lot 26, Medford Township								•	
Block 1149, Lot 3, Vineland									•
Blue Hole--near Blue Anchor									•
Bog & wetland--Carranza Road near Hampton Gate, adjoining Wharton State Forest									•
Bogs in Tabernacle Township							•		
Bogs in Southampton Township--south of Pemberton							•		
Braddocks Mill Lake							•		
Brigantine Island							•		
Brigantine National Wildlife Refuge	•						•		
Bucks Bog								•	
Bulltown									•
Bulltown Bogs									•
Burnt Bridge						•			
Burrs Mill						•			•
Burrs Mill Branch									•

TABLE 1 (Cont'd)

Sources of Nominated Ecological Critical Areas

Nominated Ecological Critical Areas	Sources: Natural Natural Landmark--potential	National Natural Landmark--registered	National Wild & Scenic River--Inventoried	National Recreational River--potential	New Jersey Natural Area--designated to System	New Jersey Natural Area--registered	Critical Area--recommended by Pinelands consultant	Critical Area--identified by public on nomination form	Critical Area--identified by public by letter, personal contact, etc.
Butterworths Bogs									•
Calico								•	
Calico Ridge--near Martha Furnace									•
Cedar Bridge--Bellepiain State Forest						•			
Cedar Creek									•
Cedar Creek--Canoka Harbor to Bamber Lake			•						
Cedar Creek--east of Whighstown							•		
Cedar Run Lake							•		
Cedar Swamp Natural Area--Lebanon State Forest					•				
Centennial Lake							•		
Chatsworth Lake and tributaries									•
Coastal Islands							•		
Coastal marshes							•		
Cole Brook								•	•
Cranberry Bog							•		
Cranberry Wildlife Management Area							•		
Deer Run--near Chatsworth									•
Corridor--between northern and southern forests									•
Curtis Pond--near Johnson Place off Soby Place Road									•
Delaware Bayshore--Reed's Beach to Maurice River							•		
Delaware Bayshore marshes between Heislerville and Elcora							•		
Delette Mistletoe Woods--Wharton State Forest						•			
Dennis Creek area							•		•
Dennis Creek Basin--Hardwood swamp near Clermont							•		
Dennis Creek--to headwaters in Cedar Swamp				•					
Double Trouble area									•
Dover Forge--between Lacey Road, Dover Road, and Garden State Parkway								•	
East Plains	•					•	•	•	
Egg Harbor--area along Rt. 30 between Hammonton and Egg Harbor City									•
Estell Manor--Hardwood swamp							•		
Evens Bridge--Rt. 563 south of Jenkins								•	
Floodplains--all									•
Forge and abandoned bogs--behind Leisuretown									•
Forked River--below Toms River estuary							•		
Forked River Mountains								•	•
Fort Dix							•		
Fort Dix marsh							•		
Friendship							•	•	•
Friendship Bog							•		•
Friendship Creek--South Branch Rancocas Creek									•
Goose Pond--below Chatsworth									•
Gravelly Run--off Rt. 559									•
Great Bay	•						•		•
Great Bay Natural Area--Great Bay Wildlife Management Area					•				

TABLE 1 (Cont'd)

Sources of Nominated Ecological Critical Areas

Nominated Ecological Critical Areas	Sources								
	National Natural Landmark--potential	National Natural Landmark--registered	National Wild & Scenic River--inventoried	National Recreational River--potential	New Jersey Natural Area--designated to System	New Jersey Natural Area--registered	Critical Area--recommended by Pinelands consultant	Critical Area--identified by public on nomination form	Critical Area--identified by public by letter, personal contact, etc.
Great Cedar Swamp							•		
Great Egg Harbor River--Great Egg Harbor Bay to south of Mays Landing			•				•		
Great Egg Harbor River--Weymouth to Atlantic City Expressway			•						
Great Egg Harbor River--New Brooklin Lake backwater to Pennsylvania railroad crossing			•						
Great Swamp--north of Pleasant Mills							•		
Green Bank--along Mullica River									•
Greenbank State Forest--along Mullica River							•		
Greenwood Forest--joins to Lebanon State Forest near Ongs Hat									•
Grouse Meadows--Jones Mill									•
Hammonton Lake						•			
Hampton Forge									•
Hampton Furnace--Wharton State Forest						•			
Hampton Gate									•
Harris Station									•
Harrisville								•	
Headwaters of Pinelands rivers									•
Highway vegetation buffers								•	
Hog Manow Bogs							•		
Holgate					•				
Island Beach Natural Area--Island Beach State Park					•				
Island Beach Research Area and Wildlife Sanctuary	•						•		
Island Beach State Park								•	
Kennedy Pond--Colliers Mill Wildlife Management Area									•
Keswick									•
Koster								•	
Lacey Township--west of Garden State Parkway								•	
Lake Fred--Stockton State College								•	
Lakehurst									•
Lakehurst NAS							•		
Lebanon Lake									•
Lebanon State Forest							•		
Leeds Point									•
Lily Lake						•			
Little Egg Harbor--west shore							•		
Lower Bank--along Mullica River							•		•
Makepeace Reservoir area									
Manahawkin--Forked River drainage north of Rt. 72, east of Rt. 9							•		
Manahawkin Bottomland Hardwood Forest		•							
Manahawkin Natural Area--Manahawkin Wildlife Management Area					•				
Manantico Creek									
Manumuskin River							•		•
Manumuskin River--marshes below railroad bridge									•
Mary Ann Forge--at Mt. Misery									•

TABLE 1 (Cont'd)

Sources of Nominated Ecological Critical Areas

Nominated Ecological Critical Areas	Sources								
	National Natural Landmark—potential	National Natural Landmark—registered	National Wild & Scenic Rivers—inventoried	National Recreational River—potential	New Jersey Natural Area—designated to System	New Jersey Natural Area—registered	Critical Area—recommended by Pinelands commission	Critical Area—identified by public on nomination form	Critical Area—identified by public by letter, personal contact, etc.
Martha Bog—Oswego River Natural Area					•				
Martha (Martha Furnace)	•								
Martha Pond—Oswego River Natural Area					•			•	
Lower Maurice River—wetlands							•		
Maurice River—Shell Pile to 3 mi. north of Laurel Lake area				•					
Mays Landing area									•
MacDonalds Branch—Lebanon State Forest	•					•			•
McGuire Air Force Base								•	
MacKay Crossing—Bellevlain State Forest						•			
Mill Creek—Manahawkin area								•	•
Mullica River—headwaters								•	
Mullica River—Great Bay to headwaters			•						
Mullica River—east of Weekstown							•		
Mullica River—estuary to Lower Bank							•		
Nescochague Creek—lower branches									•
New Egypt—bog near farmers market off Monmouth Road									•
North Branch Forked River								•	
North Branch Forked River—Garden State Parkway to headwaters of Cave Cabin Branch								•	
North Branch Rancocas Creek—agricultural area							•		
North branch Rancocas Creek and Mt. Misery Brook (middle branch)—wetlands and ponds							•		
North Brigantine Natural Area	•				•				
Oak Island—mouth of Mullica River							•		
Oceanville Bog							•	•	
Oswego Lake							•		
Oswego River								•	
Oswego River—East Branch to Sim Place Reservoir			•						
Oswego River—West Branch to near Route 563			•						
Oswego River—west of Warren Grove							•		
Oswego River system—from Harrisville Pond to Martha, Oswego Lake, Sim Place and Warren Grove							•		
Oswego River Natural Area—Wharton State Forest					•				
Oxycoccus Bogs—above Manahawkin Lake									•
Paisley									•
Paradise—off Rt. 72									•
Pasadena—abandoned terra cotta mines—Lebanon State Forest							•		•
Patcong Lake							•		
Penn State Forest—white cedar stands, Stevenson Rd. and Rt. 72								•	
Penny Pot								•	•
Pine Barrens	•								•
Pine Plains									•
Pine Plains—east side of Rt. 539 outside Preservation Area boundary									•
Pomona Nursery							•		

TABLE 1 (Cont'd)

Sources of Nominated Ecological Critical Areas

Nominated Ecological Critical Areas	Sources								
	National Natural Landmark- potential	National Natural Landmark--registered	National Wild & Scenic River—inventoried	National Recreational River--potential	New Jersey Natural Area--designated to System	New Jersey Natural Area—registered	Critical Area--recommended by Pinelands consultant	Critical Area- identified by public on nomination form	Critical Area—identified by public by letter, personal contact, etc.
Pamona Woodpecker colonies							•		
Quaker Bridge	•								
Quaker River Natural Area—Wharton State Forest						•			
Railroad on Passic watershed							•		
Railroad - Mechesacharon—Atsion watershed							•		
Railroad--Nescochague River basin							•		
Reeds Bay							•		
Retreat									•
Scenic Easement--Route 70									•
Site Place						•	•	•	
Site proposed for high density housing, Jackson Township									•
Slim Branch--Wharton State Forest						•			
Sleeper Branch—lower branches									•
Smithville area								•	
Spring Hill Basins	•					•	•		
South Branch Rancocas Creek—to Vincentown									•
South Branch Rancocas Creek—south of Medford--agricultural area							•		
Southold								•	
Springers Brook—Wharton State Forest									•
Stafford Forge--West Creek									•
Stephens Creek									•
Success Lake							•		
Timber and Beaver Swamp—Dennis Creek							•		
Timber and Beaver Swamp & Wildlife Management Area						•			
Toms River--upper reaches and floodplain									•
Toms River--tributaries				•					
Tuckahoe River—Great Egg Harbor Bay to Tuckahoe			•				•		
Tuckahoe River--Middle River from Great Egg Harbor Bay to north of Corbin City			•						
Tuckahoe River--upper reaches, inland marsh							•		
Tuckerton Marsh	•								
Tuckerton Trail									•
Tuppenocken Creek--to south of Speedwell							•		
Upper Great Egg Harbor River--northwest of Lake Lenape								•	
Wading River—headwaters								•	
Wading River watershed	•								
Wading River—confluence with Mullica River to east and west branching point			•						
Warren Grove							•		
Webbs Mill								•	
Webbs Mill Brook--both sides Rt. 539							•	•	•
Weiss Mill								•	
West Creek—mouth to Picket Factory Pond				•					
West Jersey Cranberry Meadows							•		•
West Plains							•	•	
Westecunk Creek—including tributaries									•

TABLE 1 (Cont'd)

Sources of Nominated Ecological Critical Areas

Nominated Ecological Critical Areas	Sources								
	National Natural Landmark--potential	National Natural Landmark--registered	National Wild & Scenic River--inventoried	National Recreational River potential	New Jersey Natural Area--designated to System	New Jersey Natural Area--registered	Critical Area--recommended by Pinelands Consultant	Critical Area--identified by public on nomination form	Critical Area--identified by public by letter, personal contact, etc.
Wetland--south of Coventry Rd									•
Wetlands--Lebanon State Forest						•	•	•	
Wildlife preserve--Manchester Boulevard, Crestwood Village area								•	
Woodbine Airport							•		
Woodland Township								•	

sources by a dot placed in the appropriate source column. In many cases, the boundaries of areas nominated from several sources are not specified, and place names are used to indicate their approximate location.

RANKING ECOLOGICAL CRITICAL AREAS

Critical areas definition, inventory, policy setting, and planning are of little value unless the plans can be implemented. Although much attention has been given to gathering data on critical areas, it is necessary to focus upon the relative importance of particular types of lands and establish planning, regulatory, and acquisition priorities. Setting priorities is a major step toward implementation.

The reason for ranking critical areas is based upon the need to display levels of criticality among different areas. A gradation of resource values on the basis of criticality lends more meaning to the term "critical area." Ranking methods are merely a means of differentiating levels of criticality for the purpose of selecting areas in which management strategies are most urgently needed. The ranking method applied to ecological critical areas is based upon the significant resources found in each area and the importance these resources have. A second level of evaluation must be applied to areas that rank high in value in order to determine more precisely their relative need for protection. The second level of criteria is described in the section on Criteria for Critical Area Protection and Acquisition.

As many as 14 different types of rating and scaling systems have been developed for setting priorities in critical areas, environmental assessment, facility siting, and regional planning studies. Most of these methods are quantitative in nature. Qualitative statements are helpful; however, quantitative statements are generally considered more useful in decision making (Leopold, 1969).

The rating systems that have been developed so far differ in the number of variables considered, the level of detail of information required in producing a numerical rating for any particular variable, and the mathematical manipulations performed in arriving at a final overall rating for the area or feature under consideration.

The major lessons to be learned about rating systems are that there must be explicit documentation of the following factors:

- The criteria considered
- The scaling technique applied
- Assumptions made in assigning values.

The criteria have been discussed in detail in the section on Definitions of Critical Areas and Criteria. The latter two factors are discussed in this section.

The actual delineation of critical areas occurs as a series of decisions beginning with the identification of criteria, the collection of data, the identification of specific locations, the ranking of sites, and site reconnaissance. In this process, sub-drainage basins are a logical geographic unit for delineation of critical areas because the quality, quantity, and drainage pattern of surface waters within

sub-drainage basins have a significant effect on the integrity of the natural system. Therefore, subdrainage basins are the basic map unit for this study.

In some instances, because of wide differences from headwaters to estuaries on the trunks of major streams, the trunks are subdivided to reflect differences. Due to the lack of defined surface drainage patterns in coastal areas, coastal marshes are grouped together based on the bays into which they drain. Offshore land areas also are associated with adjacent bays. In all, 399 map units are delineated. Figure 1 shows how the map units are numbered. These numbers correspond to those in the Ecological Critical Area Data Sheets in Appendix C.

The Scaling Technique

The method used in this study ranks the inherent qualities of each map unit on the basis of summation of importance values assigned to the criteria associated with resources found in the map unit. The importance values are intended to differentiate the criteria on the basis of their contribution to the essential ecological character of the Pinelands. In this method, the Pinelands staff, knowledgeable scientists, and the public assign weighted values (termed importance values) to the criteria. The summation of the importance values of all the criteria associated with a map unit yields a numerical value, which is then ranked in comparison to the values of all the other map units. This method is usually referred to as a weighting summation model. The procedure used by those who ranked ecological critical areas is outlined below.

1. The individual assigns an importance value to each criterion. The value must be from one to ten (ten is the highest value, one is the lowest value).

2. Importance values of all criteria occurring in each critical area are added.

3. The critical areas are ranked based on total points. The area with the most total points is ranked highest, the area with the least total points is ranked lowest.

4. The individual determines if areas of the same or similar rank represent his or her values.

5. Sites are ranked according to the individual's final decisions.

The method does not attempt to consider the degree to which the area satisfies each criterion, because the available data do not allow such a sophisticated distinction. For example, although habitats for rare and endangered species have been identified, it is not possible to rate the areas with habitats according to the quality of habitats provided. All sites for each criterion are therefore treated as equal.

In order for the weighting summation model to accurately represent decision maker preferences, a ratio level of measurement is necessary. That is, a criterion rated four must be twice as important as one rated two. Many existing models do not consider ratio levels of measurements. Another problem with some ranking methods is that they sum together values of incompatible criteria, generally in the case of conflicts among uses associated with different resources.

NEW JERSEY
PINELANDS
MERCER
TRENTON
PHILADELPHIA
CROSSWICKS CREEK
TOMS RIVER
NORTH BRANCH BANCOCAS CREEK
CEDAR CREEK
COOPER RIVER
SOUTH BRANCH BANCOCAS CREEK
FORKED RIVER
BATSTO RIVER
ATSION SLEEPER BRANCH
NESCOCHAGUE CREEK
HAMMONTON CREEK
BASS RIVER
E.H. TUCKERTON CREEK
UPPER GREAT EGG HARBOR RIVER
LOWER MULLICA RIVER
GREAT BAY LITTLE BAY
ABSECON CREEK
REEDS BAY
PATCONG CREEK
ATLANTIC CITY
GREAT EGG HARBOR BAY
TUCKAHOE RIVER
DENNIS CREEK
OCEAN
ATLANTIC
DELAWARE BAY
Cape May
Avalon
REGIONAL LOCATION
NEW JERSEY
NUMBERED SUB-DRAINAGE BASINS/MAP UNITS

FIGURE 1

Assumptions and Results

Figure 2 displays the relative importance values associated with each map unit. From looking at this map, it is clear that almost every map unit in the Pinelands has one or more significant natural resources and qualifies as a critical area. However, there is a pattern to the areas that are highly ranked, and, interestingly, this pattern is very similar to the map of areas most important to preserve, which was prepared by the Conceptual Framework consultants (Robichaud, 1980).

In determining relative criticality, values must be assigned to each criterion. Information on how people valued different criteria for ecologically critical areas was gained from public workshops, from a survey of the Pinelands Commission staff, natural scientists with knowledge of the Pinelands, and from the consultants (Rogers, Golden & Halpern) who compiled the criteria and definitions on critical areas.

Table 2 shows how the different groups ranked the criteria for ecological critical areas. The ranks of average scores from the workshops, shown in the right-hand column in Table 2, are very similar to the ranks of the staff, scientists, and consultants in the more highly valued criteria and the lower-valued criteria. In all cases, pristine aquatic communities, headwaters, and unique or exceptional ecosystems were ranked in the top three. Linkage corridors, nationally endangered species, breeding areas, state endangered, threatened and declining species, and diversity of vegetation types were also considered to be of relatively high value as criteria.

Table 3 shows the importance values assigned to the criteria for ecological critical areas. Again the scores are very similar for the more highly valued criteria and the lower valued criteria. The range in values is also very similar.

The major differences between the values of the staff, scientists, and consultants and the values of the public groups appear to be in the breeding areas, which the public values more than the staff, scientists, and consultants; and the outliers, disjuncts, or relicts, which the staff, scientists and consultants value more than the public.

The values displayed in Figure 2 are the average of the values assigned by staff, scientists, and consultants. A similar analysis was done for public values, and the relative importance of different map units was found not to differ substantially. This can be attributed to the similarity in ranking of criteria and importance values.

During the public workshops, participants were asked to consider the occurrence of more than one species for certain criteria. They were also asked to consider symbiotic and synergistic effects where two criteria occur together in one area. In most cases, the occurrence of more than one species in an area increased the area's value. On the other hand, very few changes occurred in the ranking of areas due to symbiotic or synergistic relationships. In terms of the staff, scientists and consultants, only the occurrence of more than one species in an area influenced the rank of the area.

In developing the importance values, several assumptions were made. The decision to increase the value of the criteria that refer to various species and their

habitats (criteria 5, 7, 8, 10, 11, 12, 13, 14) is based on the assumption that an area with many different types of associated species is more valuable than an area with only one species type. The rules for increasing the values (one and one-half times the value for two species associated with a criterion; two times the value for three or more species) is a decision reflecting this assumption.

The cut-off levels of the array of values (15, 20, 25, 30, 40) used to map the critical areas are based wholly on the distribution of the values. The cut-off levels are based on the need to limit the number of areas to be given first consideration in the next level of evaluation. They reflect different groups of areas according to their criticality as defined by the method, but they do not correspond to any meaningful level of ecological sensitivity. It would be inaccurate to state that areas with the lowest values are not ecologically sensitive. It can be stated that the distribution of values and the subsequent value groupings reflect criteria which, based on the participants' judgments, are essential to the ecological character of the Pinelands.

CRITERIA FOR CRITICAL AREA PROTECTION AND ACQUISITION

In the preceding section, ecological critical areas were discussed. In order to further distinguish among identified critical areas for the purpose of land use planning, resource management and the Pinelands acquisition program, several additional criteria, many of which are interrelated, should be considered. These criteria are as follows: balanced representation, management needs, use, size, location and maintenance, other classes of critical areas, development pressure, and adequacy of existing controls.

Balanced Representation. Are there any identified biological community types, species of flora or fauna, or individuals under-represented in present tracts of public land holdings? (For example, Green Acres Natural Areas Program has identified areas which would complement their current holdings of natural areas.) Is there any group of potential critical areas, associated exclusively with one criterion, that is consistently ranked low because overlap with other criteria does not occur in the mapping unit?

Management Needs. Are there any resources which require management to maintain their integrity? If so, do these areas need to be acquired to sustain the necessary level of management?

Location, Size, and Maintenance. The criterion of location, size, and maintenance is closely related to the criterion of management needs. Are there any areas large enough to be self-maintaining or easily managed? In regard to the preservation area, the Pinelands Protection Act states that it is necessary to "provide a sufficient amount of undeveloped land to accommodate specific management practices...necessary to maintain the special ecology of the preservation area" (PPA, sec. 8c). If the parcel is small and isolated, consideration must be given to the degree to which the area can be managed in a manner that will preserve its significant resources. Also, fragmented populations of plants and animals tend to be less stable. Immigration and emigration to and from population groups are limited when areas become fragmented. If a population in a given area is destroyed, it may not become reestablished if it is isolated from a source of new colonizers. Also,

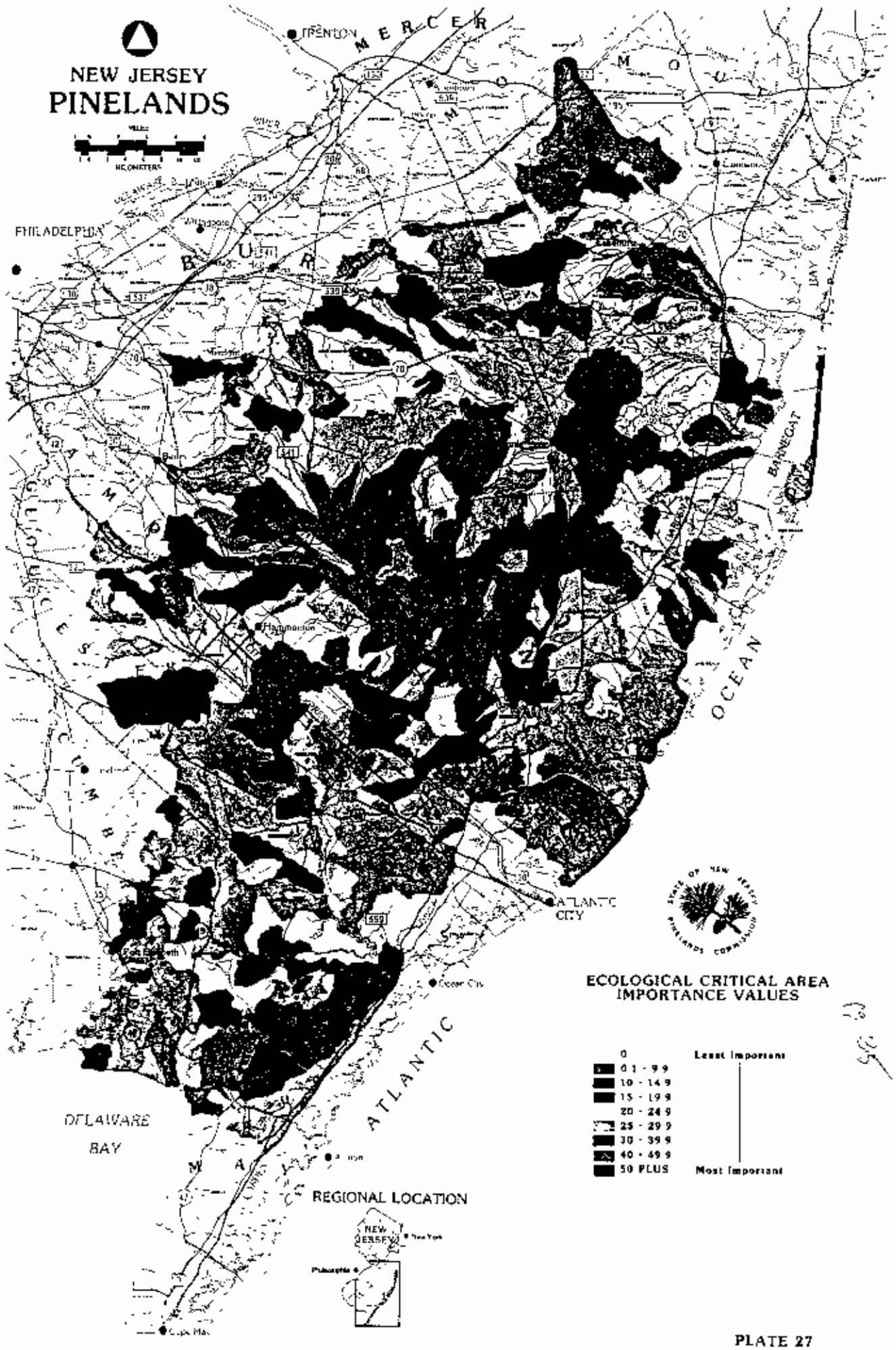
NEW JERSEY
PINELANDS
MERCER
TRENTON
PHILADELPHIA
BURLINGTON
CAMDEN
GLOUCESTER
CUMBERLAND
ATLANTIC
OCEAN
BARNEGAT
BAY
ATLANTIC CITY
Ocean City
DELAWARE
BAY
REGIONAL LOCATION
NEW JERSEY
New York
Philadelphia
Cape May
ECOLOGICAL CRITICAL AREA
IMPORTANCE VALUES
0
0.1 - 9.9
10 - 14.9
15 - 19.9
20 - 24.9
25 - 29.9
30 - 39.9
40 - 49.9
50 PLUS
Least Important
Most Important

PLATE 27

TABLE 2. RANKING OF CRITERIA FOR ECOLOGICAL CRITICAL AREAS

ECOLOGICAL CRITICAL AREA CRITERIA:	Staff, Scientists and Consultants	PUBLIC MEETINGS Burlington County	Atlantic County	Manchester Township	Average of Public Meeting
Sample Size	17	31	22	29	96
1. Pristine Aquatic Communities	1	1	1	2	1
2. Headwater	2	2	2	1	2
3. Unique or Exceptional Ecosystem	3	3	3	3	3
4. Linkage or Corridors	4	4	7	4	4
5. Nationally Endangered and Threatened Species	5	5	5	7-8	6
6. Breeding Areas--Nesting, Spawning	6	6	4	5-6	5
7. State Endangered, Threatened, Declining, or Undetermined Species	7	9	6	5-6	5
8. Nationally Proposed or Under Review Species	8	12-13	10	10	11
9. Diversity of Vegetation Types Within a Given Area	9	7	11	9	8
10. Restricted and Endemic Species	10	11	12	14	13
11. Outliers, Disjuncts or Relict Species	11	16	14	15	15
12. Migratory Stopover Areas	12	8	8	12	9
13. Representative Vegetation Types	13	12-13	13	7-8	12
14. Overwintering Concentrations	14	10	9	11	10
15. Species at Limits of Their Range--N, S, E, W	15	15	16	16	16
16. Areas of Scientific Interest and Research	16	14	15	13	14
17. Oldest, Largest or Exceptional Individuals	17	17	17	17	17

TABLE 3. IMPORTANCE VALUES OF CRITERIA FOR ECOLOGICAL CRITICAL AREAS

ECOLOGICAL CRITICAL AREA CRITERIA:		PUBLIC MEETINGS			
	Staff, Scientists and Consultants	Burlington County	Atlantic County	Manchester Township	Average of Public Meeting
Sample Size	17	31	22	19	96
1. Pristine Aquatic Communities	9.8	9.1	9.04	8.82	9.0
2. Headwater	9.2	8.55	8.52	9.17	8.8
3. Unique or Exceptional Ecosystem	8.9	8.3	8.26	8.2	8.3
4. Linkage or Corridors	8.2	7.38	6.82	7.79	7.4
5. Nationally Endangered and Threatened Species	8.0	7.2	7.39	6.89	7.2
6. Breeding Areas--Nesting, Spawning	7.4	7.06	8	7.06	6.75
7. State Endangered, Threatened, Declining or Undetermined Species	7.1	6.25	6.95	7.06	6.75
8. Nationally Proposed or Under Review Species	6.7	5.4	5.81	6.69	6.5
9. Diversity of Vegetation Types Within a Given Area	6.8	6.7	5.81	6.69	7.2
10. Restricted and Endemic Species	5.7	5.48	5.54	5.86	5.6
11. Outliers, Disjuncts or Relict Species	5.4	4.06	4.81	5.58	4.9
12. Migratory Stopover Areas	5.3	6.29	6.3	6.17	6.2
13. Representative Vegetation Types	5.3	5.4	5	6.89	5.7
14. Overwintering Concentrations	4.9	6.06	6.08	5.89	5.9
15. Species at Limits of Their Range--N, S, E, W	4.4	4.48	4.22	5.24	4.6
16. Areas of Scientific Interest and Research	3.9	4.9	4.36	6.1	5.0
17. Oldest, Largest or Exceptional Individuals	2.6	3.8	3.65	4	3.8

it is easier to manage one large tract of land than it is to manage a number of small tracts. Consideration should also be given to the facts that an area may be easier to manage if it is contiguous to publicly owned areas and that larger areas enhance genetic exchange.

Uses. Are there any critical areas which can sustain certain uses (e.g., hunting, recreation) which are limited only to those areas? Are certain critical areas (e.g., areas containing game species for hunting, recreational areas, areas supportive of local culture) more valued by the citizen of the region or state than other critical areas? What critical areas associated with particular uses are identified by state programs as being under-represented?

Sensitivity of an Area to Alteration or Destruction. Are there highly fragile or vulnerable areas which are totally incompatible with existing development? Will incompatible development result in the irreversible loss of species, habitats, high-quality water, or other sensitive resources?

Other Classes of Critical Areas. Are there any identified scenic critical areas, recreational critical areas, archaeological, historic, or architectural critical areas, or cultural critical areas within identified ecological cultural areas? (A map of cultural critical areas in shown in Appendix D.)

Development Pressure. Are there any critical areas in the "path of development" which are threatened either immediately or in the near future?

Adequacy of Existing Controls. Are there areas presently regulated, managed, and/or owned in a manner that ensures the protection of the significant resources and critical areas? Adequacy is the key word. Certain controls may appear to protect the resource (i.e., state ownership); however, management may be required. Existing controls must consider both ownership and management. Acquisition will facilitate preservation only to the extent that the management practices employed are appropriate for the significant resources.

Land acquisition may play a major role in protecting the Pinelands. Other techniques, such as performance standards, zoning regulations, and transfer of development rights, may be considered before acquisition; however, acquisition may be the only effective alternative in some instances.

Explicit guidelines for the Pinelands acquisition program are not provided in either the National Parks and Recreation Act of 1978 or the State of New Jersey Pinelands Protection Act of 1979. As pointed out by the Pinelands Technical Advisory Committee (Dr. Beryl Robichaud, August 1979), the federal legislation deals in general terms in regard to acquisition during two time periods:

- During the period in which the comprehensive plan is being developed, "Federal financial assistance (will be provided) for the acquisition of lands in the Pinelands area that have critical ecological values which are in immediate danger of being adversely affected or destroyed" (NPRA, sec. 502b).

- After approval of the plan, the Secretary of the Department of Interior "is authorized to make grants for the acquisition within the Pinelands

National Reserve of lands and waters or interests therein in a manner consistent with the management plan" (NPRA sec. 502h).

The New Jersey legislation touches on land acquisition in four ways:

- It charges the Pinelands Commission with the responsibility to "identify any lands in which the public acquisition of a fee simple or lesser interest therein is necessary or desirable in order to insure the preservation thereof, or to provide sites for public recreation..." (PPA, sec. 5).

- It cites specifically "fee acquisition of public recreation sites and ecologically sensitive areas..." as one of the variety of land and water protection techniques to be considered to carry out the goals of the legislation (PPA, sec. 7d).

- It says that "public acquisition of land or interests therein should be concentrated" in the portion of the Pinelands designated as the preservation area (PPA, sec. 2).

- The act provides that the Commissioner of Environmental Protection will have the right of first refusal to purchase land offered for sale in the preservation area (PPA, sec. 21).

The federal legislation states that the Pinelands area "provides significant ecological, natural, cultural, recreational, educational, agricultural, and public health benefits" and that "there is a national interest in protecting and preserving these benefits..." (NPRA, sec. 502a).

The state legislation states that "the Pinelands area comprises pine-oak forests, cedar swamps, and extensive surface and ground water resources of high quality which provide a unique habitat for a wide diversity of rare, threatened and endangered plant and animal species and contains many other significant and unique natural, ecological, agricultural, scenic, cultural and recreational resources"; and "that the protection of such area and resources is in the interests of the people of this State and of the Nation" (PPA, sec. 2).

When potential critical areas have been analyzed with respect to the above considerations, it will be possible to select high-priority critical areas which must be acquired or regulated in various manners. A high-priority critical area might be one which (1) has a high ranking because it contains significant resources of high value that are particularly vulnerable to the impacts of development; (2) is located in the path of development; and (3) is not adequately protected by existing regulations.

FUTURE RESEARCH NEEDS

The Pinelands have been studied by a number of investigators for over 100 years. Much is known about the Pinelands water, soils, plants and animals and their habits and distribution. This unusually well-studied area has provided a substantial amount of data on critical areas and existing resources. Clearly, the areas and resources identified in this study are well documented. However, additional research could help in identifying critical areas. The priority or need for additional

research is dependent upon policy and regulation requirements and, of course, the financial resources available.

The consultants identified data gaps and needs for future research in their reports to the Pinelands Commission. This information is helpful to our understanding of the validity of our critical areas identification process and allows us to identify areas that need additional data in order to be comprehensive.

Many of the gaps in data directly affected the critical areas identification process. Lack of complete distributional data for many plant and animal species may have caused areas with little available information to receive a lower ranking than they, in fact, merit. For example, areas inaccessible to herpetologists and collectors of herpetofauna prohibit reports of endangered or threatened reptiles and amphibians, and some of the more secretive species (e.g., the five-lined skink) which may be present but not observed. Similarly, information on bird distribution may be weighted toward easily accessible, popular bird observation areas, leaving less accessible areas of similar habitat largely unreported.

There is a need for the collection of additional distributional data for endangered and threatened plants and for aquatic communities, both to verify old reports and to generate new data. Other identified needs for future research include developing an increased understanding of the biology, life history, habitat requirements and adaptive strategies of Pinelands plant and animal species and their relationships to various land uses. Reiners (Forman, 1979) enumerates an array of ecological studies that could be done to promote a better understanding of the ecology of the Pinelands. Some consultants express the need for research into the effects of various land management practices, such as logging, fire, use of herbicides, and road salting. Related to management practices is the whole question of what sized area is required to maintain the level of species diversity characteristic of the Pinelands.

The relationship of identified data gaps and research needs to critical areas identification is clarified below for ecological critical areas by considering how these informational needs effect each of the criteria. For the other three classes of critical areas, data gaps are discussed on a broader level, as applicable.

Ecological Critical Areas

Linkage or Corridors

Studies should be conducted to determine to what extent roads block the movement of species from one area to another. The objectives of the studies should be to determine which species are restricted, partially restricted, and unrestricted by roads, as well as the effects of future increases in traffic. Remedies, such as underpasses, should also be studied.

Unique or Exceptional Ecosystem

The boundaries of the Pine plains need to be delineated, as this was not part of the vegetation study done for the Pinelands and there is not agreement as to their exact boundaries.

Although some areas where Atlantic white cedar is reproducing have been mapped, a complete survey to identify additional areas is recommended.

Pristine Aquatic Communities

According to the consultant report on Pinelands aquatic communities (Lloyd, 1980), there is a need for further data because additional candidate areas for designation as pristine are highly probable. Table 4, from Lloyd's report (1980), shows the availability of data by watershed for fish, invertebrates, macrophytes, and algae. Watersheds with poor or no data should be studied to improve classification.

In addition, study of the biology and distribution of rare and potentially endangered species is recommended. An investigation of the relationship between land use, water quality, and aquatic life, especially the effects of minor degradations, would greatly facilitate development of management policy for Pinelands streams.

Betz, Converse, and Murdock, in a surface water quality report to the Pinelands Commission (1980), recommend that additional water quality indices be developed, including indices based on aquatic community requirements. Additional surface water quality monitoring stations are recommended, as well as a survey procedure for landfills to detect associated water quality degradation.

Headwater

The concept of headwaters as related to critical areas should be functionally refined and reexamined as a land/water management unit. This refinement should deal with food chains and nutrient processing, hydrology, and vegetation.

Nationally Endangered or Threatened Plant or Animal Species

Research that would determine the status of Pinelands plant and animal species whose status is currently undetermined, and submission of such information to the U.S. Fish and Wildlife Service Office of Endangered Species (OES), would facilitate the protection of species that warrant this status. The OES should be encouraged to act expeditiously to protect deserving Pinelands species as would be appropriate to the designation of the Pinelands as a National Reserve.

Diversity of Vegetation Types Within a Given Area

Replacement of the three missing aerial photo flightlines needed to complete vegetation mapping and immediate mapping of these areas is necessary for identifying remaining areas that meet the criterion of diversity of vegetation types. The level of resolution of the mapping limits the delineation to that resolution. However, this is not a significant problem at the sub-drainage basin level.

Nationally Proposed or Under Review Plant or Animal Species

All available information on the biology and distribution of the Pine Barrens treefrog should be provided to the U.S. Fish and Wildlife Service Office of Endangered Species to expedite the review process for inclusion of this species on the national list. (See also Nationally Endangered or Threatened Plant or Animal Species.)

Table 4 - Summary of Data Availability by Watershed

	Fish	Invertebrates	Macrophytes	Algae
NBRan. C.	*	-	*	0
SB Ran. C	*	-	*	+
Cro. C	-	0	0	0
UMau. R	*	0	*	-
LMau. R	+	-	-	0
Man. C	-	0	-	0
Den. C	*	-	-	-
UGEH. R	*	*	*	-
LGEH. R	-	-	*	-
Tuc. R	-	0	-	0
Mul. R	*	*	-	*
Mec. R (Sle. R)	+	0	-	0
Ats. R (UMul. R)	+	-	*	*
Bat. R	+	0	-	-
Nes. R (inc. Ham. R)	*	0	-	*
Wad. R	-	0	-	0
Osw. R	-	*	-	-
UMul. R	+	*	*	0
Bas. R	-	0	-	-
Pat. C	-	-	-	0
Abs. C	0	*	-	*
Wes. C	-	0	-	-
Mil. C	*	0	0	
Oys. C-For. R	-	*	-	*
Ced. C	+	*	-	-
Tom. R	-	0	-	-
Met. R	*	0	0	0
Man. R	*	*	*	0

+ = Good
* = Moderate
- = Poor
0 = None available

State Endangered, Threatened, Declining, or Undetermined Plant or Animal Species

The State Endangered Species Project should continue its studies of the distribution and biology of endangered species, and these studies should be expanded if funding can be made available. The Project should be encouraged to work with the U.S. Fish and Wildlife Service Office of Endangered Species to ensure the protection of species warranting federal listing.

Studies should be carried out to verify old and locate new herptile sites, to acquire distributional data, habitat descriptions, life history information, and to determine the effects of pollution and of different management practices, e.g., timber harvesting and prescribed burning (Conservation and Environmental Studies Center, 1980). Similar information on the distribution and niche requirements for endangered plants also should be encouraged (Caiazza and Fairbrothers, 1980).

Representative Vegetation Types

The three missing aerial photo flightlines should be replaced and vegetation mapping undertaken promptly to help in identifying and mapping representative vegetation types. Additional consultations with scientists and other knowledgeable people are needed to provide a comprehensive and finer-grained analysis.

Outliers, Disjuncts, and Relict Species

There is a need for agreement as to which species fall into the categories of outliers, disjuncts, and relict species. Different scientists may use these terms differently, with the different applications generally being a matter of scale. Experts should be consulted to reach a concensus on the definitions of terms and to confirm the status of various species with regard to these criteria.

Limits of Range

The species that reach the limits of their ranges in the Pinelands are generally well known. However, a comprehensive list should be developed by consultation with experts.

Restricted and Endemic Species

There is a need for agreement on the application of the terms "restricted" and "endemic" to describe species of the Pinelands. Agreement should be reached by further consultation with experts.

Breeding Areas - Nesting, Spawning

The recording and confirmation of anadromous fish spawning runs should be continued. Extinction of at least twenty-eight anadromous clupeid (alewife, blueback herring, and American shad) spawning runs can be attributed primarily to the existence of man-made barriers located along watercourses which block or restrict fish passage and reduce spawning habitats (Zich, 1978). Remedial actions should be taken to restore fish passage.

Waterfowl nesting areas of colonial waterbirds are particularly well documented along the coast; however, inland breeding areas could be better

documented by conducting a breeding bird census. The birdlife consultant recommends that a complete breeding bird census be carried out and records of diversity and relative abundance be made (Brady, 1980). Also recommended are studies to determine, for each vegetation type, the minimum size tracts that can support a diverse breeding bird population and the adequate size for buffer zones, particularly in lowland and coastal areas. Study of the effect on birds of salt marsh ditching, logging, and fires is also recommended. Studies should be done to determine the best management of dredge spoil islands for colonial waterbirds.

Overwintering Concentrations

Areas where waterfowl concentrate over winter are well known, although the exact locations may change from year to year.

Surveys of deer yards should be continued, and the effects of deer browsing on cedar stands, particularly as this affects regeneration, should be closely monitored.

Migratory Stopover Areas

The entire zone of coastal marshes is considered to meet this criteria. A survey conducted in order to compile an inventory of areas where migratory birds congregate may be useful for policy considerations.

Areas of Scientific Interest and Research

Although most of the well-known scientific areas were identified for critical areas delineation, the list of areas could be expanded considerably by canvassing additional scientists and educational institutions.

Oldest, Largest, or Exceptional Individuals

The list of champion trees for New Jersey should be updated periodically as additional champion trees are located.

Perceptual and Cultural Critical Areas

Scenic Areas

The consultant on scenic areas (McKenzie, 1980) recommends that a Pinelands historic survey be undertaken to list all old structures and sort them into classes of historic and scenic value. A visual type map should be prepared by applying the definitions of visual types to be generated in the Pinelands scenic study to be completed this year. This map could be used in setting priorities for regulation and acquisition of scenic land. The magnitude of scenic impacts can be assessed on the basis of this map and the scenic scores. The information could be used to propose alternative locations or mitigation techniques for areas threatened by development. With the aid of a computer, visual type and scenic quality maps could be produced for individuals who had made the scenic type evaluation or for groups of people such as hunters or day trippers. The scores from the evaluation of types should be combined with the nomination of areas to allow the value of a scenic type to rise in proportion to the number of nominations it receives.

Finally, the preparation of case study maps of selected areas is recommended, combining type and area scores, and consideration should be given to automated area-wide mapping.

Recreation Areas

A study of recreation in the Pinelands is currently being carried out.

Archaeological/Historic/Architectural Areas

A study should be conducted to verify the predictive model developed for locating prehistoric archaeological sites (Mounier and Cavallo, 1980). The consultant on historic archaeological and architectural resources (Sinton, 1980, Personal communication) recommends that a series of inventories of historic, archaeological and architectural resources be conducted. A review of all architectural resources, especially vernacular, should be made.

The outline of each study unit should be expanded to include all aspects of the study units, as exemplified in the maritime study report. Criteria for ranking the importance of all cultural resources will vary according to study units, both archaeological and architectural. Criteria should be established for each of the study units with the help of local historical societies.

A study of management techniques and programs for historic, archaeological, and architectural resources needs to be done within each study unit. A full-time staff member familiar with cultural resources of the Pinelands should be employed.

Cultural Areas

The consultant report on Pinelands historic and cultural resources (Sinton, 1980) recommends that a three-month study be made to describe the study units identified in the consultant report as fully as possible in order to evaluate needs for historic and cultural preservation. Also recommended is a revision of the subregion, cultural and ethnic groups, historic land use, and cultural resources maps to rectify boundaries and sites, using the public review process and continuing research efforts. Further research should describe more accurately the relationships between people and their resource base during the course of an annual cycle. In order to understand cultural, social, economic, and family relationships in the Pinelands, historic research is needed. Additional cultural recommendations are discussed in the preceding section on Archaeological/Historic/Architectural Areas.

Resource Production Areas

Agricultural Lands

No future research needs have been noted for agricultural lands.

Timber Production Areas

According to the forestry report to the Pinelands Commission (N.J. Dept. of Environmental Protection, Bureau of Forest Management, 1980), a complete forest resource inventory should be conducted for the Pinelands. A forest type suitability map also should be prepared. It is also recommended that existing insect and

disease monitoring programs be continued, and that all harvest activities be monitored and documented.

Mineral Extraction Areas

Extraction areas are sometimes used as landfills, often without regard to environmental effects. Betz, Converse and Murdock (1980) recommend that landfills be surveyed for effects on water quality, particularly landfills located in upper reaches of watersheds.

Natural Hazard Critical Areas

Fire Hazard Areas

The consultant dealing with fire safety in the Pinelands (N.J. Dept. of Environmental Protection, Bureau of Fire Management, 1980) recommends that prescribed burning areas and fire hazard areas be mapped.

Flood Prone Areas

Completion of mapping for all waterways is recommended for flood prone areas.

Critical Air Areas

The air quality consultant recommends designation of the entire Preservation Area as a Class I air quality area. Currently, Brigantine National Wildlife Refuge is the only Class I air quality area in the Pinelands.

Studies of the effects of ozone on vegetation and of acid rain on Pinelands flora and fauna should provide information useful for management decisions involving air quality.

APPENDIX A

LITERATURE REVIEW

- State and Federal Critical Area Programs
- New Jersey Critical Area Programs

State and Federal Critical Area Programs

Critical environmental areas are a reflection of issues of critical environmental concern. The issues are identified with specific geographic areas and the resolution of the issues are the management strategies applied to the critical areas. A federal or state program's goals, policies, and implementation strategies dictate the critical environmental issues addressed which, in turn, are the basis for the program's critical areas selection process. The environmental issues addressed by some programs are specific and the result is a focus on one type of critical area. Other programs address a broad range of environmental issues and their selection process considers a variety of critical area types.

Federal programs which address critical areas are specific in their focus. The National Flood Insurance Program of the Department of Housing and Urban Development is concerned with development in flood hazard areas. Localities are required to implement land use controls for flood prone areas.

The Coastal Zone Management Act of 1972 is concerned with various types of critical areas contained within coastal areas. A component of a state's coastal zone management plan is the identification of areas for preservation or restoration based upon conservation, recreational, ecological, and aesthetic values. It is each state's responsibility to define what constitutes these values and to identify critical areas.

The proposed National Land Use Policy and Planning Assistance Act of 1973 was specifically concerned with the selection of a variety of critical areas for the purpose of land use planning by individual states. Although the Act was not passed, its definition of critical areas and its emphasis on the resolution of critical environmental issues have been influential in the design of state land use planning programs. The proposed National Land Use Policy and Planning Assistance Act states that "areas of critical environmental concern" are areas where "uncontrolled or incompatible development could result in damage to the environment, life or property, or the long term public interest which is of more than local significance." Such areas would include:

1. "Fragile or historic lands where uncontrolled or incompatible development could result in irreversible damage to important historic, cultural, scientific, or aesthetic values or natural systems which are of more than local significance, such lands to include shorelands or rivers, lakes, and streams; rare or valuable ecosystems and geological formations; significant wildlife habitats; and unique scenic or historic areas;

2. Natural hazard lands where uncontrolled or incompatible development could unreasonably endanger life and property, such lands to include flood plains, and areas frequently subject to weather disasters, areas of unstable geological, ice, or snow formations, and areas with high seismic or volcanic activity;

3. Renewable resource lands where uncontrolled or incompatible development which results in the loss or reduction of continued long-range productivity could endanger future water, food, and fiber requirements of more than local concern, such lands to include watershed lands,

aquifers and aquifer recharge areas, significant agricultural and grazing lands, and forest lands; and,

4. Such additional areas as the State determines to be of critical environmental concern."[1]

Some states have established programs to identify a broad range of critical environmental areas. Although work on various components of the program may occur in different state agencies, a lead agency typically has the responsibility for administering the program, assembling the data, and recommending land management strategies. Critical area programs are essential to a state's comprehensive land use planning efforts and they assist in directing regional growth patterns away from inappropriate areas.

The specificity of a state's definition of a critical area depends on its implementation needs. Some programs are shaped around broad policy statements, and important classes of areas (e.g., wetlands, historic sites, flood prone areas, etc.) may be simply listed. More specific programs may further classify critical areas (e.g., types of wetlands), ascribe goals and uses related to these areas, develop management policies, and delineate the areas on maps. The most specific programs rank each area according to its degree of criticality, and priority areas are identified for either acquisition or regulation.

The initial step in the selection of critical areas is to define the term "critical areas." The State of Maine established a register of critical areas which are:

..."areas containing or potentially containing plant and animal life or geologic features worthy of preservation in their natural condition, or other natural features of significant scenic, scientific or historic value and areas which are significantly affected by, or have a significant effect upon, existing or proposed major developments which tend to generate substantial development or urbanization."[2]

Minnesota's Critical Areas Act of 1973 directs its Environmental Quality Council to identify the following types of areas:

1. "An area significantly affected by, or having a significant effect upon, an existing or proposed major government development which is intended to serve substantial numbers of persons beyond the vicinity in which the development is located and which tends to generate substantial development or urbanization.

2. An area containing or having a significant impact upon historical, natural, scientific, or cultural resources or regional or statewide importance."[3]

The Florida Environmental Land and Water Management Act of 1972 describes "areas of critical state concern" as:

1. "An area containing, or having a significant impact upon environmental, historical, natural, or archaeological resources of regional or statewide importance; or

2. An area significantly affected by, or having a significant effect upon, an existing proposed major public facility or other area of major public investment; or

3. A proposed area of major development potential, which may include a proposed site of a new community, designated in a state land development plan."[4]

California's Office of Planning and Research has defined "areas of statewide interest" as areas with the following characteristics:

1. "They provide an essential resource base for the state's economy (changes in their use may be irreversible or might adversely affect the health, safety, or well-being of the total citizenry of the State);

2. They provide a rare or unique environment with resources attractive to people from various parts of the state;

3. They provide unique cultural or scientific assets that are characteristic of the state; and,

4. They contain natural hazards of varying degrees of intensity."[5]

California defines "areas of statewide critical concern" as a subset of areas of statewide interest. These areas are:

..."threatened by immediate changes in land use, are of high value for food and fiber production, are vital to the survival of certain life forms, are the superlatives of their kind, or are of an immediate and severe hazardous nature to the welfare of the people of the state."[6]

From the various definitions of critical environmental areas, different categories of areas common to critical area programs can be identified. The following is a listing of these categories (some of which overlap) and factors relevant to their selection.[7]

1. **Natural Wildlife Habitat Areas** are areas essential to the preservation of either game species or unique, rare or endangered species. These areas provide food, shelter, and breeding areas. They may be areas where animals seasonally concentrate (e.g., deer yards, migratory stop-over areas, aquatic spawning areas, and nesting areas for birds). The size of the area must be large enough to fulfill the species needs. It is important that the area is inherently stable. In general, an area is more likely to be stable if it contains a high diversity of flora and fauna. Additionally, a greater variety of animal species is associated with a diversity of vegetation types. The uses of these areas will vary according to the wildlife. Habitats of endangered species may have to be strictly protected while recreational hunting would be allowed in areas supporting game species.

2. **Natural Ecological Areas** are concerned with ecosystem units which are either superlative examples of their type or areas that perform a vital function in maintaining the ecological integrity and environmental

quality of a larger region. Additionally, they may be an important component in man's life support system.

3. **Scientific Areas** are areas of geological interest or areas which present ecological processes warranting study. Most of these areas have been studied, and they can be identified by experts within the local academic community. Scarcity on regional, state and national levels is an important factor.

4. **Wilderness Recreation Areas** are isolated tracts of land that are large enough to support recreational activities (e.g., camping, hiking, canoeing, etc.). Isolated wilderness areas in close proximity to population centers are the most valuable.

5. **Scenic Areas** contain natural features of sufficient aesthetic quality to warrant their preservation. There is no clear method for determining aesthetic quality; its assessment is subjective. Some methods attempt to survey the public's values of various landscapes and geological formations, while other methods review such factors as vegetative type, composition and texture, typography and geographic features. The scarcity and location of these areas is often an important consideration.

6. **Historic, Archaeological, Cultural Areas** are sites which are important to the heritage of the State or nation. These areas may contain structures or artifacts, or they may be associated with an important historic event. The sites may be considered by archaeologists as likely to yield important information. These areas are listed by state historical and heritage agencies or societies, although most of these organizations do not rate the sites according to their importance.

7. **Agricultural Lands** refer to areas used for crop production and sylviculture. The primary reason for including these lands is based on the belief that the private market is unable to incorporate long term or future agricultural demands. Soils for agriculture and forest for timber production are renewable resources when properly managed; however, development of these areas may cause irreversible damage to the resources. Soil productivity (generally based on the Soil Conservation Service's Soil Classes I, II, and, where applicable, specialty crops) and the availability of water are the factors important for crop production. State Agriculture Departments have agriculture production yield figures, and the U.S. Forest Service maintains a forest growth potential rating system to determine timber production areas. Proximity to population centers or access to transportation routes may also be a factor.

8. **Water Quality Areas** ensure the maintenance of sources of high quality water. These areas are generally aquifer recharge areas, headwaters, and wetlands that functions as a natural filter for surface waters.

9. **Mineral Extraction Areas** contain sufficient quantities of high quality minerals to warrant their protection from development which would exclude the possibility of extraction.

10. **Flood Prone Areas** are identified on the basis of the frequency of flooding. They may be either flood plain areas adjacent to rivers or

coastal areas within the hurricane zone. The U.S. Geological Survey can be used to identify the frequency of flooding in these areas.

11. **Fire Hazard Areas** are areas identified by the U.S. Forest Service and state wildfire management agencies as being particularly susceptible to forest fires. The important factors are the type and quantity of fuel accumulation and weather.

12. **Geological Hazard Areas** are characterized by a high frequency of earthquake shaking, landslides, fault displacements, subsidence, or severe erosion.

13. **Air Pollution Areas** require restraints on air pollution emissions due to periods of poor vertical air mixing and the subsequent entrapment of polluting substances. Topographic features and meterological conditions are the important factors in identifying these areas.

These types of critical areas fit into three classes of critical areas: fragile natural or historic areas (Nos. 1-6), resource production areas (7-9), and natural hazard areas (10-13). California's Summary Report, Environmental Goals and Policy describes these three classes of critical areas as:

1. These natural areas which are pleasant to behold, afford us opportunities to observe nature's processes, provide us opportunities for recreation and pursuit of outdoor activities or provide us with material for study in order to gain a better understanding of the world in which we live. Such areas are designated "Scenic, Scientific, Educational and Recreational Resource Areas;"

2. Areas which provide us with the raw materials necessary to maintain our economy; such areas are called "Resource Production Areas;" and

3. Areas (and natural phenomenon) which threaten our lives and property; such areas are designated "Hazardous Areas."[8]

Each type of critical area contains valuable resources worthy of preservation. The Wisconsin Critical Resources Information Program (CRIP) selects critical areas on the basis of the significant resources they contain. CRIP applies the term "critical" to geographically defined areas within which one or more significant resources are found.[9] Specific values are attributed to these significant resources and, hence, to critical areas.

"A significant natural or cultural resource is either one that:

1. Is recognized as being valuable by a substantial proportion of the regional, state, or national population in terms of one or more of the following values:
   a. economic (monetary value) -- for example, commercial forests
   b. physical health value -- for example, uncontaminated ground water for drinking
   c. safety value -- for example, flood storage provided by wetlands
   d. recreation value -- for example, lakes
   e. aesthetic value -- for example, architecturally significant structures

f. psychological/philosophical value -- for example, the prevention of extinction of endangered animal species
g. research value -- for example, the study of ecological relationships in wetlands
h. education value -- for example, historical events as reflected by historical buildings;

and the supply of which is or will be scarce relative to the regional, state, or national demand due to either inherent scarcity or to degradation or depletion by the action of man; or,

2. Is not necessarily recognized as being valuable by a substantial proportion of the population, but does appear to be an integral component of the life support system of man based upon expert analysis of existing evidence."[10]

CRIP classifies resources as natural or cultural, as follows:

I. Natural Resources
  A. Abiotic
    1. Hydrologic
      a. Surface Water
        (1) Lakes
        (2) Streams
      b. Ground Water
    2. Lithologic
      a. Physiography
      b. Unconsolidated Earth Materials
        (1) Soil
        (2) Unconsolidated Non-Metallic Mineral Deposits
    3. Climatic
      a. Air
  B. Biotic
    1. Botanic (vegetation)
    2. Zoologic (wildlife)
II. Cultural Resources
  A. Archeological Sites
  B. Historical Sites
  C. Architectural Sites
  D. Contemporary Sites[11]

(A further description of CRIP's delineation of resources is found at the end of this appendix.)

At this stage in critical areas identification, critical areas have been defined and broad classes of critical areas have been identified on the basis of their inherent environmental values and the intrinsic value of the resources that these areas contain. Some critical area programs go further by ranking critical areas according to their degree of criticality on the basis of various criteria, some of which are factors not directly related to the areas' inherent environmental qualities. The criteria related to an area's inherent qualities are closely associated with the factors listed for each of the 13 different types of critical areas. However, the criteria are more detailed and they differ for each program. Some

examples of criteria employed by various programs are contained at the end of this appendix.

The following criteria and considerations, which are not directly related to an area's inherent quality, are employed by some programs to assess an area's degree of criticality.

1. **Relative abundance** refers to the uniqueness and scarcity of the resources within the critical area on regional, state, and national levels.

2. **The types of critical areas in the state and their immediate relevance to citizen needs** is an attempt to ensure that the critical areas selected are perceived as reasonable by the public. Some types of critical areas (e.g., agricultural lands, areas containing game species for hunting, recreational areas, etc.) may be more valued by the citizens of the region or state than other critical areas. Additionally, the protection of other areas (e.g., aquifer recharge areas) may be essential for public health reasons.

3. **Areas of greater-than-local concern** are areas where benefits are derived by a substantial number of people outside of the region. Such areas may include historic sites, recreational wilderness areas, or scientific areas.

4. **The cost of maintaining an area** is important in terms of acquisition strategies. It is easier to manage one large tract of land than it is to manage a number of small plots. An area may be easier to manage if it is contiguous to an area already publicly owned. The cost of purchasing an area and related maintenance costs are factors that are considered in acquisition programs.

5. **Sensitivity of an area to alteration or destruction** focuses on the ecological fragility and vunerability of a critical area. In some areas incompatible development may result in the irreversible loss of species, habitats, prime agricultural soils, high quality water, or other sensitive resources. A variation is some programs' emphasis on protecting certain areas for present and future generations. The result is similar: ecologically fragile areas and areas with scarce resources are preserved.

6. **Degree of threat from incompatible development** is the necessary corollary to the previous consideration. Location is generally the key factor, i.e., is the critical area in the "path of development." Some areas (e.g., scenic and recreational areas) may be viewed as more valuable if they are in close proximity to population centers.

7. **Adequacy of existing controls** refers to how the area is presently managed, current regulations applicable to the area, and ownership. In general, local governments have not employed land use controls which are adequate to protect critical areas, particularly when an area provides substantial benefits to people outside the government's boundaries. Ownership is important because, in the absence of regulations, it determines how an area is managed. In general, critical areas in public ownership are more likely to be protected.

The above considerations are the basis for prioritizing critical areas. For example, California's Summary Report: Environmental Goals and Policy, states

that the relative criticality of a resource area (from not critical to very critical) is based on such factors as resource quality and size, location cost of maintenance, degree of threat, and degree of present or future scarcity.[12]

It is important to assign levels of criticality to specific areas. The concept of critical areas is diluted if the areas are not prioritized, particularly if a large percentage of a state's lands are designated as critical. Programs are limited as to the amount of areas they can acquire or regulate, and by ranking critical areas programs can focus their efforts on specific areas of special value.

Thus far general considerations used by various critical areas programs in the selection of critical areas have been discussed. Although the specific steps differ for each program, the major components of these programs have been outlined in a study of critical areas programs by the Smithsonian Institute. The outline follows.

A. Program Prerequisites

(1) Research to define the purpose, goals, and objectives of the inventory program.

(2) Assessment of the status of current environmental resources inventory programs at all levels.

(3) Definition of primary uses and users of inventory information.

(4) Consideration of alternative general approaches (the blanket and sample area methods) and selection of an alternative.

(5) Research to select the formats for data collection, information handling, and mapping.

(6) Research to adopt or develop criteria, where needed.

(7) Development of guidelines for inventory procedure or operation and specifications for data collection for use in the administration of the program.

(8) Development or selection of lists of factors to be inventoried and classification schemes to be used.

(9) Determination of required staffing and facilities.

(10) Provisions for public participation, including timing and duration.

B. Identification and assessment of sources of data, information, and maps.

(1) Survey, by information categories, the agencies, individuals, and publications that are sources.

(2) Assessment of adequacy of existing sources to meet the goals of the inventory.

C. Strategy for retrieving data and information.

(1) Procedure for obtaining publications and maps.

(2) Methods and procedures for communications and interaction with data sources.

D. Collection, organization, and compilation of data and information.

(1) Organization scheme of inventory library.

(2) Collection and storage of raw information.

(3) Selection of manual or computerized formats for compilation, including descriptive, statistical, and mapped information.

(4) Adaption and adoption for inventory use.

E. Storage of data.

(1) Selection of manual and/or automatic techniques.

(2) Use of manual techniques, including card files and hand-drawn maps.

(3) Use of automated techniques, including comprehensive information systems, cataloging files, and computer mapping; source of information on system design, development, and management.

F. Retrieval, display, and diffusion of data.

(1) Provisions for user access to stored information, including files and maps, and computer programming considerations when automated storage is used.

(2) Provisions for techniques for displaying or publishing written and graphic information.

(3) Provisions for techniques for making information available to agencies, organizations, and the public.

G. Updating the inventory.

(1) Accommodation of new information submitted by external sources or collected by program staff.

(2) Use of continual versus periodic updating and selection of techniques.

(3) Possible provisions for updating in the format of documents for public distribution and related scheduling.[13]

Three additional aspects of a program's selection of critical areas need to be discussed. They are inventory methods, procedures for ranking, and the delineation of critical areas.

There are two inventory methods: the blanket approach and the priority area approach. The blanket approach attempts to inventory and screen the entire state or region in terms of a set of criteria. This comprehensive approach requires a massive amount of information and it is very difficult to implement, particularly within the time and financial constraints placed on most programs. Additionally, accurate data is often unavailable.

The priority approach only investigates areas that have been nominated by experts or by existing programs. This approach narrows the areas to be inventoried, although certain areas which may meet the program's criteria will be excluded if they are not nominated.

As noted earlier, a ranking system, by focusing attention to priority critical areas, lends credibility to the designation of critical areas. Critical areas are selected on the basis of various criteria with which they are associated. A single criterion may not be viewed as especially important; however, due to the interrelated nature of many of the criteria, rarely is one criterion found isolated from others. The majority of the areas inventoried will be associated with a variety of criteria.

There are a number of methods for ranking critical areas. The simplest is to assign an equal value to each criterion and to sum up the number of criteria associated with each area. Critical areas are ranked according to the number of criteria with which they are associated.

Another method is to attempt to rate the degree to which an area satisfies a particular criterion. For example, a criterion might be acceptable water quality within streams. Since there are degrees to which this criterion can be satisfied (from fair to excellent water quality), a range of numerical values can be assigned to different levels of degree. The ranking of a critical area would correspond to the summation of the numerical values assigned to the different levels of the criteria associated with that area.

Other ranking methods assign different values to each criterion according to its relative importance. For example, criterion A may be assigned a value of five and criterion B may be assigned a value of two if A is viewed as more important than B. Again, a summation of values will rank each critical area.

Some methods combine the above two methods. The degree to which criterion A is satisifed may be rated as one to four (from fair to excellent), and A may also be assigned a weighted importance factor of five. A critical area which satisfies criterion A to a excellent degree will receive a score of four multiplied by the weighted value of five for an overall value of twenty. Again, a summation of rating values received from the associated criteria determines an area's total value.

Many ranking methods are sufficiently complex that an understanding as to why a particular area is ranked becomes virtually impossible. In view of the problems and hidden assumptions incorporated into any ranking method, this complexity is unacceptable.

Most ranking methods employ an ordinal scaling method which yields a ranking on the basis of relative importance. The interval between each integer does not correspond to an equal change in magnitude of importance. A criterion

assigned a value of six is relatively more important than a criterion with a value of three, but it would be inaccurate to state that the former is twice as important as the latter. Furthermore, "translating the result (of an ordinal scaling method) back into a meaningful statement reflecting the condition of the real world is not possible without implicitly inputting more information or making arbitrary choices."[14]

Some methods attempt to employ an interval scale for rating criteria. These methods assign values within a specific range (e.g. one to ten) to each criterion. The interval between each consecutive integer reflects an equal change in magnitude of importance. In this case, a criterion assigned a value of six is viewed as twice as important as one assigned a value of three. It is essential that the basis for assigning values is clear, and it must be recognized that such a method is dependent upon the expertise and subjective judgments of those rating the criteria. Furthermore, it is very difficult for an interval scaling method to function properly if it becomes too complex. The consideration of a vast number of criteria and some mathematical manipulations may invalidate the method. The latter may occur if the value of a criterion is used as a weighted importance factor and is multiplied to the value representing the degree to which the criterion is satisfied (as described above).

It is important to recognize that ranking methods are employed as a means to produce a differentiation between factors on the basis of relative importance. A sufficient degree of differentiation designed to yield a workable distribution of values is desired; but this is necessarily a balance between convenience and realism. Ranking systems incorporate trade-offs between factors, all of which may be deemed as important. Furthermore, it is conceivable that a particularly important criterion occurs in relative isolation from others, so that areas to which it is exclusively associated may be consistently ranked low. An example may be the habitat for an endangered species found in areas with few other associated criteria.

There are additional potential problems with ranking methods. Some criteria may conflict with others. This usually occurs when different uses are associated with different types of criteria and critical areas. For example, the recreational uses of a wilderness may destroy the habitats for certain endangered species. All ranking methods should recognize the uses implied with each criterion, and conflicts should be avoided. Unfortunately, some methods combine criteria which are inherently incompatible. The converse of this problem is the fact that some criteria combine in a synergistic manner, and a simple summation of values does not account for this synergism.

Some criteria (e.g., those related to scenic values) are based almost wholly on subjective judgements. These criteria may be best treated in a descriptive manner which is applied to the evaluation of a critical area separately from the ranking process. Also, it is necessary to check the results of ranking methods to see if they conform with knowledgeable "gestalt" judgements.

In short, ranking methods can be viewed in terms of (1) the scope of factors considered and their assigned values, (2) the extent of the mathematical manipulations employed, and (3) the extent to which value judgements, assumptions, and conflicts are "hidden" within the ranking process.[15]

The delineation of critical areas on maps must be precise enough to satisfy the program's implementation requirements. The initial mapping of nominated areas must be refined by on-site investigations to confirm the status of the resources and to determine accurate boundaries. If acquisition or regulatory control measures are to be implemented, public hearings will be necessary. This is particularly important since often local governments will have the responsibility for regulating critical areas.

Summary of New Jersey Programs Relevant to Critical Area Identification

Currently a critical areas program--the Heritage Program--is being developed for New Jersey. The available data on natural and cultural resources is collected by different agencies for different reasons; but, until the formalization of the Heritage Program, there will be no coordinated effort to apply the data towards a comprehensive selection of a critical environmental area.

The goal of the Heritage Program, which is a part of the New Jersey Department of Environmental Protection's (DEP) Office of Green Acres, is to preserve significant natural and cultural resources. "Natural heritage resources can refer to features such as botanic and zoologic species, their habitats, geologic features and natural scenic landscapes, (while) cultural heritage resources can be structures or objects which are notable for their architectural or historic value, archaeological sites, or scenic landscapes."[16]

To achieve its goal, the Heritage Program intends to accomplish the following:

1) Inventory resources, gathering data from existing studies, remote sensing techniques, and field surveying;

2) Organize resource information in a more efficient way so that it can be used for determining significant resources;

3) Evaluate the importance of New Jersey's resources and find the best ways to protect them; and,

4) Commit preservation efforts to the most significant areas in the most effective and economical way.[17]

Presently, the Heritage Program is in its initial developmental stage and it is beginning a LANDSAT demonstration project designed to provide an inventory of land cover within the Great Egg Harbor watershed.

There are a number of existing programs with which the Heritage Program will coordinate to gather information and analyze areas. The Office of Green Acres offers the following programs: the Natural Areas System, Wild and Scenic Rivers System, New Jersey Trails System, the Lands Trust Program, an acquisition program, and a tax exemption program. Once the Heritage Program is formalized, the Natural Areas System and the Wild and Scenic System, as well as the Historic Preservation Program under the Office of Cultural and Environmental Review, will become adjuncts to the Heritage Program.

The purpose of the Natural Areas System is to identify and preserve representative, unique, rare, and endangered habitats, natural communities, ecosystems, species, geologic features and other relevant natural characteristics of the State. At present, the program has designated 38 areas, all of which are on state owned lands. About 200 additional areas are being considered for inclusion on a Natural Areas Register for which ownership is not a consideration.

The purpose of the Wild and Scenic Rivers System is to preserve rivers and adjacent lands which possess outstanding scenic, recreation, geologic, aquatic communities, historic, and cultural characteristics of outstanding value.

The Lands Trust Program accepts donated lands which will be included in Green Acres' various programs. The tax exemption program is for conservation groups which preserve and maintain areas in their natural state, while Green Acres' acquisition program is responsible for acquiring lands for inclusion in their programs.

The Green Acres Program has also published a Statewide Comprehensive Outdoor Recreation Plan (SCORP) which serves as a basis for making decisions concerning open space and recreation and thereby qualifies New Jersey for continued participation in the Federal Land and Water Conservation Fund Program. In preparing SCORP, Green Acres pursued coordination with numerous relevant state and federal agencies.

Additional state agencies are involved in the identification of critical areas. The New Jersey DEP's Office of Coastal Zone Management identifies Geographic Areas of Particular Concern, Nominated Areas of Particular Concern and Areas of Special Interest. Historic preservation efforts are coordinated by the Office of Cultural and Environmental Review under its Historic Preservation Program. The Office of Flood Plain Management in the Division of Water Resources identifies flood prone areas. DEP's Division of Parks and Forests identifies fire hazard areas and specimen trees, and provides the administration of the state's parks and forests. Parks and Forests also cooperates in an advisory capacity with the Office of Green Acres through its Natural Areas Council. DEP's Division of Fish, Game and Wildlife has identified the habitats of various species, including seasonal concentration areas, rare and endangered species' habitats, and breeding and spawning areas. The New Jersey Conservation Foundation identifies natural areas which are important to preserve. The Department of Community Affairs, in the Division of State and Regional Planning, conducts projects analyzing development pressures and their predictive effect on environmentally sensitive areas. Finally, various publications have been prepared (e.g., the SCORP Plan, the Coastal Management Strategy Plan, and the South Jersey Resource Conservation and Development Area Plan) which provide an inventory of resources and identify environmentally sensitive areas.

It is the goal of the Heritage Program to coordinate with these and other relevant organizations for the purposes of providing a central source of information and for preserving significant resources in environmentally sensitive areas.

FOOTNOTES

[1]U.S. Congress, 93rd Congress, 1973. Senate Bill 268. Proposed National Land Use Policy and Planning Assistance Act of 1973, Section 601(i).

[2]Maine Legislature. 1974. Legislative Document No. 2311. An Act to Establish a State Register of Critical Areas, Portland, Maine, p. 2.

[3]Minnesota Legislature. 1973. The Critical Areas Act of 1973. H.F. No. 1659. St. Paul, Minn.

[4]Florida Legislature. 1972. The Florida Land and Water Management Act of 1972. Supplement to Florida Statutes 1981, Chapter 380, Environmental Land and Water Management. Section 380.05(2). Tallahassee, Florida.

[5]California Office of Planning and Research. 1973. Summary Report: Environmental Goals and Policy. Office of the Governor. Sacramento, Calif., p. 14.

[6]ibid, p. 14.

[7]Adopted, in part, from Center for Natural Areas, Smithsonian Institute. 1974. Planning Considerations for Statewide Inventories of Critical Environmental Areas: A Reference Guide. (Report Three). U.S. Army Corps of Engineers. Washington, D.C., pp. 52-58.

[8]California Office of Planning and Research, op. cit., p. 29.

[9]Institute for Environmental Studies, University of Wisconsin-Madison. 1973. The Investigation, Description and Recommendation of a Critical Resource Information Program (CRIP) for Wisconsin. Concepts of Resource Definitions, Uses and Measurement Criteria. Environmental Monitoring and Data Aquisition Group. Phase I Report. Madison, Wis., p. 12.

[10]ibid, p. 12.

[11]ibid, p. 12.

[12]California Office of Planning and Research, op. cit.

[13]Center for Natural Areas, Smithsonian Institute, op. cit., pp. 19-20.

[14]Brandes, C.E. 1973. Methods of Synthesis for Ecological Planning. Master's Thesis, Department of Landscape Architecture and Regional Planning. University of Pennsylvania. Philadelphia, Pa., p. 27.

[15]Center for Natural Areas, Smithsonian Institute, op. cit., p. 112.

[16]New Jersey Dept. of Environmental Protection. No date. New Jersey Heritage Program (brochure). Office of Green Acres. Trenton, N.J.

[17]ibid.

APPENDIX B

PUBLIC PARTICIPATION WORKSHOPS

PUBLIC PARTICIPATION WORKSHOPS

At three public meetings, residents of three different areas of the Pinelands participated in workshops where they were asked to describe what elements they felt were essential to the existing character of the Pinelands, what criteria should be used in the selection of ecologically critical areas, and how criteria should be ranked in order of importance to maintain the Pinelands essential character.

The public meetings were held at Burlington County College (March 6, 1980), Atlantic Community College (March 7, 1980), and the Manchester Township Municipal Building (March 11, 1980).

The objectives of these three regional meetings were:

1) To acquaint the public with the land planning work currently being done to help maintain the character of the Pinelands.

2) To gain information on what people value in the way of resources, and what people feel is essential for maintaining the integrity of the Pinelands.

3) To solicit nominations for sites which are potential critical areas.

The information gained from these meetings is helpful in setting priorities for the protection and acquisition of lands and resources in the Pinelands.

The meetings were organized into five sections:

1. Discussion of the Pinelands planning process.
2. Public forum to solicit recommendations.
3. Discussion and definition of criteria for ecological critical areas.
4. Criteria ranking of ecological critical areas by the public.
5. Scenic area survey.

Michael Bolan, of the Pinelands Commission planning staff, opened the meetings with an explanation of the meeting goals, and a short discussion of the National Parks and Recreation Act of 1978 and the New Jersey Pinelands Protection Act. He went on to describe how critical areas fit into the Comprehensive Management Planning process. He further described on a map the boundaries of the Pinelands National Reserve, Pinelands Preservation Area, Critical Area (for on-site sewage disposal) and Federal Project Review Area, and Pinelands Protection Area.

After this discussion, Mr. Bolan opened the meeting into a public forum, asking the participants to describe "what they felt were the specific elements which made up the essential character of the Pinelands." At the first Public Participation Workshop, which was held at the Burlington County College, this portion of the meeting was conducted in small discussion groups, in which at least one member of the Pinelands Commission staff or a staff member of Rogers, Golden & Halpern was present. People were encouraged to discuss what they felt was important to the essential character of the Pinelands and to nominate sites to be considered as potential critical areas. In the other Public Participation Workshops, the public's opinions and recommendations were elicited without

breaking into small groups. The audience was asked to speak freely. Each statement was recorded and compiled into a list of elements, which is shown below.

Essential Character of the Pinelands

Atlantic County

1. pine trees
2. huckleberry
3. sandy soils, no grass
4. potable water
5. surface water quality--cedar swamps
6. passive recreation opportunity--hiking, birdwatching
7. wilderness character
8. people of the Pinelands
9. water quality--threatened by toxic chemicals
10. non-degradation of water quality
11. ghost towns
12. history of Pinelands
13. cranberry bogs
14. blueberry production
15. forestry, forest products
16. vegetable crops
17. dryness, fire
18. low density, rural residential patterns
19. wildlife, fish
20. all wetlands
21. total ecosystem, its interrelationships

Manchester Township

1. clear, pure water
2. cedar swamps
3. blue skies
4. unique flora and fauna
5. wildlife habitat
6. sand and gravel pits
7. streams and waterways
8. fragility and sensitivity to disturbance
9. large areas of uninterrupted forest
10. fire ecology
11. historic sites
12. hunting and fishing opportunities
13. human ecology
14. cranberry, blueberry industries
15. hiking on sand roads
16. home of the Jersey devil
17. canoeing
18. sand pits
19. Pine Barrens treefrog
20. abandoned railroad
21. archaeologic digs
22. unconsolidated geology
23. unsuitability for farming

24. stunted forests
25. gathering
26. danger of nuclear power
27. diversity of habitat
28. low density population
29. high porosity soils, poor A horizon
30. diverse social groups
31. seasonal high water table

The list of elements which make up the Pinelands' essential character was very similar for each workshop and they included many of the elements contained in both the National Parks and Recreation Act of 1978, and the New Jersey Pinelands Protection Act. The people attending the workshops were quite knowledgeable about the Pinelands, its culture, and its resources.

The participants were next asked to recommend specific sites or areas that should be protected. The list of nominations is shown below.

Most Important Places to Preserve

Atlantic County Meeting

1. Mullica River; Egg Harbor River; Rancocas Creek, in parts; Wading River; Batona Trail; entire watersheds; Oswego River, Cedar Creek, Mill Creek
2. Plains, Pygmie forest
3. All Floodplains
4. Lower branches of Nescochague Creek, Batsto River, Sleeper Branch
5. Bass River State Forest
6. Headwater areas
7. Egg Harbor--area along Rt 30 between Hammonton and Egg Harbor City
8. State and Federal rare and endangered plants and animals
9. Corridor between northern and southern forests
10. Gravelly Run--5-6 miles east of Egg Harbor City
11. Stephens Creek

Manchester Township Meeting

1. Site proposed for high density housing, Jackson Township
2. Wetland south of Coventry Road
3. Cedar Creek basin
4. Burrs Mill Branch
5. East & West Plains
6. Webbs Mill Brook both sides Rt. 539
7. Sim Place
8. Oswego River
9. Toms River--upper reaches and floodplain
10. Land between Lower Bank and Wading River--Mullica River
11. Wading River
12. Pasadena--abandoned terra cotta mines--Lebanon State Forest
13. Sections of Roosevelt City
14. Wells Mills, Cold Brook
15. Entire Mill Creek, Stafford forge
16. Headwaters of Pinelands rivers

17. Mary Ann Forge--at Mt. Misery
18. Forked River Mountsins
19. Cedar and Pine stand below Dover Forge
20. Double Trouble area
21. Keswick
22. Historical trails
23. Coon Hill--near Chatsworth
24. Koster--Green Bank and Crowleytown
25. Whitesbog--Lebanon State Forest
26. McDonald's Branch--Lebanon State Forest
27. Lebanon Lake
28. Green Bank--along Mullica River
29. Lower Bank--along Mullica River

Finally, the public was asked to share any other concerns or issues they wished to bring to our attention. These concerns included, among others, the fear of a conspiracy to hold land for "big money" entrepreneurs; the taking issue; the fear of not being allowed to pass down accumulated wealth to succeeding generations; environmental degradation; and "undesirables" using the area for drug abuse and other anti-social activities. The lists recorded at the meetings are shown below.

Other Issues and Concerns

Atlantic County Meeting

1. pressure of recreation on fragile resource
2. conservation vs. preservation
3. proper management of natural resources
4. growth areas--suitable sites
5. promotion of forestry industry
6. landfills accepting urban wastes; influence, intrusion on Pinelands from outside

Manchester Township Meeting

1. abandoned excavation sites
2. dirt bikes--damage to woods in whole critical area
3. trash disposal in woods
4. problem of enforcement, arm for management (ref. to 2, 3, 5)
5. all off-road vehicles
   - interference with hiking
   - fire hazard
   - noise
   - impact on wildlife and sightings
   - damage to forest
6. registration of all O.T.V., other controls, stronger trespass laws
7. buffer along Rt. 70
8. intrusion of transmission and pipelines
9. reduction of development opportunities under moratorium
10. taking issue
11. economic implications of Act; municipal level
12. visual barrier of natural vegetation to shield development
13. landfills--impact on groundwater

14. miles 33.8-?? in Ocean County--Roadside maintenance Rt. 70
15. park rangers needed; municipalities cannot afford, so coordinate with county, State
16. compensation for reduced options
17. control of drug culture
18. land purchase opportunities for appropriate technology and their practitioners (incentives to move here)
19. maintenance of native vegetation; exclude exotic species, including grass
20. junk storage in yards--state incentives to remove
21. impact of Atlantic City casinos, housing
22. development pressure in Lacey Twp.
23. proper management for fire ecology in all forests
24. damage to champion trees

Following the public forum, John Rogers, of Rogers, Golden & Halpern, explained the definition of critical areas and the grouping of areas into four classes: Ecological, Perceptual and Cultural, Resource Production, and Natural Hazard. Each person was given a handout which explained in detail the definition, criteria, and sources of critical areas. (A sample handout is included at the end of this appendix.)

After the critical areas definitions were described, Mr. Rogers explained the sources of criteria and critical areas nominations. He explained that the emphasis of this workshop was placed on ecological critical areas because both acts emphasize that maintaining the "ecological integrity of the Pinelands" is of paramount importance.

The public was next asked to take part in a process of assigning ranks and importance values to criteria for ecological critical areas, and ranking selected examples of critical areas in their region from highest to lowest priority for protection. The exact procedure for this process is described below.

Before beginning the ranking process, Jeff Deis, of Rogers, Golden & Halpern, explained the definition and principles behind each criterion the public was asked to consider. The participants were next asked if they wanted to add or subtract any criteria. Finally, Mr. Rogers led them through each step of the ranking procedure. Each person was given a handout which contained the definitions of all the criteria, the procedure for ranking ecological critical areas, an example of the form they were asked to fill in, and additional forms and a map for formally nominating critical areas and for making comments.

After the forms were completed and the critical areas were ranked, the names and locations of the specific areas which had been ranked were announced. All the forms were collected at the end of the meeting. Information from the forms was analyzed and used in the ranking of ecological critical areas. For a more detailed description of the data analysis and ranking procedure, see the section in the report entitled "Ranking Ecological Critical Areas."

Public nominations for critical areas were also received from the nomination forms included in the public workshop handouts, from letters, and from personal contacts. A list of nominations that were not acquired from the public forum during the workshop follows.

Additional Ecological Critical Areas Nominations from the Public

Apple Pie Hill
Area between Rt. 54 and Pinelands boundary
Area between Rts. 50, 322, and 40
Area between 547 and Ridgeway Boulevard
Area between Sooy Place and Chatsworth-Tabernacle Rd., Rt. 563, and Southpark Rd.
Area between Wrangle Brook, Ocean County Air Park, and Rt. 530 in Berkeley Township
Atlantic City Reservoir
Atsion--botanical area
Bamber Lake
Bear Swamp--near Red Lion Circle
Bear Swamp Creek
Block 6208, Lot 26, Medford Township
Block 1149, Lot 3, Vineland
Blue Hole
Bog & wetland—Carranza Rd. near Hampton Gate, adjoining Wharton State Forest
Bucks Bog
Bull Creek
Bulltown Bogs
Burrs Mill
Butterworths Bogs--Butterworth and Bozarthtown Rds
Calico
Calico Ridge
Chatsworth Lake and tributaries
Curry Pond--near Johnson Place off Sooy Place Road
Dennis Creek area
Dover Forge--between Lacey Road, Dover Road, and Garden State Parkway
East Plains
Evens Bridge--Rt. 563 south of Jenkins
Forked River--below Toms River estuary
Friendship
Friendship Bogs
Friendship Creek--South Branch Rancocas Creek
Forge--off Burrs Mill and Retreat Roads
Goose Pond—below Chatsworth
Goose Pond--near Tabernacle on Rt. 532
Great Bay area
Greenwood Forest
Grouse Meadows--Jones Mill
Hampton Forge
Hampton Gate
Harris Station
Harrisville
Highway vegetation buffers
Holgate
Island Beach State Park
Kennedy Pond—Colliers Mill Wildlife Management Area
Lacey Township--west of Garden State Parkway
Lake Fred--Stockton State College
Lakehurst
Leeds Point

Makepeace Reservoir Area
Manahawkin—headwaters
Manumuskin River
Martha Pond—Oswego River Natural Area
Mays Landing Area
McGuire Air Force Base
New Egypt—bog near farmers market off Monmouth Road
North Branch Forked River
Oceanville Bog
Oxycoccus Bogs--above Manahawkin Lake
Paisley
Paradise—cedar swamp and bog off Rt. 72
Penn State Forest--white cedar stands, Stevenson Rd. and Rt. 72
Penny Pot
Pine Barrens
Pine Plains
Pygmie Forest--east side of Rt. 539
Retreat
Smithville Inn area
Springers Brook--Wharton tract
Southold
Tuckerton Trail—undeveloped sections
Upper Great Egg Harbor River--watershed northwest of Lake Lenape
Webbs Mill
West Jersey Cranberry Meadows
West Plains
Westecunk Creek--including tributaries to Stafford Forge
Wildlife preserve--Manchester Boulevard, Crestwood Village area
Woodland Township

APPENDIX C

ECOLOGICAL CRITICAL AREA DATA SHEETS

Absecon Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range -N, S, L, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Jarrets Run			X			X							X				
2 Atlantic City Reservoir			X			X											
3.1 South Branch			X	X		X							X				
3 North Branch			X	X		X								C			

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Atlantic Drainage - Intracoastal Waterway

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range - N, S, E, W	Restricted and endemic species	Breeding areas, nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 To Intracoastal Waterway						X		X									

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Atsion – Sleeper Branch

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their ranges - N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Mullica River	X		X				X	X	14	X		14		X			X	
1.1 unnamed Mull. R tributary			X	X					X			X		X				
2 Sleeper Branch			X	X			X		5	X		8		X				
2.1 Sleeper Branch			X							X								
3 Gun Branch			X	X			X	X	3			3		X			X	
4 Clark Branch			X	X				X	3			3						
4.1 Price Branch			X															
5 Wildcat Branch			X															
6 Cooper Branch			X															
7 Mays Mill Creek			X	X				X	X			X						
8 Atsion Lake			X				X	X	3	X		3					X	
8.1 Mullica R.-Atsion Lake			X	X			X	X	3			3						
8.2 Albuitka Branch			X	X			X		X			X		X				
9 Wescickaman Creek			X				X		12			12						

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Barnegat Bay

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range—N, S, E, W	Restricted and endemic species	Breeding areas -nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Stouts Creek														X				
2 South Branch														X				
3 Wrangle Creek														X				
4 Fresh Creek														X				
5 Waretown Creek								X		2			2		X			
6 unnamed creek										X		X	X		X			
7 Double Creek										2				X	2			
8 Gunning River															3			
9 Crooked Creek															2			
10 Big Flat Creek															2			
10 ; Fresh Creek		2													X			
11 Cedar Creek															X			
12 Manahawkin Creek															X			
13 Turtle Creek															X			
14 coastal marshes						X				2					X			
15 Barnegat Bay drainage						X		X		X			X		X			
16 Island Beach/Barnegat Inlet						X				4					3			
		3																

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Bass River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, the listing or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Bass River						X	C	X	3						X			
2 Jobs Creek						X	X		2			X			X			
3 East Branch						X	X		2						X		X	
3.1 Tommys Branch						X	X		X						X		X	
3.2 Dans Brigge Branch					X	X	X		1						X			
4 West Branch					X	X	X	X	3			2			X			
4.1 Bartletts Branch						X		X	1			2			X			

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Batsto River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjunctive, or relict species	Species at the limits of their range N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering and estivation	Migratory stopover areas	Areas of scientific interest and rare soils	Oldest, largest or exceptional individuals
1 Batsto River			X	X			X		2	X		X	X					
1.1 Batsto River				X	X		X		18	X		14					X	
1.2 Batsto River				X	X		X							X				
2 Penn Swamp Branch				X														
3 Springer Brook				X	X		X		3	X		3						
3.1 Deep Run				X	X		X		3	X		3		X				
3.2 Bard Branch				X	X		X							X				
3.3 Muskingum Brook				X	X			X	2			3						
3.4 Indian Mills Brook				X	X		X	X	3			X						
4 Skit Branch				X	X			X	5	X		3	X					
4.1 Roberts Branch				X	X		X							X				

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Cedar Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkages or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range - N, S, E, W	Restricted and endemic species	Breeding areas - nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Cedar Creek													X	3				
1.1 Cedar Creek			X	X			X	X	X			X						
2 Factory Branch			X	X			X				X							
3 Newbolds Branch			X	X			X	X	X			X						
4 Daniels Branch		X	X	X			X	X	X	X		X						
5 Bamber Lake		X	X	X			X	X	3	X		3			X		X	
5.1 Chamberlain Branch			X	X			X		X	X		X			X		X	
5.2 Webbs Mill Branch		X	X	X			X	X	3			3			X		X	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Cooper River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their ranges--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover sites	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	North Branch Cooper River																	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found

Crosswicks Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Crosswicks Creek				X		X											
1.1 unnamed tributary				X													
2 Jumping Brook				X		X							X				
3 South Run				X													
4 North run																	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Dennis Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range- N, S, E, W	Restricted and endemic species	Breeding areas- nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Dennis Creek			X					X			X	X	X				
1.1 Crew Creek			X						X				X				
1.2 Old Robins Branch			X	X		X							X				
1.3 Sluice Creek			X	X				X	X		X		X				
1.4 Ludlams Pond Branch			X				X	2			2		X				
1.5 Johnson Pond Branch			X	X			X	X			X		X				
1.6 Dennis Creek			X	X		X	X	2	X		2		2				
2 Delaware Bay drainage																	
3 East Creek			X			X							X				
3.1 Roaring Ditch			X	X									X				
3.2 Willis Run			X														
3.3 Savages Run			X	X													
4 West Creek								3	X		2		2				
4.1 West Creek				X		X	X	2	X		2						
5 Delaware Bay drainage													X				
6 Riggins Ditch				X	X			2	X		X		X	X			
7 Delaware Bay drainage					X			X						X			
8 Andrews Ditch					X			X						X			

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Forked River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjunctes, or relict species	Species at the limits of their range- N, S, E, W	Restricted and endemic species	Breeding areas, nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional wetlands
1 Forked River	1				1			X				2					
2 South Branch							X	X			X		X	X			
3 Middle Branch			1	X		X	X	2	X		2			X			
4 North Branch						X	X	2			3		X	X			
4.1 Cave Cabin Branch				X													
4.2 Long Branch				X													

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Great Bay/Little Bay

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Wiggam Creek					X			X					X	X			
2	Big Creek					X			X					X	X			
3	Great Bay coastal marshes					X			3					3	X			
4	Little Bay coastal marshes					2			1					3	X			

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Great Egg Harbor Bay

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range- N, S, L, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Drainage to Gr. Egg Har. Bay								X									

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Hammonton Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, L, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Hammonton Creek	X					X							X				
1.1 Hammonton Creek	X			X		X											
1.2 Hammonton Lake				X		X		X									
2 Brookway Branch	X			X		X											
3 Nortons Branch	X					X											
4 Petties Branch	X					X											

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found

Little Egg Harbor - Cedar Run

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage of corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	threading areas -nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Cedar Run				X		X			X				2	X			
2	Channel Creek													2				
3	Dinner Point Creek													2				
4	Mud Cove									X				X			X	
5	Manahawkin Bay								2					2				

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Little Egg Harbor - Tuckerton Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Tuckerton Creek						X			X					2	X			
1.1 Poopatong Lake						X			2			X		X	X			
1.2 Giffords Mill Branch						X	X		2			X		X	X			
1.3 Mill Branch						X	X		2			X		X	X			
2 Jesses Creek						X			X					X	X			
2.1 Thompson Creek						X			X					X	X			
3 Parker Run						X			X					X	X			
4 Sapp Creek						X			X					X	X			
5 Willis Creek						X			X					X	X			
6 Big Thorofare						X			X					X	X			
7 coastal marshed						X			3		X			2	X		X	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Lower Great Egg Harbor River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Lower Gr. Egg Harbor River								X	X			X	X				
1.1 Lower Gr. Egg Harbor River							X	X			X						
2 Lakes Creek								2			2		X				
3 English Creek													X				
3.1 Flat Creek													X				
3.2 Nell Run													X				
4 Middle River	X								X				X				
4.1 Griscom Creek	X								X				X				
4.2 Hawkins Creek	X			X					X				X				
4.3 Charley Creek	X								X				X				
4.4 Peters Creek	X												X				
4.5 Abrams Creek	X								X				X				
5 Gibson Creek				X		X		X			X		X				
5.1 Jackson Creek																	
6 Powell Creek																	
7 Mathews Run																	
8 Stephen Creek				X										X			
8.1 Stephen Lake				X										X			
8.2 James Branch								2			2			X			
9 Cove Run																	
10 South River				X		X							2	X			
10.1 South River	X			X		X		3	1		2						
10.2 Cedar Branch				X		X			1				X	X			
11 Miry Run													X				

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Lower Great Egg Harbor River (cont'd.)

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, L, W	Restricted and endemic species	Breeding areas -nesting, spawning	Overwintering fish populations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
12 Gravelly Run				X		X		X				X	X				
13 Babcock Creek				X		X	X	X			X						
13.1 Adams Branch				X													
13.2 Jack Pudding Branch				X										X			
13.3 Man Killer Branch				X													
14 Cedar Branch	X			X													

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found

Lower Mullica River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range- N, S, L, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Lower Mullica River			X		X			X	X				X	X			
1.1	Lower Mullica River		X			X	X	X	4	X	X	S		X	2		X	
1.2	Lower Mullica River	X			X	X	X	X	7	X		S	X	X	X		X	
2	Big Creek					X			X						X			
3	Fence Creek					X			X	X				X	X			
4	Tar Kiln Branch					X			X	X					X			
5	Matrix Run														X			
6	Morses Mill Stream			X	X	X		X	3			W		X	2			
7	Clarks Mill Stream			X	X	X			4			S		X	2			
8	Teal Creek				X	X			X						X			
9	Landing Creek	X		X	X	X			14	X		15		X	X			
9.1	Rubins Run				X	X			X						2			
9.2	Indian Cabin Creek	X			X													
9.3	Pilots Creek					X			6			S			2			
9.4	Union Creek								X			W						
10	Pine Creek				X	X	X		X					X	2		X	
11	Negro Creek	X	X		X		X								X			
12	Little Bull Creek				X	X	X		X			S	X	X	2			
13	Bull Creek				X	X	X		3			W	X	X	X			
14	Lucas Branch	X			X		X											
14.1	First Branch	X			X		X							X				
14.2	Second Branch	X			X													
15	Turtle Creek		X			X			X	X				X	X		X	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Manumuskin River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas - nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Manumuskin River			X			X	X	9			4		X				
1.1 Manumusken River			X	X		X		2		X	X						
2 Lawrens Branch			X														
3 Chinquapin Branch			X														
4 White Oak Branch			X				X	X			X						
5 Sweeten Water			X														
6 Bears Head Branch			X														
6.1 Cassa Bonnes Brand			X														
7 Cedar Branch			X														
8 Canute Branch			X														
9 Big Neal Branch			X	X				X			X						
10 Ingersall Branch			X	X				2			X						
11 Sharps Branch			X	X													

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Maurice River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, I, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Maurice River						X			2			Y		X	X			
1.1 Maurice River						X		X	X			X			X			
1.2 Maurice River						X			X						X			
1.3 Maurice River						X			2			X			X			
2 Clear Run															X			
3 Little Mill Creek										X				X				
3.1 Crowder Run															X			
4 Muskee Creek					X				2			X		X				
4.1 Slab Branch					X				X			X		X				
4.2 Middle Branch					X									X				
4.3 Nixons Branch					X				X					X				
5 Malaga Branch																		
6 Indian branch																		
6.1 Hayes Branch																		
6.2 Middle Branch																		
7 Scotland Run																		

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Mill Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Mill Creek				X		X			X				2	X		X	
1.1 Mill Creek				X		X								X			
2 Fourmile Branch				X		X		X		X	X						
3 Eightmile Branch						X								X			

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Nescochague Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Others, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas, nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Nescochague Creek		X		X		X	X	X			X		X				
2	Great Swamp Branch				X		X											
2.1	Drivers Branch				X													
2.2	Cedar Brook Branch																	
2.3	Upper Great Swamp Branch				X			X	X			X						
3	Albertson Brook		X					X	X			X						
3.1	Pump Branch				X		X											
3.2	Blue Anchor Brook				X				X			X						

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

North Branch Rancocas Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range N, S, E, W	Restricted and endemic species	Breeding areas -nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 North Branch Rancocas Creek				X		X		X										
1.1 North Branch Rancocas Creek								X	2			2						X
1.2 North Branch Rancocas Creek								X	2			2						
1.3 North Branch Rancocas Creek								X										X
2 Greenwood Branch			X					X	X			X						
2.1 Mirror Lake							X											
2.2 Ong Run																		X
2.3 Jacks Run-Big Pine Lake				X														
2.4 Newbold Run																		
2.5 Larkins Run																		
2.6 Bowkers Run				X														
2.7 Goodwater Run				X			X											
2.8 Hartshorne Mill Stream				X			X											
2.9 Counts Brook				X			X											
3 Bisphams Mill Creek																		
3.1 Shinns Branch			X				X			X								
3.2 Cooper Branch			X	X			X											
3.3 McDonalds Branch			X	X			X			X		2		2			X	
4 Gum Spring			X	X														
5 Mount Misery Brook			X	X			X	X	3			2						
5.1 S. Branch Mt. Misery Brook			X	X			X							X				
5.2 Middle Branch Mt. Misery Br.			X	X			X		3			3						
5.3 N. Branch Mt. Misery Brook			X	X			X		2			2		X				
5.4 Pole Bridge Branch			X	X			X	X	6			6						

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

North Branch Rancocas Creek (cont'd.)

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range- N, S, E, W	Restricted and endemic species	Breeding areas -heronry, shorebird	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
5.5 Baffin Brook			X														
5.6 Deer Park Branch			X			X		X								X	
5.7 Cranberry Branch				X		X	X	3			3		X				
5.8 Bucks Cove Run																	
o Barkers Brook																	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Oyster Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Oyster Creek				X		X	X		3	X	2		2	X				
1.1 Oyster Creek above reservoir				X		X								X				

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Patcong Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Mill Branch-Patcong Lake			X	X		X		2			2		X				
2	Maple Run			X														
3	Little Meadow			X														
4	Cedar Branch			X														
5	Blackmans Branch		X															

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Pennsauken Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Pennsaukin Creek																	
2	Cropwell Branch																	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Reeds Bay

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas -nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Doughty Creek					X		X	6			S		2	1			
2	Cordery Creek					X			1					1	1			
3	coastal marshes					X			2					2	1			

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

South Branch Rancocas Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 South Branch Rancocas Creek					X			X							2			
1.1 Southwest Branch															X			X
2 Bobbys Run																		
3 Little Creek					X			X	X	X			X		X			
3.1 Bear Swamp River															X			
3.2 Cold Water Run																		
4 Beaverdam Creek																		X
5 Jade Run					X										X			
6 Frinedship Creek					X			X							X			
6.1 Bread and Cheese Run					X												X	
7 Burrs Mill Brook				X	X						X							
7.1 South Branch				X	X			X							X			
7.2 Slab Causeway Run				X	X						X							
7.3 Burnt Bridge Branch				X	X													
7.4 Gum Spring				X	X													
8 Cedar Run					X													
9 Sharps Run																		
10 Haynes Creek											X							
10.1 Oakwood Lakes																		
10.2 Upper & Lower Aetna Lake					X			X	X			X						
10.3 Lake Pine								X	2			X						
10.4 Kettle Run																		
11 Barton Run								X	X	X		X		X				
11.1 Black Run																		

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

South Branch Rancocas Creek (cont'd.)

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering, concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
11.2 Jennings Lake																		
11.3																		
11.4																		

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Toms River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, L, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Toms River														X				
1.1 Toms River																		
1.2 Toms River								X	X			X						
2 Jakes Run					X		X	X	X			X						
3 Wrangel Brook		X			X		X	X	3			3			X			
3.1 Davenport Branch					X			X	3			3						
3.2 Davenport Branch					X		X	X	3			3			X			
3.3 Sunken Branch								X	X			X						
3.4 Michaels Branch		X			X		X		X			X			X			
3.5 Green Branch		X																
4 Union Branch									X			X						
4.1 Manahagua Brook					X		X	X	X			X		X				
4.2 Blacks Branch					X		X	X	X			X		X				
4.3 Old Hurrican Branch		X						X	2			2						
4.4 Little Hurricane Branch																		
4.5 Forked Brook																		
4.6 Goodwater Branch																		
4.7 South Ruckels Branch					X		X							X				
4.8 Middle Ruckels Branch					X									X				
4.9 North Ruckels Branch					X									X				
5 Ridgeway Branch					X		X	X	X			X						
5.1 Obhanon Ridgeway Branch					X		X							X				
5.2 Shannae Brook					X		X	X	5			3		X				
5.3 Borgons Mill Branch																		

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Toms River (cont'd.)

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range - N, S, E, W	Restricted and endemic species	Breeding areas-nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
5,4 Success Branch																		
5,5 Elisha Branch																		
5,6 Harris Branch														X				
6 Long Brook				X			X											
7 Maple Root Branch				X			X											
7,1 Goskin Branch				X														
7,2 Dark Branch				X										X				
8 Dove Mill Branch								X	X			X						

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Tuckahoe River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Link-age or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Tuckahoe River		X			X		X		2	X			X	X				
1.1 Tuckahoe River					X		X		X				X	X	X			
1.2 Tuckahoe River					X		X		4			2			X			
2 Cedar Swamp Creek														2				
3 Halfway Creek		X								X				2				
4 Flat Creek		X			X		X			X				2				
4.1 Mirey Run		X								X								
5 Mill Creek		X			X									X				
5.1 Black Run		X																
6 Warners Mill Stream																		
7 McNeals Branch									X									
7.1 Pole Bridge Branch					X													
8 Tarkiln Brook					X		X		X						X			
9 Green Branch					X				X									
10 Sharps Branch					X				2									
															1			

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Upper Great Egg Harbor River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range - N, S, L, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Upper Great Egg Harbor River	X									X								
1.1 Upper Great Egg Harbor River	X			X			X	X	3	X		3		X				
1.2 Upper Great Egg Harbor River	X						X	X	X	X		X		X				
1.3 Upper Great Egg Harbor River										X				X				
1.4 Upper Great Egg Harbor River				X			X		X			X						
2 Watering Race Branch				X														
3 Dry Run				X					X			X						
4 Mare Run	X																	
5 Big Ditch	X			X			X			X				X				
6 Deep Run	X																	
7 Little Mill Creek	X	X		X			X		X	X		X		X				
7.1 Makepeace Lake	X		X	X			X							X				
7.2 Makepeace Stream	X		X				X											
8 Indian Branch	X																	
9 Hospitality Branch		X		X			X											
9.1 Three Pond Branch				X			X											
9.2 Marsh Lake-McCarthus Lake				X			X											
9.3 White Oak Branch																		
9.4 Faraway Branch		X		X			X							X				
9.5 Whitehall Branch																		
9.6 Timber Lakes				X														
9.7 Oakland Branch																		
10 Penny Pot Stream	X						X		X			X		X				
11 Big Bridge Branch				X														

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Upper Great Egg Harbor River (cont'd.)

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range N, S, L, W	Restricted and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
12	Squankum Branch				X			X	X			X						
12.1	Hedges Branch																	
13	Ducks Nest Stream																	
14	Fourmile Branch				X													

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Wading River

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range: N, S, E, W	Restricted and endemic species	Breeding areas - nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1 Wading River				X	X	X	X	X	3	X		2			X		X	
1.1 West Branch Wading River				X	X	X	X		3	X		X		X	X			
1.2 West Branch Wading River				X	X	X	X		9			7	X					
2 Merrygold Branch				X		X	X	X	2	X		X			X			
3 Ives Branch				X	X	X	X	X	4	X		2			X			
4 Tub Mill Branch				X	X	X	X		3			X			X			
5 Arnold Branch				X	X	X	X		3			X			X			
6 Beaver Branch				X	X	X	X		3			X			X		X	
7 Beaver Run				X	X	X	X	X	2			X			X			
8 Oswego River				X	X	X	X	X	12	X	X	10		X	X			
8.1 Buck Run				X	X	X	X	X	2			X			X			
8.2 Oswego Lake				X			X	X	10	X	X	9		X	X		X	
8.3 Oswego River				X			X	X	4	X		4		X	X			
8.4 Breeches Branch				X			X		3	X	X	3						
8.5 Papoose Branch				X											X		X	
8.6 Plains Branch				X					X	X	X	X			X			
8.7 Dry Branch				X				X	X			X						
8.8 Yellow Dog Branch				X				X	3	X		3					X	
9 Tulpehocken Creek				X	X	X		X	8	X	X	3	X	X	X			
9.1 Bulls Branch				X			X	X	X	X		X						
9.2 Shane Branch				X			X			X								
9.3 Feathered Branch				X				X	2	X		2					X	
9.4 Ore Spung Branch				X				X	2	X		2						
10 Little Hawken Run				X	X	X		X	2		X		X	X				

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Wading River (cont'd.)

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria: Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range- N, S, E, W	Restricted and endemic species	Breeding areas, nesting, spawning	Overwintering zone entrations	Migratory stopover areas	Areas of scientific interest and research	Wide st, largest or exceptional individuals
11 Hospitality Brook			X	X	X			X					X	X			
12 Mile Run			X	X			X	X			X						
13 Shoal Branch			X	X		X	X	X			X						
13.1 Soreve Branch		X	X						X							X	
13.2 Sykes Branch		X	X						X								
13.3 Pope Branch	X	X	X			X			X							X	
13.4 Biddle Branch			X	X					X								
14 Pole Branch			X	X			X	6			6						
15 Risely Branch			X	X		X	X	6			5					X	
15.1 Goodwater Run			X						X								
16 Chatsworth Lake			X	X		X		5		X	5					X	
16.1 Reeds Branch			X	X													
16.2 Cates Branch			X			X											
16.3 Tibbs Branch			X	X		X											

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

Westecunk Creek

Ecological Critical Area Data Sheets

Critical Areas	Critical Areas Criteria	Linkage or corridors	Unique or exceptional ecosystem	Pristine aquatic communities	Headwater	Nationally endangered and threatened plant or animal species	Diversity of vegetation types within a given area	Nationally proposed or under review plant or animal species	State endangered, threatened, declining, or undetermined plant or animal species	Representative vegetation types	Outliers, disjuncts, or relict species	Species at the limits of their range--N, S, E, W	Riverine and endemic species	Breeding areas--nesting, spawning	Overwintering concentrations	Migratory stopover areas	Areas of scientific interest and research	Oldest, largest or exceptional individuals
1	Westecunk Creek			X	X		X							X				
1.1	Westecunk Creek			X	X		X		X		X	X			X		X	
2	Uriah Branch																	
3	Rail Branch			X														
4	Swamp Branch		X	X	X					X					X		X	
5	Governors Branch		X	X	X				X	X	X	X			X		X	

Legend

X The criterion applies to the critical area.

2 Two species from the criterion are found in the critical area

3 Three species from the criterion are found in the critical area

GLOSSARY

Areas of scientific interest and research. Areas which are important for research. Data have been collected from these areas, and their preservation is necessary so that long term trends or changes from comparative studies can be detected without interference from changes due to development. McDonald's Branch watershed (on the North Branch of the Rancocas River) and the Atlantic Goose Ponds are two such areas.

Biological Communities. The assemblage of living organisms in a prescribed area or habitat.

Breeding Areas--Nesting, Spawning. These are seasonal breeding areas for fish and birds. Large concentrations of waterfowl breed in the marshes within the Pinelands region, and four migratory fish--blueback herring, American shad, striped bass and alewife--ascend Pinelands streams to spawn in the spring. Additionally, amphibians concentrate in wetlands to breed. Also included are areas that have a high diversity of birds during the breeding season.

Community Diversity. The number of different species in a community and proportion of each to the total community population. High numbers of species occurring in relatively equal numbers means high diversity.

Criteria. Standards for making distinctions or choices.

Critical Areas. Geographic areas which contain one or more significant natural or cultural resources that could be degraded or lost as a result of uncontrolled or incompatible development; and natural hazard areas in which incompatible development may result in the loss of life or property.

Critical Areas Classes.

Ecological Critical Areas
Perceptual and Cultural Critical Areas
- Scenic Areas
- Recreation Areas
- Archaeological/Historical/Architectural Areas
- Cultural Areas

Resource Production Critical Areas
- Agricultural Lands
- Timber Production Areas
- Mineral Extraction Areas

Natural Hazard Critical Areas
- Fire Hazard Areas
- Flood Prone Areas
- Critical Air Areas.

Diversity of vegetation types within a given area. Eight natural vegetation types exist within the Pinelands. They are: pine-oak forests, oak-pine forests, hardwood swamps, cedar swamps, pitch pine lowlands, bogs, inland marshes, and coastal

marshes. This criterion is satisfied if at least five of these natural vegetation types are found within a watershed sub-drainage basin.

Ecological. Of the relationships among living organisms and elements of their environment.

Ecologically Critical Areas. Geographic areas which contain one or more significant natural resources that could be degraded or lost as a result of uncontrolled or incompatible development.

Ecosystem. A biological system in which plants, animals, and environmental factors are related to each other and in turn affected by interactions.

Estuary. A water passage where the tides meet fresh water currents.

Ethnic Enclave. Ethnic or racial groups that have settled in a geographic area and have remained without dispersing to other areas, keeping their culture intact.

Factors. Topics of concern (e.g., groundwater, plants, animals).

Flood plains (flood hazard areas, flood prone areas). Low-lying areas of land, adjacent to streams or rivers or in coastal areas, which are periodically covered by floods. Flooding may occur frequently or on the average of only once in 100 years or more.

Genetic Exchange or Gene Flow Exchange. The exchange of genetic material between organisms in reproduction that leads to variations in offspring traits.

Habitat. The place in which a biological community, a population, or one plant or animal lives.

Headwater. Headwaters are the beginning portions of a river system in which surface waters initially flow. They are more fragile and vulnerable to pollution that the mainstream portion of the river. They are important for the protection of the river system's water quality and for the reproduction of aquatic species. Sub-drainage areas containing bogs along with drainage areas in the upper reaches of the stream were mapped.

Hydrology. The study of the properties , distribution, and effects of water on the earth's surface, in soil, and underlying rocks and in the atmosphere.

Linkage or Corridor. Areas linking areas which are preserved in their natural state. The corridors created by linking natural areas together are along a north/south axis and, in some watersheds, from the upland areas of headwaters down to the estuarine portions of streams or rivers. These corridors are important in providing genetic continuity between populations of a species so that reproductive exchange can occur. Without such linkages, populations would be isolated, and eventually their adaptive capacity and viability would decrease due to a lack of genetic variability. Within the Pinelands these areas would link tracts of publicly owned lands.

Migratory Stopover Areas. Certain areas, particularly shoreline areas, serve as resting and feeding areas for birds flying north or south during migration. These areas, which are important to the Atlantic migratory flyway, have been identified.

Nationally endangered and threatened animal species. Two species on the National endangered and threatened species list, the bald eagle and the peregrine falcon, are found in the Pinelands.

Nationally proposed or under review plant or animal species. The Pine Barrens treefrog is the only species within the Pinelands which meets the criterion of a nationally proposed or under review species.

Natural and Cultural Resources. Resources classified as natural or cultural are as follows:

- Natural Resources
  - Abiotic elements
    - air
    - water
    - soil
  - Biotic elements
    - individuals
    - species
    - populations
    - communities
  - Abiotic and biotic elements combined
    - habitats
    - ecosystems
- Cultural Resources
  - ecological sites
  - historical sites
  - sites of value to the local human community's way of life.

Oldest, largest, or exceptional individuals. Oldest, largest, or exceptional individuals refers specifically to champion trees; that is, old trees which have grown to an exceptionally large size. Six such trees have been identified in the Pinelands.

Outliers, disjuncts or relict species. Some plants and animals at the limits of their ranges may occur as isolated populations separated from the main population distribution of their species. These populations are referred to as disjuncts or outliers. Sometimes disjunct populations are remnants of a distribution that was more widespread in the past. Such remnant populations are referred to as relicts. Examples of these species are the Pyxie moss, curly grass fern, and the bog turtle.

Overwintering concentrations. Large numbers of waterfowl concentrate in the marshes of the Pinelands in the winter. Also, deer congregate in sheltered lowland areas. The winter congregating areas for waterfowl and deer have been located and mapped.

Population. Groups of individuals of any one kind of plant or animal sharing a common gene pool.

Pristine aquatic communities. Freshwater streams that are relatively free from man's disturbances and contain aquatic species characteristic of the Pinelands. such as the Wading River, are considered pristine aquatic communities. In order to properly protect the aquatic communities, the watershed that contains the stream is the unit which is mapped.

Representative vegetation types. Areas areas which contain high quality examples of the eight natural vegetation types--pine-oak, oak-pine, hardwood swamps, cedar swamps, pitch pine lowlands, bogs, inland marshes and coastal marshes.

Restricted and endemic species. The extreme case of a relict species. A population isolated for a long period can develop so differently that it becomes a separate species genetically distinct from the species from which it originated. Two plant species, Pickerings morning glory and sand myrtle, are endemic to the Pinelands. Two other plants are found only in the Pinelands and in Delaware. They are the blazing star and Knieskern's beakrush.

Significant resources. Natural or cultural resources that are identified as being necessary to maintaining the essential character and integrity of the existing Pinelands environment.

Species at the limits of their range—North, South, East, West. A plant or animal species can be found distributed over a specific area. This area is the species' range. Populations of species living at the edges of their range are functioning at the limits of their adaptive capacities, and they are valuable for research study. The Pinelands is unusual in that many species reach either the northern or southern limits of their range there. Such species include the corn snake, the Pine Barrens treefrog, and broom crowberry.

State endangered, threatened, declining or undetermined plant or animal species. Examples of animal species on this list are the osprey, least tern, common tern, and the great blue heron. Known nesting and breeding sites of these species have been identified and mapped. Examples of plant species are the broom crowberry, Southern yellow orchid, and the New Jersey rush. Locations of recently recorded sitings have been mapped.

Unique or exceptional ecosystem. An ecosystem unit which has outstanding characteristics (e.g., pine plains and regenerating cedar swamp areas).

Vegetation type. A distinctive group of species which may be expected to grow naturally together in more or less the same population proportions under particular habitat conditions.

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