REPTILES AND AMPHIBIANS OF THE NEW JERSEY PINELANDS

A status report describing the distribution and habitat requirements of selected less common herpetofauna of the New Jersey Pine Barrens with issues and recommendations for the protection and maintenance of their sustaining habitats

Prepared for the

NEW JERSEY PINELANDS COMMISSION

by

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Special thanks are due to: Dr. Rudolf Arndt, Stockton State College; Mr. Robert T. Zappalorti, Herpetological Associates, Staten Island; Mr. J. Kevin Bowler, Philadelphia Zoo; Dr. Andrew Prieto, Glassboro State College; and Dr. R. Zweifel, American Museum of Natural History. The assistance provided by Mr. Robert Zampella and members of the research staff of the Pinelands Commission and the Endangered and Non-game Species Project of the New Jersey Division of Fish, Game and Shellfisheries is much appreciated.

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ERRATA (July 1980)
Replacement for pages 24,28, 29, 31 and 32 are found in the appendix.

p. 53: The total value for Corn Snake listed under "Species Occuring in Woodlands" should read 8. The total value for all species should read 66. The total value for Northern Pine Snake under "Species Occuring in Disturbed Areas" should read 5. The total value for all species should read 62.

REPTILES AND AMPHIBIANS OF THE NEW JERSEY PINELANDS

Executive Summary

Of the fifty nine herptile species known to inhabit the New Jersey Pinelands, thirty one were selected for intensive study because their occurrence in the Pinelands is relatively unique or because their populations are known to be declining. Snake populations in particular seem to have experienced the sharpest declines because their habitats have been destroyed by development or they have been overcollected as trophies or for the illegal pet market.

This report finds that the downward population trends of unique, threatened or endangered amphibians and reptiles like the Pine Barrens treefrog, the pine snake, the northern scarlet snake, the timber rattlesnake, the bog turtle and the marbled salamander can be halted or reversed if the Pinelands Management Plan includes these measures;

1. The laws affecting capturing and harboring of snakes, turtles and other herptiles should be more vigorously enforced. The present degree of enforcement has not checked the capture and sale of herptiles whose existence is now threatened or endangered.

2. Educational programs for the formal and non-formal sectors are recommended to provide more literacy about the place of herptiles in the Pinelands ecosystem and the need for preserving these species. The Commission could sponsor the development of teacher guides for this purpose.

3. Until lawns and fertilizers are cleared of the suspicion that they have a negative impact on Pinelands water, by means of research, deed restrictions should be developed to eliminate lawns and fertilization in the Pinelands. This would maintain the dissolved solute level in the ponds and streams of the Pinelands at levels known to be typical of unpolluted areas.

4. The use of insecticides should be restricted or eliminated in the Pinelands until their effect on water and soils is known from research. This should maintain the environmental quality of the waters and soils.

5. The Pinelands should be safeguarded from the potential hazards of untried new technologies. The effects of any permitted technologies must be documented by pilot studies or previous utilizations.

6. The Pinelands area should be zoned by means of environmental impact zoning techniques. This would identify all environmentally fragile areas and prevent an environmentally destructive land use from being permitted.

7. All wetlands in the Pinelands should be kept free of industrial and residential land use. Environmental impact statements should be required whenever new roads traverse a wetland or new aquatic recreation activities are proposed.

8. A recreational Master Plan should be prepared by the Pinelands Commission as part of its overall management plan, so that recreational needs will be met and balanced with other permitted land uses. Aquatic recreation is often destructive of herptile habitats.

9. Off-road vehicles should be licensed and required to remain in designated limited access areas. This would allow the Commission to preserve known herptile habitats from off-road vehicle destruction.

10. Traditional land uses of the Pinelands should be permitted and regulated. This would provide or increase the habitats which support the life cycles of many amphibians and reptiles.

11. The translocation of any endangered herptile species population as a means to avert extinction or further decimation should be researched and only carried out under the auspices of recognized federal or state agencies. This would prevent the ecological disasters which have sometimes accompanied earlier translocation attempts.

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CHAPTER 1

Introduction

Why This Study?

The Pinelands of New Jersey have long been the focus of interest not only of herpetologists, but also many of the general public because of the Pine Barrens or Anderson treefrog (Forman 1979, Morris 1957). In New Jersey, a state with contrasting environments, the Pinelands has been a wildlife refuge for more than fifty years as the New York metropolitan complex has mushroomed outward in a thirty mile radius into a continuous urban zone. But even in the dawn of the eighties there are probably more Pine Barrens treefrogs in the New Jersey Pinelands than anywhere else in the world. The New Jersey Pinelands are truly a refuge for this relatively rare species.

The Anderson treefrog, so representative of the New Jersey Pinelands, typifies all of the herptiles whose existence is to be assured if a successful management plan is produced for the Pinelands National Reserve. The treefrog is one of the group of tailless amphibians familiarly known as frogs and toads. Fifteen species of these animals are presently known in the Pinelands. Hatched from eggs deposited in waters of swamps and ponds, the larvae mature into adults in one season to three years. Thus the wetlands of the Pinelands are indispensable for the maintenance of the Anderson treefrog and related species.

Eleven species of tailed amphibians called salamanders inhabit the Pinelands. Like the immature frogs, the salamander larvae absorb dissolved oxygen directly from the water by gills and through their perpetually wet skins. The skin respiration persists throughout life, a cogent reason for maintaining water of the Pinelands in an ecologically healthy condition.

The amphibians are carnivorous animals feeding upon insects such as mosquitoes and flies in both their immature (larvae) stages and adult stages.

Among the zoological class of reptiles in the Pinelands, turtles are, as a group, dependent upon water for their food since most of them feed upon aquatic animals. Indeed many turtles cannot swallow any food except when submerged. The twelve Pinelands turtle species are also dependent upon wetlands.

There are eighteen species of snakes and three species of lizards in the Pinelands. All of them are carnivorous, the lizards chiefly insectivorous. Some of the larger snakes like the kingsnake, rattlesnake, corn, pine and black rat snakes are an important check in maintaining stability or lower numbers in the rodent populations of the Pinelands.

Clearly some efficacious measures are needed to insure the continuance of the fifty nine species of herptiles found in the Pinelands.

What this study should accomplish. The Pinelands Commission is charged with the task of preparing a management plan for both the preservation and protection zones of the Pine Barrens. A management plan which seeks to provide a future for herptile species requires the best answer available for the following questions:

1. What herptile species apparently find a refuge in the Pine Barrens in its present state of land use?

2. What problems relative to the maintenance of these animals in the New Jersey Pine Barrens can be identified?

3. What are the habitat requirements for herptile species whose continued existence seems in jeopardy?

4. What areas and habitats most need to be preserved, maintained or created to ensure the continuance of these "threatened"* herptile species?

5. What threats to the habitats critical for the existence of threatened herptile species can be identified?

6. What public issues relate to the protection of "threatened" herptiles or to measures proposed for the maintenance of habitats judged to be critical for their survival?

7. What recommendations can be made to manage public lands for the continuance of "threatened" herptile species?

8. What recommendations can be made to regulate non-public land use in the Pine Barrens which will maintain the habitats sustaining threatened herptiles?

* The word threatened is used here generically to refer to any species whose status for continued existence has been classed as endangered, threatened declining or uncertain. See Exhibit 7,pp. 12-14 for definitions of these terms.

Chapter 2

METHODS UTILIZED IN THIS STUDY

Description of Methods

Development of Data Tables.

The research team first developed tables for the collection of data. Many of the items selected for use in the data tables were singled out in conference with the Pinelands Commission research staff and after preliminary study of prime source of information on herptiles of the New Jersey Pine Barrens.

Three data collection tables were prepared. The first table was made to classify the habitat(s) on which the herptiles selected for study are dependent. See Exhibit A.

The habitat classification employed in Exhibit A was developed by the Pinelands Commission research staff from McCormick and Jones (1974), which maps and characterizes the chief Pine Barrens vegetation communities. In addition to these designations two additional habitats descriptors were included to designate old field communities and borrow pits (or gravel pits). The classification"special"was retained to allow for additional habitat description or designation.

A second table was developed to catalogue the locations of habitats for wetland herptile species. See Exhibit B.

This exhibit contains abbreviations for all of the chief watersheds and drainage basins and many sub-basins of significant areas. The counties of the Pine Barrens were designated by one or two initials and letters.

A third table was devised to describe the habitat essential for each selected herptile species,to catalogue threats to the habitats and to list measures to optimally manage these habitats. See Exhibit C.

Preliminary Literature Search. This phase was utilized to identify sources of information and to initiate the selection of herptile species for this study.

Selection of Herptiles for This Study.

Two sources were chosen and utilized to select the herptiles for this

study. These were the tables prepared by Conant in Forman(1979)*. This excellent summary has been reproduced for this report and is shown as Table I. A significant determiner was the list of Endangered,Threatened, Peripheral, Undetermined, Declining and Extirpated Wildlife species in New Jersey published by the Division of Fish, Game and Shellfisheries, State of New Jersey, Department of Environmental Protection (1979).

The herptiles selected for this research were selected by the use of criteria as standards. If the description of the herptile met one of these criteria, it was included for study.

(a) Placement for the New Jersey Division of Fish, Game and Shellfisheries checklist with a status endangered, threatened, declining or undetermined.

(b) Designation as occurring in the Pine Barrens of New Jersey Only (PBO) by Conant (Forman 1979) (See Table I pages 16, 17, and 18).

The list of herptiles meeting these criteria and selected for study are shown as Table II on page 19 in Chapter 3. Accessory lists were also prepared to indicate herptile species whose occurrence was marginal or presumably introduced.

Definition of terms- A need for definition of terms became immediately apparent. The following classified set of definitions was developed by the CESC staff as its optimum synthesis of what seemed to be a confusing welter of terms. The classification is shown in Exhibit D.

Consultation and Special Visits.

Consultation with Experts in the Field. One or more of the research team consulted a total of five herpetologists to obtain the following input; (a) additional sources of research information; and, (b) expansion and clarification of habitat descriptions and recommendations for habitat management.

The expert researchers visited were:

Dr. R.G. Arndt, Stockton State College.
Mr. R. T. Zappalorti, Herpetological Associates, Staten Island, New York City, and chief investigator for the New Jersey Division of Fish, Game and Shellfisheries non-game research project.
Mr. J. K. Bowler, Herptile Curator, Philadelphia Zoo.
Dr. R. G. Zweifel, Curator of Herpetology, American Museum of Natural History, New York City.
Dr. A. Prieto, Glassboro State College.

Visits to Museums and Collections. Visits were made to study three institutional collections. These provided numerous additional collection site records. Institutions visited were: New Jersey State Museum, Philadelphia Academy of Science and the American Museum of Natural History (New York City).

*Forman, Richard T. T. The Pine Barrens: Ecosystem and Landscape Academic Press, New York 1979 pp 471-474

Use of Confidential Reports.

The Pinelands Commission research staff provided access for the research team to inspect confidential reports on selected endangered and threatened herptile species prepared for the New Jersey Division of Fish, Game and Shellfisheries.

Literature Search. All of the literature located by studying bibliographies and communication with recognized experts was researched and information was recorded on the data collection tables.

Collection and Assembly of Data.

Species Files. A complete file of collected information was produced for each of the herptile species selected for study. These species are listed in Table II. See Chapter 3 for habitat descriptions.

Distribution Tables. Tables were prepared from the distribution data to indicate the diversity of populations of the selected herptile species in each watershed and county in which New Jersey Pine Barrens are located. (See Table IX).

Distribution Maps. Distribution data were placed on 1:125,000 state maps provided by the research team of the Pinelands Commission. The information was derived from research papers by Robert T. Zappalorti incorporating species sightings since 1970.

Habitat Maps. Maps of habitats were developed by utilizing data shown on especially prepared maps of classified wetlands provided by the National Wetlands Inventory staff of the United States Fish and Wildlife Service (Tiner 1979). Wetland habitats most likely to be suitable for the location of additional, but presently unknown population sites for some of the selected herptile species were located by labeling only plant communities classified as emergent palustrine or palustrine scrub-shrubs as found in the Classification of Wetlands* produced by U.S. Fish and Wildlife Service.

These two descriptors were utilized as the vegetation habitats most likely to be favorable habitats for all herptiles limited to open water habitats for breeding or possibly necessary as a favored habitat in adult life. Many of the maps obtained had been reduced in scale. These were made into transparencies and converted to scales of 1-24,000 and 1-125,000. The projected habitats are discussed in Chapter 4.

*U.S. Fish and Wildlife Service. Classification of Wetland and Deep Water Habitats of the United States (An Operational Draft) October 1977.

Development of Issues and Recommendations.

These were synthesized by the research team following data collection as described and carried out for previous sections.

Discussion of Issues and Recommendations with Experts.

Following their synthesis or partial synthesis of recommendations the research team sought the advice and criticism of the consulting experts. The final product represents the input of the experts consulted.

Drafting the Final Report.

This represents the final step of the methodology employed.

EXHIBIT A: Herptile Research Study under contract with the Pinelands Commission

Name of Investigator _____

Date _____ Sheet No. _____

Species _____

HABITAT DESCRIPTION

Abundance Code _____

Habitat

Reference	Date	PO	OP	PPL	C	HDW	WATER	BOG	MARSH	NPB	AGR	URB	NF	BP	OF	SP

See next page for legend

LEGEND FOR EXHIBIT A

PO	Pine-Oak Forest. A combination of Pitch Pine and Blackjack, Post, Black or Scrub Oaks
OP	Oak-Pine Forest. A combination of Chestnut, Black or Scarlet Oaks and Pitch Pine
PPL	Pitch Pine Lowland
C	Cedar Swamp
HDW	Hardwood Swamp
Water	Streams, Ponds or Lakes
Bog	Cranberry bogs, Sphagnum bogs, Abandoned bogs
Marsh	Freshwater Herbaceous Wetlands, Savannahs, Scrub-Shrub Wetlands
NPB	Non-Pine Barrens Forest
AGR	Agricultural Areas
URB	Urban Areas
NF	Non-forested Areas
BP	Borrow Pits (Gravel Pits also)
OF	Old Fields
SP	Special Categories

EXHIBIT B: Herptile Research Study under contract with the Pinelands Commission

Name of Investigator _____

Date _____

Sheet No. _____

DISTRIBUTION BY WATERSHED

	Watershed																			County								
			RC			MR			MRB								GEHR											
Reference	TOR	TUR	NBRC	SBRC	CC	LMR	MC	DC	LMR	WR	BR	MA	NR	BA	FR	CE	LGE	UGE	AD	A	B	CA	CM	CU	GL	O	S
D																												

See next page for legend

LEGEND FOR EXHIBIT B

TOR	Toms River Basin
TUR	Tuckahoe River Basin
RC	Rancocas Creek Basin NBRC - North Branch Rancocas Creek SBRC - South Branch Rancocas Creek
CC	Crosswicks Creek Basin
MR	Maurice River Basin LMR - Lower Maurice River MC - Manumuskin Creek
DC	Dennis Creek Basin
MRB	Mullica River Basin LMR - Lower Mullica River WR - Wading River BR - Batsto River MA - Mechesactauxin and Atsion Rivers NR - Neschochaque River
FR	Forked River Basin
CE	Cedar Creek
GEHR	Great Egg Harbor River Basin LGE - Lower Great Egg Harbor Sub-Basin UGE - Upper Great Egg Harbor Sub-Basin
AD	Atlantic Drainage Basin (includes Doughty Creek, Absecon Creek, Patcong Creek, and Sloop Creek Basins)

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EXHIBIT C. Herptile Study
Specific Habitat and Requirement Record for Pinelands Commission

Species: Common Name _____
Scientific Name _____

General Habitat Description: _____

_____

_____

HABITAT-ABIOTIC FACTORS

Edaphic (Soil) Factors

Soil Classification: _____

_____

Soil Composition: _____ pH: _____

Water Table Depth: _____

Detailed Habitat Classification: _____

_____

_____

HABITAT-BIOTIC FACTORS

Plant Community Type (s) or Other Classification

Sub biome _____ Palustrine _____ Riverine _____ Dry _____

Faunal Associates: _____

Predators: _____

Local Habitat Range: _____

_____

Habitat Vulnerability: _____

_____

_____

EXHIBIT D. A Classification of Descriptors for Characterizing Threatened and Endangered Faunal Species

A. Descriptors for Status or (Threat*) - Descriptors to indicate relative success or stability of a species population in areas such as the State of New Jersey or the New Jersey Pine Barrens.

1. Undetermined - A species about which there is not enough information available to determine the status.

2. Declining - A species which has exhibited a continued decline in population numbers over the years.

3. Extirpated - A species that formerly occurred in New Jersey, but is not now known to exist within the state.

4. Threatened - May become endangered if conditions surrounding the species begin to or continue to deteriorate.

5. Endangered - An endangered species is one whose prospects for survival within the state are in immediate danger due to one or many factors - a loss of or change in habitat, over-exploitation, predation, competition, disease. An endangered species requires immediate assistance or extinction will probably follow.

B. Descriptors for Frequency of Occurrence

1. Common (abundant) - species are herein defined as those species frequently encountered throughout the area under study (c.f. the New Jersey Pine Barrens).

2. Scattered - species are herein defined as those found in only a few relatively disjunct or local populations in the entire area under study (e.g. the New Jersey Pine Barrens); there may be few or many members of the local population present.

3. Limited occurrence - species are those for which few records exist although many suitable habitats occur in the study area (c.f. the New Jersey Pine Barrens).

C. Descriptors Referring to Geographic Limits of Distribution

1. Introduced - species apparently not historically indigenous to the area but for which one or a few identity records exist.

2. Marginal (Peripheral) - are those species apparently limited to occurrence in the periphery of the study area (c.f. the New Jersey Pine Barrens).

D. Descriptors of Regional Uniqueness*

1. Species currently subject to some degree of threat locally in New Jersey , but apparently healthy and stable throughout the major part of its range.

2. Species possibly subject to some degree of threat generally in New Jersey , but whose habitat or population is not subject to immediate threat from natural or man-induced causes in the forseeable future, and apparently healthy and stable throughout the remainder of its range.

3. Same as 2, but threat in New Jersey likely to materialize within the forseeable future.

4. Species currently subject to some degree of threat throughout a major part of its entire range.

5. Species subject to some degree of threat whose entire range is within New Jersey.

E. Descriptors of Social-Ecological-Economic Relationships*

1. Species having few supporters outside the scientific community and an unknown or apparently insignificant economic value or role in the ecosystem.

2. Species for which there is some public awareness, mainly restricted to special interest factions, but whose economic value or role in the ecosystem is unknown or apparently insignificant.

3. Species for which there is widespread public awareness but limited public support, and whose economic value or ecological role is apparently significant.

4. Species for which there is strong public awareness and opinion, and whose economic value or ecological role is apparently significant.

5. Species for which there is the highest degree of public awareness and support or that is of significant economic or ecological value.

* Landry, J.L., L.P. Hirsch and E.R. McCaffrey, A Rating System for Threatened and Endangered Species of Wildlife, New York Fish and Game Journal, Vol. 26 No. 1, Albany, N.Y., January 1979. Pp. 11-21.

EXHIBIT D (continued)

F. Descriptors of Recovery Potential*

1. (0.2) This applies to species that may be extinct, that cannot be located in New Jersey or that have been extirpated in the state and for which favorable habitat no longer exist. Because the changes in their former habitat are so great or, if migratory, because a critical part of their life cycle is spent outside New Jersey , work on them, even if funded, would probably fail to reestablish them.

2. (0.5) This applies to species that, regardless of all-out recovery or reestablishment effort, are likely to become extirpated in the wild in New Jersey or would be unable to produce viable populations. Their distribution, status and potential range are generally known. Although habitat conditions may still be favorable, other factors such as low reproductive potential, lack of support by the public, etc. may currently prevent their recovery or reestablishment.

3. (1.0) This applies to species that have a fair chance of continued success if action is taken and continued. However, their future cannot be assured because of susceptibility to fire, vandalism, hurricanes, competition with exotic species, oil and chemical spills,etc.

4. (2.0) This applies to species whose future can virtually be assured through identifiable recovery actions. Many species qualify here because their being listed as threatened or endangered has resulted from threatened or actual loss of habitat that need not be permanent. If removal of the threat or restoration of destroyed habitat is feasible, their future may be considered promising.

* Landry et al., Ibid.

Chapter 3

Herptile Species Inventory

Species Lists.

Table I is a summary of information about the amphibians and reptiles known to occur in Southern New Jersey with notes on their status in the Pine Barrens and range in the United States and Canada (from Conant in Forman 1979).

Table II is a list of the 31 herptile species selected for detailed research in this study. Selection criteria are discussed in Chapter 2 (pp. 3-4).

Tables III - VII further classify the herptiles appearing in Table I as Herptiles Common in the Pine Barrens (Table III), Herptiles Known from Scattered Records in the Pine Barrens (Table IV), Herptiles of Limited Occurrence in the Pine Barrens (Table V), Herptiles Introduced into the Pine Barrens (Table VI), and Marginal Herptiles of the Pine Barrens (Table VII). Definitions of these classification criteria appear in the Methods section (Exhibit D, pp. 12-14.) All species selected for research in this study (Table II) are represented in one or more of the categories in Tables III-VII and are distinguished in these tables by an (X) preceeding the name.

The number of herptiles listed in each of these categories may be summarized as shown below:

Table III	Herptiles Common in the Pine Barrens	28 species
Table IV	Herptiles Known from Scattered Records in the Pine Barrens	8 species
Table V	Herptiles of Limited Occurrence in the Pine Barrens	6 species
Table VI	Herptiles Introduced into the Pine Barrens	4 species
Table VII	Marginal Herptiles of the Pine Barrens	8 species

BLE I

Distribution and Status of Amphibians and Reptiles in Southern New Jersey with Special Reference to the Pine Barrens

Common Name	Scientific Name	Status in the Pine Barrens	Status in southern New Jersey	Approximate Range in United States and Canada
SALAMANDERS:				
Spotted salamander	*Ambystoma maculatum*	Uncertain	WR?, rare	Widespread: so. Canada to Gulf of Mex.; W to Wis. and Tex.
Marbled salamander	*Ambystoma opacum*	REL, locally common	Locally common	Widespread: so. New Engl. to Gulf of Mexico; W to Mo. and Tex.
Eastern tiger salamander	*Ambystoma tigrinum tigrinum*	BOR, endangered	Scattered records; endangered	Widespread: chiefly Coastal Plain, Long Island to Fla.; W to Minn. and Tex.
Red-spotted newt	*Notophthalmus viridescens viridescens*	REL, few records	Scattered records	Widespread: so. Canada to Ga. and Ala.; W to Mich. and Miss.
Northern dusky salamander	*Desmognathus fuscus fuscus*	BOR, rare	Locally common	Widespread: New Brunswick to N.C. and Ky.
Red-backed salamander	*Plethodon cinereus cinereus*	Abundant	WR, abundant	Widespread: Canad. Maritime Provs. to Minn., Mo., and N.C.
Slimy salamander	*Plethodon glutinosus glutinosus*	Uncertain	WR?, uncertain	Widespread. New Engl. to Fla. and Tex.
Four-toed salamander	*Hemidactylium scutatum*	REL, numerous records	Scattered records	Widespread: Nova Scotia to Gulf of Mex.; W to Wis. and Okla.
Eastern mud salamander	*Pseudotriton montanus montanus*	Uncertain	WR?, rare	Southern, so. N.J. to S.C. and Ga.
Northern red salamander	*Pseudotriton ruber ruber*	Abundant	WR, abundant	Widespread: SE N.Y. to N.C. and Ala.
Northern two-lined salamander	*Eurycea bislineata bislineata*	BOR, rare	Locally common	Widespread: New Brunswick and so. Quebec to Ill. and Ala.
TOADS AND FROGS				
Eastern spadefoot	*Scaphiopus holbrooki holbrooki*	Locally common	WR, locally common	Widespread: so. New Engl. to Fla.; W to Mo. and Miss.
Fowler's toad	*Bufo woodhousei fowleri*	Abundant	WR, abundant	Widespread: so. New Engl. to Gulf of Mex.; W to Mich., Mo., and Miss.
Northern cricket frog	*Acris crepitans crepitans*	BOR, scattered records	WR, locally common	Widespread: extreme so. N.Y. and Long Island to Tex. and Fla.
Pine barrens treefrog	*Hyla andersoni*	PBO, declining	Threatened by any drop ... water table level	Southern: isolated populations in so. N.J., N.C., S.C., Ga., and w. Fla.
Cope's gray treefrog	*Hyla chrysoscelis*	PER, not present	Uncertain	Widespread: extreme so. N.J. to Fla.; W to Minn. and Tex.
Northern spring peeper	*Hyla crucifer crucifer*	Abundant	WR, abundant	Widespread: Canad. Maritime Provs. to James Bay and Manitoba; S to Gulf of Mexico
Barking treefrog	*Hyla gratiosa*	INT, possibly extirpated	Possibly extirpated	Southern, SE Va. to so. Fla.; W to La.
Gray treefrog	*Hyla versicolor*	BOR, scattered records	WR, locally common	Widespread: New Brunswick to Manitoba; S to S.C.; W to Okla. and Tex.
New Jersey chorus frog	*Pseudacris triseriata kalmi*	BOR, numerous records	Abundant	Local, N.J. and east of Chesapeake Bay in Del., Md., and Va.
Bullfrog	*Rana catesbeiana*	BOR, scattered records	Abundant	Widespread. Canad. Maritime Provs. to Fla. and Rocky Mts.
Green frog	*Rana clamitans melanota*	Abundant	WR, abundant	Widespread: Canad. Maritime Provs. to Manitoba; S to Ga., Ala., and Okla.
Pickerel frog	*Rana palustris*	BOR, few records	WR, locally common	Widespread: Canad. Maritime Provs. to Wis.; S to S.C. and Tex.
Wood frog	*Rana sylvatica*	BOR, few records	WR, locally common	Northern: Labrador to Alaska; S to Ga.
Southern leopard frog	*Rana utricularia*	Abundant	WR, abundant	Southern: extreme so. N.Y. and L.I. to Fla.; W to Okla. and Tex.
Carpenter frog	*Rana virgatipes*	PBO, common	Common in Pine Barrens	Southern: so. N.J. S through Coastal Plain to Fla.

From Dr. Roger Conant in Forman, 1979, pp. 471-74. Reproduced with permission of Academic Press.

TABLE I
(continued)

Common Name	Scientific Name	Status in the Pine Barrens	Status in southern New Jersey	Approximate Range in United States and Canada
TURTLES				
Common snapping turtle	*Chelydra serpentina serpentina*	Common	WR, common	Widespread. Atlantic coast to Rocky Mts.; so. Canada to Gulf of Mex
Stinkpot	*Sternotherus odoratus*	Abundant	WR, abundant	Widespread. New Engl. and so Ontario to Gulf of Mex.; W to Wis., Kan., and Tex.
Eastern mud turtle	*Kinosternon subrubrum subrubrum*	Numerous records	WR, common	Chiefly southern: extreme SW Conn and L.I. to Fla.; W to Ill. and Miss
Spotted turtle	*Clemmys guttata*	Abundant records but declining	WR, declining	Widespread: so. Quebec to Fla.; W to Mich. and Ill.
Wood turtle	*Clemmys insculpta*	BOR, few records, threatened	Threatened	Northern: Nova Scotia to Minn.; S to ea. W.Va.
Bog turtle	*Clemmys muhlenbergi*	BOR, endangered	Endangered	Widespread but disjunct: N.Y. and so. New Engl. to w. N.C.
Eastern box turtle	*Terrapene carolina carolina*	Numerous records but declining	WR, declining	Widespread. New Engl. to Fla.; W to Ill. and Miss.
Northern diamondback terrapin	*Malaclemys terrapin terrapin*	PER, not present	Abundant along coasts	Coastal: Cape Cod, Mass. to Cape Hatteras, N.C.
Map turtle	*Graptemys geographica*	PER, not present	Delaware River, Trenton and above	Western: Vt. to Minn., Kan., and Ala.; Susquehanna and Delaware R. basins
Eastern painted turtle	*Chrysemys picta picta*	Abundant	WR, abundant	Eastern: Nova Scotia and S New Engl. to Ala.
Red-bellied turtle	*Chrysemys rubriventris*	Common	WR, common	Eastern: ea. Mass.; so. N.J. to e. N.C.
Eastern spiny softshell	*Trionyx spiniferus spiniferus*	INT, at western edge only	One river system only: Salem County	Western: N.Y. to Wis., S to Ala.
LIZARDS				
Northern fence lizard	*Sceloporus undulatus hyacinthinus*	Abundant	WR, locally abundant	Southern: so. N.Y. to S.C.; W to Okla. and Tex.
Ground skink	*Scincella lateralis*	PBO, uncommon	Uncommon	Southern: so. N.J. to Fla. W to Kan. and Tex.
Five-lined skink	*Eumeces fasciatus*	REL, few records	Uncertain	Widespread. New Engl. to Fla.; W to Minn., Kan., and Tex.
SNAKES				
Queen snake	*Natrix septemvittata*	PER, not present	Uncertain	Western so. Ontario and SE Pa. and adjacent N.J. to w. Fla. W to Ill. and Ark.
Northern water snake	*Natrix sipedon sipedon*	Abundant	WR, abundant	Widespread. Me. to N.C.; W to Colo.
Northern brown snake	*Storeria dekayi dekayi*	Scattered records	WR, locally common	Widespread: so. Quebec and New Engl. to N.C.; W to Ohio
Northern red-bellied snake	*Storeria occipitomaculata occipitomaculata*	PBO, numerous records	Local in Pine Barrens	Widespread. Canad. Maritime Provs. to Ga.; W to Saskatchewan and Tex.
Eastern ribbon snake	*Thamnophis sauritus sauritus*	Numerous records but uncommon	WR, widespread but uncommon	Widespread. New Engl. to S.C. and Fla.; W to Ill. and La.
Eastern garter snake	*Thamnophis sirtalis sirtalis*	Numerous records	WR, locally common	Widespread. Canad. Maritime Provs. and James Bay to Fla.; W to w. Ontario, Ark., and Tex.
Eastern earth snake	*Virginia valerae valerae*	Uncertain	WR?, rare	Chiefly southern. N.J. to Fla.; W to Ohio and Ala.

TABLE I
(continued)

Common Name	Scientific Name	Status in the Pine Barrens	Status in southern New Jersey	Approximate Range in United States and Canada
Eastern hognose snake	*Heterodon platyrhinos*	Locally common but declining	WR, locally common	Widespread: so. New Engl. to Fla.; W to Minn., Kan., and Tex.
Northern-southern ringneck snake (intergrading population)	*Diadophis punctatus punctatus* × *edwardsi*	Scattered	WR, spotty distribution	Parent pops. widespread: Northern from Canad. Maritime Provs. to Wis. and Ala.; Southern to Fla. and Ala.
Eastern worm snake	*Carphophis amoenus amoenus*	REL, common	Common in Pine Barrens	Widespread: so. New Engl. to S.C.; W to Ky. and Ala.
Northern black racer	*Coluber constrictor constrictor*	Locally common but declining	WR, locally common but declining	Widespread: New Engl. to S.C.; W to Tenn. and Ala.
Rough green snake	*Opheodrys aestivus*	PBO, common	Common in Pine Barrens	Southern: so. N.J. to Fla.; W to Kan., Tex. and Mexico
Corn snake	*Elaphe guttata guttata*	PBO, scattered records	Occasional in Pine Barrens	Southern: so. N.J. to Fla.; W to Ky. and La.
Black rat snake	*Elaphe obsoleta obsoleta*	Locally common	WR, locally common	Widespread: so. New Engl. to Ga.; W to Neb., Okla., and Tex.
Northern pine snake	*Pituophis melanoleucus melanoleucus*	PBO, locally common	Local in Pine Barrens	Southern: so. N.J.; SW Va. to W cent. Tenn. and cent. Ala.; E to SE N.C.
Eastern kingsnake	*Lampropeltis getulus getulus*	PBO, locally common	Local in Pine Barrens	Southern: so. N.J. to Fla.; W into Appalachians and Ala.
Eastern milk snake-scarlet kingsnake (intergrading population)	*Lampropeltis triangulum triangulum* × *elapsoides*	Numerous records	WR, locally common	Parent pops. widespread: eastern milk from New Engl. to Minn. and Tenn.; scarlet king S to Gulf of Mex.
Northern scarlet snake	*Cemophora coccinea copei*	PBO, scattered records	Secretive; probably common in Pine Barrens	Southern: so. N.J. to Fla.; W to Mo., Okla., and Tex.
Timber-canebrake rattlesnake (intergrading population)	*Crotalus horridus horridus* × *atricaudatus*	PBO, threatened	Threatened	Parent pops. widespread: timber from New Engl. to Minn., Tex., and Ga.; Canebrake in Coastal Plain, SE Va. to Fla. and Tex.

* PBO, Pine Barrens only; WR, wide ranging; BOR, border entrant; REL, relict in Pine Barrens; PER, peripheral to Pine Barrens; INT, introduced.
Totals of 80 species: 10 Pine Barrens only; 28 wide ranging; 11 border entrants; 5 relicts in Pine Barrens; 4 peripheral to Pine Barrens; 2 introduced.

TABLE II

Herptiles in Southern New Jersey classified as Endangered (E), Threatened (T), Declining (D) and Undetermined (U) by the New Jersey Department of Environmental Protection, Division of Fish, Game and Shellfisheries, March 1979. (PBO indicates species found only in the Pine Barrens as contrasted with other areas in Southern New Jersey Conant in Forman 1979).

COMMON NAME	SCIENTIFIC NAME	STATUS
SALAMANDERS		
Spotted Salamander	Ambystoma maculatum	D
Marbled Salamander	Ambystoma opacum	D
Eastern Tiger Salamander	Ambystoma t. tigrinum	E
Four-toed Salamander	Hemidactylium scutatum	D
Eastern Mud Salamander	Pseudotriton m. montanus	T
Northern Red Salamander	Pseudotriton r. ruber	D
TOADS AND FROGS		
Eastern Spadefoot Toad	Scaphiopus h. holbrooki	D
Northern Cricket Frog	Acris c. crepitans	U
Pine Barrens Treefrog	Hyla andersoni	E/PBO
Southern (Cope's) Gray Treefrog	Hyla chrysoscelis	E
Carpenter Frog	Rana virgatipes	U/PBO
TURTLES		
Spotted Turtle	Clemmys guttata	U
Wood Turtle	Clemmys insculpta	T
Bog Turtle	Clemmys muhlenbergi	E
Map Turtle	Graptemys geographica	U
Red-bellied Turtle	Chrysemys rubriventris	U
LIZARDS		
Ground Skink	Scincella lateralis	U/PBO
Five-lined Skink	Eumeces fasciatus	U
SNAKES		
Queen Snake	Natrix septemvittata	U
Northern Red-bellied Snake	Storeria o. occipitomaculata	PBO
Eastern Hognose Snake	Heterodon platyrhinos	D
Eastern Earth Snake	Virginia v. valeriae	U
Eastern Worm Snake	Carphophis a. amoenus	U
Northern Black Racer	Coluber c. constrictor	U
Rough Green Snake	Opheodrys aestivus	PBO
Corn Snake	Elaphe g.guttata	T/PBO
Black Rat Snake	Elaphe o. obsoleta	U
Northern Pine Snake	Pituophis m. melanoleucus	T/PBO

TABLE II continued

COMMON NAME	SCIENTIFIC NAME	STATUS
SNAKES (continued)		
Eastern Kingsnake	Lampropeltis g. getulus	U/PBO
Northern Scarlet Snake	Cemophora coccinea copei	U/PBO
Timber Rattlesnake	Crotalus horridus	E/PBO

TABLE III

Herptiles Known to be Common* in the Pine Barrens of New Jersey.

COMMON NAME	SCIENTIFIC NAME
SALAMANDERS	
Red-backed Salamander	Plethoden c. cinereus
x Northern Red Salamander	Pseudotriton r. ruber
TOADS AND FROGS	
x Eastern Spadefoot Toad	Scaphiopus h. holbrooki
Fowler's Toad	Bufo woodhousei fowleri
x Pine Barrens Treefrog	Hyla andersoni
Northern Spring Peeper	Hyla c. crucifer
New Jersey Chorus Frog	Pseudacris triseriata kalmi
Bullfrog	Rana catesbeiana
Green Frog	Rana clamitans melanota
Pickerel Frog	Rana palustris
Southern Leopard Frog	Rana utricularia
x Carpenter Frog	Rana virgatipes
TURTLES	
Common Snapping Turtle	Chelydra s. serpentina
Stinkpot	Sternotherus odoratus
Eastern Mud Turtle	Kinosternon s. subrubrum
x Spotted Turtle	Clemmys guttata
Eastern Box Turtle	Terrapene c. carolina
Eastern Painted Turtle	Chrysemys p. picta
x Red-bellied Turtle	Chrysemys rubriventris

* Common species are herein defined as those species frequently encountered throughout the area under study (e.g. the New Jersey Pine Barrens).

x indicates those species selected for detailed research in this study, because of status designation of some threat by the New Jersey DEP, Division of Fish, Game and Shellfisheries (1979).

TABLE III continued

	COMMON NAME	SCIENTIFIC NAME
	LIZARDS	
	Northern Fence Lizard	Sceloporus undulatus hyacinthinus
x	Ground Skink	Scincella lateralis
	SNAKES	
	Northern Water Snake	Natrix s. sipedon
	Eastern Ribbon Snake	Thamnophis s. sauritus
	Eastern Garter Snake	Thamnophis s. sirtalis
x	Eastern Worm Snake	Carphophis a. amoenus
x	Northern Black Racer	Coluber c. constrictor
x	Rough Green Snake	Opheodrys aestivus
x	Northern Pine Snake	Pituophis m. melanoleucus
	Eastern Milk-Scarlet Kingsnake	Lampropeltis t. triangulum x elapsoides

TABLE IV

Herptiles Known From Scattered* Records
Only in the Pine Barrens of New Jersey

	COMMON NAME	SCIENTIFIC NAME
	SALAMANDERS	
x	Eastern Tiger Salamander	Ambystoma t. tigrinum
	TOADS AND FROGS	
x	Northern Cricket Frog	Acris c. crepitans
	Gray Treefrog	Hyla versicolor
	SNAKES	
x	Northern Red-bellied Snake	Storeria o. occipitomaculata
x	Eastern Hognose Snake	Heterodon platyrhinos
x	Corn Snake	Elaphe g. guttata
x	Eastern Kingsnake	Lampropeltis g. getulus
x	Timber Rattlesnake	Crotalus horridus

* "Scattered" species are herein defined as those species found in only a few relatively disjunct or local populations in the entire area under study (e.g. the New Jersey Pine Barrens).

x indicates those species selected for detailed research in this study.

TABLE V

Herptiles of Limited Occurrence**
in the Pine Barrens of New Jersey

COMMON NAME	SCIENTIFIC NAME
SALAMANDERS	
x Four-toed Salamander	Hemidactylium scutatum
Red-spotted Newt	Notophthalmus v. viridescens
x Eastern Mud Salamander	Pseudotriton m. montanus
TURTLES	
x Bog Turtle	Clemmys muhlenbergi
SNAKES	
x Black Rat Snake	Elaphe o. obsoleta
x Northern Scarlet Snake	Cemophora coccinea copei

** Limited Occurrence refers to species for which few records exist although many suitable habitats occur in the study area (e.g. the New Jersey Pine Barrens).

x indicates those species selected for research in this study.

TABLE VI

Herptiles Introduced* Into the Pine Barrens of New Jersey.

COMMON NAME	SCIENTIFIC NAME
TOADS AND FROGS	
Barking Treefrog	Hyla gratiosa
TURTLES	
x Map Turtle	Graptemys geographica
Eastern Spiny Softshell Turtle	Trionyx s. spiniferus
SNAKES	
x Queen Snake	Natrix septemvittata

* Introduced species are those species which are apparently not indigenous to an area but for which one or a few sighting records exist with the study area (e.g. the New Jersey Pine Barrens).

x indicates those species selected for detailed research in this study.

TABLE VII

Marginal* Herptiles of the Pine Barrens of New Jersey.

	COMMON NAME	SCIENTIFIC NAME
	SALAMANDERS	
x	Spotted Salamander	Ambystoma maculatum
x	Marbled Salamander	Ambystoma opacum
x	Four-toed Salamander	Hemidactylium scutatum
	TOADS AND FROGS	
x	Southern (Cope's) Gray Treefrog	Hyla chrysoscelis
	TURTLES	
x	Wood Turtle	Clemmys insculpta
	Northern Diamondback Terrapin	Malaclemys t. terrapin
	LIZARDS	
x	Five-lined Skink	Eumeces fasciatus
	SNAKES	
x	Queen Snake	Natrix septemvittata
x	Eastern Earth Snake	Virginia v. valeriae

* Marginal species are those species which are apparently limited to occurrence in the periphery of the study area (c.f. the New Jersey Pine Barrens).

x indicates those species selected for research in this study.

Habitat Chart

Table VIII is a habitat chart for the 31 herptile species researched in this study. The chart represents a synthesis of data collected and categorizes habitats as preferred (P), secondary (S), or breeding (B), (the breeding habits of the egg laying herptile species were not catalogued in the table for the following reasons: 1) Some of the information was unavailable; 2) Where information was available it seemed that the disturbed borders of ponds and streams where egg laying is known to occur did not correspond to the habitat designation agreed upon in advance by all the research teams). This chart shows the actual and potential occurrence for each habitat type and further provides a clearer idea of species diversity within each habitat type. A key to habitat abbreviations appears in Exhibit A, Chapter 2, pp. 7-8.

The significance of open water and surrounding wetlands for amphibian and turtle species stands out in this table. Similarly, oak-pine and pine-oak woods are prime habitats for many lizards and snakes.

Habitats derived from former land use practices (c.f. cranberry bogs and cleared swamps) figure prominently as prime habitats for aquatically dependent species. Old fields and borrow pits are habitats for a majority of species. The relative significance of each habitat type may be seen by the ordinal listing of habitats according to increasing species diversity:

HABITAT	NUMBER OF SPECIES
Urban	1
Agricultural	8
Non-forest	8
Non-Pine Barrens	10
Borrow pits	10
Pitch Pine Lowlands	10
Bogs	12
Marshes	12
Hardwood swamps	13
Cedar swamps	14
Old fields	16
Pine-Oak forest	17
Oak- Pine forest	17
Water areas	19

Chapter 4 (page 50) discusses the relative importance of each habitat

Table VIII

HABITAT DESCRIPTION FOR SELECTED HERPTILES IN THE PINE BARRENS

COMMON NAME	SCIENTIFIC NAME	PO	OP	PPLL	C	HDW	water	bog	marsh	NPB	AGR	URB	NF	BP	OF	SPECIAL
Spotted Salamander	Ambystoma maculatum	P	P	S			B			S						Woodlands bordering ponds or open water
Marbled Salamander	Ambystoma opacum	P	P	S			B									Woodlands bordering ponds or open water
Eastern Tiger Salamander	Ambystoma t. tigrinum						B						P	P	P	Gravel pits; ponded a within these perfer habitats
Four-toed Salamander	Hemidactylium scutatum				S	P	B	P								Sphagnum bogs slow moving waters
Eastern mud Salamander	Pseudotriton m. montanus				S	S	B	P	P							Sphagnum bogs Muddy areas and seepage areas
Northern Red Salamander	Pseudotriton r. ruber				S	S	B	P	P						S	Moist areas: stream ponds, bogs, old fie with ponds.
Eastern Spadefoot Toad	Scaphiopus h. holbrooki	P	P	P			B									Woodlands near water and gravel pits
Northern Cricket Frog	Acris c. crepitans			S	P	P	B	P	P					S	S	Gravel pits and old field with ponds
Pine Barrens Treefrog	Hyla andersoni	P	P	S	P	P	B	P	S					S	S	small slow flowing a ponds and streams, Gravel pits & fields
Southern (Cope's) Gray Treefrog	Hyla chrysoscelis			P		P	B		S	S	P			P	P	Areas bordering wate within preferred habitats.

P = Preferred Habitat - those areas where species is most frequently encountered.

S = Secondary Habitat - areas where species occurs less frequently.

B = Breeding Habitat - areas where propagation of the species occurs and often are distintly different from habitats where adults are found.

Table VIII (continued)

HABITAT DESCRIPTION FOR SELECTED HERPTILES IN THE PINE BARRENS

COMMON NAME	SCIENTIFIC NAME	PO	OP	PFT	C	HDW	water	bog	marsh	MFB	AGR	URB	NF	BP	OF	SPECIAL
Carpenter Frog	Rana virgatipes				S	S	B	P	P							Man-made areas with water
Spotted Turtle	Clemmys guttata			B	P	P	P	P	P	P						Drainage ditches
Wood Turtle	Clemmys insculpta			P			P			P						Summer - woodlands Spring - near water
Bog Turtle	Clemmys muhlenbergi				P	P	P	P	P							Open areas with emergent palustrine vegetation
Map Turtle	Graptemys geographica						P		P							Man-made lakes
Red-bellied Turtle	Chrysemys rubriventris				P		P	S	S							Relatively large bod of freshwater
Ground Skink	Scincella lateralis	P	P							S	S					Upland woods or area surrounded by woods
Five-lined Skink	Eumeces faciatus	P	P							P		S	S			Disturbance areas an among decaying debri log piles, aband. ho
Queen Snake	Natrix septemittata						P			P						Borders ponds and streams
Northern Red-bellied Snake	Storeria o. occipitomaculata	S	S	P	P	P	S	P								Wooded areas near moist areas

P = Preferred Habitat - those areas where species is most frequently encountered
S = Secondary Habitat - areas where species occurs less frequently
B = Breeding Habitat - areas where propagation of the species occurs and often are distintly different from habitats where adults are found.

Table VIII

HABITAT DESCRIPTION FOR SELECTED HERPTILES IN THE PINE BARRENS

COMMON NAME	SCIENTIFIC NAME	PO	OP	PPLL	C	HDW	water	bog	marsh	NPB	AGR	URB	NF	BP	OF	SPECIAL
stern Hognose Snake	Heterodon platyrhinos	S	S								P		P		P	Disturbance areas near decaying debris
stern Worm Snake	Carphophis a. amoenus	S	S	S						S			P	P	P	Disturbance areas near decaying debris
rthern Black Racer	Coluber c. constrictor	S	P	P	P	P			P		S	S	S	S	S	Uplands, lowlands, disturbed and undisturbed areas
ugh Green Snake	Opheodrys aestivus	P	P	S				S			S		S	P	P	Arboreal in vegetation over hanging moist areas
rn Snake	Elaphe g. guttata	P	P	S						S	P		B		S	Dry terrestrial areas
ack Rat Snake	Elaphe o. obsoleta	P	P							P	P		S B		S	Moist woodlands
rthern Pine Snake	Pituophis m. melanoleucus	P	P		S	S							S B	P	P	Disturbance areas, gravel pits, fire breaks lumber sites ect.
stern King Snake	Lampropeltis g. getulus	P	P		S	S	S	S	S						S	Chiefly terrestrial near water areas
rthern Scarlet Snake	Cemophora coccinea copei	P	P											S	S	High, dry, sandy areas near water source
ber Rattlesnake	Crotalus horridus	P	P	P	S	S							B		S	Timbered areas near water

P = Preferred Habitat - those areas where species is most frequently encountered

S = Secondary Habitat - areas where species occurs less frequently

B = Breeding Habitat - areas where propagation of the species occurs and often are distintly different from habitats where adults are found.

Table VIII

HABITAT DESCRIPTION FOR SELECTED HERPTILES IN THE PINE BARRENS

COMMON NAME	SCIENTIFIC NAME		PO	OP	PPLL	C	HDW	water	bog	marsh	NPB	AGR	URB	NP	BP	OF	SPECIAL
	Sub-Totals	P	12	13	5	6	8	5	9	7	5	5	0	3	6	7	
		S	5	4	5	8	5	3	3	5	5	3	1	5	4	9	
		B	0	0	0	0	0	11	0	0	0	0	0	4	0	0	
	TOTALS		17	17	10	14	13	19	12	12	10	8	1	8	10	16	

P = Preferred Habitat - those areas where species is most frequently encountered

S = Secondary Habitat - areas where species occurs less frequently

B = Breeding Habitat - areas where propagation of the species occurs and often are distintly different from habitats where adults are found.

Distribution Chart

Table IX summarizes distribution data by watershed for the 31 herptile species researched in this study. This chart with its species totals, provides an "at a glance" notion of species diversity within each watershed (a key to watershed abbreviations appears in Exhibit B, Chapter 2, pp. 9-10). The relative significance of each watershed may be seen by the ordinal listing of watersheds according to increasing species diversity.

WATERSHEDS	NUMBER OF SPECIES
Bass River	4
Crosswicks Creek	5
Atlantic Drainage	7
Mechesactauxin/Atsion	9
Wading River	12
Forked River	12
Manumuskin Creek	13
Lower Mullica River	13
Neschochaque River	13
Lower Great Egg Harbor	16
Tuckahoe River	18
Upper Great Egg Harbor	18
Cedar Creek	20
Toms River	21
Dennis Creek	21
South Branch Rancocas Creek	22
Batsto River	22
Lower Maurice River	24
North Branch Rancocas Creek	25

Highest species counts were obtained for the North Branch (25) and South Branch of the Rancocas Creek (22) and the Lower Maurice River drainage (24). These high counts are attributed to the fact that they both flow from Pine Barrens areas. This allows marginal and introduced species to be included in the totals.

The Batsto River scores extremely high in diversity with 22 species. The Wading River of the Mullica River drainage basin is entirely within the central Pine Barrens and is recommended for preservation by McCormick (1968). It also scores relatively high with twelve (12). This total is attributed to a minimum of habitat alteration with a large portion of the drainage basin in public ownership. The Toms River, Cedar Creek and Dennis Creek drainages all of which have residentially and industria impaired lower drainage courses, have twenty (20) or twenty-one (21) species. Margi species contribute to these high totals as with the Rancocas and Lower Maurice drain

The high incidence of herptile species in these widely dispersed drainage basin indicates the presence of sustaining habitats in the entire Pine Barrens area and th desirability of habitat management procedures in all of the protection and preserva areas.

The number of habitats in the southern sectors is highlighted by diversity coun of eighteen (18) species in the Tuckahoe River and the Upper Great Egg Harbor drain basin.

Table IX

WATERSHED DISTRIBUTION FOR SELECTED HERPTILES IN THE PINE BARRENS

	WATERSHED																		
	RC					MR			MRB								GEHR		
	TOR	TUR	NBRC	SBRC	CC	LMR	MC	DC	UMR	WR	BR	MA	NR	BA	FR	CE	LGE	UGE	AD
Spotted Salamander	X																		
Marbled Salamander	X	X		X		X		X										X	
Eastern Tiger Salamander	X	X	X	X		X		X	X	X	X				X			X	
Four-toed Salamander			X												X				
Eastern Mud Salamander				X															
Northern Red Salamander	X		X	X		X		X		X		X			X				
Eastern Spadefoot Toad	X	X						X	X	X				X		X	X	X	
Northern Cricket Frog		X				X		X		X									
Pine Barrens Treefrog	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Southern (Cope's) Gray Treefrog						X	X	X											
Carpenter Frog	X	X	X	X		X		X	X	X	X	X	X	X	X		X	X	X
Spotted Turtle	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wood Turtle	X		X		X										X	X			
Bog Turtle	X	X		X						X		X			X		X	X	
Map Turtle			X																
Red-bellied Turtle	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table IX (continued)

WATERSHED DISTRIBUTION FOR SELECTED HERPTILES IN THE PINE BARRENS

	WATERSHED																		
	RC					MR			MRB							GEHR			
	TOR	TUR	NBRC	SBRC	CC	LMR	MC	DC	ULMR	WR	BR	MA	NR	BA	FR	CE	LGE	UGE	AD
Ground Skink	X		X	X		X		X	X		X		X		X	X	X		
Five-lined Skink		X		X		X		X		X	X		X				X	X	
Queen Snake			X	X															
Northern Red-bellied Snake	X		X			X	X		X		X		X			X			
Eastern Earth Snake			X			X	X												
Eastern Hognose Snake	X	X	X	X		X		X	X		X	X	X		X	X	X	X	
Eastern Worm Snake	X	X	X	X		X	X	X	X	X	X				X	X	X	X	
Northern Black Racer	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Rough Green Snake	X		X	X		X		X	X		X				X	X	X	X	
Corn Snake	X	X	X	X		X	X		X		X	X	X		X	X			
Black Rat Snake		X	X	X		X		X		X	X	X				X	X	X	
Northern Pine Snake	X	X	X	X		X	X	X			X	X	X			X	X	X	X
Eastern Kingsnake	X	X	X			X	X	X	X		X				X	X	X	X	
Northern Scarlet Snake			X	X		X				X	X				X		X	X	
Timber Rattlesnake	X		X	X		X	X	X		X	X	X				X		X	X
Total number species	21	18	25	22	5	24	13	21	13	12	22	9	13	4	12	20	16	18	7

The low counts of five (5) species in Crosswicks Creek, Bass River with four (4) species and the Atlantic Drainage with seven (7) species may be attributed to habitat alteration by agriculture or residential development.

The research team has no plausible suggestion for the relatively low counts in these areas. Perhaps the data are incomplete for these streams or perhaps these drainages have not been as frequently visited by herpetologists.

Species Comment

The species comment is a description of the status*, habitat requirement, distribution and threats to the habitat of the 31 species researched in this study. This section represents a compilation and summary of the all pertinent data collected for each species.

*The status of each species here refers to the designation assigned in the State of New Jersey, Department of Environmental Protection, Division of Fish, Game and Shellfisheries Official list of March 1979.

Spotted Salamander — Ambystoma maculatum

Status. Declining.

Habitat Description. Adults of the spotted salamander are characteristically found in moist woodlands, especially oak-pine woods bordering ponds and open water areas. The larvae of this species are found within these ponds or open water areas. Turtles, diving beetles and wading birds prey upon the larvae. The adults feed upon snails, slugs, worms and insects.

Distribution. There is only one record of this species located in Ocean County near an area on the edge of the Pine Barrens. It also occurs elsewhere along the periphery of the Pine Barrens in Salem County, and may occur in Cape May and Cumberland Counties (Arndt 1979 personal communication).

Threats to Habitat (Impact). Because the spotted salamander may only occur on the periphery of the Pine Barrens its habitat is extremely vulnerable to increased industrial and residential land use, especially any accompanying decrease of water quality. Inasmuch as the spotted salamander is successful only outside the Pine Barrens, it does not seem to be a species for which special protection and management measures are required in the Pine Barrens.

Marbled Salamander — Ambystoma opacum

Status. Declining.

Habitat Description. The adult marbled salamander is characteristically found in dry, sloping or hilly woodlands such as pine-oak and oak-pine plant communities in the Pine Barrens. It also occurs less frequently in pitch pine lowland forested areas. Larvae are generally found in moist areas, such as small ponds, temporary wet depressions, or slow-moving streams within these woodlands. The adults feed upon worms, insects, spiders, slugs and snails. Turtles, wading birds, and diving beetles prey upon the larvae.

Distribution. This species is chiefly a non-Pine Barrens species. It occurs at the periphery of the Pine Barrens in Atlantic, Ocean, Cumberland, Burlington and Cape May Counties.

Threats to Habitat (Impact). Because the marbled salamander occurs only on the periphery of the Pine Barrens, its habitat is extremely vulnerable to increased industrial and residential land use inasmuch as these areas are subject to more heavy developmental land use pressure than comparable areas in the central Pine Barrens.

Eastern Tiger Salamander — Ambystoma t. tigrinum

Status. Endangered

Habitat Description. The eastern tiger salamander breeds in borrow or gravel pits with permanent or temporary ponds or puddles located in a wide variety of habitats (forests, brush, and agricultural areas). The adults congregate for spawning in ponds in January and February. These salamanders cannot tolerate the extremely acidic waters such as those characteristic of much of the Pine Barrens. They may, however, be found near the sea coast, but not in brackish or saline waters. The adults feed upon small animals. Turtles, wading birds and diving beetles prey upon the larvae.

Distribution. Scattered records of this species exist for the entire Pine Barrens region with the last remaining "stronghold" in Cape May County (Zappalorti 1979). The success of an introduced population in the Brigantine National Wildlife Refuge in Atlantic County seems questionable. The colony has encountered adverse conditions since its introduction. The pond froze during one winter and dried up during one summer. Zappalorti (1979) was pessimistic as to the success of the colony. However, Gallegos (1980) expressed the opinion that some of the population may still exist.

Threats to Habitats (Impact). The low incidence of non-acidic waters in the Pine Barrens limits the eastern tiger salamander to border Pine Barrens areas. Therefore, these limited existing habitats are extremly vulnerable to any industrial developments. The border areas are already developed industrially and residentially and are subject to further development pressures.

Four Toed Salamander — Hemidactylim scutatum

Status. Declining

Habitat Description. Adults of the four-toed salamander are found in moist areas such as sphagnum bogs, hardwood swamps, slow moving streams and creeks, or ponds. Larvae of this species are strictly aquatic within these areas. Turtles, diving beetles and wading birds prey upon the larvae.

Distribution. This species occurs in the periphery of the Pine Barrens with scattered records in Ocean, Burlington and Atlantic Counties.

Threats to Habitat (Impact). Available information indicates that the four-toed salamander is vulnerable to any decrease in water quality within wetland areas or decreases in its wetland habitat.

Eastern Mud Salamander — Pseudotriton m. montanus

Status. Threatened.

Habitat Description. Adults of the eastern mud salamander are found in muddy wetland areas: swamps, bogs, springs, streams and ponds. Larvae of the species are strictly aquatic. Turtles, diving beetles and wading birds prey upon the larvae.

Distribution. This species is poorly known in the Pine Barrens. It has been recorded only in the Pine Barrens in eastern Atlantic and western Burlington County.

Threats to Habitat (Impact). The low incidence of the eastern mud salamander in the Pine Barrens makes its habitat extremely vulnerable to disturbance, especially decreases in water quality. However, it has not been demonstrated that the Pine Barrens provide a suitable or optimum habitat for this species.

Northern Red Salamander — Pseudotriton r. ruber

Status. Declining.

Habitat Description. The northern red salamander inhabits wetlands such as bogs, cedar and hardwood swamps, non-stagnant waters such as streams, ponds and lakes with sand, rock, or gravel bottoms. At night this species may be observed foraging along the borders of streams. Larvae are strictly aquatic. Turtles, diving beetles and wading birds prey upon the larvae.

Distribution. This species occurs throughout the Pine Barrens with records in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Ocean Counties. It is more frequent in the central region of the Pine Barrens where the eastern tiger salamander is less frequently encountered (Zappalorti 1979 personal communication).

Threats to Habitat (Impact). The northern red salamander has a wide distribution in the Pine Barrens but the habitat is vulnerable to any decrease in water quality or more overt, permanent habitat modification or destruction.

Eastern Spadefoot Toad — Scaphiopus h. holbrooki

Status. Declining.

Habitat Description. The eastern spadefoot toad inhabits woodland areas such as pine-oak or oak-pine forests which are near ponds or lakes. The larvae hatch mainly in ponds. Turtles, diving beetles and wading birds prey on the larvae. The adults feed upon insects, worms and other small animals.

Distribution. This species is known in the Pine Barrens from Atlantic, Burlington, Cape May and Ocean Counties. It is a common species within the Pine Barrens, but occurs in discontinuous populations.

Threats to Habitat (Impact). Although the eastern spadefoot toad occurs throughout the Pine Barrens, its forested habitat is vulnerable to increased residential land use and any development which would decrease the water quality.

Northern Cricket Frog — Acris c. crepitans

Status. Undetermined.

Habitat Description. The northern cricket frog inhabits deciduous forests along creeks, shrubby or recently cut-over hardwood swamps, cedar swamps and other wetlands. Larvae are aquatic in small streams or creeks. Turtles, wading birds and diving beetles are predators on the larvae.

Distribution. This species is scattered throughout the Pine Barrens with records in Burlington, Cape May, Cumberland and Ocean Counties.

Threats to Habitat (Impact). The northern cricket frog is vulnerable to excessive development of wetland areas, especially any decrease in water quality.

Pine Barrens Treefrog — *Hyla andersoni*

Status. Endangered, Pine Barrens only in relation to other South Jersey areas.

Habitat Description. Adults of the Pine Barrens treefrog are found in and around cedar swamps, hardwood swamps, bogs and small streams or ponds with acidic waters. Often times they are found within a disturbance-related area. This species is active at night. The larvae are aquatic. Turtles, wading birds, and diving beetles are predators on the larvae. The adults feed upon flies, crickets, spiders and ants.

Distribution. Widely distributed in disjunct populations throughout the Pine Barrens in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester, and Ocean Counties. It does not, however, occur anywhere in New Jersey outside of the Pine Barrens.

Threats to Habitat (Impact). Although it occurs throughout the Pine Barrens, its habitat is vulnerable to any land use or development which raises the pH of wetland waters or causes a drop in the water table level. Runoff from lawn or garden areas fertilized with lime is a potential danger to populations in that it may cause an increase in pH level above the tolerance limit of this species. The introduction of salt from ice control into the surrounding waters may cause or produce adverse environmental conditions in that the frog larvae or adults may absorb dissolved or water born chemicals directly through their skin. The effect of lead and petroleum products may also have an adverse effect although this has not been demonstrated. According to Zappalorti (1980) this species does not move from one isolated breeding pond to another. Isolated here means ponds separated from each other by dry land for a distance of 300 meters or more. Thus any pond population which is eliminated will not be replaced by incoming individuals from other areas. This indicates that the Pine Barrens treefrog may extend range by moving along stream courses to breeding ponds which are contiguous or nearly contiguous with that water course.

Southern (Cope's) Gray Treefrog — Hyla chrysoscelis

Status. Endangered

Habitat Description. The gray treefrog inhabits hardwood swamps, old fields, gravel pits bordering water, and urban and residential areas adjacent to wetlands. Larvae are aquatic. The larvae are preyed upon by turtles, wading birds and diving beetles.

Distribution. The southern (Cope's) gray treefrog is indistinguishable from the more common gray treefrog (Hyla versicolor) in the field. They are distinguishable only by distinct characteristics of blood cells and by the analysis of tracings of call frequency recordings.

The presence of H.chrysoscelis in two counties, Cumberland and Cape May, has been verified by these means. Whether all gray treefrogs in Cumberland and Cape May counties are indeed H. chrysoscelis or whether some of each species are present is uncertain; therefore, it seems safer to designate all gray treefrog habitats as containing at least some Hyla chrysoscelis.

Threats to Habitat (Impact). The southern gray treefrog is vulnerable to increased residential or industrial development which would eliminate its special wetlands, especially in those areas of Cape May and Cumberland Counties.

Carpenter Frog — Rana virgatipes

Status. Undetermined, Pine Barrens only in relation to other South Jersey areas

Habitat Description. The carpenter frog is found in a variety of lowland and wetland habitats, including bogs, marshes, swamps, streams, creeks, small lakes and man-made water areas with relatively acidic waters.

Distribution. This species is found in the Pine Barrens in Atlantic, Burlington Camden, Cape May, Cumberland and Ocean Counties. It is a relatively common species.

Threats to Habitat (Impact). Although the carpenter frog occurs throughout the Pine Barrens, its habitat is extremely vulnerable to any land use or development which raises the pH of wetland waters or causes a drop in the water table level. Highway runoff is a potential danger to populations in that it may cause an increase in pH level above the tolerance limit of this species by the introduction of salt from ice control into the surrounding acidic waters.

Spotted Turtle — Clemmy guttata

Status. Undetermined

Habitat Description. The spotted turtle is found in low wetlands such as bogs, cedar swamps, hardwood swamps, savannahs and marshes. The eggs are laid in adjacent terrestrial areas. Raccoons and other small mammals prey upon the eggs and the young of this species.

Distribution. This species is known from Atlantic, Burlington, Camden, Cape May, Cumberland and Ocean Counties within the Pine Barrens. It is an abundant species but records indicate that its numbers are declining (Conant, in Forman 1979).

Threats to Habitat (Impact). The spotted turtle is known to migrate from wetland to wetland within a watershed and is therefore vulnerable to any land use which reduces or eliminates such wetlands. This species migrates along stream courses and any development near these areas may result in increased road kills.

Spotted turtles are also considered ideal animals for the pet shop trade and can be caught in large numbers in the spring before vegetation grows up and provides greater cover. They can be sold to animal dealers for $4.00 - $5.00.

Wood Turtle — Clemmys insculpta

Status. Threatened

Habitat Description. The wood turtle inhabits dry upland meadows and woods. Its food consists of fruits, berries, tender leaves, mushrooms, insects, earthworms, slugs, snails and carrion. Raccoons and other small mammals prey upon the eggs and the young.

Distribution. This is a non-Pine Barrens species. There are records of its occurrence in the periphery of the Pine Barrens in Burlington County. It probably penetrated the northern section of the Pine Barrens by moving upstream from the Inner Coastal Plain (Conant, in Forman 1979) along water courses like the Rancocas Creek.

Threats to Habitat (Impact). The Pine Barrens does not appear to be a suitable refugeum for this species whose habitat is chiefly out of the study area. Therefore there is little information regarding habitat vulnerability in the Pinelands.

Bog Turtle — Clemmys muhlenbergi

Status. Endangered.

Habitat Description. The bog turtle inhabits open areas with emergent palustrine vegetation; bogs bordered by shrubby and hardwood swamps, slow streams with muddy bottoms. Eggs are laid in adjacent terrestrial areas. Raccoons and other small mammals prey upon the eggs and the young.

Distribution. This species does not occur throughout the Pine Barrens but does occur in Atlantic, Burlington, Cape May and Ocean Counties within the Pine Barrens.

Threats to Habitats (Impacts). Since the bog turtle is not distributed throughout the Pine Barrens, maintenance and management of the wetlands areas in which it occurs are critical to its continued success.

Even in any wetlands where the bog turtle now occurs, natural maturity or succession of an open marsh to shrubby or forested woodlands will eliminate the habitats which support the bog turtle.

This Clemmys commands a very high price on the illegal animal market and may bring $100.00 or more from a private collector.

Map Turtle — Graptemys geographica

Status. Undetermined

Habitat Description. The map turtle is a highly aquatic species occurring in large bodies of water.

Distribution. This species does not occur in the Pine Barrens but is confined primarily to the Delaware River as far south as the Trenton area in Mercer County. There is one record of its occurrence in Burlington County; however, its one occurrence leads to the notion that it was introduced to the study area.

Threats to Habitat (Impact). Since the map turtle is a non-Pine Barrens species there is no habitat vulnerability now describable within the study area.

Red-bellied Turtle — Chrysemys rubriventris

Status. Undetermined.

Habitat Description. The red-bellied turtle occurs in and around bodies of fresh and brackish water including reservoirs, man-made lakes, bogs, flooded swamps, ponds, rivers and streams. Eggs are laid in adjacent terrestial areas. Raccoons, skunks and other small mammals prey upon the eggs and the young.

Distribution. This species is common throughout the Pine Barrens with records in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Ocean Counties.

Threats to Habitat (Impact). Due to the semi-aquatic nature of this species water quality maintenance and management is essential.

Ground Skink — Scincella lateralis

Status. Undetermined, Pine Barrens only in relation to other South Jersey areas.

Habitat Description. The ground skink is found primarily in upland areas, oak-pine and pine-oak forests, and surrounding agricultural fields. They tend to be found among leaves, decaying wood and other detritus. The adults feed upon insects and grubs.

Distribution. This species is relatively common in the Pine Barrens. There are records in Cape May, Cumberland, Ocean, Atlantic and Burlington Counties.

Threats to Habitat (Impact). Since the ground skink's habitat is in upland forested areas, especially in wood piles adjoining cleared areas, it is extremely vulnerable to habitat alteration by residential and industrial land use. If management practices are adopted to prevent the disappearance of this habitat then the species should maintain itself.

Five-lined Skink — Eumeces fasciatus

Status. Undetermined

Habitat Description. The five-lined skink is found in damp terrestrial areas, oak-pine and pine-oak forests, especially in disturbance areas, i.e. lumbered areas.

It is usually located in areas where wood and debris are decaying. Insects and grubs are the major food of adults.

Distribution. This species has a scattered distribution throughout the Pine Barrens, however it is found primarily along the periphery. There are records from Cape May, Burlington, Atlantic, Cumberland and Salem Counties.

Threats to Habitat (Impact). Since the five-lined skink is found primarily in the periphery of the Pine Barrens, it is extremely vulnerable to habitat alteration by residential and industrial land use. If present land use practices are continued or similar management procedures adopted, this species should maintain itself.

Queen Snake — Natrix septemvittata

Status. Undetermined.

Habitat Description. The queen snake is an aquatic species found in and near streams, creeks and the borders of ponds. Its major food source is crayfish.

Distribution. The queen snake is not a Pine Barrens species and is confined primarily to the Delaware River. It may be found as far north as Mercer County in the Trenton vicinity. There has been only one record of the queen snake in Burlington County and it is believed to have been introduced.

Threats to Habitat (Impact). Since the queen snake has been determined to be a non-Pine Barrens species, there is no habitat vulnerability to be described within the study area.

Northern Red-bellied Snake — Storeria o. occipitomaculata

Status. Pine Barrens only in relation to other South Jersey areas.

Habitat Description. The northern red-bellied snake is found in pitch pine lowlands, cedar and hardwood swamps which border woodland areas, successional fields, oak-pine or pine-oak forests. Sphagnum bogs are a favorite habitat of the red-bellied snake. Earthworms, slugs and other invertebrates are the major food sources.

Distribution. This species is scattered throughout the Pine Barrens with records from Atlantic, Burlington, Cumberland and Ocean Counties.

Threats to Habitat (Impact). The northern red-bellied snake requires high water quality in its wetland habitats and is extremely vulnerable to industrial and residential land use which alters both its wetland and upland habitats.

Eastern Hognose Snake — Heterodon platyrhinos

Status. Declining.

Habitat Description. The eastern hognose snake is an upland species found in sandy, dry oak-pine and pine-oak forests, old fields, abandoned railroads, borrow pits and abandoned agricultural fields. This habitat reflects the hognose's strong food preference for toads. Occassionally frogs, crickets and salamanders are eaten.

Distribution. This species is scattered throughout the Pine Barrens, however, it is on the decline. There are numerous records in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Ocean Counties.

Threats to Habitat (Impact). Although the eastern hognose snake is successful in disturbed habitats, the chief threats are complete residential and industrial land use where the toad food sources and protected cover are largely reduced.

Hognose snakes are in demand and can be sold for $5.00 to $10.00 to pet shops. Because of their habit of "playing dead" to avoid capture, they are easily caught and some are killed by being mistaken as rattlesnakes.

Eastern Earth Snake — Virginia v. valeriae

Status. Undetermined.

Habitat Description. The eastern earth snake is a terrestrial species found in oak-pine and pine-oak forests. It is also found in disturbance areas near deciduous forest such as abandoned agricultural fields, trails and dirt roads. Earthworms and insects are the major food sources.

Distribution. This species is primarily a non-Pine Barrens species. However, there are records of its occurrence in Burlington and Cumberland Counties along the borders of the Pine Barrens.

Threats to Habitat (Impact). Although the eastern earth snake is chiefly a non-Pine Barrens species, it is found on the periphery of the Pine Barrens. It is successful in disturbed habitats, although low intensity disturbance only is tolerated. Therefore, this species is vulnerable to complete development of residential and industrial land use, as are most other herptiles.

Eastern Worm Snake — Carphophis a. amoenus

Status. Undetermined.

Habitat Description. The eastern worm snake is common in moist upland soil; primarily oak-pine and pine-oak forests. It can be found in uncultivated plaees under logs, stones, bark and debris deep in the woods. Abandoned farm fields with soils which support earthworm and insect populations are also prime habitats.

Distribution. This species is common throughout the Pine Barrens with records of populations in Atlantic, Burlington, Cape May, Cumberland and Ocean Counties.

Threats to Habitat (Impact). The eastern worm snake requires an earthworm population and low intensity land use activities. If complete development of residential and industrial land use occur, it will eliminate the food source and the remaining habitats will be increasingly vulnerable.

Northern Black Racer — Coluber c. constrictor

Status. Undetermined

Habitat Description. The northern black racer is a moist woodland species, both upland and lowland. It is found in oak-pine and pine-oak forests, pitch pine lowlands, cedar and hardwood swamps, agricultural areas, urban areas, old fields and non-Pine Barrens areas. The major food sources are frogs, eggs, young birds, snakes, small mammals and lizards.

Distribution. This species is common throughout the Pine Barrens. There are numerous records in Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Ocean Counties.

Threats to Habitat (Impact). Since the northern black racer is relatively common throughout the Pine Barrens and elsewhere, there is low habitat vulnerability according to present information.

Rough Green Snake — Opheodrys aestivus

Status. Pine Barrens only in relation to other South Jersey areas.

Habitat Description. The rough green snake is both an arboreal and a terrestrial species found in oak-pine and pine-oak forests. It is also found in vegetation which borders streams, lakes and bogs, agricultural areas (i.e. blueberry fields and cranberry bogs). Old fields, borrow pits and non-forested meadows are also prime habitats. Its major food sources are spiders, crickets, grasshoppers, caterpillars, treefrogs and the larvae of moths and butterflies.

Distribution. This species is common throughout the Pine Barrens. There are numerous records in Atlantic, Burlington, Camden, Cape May, Gloucester and Ocean Counties.

Threats to Habitat (Impact). Since the rough green snake is common throughout the Pine Barrens and elsewhere, there is low habitat vulnerability according to present information as long as maintenance and management of pine-oak and oak-pine forests exists.

Corn Snake — Elaphe g. guttata

Status. Threatened, Pine Barrens only in relation to other South Jersey areas.

Habitat Description. The corn snake is a terrestrial species found in pine-oak and oak-pine forests, agricultural fields, old fields and wooded lots. This species breeds in dry, non-forested areas. It occurs frequently on active and inactive railroad beds. Small mammals, birds and bird eggs are the major food sources.

Distribution. The corn snake is primarily a southern species with its northern most limit in the Pine Barrens (Zappalorti 1980). This species is scattered throughout the Pine Barrens with numerous records in Atlantic, Burlington, Ocean and Cumberland Counties. The largest population is in Burlington County.

Threats to Habitat (Impact). Since this species is confined to the Pine Barrens in New Jersey, its scattered distribution requires the continued management and maintenance of its existing habitat. Ocean County habitats have already been adversely impacted by development.

Areas where old railroad ties exist are prime breeding habitats for corn snakes. Disruption of such areas by dirt bikes or the removal of old ties for various purposes will disrupt these breeding habitats.

Corn snakes are over-collected in some areas for they can bring $25.00 to $50.00 as pets.

Black Rat Snake — Elaphe o. obsoleta

Status. Undetermined.

Habitat Description. The black rat snake is an upland species found in moist areas in oak-pine and pine-oak forests. It also is found in agricultural fields, both abandoned and existing fields, non-forested areas and non-Pine Barrens areas. The black rat snake breeds in non-forested areas usually. The major food consists of small mammals, nesting birds and birds eggs.

Distribution. It is scattered throughout the Pine Barrens with records in Atlantic, Burlington, Cape May and Gloucester Counties.

Threats to Habitat (Impact). The black rat snake is scattered throughout the study area in a wide variety of habitats. Its continued success requires proper maintenance of woodlands and adjoining areas especially those which support populations of small mammals and nesting birds. Both residential and industrial development would alter or eliminate habitats that presently support this species and its associates.

Eastern Kingsnake — Lampropeltis g. getulus

Status. Undetermined, Pine Barrens Only in relation to other South Jersey areas.

Habitat Discription. The eastern kingsnake is chiefly a terrestrial species. It is occasionally found in oak-pine and pine-oak forests, but more frequently on the periphery of cedar and hardwood swamps, streams, bogs and ponds, old fields and abandoned homesites and railroads. It feeds on rodents, lizards, small mammals, birds, water snakes and turtle eggs.

Distribution. It is scattered throughout the Pine Barrens with numerous records from Atlantic, Ocean, Cape May, Burlington, Cumberland, Camden and Gloucester Counties.

Threats to Habitat (Impact). The kingsnake is scattered throughout the Pine Barrens and low vulnerability exists if present management and maintenance of habitat is continued especially in areas of old fields, swamps, bogs, ponds and old abandoned homesites. Some of these breeding and feeding sites have been altered or eliminated by forest succession and cessation of former land use.

Kingsnakes are considered ideal pets and wholesale for around $20.00, thus making it profitable for some people to exploit their capture.

Status. Threatened, Pine Barrens only in relation to other South Jersey areas.

Habitat Description. The northern pine snake favors pine-oak and oak-pine forests, but also occurs in pitch pine lowlands and cedar and hardwood swamps. It is usually found in dry sandy areas such as old fields, borrow pits, gravel pits, fire breaks and lumbering sites. This species usually breeds in non-forested areas such as disturbance areas. Rodents, birds eggs and nesting birds are the major food source of this species.

Distribution. This species is scattered throughout the Pine Barrens with numerous records from Atlantic, Burlington, Camden, Cape May, Cumberland, Gloucester and Ocean Counties.

Threats to Habitat (Impact). The northern pine snake is scattered throughout the Pine Barrens; however, its existing habitat requires continued management and maintenance. Dry area use and development which would have an impact on the habitats of small mammals represent a loss of prey for this species. The pine snake is also vulnerable to capture by amateur and professional herpetologists. Many of its disturbance habitats such as old fields or abandoned homesites and abandoned railroads are eliminated through forest succession which alters the areas and eliminates food such as rodents. This snake is more susceptible to capture than many because of its coloration, its larger size and ease of retention in captivity as a pet. Many herptile collectors are familiar enough with the time of egg laying and capture females with eggs. For this reason pine snakes are now sold (illegally) at a cost of $40.00.

More pine snakes are killed by cars than any other herptile species. In the last 20 years retirement communities have sprung up in prime pine snake habitats. These and other new housing developments have sharply increased the numbers of cars in the Pine Barrens. The rising total of road-killed snakes is brought about both accidentally and deliberately through fear or ignorance.

Pine snakes along with corn snakes and kingsnakes are often killed by the sport of riding dirt bikes or similar vehicles on railroad beds where the ties are still in position. The destruction of the railroad ties, which provide a sheltering habitat, are increasingly damaged producing an accompanying habitat loss.

Northern Scarlet Snake — Cemophora coccinea copei

Status. Undetermined. Pine Barrens only in relation to other South Jersey areas.

Habitat Description. The northern scarlet snake prefers high, dry, sandy habitats such as pine-oak and oak-pine forests. It may also be found in old fields and borrow pits and the forests which border them. Diet consists of young mice, small snakes, lizards and snake eggs.

Distribution. It has been found primarily in Burlington County with a few records in Atlantic, Cumberland, Gloucester and Salem Counties. Zappalorti (1980) considers this species rare and with a spotty distribution in the Pine Barrens.

Threats to Habitat (Impact) Since the northern scarlet snake is not widely distributed in the Pine Barrens, its known populations are vulnerable to industrial and residential land use which indicates the necessity of management and maintenance of habitat types.

Timber Rattlesnake — Crotalus horridus

Status. Endangered. Pine Barrens only in relation to other South Jersey areas.

Habitat Description. The timber rattlesnake is found primarily in wooded habitat near water. It inhabits oak-pine and pine-oak forests, and pitch pine lowlands which border cedar and hardwood swamps.(Breeding sites of this species are usually non-forested areas). It feeds on field mice, rats, squirrels, chipmunks and young rabbits.

Distribution. This species has a number of known populations in Burlington, Camden, Cape May, and Ocean Counties. In the remaining areas of the Pine Barrens its occurrence is questionable.

Threats to Habitats (Impacts). Only a few strongholds of this species exist; therefore, these areas are extremely vulnerable to residential and industrial land use and development. Timber rattlesnakes also feel the impact of hunting either for sport, venom collection, or skin collection. Other factors which may contribute to their decrease in numbers are man's general fears or dislike of this species, the loss of their food source, or the destruction or alteration of dens. Den areas must be maintained and hunting limited to insure the success of this species.

The timber rattlers population has been sharply reduced by a number of direct human actions. These snakes are hunted for sport and for the profit. Most people kill any snake which is or resembles a rattler. The reduction of habitats which has accompanied residential development has adversely affected this species along with the corn, pine and black rat snakes. A few dens have been deliberately destroyed to prevent accidental snake bites.

CHAPTER 4

AREAS OF ACTUAL AND POTENTIAL CRITICAL CONCERN

The Relative Importance of Each Habitat

Wetlands

These habitats include pitch pine lowlands, savannahs, marshes, ponds, lakes, bogs and cedar or hardwood swamps which provide supporting habitats for 17 species considered in this report. These include almost all the salamanders, toads, frogs and turtles. Certain snakes, the queen snake and the eastern kingsnake, are also dependent on these areas. All of the salamanders and toads rely on bodies of water within these wetlands for breeding.

Woodlands

These habitats include plant communities designated as oak-pine, pine-oak and non-Pine Barrens (deciduous) forests which offer shelter, food and breeding sites for 15 species considered in this report. These fauna include the majority of snakes, the skinks and swifts, and the spotted and marbled salamanders which not only breed near water but also in temporary wet depressions in the woodlands.

Disturbance Areas

Gravel pits, borrow pits, old fields including abandoned cranberry bogs or blueberry fields, old home sites, abandoned and fallen buildings and dumping grounds containing materials such as tree slash, tree stumps and trash with no toxic outflow are disturbed areas which become micro-communities with prey populations for many herptiles. The ties of an abandoned railroad bed provide such a microcommunity for small rodents which serve as food for several snake taxa. At least fourteen herptiles are supported by and breed in such communities.

An inspection of Table VIII does not reveal any habitat with an outstanding degree of critical significance. All of the habitats are indispensable for at least some of the thirty-one herptiles selected for study. To test this notion further a rating system was developed

for the three generic groups of habitats, whose significance has been described above.

All of the herptiles found in each habitat were given a relative value according to status and distribution in or relative to the Pine Barrens as follows:

Status		Distribution Relative to or Within the Pine Barrens	
Endangered	(5)	Scattered	(2)
Threatened	(4)	Marginal	(1)
Declining	(3)	Limited	(0)
Undetermined	(2)	Common	(0)
		Introduced	(0)
		PBO with little additional range outside N.J.	(2)
		PBO with abundant additional range outside N.J.	(1)

Each species thus was given an aggregate value of rating according to status and distribution.

Table X graphically demonstrates the nearly equal significance of all the habitats for some of the herptile species selected for this study.

TABLE X

A Value Rating for Herptiles Selected for this Study
in Three General Habitats of the N.J. Pine Barrens

Species Occurring in Wetlands	Status Symbol*	Status Value	Distribution Symbol*	Distribution Value	Total Value
Spotted Salamander	D	3	M	1	4
Marbled Salamander	D	3	M	1	4
Four-toed Salamander	D	3	M	1	4
Eastern Mud Salamander	T	4	L	0	4
Northern Red Salamander	D	3	C	0	3
Eastern Spadefoot Toad	D	3	C	0	3
Northern Cricket Frog	U	2	S	2	4
Pine Barrens Tree-frog	E	5	C/PBO	0+2	7
Southern Gray Treefrog	E	5	M	1	6
Carpenter Frog	U	2	C/PBO	0+2	4
Spotted Turtle	U	2	C	0	2
Wood Turtle	T	4	M	1	5
Bog Turtle	E	5	L	0	5
Map Turtle	U	2	I	0	2
Red-bellied Turtle	U	2	C	0	2
Queen Snake	U	2	M+I	1+0	3
Eastern Kingsnake	U	2	S/PBO**	2+1	5
					67

* See Exhibit D, Pp. 12-14 for definitions of these descriptions

**See page 51 for the PBO value differentiation. A value of +1 indicates abundant additional range outside New Jersey.

Species Occurring in Woodlands	Status Symbol*	Status Value	Distribution Symbol*	Distribution Value	Total Value
Spotted Salamander	D	3	M	1	4
Marbled Salamander	D	3	M	1	4
Eastern Spadefoot Toad	D	3	C	0	3
Ground Skink	U	2	C/PBO**	0+1	3
Five-lined Skink	U	2	M	1	3
Northern Red-bellied Snake	PBO	1	S	2	3
Eastern Earth Snake	U	2	M	1	3
Eastern Hognose Snake	D	3	S	2	5
Eastern Worm Snake	U	2	C	0	2
Northern Black Racer	U	2	C	0	2
Rough Green Snake	PBO	1	C	0	1
Corn Snake	T	4	S/PBO	2+2	7
Black Rat Snake	U	2	L	0	2
Northern Pine Snake	T	4	C/PBO	0+2	6
Eastern Kingsnake	U	2	S/PBO	2+1	5
Northern Scarlet Snake	U	2	L/PBO	0+2	4
Timber Rattlesnake	E	5	S/PBO	2+1	8
					65

Species Occurring in Disturbed Areas					
Spotted Salamander	D	3	M	1	4
Eastern Tiger Salamander	E	5	S	2	7
Southern Gray Treefrog	E	5	M	1	6
Ground Skink	U	2	C/PBO**	0+1	3
Five-lined Skink	U	2	M	1	3
Eastern Earth Snake	U	2	M	1	3
Eastern Hognose Snake	D	3	S	2	5
Eastern Worm Snake	U	2	C	0	2
Northern Black Racer	U	2	C	0	2
Corn Snake	T	4	S/PBO**	2+1	7
Black Rat Snake	U	2	L	0	2
Northern Pine Snake	T	4	C?PBO*	0+1	6
Eastern Kingsnake	U	2	S/PBO*	2+1	5
Timber Rattlesnake	E	5	S/PBO*	2+1	8
					63

** See page 51 for the PBO value differentiation. A value of +1 indicates abundant additional range outside of New Jersey.

The Relative Importance of Each Habitat Within Each Watershed

Generalities

The data obtained on the distribution of herptiles in watersheds of the Pine Barrens do not indicate any importance for one or more habitats in some watersheds as contrasted with others. This generalization, stated in positive terms, has a much higher probability for accuracy; it may be stated as follows;

1. Each of the habitats within each watershed is important for the maintenance of one or more herptiles. This generality may be qualified by two subordinate generalizations.

    a. The larger the watershed area, the more likely it is to contain essential sustaining habitats for herptiles. Smaller watersheds may show some disproportionate importance for some habitats.

    b. Watersheds with one or more marginally distributed (border) herptiles will likely have some specially significant sustaining habitats.

A second generalization relates to the importance of disturbance-produced habitats. The disturbances in question are those produced by a variety of land uses or circumstances. This generality may be stated;

2. More advanced or mature plant communities generally exhibit lower herptile species diversity and species population sizes.

Table XI shows an array of disturbance communities produced in wet and dry pineland habitats. The greater faunal and floral species diversity found in many disturbance-produced habitats seems to be related to greater habitat diversity of such factors as broader ranges of light intensity, soil moisture and water table levels.

Threatened and endangered species, with which this report is particularly concerned, seem to be adapted to early succession conditions. These conditions are best reproduced in the kinds of disturbed habitats as displayed in Table XI.

Within the wetlands of the Pine Barrens, the more mature or advanced successional communities are those classified as palustrine forests in the wetlands (Classification System devised by the U.S. Fish and Wildlife Service, 1977). In this scheme, cedar swamps are palustrine forests with needle-leaved canopy trees dominant (PF04). Hardwood swamps are palustrine forests with deciduous canopy trees dominant. If these forests are lumbered or burned a recovery or early successional vegetation soon appears. These wetlands are classified as palustrine with emergent vegetation (PEM) if no trees are present. Disturbed wetlands with a cover of shrubs or young trees are classed as palustrine scrub-shrub vegetation (PSS) using most of the USGS quadrangles mapped by the National Wetlands Inventory team of the U.S. Fish and Wildlife Service (Tiner 1980). The CESC research team selected all palustrine emergent (PEM), and palustrine scrub-shrub areas (PSS) as those with the most significant habitats for aquatic dependent herptiles in the Pine Barrens.

TABLE XI

THE RELATION OF COMMON LAND DISTURBANCES
AND
PINE BARRENS' PLANT COMMUNITIES TO SITES WHERE HERPETOFAUNA ARE FOUND

DRY HABITATS

Type of Disturbance	Pine Barrens Community Type and Their Modifications	Herpetofauna Found in These Habitats
Sand Roads and railroads Fire Breaks	Pine-Oak (clearings shelter)	Hognose Snake Corn Snake Pine Snake Kingsnake
Lumbering, Pine or Oak	Pine-Oak or Oak-Pine	Pine Snake Kingsnake Corn Snake Hognose Snake
Spoil Banks from Borrow Pits or Canals	Pine-Oak	Pine Snake Kingsnake Corn Snake Hognose Snake
Canals and Fire Breaks Land Clearing-Air Fields	Pine-Oak	Hognose Snake
Wildfires or Controlled Burning	Pine-Oak	All species found in dry habitats, with proper post fire management.
Abandoned Buildings		Good for almost all herptiles.

WET HABITATS

Turfing-removing sheep laurel mats for cranberry dam stabilization	Pitch Pine Lowlands or Cedar Wetlands	Most Amphibians, Turtles
Wildfires or Controlled Burning	Pitch Pine Lowlands	
Abandoned Cranberry Bogs	Wetlands Pitch Pine Lowlands	Many Amphibians

TABLE XI (continued)

Type of Disturbance	Pine Barrens Community Type and Their Modifications	Herpetofauna Found in These Habitats
Borrow Pits Gravel Pits	Wetlands	Kingsnake Hognose Snake Tiger Salamander Red-bellied Turtle
Lumbering for Cedar	Cedar Swamp	Most Amphibians Turtles Timber Rattlesnake Kingsnake

(continued from page 54)

These maps are displayed as Appendix B of this report. Inasmuch as no herptile sighting reports were located for many of these habitats, they are suggested as areas of potential concern as important herptile habitats in wetlands.

Similarly all gravel pits, clearings or abandoned railroads shown on U.S. G. S. quadrangle maps are suggested as actual or potentially critical habitats for more dry areas.

Geographical Location of Specific Critical Habitats

Two herptile species occurring within or on the borders of the Pine Barrens require habitats which may be regionally indicated.

The tiger salamander requires shallow ponds or the waters of gravel pits for its breeding phase. This salamander has been shown to be intolerant of the pH levels (4.2-5.5) of the central Pine Barrens (see pg.34). Thus all such ponded areas in Cape May County are probably of critical concern for the maintenance of this endangered species.

The southern or Cope's gray treefrog has been limited to the wetlands of Cumberland and Cape May County in New Jersey. Wetlands of the Lower Maurice River and the Dennis Creek drainage are suggested as habitats critical for the maintenance of this threatened species.

THE MOST CRITICAL AREAS

The data and interpretations submitted in the preceding sections of this chapter may be summarized as stated below.

Habitats Critical for Herptiles of the Pinelands

The data clearly show that each of the habitats selected for analysis in this study are of importance if herptiles are to be maintained in the New Jersey Pinelands. Thus oak-pine, pine-oak, pitch pine lowlands, cedar swamps, hardwood wetlands, bogs, marshes, open water and most disturbed areas within these habitats are all essential habitats for at least some herptile species either in their adult or larval stages. Inasmuch as all or almost all of the watersheds studied have some of these habitats, then one watershed can be valued as equivalent to any other Pinelands watershed of equivalent size. Table X shows that the more dry or upland habitats; (woodlands) oak-pine, pine-oak and associated non-Pine Barren forests may be evaluated as nearly the same as wetland habitats and disturbed areas when the habitats necessary for all thirty one herptiles included in this report are compared. Table XI analyzes disturbance-produced habitats to indicate the herptile species most dependent upon disturbance habitats. Thus the distribution of herptiles in each watershed appear to be a more precise indicator of areas to be designated as critical. Appendix B includes a map showing the distribution of herptile sites in the Pinelands. This map used in conjunction with Table IX, shows the Wading-Batsto River watershed not only with many distribution locations but also with a high distribution value rating.

Utilizing these two evaluation indicators, Table X and the distribution map in Appendix B, three other watersheds score high as broad critical areas. In order, these are the Rancocas Creek (North Branch and South Branch), the Maurice River, the Dennis Creek, the Toms River and Cedar Creek watersheds. With the exception of the Maurice River, these watersheds all originate in areas now in public ownership. Wise land use practices and controls are indicated as the most likely means for preserving the herptiles of the New Jersey Pinelands.

CHAPTER 5

IMPACTS, ISSUES AND LAND MANAGEMENT TECHNIQUES

Impacts

Overcapture

One instance of critical concern is the collection of reptile species for commercial exploitation. Several snake, turtle and lizard species are sought by amateur and professional collectors who sell them for their skins, for display, for study, or for pets. This has resulted in over-collecting of many species until their numbers have been reduced to endangered, threatened or declining status. The timber rattlesnake population has been reduced drastically as a result of over-collection and related activities in the Pinelands, which once contained areas of high rattlesnake population density. The northern pine snake population in the Pine Barrens has also been reduced as a result of over-collection. Factors contributing to this species reduction include the pine snake's coloration, large size and docile temperament. Other species of snakes, such as the corn snake and black rat snake, face similar exploitation.

Fear of Snakes

The influx of residents to the Pine Barrens not only poses the problem of destruction of herptile habitats but also the deliberate killing of snakes. Many residents who see herptiles, particularly snakes, on their property are known to kill them out of sheer dislike or fear. This seems to be a result of insufficient knowledge about snakes, their potential danger to people and their place in the ecosystem.

Lawn and Garden Contaminants

As residential development increases within an area there is also an increase in the use of lime and fertilizers for lawn care. Since the sandy soil of the Pine Barrens has a rapid percolation rate, the use of fertilizer and lime can modify the water quality of adjacent wetlands as well as the ground water. The addition of nitrates, phosphates and potassium compounds have been measured with their effect on aquatic vegetation. Betlejewski and Zeide (1979) found that drainage from fertilized fields in the New Jersey Pine Barrens is detrimental to tree growth. Eutrophication of an area often results from additional mineral

levels in the water producing an adverse effect on species in the wetlands by lowering the dissolved oxygen (Hedges 1977). Specific levels of tolerance for additional salt content in water have not been scientifically documented for herptile species.

Insecticides

The introduction of insecticides into an area may contaminate the surrounding waters as a result of the rapid percolation rate and eventual movement of the soil to streams. Insecticides such as Sevin or Malathion are used for mosquito or gypsy moth control. It has been established that amphibians absorb moisture and any contaminants from the surrounding water through the skin. Larvae and eggs are especially affected because of their thin skins (Weiss 1980). Tolerance levels of many species of amphibians for various insecticides have not been scientifically documented. Since amphibians feed primarily on insects, insecticide use may produce toxic effects through biological magnification when amphibia ingest prey which have an insecticide content in their tissues.

Threat of New Technology

The environmental impact of new technology is usually not known. A case in point is the new salt water cooling tower proposed by the Jersey Central Power and Light Company at the Oyster Creek nuclear electricity generation installation. As salt water enters the tower it cools the reactor and salt is released into the atmosphere with steam. This could adversely affect the water quality by changing the chemical constituents in the surface and ground water. An adverse effect on the habitats now supporting many herptiles could occur as a result (Zappalorti 1979).

Residential and Industrial Development

The habitats or plant communities of oak-pine and pine-oak are usually first to be selected for industrial and residential development. These communities have water table levels low enough to permit on-site septic systems. With the increase in housing and industry, areas require more accessible roadways. When roads are constructed, herptile species are affected. Species such as the pine snake and the spotted turtle are reduced in numbers by road-kills. The habitats of frogs and salamanders are affected by calcium salts used in the winter for ice control on roadways. Runoff can contaminate and raise the pH level of surrounding waterways. Lead constituents in roadway runoff can also add contaminants to adjacent streams. Those species which require acidic waters, the Pine Barrens treefrog and the carpenter frog, will experience the greatest impact.

Wetland Encroachment

Wetlands in the Pine Barrens have been modified by having housing projects such as those at Fawn Lakes and Ocean Acres and by industrial plants such as the Oyster Creek nuclear generating station and many sand-gravel extraction companies. The silting of waterways, changes in water level and increased runoff can adversely affect the habitat used by herptiles within habitats in the wetland area.

Recreational Needs

With the development of the Pine Barrens and the influx of residents and tourists there will be an increase in the need for recreational facilities.

Many lakes which were once critical habitats for aquatic species of herptiles have been changed by removing foliage and stumps and by building bulkheads or other retainers to provide swimming and boating facilities for nearby residents. The removal of the aquatic vegetation from lakes eliminates food sources and protection areas for aquatic herptiles such as the Pine Barrens treefrog or the bog turtle. With these essential supporting habitat factors eliminated, a reduction in species population may be anticipated.

Off-road Vehicles

The use of off-road vehicles in the Pine Barrens has increased tremendously in the past few years and is now a problem for Pine Barrens species which inhabit areas that are now used as paths or roadways. One of the most frequented areas are the abandoned railroads which are critical habitats both for breeding and shelter of the northern pine snake, corn snake, eastern hognose snake, eastern worm snake and eastern kingsnake. These different species burrow beneath old railroad ties or into their decaying crevices. The ties are destroyed once the area is frequented by off-road vehicles. It is important that these areas which were once accessible to vehicles now be managed to prevent the destruction of these critical habitats.

Clearing of Disturbed Areas - The Effects of Succession

Table XI indicates species of herptiles in the Pine Barrens which prefer disturbed areas as critical habitats. Temporary ponds, borrow pits, gravel pits, old homesites, abandoned dumps and old fields are the primary areas of concern. Many of these areas are disappearing when replaced by residential developments or special recreational land uses.

Succession of disturbance areas, forested areas or wetland areas alters the existing environments affecting habitats of many species of herptiles in the Pine Barrens (See Table XI). Cranberry bogs succeed to scrub-shrub habitats and ultimately to needle-leaved (cedar) or broad-leaved (hardwood) wetlands. A similar reduction of habitats for herpetofauna occurs in the succession of protected oak-pine and pine-oak forests. These more advanced successional communities do not provide the favorable habitats for many herptiles as do their earlier successional stages.

Introduction of Species

The introduction of non-indigenous species to an environment may threaten other species in that habitat. If the introduced species adapts to the new environment, it may alter the natural food chain such that other native species may not be able to compete successfully or to secure an adequate food supply.

TABLE XII

PRESENT LAND USE PRACTICES IN THE N.J. PINE BARRENS PRODUCING NEGATIVE IMPACTS ON ENVIRONMENTAL QUALITY WITH RESPECT TO HERPTILES WITH RELATED ISSUES AND LAND USE MEASURES, REGULATIONS, OR CONTROLS SUGGESTED TO ALLEVIATE THE NEGATIVE IMPACTS

	Negative Impacts	Issues	Suggested Measures Controls Regulations
1.	overcapture or overkill	the need to protect herptiles from human depredation	more efficient enforcement of existing laws relating to sale or capture of herptiles, educational programs
2.	fear of snakes	the value of right of existence for reptiles	educational programs
3.	use of fertilizers on gardens and lawns	the need to determine the broad and specific effects of lawn fertilization	deed restrictions for residences and other buildings in the Pinelands
4.	use of insecticides	the need to determine the broad and specific effects of insecticides	continued research and monitoring of effects of insecticides
5.	environmental threat provided by new technology	the need to pretest the environmental impact of all technological innovations	pilot testing of new technology mandatory
6.	habitat deterioration from residential development	need for use plan involving environmental conditions	environmental impact zoning relating to fragility or uniqueness of any area
7.	encroachment of wetlands by various aspects of land use and development	need for protection of wetlands as prime critical areas for species in the Pinelands	EIS required for all permits for projects near or possibly affectin Pinelands wetlands
8.	using land for recreational needs	need to protect non-game wildlife from detrimental recreational activities	balancing recreational and environmental needs in an applied master plan

Negative Impacts	Issues	Suggested Measures Controls Regulation
9. off-road vehicles	need to protect herptiles from effects of impact-intensive types of recreations	educational programs; limited access to off-road vehicles guaranteed by licensure
10. clearing or cleaning up disturbed areas and the effect of successional change on disturbance-produced habitats	the need for research on the relation of disturbed areas and habitats favorable for herptiles	promoting or simulating traditional low impact land use practices modified by on-going research
11. introducing species to a "new" area	the need for research and supervision if animal transplantation is contemplated	carry out only under state or federal agency supervision

Issues

The impact of present and projected land use practices and conditions of the present status and condition of herptiles in the New Jersey Pinelands leads to the identification of issues. The issues as listed and discussed here are perceived as generalities indicating a prescription for land use favoring the preservation of herptiles. Each issue is stated in relation to one of the impacts discussed in the preceding section. A rationale accompanies each statement of issue.

The Need to Protect Herptiles from Human Depredation

The issue: There is a need for a broader public understanding of the threats to existence for certain herptiles and the desirability of legal protection for such herptiles.

Rationale: The continuing decline of herptiles has not been sufficiently checked by existing laws and their enforcement. There seems to be a lack of public knowledge about herptiles.

The Value of Herptiles and Their Right to Exist

The issue: Since many herptiles, especially snakes, are feared by a large number of persons, there is a need for a greater understanding of the life habits of herptiles and their right to life as a natural species.

Rationale: The right of existence for all species should be guaranteed by an enlighted society. That all herptiles occupy an ecological niche and a place in one or more food webs in the Pinelands and elsewhere should be understood by such a society. Looking for "what is good about an animal" should not be used to determine whether a society should protect the right of a species to exist. As part of the Pinelands ecosystem herptiles are entitled to the protective intent of the Pinelands legislation.

The Need to Determine the Broad and Specific Effects of Fertilized Agricultural Fields and Homesite Runoff on Herptiles

The issue: Planning funds should be expended to learn more precisely about the effects of fertilizer runoff on Pinelands water bodies in general and their herptile inhabitants in particular.

Rationale: Substances with unknown physiologic effects on flora and fauna are illustrated by fertilizers and lawn and garden chemicals. The knowledge of the effects should be researched before adequate protective measures are developed and implemented for herptiles in order to develop adequate regulations and controls.

The Need to Determine the Broad and Specific Effects of Insecticide on Herptiles

The issue: Planning funds should be expended for research on the effects of insecticides on herptiles.

Rationale: Substances toxic to many biota are exemplified by insecticides and herbicides; the protection of herptiles in the Pinelands requires this knowledge. Without this research knowledge, no protective measures for herptiles can be developed adequately.

The Need to Pretest the Environmental Impact of All Technical Innovations Proposed to be Used Near or in the Pinelands

The issue: The Pinelands should be protected from unknown effects of untried technologies.

Rationale: The effects of the proposed salt tower cooling system for the Jersey Central Power and Light Company at Oyster Creek, have been speculated upon by Zappalorti (1979) but precise information is not now available. The scientific evidence provided by the supporting company-developed environmental impact statement used an extrapolation of salt tolerance in non-Pinelands herptile species in an attempt to generate a greater degree of certainty. A pilot program seems necessary to test the effects of such a salt water cooling tower or similar untried technologies.

The Need for a Land Use Plan Made in Harmony with Environmental Conditions

The issue: The entire Pinelands should be zoned in terms of its relative environmental fragility with respect to the impact of proposed land uses (environmental impact zoning).

Rationale: In general, wetland plant communities are more fragile and susceptible to adverse environmental impact from various land uses than are upland or dry plant communities. By environmental impact zoning, each area of the pines would be zoned to indicate permitted and non-permitted uses according to the ability of that environment to withstand the impact of the proposed use.

The Need for Special Protection of Wetlands, Stream Courses and Other Water Bodies

The issue: Because of extensive habitat destruction resulting from residential, industrial, and intensive recreational use, the maintenance of satisfactory herptile habitats seem mutually exclusive. Herptiles need protection from the threat of further habitat destruction from intensive land use.

Rationale: A thorough analysis of all wetlands and an accompanying master plan for wetland use seems to be a necessity when the pressures for sewer interceptor lines, new roads and other facilities which utilize wetlands are considered for zoning and regulation.

The Need to Protect Herptiles from Detrimental Recreational Activities

The issue: Recreational activity in the Pinelands seem to be a most needed and acceptable land use. The habitats of herptiles must be protected from destruction by recreational activities.

Rationale: Recreational demands for boating and swimming will undoubtedly preempt many herptile habitats. Such facilities should be planned to keep herptile habitat destruction at a minimum. Mutually reinforcing activities such as area management for hunting could aid in maintaining habitats for many snakes.

The Need to Protect Herptiles from Off-Road Vehicles

The issue: Off-road vehicles which are often environmentally destructive should not be allowed to destroy herptile habitats in the Pinelands or elsewhere.

Rationale: Off the road vehicles are a common form of recreation in modern America and their impact is being felt in the Pine Barrens to a greater degree. Dirt bikes and jeeps upset habitats along old railroads by crushing snakes and food supplies as well as wearing away the ties. Basking herptiles fall victim to these modes of recreational pleasures.

The Need for Research on the Relation of Disturbance Areas and Habitats Favorable to Herptiles

The issue: Disturbed areas are not generally perceived as desirable habitats for herptiles, but Table XI indicates that distrubed areas actually are desirable habtats. These habitats must be maintained and recreated if and when they disappear.

Rationale: The findings of this study strongly corroborate this issue as stated.

The Need for Research and Supervision of Animal Population Transplantation is Considered

The issue: Relocation of any species to prevent the decline of species populations in an environmental option may have undesirable consequences. There is a need to protect against unexpected results of herptile population relocations.

Rationale: Should older land use practices be encouraged in the New Jersey Pine Barrens to renew or create the habitats which sustain faunal or floral species now in jeopardy? If so, continuing research is needed.

Is it feasible or desirable to relocate or introduce species of herptiles (perhaps other fauna and also flora) to Pine Barrens habitats which appear to have the needed requirements for the species in question and for which no population presently exists?

The biological disasters which have already occurred from unplannned or poorly planned introductions justify the need for pilot programs following research and the need for broad concurrence by responsible public agencies.

Suggested Measures, Controls and/or Regulations

1. Overcapture of favored herptile species may be alleviated by more efficient enforcement of existing laws relating to the sale or capture of herptiles classified as endangered, threatened, declining or species of undetermined status. Educational effort must be made to provide greater understanding for these controls and for the undesirability of deliberate herptile roadkills. See #2 for specific suggestions for education.

2. Public education concerning the ecological niches of herptiles and philosophical and aesthetic consideration of the values of non-game fauna should be encouraged and implemented. This could be done by incorporating herptile lessons in science classes at the primary, intermediate and secondary level. Various environmental education facilities, such as CESC, Inc. could be granted contracts to provide suitable herptile curriculum to teachers at various grade levels. A publicity campaign utilizing billboards, newsletters, a public lecture series and T.V. and radio time would also aid in public awareness. Such a campaign has been effective in Florida in providing public awareness of the plight of the endangered manatee.

3. Any residential or industrial land use where lawns are installed in the Pinelands require continued fertilizer applications. This could be eliminated by deed restrictions imposed by local planning boards and by conforming land use practices on public lands. Alternate kinds of ground cover should be researched, developed and utilized. For example the use of sheep laurel as a low ground planting was originally advocated by planners of the King's Grant project in Evesham Township. Other available indigenous Pinelands plants could also be utilized.

4. The regulation of insecticide use should be continually researched, monitored and licensed. The use of insecticides for controlling mosquitos or gypsy moths (sevin or malathion) should not be used in critical habitats for herptiles. Weiss (1980) pointed out that amphibians may absorb contaminants from surrounding waters (especially eggs and larvae due to their thin skin). Biological controls as an alternative to insecticide use should be researched. Wagner (1971) states that biological control of both plant and insect pests by insects has been successful many times and there is no possibility of the pest developing tolerance as has occurred with some insects and DDT.

5. The environmental impact of any new technology, such as the high evaporation rate "salt tower" proposed by Jersey Central Power and Light Company's electrical generating plant at Forked River, should be tested by valid pilot tests or with feasible alternatives employed.

6. Planning of residential or industrial developments should utilize enviromental impact zoning and increased efforts to increase the blending of human communities with the local ecological communities. For example the King's Grant project in Evesham Township was designed to promote and maintain environmental quality in harmony with the ecology of the Pinelands. Wilcox and Grarratt, Inc. have also designed "recreational developments" which environmentally disturb areas as little as possible.

7. Wetlands in the Pinelands should be zoned for extreme fragility and the prohibition of residential or industrial development. Where wetlands are crossed

by new roads or highways or recreational use and/or development is planned on water courses or water bodies, a satisfactory environmental impact statement should be required by the Pinelands Commission previous to granting approval.

8. The Pinelands must be utilized for increased recreation both of an intensive and low impact nature. A recreational segment of the master plan should spell out the details of a well considered recreational master plan.

9. The use of off-road vehicles is a recreational expression which cannot be extirpated (if there are those who would advocate this). On the other hand off-road vehicle use must be regulated. Mandatory licensing of all off-road vehicle use would serve several functions: a) vehicles would be registered b) educational material about the need to maintain limited access and the necessity of preserving faunal and floral habitats could be distributed with each license c) the license fees could be used to provide a limited monitoring of off-road activities and to help build special off-road vehicle courses d) the license fees could also be used to fund talks to off-road recreational groups and to organize them into a Pinelands protection association.

10. Many habitats favorable to herptiles include several areas which are considered to be disturbances from an ecological point of view. Many disturbances were produced from traditional land uses in the Pinelands. Where feasible these land use practices should be permitted. A list of these disturbances is found in Table XI with their relation to herptiles. This recommendation is reinforced by a simple recommendation for maintaining threatened and endangered plant species. If environmental deterioration is feared from the continuance of some traditional land uses, then these should be simulated by direct land management. The Division of Fish, Game and Shellfisheries of DEP has developed many of these alternative practices. It should be recognized however, that successful vegetation recovery methods have been developed for such a seemingly destructive activity as sand and gravel mining areas. These methods must be advocated for all Pinelands communities which have a potential for sand and gravel mining*.

11. To transplant species from one habitat to a similar one is a rational possibility to prevent the decline of a species population. This could be a successful or disastrous environmental option. If transplantation or translocation of species is contemplated the implementation of such an activity should be preceded by:

a) research on the advisability of the proposed activity
b) securing of cooperation and supervision of state and/or federal wildlife agencies.

12. A Recreational Land Control Recommendation. The Pinelands have been shown to be a fragile albeit attractive environment for many land uses. Of these, recreation is one of the most logical uses. It is recommended that all land utilization in the Pinelands by non-owners be licensed. Such fees, even though modest for children, senior citizens and needy citizens, could be used to provide educational programs and monitor the land use regulations promulgated by the Pinelands Commission.

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*Schellie, K. L. and R. Rogier. 1963. *Site Utilization and Rehabilitation Practic for Sand and Gravel Operations*, National Sand and Gravel Assn., Silver Spring, MD 209
Schellie, K. L. Editor. 1977. *Sand and Gravel Operations: A Transitional Land Use*, National Sand and Gravel Association, Silver Spring, MD 20910.

13. Some special management measures are desirable to insure the continuance of habitats of selected herptiles.

a. Bog Turtle

Set aside cranberry bogs on public lands and maintain a shallow water level to encourage growth of sphagnum moss. Maintain an emergent palustrine vegetation and prevent succession to a scrub-shrub or forested wetland.

b. Ground Skink and Five-lined Skink

Maintain piles of bush and logs in cleared areas within pine-oak or oak-pine areas. This could also provide habitats for many non-game snakes.

c. Corn, Pine and Kingsnakes

Install partly buried logs to simulate railroad ties in oak-pine or pine-oak areas; an alternative is to clear cut areas near water and plant corn and grain to attract rodents.

d. Pine Barrens Treefrog and Associated Amphibians

Require the creation of diversion ditches on all roadways crossing wetlands in the Pine Barrens so as to prevent storm water runoff with salt or lead contaminants from entering prime herptile habitats.

e. Pine Barrens Treefrog

Inasmuch as the Pine Barrens Treefrog may not travel any significant distance over land, the quality of all headwaters and many entire stream courses must be maintained by eliminating all development on all public and many private lands.

f. Tiger Salamander and Southern (Cope's) Gray Treefrog

Maintain or improve environmental quality in all ponded gravel pits and other shallow ponds or water in the Pine Barrens or CAFRA zones of Cape May and Cumberland Counties.

g. Four-toed Salamander

Maintain some undeveloped ponds on the borders or periphery of the Pine Barrens.

CHAPTER 6

DATA GAPS AND ISSUES REQUIRING FURTHER STUDY

Data Gaps

Distributional Data

Distributional data are lacking or incomplete for many herptile species. Much of the existing data are from old records (pre World War II). The occurrence of an animal in an area or even the existence of the animals habitat in an area is questionable at the present.

Most times herptiles are sought by collectors or hunters in easily accessible areas or areas with previous records of the animals occurrence. This has led to numerous records from some areas, but vast expanses of the Pine Barrens which presumably contain suitable habitats have been overlooked due to their less accessible terrain.

Much collection by amateur and professional herpetologists has concentrated on the "popular," more showy species. Many herptiles, such as the salamanders and skinks, are secretive animals and the collector's field hours might not be rewarded with a large volume of data or numerous specimens. Also, only frogs and toads call or sing, therefore these are the only herptiles detectable without actual sightings.

Another reason for the lack of distributional data is that many older hunters or collectors did not keep detailed or accurate records of their field work.

Because of the error inherent in hearsay or recall reports, the potential volume of data from sightings is reduced and represents a significant data gap.

For the identification of the southern or Cope's gray treefrog detailed analysis of tracings of song recordings are required to distinguish this species from the gray treefrog with any certainty. The gray treefrogs in Cumberland and Cape May Counties may be a mixture of these two species but they are arbitrarily assumed to be all southern or Cope's gray treefrog. Here is a data gap requiring more information.

Habitat Description

Habitat descriptions for some herptile species are incomplete. Reasons for this include generalizations and anecdotal information in the literature, much out-dated literature and the failure of many hunters and collectors (especially local woodsman or resource harvesters) to keep records of sightings of areas where collections occurred along with more complete habitat descriptions on environmental conditions in the area of the collection site.

Vegetation types and water quality and quantity within historic areas of occurrence may have been altered over the course of time by natural succession or by man's activities. Such altering of the habitat leads to the question of whether a herptile known from the mid 1900's in an area could even occur there today (Is the habitat still suitable in that area?).

Due to the secrecy of many herptiles it is also difficult to assess their range within a given habitat or their preference between specific areas.

Life Histories

The collection of information to develop life histories of the less conspicuous animals languished for several decades when this type of information was not perceived as a significant scientific endeavor. The newly awakened interest for threatened and endangered species now points up the need for this type of information.

Unfortunately this is true for many herptiles. Life history data are lacking for many species in regards to general food requirements, predator-prey relationships within the habitat, breeding cycles and growth and maturation stages of the young. A lack of this type of background data for a species makes the development of efficacious management practices difficult.

Knowledge of Management Practices

The success of attempted management practices is mostly undocumented with respect to herptiles. A good example is the 1975 introduction of a small population of the Tiger Salamander, Ambystoma tigrinum, at the Brigantine National Wildlife Refuge by the late Dr. James Anderson. Since the introduction only speculative information exists as to the success of the population. No field study of the area has occurred to determine the actual status of the A. tigrinum population.

Supplemental Field Surveys

It appears that the biggest data gap for herptiles in the Pine Barrens is the lack of an intensive field survey for many of these animals. A field survey of possible herptile habitats within the Pine Barrens would be no easy or short-term task, but inevitably would lead to bridging of existing data gaps and a better understanding of herptiles and their role within the habitat. This in turn would make management an easier and more precise undertaking.

Effects of Pollutants

The short-term and long-term effects of air pollution, roadway runoff and waste from landfills or other waste disposal areas seem likely to have an impact on herpetofauna and their specific habitats. Of critical concern is maintenance of water quality within wetlands. Unfortunately there is little or no data available as to the impacts of such pollutants.

Issues Requiring Further Study

1. Management practices to be utilized in the proposed Natural Areas Tracts should be reviewed and evaluated within DEP to reflect research on vegetation management for endangered species.

2. Risk options and cost benefits for rights-of-way of various kinds in the Pine Barrens should be developed.

3. The use of a numerical value rating system for clarifying importance of areas or endangered species analysis and recovery potential of endangered or other threatened status species.* See Exhibit D and Table IX page 30.

4. If education for the general public would indeed create a better reception of land use control on the Pine Barrens, the optimal means to conduct such education efforts need to be assessed.

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* Landry et al. Ibid.

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