

THE EFFECTS OF SALT DRIFT ON LAND
DWELLING VERTEBRATES

by

William R. Clark, Robert Rogers and Leonard J. Wolgast

Forestry Section

Rutgers - The State University

4/2/84

840409015B 840402
PDR ADOCK 05000219
R PDR

ACKNOWLEDGEMENTS

We wish at this point to acknowledge our indebtedness to Mrs. Katherine Price and Mr. Bud Cooper for supplying us with numerous records of birds observed on Island Beach State Park. We wish to recognize Dr. Paul G. Pearson of Rutgers Zoology Department for his suggestions concerning this study. We are grateful to Dr. John J. McManus of Farleigh Dickinson University for his contributions to this study. We are indebted to Dr. J. Richard Trout for his help with the statistical analysis of the data. We acknowledge likewise the cooperation of Dr. Bruno C. Moser and Dr. Stephen J. Toth who supplied us with updated information throughout the study. Finally, we acknowledge the comments of Dr. Benjamin B. Stout and Professor Richard F. West, who read the first draft of the manuscript and Mrs. Hazel Newell who typed the manuscript.

The Effects of Salt Drift on Land Dwelling Vertebrates

Objectives:

To obtain an estimate of the potential effects of salt drift on the individual land dwelling vertebrates in the Forked River area, and to consider potential alterations in community structure among those species present.

Procedures:

A check list of land dwelling vertebrates inhabiting the Forked River area has been developed using a literature survey. This information has been supplemented with field observations. A check list of land dwelling vertebrates inhabiting Island Beach has also been developed since ground level salt concentrations average ten times higher than in the Forked River area (Moser, unpublished data). Field observations were also used to supplement the Island Beach check list.

In order to develop a quantitative index of summer bird numbers in the Forked River area, aerial photographs were utilized to delineate the various habitat types present. Two sampling stations were located within each habitat type, one station within the 0.5 to 1.5 mile band surrounding the proposed cooling tower site and one station outside 1.5 miles but within a 5-mile radius of the proposed site. The salt marsh habitat type does not occur within the 0.5 to 1.5 mile band and therefore contained only one sampling station.

At each sampling site birds were observed on early morning censuses of one hour duration. Each pair of sites within a vegetation type was sampled at the same time by two observers to eliminate time of day differences. Before actual counts were started a measure of conspicuousness was determined for the common species at a site. Conspicuousness measures were the average distance that individuals of a species first attracted attention by calling, moving or just sitting still. This is an attempt to account for differences in bird activity and visibility in the different vegetation types (Kendeigh, 1944). Twice the conspicuousness distance multiplied by the linear distance traveled is equal to the area being sampled. When actual counts were made at a sample site care was taken to walk at a constant speed and not to cover the same ground twice. All distant songs were ignored, as were birds flying overhead unless they flew into or out of the vegetation. Birds not positively identified were not recorded.

Two population indices were calculated from these data. The density index was calculated by methods reviewed by Kendeigh (1944). The density index formula is as follows:

$$DI = (SN_i \cdot 43560) / (2 \cdot D \cdot C_i)$$

where

DI = density index

D = sample distance (average distance traveled during censuses at each site)

SN_i = number of birds of ith species

C_i = conspicuousness average distance for ith species

In addition, the total density for all bird species combined at each site was calculated.

The second index calculated was a diversity index. Diversity indices were calculated according to Lloyd, Zar and Karr (1968) by the formula:

$$H = 3.3219 \left(\log_{10} TN - \frac{\sum SN_i \log_{10} SN_i}{TN} \right)$$

where

H = diversity index

TN = total birds observed in one hour

SN_i = number of birds of ith species

These data were subjected to an analysis of variance utilizing a partially nested design to characterize the variability of total bird density and species diversity among vegetation types and between sites within vegetation types.

Censuses were conducted between 6:30 and 10:00 a.m., July 6 through July 30, 1971. Each pair of sites in a vegetation type was censused four times during that period, as were the marsh site and Island Beach which were not paired.

In addition, general reconnaissance of the area was conducted during this same period which included qualitative observations of the reptiles, amphibians and mammals of the area. Snap traps baited with peanut butter were used to sample the nocturnal small mammals.

Information regarding the salt tolerances of the land dwelling vertebrates inhabiting the Forked River area was obtained from the literature where available. Quantitative information was unavailable for most of the two hundred and seventeen species present, but the information available for related species has also been reviewed to arrive at an opinion of the estimated effects of salt drift from the cooling tower.

Checklist of Land Dwelling Vertebrates
Found in the Central Pine Barrens Region
of New Jersey

SALAMANDERS

Marbled Salamander (*Ambystoma opacum*)
Eastern Tiger Salamander (*Ambystoma t. tigrinum*)
Four-toed Salamander (*Hemidactylium scutatum*)
Red-backed Salamander (*Plethodon c. cinereus*)
Northern Two-lined Salamander (*Eurycea b. bislineata*)
Red-spotted Newt (*Diemictylus v. viridescens*)
Northern Red Salamander (*Pseudotriton r. ruber*)

FROGS AND TOADS

Northern Cricket Frog (*Acris c. crepitans*)
Fowler's Toad (*Bufo woodhousei fowleri*)
Pine Barrens Treefrog (*Hyla andersoni*)
Northern Spring Peeper (*Hyla c. crucifer*)
Bullfrog (*Rana catesbeiana*)
Green Frog (*Rana clamitans*)
Pickerel Frog (*Rana palustris*)
Southern Leopard Frog (*Rana pipiens sphenoccephala*)
Wood Frog (*Rana sylvatica*)
Carpenter Frog (*Rana virgatipes*)
Spadefoot Toad (*Scaphiopus holbrooki*)

TURTLES

Common Snapping Turtle (*Chelydra s. serpentina*)
Eastern Painted Turtle (*Chrysemys p. picta*)
Spotted Turtle (*Clemmys guttata*)
Wood Turtle (*Clemmys insculpta*)
Bog Turtle (*Clemmys mühlenbergi*)
Mud Turtle (*Kinosternon s. subrubrum*)
Red-bellied Turtle (*Pseudemys rubriventris*)
Stinkpot (*Sternotherus odoratus*)
Eastern Box Turtle (*Terrapene c. carolina*)

LIZARDS

Five-lined Skink (*Eumeces fasciatus*)
Ground Skink (*Lygosoma laterale*)
Northern Fence Lizard (*Sceloporus undulatus hyacinthus*)

SNAKES

Eastern Worm Snake (*Carphophis a. amoenus*)
Scarlet Snake (*Cemophora coccinea*)
Northern Black Racer (*Coluber c. constrictor*)
Timber Rattlesnake (*Crotalus h. horridus*)
Ringneck Snake (*Diadophis p. punctatus*)
Corn Snake (*Elaphe g. guttata*)
Black Rat Snake (*Elaphe o. obsoleta*)
Eastern Hognose Snake (*Heterodon platyrhinos*)
Coastal Plain Milk Snake (*Lampropeltis doliata triangulum*)
Eastern Kingsnake (*Lampropeltis g. getula*)
Northern Water Snake (*Natrix s. sipedon*)
Rough Green Snake (*Opheodrys aestivus*)
Northern Pine Snake (*Pituophis m. melanoleucus*)
Northern Brown Snake (*Storeria d. dekayi*)
Northern Red-bellied Snake (*Storeria o. occipitomaculata*)
Eastern Ribbon Snake (*Thamnophis s. sauritus*)
Eastern Garter Snake (*Thamnophis s. sirtalis*)

BIRDS

Pied-billed Grebe (*Podilymbus podiceps*)
Great Blue Heron (*Ardea herodias*)
Green Heron (*Butorides virescens*)
Common Egret (*Casmerodius albus*)
Black-crowned Night Heron (*Nycticorax nycticorax*)
Mallard (*Anas platyrhynchos*)
Black Duck (*Anas rubripes*)
Wood Duck (*Aix sponsa*)
Hooded Merganser (*Lophodytes cucullatus*)
Turkey Vulture (*Cathartes aura*)
Red-tailed Hawk (*Buteo jamaicensis*)
Red-shouldered Hawk (*Buteo lineatus*)
Broad-winged Hawk (*Buteo platypterus*)
Marsh Hawk (*Circus cyaneus*)
Osprey (*Pandion haliaetus*)
Pigeon Hawk (*Falco columbarius*)
Sparrow Hawk (*Falco sparverius*)
Ruffed Grouse (*Bonasa umbellus*)
Bobwhite (*Colinus virginianus*)
Ring-necked Pheasant (*Phasianus colchicus*)

BIRDS (Cont'd)

Killdeer (*Charadrius vociferus*)
American Woodcock (*Philohela minor*)
Spotted Sandpiper (*Actitis macularia*)
Solitary Sandpiper (*Tringa solitaria*)
Mourning Dove (*Zenaidura macroura*)
Yellow-billed Cuckoo (*Coccyzus americanus*)
Black-billed Cuckoo (*Coccyzus erythrophthalmus*)
Screech Owl (*Otus asio*)
Great Horned Owl (*Bubo virginianus*)
Short-eared Owl (*Asio flammeus*)
Saw-whet Owl (*Aegolius acadicus*)
Chuck-will's-widow (*Caprimulgus carolinensis*)
Whip-poor-will (*Caprimulgus vociferus*)
Common Nighthawk (*Chordeiles minor*)
Chimney Swift (*Chaetura pelagica*)
Ruby-throated Hummingbird (*Archilochus colubris*)
Belted Kingfisher (*Megaceryle alcyon*)
Yellow-shafted Flicker (*Colaptes auratus*)
Red-bellied Woodpecker (*Centurus carolinus*)
Yellow-bellied Sapsucker (*Sphyrapicus varius*)
Hairy Woodpecker (*Dendrocopos villosus*)
Downy Woodpecker (*Dendrocopos pubescens*)
Eastern Kingbird (*Tyrannus tyrannus*)
Great Crested Flycatcher (*Myiarchus crinitus*)
Eastern Phoebe (*Sayornis phoebe*)
Acadian Flycatcher (*Empidonax virescens*)
Traill's Flycatcher (*Empidonax traillii*)
Least Flycatcher (*Empidonax minimus*)
Eastern Wood Pewee (*Contopus virens*)
Tree Swallow (*Iridoprocne bicolor*)
Rough-winged Swallow (*Stelgidopteryx ruficollis*)
Barn Swallow (*Hirundo rustica*)
Purple Martin (*Progne subis*)
Blue Jay (*Cyanocitta cristata*)
Common Crow (*Corvus brachyrhynchos*)
Fish Crow (*Corvus ossifragus*)
Black-capped Chickadee (*Parus atricapillus*)
Carolina Chickadee (*Parus carolinensis*)
Tufted Titmouse (*Parus bicolor*)
White-breasted Nuthatch (*Sitta carolinensis*)
Red-breasted Nuthatch (*Sitta canadensis*)
Brown Creeper (*Certhia familiaris*)
House Wren (*Troglodytes aedon*)
Carolina Wren (*Thryothorus ludovicianus*)
Long-billed Marsh Wren (*Telatodytes palustris*)

BIRDS (Cont'd)

Mockingbird (*Mimus polyglottos*)
Catbird (*Dumetella carolinensis*)
Brown Thrasher (*Toxostoma rufum*)
Robin (*Turdus migratorius*)
Wood Thrush (*Hylocichla mustelina*)
Hermit Thrush (*Hylocichla guttata*)
Swainson's Thrush (*Hylocichla ustulata*)
Gray-cheeked Thrush (*Hylocichla minima*)
Veery (*Hylocichla fuscescens*)
Eastern Bluebird (*Sialia sialis*)
Blue-gray Gnatcatcher (*Polioptila caerulea*)
Golden-crowned Kinglet (*Regulus satrapa*)
Ruby-crowned Kinglet (*Regulus calendula*)
Cedar Waxwing (*Bombycilla cedrorum*)
Loggerhead Shrike (*Lanius ludovicianus*)
Starling (*Sturnus vulgaris*)
White-eyed Vireo (*Vireo griseus*)
Yellow-throated Vireo (*Vireo flavifrons*)
Red-eyed Vireo (*Vireo olivaceus*)
Black-and-white Warbler (*Mniotilta varia*)
Prothonotary Warbler (*Protonotaria citrea*)
Golden-winged Warbler (*Vermivora chrysoptera*)
Blue-winged Warbler (*Vermivora pinus*)
Tennessee Warbler (*Vermivora peregrina*)
Parula Warbler (*Parula americana*)
Yellow Warbler (*Dendroica petechia*)
Magnolia Warbler (*Dendroica magnolia*)
Cape May Warbler (*Dendroica tigrina*)
Black-throated Blue Warbler (*Dendroica caerulescens*)
Myrtle Warbler (*Dendroica coronata*)
Black-throated Green Warbler (*Dendroica virens*)
Blackpoll Warbler (*Dendroica striata*)
Pine Warbler (*Dendroica pinus*)
Prairie Warbler (*Dendroica discolor*)
Palm Warbler (*Dendroica palmarum*)
Ovenbird (*Seiurus aurocapillus*)
Northern Waterthrush (*Seiurus noveboracensis*)
Yellowthroat (*Geothlypis trichas*)
Yellow-breasted Chat (*Icteria virens*)
Hooded Warbler (*Wilsonia citrina*)
Wilson's Warbler (*Wilsonia pusilla*)
American Redstart (*Setophaga ruticilla*)
House Sparrow (*Passer domesticus*)
Eastern Meadowlark (*Sturnella magna*)
Red-winged Blackbird (*Agelaius phoeniceus*)

BIRDS (Cont'd)

Orchard Oriole (*Icterus spurius*)
Baltimore Oriole (*Icterus galbula*)
Common Grackle (*Quiscalus quiscula*)
Brown-headed Cowbird (*Molothrus ater*)
Scarlet Tanager (*Piranga olivacea*)
Cardinal (*Richmondia cardinalis*)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)
Indigo Bunting (*Passerina cyanea*)
Evening Grosbeak (*Hesperiphona vespertina*)
Purple Finch (*Carpodacus purpureus*)
Common Redpoll (*Acanthis flammea*)
Pine Siskin (*Spinus pinus*)
American Goldfinch (*Spinus tristis*)
Red Crossbill (*Loxia curvirostra*)
White-winged Crossbill (*Loxia leucoptera*)
Rufous-sided Towhee (*Pipilo erythrophthalmus*)
Henslow's Sparrow (*Passerherbulus henslowii*)
Sharp-tailed Sparrow (*Ammodramus caudacuta*)
Seaside Sparrow (*Ammodramus maritima*)
Vesper Sparrow (*Pooecetes gramineus*)
Slate-colored Junco (*Junco hyemalis*)
Chipping Sparrow (*Spizella passerina*)
Field Sparrow (*Spizella pusilla*)
White-throated Sparrow (*Zonotrichia albicollis*)
Fox Sparrow (*Passerella iliaca*)
Swamp Sparrow (*Melospiza georgiana*)
Song Sparrow (*Melospiza melodia*)

MAMMALS OF THE NEW JERSEY PINE BARRENS

Opossum (*Didelphis marsupialis*)
Masked Shrew (*Sorex cinereus*)
Short-tailed Shrew (*Blarina brevicauda*)
Least Shrew (*Cryptotis parva*)
Eastern Mole (*Scalopus aquaticus*)
Star-nosed Mole (*Condylura cristata*)
Little Brown Myotis (*Myotis lucifugus*)
Eastern Pipistrelle (*Pipistrellus subflavus*)
Big Brown Bat (*Eptesicus fuscus*)
Eastern Cottontail (*Sylvilagus floridanus*)
Eastern Chipmunk (*Tamias striatus*)
Woodchuck (*Marmota monax*)
Gray Squirrel (*Sciurus carolinensis*)
Red Squirrel (*Tamiasciurus hudsonicus*)

MAMMALS (Cont'd)

Southern Flying Squirrel (*Glaucomys volans*)
Beaver (*Castor canadensis*)
White-footed mouse (*Peromyscus leucopus*)
Red-backed Mouse (*Clethrionomys gapperi*)
Meadow Vole (*Microtus pennsylvanicus*)
Pine Vole (*Pitymys pinetorum*)
Muskrat (*Ondatra zibethicus*)
Southern Bog Lemming (*Synaptomys cooperi*)
Norway Rat (*Rattus norvegicus*)
House Mouse (*Mus musculus*)
Meadow Jumping Mouse (*Zapus hudsonius*)
Red Fox (*Vulpes fulva*)
Gray Fox (*Urocyon cinereoargenteus*)
Raccoon (*Procyon lotor*)
Long-tailed Weasel (*Mustela frenata*)
Mink (*Mustela vison*)
Striped Skunk (*Mephitis mephitis*)
River Otter (*Lutra canadensis*)
White-tailed Deer (*Odocoileus virginianus*)

Compiled from Conant (1962), Connor (1953), Fables (1962)
and McCormick (1970).

FIELD SURVEY
FORKED RIVER AREA

SALAMANDERS

None found during general reconnaissance.

FROGS AND TOADS

Green Frog - Common in all wet places.
Southern Leopard Frog - Caught in both cedar swamp sites.
Pine Barrens Treefrog - Heard calling at both cedar swamp sites.
Carpenter Frog - Heard calling at one cedar swamp and at other swamps in the area.
Fowler's Toad - Caught on upland sites and frequently caught in salt marsh.

TURTLES

Eastern Painted Turtle - Caught at pond near cedar swamp.
Spotted Turtle - Seen along Cedar Creek.
Wood Turtle - Single individual caught in pine upland site.
Eastern Box Turtle - Very common at all sites.

LIZARDS

Northern Fence Lizard - Seen at upland mixed site.

SNAKES

Northern Black Racer - Seen along road in upland hardwood area.
Northern Water Snake - Found at lake near cedar swamp.

MAMMALS

Opossum - Two individuals seen dead along the road.
Eastern Cottontail - Very common at all sites.
Red Squirrel - Common in pine and mixed sites.
Gray Squirrel - Individuals seen in woods near Waretown.
White-footed Mouse - Thirteen individuals caught at sites #5 and #7 during 40 trap-nights.

MAMMALS (Cont'd)

Red-backed Vole - Single individual seen in cedar swamp.
Meadow Vole - Droppings and cuttings abundant in salt marsh.
Pine Vole - Seen frequently at upland sites.
Muskrat - Signs and houses common in salt marsh.
Eastern Mole - Tunnels common on upland sites.
Raccoon - Tracks seen at lakes in the area and in the salt marsh.
White-tailed Deer - Very common at all sites.

BIRDS (Species judged to be nesting within the 5-mile radius area from field observations.)

Green Heron	Tufted Titmouse
Mallard	White-breasted Nuthatch
Black Duck	House Wren
Wood Duck	Mockingbird
Turkey Vulture	Catbird
Red-shouldered Hawk	Brown Thrasher
Sparrow Hawk	Robin
Ruffed Grouse	Starling
Bobwhite	Red-eyed Vireo
Killdeer	Black and White Warbler
Mourning Dove	Blue-winged Warbler
Yellow-billed Cuckoo	Pine Warbler
Whip-poor-will	Ovenbird
Common Nighthawk	Yellowthroat
Belted Kingfisher	House Sparrow
Yellow-shafted Flicker	Red-winged Blackbird
Hairy Woodpecker	Baltimore Oriole
Downy Woodpecker	Common Grackle
Eastern Kingbird	Brown-headed Cowbird
Great Crested Flycatcher	Scarlet Tanager
Eastern Phoebe	Cardinal
Eastern Wood Pewee	American Goldfinch
Tree Swallow	Rufous-sided Towhee
Barn Swallow	Seaside Sparrow
Purple Martin	Chipping Sparrow
Blue Jay	Field Sparrow
Common Crow	Swamp Sparrow
Fish Crow	Song Sparrow
Carolina Chickadee	

Checklist of Land Dwelling Vertebrates of
Island Beach State Park, New Jersey*

MAMMALS

Red Fox (*Vulpes fulva*)
Mink (*Mustela vison*)
House Mouse (*Mus musculus*)
Meadow Jumping Mouse (*Zapus hudsonius*)
White-footed Mouse (*Peromyscus leucopus*)
Muskrat (*Ondatra zibethicus*)
Opossum (*Didelphis marsupialis*)
Eastern Cottontail Rabbit (*Sylvilagus floridanus*)
Raccoon (*Procyon lotor*)
Masked Shrew (*Sorex cinereus*)
Gray Squirrel (*Sciurus carolinensis*)
Meadow Vole (*Microtus pennsylvanicus*)
Long-tailed Weasel (*Mustela frenata*)
Little Brown Bat (*Myotis lucifugus*)

REPTILES

Northern Black Racer (*Coluber c. constrictor*)
Eastern Hognose Snake (*Heterodon platyrhinos*)
Common Musk Turtle (*Sternotherus odoratus*)
Diamond Back Terrapin (*Malaclemys terrapin*)
Eastern Box Turtle (*Terrapene carolina*)
Snapping Turtle (*Chelydra serpentina*)
Spotted Turtle (*Clemmys guttata*)

*No list of amphibians of Island Beach has been compiled.

Birds that have been seen at Island Beach:

Common Loon (*Gavia immer*)
Red-throated Loon (*Gavia stellata*)
Horned Grebe (*Podiceps grisegena*)
Pied-billed Grebe (*Podilymbus podiceps*)
Eastern Brown Pelican (*Pelecanus occidentalis*)
Double-crested Cormorant (*Phalacrocorax auritus*)
Great Blue Heron (*Ardea herodias*)
Eastern Green Heron (*Butorides virescens*)
Little Blue Heron (*Florida caerulea*)
Cattle Egret (*Bubulcus ibis*)
Common Egret (*Casmerodius albus*)
Snowy Egret (*Lencophoyx thula*)
Black-crowned Night Heron (*Nycticorax nycticorax*)
Eastern Least Bittern (*Ixobrychus exilis*)
American Bittern (*Botaurus lentiginosus*)
Glossy Ibis (*Plegadis falcinellus*)
Mute Swan (*Cygnus olor*)
Whistling Swan (*Olor columbianus*)
Canada Goose (*Branta canadensis*)
Brant (*Branta bernicla*)
Snow Goose (*Chen hyperborea*)
Mallard (*Anas platyrhynchos*)
Black Duck (*Anas rubripes*)
Pintail (*Anas acuta*)
Green-winged Teal (*Anas carolinensis*)
Blue-winged Teal (*Anas discors*)
American Widgeon (*Mareca americana*)
Wood Duck (*Aix sponsa*)
Redhead (*Aythya americana*)
Canvasback (*Aythya valisineria*)
Greater Scaup (*Aythya marila*)
Lesser Scaup (*Aythya affinis*)
Common Goldeneye (*Bucephala clangula*)
Bufflehead (*Bucephala albeola*)
Oldsquaw (*Clangula hyemalis*)
White-winged Scoter (*Melanitta deglandi*)
Surf Scoter (*Melanitta perspicillata*)
Common Scoter (*Oidemia nigra*)
Hooded Merganser (*Lophodytes cucullatus*)
Common Merganser (*Mergus merganser*)
Turkey Vulture (*Cathartes aura*)
Sharp-shinned Hawk (*Accipiter striatus*)
Marsh Hawk (*Circus cyaneus*)
Osprey (*Pandion haliaetus*)
Peregrine Falcon (*Falco peregrinus*)

Pigeon Hawk (*Falco columbarius*)
Sparrow Hawk (*Falco sparverius*)
Bobwhite (*Colinus virginianus*)
Ring-necked Pheasant (*Phasianus colchicus*)
Clapper Rail (*Rallus longirostris*)
Virginia Rail (*Rallus limicola*)
Sora (*Porzana carolina*)
Purple Gallinule (*Porphyryla maritima*)
American Coot (*Fulica americana*)
American Oystercatcher (*Haematopus palliatus*)
Semipalmated Plover (*Charadrius semipalmatus*)
Piping Plover (*Charadrius melodus*)
Killdeer (*Charadrius vociferus*)
American Golden Plover (*Pluvialis dominica*)
Black-bellied Plover (*Squatarola squatarola*)
Ruddy Turnstone (*Arenaria interpres*)
American Woodcock (*Philohela minor*)
Common Snipe (*Capella gallinago*)
Spotted Sandpiper (*Actitis macularia*)
Solitary Sandpiper (*Tringa solitaria*)
Willet (*Catoptrophorus semipalmatus*)
Greater Yellowlegs (*Totanus melanoleucus*)
Lesser Yellowlegs (*Totanus flavipes*)
Knot (*Calidris canutus*)
Purple Sandpiper (*Erolia maritima*)
Pectoral Sandpiper (*Erolia melanotos*)
White-rumped Sandpiper (*Erolia fuscicollis*)
Least Sandpiper (*Erolia minutilla*)
Dunlin (*Erolia alpina*)
Short-billed Dowitcher (*Limnodromus griseus*)
Stilt Sandpiper (*Micropalama himantopus*)
Semipalmated Sandpiper (*Ereunetes pusillus*)
Western Sandpiper (*Ereunetes mauri*)
Sanderling (*Crocethia alba*)
Northern Phalarope (*Lobipes lobatus*)
Parasitic Jaeger (*Stercorarius parasiticus*)
Great Black-backed Gull (*Larus marinus*)
Herring Gull (*Larus argentatus*)
Ring-billed Gull (*Larus delawarensis*)
Laughing Gull (*Larus atricilla*)
Black-legged Kittiwake (*Rissa tridactyla*)
Common Tern (*Sterna hirundo*)
Least Tern (*Sterna albifrons*)
Black Tern (*Chilidonias niger*)
Black Skimmer (*Rynchops nigra*)
Dovekie (*Plautus alle*)
Mourning Dove (*Zenaidura macroura*)

Yellow-billed Cuckoo (*Coccyzus americanus*)
Black-billed Cuckoo (*Coccyzus erythrophthalmus*)
Snowy Owl (*Nyctea scandiaca*)
Long-eared Owl (*Asio otus*)
Saw-whet Owl (*Aegolius acadicus*)
Chuck-will's Widow (*Caprimulgus carolinensis*)
Whip-poor-will (*Caprimulgus vociferous*)
Common Nighthawk (*Chordeiles minor*)
Ruby-throated Hummingbird (*Archilochus colubris*)
Belted Kingfisher (*Megasceryle alcyon*)
Yellow-shafted Flicker (*Colaptes auratus*)
Red-bellied Woodpecker (*Centurus carolinus*)
Red-headed Woodpecker (*Melanerpes erythrocephalus*)
Yellow-bellied Sapsucker (*Sphyrapicus varius*)
Hairy Woodpecker (*Dendrocopos villosus*)
Downy Woodpecker (*Dendrocopos pubescens*)
Black-back Three-toed Woodpecker (*Picoides arcticus*)
Eastern Kingbird (*Tyrannus tyrannus*)
Western Kingbird (*Tyrannus verticalis*)
Great Crested Flycatcher (*Myiarchus crinitus*)
Eastern Phoebe (*Sayornis phoebe*)
Yellow-bellied Flycatcher (*Empidonax flaviventris*)
Acadian Flycatcher (*Empidonax virescens*)
Traill's Flycatcher (*Empidonax traillii*)
Least Flycatcher (*Empidonax minimus*)
Eastern Wood Pewee (*Contopus virens*)
Olive-sided Flycatcher (*Nuttallornis borealis*)
Horned Lark (*Eremophila alpestris*)
Tree Swallow (*Iridopronce bicolor*)
Bank Swallow (*Riparia riparia*)
Barn Swallow (*Hirundo rustica*)
Cliff Swallow (*Petrochelidon pyrrhonota*)
Purple Martin (*Progne subis*)
Blue Jay (*Cyanocitta cristata*)
Fish Crow (*Corvus ossifragus*)
Black-capped Chickadee (*Parus atricapillus*)
Carolina Chickadee (*Parus carolinensis*)
Tufted Titmouse (*Parus bicolor*)
White-breasted Nuthatch (*Sitta carolinensis*)
Red-breasted Nuthatch (*Sitta canadensis*)
Brown Creeper (*Certhia familiaris*)
House Wren (*Troglodytes aedon*)
Winter Wren (*Troglodytes troglodytes*)
Bewick's Wren (*Thyromanes bewickii*)
Carolina Wren (*Thyrothorus ludovicianus*)
Long-billed Marsh Wren (*Telmatodytes palustris*)
Short-billed Marsh Wren (*Cistothorus platensis*)

Mockingbird (*Mimus polyglottos*)
Catbird (*Dumetella carolinensis*)
Brown Thrasher (*Toxostoma rufum*)
Robin (*Turdus migratorius*)
Wood Thrush (*Hylocichla mustelina*)
Hermit Thrush (*Hylocichla guttata*)
Swainson's Thrush (*Hylocichla ustulata*)
Gray-cheeked Thrush (*Hylocichla minima*)
Veery (*Hylocichla fuscescens*)
Eastern Bluebird (*Sialis sialis*)
Blue-gray Gnatcatcher (*Polioptila caerulea*)
Golden-crowned Kinglet (*Regulus satrapa*)
Ruby-crowned Kinglet (*Regulus calendula*)
Cedar Waxwing (*Bombycilla cedrorum*)
Loggerhead Shrike (*Lanius ludovicianus*)
Starling (*Sturnus vulgaris*)
White-eyed Vireo (*Vireo griseus*)
Bell's Vireo (*Vireo bellii*)
Yellow-throated Vireo (*Vireo flavifrons*)
Solitary Vireo (*Vireo solitarius*)
Red-eyed Vireo (*Vireo olivaceus*)
Philadelphia Vireo (*Vireo philadelphicus*)
Warbling Vireo (*Vireo gilvus*)
Black-and-white Warbler (*Mniotilta varia*)
Prothonotary Warbler (*Protonotaria citrea*)
Worm-eating Warbler (*Helminthophila vermivorus*)
Golden-winged Warbler (*Vermivora chrysoptera*)
Blue-winged Warbler (*Vermivora pinus*)
Brewster's Warbler (*Vermivora pinus x chrysoptera*)
Tennessee Warbler (*Vermivora peregrina*)
Orange-crowned Warbler (*Vermivora celata*)
Nashville Warbler (*Vermivora ruficapilla*)
Virginia's Warbler (*Vermivora virginiae*)
Parula Warbler (*Parula americana*)
Yellow Warbler (*Dendroica petechia*)
Magnolia Warbler (*Dendroica magnolia*)
Cape May Warbler (*Dendroica tigrina*)
Black-throated Blue Warbler (*Dendroica caerulescens*)
Myrtle Warbler (*Dendroica coronata*)
Black-throated Gray Warbler (*Dendroica nigrescens*)
Black-throated Green Warbler (*Dendroica virens*)
Cerulean Warbler (*Dendroica cerulea*)
Blackburnian Warbler (*Dendroica fusca*)
Yellow-throated Warbler (*Dendroica dominica*)
Chestnut-sided Warbler (*Dendroica pennsylvanica*)
Bay-breasted Warbler (*Dendroica castanea*)
Blackpoll Warbler (*Dendroica striata*)

Pine Warbler (*Dendroica pinus*)
Prairie Warbler (*Dendroica discolor*)
Palm Warbler (*Dendroica palmarum*)
Ovenbird (*Seiurus aurocapillus*)
Northern Waterthrush (*Seiurus noveboracensis*)
Louisiana Waterthrush (*Seiurus motacilla*)
Kentucky Warbler (*Oporornis formosus*)
Connecticut Warbler (*Oporornis agilis*)
Mourning Warbler (*Oporornis philadelphia*)
Yellowthroat (*Geothlypis trichas*)
Yellow-breasted Chat (*Icteria virens*)
Hooded Warbler (*Wilsonia citrina*)
Wilson's Warbler (*Wilsonia pusilla*)
Canada Warbler (*Wilsonia canadensis*)
American Redstart (*Setophaga ruticilla*)
House Sparrow (*Passer domesticus*)
Bobolink (*Dolichonyx oryzivorus*)
Eastern Meadowlark (*Sternella magna*)
Red-winged Blackbird (*Agelaius phoeniceus*)
Orchard Oriole (*Icterus spurius*)
Baltimore Oriole (*Icterus galbula*)
Rusty Blackbird (*Euphagus carolinus*)
Common Grackle (*Quiscalus quiscula*)
Brown-headed Cowbird (*Molothrus ater*)
Scarlet Tanager (*Piranga olivacea*)
Summer Tanager (*Piranga rubra*)
Cardinal (*Richmondia cardinalis*)
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)
Black-headed Grosbeak (*Pheucticus melanocephalus*)
Blue Grosbeak (*Guiraca caerulea*)
Indigo Bunting (*Passerina cyanea*)
Painted Bunting (*Passerina ciris*)
Dickcissel (*Spiza americana*)
Evening Grosbeak (*Hesperiphona vespertina*)
Purple Finch (*Carpodacus purpureus*)
House Finch (*Carpodacus mexicanus*)
Common Redpoll (*Acanthis flammea*)
Pine Siskin (*Spinus pinus*)
American Goldfinch (*Spinus tristis*)
Eastern Rufous-sided Towhee (*Pipilo erythrophthalmus*)
Lark Bunting (*Calamospiza melanocorys*)
Ipswich Sparrow (*Passerculus princeps*)
Savannah Sparrow (*Passerculus sandwichensis*)
Grasshopper Sparrow (*Ammodramus savannarum*)
Henslow's Sparrow (*Passerherbulus henslowii*)
Sharp-tailed Sparrow (*Ammospiza caudacuta*)
Seaside Sparrow (*Ammospiza maritima*)

Vesper Sparrow (*Poocetes gramineus*)
-rk Sparrow (*Chondestes grammacus*)
-ssin's Sparrow (*Aimophila cassinii*)
Slate-colored Junco (*Junco hyemalis*)
Tree Sparrow (*Spizella arborea*)
Chipping Sparrow (*Spizella passerina*)
Clay-colored Sparrow (*Spizella pallida*)
Field Sparrow (*Spizella pusilla*)
Harris' Sparrow (*Zonotrichia querula*)
White-crowned Sparrow (*Zonotrichia leucophrys*)
White-throated Sparrow (*Zonotrichia albicollis*)
Fox Sparrow (*Passerella iliaca*)
Lincoln's Sparrow (*Melospiza lincolni*)
Swamp Sparrow (*Melospiza georgiana*)
Song Sparrow (*Melospiza melodia*)
Snow Bunting (*Plectrophenax nivalis*)

Compiled from: (Cooper - unpublished list)

FIELD SURVEY

ISLAND BEACH STATE PARK, NEW JERSEY

BIRDS (Species judged to be nesting within the park
from field observation, and personal communication
with Mrs. Katherine Price.)

Green Heron
Black-crowned Night Heron
Mallard
Osprey
Spotted Sandpiper
Laughing Gull
Mourning Dove
Belted Kingfisher
Eastern Kingbird
Tree Swallow
Barn Swallow
Fish Crow
Carolina Chickadee
House Wren
Mockingbird
Catbird
Brown Thrasher
Robin
Starling
Yellow Throat
House Sparrow
Red-winged Blackbird
Common Grackle
Cardinal
American Goldfinch
Eastern Rufous-sided Towhee
Seaside Sparrow
Song Sparrow

Checklist of Land Dwelling Vertebrates that Occur
on Both Island Beach and the Mainland

AMPHIBIANS - No list available

REPTILES

Common Snapping Turtle
Spotted Turtle
Stinkpot
Eastern Box Turtle
Northern Black Racer
Eastern Hognose Snake

BIRDS

Pied-billed Grebe
Great Blue Heron
Common Egret
Black-crowned Night Heron
Mallard
Black Duck
Hooded Merganser
Turkey Vulture
Marsh Hawk
Osprey
Pigeon Hawk
Sparrow Hawk
Bobwhite
Ring-necked Pheasant
Killdeer
American Woodcock
Spotted Sandpiper
Solitary Sandpiper
Mourning Dove
Yellow-billed Cuckoo
Black-billed Cuckoo
Saw-whet Owl
Chuck-will's widow
Whip-poor-will
Common Nighthawk
Ruby-throated Hummingbird
Belted Kingfisher

BIRDS (Cont'd)

Yellow-shafted Flicker
Red-bellied Woodpecker
Yellow-bellied Sapsucker
Hairy Woodpecker
Downy Woodpecker
Eastern Kingbird
Great Crested Flycatcher
Eastern Phoebe
Acadian Flycatcher
Traill's Flycatcher
Least Flycatcher
Eastern Wood Pewee
Tree Swallow
Barn Swallow
Purple Martin
Blue Jay
Fish Crow
Black-capped Chickadee
Carolina Chickadee
Tufted Titmouse
White-breasted Nuthatch
Red-breasted Nuthatch
Brown Creeper
House Wren
Carolina Wren
Long-billed Marsh Wren
Mockingbird
Catbird
Brown Thrasher
Robin
Wood Thrush
Hermit Thrush
Swainson's Thrush
Gray-cheeked Thrush
Veery
Eastern Bluebird
Blue-gray Gnatcatcher
Golden-crowned Kinglet
Ruby-crowned Kinglet
Cedar Waxwing
Loggerhead Shrike
Starling
White-eyed Vireo
Yellow-throated Vireo
Red-eyed Vireo

Black-and-white Warbler
Prothonotary Warbler
Golden-winged Warbler
Blue-winged Warbler
Tennessee Warbler
Parula Warbler
Yellow Warbler
Magnolia Warbler
Cape May Warbler
Black-throated Blue Warbler
Myrtle Warbler
Black-throated Green Warbler
Blackpoll Warbler
Pine Warbler
Prairie Warbler
Palm Warbler
Ovenbird
Northern Waterthrush
Yellowthroat
Yellow-breasted Chat
Hooded Warbler
Wilson's Warbler
American Redstart
House Sparrow
Eastern Meadowlark
Red-winged Blackbird
Orchard Oriole
Baltimore Oriole
Common Grackle
Brown-headed Cowbird
Scarlet Tanager
Cardinal
Rose-breasted Grosbeak
Indigo Bunting
Evening Grosbeak
Purple Finch
Common Redpoll
Pine Siskin
American Goldfinch
Rufous-sided Towhee
Henslow's Sparrow
Sharp-tailed Sparrow
Seaside Sparrow
Vesper Sparrow
Slate-colored Junco

BIRDS (Cont'd)

Chipping Sparrow
Field Sparrow
White-throated Sparrow
Fox Sparrow
Swamp Sparrow
Song Sparrow

MAMMALS

Opossum
Masked Shrew
Little Brown Bat
Eastern Cottontail Rabbit
Gray Squirrel
White-footed Mouse
Meadow Vole
Muskrat
House Mouse
Meadow Jumping Mouse
Red Fox
Raccoon
Long-tailed Weasel
Mink

Two hundred and seventeen species of land dwelling vertebrates have been reported for the Pine Barrens of New Jersey. Evidence of many of these species was actually found during the field survey in the Forked River area.

Two hundred and seventy-one species of land dwelling vertebrates have been reported from Island Beach State Park. Twenty-eight of the bird species were judged from the field surveys to be breeding on Island Beach.








Twenty-one percent of the reptilian species reported for the Pine Barrens are also reported for Island Beach. Forty-two percent of the mammalian species reported in the literature for the Pine Barrens also occur on Island Beach. Ninety percent of the birds which have been seen in the Pine Barrens have also been seen on Island Beach. Comparison of the field survey data reveals that 47% of the birds judged to be breeding in the Pine Barrens during July also breed on Island Beach. These comparisons indicate that a significant number of the land dwelling vertebrates which inhabit the Forked River area also inhabit areas with much higher salt concentrations in the environment.

The background airborne salt concentrations on Island Beach range from approximately 5 to 18 times higher on Island Beach than on the mainland one mile inland from the tower site. Yet many of the vertebrates that are found in the Forked River area also live quite well on Island Beach. Those vertebrates that do not occur on Island Beach are probably excluded because of a lack of some essential habitat component. For example, the pine vole (Pitymys pinetorum) is probably excluded from Island Beach because of the lack of sod for tunneling and its local distribution in the South Jersey area (Pearson, personal communication).

The fresh water areas on Island Beach have a ground water salinity of approximately 2,000 ppm (Martin, 1959). The vertebrates of Island Beach have no difficulty tolerating these salt concentrations in their water supply. The salinities expected to exist after the cooling tower is in operation will be well below the present concentrations in the fresh water on Island Beach. Since the projected depositional rates are 5 times the present depositional rates in the area of the tower, the total salinity of flowing streams should not exceed 42.0 ppm NaCl. The total salinity of the ponds in the area should not exceed 99.0 ppm NaCl (Toth, personal communication). These salinity levels are negligible compared to those which currently exist on Island Beach.

99.5 ppm
Toth

KEY TO VEGETATION TYPE MAP
WITH APPROXIMATE ACREAGES

KEY	VEGETATION TYPE	ACREAGE	PERCENT OF TOTAL AREA
	Hardwood	4,552	9.1
	Southern White Cedar	602	1.2
	Mixed Hardwood-Yellow Pine	15,926	31.7
	Yellow Pine	3,766	7.5
	Saltwater Marsh	1,758	3.5
	Bay	10,960	21.7
	Non-Forested	12,702	25.3
	TOTAL	50,266	100.0
Total Forested Area		26,604	53.0
Non-Forested		12,702	25.3
Bay		10,960	21.7
Total area within 5-mile radius of Proposed cooling tower		50,266	100.0

Map Scale:

FIGURE I

Vegetation Map Showing Location

of Sampling Stations

(LATER)

Table 1. Bird Density Index - Total Densities (Birds/Acre)

Cedar Swamp

Time	#1	Site	#2
1	1.459		5.457
2	3.935		3.042
3	3.022		5.684
4	<u>5.344</u>		<u>2.256</u>
	$\bar{x} = 3.440$		$\bar{x} = 4.110$

Salt Marsh

Time	#3	Site	
1	5.904		
2	8.398		
3	4.764		No data
4	<u>4.039</u>		
	$\bar{x} = 5.776$		

Pine

Time	#5	Site	#6
1	6.814		5.118
2	4.739		8.653
3	7.875		5.854
4	<u>4.075</u>		<u>6.878</u>
	$\bar{x} = 5.876$		$\bar{x} = 6.626$

Table 1. (Cont'd) Density Index

Time	<u>Mixed Pine - Hardwood</u>		Site	#8
	#7			
1	5.039			0.845
2	3.731			2.059
3	2.918			1.035
4	<u>3.790</u>			<u>1.732</u>
	$\bar{x} = 3.870$			$\bar{x} = 1.418$

Time	<u>Hardwood</u>		Site	#10
	#9			
1	2.171			5.240
2	1.059			5.897
3	1.962			5.048
4	<u>3.482</u>			<u>4.413</u>
	$\bar{x} = 2.169$			$\bar{x} = 5.150$

Time	<u>Island Beach</u>		Site	
	#11			
1	3.736			
2	15.887			
3	14.744			
4	15.918			No data
5	11.856			
6	<u>16.031</u>			
	$\bar{x} = 13.029$			

Table 2. Bird Density Index - Summary Sheet (Birds/ Acre)

<u>Vegetation Type</u>	<u>Site Number</u>		<u>Mean</u>
Cedar Swamp	#1 3.440	#2 4.110	3.775
Salt Marsh	#3 5.776	No data	5.776
Pine	#5 5.876	#6 6.626	6.250
Mixed Pine-Hardwood	#7 3.870	#8 1.418	2.644
Hardwood	#9 2.169	#10 5.150	3.660
Island Beach	#11 13.029	No data	13.029

Appendix I presents density indices of the common bird species in the Forked River area. Tables 1 and 2 summarize the data for the bird density indices. A partially nested design has been utilized to investigate the influence of vegetation type, sites within vegetation type and time of sampling on bird density and diversity indices. The analysis of variance of the bird density data follows:

Bird Density Index

Analysis of Variance

<u>Source</u>	<u>Degrees of freedom</u>	<u>Sums of squares</u>	<u>Mean Squares</u>	<u>F ratio</u>
Total	31	128.877	-	-
Vegetation	3	56.365	18.788	24.344***
Sites (Vegetation)	4	31.817	7.954	10.306***
Time	1	0.007	0.007	NS
Vegetation X Time	3	0.642	0.214	NS
Sites (Vegetation) X Time	4	28.470	7.117	9.222***
Replicates	1	0.001	0.001	
Vegetation X Replicates	3	1.420	0.473	
Sites (Vegetation) X Replicates	4	4.171	1.043	
Time X Replicates	1	0.180	0.180	pooled error
Vegetation X Time X Replicates	3	2.803	0.934	variance
Sites (Vegetation) X Time X Replicates	4	3.003	0.751	= 0.772

*** Significant at .001 level of confidence.

Tabular value of F with 3 and 15 d.f. = 9.34

Tabular value of F with 4 and 15 d.f. = 8.25

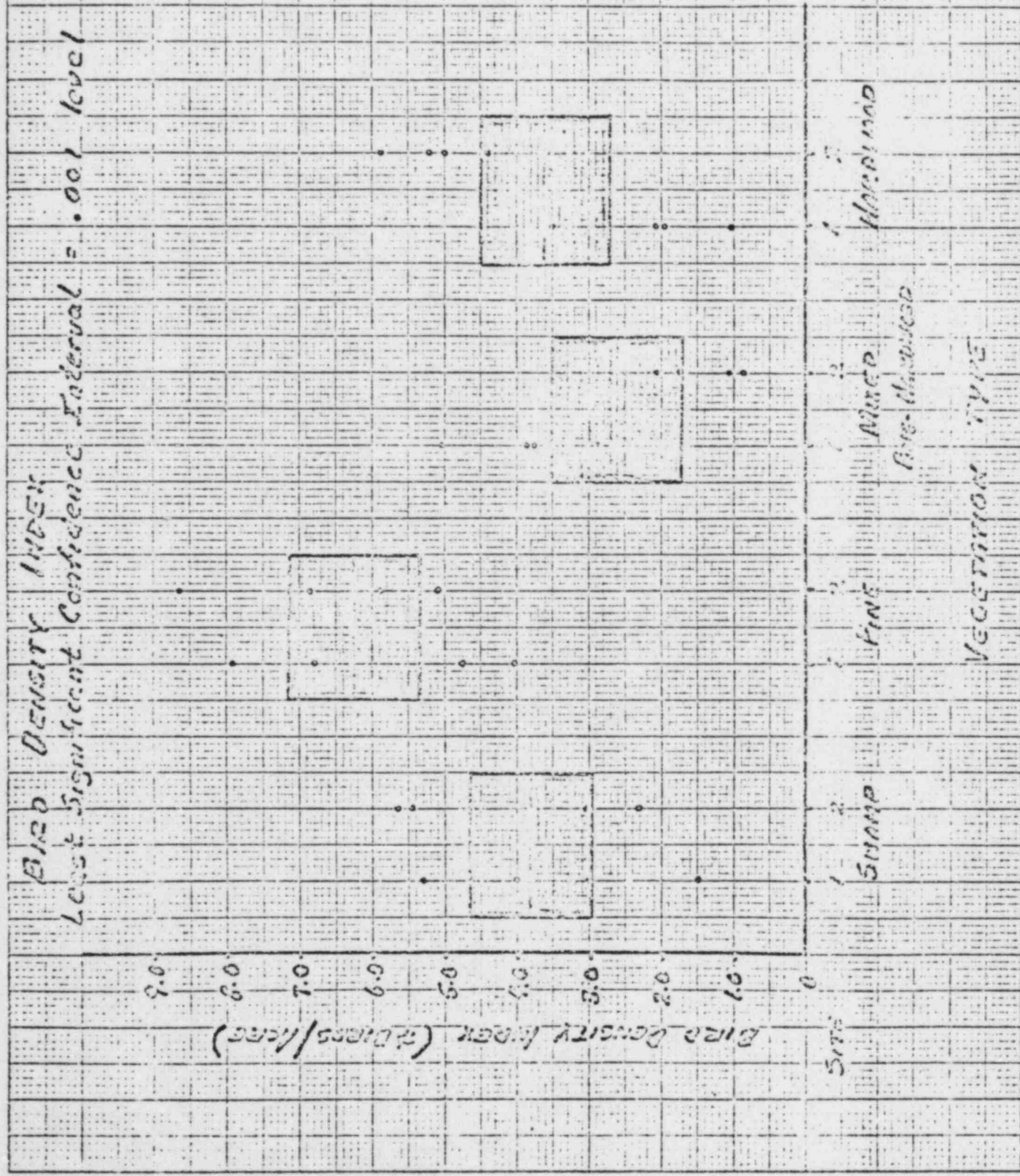


Figure 2

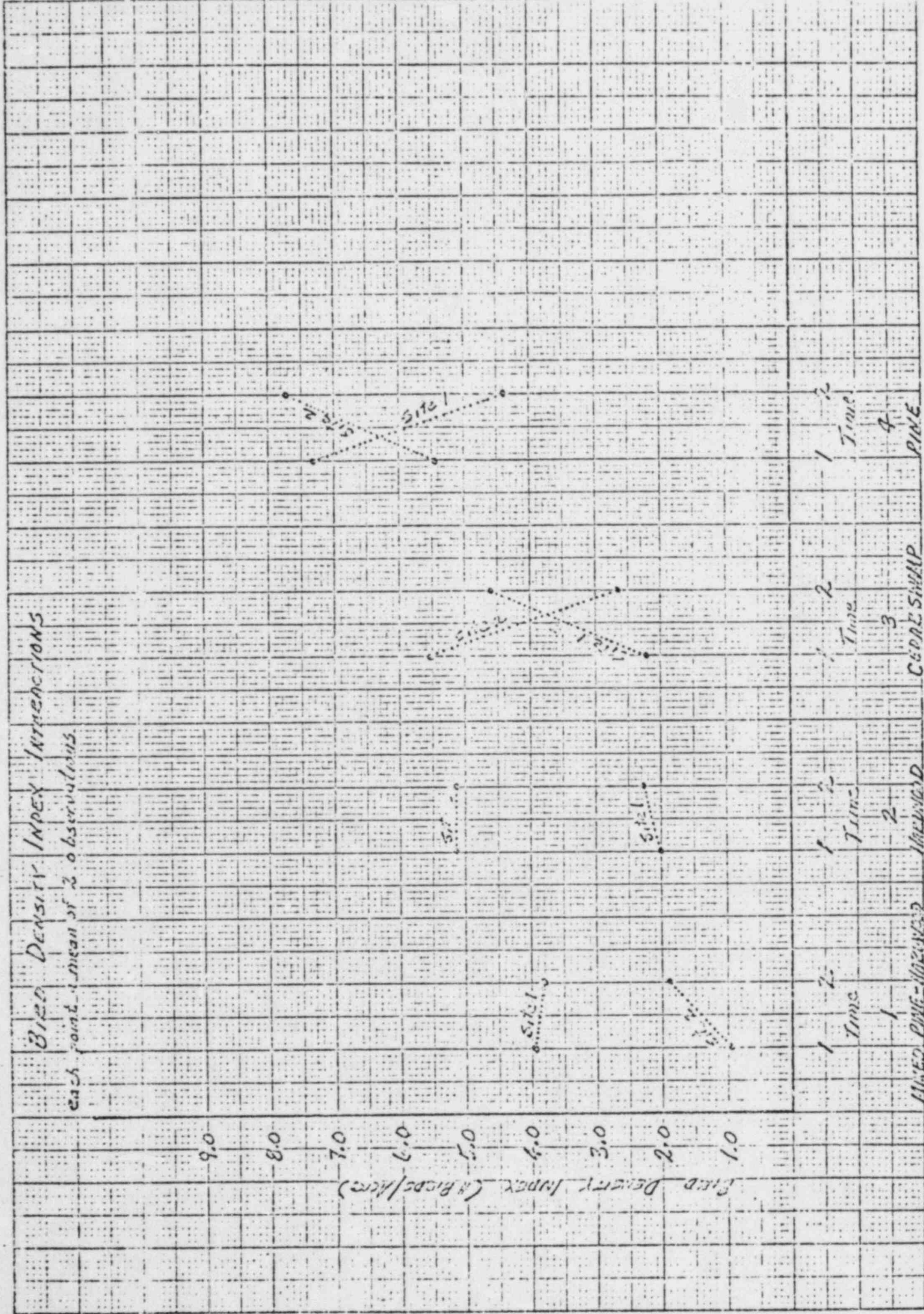


Figure 3

Table 3. Bird Diversity Index - Raw Data

Cedar Swamp

Time	#1	Site	#2
1	1.664		1.807
2	2.038		1.611
3	2.611		2.483
4	<u>2.394</u>		<u>1.485</u>

$$\bar{x} = 2.177$$

$$\bar{x} = 1.847$$

Salt Marsh

Time	#3	Site
1	2.201	
2	2.369	
3	2.943	No data
4	<u>2.174</u>	

$$\bar{x} = 2.422$$

Pine

Time	#5	Site	#6
1	3.111		3.128
2	3.003		2.871
3	3.505		2.462
4	<u>3.252</u>		<u>2.469</u>

$$\bar{x} = 3.218$$

$$\bar{x} = 2.733$$

Table 3. (Cont'd) Diversity Index

Mixed Pine-Hardwood

Time	#7	Site	#8
1	2.904		2.656
2	3.016		2.803
3	2.876		1.700
4	<u>2.877</u>		<u>2.699</u>
$\bar{x} = 2.918$		$\bar{x} = 2.465$	

Hardwood

Time	#9	Site	#10
1	2.445		2.621
2	2.548		2.873
3	2.544		2.902
4	<u>3.057</u>		<u>2.909</u>
$\bar{x} = 2.649$		$\bar{x} = 2.826$	

Island Beach

Time	#11	Site	
1	3.311		
2	2.858		
3	3.344		No data
4	3.086		
5	2.961		
6	<u>3.192</u>		
$\bar{x} = 3.125$			

Table 4. Bird Diversity Index - Summary Sheet

<u>Vegetation Type</u>	<u>Site Number</u>		<u>Mean</u>
Cedar Swamp	#1 2.177	#2 1.847	2.012
Salt Marsh	#3 2.422	No data	2.422
Pine	#5 3.218	#6 2.733	2.975
Mixed Pine-Hardwood	#7 2.918	#8 2.465	2.691
Hardwood	#9 2.649	#10 2.826	2.737
Island Beach	#11 3.125	No data	3.125

Highly significant differences (.001) were found to exist among vegetation types for total density index. Figure 2 represents this result graphically. Least significant confidence intervals have been plotted around the mean density index for each vegetation type. Non-overlapping red blocks represent significant differences in bird density indices among vegetation types. Bird density indices are significantly higher in pine than in the other three vegetation types.

Figure 3 illustrates the nature of the highly significant (.001) interaction which exists between time and sites within vegetation. This interaction means that the time at which a given site was sampled strongly influenced the density index for that site. If this total bird density index is to be used in the future as an indicator of the environmental effects of the cooling tower, it is suggested that sampling be expanded to include all sites at the same time.

Diversity index, which is the ratio between the number of species and the number of individuals, is considered to be a more sensitive indicator of changes in community structure than the total density index. Odum (1959, 2nd Ed.) indicates that when man introduces a stringent limiting factor into a natural community, diversity is usually reduced even though the total number of individuals remains unchanged or perhaps is increased.

Tables 3 and 4 present a summary of the bird diversity index data. The analysis of variance follows:

Bird Diversity Index

Analysis of Variance

<u>Source</u>	<u>Degrees of freedom</u>	<u>Sums of squares</u>	<u>Mean Squares</u>	<u>F ratio</u>
Total	31	7.934	-	-
Vegetation	3	4.113	1.371	11.92***
Sites (Vegetation)	4	1.164	0.291	NS
Time	1	0.008	0.008	NS
Vegetation X Time	3	0.472	0.157	NS
Sites (Vegetation) X Time	4	0.418	0.105	NS
Replicates	1	0.035	0.035	
Vegetation X Replicates	3	0.712	0.237	
Sites (Vegetation) X Replicates	4	0.547	0.137	
Time X Replicates	1	0.044	0.044	
Vegetation X Time X Replicates	3	0.268	0.089	
Sites (Vegetation) X Time X Replicates	4	0.153	0.038	
				pooled error variance = 0.115

*** Significant at .001 level of confidence.
Tabular value of F with 3 and 15 d.f. = 9.34

16" x 10" x 1/4" THICK
 7 x 10 INCHES
 REUFEL & FRISH CO.

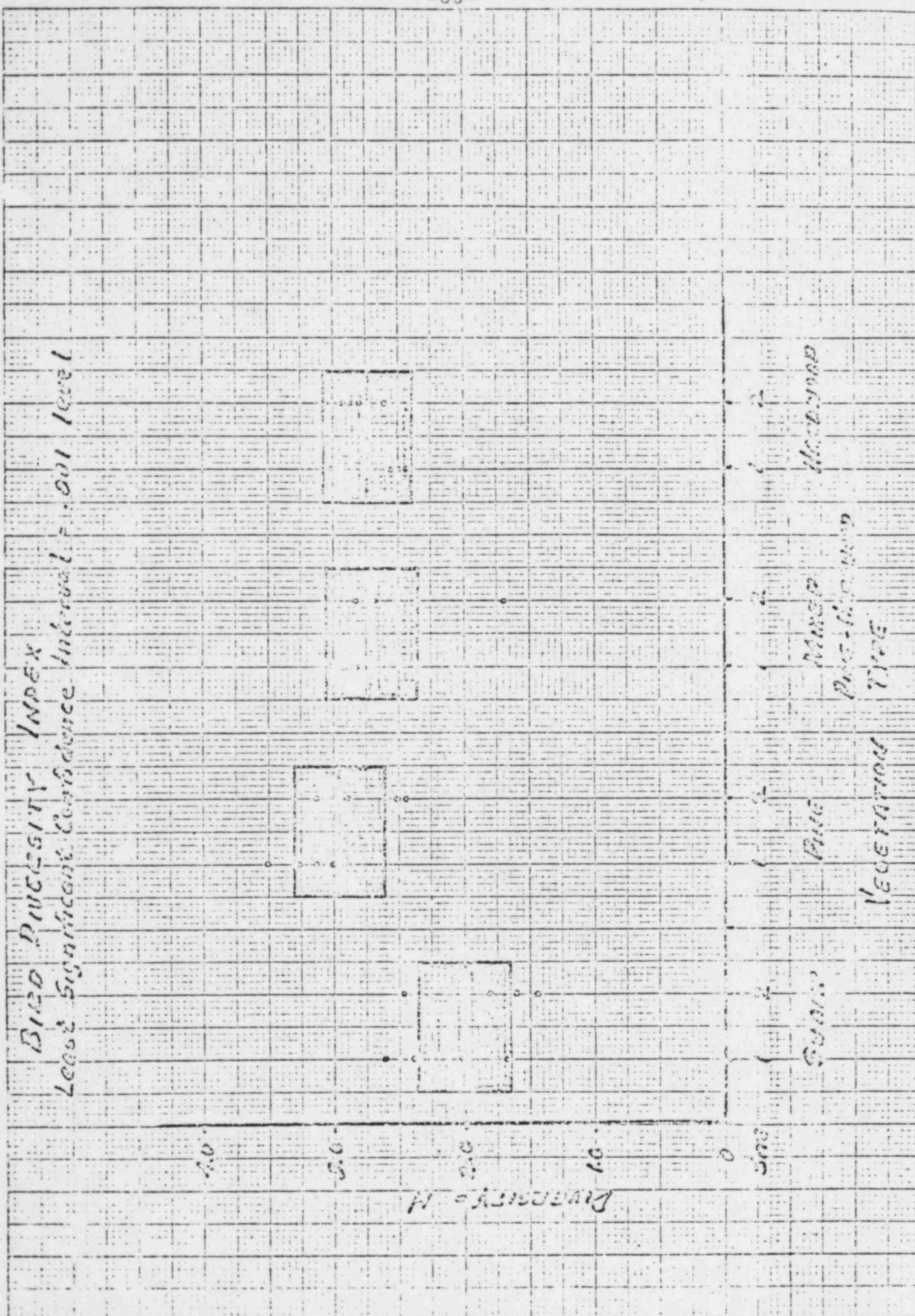


Figure 4

Highly significant differences (.001) were found to exist among vegetation types for bird diversity index. Figure 4 shows the data with least significant confidence intervals plotted around the mean bird diversity index for each vegetation type. Non-overlapping red blocks represent significant differences in bird diversity indices among vegetation types. Bird diversity indices are significantly lower in cedar swamps than in the other three vegetation types.

Results of Literature Review

Salt poisoning can and has occurred in land dwelling vertebrates under certain conditions. Definitive evidence of salt poisoning under field conditions has been presented by Trainer and Karstad (1960) for cottontail rabbits (Sylvilagus floridanus), bobwhite quail (Colinus virginianus), ringneck pheasant (Phasianus colchicus), and rock dove (Columba ilvia). Todd, Lawson, and Dow (1964) have presented clinical and histological evidence of salt poisoning in barnyard pigs. Sodium chloride poisoning has also been reported for domestic fowl (Elaxand, 1946). The U. S. Bureau of Sport Fisheries and Wildlife warns against the excessive use of rock salt in winter road maintenance since under certain conditions wildlife mortality may occur (The Conservationist, April-May 1971). Little is known about the exact levels of tolerance to ingested sodium chloride for the land dwelling vertebrates which do occur in the Forked River area. However, some quantitative studies have been conducted for a few of the wildlife species, and for related domestic animals.

Trainer and Karstad (1960) report mortality within 24 hours after 3 grams of NaCl were administered in a single dose directly into the digestive systems of adult ringneck pheasants and cottontail rabbits. However, in pheasants fed increased amounts of salt in their dry mash, signs of intoxication appeared only when the quantity of drinking water was restricted (Trainer and Karstad, 1960).

Sublethal effects have been demonstrated in bobwhite quail. Quail lost weight when drinking 1% or higher NaCl solutions, and markedly increased their fluid consumption (McNabb, 1969).

Experimental evidence of NaCl tolerances in chicks, hens, turkey poults, and ducklings has been presented by Krista, Carlson, and Olson (1961). No detrimental effects were found in chicks fed solutions containing 4,000 ppm sodium chloride, but decreased growth and 14 to 47% mortality occurred at 7,000 ppm, and 75 to 100% mortality occurred at levels of 10,000 and 12,000 ppm sodium chloride. Egg production was reduced in laying hens at and above 10,000 ppm sodium chloride. Turkey poult mortality increased as sodium chloride concentration increased above 4,000 ppm. Forty-three percent mortality occurred in ducklings at 10,000 ppm sodium chloride while little mortality occurred below this level. However, a linear relationship exists between growth retardation and NaCl concentration between 4,000 and 12,000 ppm sodium chloride.

Similar responses by chicks to NaCl administered in solution have been reported by other researchers. Doll, Hull, and Insko (1946) report distress caused by drinking solutions containing 5,000 and 9,000 ppm sodium chloride. No evidence of toxicity was reported in chicks receiving 2500 ppm sodium chloride.

Experiments in which NaCl has been ingested with the feed have been conducted on fowl and pigs. Blaxland (1946) found that mash containing 5% and 10% NaCl caused heavy mortality within one week among baby chicks. However, NaCl concentrations ranging up to 20% in the feed produced no mortality among mature fowls over a period of 4 weeks when their water supply was unrestricted.

Adult pigs ingesting NaCl with their feed have shown evidence of salt poisoning at a concentration of 5% NaCl when their water supply was restricted (Ek, 1966). In this same experiment the control group was fed 0.6% NaCl in the feed with restricted water and showed no symptoms of salt toxicity.

Although excess NaCl may have deleterious effects as previously discussed, NaCl can be a valuable supplement in the diet of some vertebrates. In areas where sufficient salt is not present in the diet, salt cravings may develop in vertebrates, especially birds and mammals. This leads to the common practice of placing salt blocks in an area to attract deer. Bleitz (1958) reports that Cassin's finches (Carpodacus cassinii), red crossbills (Loxia curvirostra) evening grosbeaks (Hesperiphona vespertina), and pine siskins (Spinus pinus) are attracted to salt licks placed for mammals. Heavy snow cover can predispose wildlife populations to salt hunger. Trainer and Karstad (1960) report that cotton-tails in need of NaCl might take excessive amounts when a readily available supply is found. While the quantity of salt ingested under these circumstances might not be harmful in the presence of a readily available water supply, the deleterious effects may be increased when the source of water is limited as occurs during severe winter conditions.

Many species are able to cope with high salt concentrations in the environment while others are less successful. One of the mechanisms by which salt can influence the relative success of a species is through its effect on water balance. For example, the habitats of frogs and toads have been correlated with their ability to survive loss of body water. Such loss can be the result of dry weather or high salt concentrations in the environment (Thorson and Svihla, 1943).

Neill (1958) reports that many amphibians and reptiles occur in salt water areas. As a group salamanders are poorly adapted to withstand high salt in the environment, while frogs are more successful in this regard. Snakes and fresh water species of turtles have been found to invade salt water areas. Salt water races often exhibit such modification as darker coloration, structural adaptations, or alteration of diet. Examples of amphibians which have been found in areas of high salt content include spotted salamanders Ambystoma maculatum, southern leopard frog Rana pipiens sphenocephala, Fowlers toad Bufo woodhousesi fowleri, and representatives of the genera Acris and Hyla. Reptilian species include the snapping turtle Chelydra serpentina, mud turtle Kinosternon subrubrum, spotted turtle Chemyms guttata, painted turtle Chrysemys picta, box turtle Terrapene carolina, northern water snake Natrix sipedon, garter snake, Thamnophis sirtalis and the northern black snake Coluber constrictor. These species or their close relatives are all found in the Forked River area.

The degree of tolerance of some species of amphibians to salt environments is striking. Tercafs and Schoffeniels (1962) found Bufo viridis, a fresh water species of toad able to tolerate 2.34% solutions of sodium chloride (75% sea water). The crab-eating frog (Rana cancrivora) is able to complete its life cycle in 20% sea water although in the field breeding occurs after heavy rains when the salinities are lower (Gordon and Tucker, 1965).

Strahan (1957) found that the capacity of a fresh water toad, Bufo melanostictus, to resist saline conditions increases during larval life. One and one-half day old tadpoles were unaffected by 0.25% solutions while tadpoles eight and one-half days old were unaffected by solutions up to 0.75% sodium chloride.

While differences in tolerance to high salt concentrations are also present among birds and mammals, these higher organisms are generally more adaptable to salt in the environment. The more advanced excretory systems found in these vertebrates enable them to deal more effectively with most water balance problems. Many raptors secrete salt through the nostrils. This mechanism is of adaptive value for these carnivores since they acquire a high sodium load from their food (Cade and Greenwald, 1966).

Savannah sparrows (Passerculus sandwichensis) have evolved an especially efficient salt utilization ability. Those subspecies which are year-round inhabitants of salt marshes are able to maintain their body weight when fed 0.55 molar sodium chloride over a period of ten days (Cade and Bartholomew, 1959).

Getz (1968) reports that the white footed mouse (Peromyscus leucopus) is able to tolerate drinking solutions of up to 0.3 molar sodium chloride for ten days without changes in body weight or significant mortality. This agrees closely with current research being conducted at Farleigh Dickinson University (McManus, personal communication). Other small mammals such as the red back vole (Clethrionomys gapperi) are less adaptable to increasing salt concentrations. This species can only tolerate salt solutions of up to 0.1 molar sodium chloride (Getz, 1968).

In addition to the possibility of direct physiological effects vertebrate populations may be influenced indirectly by changes in plant communities. Vertebrate population levels are partially a function of the plant communities present in an area. Various plants have differing salt tolerances, and adding salt to the environment may favor some plants over others. Plant community changes could result in altered vertebrate communities. In areas where herbicides have been used to control weeds, changes in the populations of insects dependant upon the weeds resulted in changes in bird populations (Moore, 1962). Woodbury (1948) indicates that salinity as a factor influencing vertebrate populations in the Great Basin is probably most important as it affects the distribution of plants.

Research conducted at Island Beach State Park indicates that the arrangement of plant populations is determined by a salt spray gradient and the ecological amplitude of each species population in relation to the salt spray factory (Martin, 1959). Shure (1970) has reported on the ecological relationships of small mammals on Island Beach. The distribution of these vertebrates on Island Beach is related to the topographically controlled pattern of environment and vegetation. The maritime vegetation of Island Beach supports a greater abundance of small mammals than those reported in mainland studies. Shure indicates that a possible factor causing these high densities may involve the heterogeneity of the vegetation. This salt spray induced vegetational mosaic includes a large proportion of ecotonal area, which by an edge effect may lead to greater small mammal abundance. Woolfenden (1958) had previously reported on unusually high densities of masked shrews (Sorex cinereus) on Island Beach.

Certain species warrant special consideration because they are restricted to very specialized habitats. Any alterations in these habitats could drastically affect the total numbers of such species. The official list of Endangered Species of The United States published by the U. S. Department of the Interior, Bureau of Sport Fisheries and Wildlife (1970) does not include any of the species found in the Forked River area. However, two species of amphibians which are relatively rare and occur in restricted habitats are found in this area. According to Gosner and Black (1957), the pine barrens tree frog (Hyla andersoni) and the carpenter frog (Rana virgatipes) are restricted to areas containing acid waters such as the New Jersey pine barrens. These frogs have a competitive advantage during embryonic development because they can tolerate more strongly acid solutions than other New Jersey frogs. The pine barrens tree frog breeds in small basins or slow moving streams, but never in stagnant water. The carpenter frog inhabits larger rivers and lakes where there is floating vegetation (Noble and Noble, 1923; Standaert, 1967). In addition, Noble and Noble report that breeding of the pine barrens tree frog is synchronized with rainy periods. Such breeding behavior could potentially be an advantage if NaCl concentrations increase in the environment.

CONCLUSIONS

1. For those species of land dwelling vertebrates which occur on both Island Beach and in the Forked River area we would expect there to be no direct physiological effect at the levels of salt concentration expected to exist after the cooling tower is in operation.
2. The bird population indices developed to this point should prove useful in assessing future population shifts, if any, which may be a result of the cooling tower operation. Much more work needs to be conducted in this regard.
3. We would expect there to be no direct physiological effects for those species investigated in the literature at the levels of salt concentration expected after the cooling tower operation. Since the salt tolerances of many of the species in this area have not been studied, predictions concerning these vertebrates can only be based on the authors' opinions. Our opinion is that direct physiological effects on those species whose salt tolerances have not been studied will be negligible.
4. The relatively rare pine barrens tree frog and carpenter frog should not have the specialized nature of their habitats changed by the higher concentrations of sodium chloride expected after the tower is in operation.
5. A possibility exists that some vertebrates may be attracted to the area by the added salt in the environment. Since salt is not expected to accumulate in the area, it is our opinion that this effect will be minimal.
6. Since the living components of the pine barrens ecosystem may vary considerably with regard to their salt tolerances, some species may ultimately be favored at the expense of others. Due to the complex nature of the interactions which exist in biological systems, the direction and magnitude of these changes in community structure cannot be predicted with a high degree of certainty.

LITERATURE CITED

- Blaxland, J. D. 1946. Toxicity of sodium chloride for fowls. Vet. J. 102:157-173.
- Bleitz, Don. 1958. Attraction of birds to salt licks placed for mammals. Wilson Bull. 70(1):92 (Abstr.).
- Cade, T. J. and G. A. Bartholomew. 1959. Sea-water and salt utilization by savannah sparrow. Physiol. Zool. 32:230-238.
- Cade, T. J. and L. Greenwald. 1966. Nasal salt secretion in falconiform birds. Condor 68:338-350.
- Conant, Roger. 1962. Notes on the distribution of reptiles and amphibians in the Pine Barrens of New Jersey. N.J. Nature News, 17:16-21.
- Connor, P. 1953. Notes on the mammals of a New Jersey Pine Barrens area. J. Mammal 34:227-235.
- Doll, E. R., F. E. Hull and W. M. Insko Jr. 1946. Toxicity of sodium chloride for baby chicks. Vet. Med. 41:361-363.
- Ek, Nils. 1966. Experimental salt poisoning in pigs. Nord. Veterinaer Med. 17:604-613 (Abstr.).
- Fables, D. G. 1962. Breeding birds of the New Jersey Pine Barrens. N. J. Nature News 17:60-64.
- Getz, L. L. 1968. Influence of water balance and microclimate on the local distribution of the redback vole and white-footed mouse. Ecol. 49:275-286.
- Gordon, M. S. and V. A. Tucker. 1965. Osmotic regulation in the tadpoles of the crab-eating frog (Rana cancrivora). J. Exp. Biol. 42:437-445.
- Gosner, K. L. and I. H. Black. 1957. The effects of acidity on the development and hatching of New Jersey frogs. Ecol. 38:256-262.
- Kendeigh, S. C. 1944. Measurement of bird populations. Ecol. Monogr. 14:67-106.
- Krista, L. M., C. W. Carlson and O. E. Olson. 1961. Some effects of saline waters on chicks, laying hens, poults and ducklings. Poultry Sci. 40:938-944.
- Lloyd, M., J. H. Zar and J. R. Karr. 1968. On the calculation of information - theoretical measure of diversity. Amer. Mid. Naturalist 79:257-272.

- Martin, William E. 1959. The vegetation of Island Beach State Park, New Jersey. Ecol. Mono. 29:1-46.
- McCormick, J. 1970. The Pine Barrons. A Preliminary Ecological Inventory. New Jersey State Museum Research Report #2. Trenton, N.J. 104 p.
- McNabb, F. M. A. 1969. A comparative study of water balance in three species of quail - II. Utilization of saline drinking solutions. Comp. Biochem. and Physiol. 23:1059-1074.
- Moore, N. W. 1962. Toxic chemicals and birds: The ecological background to conservation problems. British Birds, 55:428-435 (Abstr.).
- Neill, Wilfred T. 1958. The occurrence of amphibians and reptiles in salt-water areas, and a bibliography. Bull. Mar. Sci. Gulf and Caribbean 2:1-97.
- Noble, G.K. and R. C. Noble. 1923. The Anderson Treefrog. Observations on its habits and life history. Zoologica 2(18):416-455.
- Odum, Eugene P. 1959. Fundamentals of Ecology. 2nd Ed. W. B. Saunders Co., Philadelphia. 546 p.
- Rohlf, F. J. and R. R. Sokal. 1969. Statistical Tables. W. H. Freeman Co., San Francisco. 253 p.
- Shure, Donald J. 1970. Ecological relationships of small mammals in a New Jersey barrier beach habitat. J. Mammal. 51:267-278.
- Standaert, W. F. 1967. Growth, maturation and population ecology of the carpenter frog (Rana virgatipes). Rutgers U. Unpublished Ph.D. thesis.
- State of New York Department of Environmental Conservation. 1971. Rock salt threatens wildlife. Conservationist, 25(5):40.
- Strahan, Ronald. 1957. The effect of salinity on the survival of larvae of Bufo melanostictus. Copeia 1957(2):146-147.
- Tercalcs, R. R. and E. Schoffeniels. 1962. Adaptation of amphibians to salt water. Life Sciences 1:19-24.
- Thorson, T. and A. Svihla. 1943. Correlation of the habitats of amphibians with their ability to survive the loss of body water. Ecol. 24:374-381.
- Todd, J. R., G. H. K. Lawson and C. Dow. 1964. An experimental study of salt poisoning in the pig. J. Comp. Pathol. and Therap. 74:331-337.
- Trainer, D. O. and L. Karstad. 1960. Salt poisoning in Wisconsin wildlife. J. Amer. Vet. Med. Assoc. 136:14-17.

-44-

United States Department of Interior. Bureau of Sport Fisheries and Wildlife.
1970. Endangered Species of the United States. 4 p.

Woodbury, A. M. 1948. Animals and salinity in the Great Basin. Amer.
Naturalist 82:171-187.

Woolfenden, G. E. 1958. An unusual concentration of Sorex cinereus.
J. Mammal. 40:37.

APPENDIX I

Bird Density Indices - Raw Data

SAMPLE I. D.

11

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CAR CHICKADEE
YELLOWTHROAT

0.359
1.100

TOTAL PER ACRE

1.459

CEDAR SWAMP Site #1

8:45 a.m.

July 15, 1971

SAMPLE I. D. 12

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

ROBIN	0.412
CAR CHICKADEE	0.359
CATBIRD	0.846
BLUE JAY	0.943
YELLOWTHROAT	1.375

TOTAL PER ACRE 3.935

CEDAR SWAMP Site #1

6:30 a.m.

July 21, 1971

SAMPLE I. D. 13

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD

0.846

CAR CHICKADEE

1.076

YELLOWTHROAT

1.100

TOTAL PER ACRE

3.022

CEDAR SWAMP Site #1

7:55 a.m.

July 27, 1971

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

BLUE JAY	0.236
TOWHEE	0.275
ROBIN	1.237
CATBIRD	0.846
YELLOWTHROAT	2.750

TOTAL PER ACRE 5.344

CEDAR SWAMP Site #1

6:30 a.m.

July 29, 1971

SAMPLE 1. D.
SPECIES

21

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TOWHEE

1.019

ROBIN

0.611

BLUE JAY

0.349

CATBIRD

0.627

YELLOWTHROAT

2.852

TOTAL PER ACRE

5.457

CEDAR SWAMP Site #2

8:45 a.m.

July 15, 1971

SAMPLE I. D. 22
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TOWHEE	0.611
BLUE JAY	0.175
CATBIRD	0.627
YELLOWTHROAT	1.630

TOTAL PER ACRE 3.042

CEDAR SWAMP Site #2

6:30 a.m.

July 21, 1971

SAMPLE I. D. 23

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CAR CHICKADEE

1.063

BLUEJAY

0.524

TOWHEE

1.019

CATBIRD

0.940

ROBIN

0.306

YELLOWTHROAT

1.833

TOTAL PER ACRE

5.684

CEDAR SWAMP Site #2

7:55 a.m.

July 27, 1971

SAMPLE I. D.
SPECIES

24

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TOWHEE
CATBIRD
YELLOWTHROAT

0.611
0.627
1.019

TOTAL PER ACRE

2.256

CEDAR SWAMP Site #2

6:30 a.m.

July 29, 1971

SAMPLE I. D.
SPECIES

31

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TREE SWALLOW	2.560
BARN SWALLOW	0.114
RED-W BLACKBIRD	0.782
SONG SPARROW	0.603
MOCKINGBIRD	0.284
GOLDFINCH	0.042
YELLOWTHROAT	1.517

TOTAL PER ACRE

5.904

SALT MARSH Site #3

9:00 a.m.

July 26, 1971

SAMPLE I. D. 32

SPECIES

BIRD DENSITY INDEX

NO. OF BIRDS/ACRE

TREE SWALLOW	4.267
BARN SWALLOW	1.422
CATBIRD	0.427
RED-W BLACKBIRD	1.067
SONG SPARROW	0.603
YELLOWTHROAT	0.569
GOLDFINCH	0.042

TOTAL PER ACRE

8.398

SALT MARSH Site #3

9:45 a.m.

July 27, 1971

x

SAMPLE I. D.
SPECIES

33

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TREESWALLOW	0.171
BARN SWALLOW	0.455
RED-W BLACKBIRD	1.209
SONG SPARROW	0.948
YELLOWTHROAT	1.328
CATBIRD	0.427
GOLDFINCH	0.084
MOCKINGBIRD	0.142

TOTAL PER ACRE

4.764

SALT MARSH Site #3

9:20 a.m.

July 29, 1971

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TREE SWALLOW	0.341
RED-W BLACKBIRD	1.920
SONG SPARROW	1.034
CATBIRD	0.427
YELLOWTHROAT	0.190
GOLDFINCH	0.126

TOTAL PER ACRE 4.039

SALT MARSH Site #3

7:45 a.m.

July 30, 1971

SAMPLE I. D.
SPECIES

51

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

DOWNY WDP	0.362
BLUE JAY	0.686
CAR CHICKADEE	1.861
TUFTED TITHOUSE	0.113
BRN THRASHER	0.482
B-WINGED WARB	0.305
OVENBIRD	0.076
YELLOWTHROAT	0.560
GRACKLE	0.117
COWBIRD	0.122
SCAR TANANGER	0.155
CARDINAL	0.134
TOWHEE	1.842

TOTAL PER ACRE 6.814

PINE Site #5

6:30 a.m.

July 13, 1971

SAMPLE I. D. 53
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

BLUEJAY	0.076
C CROW	0.055
CAR CJICKADEE	1.861
B&W WARB	1.447
B-PINGED WARB	0.152
YELLOWTHROAT	0.280
SCAR TANANGER	0.078
TOWHEE	0.789

TOTAL PER ACRE 4.739

PINE Site #5

7:45 a.m.

July 16, 1971

SAMPLE I. D. 55
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.202
Y-S FLICKER	0.079
WOOD PEEWEE	0.145
CRESTED FLYC	0.121
UE JAY	0.305
CAR CHICKADEE	1.241
TUFTED TITMOUSE	0.226
BRN THRASHER	0.322
ROBIN	0.579
B&W WARB	1.447
B-RINGED WARB	0.152
PINE WARB	0.609
YELLOWTHROAT	0.280
GRACKLE	0.117
SCAR TANANGER	0.078
TOWHEE	1.974

TOTAL PER ACRE 7.875

PINE Site #5

6:30 a.m.

July 26, 1971

SAMPLE 1. D.
SPECIES

57

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.404
TOWHEE	0.921
DOWNY WOP	0.241
CRESTED FLYC	0.241
CAR CHICKADEE	1.241
ROBIN	0.386
WOOD PEWEE	0.072
SCAR TANANGER	0.078
GRACKLE	0.058
YELLOWTHROAT	0.280
BLUE JAY	0.152

TOTAL PER ACRE 4.075

PINE Site #5

8:45 a.m.

July 28, 1971

SAMPLE I. D. 61

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.183
MOURNING DOVE	0.072
DOWNY W?	0.109
BLUE JAY	0.069
C CHICKADEE	1.122
TOFTED TITMOUSE	0.612
B&W WARB	0.655
YELLOWTHROAT	1.014
GRACKLE	0.211
TOWHEE	1.071

TOTAL PER ACRE

5.118

PINE Site #6

6:30 a.m.

July 13, 1971

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.365
MOURNING DOVE	0.072
Y- FLICKER	0.071
DOWNY WOP	0.109
BLUE JAY	0.276
CAR CHICKADEE	2.526
ROBIN	0.175
YELLOWTHROAT	3.041
GRACKLE	0.053
COWBIRD	0.775
TOWHEE	1.190

TOTAL PER ACRE 8.653

PINE Site #6

7:45 a.m.

July 16, 1971

SAMPLE I. D. 65

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

MOURNING DOVE

0.144

DOWNY WDP

0.109

BLUE JAT

0.138

CAR CHICKADEE

2.245

YELLOWTHROAT

2.028

TOWHEE

1.190

TOTAL PER ACRE

5.854

PINE Site #6

6:30 a.m.

July 26, 1971

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TOWHEE	2.381
BLUE JAY	0.276
YELLOWTHROAT	2.788
Y-S FLICKER	0.071
CAR CHICKADEE	0.561
BRN THRASHER	0.291
CARBITD	0.365
MOURNING DOVE	0.144

TOTAL PER ACRE

6.878

PINE Site #6

8:45 a.m.

July 28, 1971

xx

SAMPLE I. D.
SPECIES

71

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.341
Y-BILLED CUCKOO	0.062
DOWNY WOP	0.102
CRESTED FLYC	0.204
CAR CHICKADEE	1.048
TUFTED TITMOUSE	0.286
B&W WARB	0.917
COWBIRD	0.103
SCAR TANANGER	0.196
CARDINAL	0.226
TOWREE	1.556

TOTAL PER ACRE 5.039

MIXED Site #7

8:00 a.m.

July 13, 1971

xxi

SAMPLE 1. D. 73
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

Y-BILLED CUCKOO	0.123
CATEIRD	1.023
BLUE JAY	0.064
C CROW	0.047
CAR CHICKADEE	0.524
TUFTED TITMOUSE	0.190
BRN THRASHER	0.136
ROBIN	0.163
YELLOWTHROAT	0.237
CARDINAL	0.113
TOWHEE	1.111

TOTAL PER ACRE 3.731

MIXED Site #7

6:30 a.m.

July 16, 1971

SAMPLE I. D. 75

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

MOUNING DOVE

0.135

DOWNY WOP

0.102

BLUE JAY

0.129

C CROW

0.047

ROBIN

0.489

B&W WARB

0.611

GRACKLE

0.098

SCAR TANANGER

0.106

TOWHEE

1.111

TOTAL PER ACRE

2.918

MIXED Site #7

7:40 a.m.

July 26, 1971

SAMPLE I. D. 77

SPECIES

BIRD DENSITY INDEX

NO. OF BIRDS/ACRE

BL. JAY

0.322

TOWHEE

1.000

CAR CHICKADEE

1.571

C CROW

0.047

S&W WARB

0.306

TUFTED TITMOUSE

0.286

OVENBIRE

0.064

Y-S FLICKER

0.133

Y-BILLED CUCKOO

0.062

TOTAL PER ACRE

3.790

MIXED Site #7

7:35 a.m.

July 28, 1971

SAMPLE I. D. 81

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

MOURNING DOVE

0.042

BLUE JAY

0.081

C CROW

0.059

MOCKINGBIRD

0.171

CARDINAL

0.071

TOWHEE

0.420

TOTAL PER ACRE

0.845

MIXED Site #8

8:00 a.m.

July 13, 1971

SAMPLE 1. D. 83

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

Y-BILLED CUCKOO

0.039

R-S HAWK

0.029

MOURNING DOVE

0.127

BLUE JAY

0.081

CAR CHICKADEE

0.660

MOCKINGBIRD

0.086

ROBIN

0.103

OVENBIRD

0.203

GRACKLE

0.031

TOWHEE

0.700

TOTAL PER ACRE

2.059

MIXED Site #8

6:30 a.m.

July 16, 1971

SAMPLE 1. D. 85

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

Y-S FLICKER

0.042

CAR CHICKADFE

0.330

ROBIN

0.103

TOWHEE

0.560

TOTAL PER ACRE

1.035

MIXED Site #8

7:40 a.m.

July 26, 1971

SAMPLE 1. D. 87
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

Y-S FLICKER	0.042
BLUE JAY	0.122
R CHICKADEE	0.330
FTED TITMOUSE	0.060
ROBIN	0.205
TOWHEE	0.700
Y-BILLED CUCKOO	0.039
OVENBIRD	0.041
CATBIRD	0.107
MOCKINGBIRD	0.086

TOTAL PER ACRE 1.732

MIXED Site #8

7:35 a.m.

July 28, 1971

SAMPLE I. D.
SPECIES

92

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

Y-BILLED CUCKOO	0.032
Y-S FLICKER	0.068
MOURNING DOVE	0.138
BLUE JAY	0.099
CAR CHICKADEE	1.071
TUFTED TITMOUSE	0.049
OVENBIRD	0.033
TOWHEE	0.682

TOTAL PER ACRE 2.171

HARDWOOD Site #9

7:30 a.m.

July 15, 1971

SAMPLE I. D. 94

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

R-S HAWK

0.024

BLUE JAY

0.132

F CROW

0.048

TUFTED TITMOUSE

0.146

ROBIN

0.083

CARDINAL

0.058

TOEHEE

0.568

TOTAL PER ACRE

1.059

HARDWOOD Site #9

8:10 a.m.

July 21, 1971

xxx

SAMPLE I. D.
SPECIES

96

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.262
R-S HAWK	0.024
BLUE JAY	0.230
C CROW	0.072
CAR CHICKADEE	0.402
YELLOWTHROAT	0.121
TONHEE	0.852

TOTAL PER ACRE 1.962

HARDWOOD Site #9

6:25 a.m.

July 27, 1971

xxxi

SAMPLE I.D. 98

SPECIES

Bird Density Index
No. of Birds/Acre

Towhee .625

Car Chickadee .536

Mourning Dove .034

C Crow .024

Catbird .087

Blue Jay .132

Cardinal .115

F Crow .955

Tufted Titmouse .974

Total per acre 3.482

HARDWOOD Site #9

8:00 a.m.

July 29, 1971

SAMPLE I. D. 102

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.535
Y-S FLICKER	0.209
BLUE JAY	0.337
TUFTED TITMOUSE	0.498
ROBIN	2.729
CARDINAL	0.118
TOWHEE	0.814

TOTAL PER ACRE 5.240

HARDWOOD Site #10

7:30 a.m.

July 15, 1971

xxd11

SAMPLE I. D. 104

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.357
MOCKINGBIRD	0.284
BLUE JAY	0.337
CAR CHICKADEE	1.096
TUFTED TITMOUSE	0.399
BRN THRASHER	0.284
ROBIN	2.558
TOWHEE	0.581

TOTAL PER ACRE 5.897

HARDWOOD Site #10

8:10 a.m.

July 21, 1971

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.714
Y-S FLICKER	0.140
BLUE JAY	0.269
CAR CHICKADEE	0.274
ROBIN	2.558
YELLOWTHROAT	0.743
CARDINAL	0.118
TOWHEE	0.233

TOTAL PER ACRE 5.048

HARDWOOD Site #10

6:25 a.m.

July 27, 1971

SAMPLE I. D. 108

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TOWHEE	0.930
CATBIRD	0.714
BLUE JAY	0.539
ROBIN	1.535
BRN THRASHER	0.142
YELLOWTHRAT	0.248
TUFTED TITMOUSE	0.199
DOWNY WDP	0.107

TOTAL PER ACRE 4.413

HARDWOOD Site #10

8:00 a.m.

July 29, 1971

SAMPLE I. D. 111
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CATBIRD	0.639
MOURNING	0.106
BRN THRASHER	0.248
YELLOWTHROAT	1.117
GRACKLE	0.447
CARDINAL	0.169
TOWHEE	0.670
SONG SPARROW	0.339

TOTAL PER ACRE 3.736

ISLAND BEACH Site #11

6:35 a.m.

July 20, 1971

SAMPLE 1. D. 112

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TREE SWALLOW	0.559
BARN SWALLOW	1.676
F CROW	0.894
R-WINGED BLACKBIRD	0.419
SONG SPARROW	0.508
CATBIRD	3.512
TOWHEE	1.788
YELLOWTHROAT	4.842
GRACKLE	0.447
YELLOW WARB	0.745
BRN THRASHER	0.497

TOTAL PER ACRE 15.887

ISLAND BEACH Site #11

6:45 a.m.

July 20, 1971

SAMPLE 1. D. 113
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TREE SWALLOW	0.447
BARN SWALLOW	1.006
F CROW	0.074
RED W BVLACKBIRD	1.676
MOURNING DOVE	0.213
SONG SPARROW	0.508
CATBIRD	5.109
TOWHEE	1.117
YELLOWTHROAT	3.352
BRN THRASHER	1.242

TOTAL PER ACRE 14.744

ISLAND BEACH Site #11

8:50 a.m.

July 20, 1971

SAMPLE I. D. 114

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

RED-W BLACKBIRD

2.235

SONG SPARROW

0.677

YELLOW WARB

1.490

TOWHEE

1.564

MOURNING DIVE

0.426

YELLOWTHROAT

3.352

CATBIRD

5.423

GRACKLE

0.745

TOTAL PER ACRE

15.918

ISLAND BEACH Site #11

7:15 a.m.

July 23, 1971

SAMPLE 1. D. 115.
SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

TOWHEE	0.670
BRN THRASHER	1.242
TREE SWALLOW	0.223
BARN SWALLOW	0.112
F CROW	0.149
RED-W BLACKBIRD	2.654
SONG SPARROW	1.016
CATBIRD	3.831
YELLOWTHROAT	1.490
GRACKLE	0.149
MOURNING DOVE	0.319

TOTAL PER ACRE 11.856

ISLAND BEACH Site #11

8:40 a.m.

July 23, 1971

SAMPLE 100D. 116

SPECIES

BIRD DENSITY INDEX
NO. OF BIRDS/ACRE

CARDINAL	0.339
MOURNING DOVE	0.213
F CROW	0.372
RED-W BLACKBIRD	1.956
SONG SPARROW	0.508
CATBIRD	6.386
TOWHEE	1.788
BRN THRASHER	1.490
YELLOW WARB	2.980

TOTAL PER ACRE 16.031

ISLAND BEACH Site #11

8:40 a.m.

July 23, 1971