

PENNSYLVANIA GAP ANALYSIS PROJECT

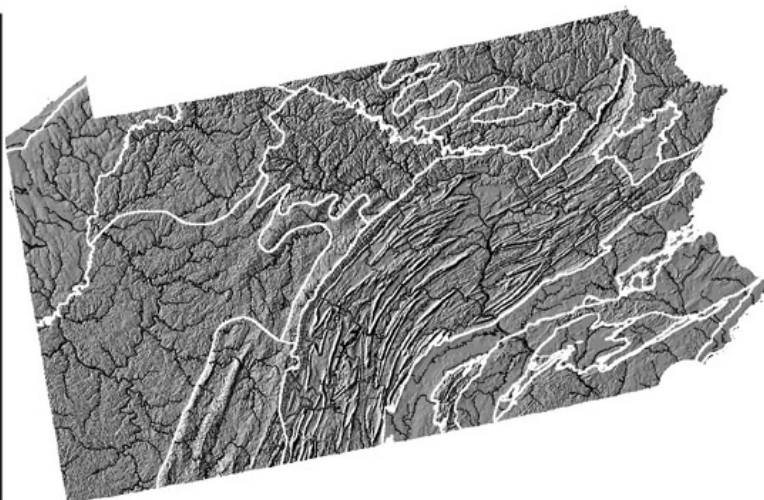
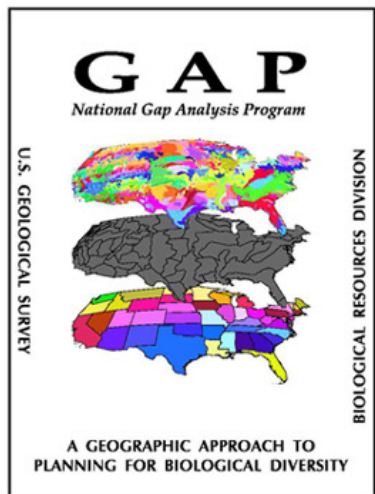
LEADING LANDSCAPES FOR COLLABORATIVE CONSERVATION

FINAL REPORT

School of Forest Resources
and
Cooperative Fish and Wildlife Research Unit
and
Environmental Resources Research Institute

The Pennsylvania State University
University Park, Pennsylvania 16802

U.S. Geological Survey
Biological Resources Division
Gap Analysis Program



THE PENNSYLVANIA GAP ANALYSIS PROJECT
FINAL REPORT
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DEDICATION

This Gap Analysis work is dedicated to promoting landscape perspectives for sustaining Pennsylvania's natural heritage in harmony with human habitation.

EXECUTIVE SUMMARY

The Pennsylvania Gap Analysis Project (PA-GAP) was initiated in 1993 with the general goal of providing a landscape-level perspective on the conservation status of reproductive habitats for mammals, birds, amphibians, reptiles, and fishes. The intent has been to attain this overall goal of landscape perspective within the general framework of the national Gap Analysis Program (GAP), but with some accommodation for Pennsylvania's special blend of physiography and historical human habitation.

Pennsylvania's contemporary habitats are largely a legacy of historic human disturbance. Major modes of disturbance have included strip mining, marginal agriculture, and extensive forest clearcutting, often followed by fire. There has been a physiographic propensity for exposed soils to be degraded by erosion, leading to abandonment of lands and their eventual reversion to the public domain. Regrowth and reforestation, along with restoration of mine spoils, have created habitats that harbor a considerable variety of wildlife.

Thus, geography, physical environment, land cover and disturbance, and wetland occurrence are major determinants of habitat for the Pennsylvania context. Species composition and density of vegetation are somewhat secondary as habitat factors at landscape scales in this region. For these reasons, the landscape-scale habitat models for Pennsylvania give more emphasis to the former features, whereas GAP would traditionally emphasize vegetation types.

Pennsylvania history is replete with negative human influences on waters and wetlands. Water and wetland ecosystems have not been as resilient to human impacts as terrestrial systems. Erosion of exposed soils generates sediment that fills in wetlands, aggravating the loss and modification of wetlands due to development. Pollution from industry, mining, agriculture, urbanization, and transportation contributes toxic chemicals to the waters, increases their acidity, and builds up excess nutrients in lakes and ponds, which can ultimately be deadly for fish and other aquatic life. Acid mine drainage and acid rain have been especially problematic for Pennsylvania. Hydrologic engineering for transportation, flood control, cooling, and power generation has disrupted natural hydrologic patterns. The location of major urban centers in the state is strongly associated with large rivers, estuaries, and Lake Erie. Drainage divides between major river basins constitute virtually complete barriers to dispersal and recolonization by aquatic species. This multitude of long-term stresses, coupled with segregation imposed by Pennsylvania's physical geography, has put several of the state's aquatic species in jeopardy, and a number of others are apparently already eliminated from entire geographic sectors.

In tracking the conservation situation, National Gap Analysis protocols differentiate status levels of land stewardship. On status 1 lands, human disturbance of habitat is legally prohibited (except for managed access and/or interpretation) and non-human disturbance is not controlled unless it threatens human life or property. Status 2 lands are naturalistic areas with a legal mandate prohibiting conversion to humanistic/cultural

development. On status 3 lands, any further permanent conversion of lands to humanistic/cultural development is restricted by legal mandate. In Pennsylvania, a distinction was made between status 4 lands having no specific provisions for conservation and lands for which conservation status could not be determined.

Examples of GAP status 1 lands in Pennsylvania are wilderness areas, natural areas, wild areas, and conservancies. Pennsylvania has less than 1% of its approximately 11.6 million hectares in status 1 lands. GAP status 2 lands in Pennsylvania include state parks, state forests, state gamelands, state scenic rivers, national wildlife refuges, and less restrictive private conservancies. Pennsylvania has 12% of its area in status 2 lands, with the interesting irony that a substantial share of this large area was historically degraded land that reverted to the public domain for rehabilitation. Pennsylvania's GAP status 3 lands consist mostly of national forest, national parks, national recreation areas, and national scenic and recreational rivers. Status 3 lands account for a little more than 2% of Pennsylvania's area. Therefore, the Commonwealth has approximately 15% of its land area in stewardship status 3 or better, with the more pristine status 1 lands being quite limited. Importantly, the major status 2 lands are concentrated in particular parts of the state that have been demonstrated historically to be unsuitable for intensive human development.

Generalized land cover and disturbance were mapped in several modes from Landsat Thematic Mapper (TM) digital data collected during a period from 1991 through 1994. The image data were compressed for mapping purposes so as to be compatible with geographic information systems (GIS) software. The compressed images have been made available to the public and have received considerable use in Pennsylvania as backdrops for GIS applications. An initial interpretive mapping at 100-ha resolution classified landscapes as being either *naturalistic* or *humanistic*. Naturalistic landscapes included forests, wetlands, and water. Humanistic landscapes included agricultural, suburban, and urban land uses. Nearly 70% of the state has a naturalistic (mainly forested) landscape, with approximately 65% in one large unit encompassing much of the northern third of the Commonwealth and extending through the mountains to the southern border.

Landscapes in several regions of Pennsylvania are heavily influenced by human development. Habitat disturbance due to human development was mapped interpretively in three types with no specific minimum resolution. The disturbance classes were rural, suburban (primarily residential), and urban (commercial/industrial). Pennsylvania is predominantly rural, with 1.5% of its area being intensively urbanized and another 4.1% being suburban. Much of the urbanization is due to a few large metropolitan areas such as Philadelphia, Pittsburgh, Harrisburg, Erie, and Wilkes-Barre/Scranton.

By reference to selected digital aerial photos, 8 general land cover categories were mapped through computer-assisted classification of spectral groupings in the compressed image data. These land cover categories were: (1) water; (2) evergreen forest; (3) mixed evergreen/deciduous forest; (4) deciduous forest; (5) woody transitional such as bushes; (6) perennial herbaceous such as grasslands and forage crops; (7) annual herbaceous such

as row crops and grains; and (8) barren/hard-surface/rubble/gravel. Combining the land cover and disturbance mappings yielded 24 classes for habitat modeling.

Habitat models were developed in tabular (matrix) form as spreadsheets, with columns representing habitat factors and rows representing species. A map of suitable habitat was then prepared for each species from the respective model by analytically combining spatial data layers for the habitat factors using computerized geographic information systems (GIS). The modeling for fishes was done on the basis of 9,855 small watersheds.

GAP analysis conventionally takes note whether a species has 10%, 20%, or 50% of its potential habitat on lands with management status 1 or 2. Pennsylvania has approximately 13% of its total land area in GAP status 1 and 2, so common species fall mostly in the 10% to 20% range for this level of conservation. Higher percentages indicate some degree of habitat restriction to conservation areas. Lower percentages indicate relative under-representation of habitat within conservation areas, but do not necessarily reflect overall degree of statewide habitat scarcity.

There are no mammals having 50% or more of the potential habitat in status 1 and 2. The following species have 20% to 50% of potential habitat in status 1 and 2: northern water shrew, long-tailed shrew, pygmy shrew, Indiana myotis, Appalachian cottontail, snowshoe hare, northern flying squirrel, Allegheny woodrat, woodland jumping mouse, common porcupine, fisher, eastern spotted skunk, bobcat, and elk. Species having less than 10% of potential habitat in status 1 and 2 are: eastern mole, evening bat, Norway rat, house mouse, meadow jumping mouse, and least weasel. The remaining species have 10% to 20% of potential habitat in status 1 and 2.

There are four species of birds with 50% or more of potential habitat in GAP status 1 and 2: American wigeon, black tern, yellow-bellied flycatcher, and blackpoll warbler. Bird species having 20% to 50% of habitat in GAP status 1 and 2 are: northern goshawk, black-necked stilt, northern saw-whet owl, yellow-bellied sapsucker, olive-sided flycatcher, red-breasted nuthatch, winter wren, golden-crowned kinglet, Swainson's thrush, hermit thrush, blue-headed vireo, yellow-throated vireo, warbling vireo, Nashville warbler, black-throated blue warbler, yellow-rumped warbler, black-throated green warbler, Blackburnian warbler, pine warbler, worm-eating warbler, northern waterthrush, mourning warbler, Canada warbler, rose-breasted grosbeak, white-throated sparrow, dark-eyed junco, and purple finch.

Bird species having less than 10% of potential habitat in GAP status 1 and status 2 are: least bittern, great egret, snowy egret, cattle egret, black-crowned night heron, yellow-crowned night heron, mute swan, Canada goose, mallard, blue-winged teal, northern shoveler, bald eagle, northern harrier, peregrine falcon, ring-necked pheasant, northern bobwhite, king rail, Virginia rail, sora, killdeer, upland sandpiper, common snipe, American woodcock, rock dove, barn owl, short-eared owl, common nighthawk, Chuck Wills's widow, chimney swift, willow flycatcher, eastern kingbird, horned lark, purple martin, tree swallow, bank swallow, cliff swallow, barn swallow, fish crow, Carolina chickadee, sedge wren, eastern bluebird, loggerhead shrike, European starling, white-

eyed vireo, blue-winged warbler, yellow warbler, magnolia warbler, prairie warbler, common yellowthroat, yellow-breasted chat, summer tanager, blue grosbeak, dickcissel, clay-colored sparrow, field sparrow, vesper sparrow, savannah sparrow, grasshopper sparrow, Henslow's sparrow, song sparrow, bobolink, red-winged blackbird, eastern meadowlark, western meadowlark, common grackle, house finch, house sparrow. The remaining species have 10% to 20% of potential habitat in GAP status 1 and status 2.

The mud salamander is the only amphibian species having 50% or more of the potential habitat in GAP status 1 and 2. The valley and ridge salamander along with Wehrle's salamander are the only species with 20% to 50% of potential habitat in GAP status 1 and 2. Amphibian species having less than 10% of potential habitat in GAP status 1 and 2 are: hellbender, seal salamander, ravine salamander, mudpuppy salamander, Woodhouse's toad, northern cricket frog, gray tree frog, mountain chorus frog, western chorus frog, northern leopard frog, and southern leopard frog. The remaining species have from 10% to 20% of potential habitat in status 1 and 2.

There are no turtle species having 20% or more of the potential habitat in GAP status 1 and 2. The wood turtle and bog turtle have 10% to 20% of potential habitat in status 1 and 2. The other 8 turtle species have less than 10% of potential habitat in status 1 and 2.

Among snakes and lizards, there are no species with 50% or more of potential habitat in GAP status 1 and 2. Species having 20% to 50% of potential habitat in status 1 and 2 are: eastern fence lizard, coal skink, five-lined skink, redbelly snake, smooth earth snake, and timber rattlesnake. Species having less than 10% of potential habitat in status 1 and 2 are: broadhead skink, Kirtland's snake, rough green snake, queen snake, brown snake, copperhead, and massasauga. The remaining species have 10% to 20% of potential habitat in status 1 and 2.

Consistent with the problematic conservation context for fishes in Pennsylvania, the majority of species in this group have less than 10% of the potential habitat in GAP status 1 and 2. There are no fish species with 50% or more of habitat in status 1 and 2. Species having 20% to 50% of habitat in status 1 and 2 are: shortnose sturgeon, brook trout, redbelly dace, bluespotted sunfish, longear sunfish, and slimy sculpin. Species having 10% to 20% of habitat in status 1 and 2 are: Atlantic sturgeon, American eel, rainbow trout, brown trout, chain pickerel, cutlips minnow, bigeye chub, eastern silvery minnow, hornyhead chub, spotted shiner, silver shiner, ironcolor shiner, southern redbelly dace, blacknose dace, fallfish, satinfin shiner, gravel chub, white sucker, creek chubsucker, northern hog sucker, margined madtom, brown bullhead, green sunfish, pumpkinseed, bluegill, mottled sculpin, and Potomac sculpin. The remaining species have less than 10% of the potential habitat in GAP status 1 and 2.

For the Pennsylvania context, it is important to have a relatively objective way of analyzing the model results to determine which species may be particularly problematic with respect to scarcity of suitable habitat and conservation of the habitat that remains. A special mode of analysis was conceived to rank species in this regard and determine where there is notable co-occurrence among such species. *A Regional Habitat Insecurity*

Index (RHII) was formulated which combines overall habitat scarcity with scarcity of habitat in conservation areas and scarcity of conservable habitat. It lends particular emphasis to species that couple overall habitat scarcity with low representation in conservation areas and difficulty of finding habitat outside existing conservation areas by which to enhance the level of stewardship. The RHII results were mapped on a 1-km grid having 118,218 cells in Pennsylvania. A weighted spatial index of landscape importance was determined for each of six (taxonomic) groups of species by summing the RHII values for species having suitable habitat in the cell.

The index of landscape importance was mapped separately for the portion of Pennsylvania *not contained* in conservation areas having status 3 or better. A threshold was then determined for the composite RHII importance index of each group of species. Cells above this threshold were designated as **leading landscapes** for conservation concern regarding that group of species. Cells occurring as small patches were suppressed in the leading landscapes map to avoid habitat fragments. The mappings of leading landscapes were also cross-compiled among groups of species to show where landscapes are important for multiple groups.

Analysis of turtles in this manner places emphasis on the map turtle, bog turtle, and eastern spiny softshell turtle. Analysis of snakes and lizards emphasizes the broadhead skink, Kirtland's snake, rough green snake, eastern massasauga, and eastern worm snake. Emphasis for amphibians is on the eastern mud salamander, southern leopard frog, green salamander, eastern spadefoot toad, ravine salamander, northern cricket frog, mudpuppy salamander, mountain chorus frog, and Appalachian seal salamander.

Analysis of mammals lends emphasis to eastern spotted skunk, evening bat, least shrew, rock vole, Indiana myotis, elk, Appalachian cottontail, northern water shrew, fisher, river otter, fox squirrel, least weasel, Allegheny woodrat and snowshoe hare. Placement of existing conservation stewardship areas generally matches better with the needs for mammals than for other taxonomic groups of vertebrates.

The RHII approach emphasizes several bird species as given in Table 5.2 of the report, with wetland associated species and grassland species both being prominently represented. The leading landscapes for birds, likewise, show this emphasis. Not surprisingly, the fish list is largest (Table 5.6) and loaded with endangered, threatened, and candidate species. French Creek and the Ohio River are prominent in the leading landscapes for fishes.

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