THE ARKANSAS GAP ANALYSIS PROJECT
FINAL REPORT
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STATE-WIDE BIODIVERSITY MAPPING
FOR ARKANSAS

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DEDICATION

J. Michael Scott and Blair Csuti

Two individuals who had the vision to see the usefulness of the GAP approach to biodiversity monitoring, planning, and management, and who were a great resource for the Arkansas Gap Project

and to

Peggy, Elaine, Stephanie, Linda, and Debbie

Wives who were also a great asset to the Arkansas Gap Project, as they learned to live with GAP, as did we.
EXECUTIVE SUMMARY

The Arkansas Gap Analysis project (AR-GAP) was initiated as a cooperative effort between the Biological Resource Division of the U.S. Geological Survey, and state, federal, and private natural resources groups in Arkansas. The major objectives of the project were to (1) produce GIS-databases describing the actual land cover type, predicted distributions of terrestrial vertebrates, land ownership, and land management status at a scale of 1:100,000, (2) identify land cover types and terrestrial vertebrate species that currently are not represented or are underrepresented in areas managed for long-term maintenance of biodiversity, i.e., “gaps”, and (3) facilitate cooperative development and use of information so that institutions, agencies, and private land owners may be more effective stewards of Arkansas’ natural resources. The AR-GAP project is a preliminary step toward the more detailed efforts and studies needed for long-term planning for biodiversity conservation in Arkansas.

The map of actual land cover was the first GIS layer completed by AR-GAP and represents the first actual vegetation map for the state of Arkansas. Landsat TM data, mostly from 1992, constituted the base data layer for the land cover map. Image processing was conducted on 10 scenes needed to cover the entire state. After geometric correction, a tasseled cap transformation vegetation index was calculated for each scene to enhance brightness, greenness, and wetness. Each image was then stratified by the Natural Resource Conservation Service’s Arkansas STATSGO (State Soil Geographic Data Base) soil boundary polygons to help isolate spectrally homogeneous regions within scenes prior to classification. An unsupervised classification resulted in a map with 2,778 different spectral classes across the state. Initial classification utilized the USDA Forest Service Southern Forest Inventory and Analysis (SOFIA) plots and Continuous Inventory Stand Condition (CISC) data and US Army Corps of Engineers Computerized Environmental Resources Data System (CERDS). Various classification schemes were cross-walked into a single UNESCO based natural vegetation classification system developed for AR-GAP. Addition data then were incorporated into the map: 8 digital USDA Forest Service ranger districts and Timber Management Inventory (TMI) plot data from the Arkansas Game and Fish Commission. US Census Bureau TIGER (Topologically Integrated Geographic Encoding and Reference) incorporated boundaries and TIGER water were also added to the map. To move from the 30 m pixel resolution to the national standard of 100 ha minimum mapping units (MMU), the AR-GAP tested and implemented an aggregation method developed by the Montana GAP. Final map editing included a cartographic adaptation of the land cover data, with color coding linked directly to the vegetation classification system; line smoothing and tiling; and moving from a raster to vector file format.

The resulting data layer includes the distribution of 36 land cover classes, mapped as polygons with 100 ha MMU for uplands and 40 ha for wetlands. Nearly 44% of the state was classified as Agricultural (pasture and crops) with no other category occupying more than 10% of the land area of Arkansas. Accuracy assessment was performed using some TMI plot data reserved for that purpose and the development of a Rapid Assessment Track (RAT), whereby personnel from the Arkansas Forestry Commission ground-truthed 100 areas across the state in a manner similar to that used by the UT-GAP. Based on those analyses, we estimated that the over-all accuracy of the land cover map to be 98% at level 1, 69% at level 2, 49% at levels 3 and 4 (formation), and 36% at level 5 (alliance). Variation existed at all levels in accuracy of classifying different vegetation categories. For example, the Pinus echinata alliance was mapped with 75% accuracy and Quercus alba - mixed hardwoods alliance was mapped with 79% accuracy at level 5.
Distributions of 67 mammals, 144 breeding birds, and 109 reptiles and amphibians were predicted by county using a variety of sources. Bird distributions were generated from published and unpublished sources and final predicted distributions were reviewed by a panel of professional ornithologists and amateur bird watchers. Mammal distributions were generated primarily based on museum specimens at Arkansas State University and University of Arkansas at Monticello. Reptile and amphibian distributions were digitized from Conant and Collins’ (1991) book. Habitat relationships for all terrestrial vertebrates were taken from published works on each taxa and crosswalked into 6 vegetation classifications based on the land cover map. Predicted distribution maps were produced for each species based on county of occurrence and habitat affinities. Vegetation units were also further classified as optimal, suitable, or marginal for each species.

For further analysis, county of occurrence maps were translated to the Environmental Monitoring Assessment Program (EMAP) 635 km2 hexagon tessellation of Arkansas. Only 70 species separate the most specious hexagon from the least. The least specious hexagon includes 200 species (62% of the terrestrial vertebrate diversity of Arkansas) and the most specious hexagon includes 270 species (83% of the terrestrial vertebrate diversity of Arkansas). The least specious hexagons are located in the Mississippi Alluvial Basin Section where a high degree of human modification of the landscape for agricultural purposes dominates the region. Hexagons with high diversity of terrestrial vertebrates are centrally located in Arkansas, where Arkansas Valley, Ouachita Mountain, and Mississippi Alluvial Basin ecoregion sections meet. Other areas with high biodiversity include the western edge of Arkansas and parts of the Ouachita Mountains. Avian hexagon biodiversity ranges from 80 species (56% of the avian diversity of Arkansas) to 126 species (88% of the avian diversity of Arkansas). High concentrations of avian biodiversity are found in central, northwest, and southwest Arkansas. Similar to the patterns observed for all terrestrial vertebrates, hexagons with high avian biodiversity are found along the borders of two or more ecoregions. Mammalian hexagon biodiversity ranges from 48 species (72% of the mammalian diversity of Arkansas) to 62 species (93% of the mammalian diversity of Arkansas). High concentrations of mammalian biodiversity are found in northwest Arkansas while relatively low concentrations of mammals are found in the southern half of the state. Amphibian hexagon biodiversity ranges from 18 species (40% of the amphibian diversity of Arkansas) to 33 species (73% of the amphibian diversity of Arkansas). High concentrations of amphibian biodiversity are scattered throughout the Interior Highlands while low concentrations of amphibian biodiversity are found in the Mississippi Alluvial Basin. Reptilian hexagon biodiversity ranges from 41 species (64% of the reptilian diversity of Arkansas) to 60 species (94% of the reptilian diversity of Arkansas). A large concentration of reptiles are found in central Arkansas. Unlike other taxonomic groups treated by AR-GAP, the Mississippi Alluvial Basin is not depauperated of reptiles.

The terrestrial vertebrate diversity is the sum total of 322 individual predictive models of breeding birds, mammals, reptiles and amphibians. The polygon with the highest biodiversity in the state is oak-gum-cypress, provides habitat for 214 species (64% of the biodiversity of Arkansas), and is located in central Arkansas. Other areas of high terrestrial biodiversity include some bottomland hardwood regions near the Saline River (central Arkansas) and Lake Millwood (southwest Arkansas) and small sections of the Boston Mountains. Low areas of biodiversity are all agricultural areas, especially those within the Mississippi Alluvial Basin. Major centers of avian biodiversity are found in the oak-hickory areas of the Boston Mountains and Crowley’s Ridge and along the Saline River. There is no major center of mammalian diversity as many mammals are
found throughout the entire state. The polygon with the highest biodiversity in the state provides habitat for 39 species (58% of the mammalian biodiversity of Arkansas. Major centers of amphibian biodiversity are found in the oak-gum-cypress areas the Saline and Ouachita Rivers. The polygon with the highest amphibian biodiversity in the state provides habitat for 38 species (84% of the biodiversity of Arkansas). Most areas in Arkansas have low biodiversity of amphibians due to their intimate linkage with water bodies. Major centers of reptilian biodiversity are found in the oak-gum-cypress areas the Saline and Ouachita Rivers. The polygon with the highest reptile biodiversity in the state provides habitat for 57 species (90% of the biodiversity of Arkansas).

A method of using US Fish and Wildlife Breeding Bird Surveys (BBS) from 1980-1992 was developed for accuracy assessment of the avian models. This allowed an analysis of errors of omission (occurrence of species where not predicted to occur) and commission (predicted occurrence of species where it did not occur). While both kinds of errors varied greatly between and within species, errors of omission were generally low compared to errors of commission, which is not surprising since gap models usually overpredict actual species distributions. Ignoring both the biases in the predicted avian distributions and in the BBS data base itself, predicted avian distributions had an overall mean accuracy of about 70%. Due to funding and time constraints, no accuracy assessment was performed on predicted models for mammals, reptiles, or amphibians.

There is no single entity that is responsible for maintaining a comprehensive inventory of all public lands, so the ownership and management maps for the state of Arkansas were developed for the first time. Thirteen state and federal agencies were asked to submit the boundaries for public land they owned or managed within the state. They also were asked to classify their land into the 4 GAP stewardship categories. Data were collected through fall of 1995. Almost 90% of the state of Arkansas is privately owned and in unknown management status (status 4). The USDA Forest Service is the largest public land owner (7.3%) and the Arkansas Game and Fish Commission is the largest state land owner (0.75%). Only 0.45% of the state of Arkansas is currently in status 1 (e.g., preserves, wilderness areas) and only 1.77% of the state is in status 2, areas generally managed for natural values.

Given the vast of amount of private land in Arkansas, it is not surprising that a majority (17 of 31, 55%) of the AR-GAP natural land cover classes have more than 90% of their distribution in private ownership. Only one class, Fagus grandifolia, had more than 50% of its area mapped in another land ownership category. Only 6 land cover classes had more than 10% of their mapped distribution in status 1 and 2 combined, and only 1, Nyssa, had more than 1% of its distribution in status 1.

Likewise, 68 species of terrestrial vertebrates have less than 1% of their predicted distribution within status 1 and 2. Only the Rufous-crowned Sparrow, a very rare breeding bird in Arkansas, has more than 20% of its predicted distribution in status 1 and 2.

Using the 3 species categories proposed by the national GAP for estimated required area for viable populations, 114 species of vertebrates in Arkansas appear to be under-protected. Using the EMAP hexagon grid and a greedy heuristic algorithm, areas within the state of Arkansas that show the most promise for protecting these “gap species” include: (1) central Arkansas where the Arkansas River enters the Delta region flanked by the Ozark and Ouachita Mountains, (2) the eastern edge of the Ozark Mountains, (3) extreme northwestern Arkansas which has a prairie/grassland influence, and (4) The Red River Valley and the southern edge of Gulf Coastal Plain.
With the conclusion of the AR-GAP, it is anticipated that state and federal agencies within Arkansas will use and continue to refine the GIS-databases presented in this report, none of which existed prior to this project. The Arkansas Natural Heritage Commission has expressed an interest in becoming the lead organization for this transition.
ACKNOWLEDGMENTS

Over the course of the last 5 years, literally hundreds of individuals participated in one way or another to make this project a success. Dr. Thomas E. Martin was instrumental in obtaining the initial funding and served briefly as a co-principal investigator. Dr. Xiaojun Li and Wang Song were also involved in initial conceptual development and direction of vegetation classification work on the landcover map, as was Cameron Ghlambar for vertebrate mapping.

Anne Gisiger and Yew Yau customized the interactive mapper to produce the maps contained on the CD-ROM. Rick Thompson assisted with classification and aggregation of landcover data. The aggregation process would not have been possible without support of Roland Redmond and Z. Ma, University of Montana, and Collin Homer and Scott Bassett, Utah State University. Paul Teague conducted research on appropriate line smoothing weighting factors and John Wilson and Alynne Bayard edited smoothed vector linework. Katheryn Hargis scanned Arkansas Forestry Commission (AFC) field photos on the CDROM and Anasuya Soundararajan and Balamurugan Krishnasamy entered AFC collected field data into a database. Robert McFarland, AFC, and J. Garner Barnum, AFC, helped coordinate the Rapid Assessment Tract at AFC, and we thank all the district foresters and rangers that participated in the collection of assessment data. Stephan Pollard was responsible for cartographic production of AR-GAP hardcopy map series.

The basic vegetation classification scheme was developed through meetings of the Vegetation Committee, which included M. Blaney, B. Ederington, and C. Ware, Arkansas Game and Fish Commission (AGFC); T. Foti, Arkansas Natural Heritage Commission (ANHC); J. Grant, AFC; R. Bennett, Arkansas State University (ASU); P. Tappe, University of Arkansas at Monticello (UAM); E.E. Dale and X. Li, University of Arkansas, Fayetteville (UAF); W. Pell, Ouachita National Forest (ONF); C. Minehart, Ozark-St. Frances National Forest (OSFNF) and L. Peacock, Arkansas Field Office, The Nature Conservancy (TNC). Tammy Hocut assisted in obtaining CISC data for the OSFNF; Ron Perisho assisted in obtaining CISC data for the ONF. Dan Twedt has helpful in initial stages of vegetation classification of the Delta region, and Victor Rudis, US Forest Service, helped with the SOFIA dataset.

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LANDCOVER MAPS

Over 3,000 maps (in Adobe Acrobat format) have been prepared to accompany this written report. They are included on disc 1 of the CD-ROM set. Three different map series are presented: county, USGS 30 x 60 minute, and USGS 7.5 minute. Three different Landsat Thematic Mapper (TM) raster backgrounds are used on each scale series: False Color Infrared, Tasselled Cap Index, and 100 ha AR-GAP Landcover. Included on disc 2 of the CD-ROM set are 100 “ground-truth” maps (7.5 minute series) utilized in the assessment (see Chapter 2) of the AR-GAP Landcover map. Photographs recorded at the “ground-truth” site are also linked to 23 of those 100 maps.

VERTEBRATE MODELS

Maps (also in Adobe Acrobat format) of 322 terrestrial vertebrate models were prepared and are included on disc 1 of the CD-ROM set. For each terrestrial vertebrate species studied by AR-GAP, three maps are supplied: distribution by county, breeding habitat distribution, and predicted distribution.

STEWARDSHIP MAPS

Stewardship browse graphics can be viewed in section 7.3.2. of the Data Use and Availability chapter.