A GEOGRAPHICALLY-REFERENCED MULTIPLE-RESOURCE DATA MANAGEMENT SYSTEM FOR THE OAK SAVANNAS OF THE MALPAI BORDERLAND REGION

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Twelve watersheds in the oak savannas on the eastern side of the Peloncillo Mountains in the Southwestern Borderlands Region of New Mexico are being monitored to document the ecological and hydrologic characteristics, and to determine the effects of burning treatments on this ecosystem. Ecological components monitored include tree overstories, loadings of fuel fractions, and numbers and diversity of mammals and birds. Hydrologic components monitored are streamflow regimes, soil erosion and deposition, and sedimentation. Watershed descriptors for each watershed include its designation, size, orientation, streamflow network, monitoring network and protocols, and physiographic characteristics. The geographically-referenced data sets are incorporated into the system to facilitate their spatial interpretations.

STRUCTURE OF SYSTEM

Twelve watersheds from 20 to 60 acres in size were established on the eastern slope of the Peloncillo Mountains in Southwestern New Mexico by the Rocky Mountain Research Station, U.S. Forest Service and their cooperators. These watersheds contain 421 permanent sampling plots, with 35 and 45 permanent sampling plots on each watershed. These plots are located along transects perpendicular to the main stream system and situated from ridge to ridge with an interval between the plots ranging from 70 to 240 feet depending on the size and configuration of the watershed.

The primary objective of the research on these watersheds is to determine the effects of burning treatments on the ecological and hydrologic dynamics in the oak savannas of the Southwestern Borderlands. A secondary objective is to gather baseline data to learn more about the ecological, hydrologic, and environmental characteristics of this ecosystem in the region (Gottfried et al. 2007).

A geographically-referenced multiple-resource data management system is under development to enable researchers, managers, and other stakeholders to store, interpret, and analysis datasets from the Cascabel watersheds with relative ease. The geo-spatial database (Figure 1) has been developed using Microsoft Access to manage and retrieve the datasets.

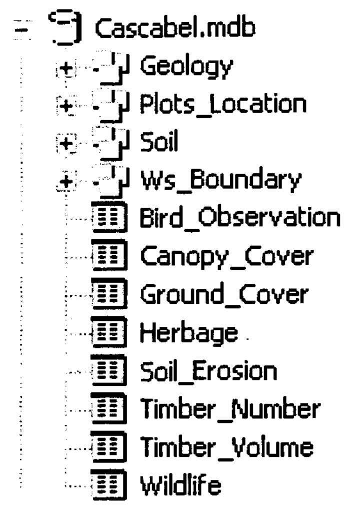

Figure 1. Outlook of Geodatabase

Data sets fall into three general categories: watershed descriptors, biological characteristics, and hydrological characteristic. Watershed descriptors describe the characteristics for each watershed including its designation, size, orientation, streamflow network, monitoring network and protocols, and physiographic characteristics. Biological components monitored are tree overstories, canopy cover, herbaceous understories, loadings of fuel fractions, ground cover, and mammals and birds. Hydrologic components include streamflow regimes, soil movement (both soil erosion and soil deposition), water repellency, sedimentation, and water quality (chemical) constituents.

Global positioning system measurements have been taken to spatially reference the sampling plots, watersheds boundaries, and stream channels. As a result, geographically-referenced data can be incorporated into the data management system to facilitate spatial interpretations. Figure 2 shows the geodatabase named Cascabel.mdb including examples of feature data sets and tables (Geology, Soil, Plots_Location and Ws_Boundary). The feature data set of Plots_Location, for example, comprises 12 point

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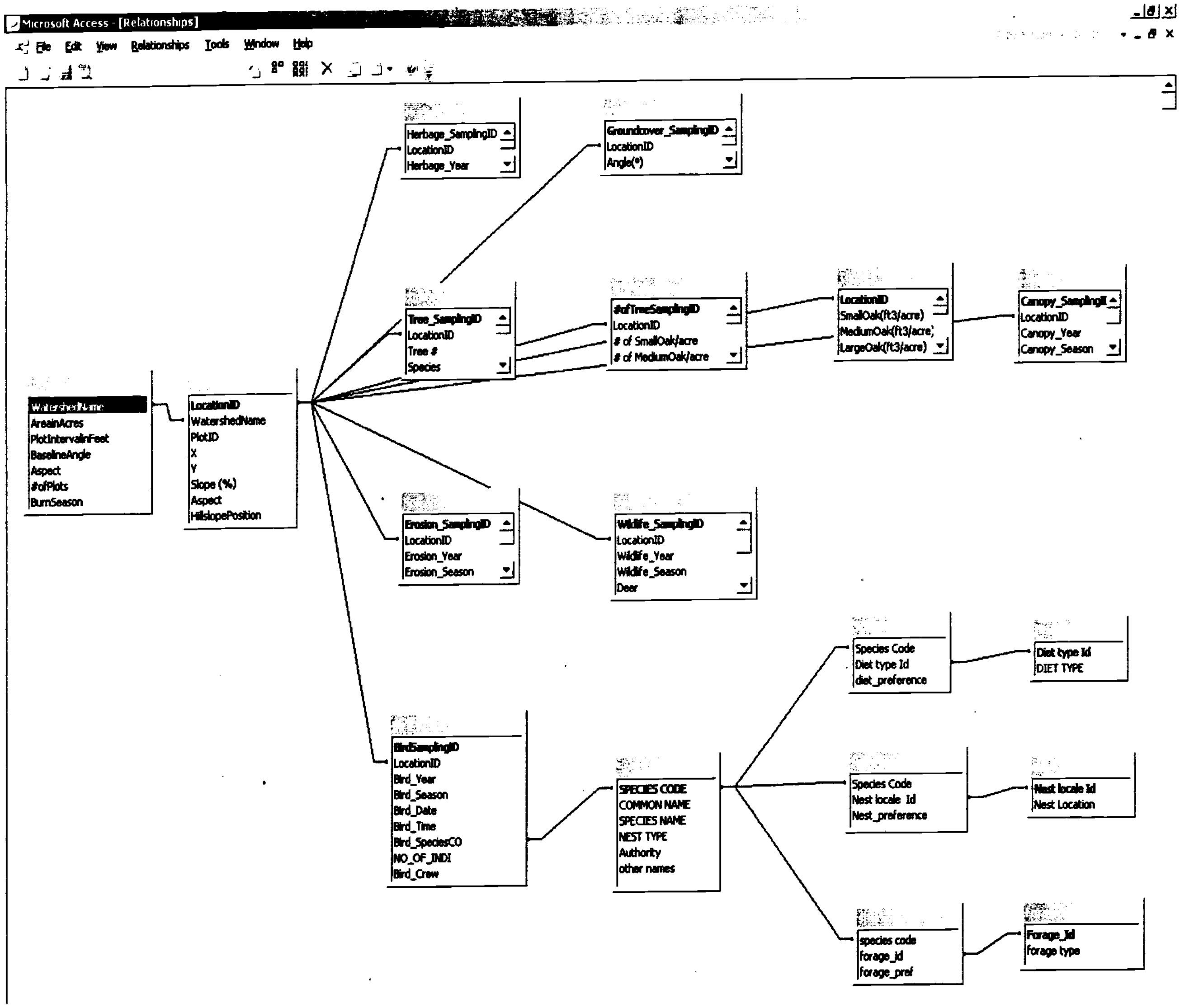

Figure 2. Outlook of the Related Database of Cascabel.mdb.

feature classes describing the location of sampling plots on each watershed, while the feature data set of Ws_Boundary contains 12 polygon feature classes describing the boundary of each watershed. ARC GIS software is used to display the spatial distribution of data sets by joining the tables to feature classes based on the common fields they possess.

DATA SETS IN SYSTEM

Watershed Descriptors

Table 1 and Table 2 describe the physiographic characteristics of the watersheds and sampling plots. These tables are related by the common field presented in WatershedName. The table of Plot_Physiography is also associated with other tables that contain field measurements based on sampling plots by the common field of LocationID.

Table 1. Cascabel_Watersheds

Watershed Name	Area (Acres)	Plot Interval (Feet)	Baseline Angle	Aspect	#ofPlots
A	31.5	80	N10W	South	34
B	38.8	90	N15W	South	36
⋮	⋮	⋮	⋮	⋮	⋮
N	29.6	70	S0	North	37

Table 2. Plot_Physiography

Location ID	Watershed Name	PlotID	X	Y	Slope (%)	Aspect	Hillslope Position
A-01	A	1	-108.9915583	31.5334944	10	E	U
A-02	A	2	-108.9911694	31.5335556	0	S	L
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
N-37	N	37	-108.9727583	31.5331389	15	NE	L

Biological Characteristics

Tree Overstories

One-quarter-acre plots were established to measure species compositions and tree characteristics in terms of diameter root collar for single stem trees, equivalent diameter root collar for multiple stemmed trees, and total height. The tree overstory component of the database is displayed in Figure 3. The field data are transcribed into a table called Timber_Inverntori, where the field data can be summarized by number of trees, basal area, and volume per acre. Canopy cover measured in percent closure is also included in the data.

Herbaceous Understories

The production (biomass) of the herbaceous understory is estimated seasonally at each sampling plot by the weight-estimate procedure originally outlined by Pechanec and Pickford (1937) in 9.6-ft2 circular plots. Seasonal (spring and fall) species composition and the estimated production of grasses, forbs, and shrubs are recorded. The three categories of grasses, forbs, and shrubs are summed together to determine total herbage production. An example of how the records of Herbage_Production are displayed is shown in Table 3.

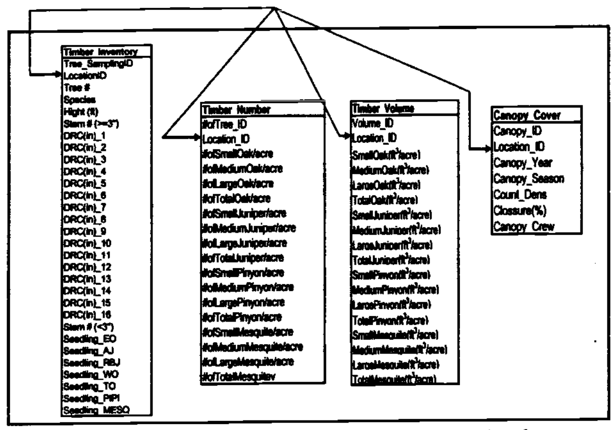

Figure 3. Tree Overstory Component in the database.

Table 3. Herbage Production

Herbage Sampling ID	Location ID	Herbage Year	Herbage Season	Total (lbs/acre)	Grass (lbs/acre)	Forbs (lbs/acre)	Shrubs (lbs/acre)	Herbage Crew
1	A-01	2004	Spring	20.6	20.6	0	0	CLS
2	A-02	2004	Spring	103	97.85	5.15	0	CLS
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
3672	N-37	2007	Fall	230	161	69	0	CLS

Loadings of Fuel Fractions

Loadings of fuel fractions on the Cascabel Watershed have been measured. These fractions are the standing trees, herbaceous understories, downed woody material, and organic matter represented by the litter and duff layers. The fractions consisting of standing trees and herbaceous understories are estimated through interpretations of these respective components of the data management system. Estimates of the downed woody materials and organic matter fractions are obtained by the methods of Brown et al. (1982).

Ground Cover

The percentages of plant material, litter, bare soil and bedrock on the ground surface are estimated annually at each of sampling plot. These measurements are often indictors of hillslope erosion rates (Renard et al.1997) and the successional status of vegetative communities (Bedell 1988). Ground cover is estimated in a rectangle frame of 12-by-18 inches placed at three equally spaced locations within 3 feet of the sampling plots. Table 4 shows how the records in the table of Ground_Cover are displayed within the system.

Table 4. Ground Cover

Ground cover Sampling ID	Location ID	Angle (°)	Ground cover Year	Ground cover Season	Bare Soil (%)	Rock (%)	Litter (%)	Plant Material (%)	Ground cover Crew
1	A-01	0	2007	spring	0	55	15	30	HC
2	A-01	120	2007	spring	0	90	10	0	HC
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
1266	N-37	240	2007	spring	0	0	90	10	CLS

Mammals

The presence of mammals is measured seasonally by counting fecal pellet on 40.5 m^2 circular plots centered over each sampling location. The mammals recorded are deer, cottontail, and coyote. The fecal deposits are cleared from the plot after each counting and, therefore, the seasonal use of the habitats on a watershed can be estimated. Table 5 displays the records in the wildlife section of the database.

Table 5. Mammal data

Wildlife Sampling ID	Location ID	Wildlife Year	Wildlife Season	Deer	Cotton tail	Coyote	Other	Wildlife Crew
1	A-01	2003	Fall	2	45	0	0	WJ
2	A-02	2003	Fall	0	0	0	0	WJ
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
3339	N-37	2006	Fall	0	0	0	0	AK&CLS

Avifauna

Species and numbers of birds sighted in a 5-minute observation period at every third plot on the watersheds is the method used to obtain avifauna data (Ralph et al.1995). Bird tallies are made between 0800 and 1130 hours on clear or partly cloudy days when minimal wind movement exists. The table Bird_Observation presents the time and location of the tallies. An avifauna sub-database (Figure 4) was developed to enable a user of the system to retrieve comprehensive information for each bird species tallied. Examples of the information that is available on this sub-database are the species scientific name, common name, diet type, forage technique, and nesting location.

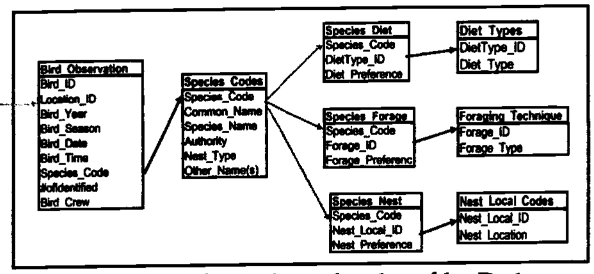

Figure 4. Avifauna sub-database developed by Beth Willaims.

Hydrologic Characteristics

The hydrological components in data management system at this time are soil movement in terms of soil erosion and soil deposition. Other hydrological components to eventually be incorporated into the system include the characteristics of streamflow regimes, channel cross-sections, sediment accumulations, and channel erosion-degradation.

Soil erosion and soil deposition were measured seasonally (spring and fall) using the erosion-pin method. Implementation of this method involved the installation of three erosion pins around every third plot with two pins located 6-feet upslope and one pin is located 6-feet downslope of a plot center. Soil movement is measured by the distance from the cap of a pin to the soil surface (soil erosion) or the accumulation of soil on top of the cap (soil deposition). After of the measurements are taken, the erosion pins are re-set to be flush with the soil surface to facilitate the subsequent measurements. Table 6 displays records in the table of Soil_Erosion, with positive measurements representing soil erosion, negative measurements representing soil deposition, and a number of 0 implying soil erosion and deposition are equivalent at the pin location during that sampling time.

Table 6. Soil movement

Erosion Sampling ID	Location ID	Erosion Year	Erosion Season	Pin1 Depth (mm)	Pin2 Depth (mm)	Pin3 Depth (mm)	Erosion Comments	Erosion Crew
1	A-01	2004	Fall	7	0	8		CLS&DVZ
2	A-04	2004	Fall	7	-	-	Pins 2 and 3 not found replaced	CLS&DVZ
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
1314	N-37	2008	Fall	1	0	1		AK

RETRIEVAL OF DATA AND OTHER INFORMATION

These data sets contained in the data management system make Cascabel.mdb a comprehensive geo-spatial database. One-to-one or one-to-many relationships are created within all the tables on the system, with established relationships enabling a user to move data from more than one table to satisfy a request for information request. The tables are related with each other through pathways and through relationships between any two tables that possess either a one-to-one or one-to-many relationship. Retrieval of data is made by a function of QUERY in the MS Access. A query posed to the data management system by a user navigates through all of the tables to find and list all of the records that satisfy the question asked (Habraken 2000). The format of the query results in the form of a table that can be helpful when further analysis is needed.

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