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August 27, 1990

GRASSLAND AND SHRUBLAND COMMUNITIES ON USDI BUREAU OF LAND MANAGEMENT LANDS IN MONTANA

A Proposal by

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MISSION STATEMENT

The proposed Montana Natural Heritage Program's (MTNHP) grasslands/shrublands ecological classification project (GSCP) on Bureau of Land Management (BLM) lands is a working component of The Nature Conservancy's ecology program in the western United States. The Nature Conservancy program provides key information on plant communities to be used for conservation planning, management, research, and monitoring. Although grasslands and shrublands cover over 75% of the Montana landscape, an exhaustive review of existing information (MTNHP 1990) showed that they are the least documented vegetation types of the state. Therefore, the GSCP is designed to complete the classification over the whole ecological space and to conduct regional correlations of existing classifications. The information provided by the project will be the basis for programs to model the effects of management, global changes, and other variables on the vegetation types and diversity patterns, and their implications for further management and conservation planning. The GSCP reflects general conservation planning, management, and research issues. The project will continue to focus on strong collaborative work with the various state and federal agencies (BLM, USFS, BIA, DOD) and other institutions (e.g. Montana universities) in order to contribute to the development of a tightly integrated state-wide classification system.

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SUMMARY

The proposed research would develop a classification of plant communities (primarily grasslands and shrublands) on BLM lands throughout Montana. Such a classification will be useful in identifying sensitive communities and natural areas where environmental impact from resource manipulations (e.g., domestic grazing; mining) would be minimized. Additionally, the classification would provide a reference system for baseline monitoring of environmental impacts and vegetation recovery and would provide an ecological basis for categorizing environmental variation. The classification would be based on the integration and synthesis of both existing data and newly sampled plots.

INTRODUCTION

A more complete assessment of sensitive plant species and communities would complement the BLM's existing range site characterization process. The proposed work would provide a classification of Montana grassland and shrubland communities on BLM lands that could be used to assess ecosystem sensitivities and potential responses to perturbation.

In addition to the environmental impact assessment applications, the proposed work represents a step towards developing a comprehensive classification of Montana plant communities that will provide land managers and scientists a state-wide perspective of community variation. Such a perspective is invaluable towards making

sound management prescriptions and predictions, designing and interpreting experiments, and identifying areas of critical importance for conservation.

PREVIOUS RESEARCH

Grasslands and shrublands cover over 75 percent of the Montana landscape yet are the most poorly described vegetation types of the state. In contrast, the classification of the forest types of Montana is largely complete. Figure 1 highlights both the vast expanse of Montana grasslands and the sparseness of available detailed community characterizations, particularly in the eastern half of the state. Filling this gap constitutes the primary goal of the proposed project. It is a major and necessary step towards developing a comprehensive classification of all Montana plant communities.

To date, studies characterizing grassland and shrubland communities of Montana have been of limited geographical and ecological scope. The most extensive existing studies include Mueggler and Stewart's (1980) in western Montana, Jorgensen's (1979) and Harvey's (1982) studies in east-central Montana, and Hansen and Hoffman's (1985) work in southeastern Montana. A dissertation describing grassland communities of south-central Montana is currently being completed (by Steve Harvey, Montana State University, Bozeman).

The MTNHP conducted fieldwork (largely on BLM lands) in northcentral and northeastern Montana during the summer of 1990. Vegetation and site data were collected from 124 sites representing a wide-range of grassland/shrubland environments

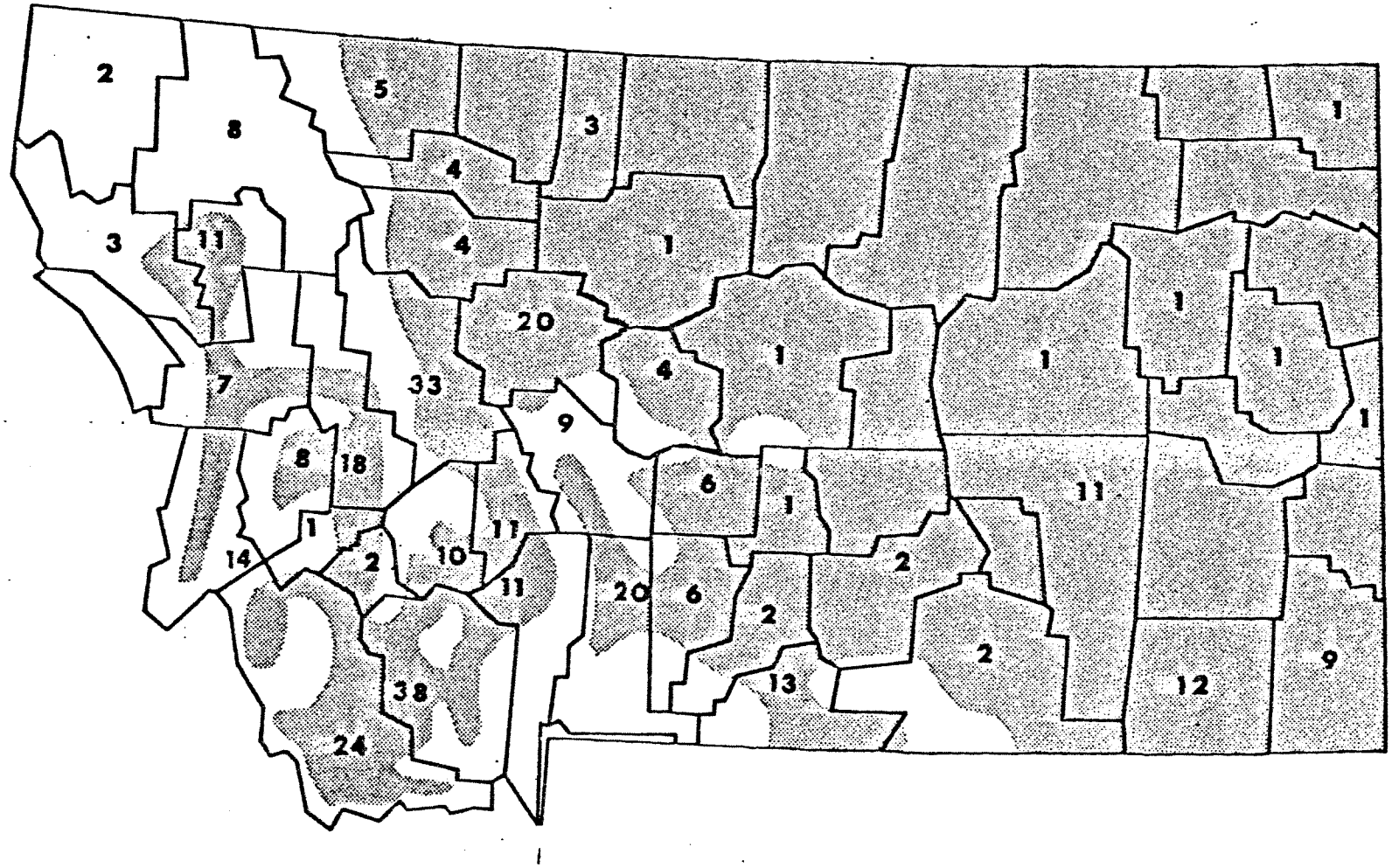

Figure 1. Number of grassland plant community Element Occurrence Records (EOR's) in the Montana Natural Heritage Program database (as of Nov. 21, 1989), by county. The shaded area represents grassland ecoregions of Montana as defined by Omernik (1987).

and species assemblages. These data are currently being analyzed and a report describing the communities and their environmental relations will be completed by November 1990. At present, 22 grassland/shrubland community types have been tentatively identified based on the 1990 data (Table 1).

Relevant grassland/shrubland classifications from adjacent states and provinces include: Coupland (1950; 1961), Girard et al. (1989), Hansen et al. (1984), Whitman and Hanson (1939), and Jones (1989).

The classification of Montana's upland forest plant associations provided by Pfister et al. (1977) has been refined and completed by the work of Cooper and Pfister (1981; 1985), Hansen and Hoffman (1985), Hoffman and Hansen (1981), and Roberts (1980). Classifications of Montana riparian sites (including forested, shrub dominated, and herb dominated communities) are nearing completion (personal communication, Paul Hansen, Montana Riparian Association, School of Forestry, University of Montana, Missoula).

SCOPE OF PROPOSED RESEARCH

Objectives

The proposed research would provide the following:

1) A classification of grassland and shrubland communities on BLM lands in Montana. In addition, undescribed or poorly-known forest and woodland communities will be sampled and classified as good examples are found.

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Table 1. Community types preliminarily identified in northeastern/northcentral Montana based on 1990 MTNHP fieldwork.

Shrublands

Artemisia cana/Agropyron smithii

Artemisia longifolia

Artemisia tridentata/Agropyron smithii
Artemisia tridentata/Agropyron spicatum
Artemisia tridentata-Atriplex confertifolia

Atriplex gardneri

Juniperun horizontalis/Andropogon scoparius

Rhus aromatica/Agropyron spicatum

Sarcobatus vermiculatus/Agropyron smithii
Sarcobatus vermiculatus-Artemisia tridentata

Grasslands

Agropyron smithii
Agropyron smithii-Bouteloua gracilis
Agropyron smithii-Carex filifolia
Agropyron smithii-Stipa viridula

Agropyron spicatum-Agropyron smithii
Agropyron spicatum-Bouteloua gracilis
Agropyron spicatum-Carex filifolia
Agropyron spicatum-Poa sandbergii

Andropogon scoparius-Muhlenbergia cuspidata

Calamovilfa longifolia-Agropyron smithii

Stipa comata-Bouteloua gracilis
Stipa comata-Carex filifolia

2) Descriptions of the floristic, geographic, and physiographic features of each community.

3) Relevant information regarding such features as successional trends, site productivity potential, and potential sensitivities to a range of perturbations.

4) Descriptions of the location and characteristics of high priority communities and sites for conservation.

Expected Significance

The BLM would find a classification of grassland and shrubland communities useful in stratifying vegetation/environmental variation to assess management options and results. Additionally, the classification will assist in minimizing impacts from intensive management by identifying sensitive plant communities.

One function of the MTNHP is the development of a statewide database of plant community occurrences. A major limitation is the current lack of a comprehensive grassland/shrubland community classification. The proposed work would be a significant step towards achieving such a comprehensive classification.

Relation to Longer-Term Goals

The BLM would find a state-wide grassland/shrubland community classification useful as a reference system for baseline monitoring of ecological impacts and assessing vegetation recovery following disturbance. Additionally, the classification would be useful as a tool for predicting long-term vegetation responses to management activities.

One of the functions of the MTNHP is to provide information to The Nature Conservancy regarding communities and sites for conservation. A statewide classification of Montana vegetation (including grasslands/shrublands) is necessary to define and identify key elements and sites for potential long-term preservation. Similarly, the BLM could use the classification for the identification and design of Areas of Critical Environmental Concern (ACEC's). For example, by using vegetation community as a data theme within a Geographic Information System (GIS), preserves could be efficiently designed to contain the range of community/environmental patterns of an area. Such capability is invaluable towards global biodiversity preservation.

Relation to Present State of Knowledge

Existing classifications and data inadequately describe the grassland and shrubland communities of Montana. Major additional field

sampling (as proposed here) is necessary before a comprehensive grassland/shrubland community classification can be developed.

METHODS

Prior to initiating field sampling, data from previous research and range site data will be used to develop a preliminary classification of Montana's grassland/shrubland communities. A preliminary listing of grassland and shrubland communities for all of eastern Montana has already been compiled by the MTNHP (Table 2). This list will be refined and reevaluated in reference to all of Montana to provide an initial perspective of community species composition and diversity.

To maximize the efficiency in sampling the range of vegetation and environmental variation, field samples will be subjectively selected using the "gradsect" method described and evaluated by Gillison and Brewer (1985) and applied by Austin and Heyligers (1989). The method involves preferential sampling along local transects following the maximum perceived environmental gradients. Representation of the range of moisture, temperature, radiation, and soil nutrient regimes on BLM lands in Montana will be emphasized.

In the office, a regular grid with 0.01° (approximately 0.3 mi^2) spacing in both longitudinal and latitudinal directions will be overlayed on 7.5 minute USGS topographic maps covering BLM lands. Land-use maps will be used to determine which grid cells fall on farmed and urban/industrial areas and these cells will not be examined further. The following will be recorded for each of the remaining grid cells:

Table 1. Relationship of preliminary eastern Montana grassland plant communities identified by the MTNHP to previous classifications. Riparian and tundra communities are not included.

other[1]	Brown 1971	Mackie 1970	Dusek 1971	Jorgens. 1979	Harvey 1982	Cul./Scow 1982	Culwell 1986	Progers 1978	Hansen 1965	Mus./Sta. 1940	MTNHP
Arnd. '73 Cou. '50	•	•	•	•	•	•	•	•	•	•	Agsm
•	•	•	•	•	•	Agsm/Bogr/ Buda	•	Agsm/Bogr	•	•	Agsm-Bogr
•	•	•	•	•	•	•	Elam/Bogr/ Caft	•	Agsm/Caft	•	Agsm-Caft
•	•	•	•	•	Agsm/Bivi	•	Bico/Bivi	Bivi-Agsm/ Bogr	•	•	Agsm-Bivi
•	•	•	•	Agsp/Agsm	•	•	•	•	•	Agsp/Agsm	Agsp-Agsm[2]
•	•	•	•	•	•	•	•	•	Agsp/Bocu	•	Agsp-Bocu
•	•	•	•	•	Agsp/Bogr	•	•	Agsp/Bogr	•	Agsp/Bogr	Agsp-Bogr[2]
•	•	•	•	•	•	•	•	•	Agsp/Caft	•	Agsp-Caft[2]
•	•	•	•	•	•	•	•	Mucu/Agsp	•	•	Agsp-Mucu[2]
•	•	•	•	•	•	•	•	•	•	Agsp/Poas	Agsp-Poas[2]
+/- Tay. '76	•	•	•	•	•	•	•	•	•	•	Ange
Tay. '76	•	•	•	•	•	•	•	•	•	•	Ange-Anac
•	•	•	•	•	•	•	•	Anac-Agsp	•	•	Anac-Agsp
•	•	•	•	•	•	•	Calo/Anac	Anac-Calo	Anac/Caft	•	Anac-Caft
•	•	•	•	•	•	Anac/Caha/ Bocu/Calo	•	•	•	•	Anac-Caha
•	•	•	•	Mucu/Anac	•	•	•	•	•	•	Anac-Mucu
Bog. '84	•	•	•	•	•	•	•	•	•	•	Calo-Agsm
+/- Ros. '73	•	•	•	•	•	•	•	•	•	•	Calo-Anha
•	•	•	•	•	•	•	Calo/Caft	•	•	•	Calo-Caft
•	•	•	•	•	•	•	•	•	Calo/Caha	•	Calo-Caha

Table 2. (continued)

other	Brown 1971	Mackie 1970	Dusek 1971	Jorgens. 1979	Harvey 1982	Cul./Scow 1982	Culwell 1986	Rogers 1978	Hansen 1985	Mus./Sta. 1980	MTNHP
•	•	•	•	•	•	•	•	•	•	Feid/Agca	Feid-Agca
•	•	•	•	•	•	•	•	•	•	Feid/Agsm	Feid-Agsm
•	•	•	•	•	•	•	•	•	•	Feid/Agsp	Feid-Agsp
•	•	•	•	•	•	•	•	•	Feid/Cahe	•	Feid-Cahe
•	•	•	•	•	•	•	•	•	•	Feid/Casc	Feid-Casc
•	•	•	•	•	•	•	•	•	•	Feid/Stri	Feid-Stri
•	•	•	•	•	•	•	•	•	•	Fesc/Agsp	Fesc-Agsp
•	•	•	•	•	•	•	•	•	•	Fesc/Feid	Fesc-Feid
•	•	•	Stipa (in part)	•	Stco/Bogr	Stco/Agsm	Stco/Caf/ Bogr	Stco/Bogr-Caf	•	Stco/Bogr	Stco-Bogr
•	•	•	Stipa (in part)	•	•	Stco/Caf/ Kocr	•	•	Stco/Caf	•	Stco-Caf
•	•	•	•	•	•	•	•	•	Stco/Cahe	•	Stco-Cahe

[1]authors describing associations not described by the other authors listed.

[2]Agropyron spicatum community where Stipa comata is often well-represented.

Table 2. Relationship of preliminary eastern Montana shrubland plant communities identified by the MTNHP to previous classifications. Riparian and tundra communities are not included.

other[1]	Brown 1971	Mackie 1970	Dusek 1971	Jorgens. 1979	Harvey 1982	Cul./Scow 1982	Culwell 1986	Progers 1978	Hansen 1985	Mus./Sta. 1980	MTNHP
•	•	•	Arca-Agro	Arca/Agsm	Arca/Agsm	Arca/Agsm	Arca/Elsm	Arca/Agsm/ Bogr	Arca/Agsm	•	Arca/Agsm
•	•	•	•	•	•	•	•	•	•	Arca/Feid	Arca/Feid
•	•	•	•	•	•	•	•	Arca/Stvi-Agsm	•	•	Arca/Stvi
•	•	Arlo	•	•	Arlo/Calo	•	•	•	•	•	Arlo
•	•	•	•	•	•	•	•	•	•	Arar/Agsp	Arno/Agsp
•	•	•	•	•	•	•	•	•	•	Arar/Feid	Arno/Feid
•	•	•	•	Artr/Agda, Agsp ph.	•	•	•	•	•	•	Artr/Agda
•	•	Artr-Agsm	Artr-Agro	Artr/Agsp, Agsm ph.	•	Artr/Agsm	Artr/Elsm	Artr/Agsm/ Bogr	Artr/Agsm	•	Artr/Agsm
•	Artr/Agsp	Artr-Agsp	•	Artr/Agsp, Bogr ph.	Artr/Agsp	Artr/Agsp	•	•	Artr/Agsp	Artr/Agsp	Artr/Agsp
•	Atco-Artr; Artr-Atco-Agsp	•	•	•	•	+/- breaks complex	Artr/Atco; Atco/Artr	Artr bad-lands (in part)	•	•	Artr-Atco
•	•	•	•	•	Artr/Atnu	•	•	•	•	•	Artr-Atnu
•	•	•	•	Artr/Feid	•	•	•	•	•	•	Artr/Feid
•	•	•	•	•	•	•	•	•	•	Artr/Fesc	Artr/Fesc
•	•	•	•	•	Artr/Stco	•	•	•	•	•	Artr/Stco
•	•	•	•	•	Atnu/Agsm	•	•	•	•	•	Atnu
•	•	•	•	•	•	•	•	•	•	Cela/Agsp	Cela/Agsp
•	•	•	•	•	•	Juho side-hill	•	Juho/Arsc-Agsp	•	•	Juho/Arsc
•	•	•	Juho	•	•	•	•	•	Juho/Calo	•	Juho/Calo
•	•	•	•	•	•	•	•	•	•	Pofr/Feid	Pofr/Feid
•	•	•	•	•	•	•	•	•	•	Pofr/Fesc	Pofr/Fesc

Table 2. (continued)

other	Brown 1971	Mackie 1970	Dusek 1971	Jorgens. 1979	Harvey 1982	Cul./Scow 1982	Culwell 1988	Progers 1978	Hansen 1985	Mue./Sta. 1980	MTNHP
•	•	•	•	•	•	•	•	•	•	Putr/Feid	Putr/Feid
•	•	•	•	•	•	•	•	•	•	Putr/Fesc	Putr/Fesc
•	•	•	decid. shrub	•	•	Rhtr/Agsp	•	•	Rhar/Agsp	Rhtr/Agsp	Rhar/Agsp
Cul. '85	•	•	•	•	•	•	•	•	•	•	Rhar/Arnu
•	•	•	•	•	•	•	•	•	Rhar/Cafl	•	Rhar/Cafl
•	•	•	•	•	•	Rhtr/Stco; Rhtr/side-hill	•	•	•	•	Rhar/Calo
•	•	•	•	•	•	•	•	•	Rhar/Feid	Rhtr/Feid	Rhar/Feid
•	•	•	•	Seve/Agda	•	•	•	•	•	•	Seve/Agda
•	•	Seve-Agum (in part)	•	•	Seve/Agum; Seve/Atnu	•	•	•	Seve/Agum	Seve/Agum	Seve/Agum
•	Seve	•	•	•	•	•	•	•	Seve/Agsp	•	Seve/Agsp
•	•	Seve-Agum (in part)	Artr-Seve; Seve	Artr/Agda, Seve ph.	Seve/Artr; Seve/Artr-Atnu	•	Seve	•	•	•	Seve/Artr

[1]authors describing associations not described by the other authors listed.

a) predominant surface geology map unit

b) predominant soil map unit

c) altitude (at center of grid cell)

d) estimated mean annual rainfall

e) estimated solar radiation

Grid cells representing the range of these characteristics within BLM lands will be selected for field sampling to ensure representation of the total environmental variation present. Each sample will consist of one to five plots chosen from different topographic positions and where subjective judgement indicates a marked change in vegetation composition.

To minimize the confounding nature of heavy disturbance on vegetation occurrence, areas severely overgrazed, herbicide treated, mechanically disturbed, artificially seeded, or irrigated will not be sampled. Plots will be established within portions of stands that appear to be relatively uniform in topography and vegetation structure.

Complete taxonomic lists of vascular plants will be recorded within each 375 m^2 circular study plot. Canopy cover classes of each species will be estimated. The data gathered will include completing a Natural Heritage Program Community Survey Form for each plot.

Analysis will focus on using a combination of classification to determine community types, and gradient analyses to describe general patterns of communities/species in relation to environmental factors. Classification will initially

be achieved using the objective TWo-way INdicator SPecies ANalysis (TWINSPAN: Hill 1979a) procedure and cluster analysis (CA: Lance and Williams 1967). The final classification will be based on a combination of the objective analyses, subjective ecological judgement, and consideration of the gradient analysis results.

The gradient analyses will utilize a combination of objective procedures, including DEtrended CORrespondence ANAlysis (DECORANA: Hill 1979b) and Nonmetric MultiDimensional Scaling (NMDS: Ludwig and Reynolds 1988), and subjective graphic descriptions of community/environmental patterns (Whittaker 1967). CANOnical COrrespondence analysis (CANOCO: Ter Braak 1986) and Multiple Discriminant Analysis (MDA: Ludwig and Reynolds 1988) will be used to statistically test the degree the species and communities are related to supplied environmental variables.

OUTPUTS

	Date	Content
A	05/91	Preliminary classification of grassland/shrubland communities on BLM lands in Montana based on existing data and literature.
B	06/91	Descriptions and maps of grid cells selected for sampling in 1991.
C	12/91	Refined preliminary classification of Montana grassland and shrubland communities on BLM lands based on 1991 fieldwork.

D	06/92	Descriptions and maps of grid cells selected for sampling in 1992.
E	04/93	"Final" classification of Montana grassland and shrubland communities on BLM lands including discussion of sensitivities and potential responses to perturbation, and identification of high priority communities and sites for conservation.
F	07/93	Following critical review of Output E by the BLM, the classification will be published. Also, a journal article will be submitted that describes grassland-shrubland community /environmental patterns in Montana.

CURRENT AND POTENTIAL SUPPORT

The Nature Conservancy currently provides salary and limited field-work support for R. DeVelice. A project of the magnitude proposed will require additional personnel for field and office assistance and an expanded travel budget.

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ESTIMATED BUDGET

Project Duration: April 1, 1991 - April 30, 1993

Direct Costs

Salaries and Wages

Robert L. DeVelice, Ph.D.

1991-92, 12 mos., 0.1 FTE	$ 3000	
1992-93, 12 mos., 0.1 FTE	3500	
field assistant		
1991, 3 mos., 1.0 FTE	5000	
1992, 3 mos., 1.0 FTE	5500	
office assistant		
1991, 1 mo., 1.0 FTE	1000	
1992, 1 mo., 1.0 FTE	1000	
Total Salaries and Wages		$19000
Fringe Benefits (approx. 15% Sal. & Wages)		$ 2500
Materials and Supplies		
topographic maps	$ 300	
miscellaneous	500	
Total Materials and Supplies		$ 800

Travel		
fieldwork (5000 mis. @ $0.27/mi.)	$1350	
"Per diem" (20 days @ $25/day)	500	
Total Travel		$ 1850
Total Direct Costs (TDC)		$24150
Total Indirect Costs (circa 30% of TDC)		$ 5850
TOTAL PROJECT COSTS		**$30,000**

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