NPS Inventory and Monitoring Program
USGS National Park Monitoring Project
2004 Request for Proposals on Sampling Design for Invasive Species

Title: Invasive Species in Big Bend National Park: Identification and Verification Using Remotely Sensed Data

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PROJECT DESCRIPTION

Big Bend National Park (BBNP) was established in 1944 to preserve a portion of the Chihuahuan Desert ecosystem (National Parks Conservation Association 2003). The park hosts an array of Chihuahuan Desert shrubland, grassland, high elevation woodland, riparian and wetland areas. BBNP has more than 350 perennial springs which are important to plant and wildlife communities.

The National Parks Conservation Association (NPCA; 2003) assessed BBNP in terms of natural resources, cultural resources, and stewardship capacity. The assessment rated the overall condition of natural resources at BBNP as 62 out of 100. This rating was based on evaluation of more than 120 elements describing environmental quality, biotic health, and ecosystem integrity. The relatively low score reflects the impacts of historic land-use practices, pollution, and threats to biodiversity from pollution and invasive species. The introduction of non-native animals such as feral hogs (*Sus scrofa*), and non-native plants such as tamarisk (*Tamarix* spp.), Johnson grass (*Sorghum halepense*), Russian thistle (*Salsola tragus*), and buffelgrass (*Cenchrus ciliaris*) have degraded natural habitats and reduced biodiversity (National Parks Conservation Association 2003). Invasive species impact natural habitats by disrupting ecological processes and replacing functional roles. For example, invasive species out-compete native vegetation for limited resources, such as water, promote more intense fires and may alter the character of the community enhancing additional invasions (Zavaleta et al. 2001).

A research priority of The National Park Service (NPS) is to identify the occurrence and distribution of invasive species in our national parks and to devise a strategy to eradicate or control them. The National Biological Information Infrastructure has identified over 200 possible invasive plants, and over 100 possible invasive animals in BBNP (http://cswgcin.nbii.gov/index.html). Further, the Intermountain Region (IMR) Inventory & Monitoring Program Managers have recently identified early detection of invasive species inot NPS parks units as a priority for the program. This aspect is important in the development of appropriate long-term monitoring protocols. One potentially cost-effective approach to identify the occurrence of invasive species is to use remotely sensed data to predict their distributions based n knowledge of species ecology and environmental tolerances. Once potential areas of invasive species occurrence are predicted, ground reconnaissance can be more effectively used for verification and eradication. The New Mexico Cooperative Fish and Wildlife Research Unit (NMCFWRU) at New Mexico State University are in a unique position to assist in such an endeavor.

The NMCFWRU is mapping the vegetation of New Mexico as part of the USGS Gap Analysis Program (GAP) (Boykin et al. 2000). GAP is a nation wide ecoregion mapping effort that is generating landscape level vegetation maps for use in conservation planning. As part of this program, NMCFWRU is developing a series of animal models for 652 vertebrate species to predict habitats where these species could occur. This effort is being accomplished by identifying the ecological requirements of these vertebrates using the literature, historic collection sites, and expert opinion, and then integrating these data

with the vegetation map to predict potential species occurrence. Further, the NMCFWRU (with funding from BBNP) has recently completed a change detection project for the Chisos Mountains in Big Bend (Ernst et al. 2004) and, in conjunction with the Department of Fishery and Wildlife Sciences are currently developing alternative conservation strategies for controlling invasive vertebrate species in BBNP (Roemer et al. 2002). Approaches used to model vegetation, predict species occurrence, and address the impacts of exotic species could be applied to predict invasive species occurrence, identify potential sites of infestation, and develop strategies for control. For example, the costs associated with ground-based visits and the size of BBNP preclude the National Park Service from visiting every parcel of land to determine the presence of invasive species. Thus, the use of GIS and remotely sensed data provides a method to efficiently identify and prioritize sites to visit. Identification of distributional pathways, development of sampling designs, and application of risk analysis approaches will then provide the framework for developing conservation strategies to restrict or eradicate invasive species on BBNP.

Objectives:

1) Identify and prioritize a list of invasive species that occurring within Big Bend National Park;

2) Create spatially explicit models of predicted distributions of targeted species using remotely sensed data and geographical information systems;

3) Test the efficacy of spatially explicit models by verifying and quantifying the accuracy of the predicted habitat distributions with actual occurrence based on historic data, and propose potential improvements to the models;

4) Develop a field sampling protocol that will be used to efficiently assay areas for invasive species occurrence, and that will lend itself to adaptive management of invasive species threats to the Park's biological integrity;

5) Identify distribution vectors and pathways for the selected invasive species; and

6) Conduct a regional assessment of risks posed by invasive species to the Park's biodiversity based on above analysis

Methods:

Park Service staff, state and federal agencies, and other knowledgeable parties will be contacted to identify a complete list of all invasive species that occur within Big Bend National Park (e.g., http://cswgcin.nbii.gov/index.html) and surrounding areas; county extension agents will be asked to provide information on priority invasive species in area adjacent to the Park. This comprehensive list will be restricted to species that have the following criteria: 1) considered a priority species by Park Service staff; 2) exhibit

specific habitat requirements or characteristics that can be meaningfully modeled or evaluated by spatial data; and 3) species that have been or are currently undergoing evaluation within BBNP with known spatial locations of occurrence.

Park Service staff, state and federal agencies, and other knowledgeable parties will be contacted to identify physical habitat requirements and characteristics that represent each targeted species. A complete literature review will be conducted on each targeted species to enhance this information (Boykin et al. 2000). Also, the specific seasonal timing needs of satellite imagery will be determined to capture and enhance species detection throughout the landscape (Pickup et al. 1993; Asner et al. 2000; Parker-Williams and Hunt 2004). Spatial data will be acquired and/or created to represent specific requirements and characteristics for each targeted species. Using these associations, predicted habitat models for each targeted species will be generated. These models are identical in approach and structure to the species occurrence models used in GAP analysis (Boykin et al. 2000). For example, if a species requires elevations between 1000-1500 m, and occur on south facing slopes of less than 20% in sandy loam soils, then binary layers (0 = not suitable/1= suitable) representing the spatial occurrences of each variable will be created and then spatially joined in the GIS environment to locate areas of co-occurring habitat characteristics.

Predicted habitat models will be evaluated by current and historic known spatial locations of occurrence for each targeted species (Conroy and Moore 2002). In addition, representative samples of predicted habitats will be ground verified, using a standardized protocol that evaluates model input variables. Based on this assessment, the models can be further refined by incorporating these data through an adaptive iterative process. In [illegible]tion, we will propose improvements to the models by considering relationships between additional variables and invasive species occurrence (Kalkhan and Strohlgren 2000).

Once the models are committed to a working form pending additional adaptive modification, a detailed assessment will be conducted with ground evaluation of a representative sample of predicted habitats. Models will be assessed based on errors of omission and commission (Shrader-Frechetter and McCoy 1993). We will use the predicted distributions of invasive species to simulate the effectiveness of different sampling designs for detection, inventory and monitoring of invasive species. These sampling designs will incorporate demographic considerations, and will be based on an adaptive multi-stage approach, as with sampling designs proposed for monitoring endangered species (Philippi et al. 2001).

Based on predictive habitat modeling approaches and current known distributions of the selected invasive species, we will identify corridors and pathways for the invasive species to expand their range. This will include both an assessment of the specific landscape units and/or habitat types most vulnerable to invasion, and of additional variables that may influence susceptibility of a habitat to invasion. Such variables may include distance to water, prevailing wind direction, occurrences of natural and man made disturbances, neighboring vegetation communities, and topographic and physiographic features and

modes of dispersal. We will use this information to conduct a regional risk analysis (Landis and Weigers 1977; Walker et al. 2001; Andersen et al. in press) to model both the exposure of the biotic resources of BBNP to invasive species, an the effects of potential invasions. This model will likely be a categorical model of low, moderate, or high risk potential for each combination of targeted species and habitat type/landscape unit. This model will provide land managers with predictive tools to evaluate current and future control needs and provide a means to prioritize conservation efforts.

Progress and Final Reporting:

The Cooperative Research Unit and the Department will provide written semi-annual progress reports, annual reports, and a final project report to the sponsor(s). These reports are strategically timed and formatted to facilitate sponsor and collaborator awareness for monitoring project mileposts.

Two semi-annual reports will be submitted in brief format by 15 March 2005 and 2006 to summarize important accomplishments relative to the study objectives, why those accomplishments represent notable progress, difficulties encountered, and an assessment of how project actions meet established timelines. These reports will be transmitted from the field project coordinator directly to the sponsor representative to expedite information transfer. One annual progress report will be delivered to the sponsor(s) by15 October 2005 to describe current project status and summarize data collected and analyzed to date

A draft final report will be submitted to the sponsor(s) for a 30-day review period. Review comments will be incorporated in a revision due as a final report to be provided within 60 days of receipt of review comments from sponsor. The final report will include complete description of background, study area, methods, results, discussion, recommendations, literature cited, and pertinent appendices. Specific emphasis will be placed on providing distinct management recommendations and archiving of key field data in electronic format delivered with the report. GIS data sets will be provided with format and metadata that meet the Federal Geographic Data Committee (FGDC) standards for each dataset created in modeling efforts.

Written, audio-visual, and electronic deliverables will contain a section acknowledging contributions and support by sponsors and collaborators.

Expected Products:

In addition to progress and final reports, we expect to deliver the following products:

1) Spatial models of a prioritized list of invasive species that occur on Big Bend National Park. Models will be delivered in a format usable with most GIS/Remote Sensing software packages.
2) An assessment of the utility of the habitat association modeling compared to existing datasets.
3) Identification and spatial depiction of potential vectors and pathways for invasive species to spread.

4) A risk analysis and probability surface of the current population, the predicted habitat, and the potential pathways of the selected invasive species.
5) Peer review journal manuscript(s) of research results.

All products will be delivered to Big Bend National Park to provide information for invasive species management. The information derived from this project is applicable to other National Parks and the region in general. Successful methods can be applied to other National Parks, and species models will aid in developing monitoring protocols for invasive species.

Project Personnel:

Research Implementation: NM Cooperative Fish and Wildlife Research Unit
Colleen Caldwell, USGS Project Liaison
Kendal Young, Co-Investigator & Project Coordinator
Scott Schrader, Co-Investigator & Project Coordinator
Ken Boykin, Co-Investigator
Department of Fishery and Wildlife Sciences
Mark Andersen, Co-Principal Investigator
Gary Roemer, Co-Principal Investigator
National Park Service
Hildy Reiser, Project Coordinator
Research Staff: Field Technician – to be filled.

Facilities and Equipment:

A fully equipped GIS lab (Center for Applied Spatial Ecology) is available in the New Mexico Cooperative Fish and Wildlife Unit and Department of Fishery and Wildlife Sciences at New Mexico State University. These facilities include current GIS and Remote Sensing software licenses; however, software updates will be needed to complete the project.

Work Schedule:

First Year Tasks	Time Frame
Identify potential invasive species	0 – 2 months
Test the efficacy of remotely sensed data and GIS to identify potential habitat for invasive species	2 – 8 months
Verify model with ground reconnaissance and commit final model	7 – 11 months
Sponsor review of first year report	11 – 12 months

Second Year Tasks	Time Frame
Assess final model for accuracy with ground data and occurrences based on historical data	0 – 3 months
Identify distribution vectors and pathways for the selected invasive species	3 - 7 months
Conduct a potential risk analysis on spread of these species based on above analysis	6 – 11 months
Sponsor review of second year report (final report)	11 - 12 months

Out Year Plans:

Two years are needed to complete all the objectives for this project. Products of the first year include the production of invasive species models and model validation. Second year products include model accuracy assessment and potential risk analysis on the spread of invasive species.

Budget:

	First Year	Second Year
PERSONNEL[1]		
NMSU Undergraduate Technician (includes14% Fringe)	$ 7,650	$ 7,650
NMSU Research Specialist (includes 27% Fringe)	$32,000	$32,000
MATERIALS AND SUPPLIES[2]	$ 1,000	$ 1,000
SERVICES[3]	$ 500	$ 500
TRAVEL[4]	$ 4,500	$ 4,500
DIRECT COSTS	$45,650	$45,650
NMSU INDIRECT COSTS @ 15% [5]	$ 6,848	$ 6,848
TOTAL REQUESTED[6]	$52,498	$52,498

[1]Funds are needed to support personnel at New Mexico State University for 2/3 of their time.
[2] Funds are needed for printing (ink, paper), diskettes, and imagery.
[3] Funds are needed for software GIS and Image Processing site license: Erdas Imagine and ESRI ArcGIS.
[4]Funds are requested for the field work and travel between NMSU and BBNP and includes the cost of a NMSU vehicle @ 44 cents/mile and perdiem.
[5] NMSU Indirect costs at 15% represents a waiver of 22% by New Mexico State University, or, a savings of $ 10,043.
[6] Project sponsor allows costs to exceed project categories as long as the total project costs are not exceeded.

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Paul,

Please find attached a file in WORD that should fit the needs of the NPS
Inventory and Monitoring Program regarding invasive species. Dr. Hildy Reiser, Program Manager of Inventory and Monitoring of the Chihuahuan Desert Network brought this opportunity to our attention. Please note that the research is an excellent example of a collaborative effort among USGS, the National Park Service, and a university (New Mexico State University). Would you please acknowledge receipt of this proposal? We look forward to hearing from you regarding your decision. Thank you for your time and consideration. --Colleen Caldwell

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