

Phase I Workshops and Assistance in the Development of the Phase I Report

Amendment to

**Data Mining and Data Entry for Chihuahuan Desert I&M Network
and
Development of a Vital Signs Monitoring Plan**

Final Report

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Background

Inventory and monitoring of resources administered through the National Park Service (NPS) is conducted through the NPS Inventory and Monitoring Program. To facilitate this goal individual park units have been clustered into groups representing distinctive physiographic regions. The Chihuahuan Desert Network (CHDN) includes seven park units including Amistad National Recreation Area, Big Bend National Park, Carlsbad Caverns National Park, Fort Davis National Historic Site, Guadalupe Mountains National Park, White Sands National Monument and Rio Grande Wildlife and Scenic River (administered by Big Bend NP). The overall goal of the inventory effort is to document the diversity of vertebrates and vascular plants in each park unit. A priority of this effort is to document 90% of the species in each park through verifiable data. NPS maintains a special data base (NPSpecies) to store, manage, and disseminate scientific information about organisms occurring in National Park Service units.

A second goal of the Inventory program is to provide baseline data needed to develop a strategy for monitoring threats and resources in park units. NPS monitoring plans are called Vital Signs Monitoring Plans and are developed according to a 3-phase plan. Phase I culminates in a peer-reviewed, formally approved document that 1) defines goals and objectives, 2) provides initial identification, evaluation, and synthesis of existing data, 3) develops draft conceptual models, and 4) identifies potential “vital signs” that will be the focus of subsequent monitoring efforts. Vital signs are elements or processes that represent the overall health of the park. Development of a Phase I report requires significant knowledge about the organisms and ecosystems of represented park units. Consequently, the development of a Phase I report requires significant data compilation, including inventory results.

A cooperative agreement (CA-1248-00-002) was entered between the Chihuahuan Desert Inventory and Monitoring Network (CHDN) and New Mexico State University (NMSU) on 1 September 2003 for the purpose of “Data mining and data entry for the Chihuahuan Desert I&M Network and development of a Vital Signs Monitoring Plan”. The overall purpose of this cooperative agreement was for NMSU to lend expertise and support to CHDN for the purposes of information gathering and Phase I report preparation. Activities during the first year of the project primarily dealt with Part I of the overall project. Part I consisted of data mining and data entry activities and results were detailed in the Annual Report submitted to CHDN on 31 August 2004 (see Appendix I). In September 2004 CHDN and NMSU entered into a continuation and amendment of the original task agreement titled: “Phase I Workshops and Assistance in the Development of the Phase I Report”. The amendment stipulated a 1 September 2004 project initiation with an emphasis on NMSU assisting CHDN with development of a Vital Signs Monitoring Plan including 1) data compilation, synthesis and review, 2) literature searches, and 3) vital signs workshops. During year 2, work was accomplished concurrently on objectives associated with both Part 1 and Part 2 of the overall project. This report details those activities completed during the second (i.e., final) year of the project, including 1) data mining and data entry, 2) park species checklists, and 3) vital signs workshops.

Timeline of Key Events

Fall Semester 2004

- Preston Hould was hired part time and trained as an undergraduate assistant on the project; he quit the position in early October.
- Lori Lomas was hired at 10 hours per week and trained as the graduate assistant on the project.
- Jennifer Frey continued as the part time project coordinator.

1 September 2004

Initiation of year 2 and the amended task agreement “Phase I Workshops and Assistance in the Development of the Phase I Report”. Work began concurrently on Part 1 (data mining) and Part 2 (vital signs) of the project.

4 October 2004

Meeting Location: New Mexico State University
Park representatives: Hildy Reiser
NMSU representative: Jennifer Frey, Don Caccamise

The purpose of this meeting was to strategize the developing the Phase I monitoring plan. Key points included:

- CHDN would be responsible for reviewing and uploading voucher records resulting from current CHDN inventory projects.
- CHDN would be responsible for obtaining documents needed for developing the draft of Chapter 1.
- Initiated plans for holding scoping meetings with each park
- NMSU would be responsible for conducting a search for literature relevant to modeling Chihuahuan Desert ecosystems.
- NMSU would identify potential subject specialists that could be called upon to assist with reviewing models and documents.
- Duties and a schedule for parks, CHDN, and NMSU were reviewed and discussed.
- Reviewed the outline for the Phase I report.

7 October 2004

NMSU delivered a project summary for the 2004 CHDN administrative report (see Appendix II).

18 October 2004

Meeting Location: New Mexico State University
Park representatives: Hildy Reiser, Bill Reid
NMSU representative: Jennifer Frey

The purpose of this meeting was for further planning of park scoping meetings and writing of Phase I report. In particular, this meeting focused on data/information requests sent to parks and the planning of a preliminary scoping meeting at White Sands National Monument.

15 November 2004

Meeting Location: White Sands National Monument
Park representatives: Hildy Reiser, Cliff Spencer, Bill Conrod, Diane White
NMSU representative: Jennifer Frey

The purpose of this meeting was to conduct a pre-scoping meeting with a park. Objectives were to explain the purpose of the Vital Signs Monitoring program, explain the purpose of the scoping meetings, and receive feedback from the park.

17 December 2004

Meeting Location: New Mexico State University
Park representatives: Hildy Reiser
NMSU representative: Jennifer Frey

The purpose of this meeting was to plan and ready for the upcoming White Sands National Monument Phase I scoping meeting. Additional questions were discussed and added to interview questions sent to park staff. It was agreed that Jennifer Frey would serve as the facilitator at the scoping meeting. It was agreed that Kim Hould's first task would be to conduct an exhaustive literature search for the Phase I report.

20 December 2004

Meeting Location: White Sands National Monument
Park representatives: Hildy Reiser, Cliff Spencer, Bill Conrod, Diane White
NMSU representative: Jennifer Frey

The purpose of this meeting was to conduct a Phase I scoping meeting with White Sands National Monument. Major activities included:

- CHDN provided an overview of the Vital Signs Monitoring program
- Interview questions were reviewed and priority answers were identified.
- Geoindicator scores were reviewed and discussed
- Top ranked vital signs were reviewed and discussed in relation to WHSA
- The park data compilation worksheet was reviewed and discussed.

- Timeline for project completion was discussed

Spring Semester 2005

- Kim Hould hired at 20 hours per week and trained as the graduate assistant on the project.
- Jennifer Frey continued as the part time project coordinator.

24 January 2005

Meeting Location: New Mexico State University
 Park representatives: Hildy Reiser
 NMSU representative: Jennifer Frey, Kim Hould

The purpose of this meeting was to prioritize activities for the spring semester. It was decided that Kim would split her time between completing the literature search and compiling data for creation of park species checklists. Literature search criteria were discussed. Discussion also focused on scheduling and planning for scoping meetings with other parks.

14 March 2005

Literature search for Phase I report was completed.

21 March 2005

Scoping meeting interview summaries completed.

Summer 2005

- Verity Mathis hired and trained as the graduate assistant on the project.
- Jennifer Frey continued as the part time project coordinator.

Data Mining and Data Entry

Part I of the project was to assist with data mining and data entry that would populate the NPSpecies Database with museum voucher records, literature records, and observation records for each park unit within the Chihuahuan Desert Network. The original task agreement enumerated 7 specific activities related to this goal. Accomplishments towards each of those tasks were reported in the 2004 annual report. Here we report additional efforts that occurred during year 2. During this year it was determined that additional data mining and data entry effort should be directed at review of data files posted in the National Park Service Biodiversity Data Store (BDS). The BDS is an archive of miscellaneous files that contain natural history information for National Park units. Included, were files that resulted from a nation-wide Park Service effort to obtain voucher specimen records for park units. At the end of year 1, we were advised that results of the nation-wide museum data mining effort had not been added to the NPSpecies databases as we had assumed. Rather the nation-wide data mining results were simply archived in the BDS. Individual parks or networks were responsible for reviewing the files and having them uploaded to NPSpecies. Thus, it was determined that NMSU would review data mining files in the BDS in order to determine what, if any, data they contained that were relevant to CHDN.

Of the files in the BDS, NMSU initially identified 53 files as potentially having voucher records relevant to CHDN. It also was discovered that the national data mining effort may have duplicated some of the data mining efforts conducted by CHDN. Further, it was determined that some files in the BDS had already been loaded into NPSpecies, although it was not possible to look at the files to determine if the data had already been loaded into NPSpecies. Thus, in order to assure that voucher records would not be duplicated in NPSpecies, it was necessary to review the contents of each file. Files were very large and consisted of complete voucher records, for all taxa, for all parks, contained within a particular museum collection. Consequently, the review involved determining which records were relevant to parks within the CHDN and then comparing file records with records already entered into NPSpecies. In this way, files were identified that contributed unique, new voucher data for CHDN parks. A summary of the status of each of the 53 files is presented in Appendix III. On basis of NMSU's review of the many thousands of records in those 53 files, a total of 14 files were identified as needing upload into NPSpecies. These 14 files, which included a total of 1,981 voucher records, were uploaded into NPSpecies (Table 1).

Table 1. Number of voucher records uploaded to NPSpecies as a result of review of files in the Biodiversity Data Store.

Park Unit	Number Records
AMIS	168
BIBE	958
CAVE	14
FODA	125
GUMO	362
WHSA	354

Summary of Data Mining and Data Entry Accomplishments.—The NMSU data mining effort (Part 1 of project) was efficient and effective. Prior to the start of NMSU’s involvement, there were only 2,720 records in the NPSpecies data base. NMSU reviewed and georeferenced 20,183 voucher specimen and observation records in just the first year of the project. Of those, 10,359 were deemed suitable for conversion into NPSpecies. To this an additional 1,981 voucher records were added during year 2 through review of the nation-wide data mining files archived in the BDS. Thus a total of 12,340 records were added to NPSpecies by NMSU during the course of the entire project.

Park Species Checklists

The purpose of the NPSpecies data base is to store, manage, and disseminate scientific information about organisms occurring in National Park Service units. The data base has two separate, but interconnected primary functions. First, it manages “evidence” concerning the occurrence of species in specific park units. Evidence includes three categories: museum voucher specimens, observations, and literature records. Part I of the project (primarily conducted during year 1) focused on data mining and data entry activities to populate NPSpecies with voucher specimen and observation records. The second major function of NPSpecies is to create and manage checklists of organisms that occur in each park. Besides information on the taxonomy and common name of each species, checklists also provide the following information on each species associated with a park: status, abundance, residency, nativity, cultivation, pest, management priority, and exploitation concern. Park checklists are created and then “certified” for accuracy prior to disseminating to the public.

The preparation and eventual certification of park checklists requires accurate information on species occurrence within each park. Consequently, each name in a checklist must be associated with some type of evidence. CHDN and NMSU acknowledged that different types of evidence vary in reliability. Following extensive discussions between CHDN and NMSU it was decided that park checklists preferentially should be developed based on reference to records contained in biodiversity studies performed by taxon experts. Further, it was decided that published, peer-reviewed work was preferential to unpublished reports and other types of “gray” literature. Such works provide the most reliable information on species occurrence because identification of museum voucher specimens generally is confirmed by the expert and the expert has the knowledge to assess the credibility of observations and other reports that lack physical evidence. In contrast, checklists developed based on museum records, observations, unpublished reports, and studies performed by non-taxon experts lack the same degree of rigor and credibility. Use of museum records was deemed less appropriate because accurate identification of specimens is not guaranteed and museums routinely caution that identifications and associated data need to be verified by the user prior to use. Consequently, CHDN and NMSU sought to locate appropriate literature containing species occurrence records for each park.

After gathering available literature, it became clear that the quality and quantity of literature varied considerably by taxon and park. Thus, references were prioritized for entry into NPSpecies. Those with first priority included accessible published works by taxon experts. Secondly, references were included that could be used to populate the species names associated with each park. Data entry for the creation of checklists a time consuming process involving multiple steps. In order to make the creation of park checklists as time efficient as possible, it was decided to enter checklist data directly into the on-line version of NPSpecies rather than using the desktop version with subsequently submission of up-load material to Fort Collins. These activities resulted in population park checklists with a total of 4,475 species names associated with 38 references. A summary of the number of new references and species

names associated with each park is in Table 2. A list of references utilized and the number of species names associated with each is in Appendix IV.

Table 2. Number of species names in park checklists associated with new references for each park.

Park	References	Number of Species
AMIS	8	498
BIBE	4	1,136
CAVE	3	512
FODA	4	619
GUMO	24	2,420
WHS	5	290

Development of a Vital Signs Monitoring Plan

Part 2 of the original contract between CHDN and NMSU included five specific tasks towards NMSU assisting CHDN with the development of a Vital Signs Monitoring Plan. This part of the project started at the beginning of year 2 of the project and was specifically addressed in the 1 September 2004 contract amendment. Activities related to the development of a Vital Signs Monitoring Plan were the primary project activities during year 2 of the project. Below are listed each of the five tasks.

1) Conduct data compilation, synthesis and reviews

Data mining and data entry activities for populating the NPSpecies evidence data bases was primarily conducted through part 1 of the project during the first year. Additional evidence data mining and data entry occurred during year 2 of the project to help facilitate the overall goals of developing a Vital Signs Monitoring Plan. Those activities involved the review and upload of nearly 2,000 additional voucher records as described above under “Data Mining and Data Entry”. These data are available to supplement syntheses provided by species checklists.

Identification of appropriate vital signs for monitoring requires thorough knowledge of the organisms present in each park. Species checklists provide a convenient compilation, synthesis, and review of the status of biodiversity in each park. Thus, development of park specific species checklists was determined to be a critical element in the development of a network monitoring plan. Details of park species checklist preparation is described above under “Park Species Checklists”.

2) Conduct literature searches and synthesis

NMSU conducted an exhaustive literature search to find published references of relevance to the development of the Phase I report. All searches were conducted using SciSearch, a powerful on-line library search engine for published peer-reviewed papers in science. A total of 490 individual searches involving 44 separate words or phrases were performed. These searches resulted in the return of 24,130 published papers. Titles and abstracts of returned papers were reviewed for relevance to the project. A total of 94 published papers were determined to be potentially relevant. Details and results of the search, including citations and abstracts of all potentially relevant papers, were delivered to CHDN.

3) Assist with vital signs workshops

During Fall 2004 and winter 2005, CHDN and NMSU engaged in numerous face-to-face, email, and phone meetings concerning the development of a Phase I report. Highlights of some of these meetings are detailed above under “Timeline Key Events”.

For reasons beyond the control of CHDN or NMSU, many of the plans and scheduled timelines were not realized. An important aspect of these plans concerned holding scoping meetings with each park. Scoping meetings were to provide an avenue by which the network could determine and assess issues relevant to each park. CHDN and NMSU hosted both a pre-scoping meeting and a trial scoping meeting with White Sands National Monument during November and December 2004 (see Timeline above for details). No additional CHDN-NMSU-park unit scoping meetings occurred. Rather, to generate park specific information, CHDN conducted interviews with staff at each park. Results of staff scoping interviews were then submitted to NMSU. NMSU reviewed and compiled the questionnaire/interview answers in spreadsheet format and delivered the compilation to CHDN.

4) Assist with design of monitoring protocols

Due to unavoidable circumstances, this portion of the Phase I report was postponed by CHDN. Thus, no activity with regards to this task occurred.

5) Assist with ecosystem modeling

Due to unavoidable circumstances, this portion of the Phase I report was postponed by CHDN. Thus, no activity with regards to this task occurred.

APPENDIX I

(2004 Draft Annual Report)

**Data Mining and Data Entry for Chihuahuan Desert I&M Network
and
Development of a Vital Signs Monitoring Plan**

Draft Annual Report

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Introduction

A cooperative agreement (CA-1248-00-002) was entered between the Chihuahuan Desert Inventory and Monitoring Network and New Mexico State University on 1 September 2003 for the purpose of “Data mining and data entry for the Chihuahuan Desert I&M Network and development of a Vital Signs Monitoring Plan”. Activities during the first year of the project primarily dealt with the data mining and data entry component of the project. The contract with NMSU stipulated 7 specific activities for the completion and certification of NPSpecies and natural resources databases. These included:

1. Enter, clean, and certify voucher data that had been partially entered into NPSpecies by Texas Tech University and network technicians. Only records within 1 mile of a park boundary were to be included. There was an estimated 6000 records.
2. Locate, enter, and certify data from regional museums into NPSpecies.
3. Enter exotic plant management data into the Alien Plant Control and Monitoring database and NPSpecies.
4. Enter and certify park natural resources observation cards in NPSpecies.
5. Enter and certify biological inventory data from current inventory projects.
6. Enter literature data into NatureBib.
7. Describe important park datasets in the Dataset Catalog.

Timeline of Key Events

8 October 2003

Dr. Jennifer Frey was hired as a salaried (0.5 full-time equivalent) faculty to implement the project.

15 October 2003

Meeting Location: White Sands National Monument
Park representatives: Hildy Reiser, Dave Roemer
NMSU representatives: Don Caccamise, Jennifer Frey

This was the initial meeting between the park network and NMSU for the purpose of reviewing and discussing specific tasks for the completion and certification of NPSpecies and natural resources databases. Key activities with respect to the initial tasks included:

- 1) NMSU was provided a brief overview about the NPSpecies database and previous data mining activities. The network agreed to provide NMSU with available data and documents from the Texas Tech University data mining effort. The network agreed to provide NMSU instruction on the extent of a boundary buffer zone for inclusion of

voucher records into NPSSpecies. The network agreed to provide NMSU with park maps and GIS data.

- 2) The network agreed to obtain information on what collections had previously been contacted for voucher records. NMSU agreed to inform the network when NMSU was ready to deal with new voucher record data from regional museums that had not been included in the Texas Tech University data mining effort.
- 3) The participation of NMSU in the exotic plant management data task was put on hold. The network agreed to communicate with the exotic pest management program director for guidance.
- 4) It was decided that individual parks were responsible for filtering observation card records and were to provide NMSU with summary reports for entry data mining purposes.
- 5) NMSU was instructed that the network would be responsible for delivering data and reports of current inventory projects.
- 6) NMSU was briefed on Naturebib and a comprehensive park service literature survey that occurred in 1994-1995. The network agreed to instruct individual parks to compile relevant literature and to flag literature that contains occurrence records; the parks were then to submit this information to NMSU for entry.
- 7) NMSU was instructed that entering park datasets into the Dataset Catalog was put on hold.

In addition to these specific task related discussions, other significant communication included 1) a network data manager would be hired who would oversee the data effort; this position was anticipated to begin 4 February 2004; and 2) herbarium specimens were to be certified by a botanist.

7 November 2003

Meeting location: New Mexico State University
Park representatives: Hildy Reiser, Bill Reid, Fred Vogt
NMSU representatives: Don Caccamise, Jennifer Frey

The purpose of this meeting was to provide NMSU with a review of previous data mining and NPSSpecies entry efforts, especially as related to the data mining effort conducted by Texas Tech University. Key points included:

- NMSU was provided 1) a disk containing raw data gathered during the Texas Tech data mining effort and other miscellaneous files, 2) a notebook from Fred Vogt containing his

hardcopy paper trail of his efforts to verify and enter voucher data provided by Texas Tech, and 3) a disk containing GUMO observations.

- Entry of herbarium data from GUMO was put on hold until ANCS+ catalog numbers are made available. Identifications of plant specimens were verified by a botanist.
- Entry of the CAVE mammal collection was put on hold until ANCS+ catalog numbers are made available. Entry into ANCS+ is awaiting confirmation of identifications.
- NMSU was briefed by Fred Vogt on the process of reviewing and verifying voucher records obtained by Texas Tech. NMSU was advised that approximately half of the data files prepared by Texas Tech posed a significant problem.
- The network agreed to inquire about the status of a national datamining effort.

18 December 2003

Meeting location: Fort Collins, Colorado

Park representatives: Simon Kingston

NMSU representatives: Jennifer Frey

The purpose of this meeting was to brief and train NMSU on NPSpecies and the certification process.

January 2004

A graduate student assistant was hired part time (10 hours per week) to assist with project tasks.

April 2004

Review of data provided by Texas Tech University was completed (Task 1).

20 April 2004

Meeting location: New Mexico State University

Park representatives: Hildy Reiser, Bill Reid

NMSU representatives: Don Caccamise, Jennifer Frey

The purpose of this meeting was 1) for NMSU to update the network on progress and problems, and 2) to reevaluate the direction of the data mining project based on an improved understanding of the project scope by both NMSU and the network. See Appendix 1 for the NMSU update report. Based on the reevaluation, the following decisions were made:

- 1) At the time of this meeting NMSU was near completion of major data verification tasks outlined as a priority at the 15 October and 7 November meetings. It was decided that upon completion of those tasks, NMSU would switch priorities to obtaining and verifying voucher records from regional museums in New Mexico.
- 2) NMSU was instructed to make the obtaining and verifying voucher records from regional museums in New Mexico a priority. NMSU was charged with contacting appropriate curators for access to relevant data.
- 3) The network agreed to communicate with the exotic pest management program for guidance. NMSU was instructed to enter these data into NPSpecies once received from the network
- 4) The network agreed to provide electronic observation card data to NMSU. NMSU was instructed to clean and enter observation card data into NPSpecies once electronic files were received from the network.
- 5) The network agreed to review the status of current inventory and monitoring projects in the network and to prepare a spreadsheet of the status of each taxonomic inventory in each park. This was to be forwarded to NMSU. In addition, the network agreed to request that each PI on an inventory and monitoring project complete a literature review; the network was to send each literature review to NMSU. In addition, the network agreed to request ANCS+ databases in Excel format from current inventory and monitoring projects. The network agreed to send the databases to NMSU as they received them from individual parks. The network agreed to provide guidance to NMSU concerning which data should be incorporated into the current NPSpecies effort.
- 6) The network agreed to solicit lists of key historic biodiversity literature for each taxonomic group from the current inventory and monitoring primary investigators. The network would then forward this information to NMSU for entry into NPSpecies. NMSU was instructed to only include literature used for occurrence records into NatureBib.
- 7) The Inventory and Monitoring Dataset catalog continued to be placed in hold.
- 8) Other

In addition to these revised tasks that relate to the original activities stipulated in the contract, NMSU was asked to clean and enter existing ANCS+ data maintained by individual parks into NPSpecies. The network agreed to request the ANCS+ data from each park in Excel format and individual parks were to be asked to bring the data to the meeting during the week of 26 April. Parks were to be given a one month deadline to deliver the data to the network. The network was then to forward the Excel data to NMSU for entry into the NPSpecies system. NMSU agreed to confirm that FODA ANCS + data were previously entered into NPSpecies.

15 June 2004

Meeting location: White Sands National Monument

Park representatives: Hildy Reiser, Diane White

NMSU representatives: Jennifer Frey

The purpose of this meeting was to brief the network and NMSU on protocols and methods used by individual parks for cataloging specimens and entering data into ANCS+.

23 August 2004

Meeting location: New Mexico State University

Park representatives: Hildy Reiser, Bill Reid

NMSU representatives: Don Caccamise, Jennifer Frey

The purpose of this meeting was to discuss specific activities outlined in the contract for the development of the vital signs monitoring plan. The network requested that NMSU assist with a series of workshops to initiate development of monitoring plans. This would include one meeting at each park and 2 to 3 joint meetings with experts. NMSU was also asked to assist with the writing of the Phase I report. NMSU agreed to assist with these efforts as possible.

Status of Activities

As of 1 September 2004, the current status of each of the originally contracted 7 specific activities is summarized below:

1. Enter, clean, and certify voucher data that had been partially entered into NPSpecies by Texas Tech University and network technicians.

With the exception of certification, NMSU has completed this task (see Table 1). This task was identified as the first priority during the 7 November scoping meeting. The initial steps towards the completion of this task required deciphering and reconstructing previous data mining efforts by Texas Tech University and park personnel. To assist with this effort, NMSU was given a disk containing 113 folders and 373 files; no metadata accompanied these files. In addition, NMSU was given a folder containing a hard copy trail of a previous park service effort to clean and enter the TTU data. First, NMSU had to organize the material and decipher what had previously occurred in order to make a plan for continuing and completing the task. The second step was a spot-check the accuracy of data that had previously been entered into NPSpecies as part of the data mining effort. NMSU found that while all records that had been reported to have been entered into NPSpecies were in fact entered, a small proportion contained errors. No effort was made to correct the errors found. The final step of this process was the review all records that had not been previously reviewed. NMSU reviewed a total of 5,036 voucher records that had been included on the TTU disk and that had not been reviewed or entered during previous efforts. The process involved reviewing the record for accuracy and

utility as an occurrence record, and georeferencing to within 1.0 miles of a park boundary. Georeferencing was completed, by hand, with the aid of a computer mapping program provided by NMSU. Once a set of data was reviewed and georeferenced, the file was sent to Fort Collins for conversion to NPSpecies format.

2. Locate, enter, and certify data from regional museums into NPSpecies.

After task 1 was completed in spring 2003, the 20 April 2003 scoping meeting set task 2 as the next priority for completion. The network made NMSU responsible for contacting appropriate curators at regional museum (i.e., Eastern New Mexico University, Western New Mexico University, New Mexico State University) to request voucher records from each park. Voucher records of plants, invertebrates, and vertebrates were requested from counties containing park units (see Appendix II for a copy of a letter that was sent). Eastern New Mexico University, which is nearly fully computerized, sent 6,831 records to NMSU for review (see Table 1). The review and georeferencing of this dataset was completed in August 2004. Review and georeferencing of this large dataset was time consuming and only resulted in the acceptance of 103 records (1.5 % of records reviewed) for conversion to NPSpecies. Thus, cost-benefit ratios should be considered when prioritizing future tasks. Western New Mexico University, which is also largely computerized, sent NMSU 9 files of voucher records. NMSU is currently in the process of reviewing and georeferencing these records. The NMSU collections are more problematic because they are less fully computerized. For example, the NMSU herbarium is only about 50% computerized (D. Bailey personal communication). The herbarium recommended that we visit the collection and perform our own searches. The bird and mammal collections are also not fully computerized. For example, mammals are only partially computerized and localities are only entered to county. Thus, a review of these records will first require having personnel review hard copy card catalogs and enter data into an electronic format. A similar situation exists with the NMSU amphibian and reptile collection. We were sent an unsorted database of 6,958 amphibian and reptile records. However, the database is largely unusable because specific locality data are not included. To further complicate this situation, the curator of the NMSU amphibian and reptile collection has recently left his position and no one has been appointed to fill this role.

3. Enter exotic plant management data into the Alien Plant Control and Monitoring database and NPSpecies.

This task was put on hold during both the 15 October and 20 April scoping meetings. As of 1 September 2004 no exotic plant management data had been delivered to NMSU for review.

4. Enter and certify park natural resources observation cards in NPSpecies.

NMSU reviewed a total of 7,564 observation card records in electronic format from GUMO (see Table 1). Of these, a total of 7,330 records were accepted and sent for conversion to NPSpecies format. NMSU has received no other observation card data for review and entry.

5. Enter and certify biological inventory data from current inventory projects.

During the 20 April scoping meeting, it was decided that the network would be responsible for forwarding datasets from current inventory projects to NMSU for review and entry into NPSpecies. As of 1 September 2004, 2 files had been received by NMSU for review. One file included 28 amphibian and reptile vouchers collected during the current I&M project on WHSA (see Table 1). This file was reviewed and sent for conversion to NPSpecies. An additional file of 65 mammal vouchers from the current I& M project at GUMO was also received by NMSU. However, this file has not been reviewed or sent for conversion because it contains neither museum catalog numbers nor ANCS+ numbers. At least one of these unique numbers must be provided before it can be entered into NPSpecies.

6. Enter literature data into NatureBib.

During the 15 October scoping meeting, the network agreed to instruct individual parks to compile relevant literature and submit this information to NMSU for entry. NMSU did not receive any literature from individual parks. During the 20 April scoping meeting, the network agreed to solicit lists of key historic biodiversity literature from the current inventory and monitoring primary investigators and forward this to NMSU. Such information has not been forwarded to NMSU. However, the network has independently forwarded several pieces of literature to NMSU. Literature used to document the occurrence of species in specific parks that is used for the certification process will be entered into NatureBib. Certification is scheduled to begin in September 2004.

7. Describe important park datasets in the Dataset Catalog.

During the 15 October and 20 April scoping meetings, NMSU was asked to put this task on hold. No activity with regards to this task has occurred as of 1 September 2004.

8. Summary of Data Mining

The NMSU data mining effort has been efficient and effective. As of 1 September 2004, NMSU had reviewed and georeferenced 20,183 voucher specimen and observation records (See Table 1). Of those, 10,359 were deemed suitable for conversion into NPSpecies. To put these numbers into perspective, network records indicated that there were a total of 2,720 records as of 12 August 2003, just prior to initiation of the NMSU effort. Thus, in much less than one year, NMSU succeeded in quadrupling the evidence for species occurrence in network parks.

Other Tasks Completed

1. NPSpecies database and certification training

The primary, ultimate objective of the data mining effort was to populate and certify the NPSpecies database. At the inception of the project, the Chihuahuan Desert Network lacked significant expertise on the NPSpecies database and the certification process. Consequently, during Fall 2003, NMSU personnel attempted to understand the system and concepts and learn the software utilizing information available on the internet. However, this proved to be inefficient and ineffective. As a result, a representative from NMSU traveled to the National Park Service NPSpecies and Inventory Office in Fort Collins for a briefing and personal instruction. One crucial outcome of this meeting was that it became apparent that the network had a fundamental misunderstanding of the concept of “certification”. The network had been approaching certification as a process of verifying each record uploaded into NPSpecies. Thus, the original contract stipulated that each voucher or observation record was to be certified. In fact, certification is a quality assurance procedure for verifying checklists of species for each park. Park checklists are created using NPSpecies software and contain a variety of information about each species listed for a park (e.g., relative abundance, management status). Checklists summarize information gathered during inventory projects and other incidental studies. The NPSpecies database of observation and voucher records is important to the process of certifying checklists in that those records provide evidence for a species occurrence within a park. Thus, development of certified species checklists is best completed with a maximally populated NPSpecies database. Consequently, preparation and certification of park checklists was scheduled to begin in Fall 2004, after major data mining efforts had been completed.

2. Literature review

Peer-reviewed, published floral and faunal surveys were identified as particularly important to the development and certification of park checklists. However, as of 1 September, few (< 10) papers have been delivered to NMSU from the network. No literature has been sent to NMSU by either the individual parks or inventory principal investigators. Consequently, NMSU undertook a literature search for each major taxonomic ground and each park. Standard electronic databasing resources available at the NMSU library were used to perform the searches. Unfortunately, these searches resulted in very few papers of relevance to the project. It is very possible that important relevant papers have been published in outlets that are not routinely covered by academic library search engines. Thus, there continues to be a need for relevant literature to be forwarded from the parks, network, and principal investigators.

3. Assistance and Consultation

NMSU provided assistance and consultation for several important issues. This included perspectives on voucher specimen collection, roles and function of university museums, database formats for voucher specimens resulting from inventory projects, the certification process, issues involving NPSpecies databasing, and others.

Issues and Future Direction

1. ANCS+

The Automated National Catalog System (ANCS+) is the National Park Service databasing program for cataloging and providing unique numbers to specimens maintained in park collections (or those on permanent loan originating from park collections). There was considerable confusion over the relationship between the ANCS+ and NPSpecies databases. Partial clarification was gained through a meeting between park representatives and NMSU held at White Sands National Monument. In addition, these issues have largely been resolved due to recently upgraded software capabilities in NPSpecies. Currently it is possible to enter park voucher data into NPSpecies in such a way as to also enter it into the ANCS+ system. This eliminates considerable redundancy in data entry. Further, the network has developed a flow chart for proper processing of voucher material stemming from current inventory projects. This should help to streamline the process of data entry. Further, older specimens contained in non-park museum collections are not required to be entered into the ANCS+ catalog.

2. Overlap in data mining and data entry efforts

There has been redundancy in data mining and data entry activities. Individual parks and the network have been engaged in various data mining and data entry activities, especially through the previous efforts of Texas Tech University and the current efforts of NMSU. Some of these activities have resulted in duplicated records in NPSpecies. However, the extent of current duplication in the database is unknown. More recently, the park service has conducted a single nationwide data mining activity to extract available voucher data from all major museums. These data are currently being georeferenced before being made available for populating NPSpecies. Currently, only 26 of an approximate 70 files have been georeferenced and made available. Given the previous data mining efforts by the parks and network, it is very likely that some unknown fraction of the data available through the national effort will be duplicates of data already entered into NPSpecies. The preparation and certification of park checklists is best done with a maximally populated NPSpecies database. Thus, it must be determined if the available files will be uploaded in their entirety or if each record within each file will be checked for redundancy. Checking each record for redundancy would be a very time consuming task.

3. Checklist preparation and certification.

The preparation and certification of park checklists requires a maximally populated NPSpecies database and appropriate floral and faunal literature. Consequently, initiation of this task was scheduled to begin in early Fall 2004, after major data components had been added and current inventory results were available. Although training was conducted on an old version of NPSpecies, the final checklist preparation and certification will be completed on the new version of NPSpecies. Data sets delivered for conversion to NPSpecies last spring already have been converted to the new version of NPSpecies.

4. Development of a Vital Signs Monitoring Plan.

In addition to the data mining and checklist certification, the contract also included 5 specific tasks towards assisting the network with the development of a Vital Signs Monitoring Plan. This phase of the project had not been discussed until the scoping meeting of 23 August 2004. Consequently, a time budget for these activities had not been worked out in conjunctions with the data mining and checklist preparation/certification tasks. These five tasks and their current status are:

- Conduct data compilation, synthesis and reviews

Data mining activities as part of phase 1 has provided significant new records. Compilation and synthesis of available data will occur with the checklist preparation and certification activities scheduled to begin 1 September.

- Conduct literature searches and synthesis

Literature searches regarding flora and fauna of each park have been completed by NMSU at their own initiation. However, as of 1 September 2004, little (< 10 references) additional literature information has been sent to NMSU by parks, principal investigators, or the network.

- Assist with vital signs workshops

As of 1 September 2004, the scope and nature of NMSU's participation in vital signs workshops has yet to be determined. Because of the potentially high time demands of this activity, priorities for NMSU time must be made in relation to databasing and certification activities stipulated in phase 1.

- Assist with design of monitoring protocols

No activity with regards to this task has occurred as of 1 September 2004. This task is dependant on completion of antecedent tasks.

- Assist with ecosystem modeling

No activity with regards to this task has occurred as of 1 September 2004. This task is dependant on completion of antecedent tasks.

Budget Summary

The total project budget awarded to NMSU was \$85,000. Through July 2004 total expenses were \$41,458. Of this, \$35,069 was for personnel including a 0.5 time academic position with benefits, a 0.25 time graduate student assistantship during Spring 2004, and an irregular specialist during Summer 2004. In addition, there was \$851 in domestic travel, \$107 in computer software (map program), \$24 in office supplies, and \$5,408 in indirect costs.

Table 1. Data reviewed, georeferenced, and prepared for NPSpecies conversion by NMSU to 1 September 2004.

File	Park	Taxon	Source	Records Reviewed	Records prepared for NPSpecies conversion
1	CAVE	mammals	CAVE	655	393
1	BIBE	herps	TCWC	562	562
1	FODA	herps/birds	TCWC/MVZ	78	65
1	WHSA	birds	MVZ	51	37
subtotal				1,346	1,057
2	BIBE	mammals	DMNH	934	6
2	WHSA	herps	FMNH	103	10
2	CAVE	herps	FMNH	1	1
2	WHSA	herps	FMNH	63	42
2	BIBE	herps	FMNH	485	402
2	AMIS	herps	FMNH	1,060	69
2	FODA	herps	FMNH	22	1
2	AMIS	herps	FMNH	14	1
2	WHSA	herps	FMNH	12	0
subtotal				2,694	532
3	WHSA	birds	UMMZ	6	2
3	FODA	birds	UMMZ	307	100
subtotal				313	102
4	various	mammals	LAMNH	606	480
5	various	fish	UMMZ	77	37
6	GUMO	various	observations	7,564	7,330
7	FODA	plants	FODA	724	690
8	various	all	ENMU	6,831	103
9	WHSA	herp	I&M	28	28
10	various	various	WNMU	In progress	in progress
TOTAL				20,183	10,359

APPENDIX I

Chihuahuan Desert National Parks Data Mining Update Meeting 20 April 2004

Summary of Activities

October 2003

Dr. Jennifer Frey was hired part time (20 hours per week) to oversee the CDN Data Mining project.

Fall 2003

Several organizational meetings were held between CDN and NMSU personnel to determine project history/status and to establish direction and objectives for the future. Major outcomes included

- The CDN-NMSU contract identified 7 specific tasks to be completed. These tasks were discussed and strategies developed. These included [current status is in brackets]:
 - Enter, clean, and “certify” remaining museum data originally compiled by TTU. This was made the first priority. [completed]
 - Locate, enter, and certify data from other museums. It was decided that museum data would be requested by the CDN. A nation-wide effort is currently underway. [status of CDN effort is unknown; nation-wide data is to become available in April 2004]
 - Enter APCAM data. This task was put on hold. [on hold]
 - Enter observation card data. It was decided that CDN will coordinate this effort. Each park would do an initial filter of these data and provide a summary report that could be entered. [GUMO reptile observations are nearing completion for being uploaded; no additional data has been provided]
 - Enter and “certify” inventory data as received. [only one file (herp inventory annual report) has been received; entry is awaiting voucher /ANCS data]
 - Enter written reports into NatureBib. It was decided that individual parks were to provide this data [no data received]
 - Enter important park datasets into the IMD Catalog. This task was put on hold. [on hold]
- Frey was given 2 sets of data to be entered into NPSpecies. These included a large file created by Texas Tech University that included various museum holdings; some of these data had already been entered into NPSpecies. A large notebook “paper trail” accompanied these files that provided a crude record of what had previously been done. The second dataset included reptile observations from Guadalupe Mountains NP (it did not include GUMO herbarium).

Frey reviewed available literature and software on NPSpecies and the certification process in an attempt to provide self-training. This effort proved to be an inefficient use of time

because of a general lack of knowledge about the broader philosophy and methods of the program and a lack of contacts for questions. It was determined that NPSpecies training would be critical for the success of the project.

17-18 December 2003

Frey traveled to Fort Collins to meet with Simon Kingston for certification training. This meeting provided crucial information about the certification process. Important points were:

- “Certification” is a quality assurance process of verifying individual park checklists and associated fields including status, abundance, residency, nativity, cultivation, weedy, pest, management priority, and exploitation concern. Most networks that have completed this step have done so by hosting workshops of taxon experts. However, the wording of the CDN-NMSU contract indicated a misunderstanding of the certification process. This led to initial confusion about the goals and objectives of the project.
- A nationwide museum data mining effort was being conducted by the national office. It was recommended to Frey that the building and certification of park lists not begin until after these data became available in spring 2004.
- Frey was provided basic training on the steps involved in the building of park lists, the quality assurance process, and NPSpecies software.
- It was recommended that Frey participate in other training workshops that might become available.

January 2004

It was determined that the much of the data entry needs would be most efficiently completed by a graduate student working closely with Dr. Frey. Consequently, a graduate student employee, Brandon Barrett, was hired part time (10 hours per week) to assist with data entry tasks. In conjunction with Dr. Frey, his initial task was to gain familiarity and knowledge about the NPSpecies program. Second, we thoroughly reviewed the existing databases and documents in order to figure out what had been completed previously and what still needed to be done. Frey then prioritized specific tasks for the student employee to begin working on.

Spring 2004

Because it had been recommended that the NPSpecies database be fairly complete prior to initiating the construction and certification of park lists, it was decided that the primary thrust of the project effort during spring would be directed at completing the NPSpecies database. Specific tasks included:

- The TTU data files and other data-related documents were compiled, reviewed, and organized in order to better understand the history and direction of the data mining project. From this effort we were able to establish which data sets had previously been entered into NPSpecies and which still needed to be reviewed, cleaned, and entered into NPSpecies.
- The TTU data previously entered into NPSpecies was spot-checked for accuracy against the original museum data files. A small percentage of errors were detected during this check. Errors primarily included records that were from localities outside of park

boundaries. Other problems consisted of taxonomic name issues. Taxonomy issues in the database will be cleaned during the quality assurance process.

- All remaining TTU museum data that had not been entered into NPSpecies were reviewed for accuracy and georeference. This included a total of 5,429 records reviewed for accuracy and inclusion within a 1 mile buffer zone around park boundaries (when specific locality could be determined).
- Based on the review of TTU data, 5 separate cleaned files including a total of 2,208 park records were sent to Fort Collins for conversion into NPSpecies format. Once converted, Fort Collins will send the files back to Frey for a final check before being uploaded to the on-line NPSpecies database. Fort Collins has not yet returned any of the files.
- Currently, we are reviewing GUMO observation card data (ca 7564 records) for accuracy and georeference.

Future Goals

- Complete review and entry of GUMO observation card data (expected by 10 May).
- Once nationwide data-mining records become available, Frey will begin concerted effort at creating and certifying park lists.
- ?

APPENDIX II

Dear Dr. Bailey

The National Park Service Inventory and Monitoring Program is accumulating data on biological specimens collected from within National Park units in order to better manage and disseminate scientific information on the biodiversity. The Chihuahuan Desert Inventory and Monitoring Network (CHDN) includes six park units in Texas and New Mexico including:

Amistad National Recreation Area: Val Verde Co. Texas
Big Bend National Park: Brewster and Presidio counties Texas
Rio Grande Wild and Scenic River: Brewster and Terrell counties Texas
Fort Davis National Historic Site: Jeff Davis Co. Texas
Guadalupe Mountains National Park: Hudspeth, Culberson Co. TX; Eddy Co. New Mexico
Carlsbad Caverns National Park: Eddy Co. New Mexico
White Sands National Monument: Dona Ana and Otero counties New Mexico

The CHDN would like to request information on any biological specimens from these areas that you have in your holdings. Information at the county level is acceptable. If your collection is computerized, CHDN requests that specimen data be sent via email in electronic format. If your collection is not computerized, CHDN requests permission to visit your collection in order to search catalogs for appropriate records. Thank you for your help.

Sincerely,

Jennifer K. Frey, PhD
Chihuahuan Desert National Parks
Biodiversity Database Coordinator

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Please visit my Southwest Mammal Resource Web Page at:
http://leopold.nmsu.edu/jfrey/southwest_mammal_resource_page.htm

APPENDIX II

(Summary for 2004 Annual Administrative Report)

**Data Mining and Data Entry for Chihuahuan Desert I&M Network
and
Development of a Vital Signs Monitoring Plan**

Summary for 2004 Annual Administrative Report

Prepared by:

Jennifer K. Frey

**Department of Fishery and Wildlife Sciences
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Las Cruces, New Mexico 88003**

Submitted to:

**Dr. Hildy Reiser, Program Manager
Chihuahuan Desert Network
3225 National Parks Hwy.
Carlsbad, NM 88220**

DSCESU Cooperative Agreement CA-1248-00-002

7 October 2004

Summary

A cooperative agreement (CA-1248-00-002) was entered between the Chihuahuan Desert Inventory and Monitoring Network and New Mexico State University on 1 September 2003 for the purpose of “Data mining and data entry for the Chihuahuan Desert I&M Network and development of a Vital Signs Monitoring Plan”. Activities during the first year of the project primarily dealt with the data mining and data entry component of the project. The contract with NMSU stipulated 7 specific activities for the completion and certification of NPSpecies and natural resources databases. These included: 1) Enter, clean, and certify voucher data that had been partially entered into NPSpecies by Texas Tech University and network technicians, 2) Locate, enter, and certify data from regional museums into NPSpecies, 3) Enter exotic plant management data into the Alien Plant Control and Monitoring database and NPSpecies, 4) Enter and certify park natural resources observation cards in NPSpecies, 5) Enter and certify biological inventory data from current inventory projects, 6) Enter literature data into NatureBib, 7) Describe important park datasets in the Dataset Catalog.

As of the end of the first year, NMSU had hired a salaried, part time faculty member to oversee the project as well as several student assistants. Regarding the 7 specific tasks, NMSU completed the review and georeference all data (5036 records) provided by Texas Tech University. Additional records were sought from regional museums; a total of 6876 were reviewed and georeferenced. The exotic plant data task was put on hold by directive of the network. A total of 7,564 observation card records were reviewed and georeferenced. A file of 65 records was received from the network from current inventory projects; these data were reviewed and georeferenced. NMSU completed a literature search of each taxonomic group for each park unit. The dataset catalog task was put on hold by directive of the network. Other tasks completed included completion of training on NPSpecies and the certification process, completion of a literature review, and NMSU provided assistance and consultation for a variety of matters. As of the end of the year, a total of 20,228 records were reviewed and georeferenced, of these 10,359 were prepared for NPSpecies conversion. Other than the reviewed and georeferenced databases, there have been no additional products or presentations.

APPENDIX III

(Review of Biodiversity Data Store Files)

Files contained in the Biodiversity Data Store that were reviewed for voucher records resulting from the nation-wide Park Service data mining effort. The status of file records is reported by park unit. E=Files were already entered into NPSpecies; NE=File had not been entered into NPSpecies; PNI=File was partially entered into NPSpecies; DO=File could not be opened; NO=File did not contain relevant voucher records.

File	AMIS	BIBE	CAVE	FODA	GUMO	WHSA
137	NE	NE	NE	NE	NE	NE
138	NE	NE			NE	NE
139		NE				
142		NE				
147						NE
148	NE	NE		NE	NE	NE
149	NE	NE	NE	NE	NE	PNI
151		NE	NE	NE	NE	NE
152		NE				
153		NE			NE	
155		NE				
574		DO				
575				DO		
576						DO
616					E	
653						
666					DO	
668		DO				
673			PNI			
674					E	
681		NO #'s				
682					E	
683					E	
684			E			
685	E					
686			E			
687	E					
688	E					
726			E			

File	AMIS	BIBE	CAVE	FODA	GUMO	WHS A
727					E	
800	NO #'s		NE		NE	NE
860	NE	NE	NE	NE	NE	NE
894	PNI					
895		E				
899			E			
900				E		
901						E
905	E					
906		E				
907			E			
908				E		
909					E	
910						E
912				E		
913						E
1061					DO	
1066		DO				
1067			E			
1068				E		
1069						E
1237					DO	E
1316	DO	DO	DO	DO	DO	DO
1377					DO	
1378						E
1467		E				
1470			DO			
1500						

APPENDIX IV

Inventory Literature Used to Develop Park Checklists

Amistad National Recreation Area

Vascular Plants

- **Bibkey ID: 572062** Texas Natural Heritage Program. 1995. Biological survey of Lake Amistad Recreation Site: Unpublished Final Report to the US Air Force. [199 names]

Fishes

- **Bibkey ID: 585096** Moring, J. B. 2002. Baseline Assessment of Instream and Riparian-Zone Biological Resources on the Rio Grande in and Near Big Bend National Park, Texas. United States Geological Survey, Austin, TX. [18 names]

Amphibians

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [9 names]

Reptiles

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [28 names]

Birds

- **Bibkey ID: 590352** Larson, D. H. 2004. 2000 Bird Migration Report for Amistad National Recreation Area. Unpublished Report [23 names]
- **Bibkey ID: 590353** Larson, D. H. 2004. 2001 Bird Migration Report for Amistad National Recreation Area Unpublished Report [52 names]
- **Bibkey ID: 590354** Larson, D. H. 2004. 2002 Bird Migration Report for Amistad National Recreation Area, Unpublished Report [62 names].
- **Bibkey ID: 590355** Larson, D. H. 1999. Banding Report for Vesper Sparrow (*Pooecetes gramineus*). Unpublished Report. [1 name]
- **Bibkey ID: 572062** Texas Natural Heritage Program. 1995. Biological survey of Lake Amistad Recreation Site: Unpublished Final Report to the US Air Force. [43 names]

Mammals

- **Bibkey ID: 590937** Bahm, M A and J M Mueller. 2005. The Mammals of Amistad National Recreation Area, Texas. Unpublished Report. [63 names]

Big Bend National Park

Fishes

- **Bibkey ID: 585096** Moring, J. B. 2002. Baseline Assessment of Instream and Riparian-Zone Biological Resources on the Rio Grande in and Near Big Bend National Park, Texas. United States Geological Survey, Austin, TX. [18 names]

Amphibians

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [7 names]

Reptiles

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [37 names]

Mammals

- **Bibkey ID: 590351** Borrell, A. E. and M. D. Bryant. 1942. Mammals of the Big Bend Area of Texas. University of California Publications in Zoology, :1-49. [56 names]
- **Bibkey ID: 590318** Easterla, D. 1973. Ecology of the 18 Species of Chiroptera at Big Bend National Park, Texas Parts I and II. The Northwest Missouri State University, Maryville, Missouri 64468, 34:1-165. [18 names]

Carlsbad Caverns National Park

Vascular Plants

- **Bibkey ID: 590405** Muldavin, E., P. Neville, P. Arbetan, Y. Chauvin, A. Browder and T. Neville. 2003. A Vegetation Map of Carlsbad Caverns National Park, New Mexico. New Mexico Natural Heritage Program [416 names]

Amphibians

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [5 names]

Reptiles

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [35 names]

Birds

- **Bibkey ID: 585338** West, S. 2004. Inventory of high elevation breeding birds at Carlsbad Caverns National Park. Unpublished Report [56 names]

Fort Davis National Historic Site

Non-Vascular Plants

- **Bibkey ID: 596855** Worthington, R. D. 2002. Inventory of the Flora of the Davis Mountains, Texas, Second Working Draft. Unpublished Report [19 names]

Vascular Plants

- **Bibkey ID: 596855** Worthington, R. D. 2002. Inventory of the Flora of the Davis Mountains, Texas, Second Working Draft. Unpublished Report [319 names]
- **Bibkey ID: 590940** Haynie, S. D. 2000. Vegetative Analysis of Fort Davis. Chihuahuan Desert Research Institute. Unpublished report [227 names]

Amphibians

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [5 names]

Reptiles

- **Bibkey ID: 590642** Prival, D., J. Borgmeyer and M. Goode. 2003. Chihuahuan Desert National Parks Reptile and Amphibian Inventory, 2003. Unpublished report [23 names]

Birds

- **Bibkey ID: 590322** Bryan, K. and J. Karges. 2001. Recent Bird Records in the Davis Mountains. Texas Birds, 3:41-53. [26 names]

Guadalupe Mountains National Park

Fungi

- **Bibkey ID: 552207** Worthington, R. D. 2002. Inventory of the Flora of the Guadalupe Mountains, New Mexico and Texas, Second Working Draft. Flosistic Inventories of the Southwest Program, El Paso, TX. Unpublished Report [88 names]

Non-vascular Plants

- **Bibkey ID: 72091** Lind, O. T. 1979. Limnology of McKittrick Creek, Guadalupe Mountains National Park, Texas. Pages 123-139 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [5 names]
- **Bibkey ID: 552207** Worthington, R. D. 2002. Inventory of the Flora of the Guadalupe Mountains, New Mexico and Texas, Second Working Draft. Flosistic Inventories of the Southwest Program, El Paso, TX. Unpublished Report [50 names]

Vascular Plants

- **Bibkey ID: 590404** Worthington, R.D. and W. H. Reid. 1985. Vegetation of the gypsum dune habitat, Hudspeth County, Texas. Unpublished Report [98 names]
- **Bibkey ID: 590018** Andersen, E. M. and J. M. Mueller. 2003. Baseline Inventory of Biological Resources at Choza, Smith, and Juniper Springs, Guadalupe Mountains National Park, Texas. Unpublished Report [167 names]
- **Bibkey ID: 72091** Lind, O. T. 1979. Limnology of McKittrick Creek, Guadalupe Mountains National Park, Texas. Pages 123-139 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [3 names]
- **Bibkey ID: 552207** Worthington, R. D. 2002. Inventory of the Flora of the Guadalupe Mountains, New Mexico and Texas, Second Working Draft. Flosistic Inventories of the Southwest Program, El Paso, TX. Unpublished Report [1053 names]
- **Bibkey ID: 572533** Correll, D. S. and M. C. Johnston. 1970. Manual of the vascular plants of Texas. Texas Research Foundation. [9 names]
- **Bibkey ID: 118436** Northington, D.K., and T.L. Burgess. 1979. Status of rare and endangered plant species of the Guadalupe Mountains National Park, Texas. Pages 59-78 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [113 names]
- **Bibkey ID: 16716** Gehlbach, R.R. 1979. Biomes of the Guadalupe Escarpment: vegetation, lizards, and human impact. Pages 427-440 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [56 names]

Other Non-vertebrates

- **Bibkey ID: 72091** Lind, O. T. 1979. Limnology of McKittrick Creek, Guadalupe Mountains National Park, Texas. Pages 123-139 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [5 names]

Slug/snail

- **Bibkey ID: 590537** Fullington, R. W. 1979. The Land and Freshwater Mollusca of the Guadalupe Mountains National Park, Texas. Pages 91-111 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [58 names]

Insect

- **Bibkey ID: 72091** Lind, O. T. 1979. Limnology of McKittrick Creek, Guadalupe Mountains National Park, Texas. Pages 123-139 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [28 names]
- **Bibkey ID: 94057** Fullington, R. W. and D. Harrington. 1979. *Plusiotis woodi* and *Plusiotis gloriosa* (Scarabaeidae): First Report of the Guadalupe Mountains National Park. Pages 113-114 in (H.H. Genoways and R.J. Baker, editors). Biological Investigations in the Guadalupe Mountains National Park, Texas. National Park Service Proceedings and Transactions Series, 4:1-442 pp. [3 names]
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