

LCR DATABASE ACTIVITIES

DRAFT

ANNUAL PROGRESS REPORT FISCAL YEAR 1992

Prepared for
BUREAU OF RECLAMATION
GLEN CANYON ENVIRONMENTAL STUDIES



Prepared by
NAVAJO NATURAL HERITAGE PROGRAM
FISH & WILDLIFE DEPARTMENT
NAVAJO NATION
As part of
COOPERATIVE AGREEMENT No. 1-FC-40-10520

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September 1992



This is the annual report on activities during fiscal year 1991/1992 covering the time period from Oct 1, 1991 to Sep 30, 1992. The activities reported on will be those specified in Objective Number One of the Cooperative Agreement for the Development of a Data Base for the Little Colorado River (LCR) Endangered Species Studies and Cultural Resources (Cooperative Agreement No. 1-FC-40-10520, Modification No. 1), hereafter referred to as the project. A synopsis of all activities since October 1 of 1991 will be presented. This will address the three work tasks of Objective 1 as well as the schedule of reports on work items as specified in the Memorandum UC-823 with attached Modification of Assistance Agreement (7_2278 (4-90)) dated 6 February 1992.

The work activities of the project are generally divided into work on the LCR bibliography and work on the geographic information system (GIS) for the LCR. The bibliography is the form chosen to compile information about the biology, geology and hydrology of the LCR basin. The GIS is a digital database created and maintained by specialized software (Environmental Systems Research Institute's Arc/Info) and will consist of standard GIS data layers developed from existing sources. The reports on work items will be a synopsis of the material compiled in the two groups and will not contain any original work.

A telegraph style summary of activities by quarter followed by a narrative of completed, ongoing, and scheduled work activities is presented.

Summary of project activities by quarter:

First Quarter of Fiscal Year 1991/1992 - October 1, 1991 to December 31, 1991.

Programmer Analyst hired. Initial design and development of LCR database. Software (dBase III+) selected and installed. Additions made to the purchase order for the GIS workstation made and the equipment ordered. Database structure created and documented. Review of existing literature and information on LCR and the development of the LCR project. Support databases and procedures developed to organize project effort. Phone calls to various tribal, local, state and federal agencies made to solicit information. Existing bibliographies obtained from previous workers from the GCES office and others. Program secretary recruited for data entry. Data base entry begun. Worked on refinement of database structure and documentation. Development of documentation of needed GIS data layers, the logical structure of themes and individual coverages. Presentation of initial work progress and intended course of project to GCES LCR workgroup meeting at GCES office on October 24, 1991.

Meetings held with Arizona state offices to find additional information and literature. Data base entry continues. Development of data entry program to provide error checking and consistency in category field entry. Developed printing program. Began looking at applicants for Natural Resource technician to work on the bibliography.

Interviewed three candidates. Selected Claudia Willetto Dec 6. She started Dec 9. Began training technician on PC and dBase/database and procedures. Complications with tribal departments slow down the purchasing process of the GIS workstation. The GIS software received in late November. Jurisdiction of various state and federal agencies, with regard to impacts to fish and fish habitat, is researched. Jurisdiction and permitting process literature gathered. Modification of LCR project started. Jurisdictional flowchart to be included with December quarterly report. GIS workstation delivered 23 Dec. Christmas vacation. Sent quarterly report 30 Dec.

Second Quarter of Fiscal Year 1991/1992 - January 1, 1992 to March 31, 1992.



New Years and annual leave. Setup and configuration of workstation started 6 Jan. Installed all system software and Arc/Info. Factory configuration not sufficient. Began planning on repartitioning disk and reinstalling operating system kernel. Because of cost cutting, printed manual not purchased. Online documentation a problem during reconfiguration when system is down. Preliminary list of needed equipment made and LCR equipment and supplies budget given to director. Continued training of technician. Data entry continues on bibliography and refinement of data entry program performed. System setup to my liking, new operating system software installed, disk repartitioned to provide modular backup of GIS files, home directory and the local system files. All ancillary software installed (wordprocessing, system utilities from UNM, programming/X11R4 files, videopix video capture software) and system administration scripts and protocols finished by late Jan.

Began going to tribal departments with tapes to get coverages. Sent tapes and letters to all federal (USGS) and state agencies (ALRIS) for GIS layers. System needs/deficiencies (particularly disk space) identified and LCR equipment budget finalized. The GIS/system printer suffers shipping delays. Obtained ancient line printer from tribal Resource Information Management (tribal GIS group) and after a bit of work got it working. Natural resource technician continued data entry, researching potential sources of information and sending requests for information, proofread existing bibliography, and traveled to Albuquerque to begin to make copies of citations. Began installing coverages obtained from tribal groups. Problems with documentation of source, accuracy, and consistency (scale, fit on overlay) of layers from various tribal agencies.

Began to investigate of cost of obtaining new digital line graphs from USGS at various scales. Met with the Rural Addressing office for McKinley Co. and got 1990 Precensus tiger line files on CD. Small problems with Arc/Info and format of CD. Wrote program to process files correctly. Decide on 1:100,000 as best scale for GIS layers. Talk to GIS user group about obtaining post-census tiger files. Some had thought of it already. Was asked if program could pitch in money to purchase them. Said ok but as it turned out cost was covered by others. So the tiger files were ordered. Received GIS coverages from USGS in Tucson on Feb 20.

Project modification requires full review by tribal procedures with signature approval sheet (SAS process). Submit requisition for the additional disk drive, serial port expansion to hook up the requested digitizer, and 8mm tape drive for more efficient data backup. Purchase order for Spot image at Nature Conservancy discount price came back disapproved because of no money in the account. All activity on LCR account put on hold until SAS process complete. Master tic and boundary coverage, abandoned mine sites, geographic names, hydrologic unit code, cities, reservation boundary and chapter boundaries coverages complete. Most of coverages in system. Natural resource technician left at end of temporary employment period on Feb 28. Tektronix printer came in Feb 28.

Printer required work to get connected. Virtually no support for connecting to a unix workstation. Once the needed printcap entry was found it worked. Attended GCES GIS overview in Phoenix Mar 4. Natural Resource technician re-advertised. Got new HP laser jet cartridge to use with bibliography print module. Data entry and sending requests for additional information on LCR continues. Received GIS coverages from Arizona Land Dept.'s resource information system (ALRIS) on Mar 16. Received first Tiger files Mar 17 from Navajo water dept. Coverage processing has left little room. Fill up the disk on first try at processing the tiger files. Edited coverage layers and deleted those that were duplicates of the coverages received from ALRIS. Deleted all ALRIS coverages to make room for processing. All coverages backed up onto tape for archival. Continued work on rest of coverages. Received and installed the new Arc/Info 6.0.1 upgrade Mar 19. Reprocessed the tiger files, still bombs. Called ESRI. Apparently a software bug in Arc/Info 6.0.1. Tried the suggested workaround and it worked. Printed out several sample images and tried printing



satellite images and worked on setup and printer configuration. Attended several mandatory tribal employee training sessions. Began coverage inventory and editing. Attended EOSAT gis/remote sensing workshop in Denver, Co. (March 30-April 1). All paper work on the project is tied up in the SAS process. In retrospect have missed the March quarterly report.

Third Quarter of Fiscal Year 1991/1992 - April 1, 1992 to June 31, 1992.

Prepared and presented overview of program to the Arizona Riparian Council in Cottonwood, AZ April 10. Trip to Albuquerque to acquire image processing software and to check on possible coverage availability. Meetings with GIS users group to discuss standards and documentation procedures for tribal coverages and to check on status of tiger file acquisition. Work with Tribal Forestry to convert 9-track image files of commercial forest land on reservation to 1/4" tape in return for access to images. Discussed need to get another person working on bibliographic database and problem of getting qualified personnel. Selected technician who had good organizational and clerical skills 16 April. Began training on dBase/database requirements. Continued inventory of coverages acquired and assessed quality and suitability of coverages to project. New building put for Heritage Program use. Move office and equipment around 30 April.

Began documentation of what coverages I could from notes taken from meetings with tribal personnel. Printer is a postscript printer and only prints postscript files. Researched what postscript information I could find and wrote a C program and installed it as a printcap input filter to print ASCII files. Purchase order received by vendor on May 15. Asked her wait a little on order while researched differences between 8mm and 4mm DAT tape drives and to insure compatibility with other departments and agencies. Chose the 4mm drive 19 May. Migration of project files, memos, etc from the PC's to the SUN. Continuation of editing and moving coverages into permanent data directory. All tiger files on CD for Arizona, New Mexico, Utah and Colorado arrived at various tribal programs and departments. Meeting on 20 May with tribal departments of Forestry, Water Rights, Utility Authority, Navajo/Hopi relocation, and Land Administration and discussed use of tiger files for reservation wide base coverages, the attributes needed, use of 1990 census data, and division of labor in processing. As the person with system level experience I accepted the initial processing of files from CD and initial separation of layers and transfer to other media for distribution to others for final processing, mostly attribute additions and error checking. As part of the SAS process for the project the modification went through the Justice and Water Rights departments. They attached several comments and signed off on the SAS.

Backed up and deleted extraneous files to make additional work space on system. Worked on bibliographic database. Quality control work on various files used by technicians for data entry and merged into master file. Ran programs to check for duplication in database. Edited database and tried to reconcile various styles of abbreviation and interpretation of bibliographic formats entered from newly acquired citations and existing papers and other information sources. SAS process on Project Modification completed on 11 June. Revised LCR budget entered in Tribal Contract Accounting system. Many accounts in the red. Went over budget and put budget into a Lotus 123 spreadsheet, will maintain from now on. Began work on June quarterly report and FY 93 budget proposal.

Fourth Quarter of Fiscal Year 1991/1992 - July 1, 1992 to September 30, 1992.

Holiday and annual leave from 2 July to 7 July. Started working on the TIGER data. There were bugs in the software and macros used by ARC/INFO that complicated the



problem. Called Environmental Systems Research Institute and got work-arounds to specific bugs. The new 1.2 gigabyte drive and the 4mm DAT backup drive arrived 10 July. Unpacked equipment and connected equipment. Needed to add information to the system kernel configuration files and recompiled the kernel to support the newer 4mm DAT format. A couple of days were spent configuring the system to take advantage of the new storage. The entire system was backed up onto the 4mm DAT and selective restores were done to ensure the integrity of the backup data. A worksheet was developed for repartitioning of both disks and the system was reconfigured and the system and data was restored.

Requisitions for an additional disk, digitizer, and software, reports and DEM data submitted. TIGER processing involves a good deal of error correction of data attributes. Multiple relate files among three feature classes make the problem quite complex. Ongoing work on data entry and validation on citations entered into the LCR bibliography database. New system of numbering the citations begun last quarter finished. Began to program a set of AML programs to try to automate the processing and layer extraction. Installed SUN NFS (network file system) software for networking the PC with the SUN. Moved the LCR database from the PC to a partition on the SUN. This allows me to better backup the data base as part of the daily backup routine. Almost all of the purchase requisitions were effectively denied because Contracts and Grants and the Property Department had problems with the sub-account line item used, which was part of the original agreement and could not be changed. I was called by both departments to explain what the items on the Purchase Requisition were. Had a meeting with the director of Property and Stores to try to explain what was what.

The census information coding in the TIGER files is a maze. Decided that I do not have the time to figure it all out and will concentrate on the roads, other transportation, hydrography, physical features, and county and other non-visible political boundaries. The TIGER data is fairly complex and despite some problems with attribute coding withing the files they should provide good base layers. Abstracts for the bibliography are being typed into a WordPerfect document due computer time conflicts. I'm sure this will cause a little difficulty in incorporating abstracts into database but that will be figured out. Attended the GCES mapping and surveying workgroup meeting on 11 Aug. Reported to project director on meeting. Suggested that we get together with GCES folks on what we are doing. Spent a day working the one SPOT multi-spectral image that we could afford. We requested a 1600 bpi 9-track and after fiddling with it for a while assumed that the tape was really 9600 bpi. Called UNM computer engineering folks and scheduled a time I could go over there and use their tape drive. Incorporated new printing module in the LCR dbase system. Meeting with director and assistant to put priority on obtaining copies of the citations in the bibliography. Attended the GCES scientific information management workgroup meeting in Flagstaff 21 Aug. Suggested that a workgroup meeting would be beneficial at this time. TIGER processing AML's are complete and testing on additional data sets started.

Additional cases found in new data sets requiring a refinement and additional error checks in the AML programs. Filled up the file system again on TIGER processing. Put some things back on tape that I had reinstalled after getting new disk. It's amazing how much space is taken up by miscellaneous stuff. Cleaned up disk and pressed on. Processed all New Mexico counties. Abstracts are being transferred from the WordPerfect files to the database. I was hoping that we would receive the dBase IV for the SUN but the purchase requisition and other delays have prevented that. The PC Windows environment is being used to cut and paste the abstracts to the database. It's not as fast as directly reading in the memos but most will be input fairly quickly. Attended Navajo Resource Committee meeting to approve the Modification 2 of the Cooperative Agreement. It now goes to the Intergovernmental Relations (IGR) Committee. Compared the TIGER data and the transportation coverages that were received from ALRIS for the Gallup, NM area and was



reassured that the time spent on processing the TIGER was not a complete waste of time. There were quite a few areas of much improved accuracy in both spatial and attribute information. I think the TIGER data will provide the best, most accurate data base of transportation and hydrography at 1:100000 scale of the whole LCR basin that is available. Worked on map AML's for irrigable soils and biotic communities. Modification number 2 of the Cooperative Agreement has been signed off by the IGR committee and the President's Office and has gone to Contracts and Grants. Began work on Annual Report.

Narrative of project activities:

Work began on the project in October of 1991 with the hiring of myself, Tom Garrison, as a Computer Programmer Analyst. Suggested additions to the purchase order, for which the vendor and model of computer (a SUN IPX workstation) had already been chosen, was made and the equipment was ordered. In the absence of the workstation, activities were concentrated on the development of the LCR bibliographic database. During this period, all correspondence and other material concerning the project were reviewed and organized in chronological order and filed. Database software was chosen based on availability, use by other agencies, support for the database file format, and familiarity. Dbase III+ had already been purchased, was in use by the GCES office, is a very popular software package and is supported by a wide variety of other database software, and was familiar to myself. Design of the database structure was guided by common bibliographic structure and the criteria specified in the project agreement. This structure has been presented during a previous LCR work-group meeting and included in earlier reports to the Glen Canyon Environmental Studies office. Since there have been modifications and in the interest of completeness, it is included here.

The field names, type, width and description of the database structure is as follows:

Field	Name	Type	Width	
1	RN	Character	12	Reprint number. Indicates that a copy is available in the library. Copies are maintained in reprint order.
2	AU	Character	136	Author(s). Authors after the 4th will be referred to as et al.
3	YR	Character	5	Year
4	TI	Character	253	Title.
5	T2	Character	68	Title Continuation
6	PB	Character	164	Where/Who published. Will not included statements like, 'in cooperation with', 'with the assistance of', etc.
7	KW	Character	140	Key words. Jargon, and technical and specific terminology used in abstract or summary (see below).
8	CT	Character	128	Category. Will use a restricted set of key words loosely based on scientific disciplines. Will at least contain the broad categories, geology, hydrology, biology, or environmental (see below).



9	AN	Memo	10	Annotation of citation. Cannot be searched.
10	SL	Logical	1	Selected field. Used in database operations as a flag.

The method used to index the LCR Bibliography by subject will use a category and key word field. The category field is indexed with a bi-level hierarchial system arranged in the following manner:

{level}-[category]:[sub-category]:[detail-category]... {level}-[category]:[sub-category]:[detail-category]...

The levels represent whether the category is the primary or secondary topic. The current categories are, **biology**, **climatology**, **geology**, **hydrology**, and **environmental**.

Within each major category there is a restricted number of general sub-categories roughly corresponding to sub-disciplines or fields within the major category. Terminology is meant to be semi-technical, yet using the most common phrase and avoiding jargon. The aim is to supply a minimum inclusive categorization. The key word field supplies topic specific information such as species, technical terminology, geographic area covered, specific mention of type of work, methodology, etc.

The sub-categories currently recognized for each major category are:

biology

agriculture	botany	limnology	recreation
anthropology	ecology	mammals	socioecology
archaeology	fish	paleoecology	systematics
biogeography	forestry	paleontology	wildlife
birds	invertebrates	physiology	

climatology (no sub-categories at this time)

geology

geochemistry	geohydrology	maps	soils
geochronology	geophysics	minerals	physiography
geomorphology	lithology	mining	

hydrology

contamination	groundwater	sediments	watersupply
erosion	hydrodynamics	surfacewater	maps
floods	paleohydrology	waterquality	
geohydrology	radiological	watersheds	

environmental

management
regulatory



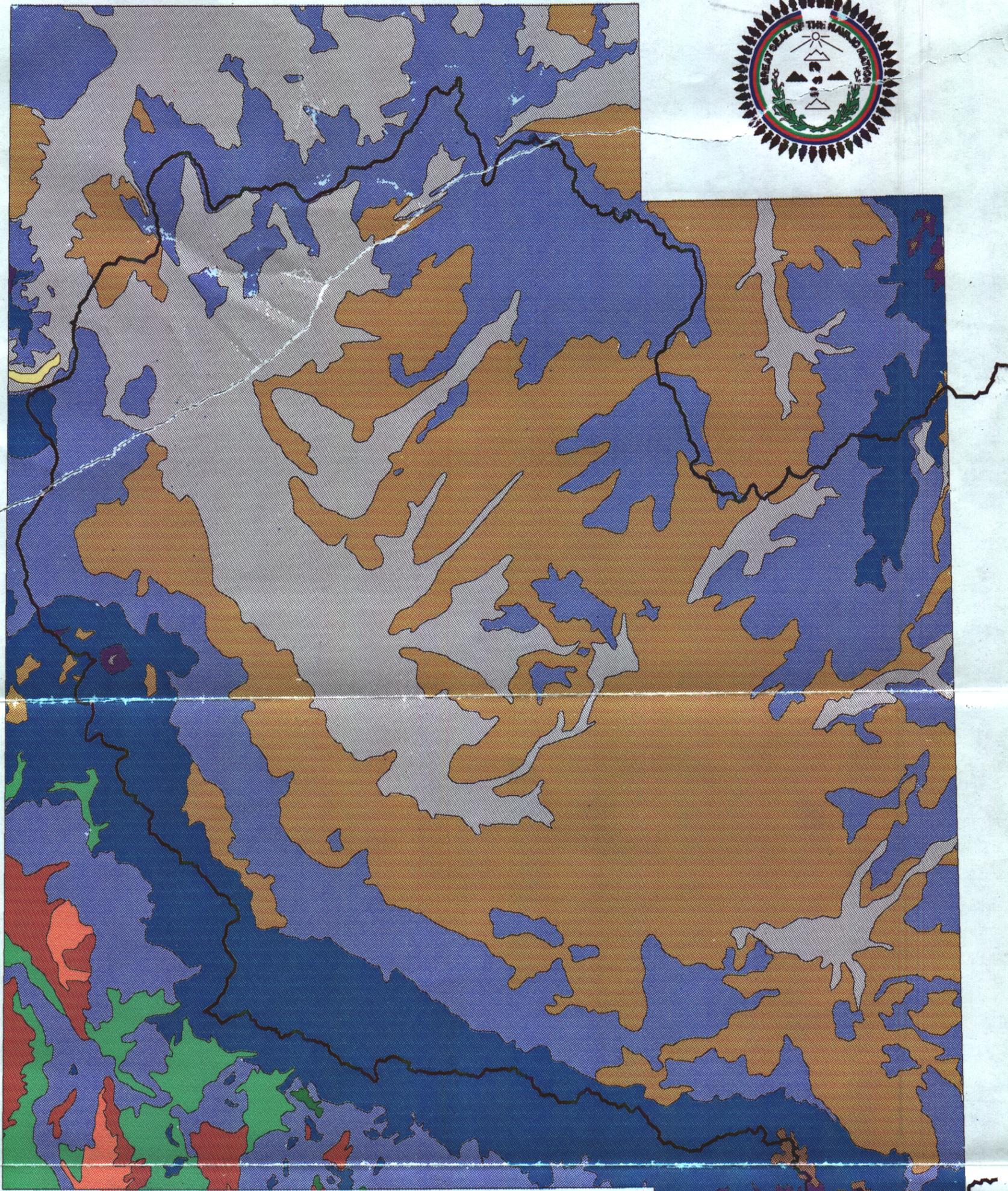
For example, a paper on fish habitat that correlates the habitat with geomorphology of the streambed and water quality would be indexed with a category field as: 1-biology:fish:ecology 2-geology:geomorphology 2-hydrology:waterquality.

This translates to a biology paper about fish ecology (as opposed to fish physiology), with the secondary topics being geology within the discipline geomorphology, and hydrology with water-quality issues. If the geomorphology and biology were judged as having equal weight the level for both might be level 1, or alternately, if all three had equal weight, the all three levels would be 1. This situation would normally be rare, however with only two category topics, such as geology and hydrology, it would be common for both categories to be considered primary topics. The issue of primary or secondary topics can be avoided by searching for -biology or -biology:fish. This would find all papers concerning biology and fish, respectively. Hopefully, this will provide some utility in the category scheme with so many hydrology papers talking about water-bearing rocks in terms of the geology of the area. With different people entering data, the primary purpose of the category field is to try to impose some consistency to the keywords used to characterize the citation or other source. The data entry module does this by only allowing categories and sub-categories that are predetermined. This set of keywords can be modified easily. The use of the primary and secondary designation is used for two reasons. The first is to provide a simple mechanism to differentiate the category 'hydrology' and the sub-category 'geohydrology'. The second reason is that as the database grows, the amount of data produced and the time it takes to produce reports will get larger and the penalty for being too general in selecting records will become more severe. I think that the judicious use of the primary and secondary designations when entering individual citations can result in more efficient and faster retrieval of information. Secondary topics are considered those papers or citations in which the topic is only mentioned briefly or are summarized with citations to the authorities on the subject.

Most of the sub-categories are self explanatory and work well as pigeon holes to stick citations into. However there are there are many citations that are not as easily categorized and a single pigeon-hole is harder to find. Several factors have caused the inclusion of a fair amount of these types of citations. The major factors are; the overlap in hydrology and geology with respect to the basin; the directive to include information about impacts to the basin with respect to the fish; the occurrence of rich mineral deposits in the basin; and the 1979 failure of a United Nuclear Corporation's Church Rock uranium milling pond dam and the subsequent discharge of radiological contaminants into the Puerco river, a tributary of the Little Colorado river. These factors are responsible for the addition of the environmental category and the sub-categories of geochemistry, geophysics, minerals, and mining within the geology category, and contamination, hydrodynamics, radiological, and sediments within the hydrology category. It is also the reason the geology and hydrology categories have two sub-categories in common, maps and geohydrology. Since the hydrology is the more important to the chub, all citations dealing with the geologic aspects of hydrology, whether it is primarily a geology or hydrology paper, and also irrespective of the use of the words geohydrology or hydrogeology within the title or text of the work, will be categorized using the sub-category geohydrology.

Much of the information and reports on the hydrology and impacts to the water supply of the basin that could affect the humpback chub have originated with local, state, and federal agencies concerned with human health and other economic issues. This information has been included in the database. However, the articles do not say anything about the hydrology or geology of the area but report findings and results in terms of state and federal water quality and other environmental standards. If the citation deals directly with standards of this kind it is categorized as regulatory. Otherwise, if it is

BIOTIC COMMUNITIES OF THE LCR BASIN



LEGEND

- 111.5 -- Alpine Tundra
- 121.3 -- Petran Subalpine Forest
- 122.3 -- Petran Montane Conifer Forest
- 122.4 -- Great Basin Conifer Woodland
- 123.3 -- Madrean Evergreen Woodland
- 133.3 -- Interior Chaparral
- 141.4 -- Subalpine Grassland
- 142.1 -- Plains & Great Basin Grasslands
- 143.1 -- Semi-desert Grasslands
- 152.1 -- Great Basin Desertscrub
- 153.1 -- Mohave Desertscrub
- 154.12 -- Arizona Upland Division



SCALE 1:1183399



NAVAJO NATURAL HERITAGE PROGRAM
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PLOT FILE: LCRBIOMES DATE: 29 Sep 92

BIOTIC COMMUNITIES OF THE
LITTLE COLORADO RIVER BASIN
from Brown and Lowe, 1980



concerned with more general environmental issues or management policy like permitting or land use within riparian corridors it is categorized as management. Papers on conservation, whether of riparian areas or wildlife, that are concerned with policy or guidelines are treated as environmental management and are categorized as such. Biological conservation papers where conservation is dealt with in terms like species diversity, landscape ecology, or the effect of anthropogenic factors on the reproductive ecology or habitat use, are categorized as biology papers with the sub-categories referencing the taxonomic group and ecology, physiology, socioecology, or wildlife. The marriage of geology and hydrology in many of the papers are caused by the mining industries demand for water, the importance of groundwater as a surface water source, and the current adjudication of water rights within the basin. This last factor has also created a heightened sensitivity to hydrologic issues. Some of the more recent information and reports on the hydrology and geohydrology of the basin are not available due to their being confidential attorney-witness work products.

The type or species of fish would be listed in the key words field. For example, possible keywords might be: native fish, freshwater, Cyprinidae, *Gila cypha*, New Mexico, Arizona, Little Colorado River.

To track all agencies and individuals contacted for information an additional database was created to provide a log of contacts with address, phone and summary of contact. To date, 87 individuals have been contacted in various commercial, state, and federal agencies. There are additional contacts and agencies that have been sent requests for information by mail with a copy of the memo on file that have not been entered into this data base. A solicitation for information was given to the members and guests of the Little Colorado River Plateau Resource Conservation and Development Council at a quarterly meeting held in Winslow, AZ on January 22, 1992. A slide presentation was given at the sixth annual meeting of the Arizona riparian council held in Cottonwood, AZ on 10 April 1992. This consisted of an overview of the project and a solicitation for information. Meetings have been held with personnel from McKinley County rural addressing office, New Mexico Geographic Council, New Mexico Environmental Improvement Division, NASA Technology Application Center, U.S. Geological Survey offices in Albuquerque, NM and Phoenix, AZ, University of Arizona Arid Lands Studies Office, Arizona Department of Land, Arizona Department of Water Resources, Arizona Department of Environmental Quality, U.S Forest Service at Phoenix, Arizona Fish and Game Department, and the Arizona State Highway Department.

Currently, there are 1362 citations in the database. There are about 10 citations that have recently come in the mail and are currently being entered. Of these we have 374 copies that have been given program numbers and are filed. And of these 318 have had abstracts written or typed from the abstract provided. The numbering and filing system has been adopted from the Nature Conservancy system used for the Heritage database. The reprint number consists of a 12 character string in the following form: GnnABCxxNNUS. Where G is a group category and is the character 'N', 'A', or 'U'; 'N' is a published book, 'A' is a published article, and 'U' is an unpublished paper or report from any source. The last two numbers of the year are coded in the characters 'nn'. 'ABC' is the first three characters of the authors last name. 'xx' is a sequential number to break a tie between two entries with the first 6 characters the same. 'NNUS' is a literal string that was originally intended to occur in all entries. It signified that the copy resides with the Navajo Nation Heritage Program in the United States. However, this last four characters have been allowed to be a little more flexible to code for a general source of the citation. For example, all the citations that Chuck Minckley provided in the Humpback chub bibliography have "MINC" as the last four characters of the reprint number. As an illustration of this numbering scheme, the reprint number



A90GAR01NNUS is a article published in 1990 by an author whose last name starts with 'Gar'. Papers are filed within groups alphabetically and by year.

A set of integrated dBase III programs have been developed for data entry, query and printing of citations from the database. The data entry and printing modules have been functionally completed. Both are being further developed for ease of use and to support additional data validation and error checking and to generate multiple report formats. Currently all queries and filters is accomplished through dBase commands. We are continuing to type in abstracts for each citations that we have copies for, and to gather and purchase copies of other citations.

There are two general formats for annotated bibliographies. The first is a alphabetical, cross-referenced list by category and sub-category. The second is a numbered alphabetical list of the whole database with an category index that references the citation by number. A program for the first format has been written and the second is under development. The intention is to provide programs that will produce both formats directly without the need to bring a file into a word processor to provide formatting. Though that option is supported by the ability to produce a ASCII file of the database.

A draft copy of a cross-referenced alphabetically by category version of the LCR Bibliography was provided as part of the Second Quarter 1992 (Third Quarter Fiscal Year 1992). Unless an request for an additional draft copy of this type is made we will wait until the Final Annual Report in November to submit a current version. As there has been changes made on the database a copy of a alphabetical list with category index type is provided. Additional copies can be provided upon request. It is reiterated that what would help at this point is to allow researchers in the various fields to review the pertinent section of the bibliography and critique the citations included, the keywords used to categorize the citation, and to provide additional citations that we may have missed. I would encourage distribution and comment on this draft version.

The SUN IPX Unix workstation arrived December 23, 1992. Setup and configuration of the workstation and organization of the GIS side of the project took up most of January. A overview of suggested layers was presented at the LCR workgroup meeting in Flagstaff on Oct 24, 1991. It has been used, to the extent possible, as a guide to the coverages that have been sought out. The following is the original list:

-
- | | |
|-----------------------|---|
| Template | - Registration base maps. |
| Boundary | - various boundaries (Res, Parks, Forests, Monuments etc). |
| Trans | - transportation, including power, pipe and rail lines. |
| Hydrology | - includes subsurface and stream chemistry and geomorphology, possibly historic use. |
| Geology | - the same |
| Archeology | - includes Navajo sacred and historic sites |
| Hypsography | - the same |
| Landuse/status | - includes development (diversions, water quality, effluent discharge location, etc.) |
| Recreation | - user days, trails |
| Vegetation | - general (i.e, Brown and Lowe 1980). |
| Biology | - detailed mapping of chub habitat, includes large scale vegetation mapping, micro-habitat, submerged vegetation, sub-populations, migration, other wildlife, T&E species etc. Data transfer from field work to GIS needs to be worked out. |
| Sites | - sampling/research sites, may include project specific benchmarks |



The Arizona Geographic Information Council (AGIC) does not at this time have a publication that specifies a set of standards and protocols for development, maintenance, and documentation of GIS data bases. Gary Irish, director of Arizona Land Resource Information System (ALRIS) indicated that AGIC is currently involved with the development of such a document that should be completed within a year.

In the interim, it is suggested that the GIS Data base of coverages follow that of the Standards and Guidelines for Geographic Information Systems in New Mexico which has been recommended by the New Mexico GIS Advisory Committee and submitted to the Information Systems Council (ICS) of New Mexico.

The following is a listing of the items from the standards and guidelines suggested for documenting the LCR GIS data layers. It includes additional information to facilitate the administrative management of the various data layers. These in combination represent a Data Quality Report that will be maintained for each GIS data set. Unfortunately, virtually all the coverages received from all sources lacked some or all of the information needed to compile a complete coverage data quality report. Data quality reports for all coverages will be maintained to the extent possible. This is an ongoing effort. The elements of the data report will be fields in a database and are given in the following list.

Source Lineage	11. Category of data	21. Contact
1. Name	12. Capture Date	Data Element Dictionary
2. Source Scale	13. Capture Author	22. DED file
3. Capture Scale	14. Contractor	Administration
4. Source Author	15. Software used	23. Reference number
5. Source Projection	16. Capture Method	24. Location
6. Datum	Data Quality	25. Status
7. Compilation Date	17. Coordinate Transformation	26. Comment
8. Last Revision Date	18. Positional Error	27. Map file
9. Source Media	19. Attribute Error	
10. Media Quality	20. Use Restrictions	

The following list represents the set of initial coverages as of the last quarterly report. All of these coverages had not been processed to date and some still needed to be deleted pending a determination of their suitability to the project. This progress report will not discuss any coverage in detail. The bulk of the coverages obtained from ALRIS had actually been deleted to make room for tiger processing. They were archived on tape as received from ALRIS. They were initially put back on the system for further analysis when the additional disk for the system arrived. To give an appreciation of the amount of data gathered the list with the support files that are maintained by the software constitute almost 440 megabytes, almost half a gigabyte of data. The machine was shipped with one 1.2 gigabyte disk with nothing on it but the basic operating and a small swap partition (a chunk of the hard disk storage reserved by the system for temporary files, a feature of Unix). Arc/Info requires about 114 megabytes for itself and about 70 megabytes of swap space. Currently the partition used for data has about 89 megabytes free. The TIGER files, which represents a county, can be from 1 to 125 megabytes (from the TIGER/Line Census Files, 1990, Technical Documentation). The TIGER files for McKinley, NM; Apache, Coconino, and Maricopa counties, AZ are 43, 57, 65, and 91 megabytes respectively. In creating GIS coverages from TIGER Line files the space used is essentially doubled. The list follows:

s-water/gen_hydr	s-water/lakes	s-water/wheatfield	g-water/n-aquif
s-water/wsheds	s-water/smoky_mtn	g-water/c-bnds	g-water/n-cf_ucf
s-water/bluff	s-water/spimap	g-water/c-ptcon	g-water/n-stk_con
s-water/cortez	s-water/sttmap	g-water/hydrb	bcd/eors
s-water/hydro-points	s-water/sws-nn	g-water/hydrb1	bcd/eors-s



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topo/pinon1	ranches/arviso	trees/pj	lcr/template/100kquadric
topo/redslide	ranches/eli	trees/compart	lcr/template/250kquadric
cmmtty/towns/capital	ranches/lrp	wmip/covers/lakes	lcr/hydr/genhydr
cmmtty/towns/ft_defiance	ranches/berryhill	tgr90nm/006	lcr/hydr/basin
cmmtty/towns/oaksprings	ranches/blanco	tgr90nm/031	lcr/hydr/gen_hydr
cmmtty/towns/fruitland	ranches/bluewater	tgr90nm/045	lcr/hydr/subbasins
cmmtty/towns/sawmill	ranches/carrica	tgr90nm/003	images/spoti
cmmtty/towns/st_michaels	ranches/chaco	tgr90nm/amlmap	images/fullscn
cmmtty/towns/ganado	ranches/crow	tgr90nm/catron1	images/spotmap
cmmtty/towns/lupton	ranches/elkins	tgr90nm/trans	images/regis
cmmtty/towns/sanders	ranches/bo	dgarrison/counties	gnis/gnis
cmmtty/towns/houck	ranches/henderson	dgarrison/subbasins	mines/minres
cmmtty/towns/navajo	ranches/herrera	dgarrison/basins	mines/mine-lines
cmmtty/roads/capital	ranches/pitt	dgarrison/hucs	mines/pbcm
cmmtty/roads/ft_defiance	ranches/mayfield	dgarrison/azpls	mines/ur-mins
cmmtty/roads/oaksprings	ranches/shaw	dgarrison/azlltics	mines/og
cmmtty/roads/sawmill	ranches/sims	dgarrison/nmgeol	trans/glencanyon
cmmtty/roads/fruitland	ranches/starlake	dgarrison/azbnd	trans/holbrook
cmmtty/roads/st_michaels	ranches/westbrook	dgarrison/riop-shyd	trans/kayenta
cmmtty/roads/ganado	ranches/winslow	dgarrison/azcounties	trans/pinon
cmmtty/roads/lupton	ranches/retherford	dgarrison/export_files	trans/chelly
cmmtty/roads/sanders	ranches/vanderwagon	lcr/bnd/admbnd	trans/payson
cmmtty/roads/houck	ranches/venado	lcr/bnd/agency	trans/cameron
cmmtty/roads/navajo	ranches/foster	lcr/bnd/1882bnd	trans/flagstaff
geo/az	ranches/espil	lcr/bnd/chapters	trans/winslow
geo/co	ranches/nicoll	lcr/bnd/counties	trans/ganado
geo/nm	ranches/paragon	lcr/bnd/bbox	trans/polacca
geo/ut	ranches/mccracken	lcr/bnd/dist6	trans/aztrans
misc/arrow	soils/lc-soils	lcr/bnd/districts	trans/gallup
misc/pipeline	soils/alb	lcr/bnd/eomap	trans/stjohn
misc/powerline	soils/alblab	lcr/bnd/gd-1937	trans/tubacity
misc/nmseal	soils/aztec	lcr/bnd/hpl	trans/catron
misc/railroad	soils/aztlab	lcr/bnd/nhpl	trans/nutriosio
misc/north	soils/cortez	lcr/bnd/nnbobox	trans/toadlena
misc/northarrow	soils/escal	lcr/bnd/resbnd	trans/zuni
misc/usa-res	soils/flagstaff	lcr/bnd/places	trans/fencelake
misc/eagle	soils/flalab	lcr/bnd/states	trans/sanders
misc/sunset	soils/gallab	lcr/bnd/winbnd	trans/sedona
misc/sacred-mount	soils/gallup	lcr/bnd/jbox	trans/showlo
mona	soils/marble	lcr/bnd/nm75quads	trans/sprgrville
mona/station-map	soils/marlab	lcr/bnd/az75quads	trans/lcraztr
pls/nsect1	soils/shilab	lcr/template/lcrtmplt	trans/nmtrans
pls/townlabels	soils/shiprock	lcr/template/15mquadgrid	trans/lcrnmtr
pls/town1	soils/soclab	lcr/template/7.5mquadgrid	trans/quemado
pls/nsect2	soils/socorro	lcr/template/100kquadgrid	trans/lcrquem
pls/section1	soils/stjlab	lcr/template/250kquadgrid	tgr90az/document
pls/newest-sect	soils/st_johns	lcr/template/7.5mquadtic	tgr90az/001
pls/township	trees/cfbnd	lcr/template/15mquadtic	

The last quarter of the fiscal year has been spent in figuring out the TIGER files, writing several AML's to automate the TIGER processing, sorting through all of the rest of the coverages received from other agencies and doing QA/QC and of writing support AML's to assist in providing a consistent map appearance and map documentation. Once a coverage has been examined, it is placed in the permanent storage workspace determined by the geographical and to a lesser extent, the jurisdictional extent and the feature class of the data layer. To give an overall feel for the current organization and number of coverages that have been kept, a current list of all of the workspaces (directories) and coverages is presented:

az/bio/biomes	az/socio/aztowns	carto/nmseal	carto/sunset
az/bnd/7.5quads	az/soils/azsoils	carto/north	carto/usa-res
az/bnd/azbnd	bcd/eors-buf	carto/northarrow	gnis/gnis
az/bnd/counties	bcd/eors-s	carto/pipeline	images/fullscn
az/hydr/hucs	bcd/eors-sel	carto/powerline	images/regis
az/hydr/subbasins	carto/arrow	carto/railroad	images/spoti
az/socio/azcities	carto/eagle	carto/sacred-mount	images/spotmap



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lcr/geo/mines
lcr/geo/mines/maps
lcr/geo/mines/maps/amlmap
lcr/geo/mines/mine-lines
lcr/geo/mines/minres
lcr/geo/mines/og
lcr/geo/mines/pbcm
lcr/geo/mines/ur-mins
lcr/hydr/azhuc
lcr/hydr/basin
lcr/hydr/c-aquif
lcr/hydr/c-ppt_con
lcr/hydr/genhydr
lcr/hydr/hydrb
lcr/hydr/lcrhuus
lcr/hydr/maps/lcrcover
lcr/hydr/n-aquif
lcr/hydr/n-cf_ufc
lcr/hydr/n-stk_con
lcr/hydr/riopuerco
lcr/soils/lcrsoils
lcr/tmp/100kquadgrid
lcr/tmp/100kquadtic
lcr/tmp/15mquadgrid
lcr/tmp/15mquadtic
lcr/tmp/250kquadgrid
lcr/tmp/250kquadtic
lcr/tmp/7.5mqu adgrid
lcr/tmp/7.5mquadtic
lcr/tmp/gallup
lcr/tmp/lcrtmplt
lcr/tmp/maps/tmpmplt
lcr/tmp/tularosa
lcr/trans/cameron
lcr/trans/catron
lcr/trans/chelly
lcr/trans/fencelake
lcr/trans/flagstaff
lcr/trans/gallup
lcr/trans/gallupt
lcr/trans/ganado
lcr/trans/glencanyon
lcr/trans/holbrook
lcr/trans/kayenta
lcr/trans/lcraztr
lcr/trans/lcrnmtr
lcr/trans/lcrquem
lcr/trans/nmtrans
lcr/trans/nutriosos
lcr/trans/payson
lcr/trans/pinon
lcr/trans/polacca
lcr/trans/quemado
lcr/trans/sanders
lcr/trans/sedona
lcr/trans/showlo
lcr/trans/sprgrville
lcr/trans/stjohn
lcr/trans/toadlena
lcr/trans/tubacity
lcr/trans/tularosa
lcr/trans/winslow
lcr/trans/zuni
maps/amlmap
maps/jmap
maps/nnseal-fig
maps/seal
maps/soil
maps/ushwy
maps/ushwybar
maps/wetlmap
nm/bnd/county
nm/bnd/county/bernalillo
nm/bnd/county/catron
nm/bnd/county/cibola
nm/bnd/county/m
nm/geo/nmgeol
nn/bnd/1882bnd
nn/bnd/admbnd
nn/bnd/agency
nn/bnd/bbox
nn/bnd/chap-co
nn/bnd/chap-stlines
nn/bnd/chapnames
nn/bnd/chaps-ud4
nn/bnd/counties
nn/bnd/dist6
nn/bnd/districts
nn/bnd/eomap
nn/bnd/gd-1937
nn/bnd/hpl
nn/bnd/maps
nn/bnd/maps/resbnd
nn/bnd/nhpl
nn/bnd/nnbobox
nn/bnd/places
nn/bnd/resbnd
nn/bnd/states
nn/bnd/winbnd
nn/bnd/zalltics
nn/cmnty/capital
nn/cmnty/fruitland
nn/cmnty/ft_defiance
nn/cmnty/roads/ganado
nn/cmnty/roads/houck
nn/cmnty/roads/lupton
nn/cmnty/roads/navajo
nn/cmnty/roads/oaksprings
nn/cmnty/roads/sanders
nn/cmnty/roads/sawmill
nn/cmnty/roads/st_michaels
nn/cmnty/towns/capital
nn/cmnty/towns/fruitland
nn/cmnty/towns/ft_defiance
nn/cmnty/towns/ganado
nn/cmnty/towns/houck
nn/cmnty/towns/lupton
nn/cmnty/towns/navajo
nn/cmnty/towns/oaksprings
nn/cmnty/towns/sanders
nn/cmnty/towns/sawmill
nn/cmnty/towns/st_michaels
nn/geo/az
nn/geo/co
nn/geo/nm
nn/geo/ut
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nn/hydr/hydro-pts
nn/hydr/lakes
nn/hydr/sprgs
nn/hydr/sttmap
nn/hydr/sws-nn
nn/hydr/wsheds
nn/mona/station-map
nn/pls/newest-sect
nn/pls/nsect1
nn/pls/nsect2
nn/pls/section1
nn/pls/town1
nn/pls/townlabels
nn/pls/township
nn/ranches/arviso
nn/ranches/berryhill
nn/ranches/blanco
nn/ranches/bluewater
nn/ranches/bo
nn/ranches/carrica
nn/ranches/chaco
nn/ranches/crow
nn/ranches/eli
nn/ranches/elkins
nn/ranches/espil
nn/ranches/foster
nn/ranches/henderson
nn/ranches/herrera
nn/ranches/lrp
nn/ranches/mayfield
nn/ranches/mccracken
nn/ranches/nicoll
nn/ranches/paragon
nn/ranches/pitt
nn/ranches/retherford
nn/ranches/shaw
nn/ranches/sims
nn/ranches/starlake
nn/ranches/vanderwagon
nn/ranches/venado
nn/ranches/westbrook
nn/ranches/winslow
nn/soils/alb
nn/soils/alblab
nn/soils/aztec
nn/soils/aztlab
nn/soils/cortez
nn/soils/escal
nn/soils/flagstaff
nn/soils/flalab
nn/soils/gallab
nn/soils/gallup
nn/soils/lc-soils
nn/soils/marble
nn/soils/marlab
nn/soils/shilab
nn/soils/shiprock
nn/soils/soclab
nn/soils/socorro
nn/soils/st_johns
nn/soils/stjlab
nn/trees/cfbnd
nn/trees/compart
nn/trees/pj
tiger/nm/catr-co
tiger/nm/catr-cou
tiger/nm/catr-hyd
tiger/nm/catr-hydro
tiger/nm/catr-nonvisb
tiger/nm/catr-phy
tiger/nm/catr-phys
tiger/nm/catr-rds
tiger/nm/catr-roads
tiger/nm/catr-trans
tiger/nm/catr-trn
tiger/nm/catr-vis
tiger/nm/catr1
tiger/nm/catr2
tiger/nm/catr3
tiger/nm/cibo-co
tiger/nm/cibo-cou
tiger/nm/cibo-hyd
tiger/nm/cibo-hydro
tiger/nm/cibo-nonvisb
tiger/nm/cibo-phy
tiger/nm/cibo-phys
tiger/nm/cibo-rds
tiger/nm/cibo-roads
tiger/nm/cibo-trans
tiger/nm/cibo-trn
tiger/nm/cibo-vis
tiger/nm/cibo1
tiger/nm/cibo1-bk
tiger/nm/cibo2
tiger/nm/cibo3
tiger/nm/mckn-co
tiger/nm/mckn-cou
tiger/nm/mckn-hyd
tiger/nm/mckn-hydro
tiger/nm/mckn-nonvisb
tiger/nm/mckn-phy
tiger/nm/mckn-phys
tiger/nm/mckn-rds
tiger/nm/mckn-roads
tiger/nm/mckn-trans
tiger/nm/mckn-trn
tiger/nm/mckn-vis
tiger/nm/mckn1
tiger/nm/mckn2
tiger/nm/mckn3
tiger/nm/sanjn-co
tiger/nm/sanjn-cou
tiger/nm/sanjn-hyd
tiger/nm/sanjn-hydro
tiger/nm/sanjn-nonvisb
tiger/nm/sanjn-phy
tiger/nm/sanjn-phys
tiger/nm/sanjn-rds
tiger/nm/sanjn-roads
tiger/nm/sanjn-trans
tiger/nm/sanjn-trn
tiger/nm/sanjn-vis
tiger/nm/sanjn1
tiger/nm/sanjn2
tiger/nm/sanjn3



Virtually all the existing data has been obtained from tribal departments using GIS, Arizona State Land Department Land Resource Information System (ALRIS), and the USGS office in Tucson, AZ. Most of the larger state coverages that tribal departments had were also from ALRIS. The rest of the coverages concerned regional data sets on the reservation. Some, as a result of the adjudication (which made some coverages unavailable) and time and cost restraints, were hybrid coverages that depicted data for a specific project and, in the case of a lot of reservation wide coverages, have the Hopi reservation clipped out. These coverages, while informative, are usually not appropriate for a basin wide coverage. To illustrate this, Figure 1 shows a map of soils on the reservation. A further problem with some of the coverages from the state and federal agencies are the age of the coverages and the fact that some of them lack information on the Navajo Reservation. A good example is the public land survey system coverage from ALRIS. Figure 2 shows the PLS coverage from ALRIS with the Navajo Reservation neatly excised. Many state wide coverages of Arizona that have been received from other organizations are the same for the simple reason that they have all got the coverages from ALRIS.

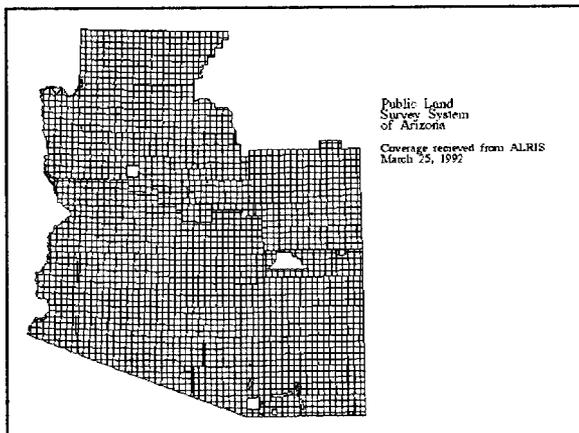


Figure 2 Coverage Showing missing Navajo Reservation area.

coverages originally selected to support the LCR endangered species studies GIS and database would already be available. Those that were not were thought to be small projects that could be digitized using the digitizer and PRIME computer that was available at the Navajo Resource Information Management System (RIMS). That turned out to be an invalid assumption and since that time RIMS has been transferred to the Land Department which had intended to revamp the program with an additional funds from an ANA grant (a federal grant from an administration for Native Americans). That grant was not approved so at this time there is no staff to administer the PRIME and

General Soil's Map of the Navajo Reservation within the Little Colorado River Basin

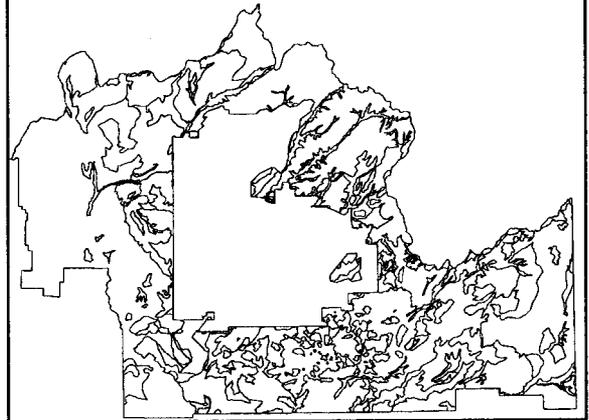


Figure 1 Soils coverage showing how tribal coverages are for specific purposes and are not suitable for basin wide coverages.

Current work is concentrated on putting together coverages that cover the extent of the basin; continue coverage editing and quality control; updating of coverage attributes; documentation of datalayers; and programming ARC/INFO AML modules. Finishing the processing of the 1990 Census TIGER files for transportation, hydrography, physical features and other miscellaneous layers for the three counties in Arizona will be an priority in the next month. All AML's to process the TIGER files are complete. The coverages from ALRIS are back on the system and most have been evaluated and either deleted off the system or moved to the appropriate workspace and will be documented. It was thought that most of the



peripheral equipment. With this situation anticipated, a CalComp digitizer was ordered in July after carryover funds and the Modification to the agreement was made. However, at the time of this report the digitizer has not been received.

The map extent of the data layers has been based on those 1:100,000 USGS quads that are needed to cover the LCR basin. In fact the scale used for all base coverages for the LCR basin will be 1 to 100,000. Twenty four USGS 1:100000 quads are required to cover the basin. Figure 3 shows the template cover for the LCR project. Registration tics for the coverage are the USGS 7.5 minute series corner tics. Tic id's for the coverage follow the convention used by the Navajo Heritage Program. This will allow easy registration of any 7.5 USGS quad in the basin for a specific digitization project. The SAS requirement for the Modification 001 and 002 of the agreement has delayed some equipment purchases. Once the Calcomp 9500 digitizer is received, it will be used to input data that is not available as digital data from other sources. Examples are locations of power generation stations, water diversions,

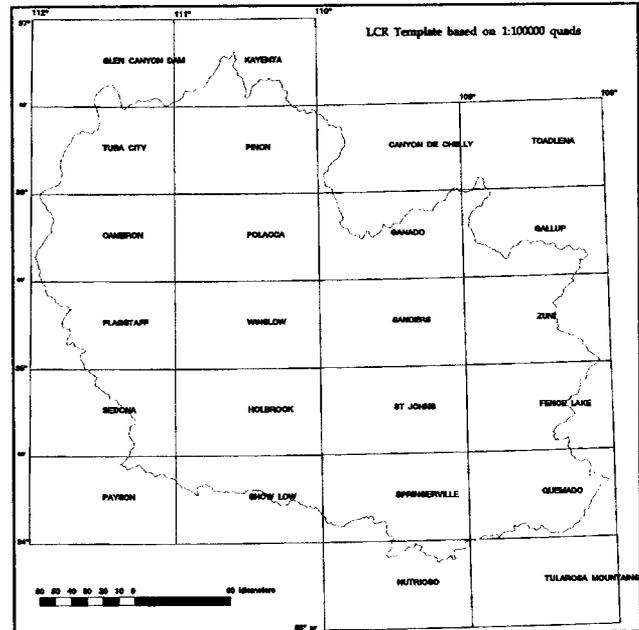


Figure 3 Template coverage for the LCR project.

pumping stations, dumpsites, etc, and a fair amount of geologic and hydrologic information from papers and thesis' that is mainly concerned with the lower part of the LCR.

At this point some coverages have been finalized and moved to the permanent storage workspaces and other coverages are currently undergoing that process. Work on a consistent appearance and documentation of map products from the GIS is primarily through development of AML's that provide tools to more quickly produce these products. These maps and other graphic products will be incorporated into the workbook and final reports. The format of most, if not all, maps produced as a LCR GIS product will appear similar to the map of biotic communities of the LCR provided as an fold-out map, which has been clipped from a coverage digitized from the Biotic Communities of the Southwest by Brown and Lowe, 1980 obtained from ALRIS. Other ARC/INFO macros and menus will be developed in the course of the project that will, to a some extent, automate access, display, and the creation of maps and other graphics from the data themes and individual coverages. These will be available for persons to use if they wish.

The Little Colorado River basin comprises an area of approximately 26,964 square miles. It lies in seven (7) counties and two (2) states. Land ownership is divided between the Navajo, Hopi, Zuni, and White Mountain Apache (a small area), state trust lands of both Arizona and New Mexico, Federal land (National Forests, BLM, National Parks), thousands of private farmers, several large irrigation companies, municipalities, and several large corporate entities (Salt River Project, Phelps Dodge, Arizona Public Service Company, etc). Compiling a comprehensive GIS and technical database on as large and diverse area as the LCR basin is an enormous undertaking. The focus has and will, to some degree, still be on developing the database at this large, "small" scale as discussed at the LCR and the GIS workgroup meetings. As the bibliographic database and activities are well developed and personnel have been trained on manipulating the



database and the process of tracking down the citations, a greater percentage of time will be devoted to the GIS database. In addition, the last of the equipment should be procured early in the next fiscal year. This will greatly accelerate progress on the GIS side of the project. Much more emphasis will be placed on the development of the GIS layers covering the LCR gorge from Blue Springs to the confluence. As data becomes available from the surveying effort of the LCR, more useful and pertinent data to the endangered fish studies should be able to be produced at the precision necessary to fully support the interim flow studies and long term monitoring projects. With the anticipated increase in development of data layers in the gorge area; the survey work in the gorge; the recent initiation of the GCES Scientific Information Management program; and, hopefully, more collaboration between the GIS development and the field research personnel, fiscal year 1993 should be a fruitful one.