DISTRIBUTION AND SPECIES VIABILITY OF NATIVE FISHES

A Human Resources Agreement proposal

to:

U.S. Forest Service, Tonto National Forest, Phoenix, Arizona 85006.

Submitted by:

Arizona State University, Tempe, Arizona 85287

W. L Minckley, Department of Biology (lead)

William F. Fagan, Department of Biology (co-principal investigator)

Jana Fry, Information Technology (co-principal investigator).

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INTRODUCTION

Arizona State University (ASU) proposes to join in a partnership with the U.S. For - est Service, Tonto National Forest, through participation in a Human Resources Agreement. In this document, we describe:

- what has already been developed relative to databases and its inherent adaptability for Geographical Information System (GIS) manipulation of distributional data (mostly for inland fishes);
- how it may be increased in utility and coverage through the use of student assistants, who are at the same time deriving additional, specialized education; and
- how we conceive of its application in the ultimate assessment and/or estimation of species' viability under different land-use regimens, with ideas for beginning a program of estimating species' viability based on database content and other available information.

EXISTING DISTRIBUTIONAL DATABASE AND GIS SYSTEMS

The present ASU database for native, inland, western fishes is constructed at three different "Levels:"

I) historic records of native and non-native fishes represented by voucher specimens in museums;

II) records from published, peer-reviewed literature, typically based on some of the same museum records accumulated for Level I (and cross-referenced with them); and

III) records from field notes, agency/institutional reports, and other sources (e.g.., "gray literature"), neither peer reviewed nor based on vouchers housed in permanent depositories.

These last records (level III) are used only after careful review by specialists. Our error rate in Levels I and II has been forced downward from perhaps 5% at initial input (commenced in 1994-95) to about 1% at present.

We estimate coverage of levels I and II for Arizona at about 90% of available data (-25,000 entries at present), and expect to have about 50% of Level III entered into the GIS (-40,000 additional entries) by the end of summer. Coverage of ~15,000 additional entries (Levels I and II) also is developed for parts of other drainages south of the Columbia River basin (in southern California east of the Sierra Nevada Crest, southern Oregon and Idaho, Nevada, Utah, southwestern Colorado, western New Mexico, and the States of Baja California, Sonora, and western Chihuahua, in Mexico. We have little coverage as yet eastward of the Continental Divide, either in the USA or Mexico. The ultimate goal is to have a working database for fishes of the intermountain region south of the Columbia River basin, extending eastward of the Continental Divide to a point where Mississippi River fishes begin to dominate the fauna, and southward into Mexico to where tropical fishes (as opposed to temperate species) become dominant.

The database is being constructed for bioecological and conservation-oriented documentation and analysis, while retaining its applicability for quickly and efficiently extracting data at any level, from a single sampling site, through individual streams or watersheds, to political units or regions. It functions as a basis for query either directly from the tabulation or through indicating which dot one desires to examine on a output map, from any or all of the following aspects: GENUS, SPECIES, SUBSPECIES, COUNTRY, STATE, COUNTY, MAJOR RIVER BASIN, DRAINAGE, WATERSHED, SPECIFIC LOCALITY, NUMBER OF SPECIMENS, COLLECTION DATE, COLLECTOR(S), DEPOSITORY(IES), CATALOG NUMBER OR REFERENCE(S), and NOTE(S). Input is designed for simplicity, with fields separated only by commas, etc. We are maximizing information while minimizing complexity. The system runs on ArcInfo, ArcView, and associated software, and with manipulation on multiple hardware.

To date, we have received direct and "in-kind" funding from American Rivers, ASU, The Nature Conservancy, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and U.S. Forest Service for the over-all effort. The data are available in read-only format to anyone requesting them. Both Arizona and New Mexico Game and Fish departments have committed to the effort, and other State agencies have expressed sincere interest.

VI USE OF STUDENT ASSISTANCE FOR DATA COMPILATION AND SPECIES' ABILITY ESTIMATION PROJECTS

Three things which limit database advancement are:

a) availability of trained assistants for input, quality control, and data manipulation;

b) availability of work space; and

c) time available for professionals to be dedicated to the project.

We propose to alleviate the first by hiring and educating hourly student assistants under a Human Resources Agreement, the second (and part of the third) by emphasizing use of our existing ASU GIS laboratory and its facilities for physical space and hardware, and the third by spreading the effort among three Co-principal Investigators, each with a different and complementary area of expertise, and by using one or more graduate students to assist in supervising both data accumulation and undergraduate assistants.

The rate at which the database can be expanded and information therein applied to species' viability and other analyses depends mostly on funding available for assistants. The other two limitations can be readily overcome to a point, then become constraints on speed of development. We propose a program that is realistic within our projected space and personal constraints.

a) Assistants. Student assistants will be recruited from undergraduate classes and graduate programs in geography, mathematics, biology, conservation, or related disciplines. Implicit requirements for participation will be a relatively high level of computer literacy, sufficient time to dedicate to the project (a minimum of 10-20 hours/week), and expressed interest in the process and the project itself. Students will be used initially for data input and checking, then later encouraged to obtain GIS training and expansion into other areas related to over-all project goals (e.g., biogeography, species' viability and other ecological analyses, population modeling, conservation biology) so they may participate in advanced analytical phases. Work-study students will be sought to encourage those with limited funds to continue their educational efforts, but hourly undergraduate (not work-study) and graduate support also will be offered, as required. Rates of pay will exceed minimum wage and advance with educational level (higher than minimum hourly wage for more advanced undergraduates and higher yet for graduate students, not to exceed Institutional standard) to encourage excellence in performance. All students will be reviewed for performance at intervals of 3 to 6 months.

b) The GIS Lab in the Computing Commons (Rm 235) features software on both UNIX and PC platforms: ArcInfo, ArcView with Spatial, Surface, and Network Analysis; ERDAS Professional (plus MapSheets); MapInfo; IDRESI; AutoDesk World; Photoshop; and MSOffice. The following hardware is available: SUN Ultra-2 Server; HP 700 Server; HDS Xterms; Pentium PCs; CalComp Digitizer; HP Laser Printers; and Tektronix large-format color plotter. National and international intercommunication is highly developed and functional. Satellite labs with direct links to the GIS Laboratory are located in 10 additional ASU, on-campus units, with two physically located in the Department of Biology (one in Minckley's laboratory).

c) Co-principal Investigators will be William F. Fagan, Ph.D., Assistant Professor of Biology, Jana Fry, M.S., Technical Support Coordinator, Information Technology, and W. L Minckley, Ph.D., Professor of Biology (Curriculum Vitae appended). Fagan and Minckley have full-time teaching appointments, direct graduate students, and maintain other funded and non-funded research programs in the Department of Biology. Fry is director of the ASU Institutional GIS laboratory, where she maintains hardware and software, supervises unit employees, and provides technical support for the ASU research community. Fry also will supervise data input and quality control and assist in maintenance of database integrity for the project. Fagan's role will be to work toward species' viability and other survivorship analyses relative to habitat conditions, guiding use and development of the database toward that end. Minckley will provide ichthyological and historical expertise, evaluate data (especially Level III) as it becomes available, and direct data clean up and manipulation prior to entry into the database proper. All three will participate in analyses and advise the U.S. Forest Service and others as requested and as database uses are better defined and increased in utility and application. Brief curriculum vitae for each co-principal investigator are appended.

ANALYTICAL POTENTIALS

The database described above provides direct, quantitative information on present distributions of all species and species assemblages of fishes relative to their his distributions, and thereby relative, indirectly but intimately, to the different kinds and qualities of habitat they occupied in the past or now inhabit. The ecology of Western fishes has become well known in the past few decades, and present information can be extrapolated into the past with a high degree of confidence. Thus, based on presence-absence distributional data alone, we can provide advice concerning:

a) what species or species assemblages of aquatic organisms are most at risk of extinction or elimination today;

b) what sites (e.g., watersheds) continue to harbor representative populations and assemblages vs. which sites are candidates for restoration vs. which are highly degraded; and

c) ite- and watershed-appropriate habitat information applicable in a diver - sity of approaches to species' maintenance and restoration.

For example, change in distributional status (e.g., range contraction, fragmentation) can be used as an index of threats because those species most impacted by human activities will show patterns of extirpation from large portions of their former range. Such distributional analyses of threats can facilitate prioritization among species of management efforts.

Note that because all data available in th database reflect only presence-absence distributional records, ASU cannot provide pdpulation viability analyses ("PVAs") as typically involved in other conservation programs. Instead ASU will provide advice concerning items a), b), and c) above. This information can then be used by the Forest Service to develop regional planning efforts and prioritize resources among species and sites with an eye to developing more detailed population viability analyses, which are based on demographic and ecological studies far beyond the scope of this proposed effort.

Merging current and former distribution data with maps of habitat type, quality, etc., will permit identification of candidate sites for special management efforts. This will facilitate prioritization among sites with emphasis on decreasing extirpation risks for extant populations and assemblages as well as allocating restoration effort among lower-ranked sites. Finally, combining distribution and habitat maps with expert knowledge on biological requirements of individual species or species assemblages will yield insight on how aquatic species have been and continue to be impacted by forest management practices. These analyses can serve as baselines for management recommendations. Such a multi-tiered approach to linking distributional data to viability assessment is applicable to non-aquatic groups as well.

This a formal proposal processed through ASU's Office of Research and Creative Activities (ORCA). We understand that the allowable indirect cost rate for Human Resources Agreements is 10%, and follow that guideline although Institutional indirect costs are higher fide ASU-ORCA. Estimated costs for the project are contingent on the number of qualified assistants to be hired as well as requests for deliverables by the U.S. Forest Service and availability of funds. It may thus be appropriate to adjust the following budget as circumstances require.

ESTIMATED BUDGET (1 OCTOBER 1998 - 31 SEPTEMBER 1999)

Student hourly wages:	
Undergraduates (4 @ avg 15 hr/wk, 50 wks @ avg $7.50/hr)	$ 22,500.00
Graduates (2 @ avg 20 hr/wk, 50 wks @ avg $13.00/hr)	$ 26,000.00
Workman's Compensation (4.0% hourly wages)	$ 1940.00
Supplies: (paper, printer cartridges, memory, back-up tapes, maintenance, xeroxing, office supplies,	$ 3000.00
Maintenance contracts and costs:	$ 2000.00
Data acquisition: (interlibrary loans, electronic data transfer, travel to museums and libraries for levels I-II data confirmations)	$ 3000.00
Subtotal:	**$** 58,440.00
Indirect costs: 10% total direct costs)	$ 5844.00
Total Estimated Budget:	$ 64,284.00