

PROJECT 4: EXTENSION AND OUTREACH

4.D. ABSTRACT

Applying Spatial and Temporal Modeling of Statistical Surveys to Aquatic Resources

Research Category: Research Program on Statistical Survey Design and Analysis for Aquatic Resources

1. **Sorting Code:** 2001-STAR-D1; responding to Statistical Research Area 2
2. **Title:** Applying Spatial and Temporal Modeling of Statistical Surveys to Aquatic Resources: Extension of Expertise on Design and Analysis to States and Tribes
3. **Investigators:**
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4. **Institutions:** Colorado State University , Water Quality Technology, Inc. (WQTI)
5. **Project Period:** October 1, 2001 – September 30, 2005
6. **Project Cost:** \$57,073, first year cost
\$443,652, total cost over four years

7. **Overall Summary:**

Objectives: (a) To identify and establish the statistical needs of personnel in State and Tribal environmental management agencies (target audience); (b) to prepare, test, and deliver various (traditional, electronic, and web-based) means of delivering relevant information to the target audience.

Expected Results: It is expected that State, Tribal, and local agency personnel will be able to increase their understanding of basic statistical concepts and their awareness of currently available analysis tools while simultaneously developing additional data collection/data analysis/data interpretation skills directly pertaining to their job related tasks. Depending on the interest in the client groups, they will be prepared to either conduct monitoring studies or manage consultants who will conduct the studies. For the latter audience, emphasis will be on concepts and meaning, not on techniques of analysis.

Supplemental Keywords: Outreach, Distance Education, Web-based learning, Manuals,

Workshops., Needs-based Instruction, Accommodating Cultural Differences

Applying Spatial and Temporal Modeling of Statistical Surveys to Aquatic Resources: Extension of Expertise on Design and Analysis to States and Tribes

4.E. OVERALL DESCRIPTION

4.1. OBJECTIVES

The proposed Project will

- ★ Identify and establish the statistical design and analysis needs of personnel in State, Tribal, and local environmental and resource management agencies (target audience)
- ★ Prepare content material relevant to the target audience, keeping in mind the various levels of prior statistical background/training extant in these agencies.
- ★ Develop information delivery methods using traditional means (printed material, short courses, workshops) as well as electronic (CD-R, downloadable files, software) and Web-based (online lectures, self-assessment tools, software) methods. Allowance will be made for incorporation of emerging technology.
- ★ Intercompare and refine the different methods based on the initial experience and feedback received from target audience participants in the outreach activities.
- ★ Develop and distribute an easy to use software tools with a particular focus on statistical routines capable of performing a variety of spatial analyses.

Importance of the proposed activity

State, Tribal and local agencies are engaged in activities related to assessment, monitoring, and reporting of the nation's aquatic resources. These activities include data collection, survey design, database maintenance, preparation of statistical summaries, estimation of species abundance and other key population parameters, analyses related to compliance and to trends monitoring, understanding spatial and temporal patterns in the data. Most of the target audience either do not have the needed statistical training or are unfamiliar with the advances in statistical methodology relevant to their applications, including approaches developed in Projects 1, 2 and 3. Materials and methods developed under this project will directly benefit State, Tribal and local personnel who will gain the necessary knowledge and tools for aquatic resource monitoring design and data analysis.

4.2 APPROACH

- ★ The program director has begun identifying potential users of environmental statistics and their needs. In addition, Dr. Johnson (subcontractor) has several years of experience working with many different tribal agencies on water quality monitoring and related issues. A number of contacts have already been made with State, Tribal and local personnel and additional contacts will be sought so as to form a representative pool of users of environmental statistics whose input will guide our "needs assessment" effort.
- ★ An outcome of the "needs assessment" exercise will be a document detailing a systematic

classification of the types of activities required of the target audience and the associated collection of statistical tools that will directly help them in their activities. As part of this process we will also collect information on the extent of statistical expertise that is present in these agencies – (i) none, (ii) elementary, or (iii) intermediate/advanced. This will guide us in the preparation of outreach material at the proper level for each subset of the target audience. Another type of information that will be collected is the level of technological tools currently available (and likely to become available in the near future) to the target audience, including various spreadsheet programs and special purpose statistical software packages. This will guide us in apportioning our efforts in development of the most beneficial outreach approaches and software tools. Such information will be collected using carefully developed questionnaires and personal interviews.

- ★ Although the proportions of our target audience who will fall into various categories will become better known after the needs assessment phase of the project, it is anticipated that 3 types of outreach material/activities will be developed.

(a) Printed Documents:

Manuals detailing the conduct of routine activities such as preparing environmental status reports, preparation of statistical summaries, precautionary steps for data quality assurance, efficient formats for storage of data and other information that will simplify data preprocessing for statistical analyses.

(b) On-site Workshops/short courses:

Design of workshops or short courses on fundamental statistical concepts (variation, bias, precision, uncertainty, margin of error, probability based sampling, simple methods of estimating key population characteristics) aimed at raising the statistical knowledge base of the target audience. We plan on conducting at least three such short courses during the span of this project. Feedback obtained from the participants in the first workshop will help us fine-tune and improve the workshop content and organization. It is anticipated that, even after project completion, such workshops will continue to be offered periodically.

Three workshops are envisioned:

Workshop 1: basic concepts of statistics and probability and their applications in the context of aquatic resources. This short course will emphasize the importance of consistent and quality data, the meaning of data and summaries, and interpretation of simple studies.

Workshop 2: basics of environmental sampling and monitoring techniques and associated statistical analyses and software. This workshop will also emphasize the interpretation and use of completed analyses, foreseeing the need for some members of the target audience to utilize consultants outside their respective agencies.

Workshop 3: basics of spatial and temporal modeling and analysis techniques and the use

of spatial analysis software. This workshop will emphasize approaches developed in Projects 1, 2, and 3 of this same Program.

A large component of the target audience will benefit from workshop 1 which will serve as prerequisite material for workshops 2 and 3. Each workshop will address computational issues within the context of spreadsheet programs as much as possible since special purpose software may be unavailable to the majority of the target audience. However, use of special purpose software is unavoidable in many situations, particularly for spatial data analysis. Workshop 3 will therefore also address the use of the spatial library of routines developed as part of the overall proposal.

(c) Distance Learning Component:

It is recognized that many of our target audience will be unable to travel and be physically present at the “workshop site,” but will be willing and able to participate in workshops offered in a “distance mode” using the World Wide Web. Therefore, distance learning will be an integral part of the outreach effort. We anticipate the development of the following distance learning tools.

- (i) Instructional material developed for on-site workshops will be also made web-ready for on-line workshop offerings. Self-paced learning modules will be created and administered using interfaces such as WebCT. The material will include audio as well as video components.
- (ii) Chat rooms and discussion groups will be organized and maintained for the duration of each workshop.
- (iii) Self-assessment modules will be created and made available along with the online workshops and this will help participants track their progress.
- (iv) Web-accessible software, with particular emphasis on programs for performing “on-line analysis” of spatial data.
- (v) We recognize that some members of the target audience may have only distractingly slow access to the web. The frustrations this produces can be greatly lessened by committing much of the need material to a CD-R for those participants who have slow web access, as via a modem.

This effort will help us reach a much larger fraction of our target audience while “on-site” workshops will be primarily geared towards the segment of the audience that is not technologically up to date or does not have convenient electronic or web access. We envision that, in time, the need for “on-site” workshops will diminish.

4.3 EXPECTED RESULTS OR BENEFITS

It is expected that State, Tribal, and local agency personnel will be able to increase their understanding of basic statistical concepts and their awareness of currently available analysis tools while simultaneously developing additional data collection/data analysis/data interpretation skills directly pertaining to their job related tasks. Depending on the interest in the client groups, they will be prepared to either conduct monitoring studies or manage consultants who will conduct the studies.

For the latter audience, emphasis will be on concepts and meaning, not on techniques of analysis.

4.4 MANAGEMENT PLAN AND MILESTONES

Year 1:

(a) We will conduct a “needs assessment” study. A survey will be conducted of State, Tribal, and Local environmental and resource management agency personnel. Services of a subcontractor (Dr. Johnson, Water Quality Inc, Fort Collins, Colorado) services will be sought specifically with respect to conducting a needs assessment for the Tribal agencies. For our entire target audience, a determination will be made of their current status and needs in the following areas:

- (i) Educational and Statistical Background
- (ii) Perceived areas where help is most needed
- (iii) Current status of technological tools – availability of personal computers, access to the world wide web.
- (iv) Availability of financial resources for participating in “on-site” workshops.
- (v) Ability to participate in “on-line” workshops.

As a by-product of this study, we will have estimates of the fraction of the target audience that will attend on-site workshops and the fraction that is able to participate in on-line workshops or use workshop contents supplied to them on a CD-R. This will allow us to budget our efforts in line with the anticipated levels of participation.

(b) We will begin the planning and development of a series of self-paced courses for the World Wide Web in spatial analysis and modeling. A spatial analysis library has been developed (using the software package SPlus) over the past five years as part of a course in Quantitative Spatial Analysis taught by the Departments of Statistics and Forest Sciences (Dr. Davis and Dr. Reich). Because of the limitations associated with using Splus, functions within the spatial library need to be enhanced and modified to take advantage of object oriented architecture available in programs such as Visual Basic. Visual Basic, which requires the Microsoft Windows operating system, allows us to take advantage of Object Linking and Embedding technology to seamlessly integrate the geostatistical tools in the spatial library with other applications such as spreadsheets, word processors, and the Internet. Visual Basic can also be linked to ESRI’s ArcIMS interactive mapping software to develop a suite of Web-based spatial analysis tools for doing geo-based analysis. This powerful GIS technology, designed specifically for the Web, provides a diverse set of mapping, and analysis tools, as well as an amazing graphical interface for presenting and analyzing spatial data. Users could use the software to view maps and tables of sample data, as well as perform spatial data analysis such as predictive modeling and simulations.

Year 2:

(a) We will assemble instructional material for workshop-I (basic statistics and probability in the context of aquatic resources), organize this material, and develop an on-site short course. The short

course will be offered during the summer of 2003 on Colorado State University Campus or at a site more convenient to the participants, as recommended by the Consortium of Users of Environmental Statistics, described later. A workbook will be prepared for participant use during the short course. Feedback obtained from participants will be used to further fine-tune the content and presentation approach.

(b) Material developed in part (a) will be made web-ready for an online workshop. This material will include audio-video presentations, self-assessment modules for allowing participants to measure their progress, email and chat-room interaction opportunities as well as the design and management of a discussions site. A graduate research assistant will be made available for “online interaction” with the participants and for tasks related to course administration. The workbook prepared in (a) above will be made available on the web to assist participants follow an organized learning path.

(c) Relative successes of the “on-site” approach versus the “on-line” and “electronic” (CD-R) approaches will be evaluated based on participant feedback. While this will not be a scientifically conducted comparison study, it will give us a very good idea of the advantages and disadvantages of each of the approaches.

(d) We will continue with the development of self-paced modules for the World Wide Web in spatial analysis and modeling. Results from our needs analysis will be used in determining the content of the self-paced modules and the software components needed for each module. The conversion of our spatial library of routines to a form more suitable for Web access and on-line computing will also be undertaken.

Year 3:

(a) Additional content, both on-site and on-line, will be developed for workshop 2 on statistical methods for environmental sampling, monitoring, and related statistical analyses. If appropriate, we will be able to incorporate new approaches developed by the co-investigators on this project in the areas of sampling design and monitoring. Both the on-site and the on-line workshops will be offered during the summer of 2004. The online version of workshop 1 will also be offered during this period. A graduate student and a post doctoral fellow will help with the compilation and organization of workshop material as well as prepare a workbook for workshop participants. The post-doctoral fellow will also help prepare appropriate printed manuals detailing systematic and statistically sound approaches for routine tasks.

(b) Instructional material for workshop 3 on spatial modeling and data analysis, both on-site and on-line, will be developed. New approaches developed by the co-investigators on this project in the area of spatial data analysis will be incorporated as appropriate. Both the on-site and the on-line workshops will be offered during the summer of 2004. A graduate student and a post doctoral fellow will help with the compilation and organization of workshop material and help prepare a workbook for workshop participants. The postdoctoral fellow will also assist in the conversion of our spatial library for web use.

Year 4: Based on feedback from participants of our workshops in years 2 and 3 of the project,

instructional and computational material will be refined. All three workshops will be offered on-line during the summer of 2005. A graduate research assistant will be used for online interaction with the participants in these workshops and for course related administrative tasks.

4.5 GENERAL INFORMATION

Consortium of Users of Environmental Statistics (CUES): Some of the results and outreach is intended to benefit aquatic environmental activities in the States, Tribes and local agencies. The Program can help identify what design and analysis needs such entities have. The director of this proposed program, in collaboration with a program being proposed by Oregon State University, has begun identifying potential users of environmental statistics and some of their needs. Many such “clients” of the proposed Program express a substantial interest in the proposed extension efforts of the Program, under the auspices of the outreach project, #6. These potential clients have volunteered a number of situations of both design and analysis sorts. The following people have been contacted and have expressed, on behalf of their respective agencies, an interest in using techniques and materials developed under this program, and in collaborating on the evaluation of outreach materials:

Mike Ell, Division of Water Quality, Bismark, ND
Jim Harrington, Dept Fish & Game, Rancho Cordova, CA
Rick Hafele, Oregon Dept Environmental Quality, Portland, OR
Shannon Hubler, Oregon Dept Environmental Quality, Portland, OR
Deb Madison, Assiniboine & Sioux Tribes, Ft Peck Reservation, MT
Glenn Merritt, Dept Ecology, Olympia, WA
Dan Mosley, Pyramid Lake Paiute Tribe, Nixon, NV
Lynette Stevens, Navajo EPA, Window Rock, AZ
Rosie Sada, Dept Environmental Quality, Helena, MT
Ann Storrar, Nez Perce Tribe, Lapwai, ID
Sandra White Eagle, Assiniboine & Sioux Tribes, Ft Peck Reservation, MT
Craig Wilson, State Water Resources Control Board, Sacramento, CA
John Woodling, Division of Wildlife, Denver, CO

Letters of support from three of the above appear in the additional materials section of this proposal.

Our Experience in Outreach/Distance Learning Areas:

Information pertaining to workshops 1 & 2: One of the co-investigators (Jim Loftis) has taught 5-day short courses on water quality monitoring (design and analysis) each of past several summers. Participants include environmental consultants, managers, and government workers. Additionally, Jim Loftis and Hari Iyer have been team-teaching a “distance course” on “Statistical Methods for Environmental Monitoring” for the past several years. The distance students have included environmental managers, consultants, ecologists, and even government workers.

The distance course has been offered using two different modes:

- (a) For the past several years we have produced video-tapes of our course (taped live during

classroom lectures) and mailed these tapes to our distance students along with handouts and assignments. These students have interacted with the instructors via email and telephone. This approach has been used by Colorado State University for over 20 years and participant feedback has been generally very favorable.

- (b) More recently we have switched over to an on-line delivery of our course (no video tapes shipped to participants). In this mode, we use email, discussion groups and chat rooms as primary means of participant interaction with instructors. Hari Iyer has also offered a web-based introductory general statistics course to distance students. Feedback received thus far suggests that students are fully satisfied with this approach. Some students who are participating in a distance degree program offered by the statistics department have had the opportunity to experience both approaches – video-tapes and web-based – and a subset of them have indicated that they actually preferred the on-line version.

Consequently, Jim Loftis and Hari Iyer will serve as the primary designers of workshops 1 and 2.

Information pertaining to workshop 3 and the spatial library:

Dr. Davis (Department of Statistics, CSU) and Dr. Reich (Department of Forest Sciences, CSU) have team-taught a course in Quantitative Spatial Analysis for the past five years. During this period, they have developed a spatial library consisting of more than 86 functions written specifically for Splus and capable of performing a variety of spatial analyses such as:

- Characterization and modeling the spatial distribution and association of point data
- Quadrat and distance sampling techniques
- Spatial autocorrelation (Moran's I, Geary's C, join statistics)
- Spatial interpolation (inverse distance weighting, kriging, cokriging, disjunctive kriging, categorical kriging)
- Spatial autoregressive models

It is also clear that functions within this spatial library need to be enhanced and modified to take advantage of object oriented architecture available in programs such as Visual Basic and seamlessly integrate the geostatistical tools in the spatial library with other applications such as spreadsheets, word processors, and the Internet. This will facilitate the offering of on-line workshops and/or self paced courses in spatial analysis and modeling.

Consequently, Dr. Davis and Dr. Reich will be the primary designers of workshop 3 and for developing the needed spatial software tools for the web.

Experience With Development of Java Based Web Tools

Hari Iyer has supervised the design and implementation of Java programs for participant self-assessment and progress tracking for use in courses taught by the Department of Statistics. This program is currently being used in many of our introductory level statistics courses and in at least one graduate level research methods (for graduate students majoring in the health, biological, ecological, and agricultural sciences, as well as some fields in engineering). The program is available via the web and can also be made available on a CD-R. Participants can have their answers graded immediately and receive feedback explaining the relevant concepts. Our experience has been that

participants find this tool extremely valuable.

It is our expectation that a version of such a tool will be developed and used with the on-line workshops addressed in this proposal.

Nontraditional Course Development Experience and Its Implications for the Development of On-Site Short Courses

Hari Iyer has designed two introductory level statistics courses during the past three years at Colorado State University. These courses focus on “activity-based” learning and employ several “real-life” case-studies and hands-on projects (individual and group projects) which allow participants to plan studies, carry out data collection efforts, analyze data, and write reports. The feedback from participants has been very positive and it is our assessment that participants exhibited a greater motivation for learning and are actually more likely to retain the concepts and skills they acquired in an activity-based setting. Therefore, it is our intent to include such hands-on activities and data collection/data analysis experience as part of our on-site summer workshops.

4.6 IMPORTANT ATTACHMENTS - The following pages reproduce letters of support for the sort of outreach proposed here. Urquhart (Director of this proposal) and Stevens (Director of the companion proposal from OSU) have talked to members of several client groups. These people have been uniformly supportive, as indicated by the letters reproduced on the following pages.

4.7. REFERENCES - none