



FINAL TECHNICAL REPORT: PROJECT 1
COMBINING ENVIRONMENTAL DATA SETS

PERIOD COVERED BY FINAL REPORT: October 1, 2001 - September 30, 2006

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PROGRAM NAME (TITLE): SPACE-TIME AQUATIC RESOURCES MODELING AND ANALYSIS PROGRAM (STARMAP)

PROJECT TITLE: Combining Environmental Data Sets

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INSTITUTIONS: Colorado State University (CSU), Oregon State University (OSU), and Southern California Coastal Water Research Project (SCCWRP), University of Alaska Fairbanks (UAF)

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

PROJECT PERIOD: 10/1/2001 - 9/30/2006

OBJECTIVE OF RESEARCH: To Develop Approaches for Spatio-Temporal Design and Modeling to Further Understanding of Aquatic Resources; develop, test, and implement alternative spatial sampling designs for near-coastal systems.

Supplemental Keywords: Geostatistical modeling, computational statistics, latent processes, spatial covariance functions, model selection, sampling design

Relevant Web Sites: <http://www.stat.colostate.edu/starmap>
<http://www.stat.colostate.edu/~jah/software/matern.R>

1. ACCOMPLISHMENTS of PROJECT 1: COMBINING ENVIRONMENTAL DATA SETS

This Project expanded the analysis and interpretation tools available to aquatic scientists, and statisticians who assist them, especially with tools which utilize spatial or temporal models, as well as ones which utilize hierarchical (Bayesian) methods. Specifically:

- ◆ Adapted spatial statistical models to accommodate the branching nature of stream networks; implemented statistical computing tools to support the selection of predictor variables in an aquatic context;
- ◆ Developed hierarchal methods for the analysis of categorical responses, of the sort resulting from macroinvertebrate studies in streams;
- ◆ Developed hierarchal methods for the analysis of ordered categorical responses, of the sort resulting from studies to monitor stream health;

- ◆ Developed and demonstrated hierarchical analysis methods for assigning causes of effects in aquatic systems like stream networks;
- ◆ Produced a textbook that surveys modern methods in computational statistics;
- ◆ Expanded temporal methods for identifying structural breaks;
- ◆ Investigated the uncertainty associated with contour curves developed from spatial statistical models;
- ◆ Developed sampling plans for near-coastal systems;
- ◆ Expanded components of variance tools for characterizing both temporal and spatial variability; and
- ◆ Trained future statisticians, some of whom are already working in environmental fields.

1a. Summary of work

Project 1 involved a substantial number of researchers working in a large variety of areas. This section summarizes the output of Project 1.

Methodology for statistical modeling of spatially-referenced, aquatic, and other environmental data

PI Hoeting produced a textbook, *Computational Statistics*, under this cooperative agreement, co-authored by G. H. Givens. This graduate level textbook surveys a wide variety of topics in modern statistical computing and computational statistics, including optimization, integration (including MCMC methods), bootstrapping, and smoothing. The book has been adopted widely for teaching and is being used by statisticians and non-statisticians alike as a reference book on methods for computational statistics. The book includes a webpage with related software and numerous examples and homework problems. *Computational Statistics* has become a bestselling textbook for Wiley (publisher) and is currently in its fourth printing.

Investigator Gitelman's "Isomorphic Chain Graphs for Modeling Spatial Dependence in Ecological Data" by Gitelman and Herlihy (to appear in *Environmental and Ecological Statistics*) was an important contribution toward developing causal inference models. In this paper, they extend Bayesian belief network models (also called acyclic directed graphs) to accommodate correlation through space.

In conjunction with this work, Investigator Gitelman was invited to serve as the guest associate editor for a special forum on the application of Bayesian belief networks to natural resource management problems organized by the *Canadian Journal for Forest Research*. She was invited to participate in a section on models for multi-scale analysis at the 2005 annual meeting of the Ecological Society of America in Montreal, and to review a collection of papers for inclusion in *EcoHealth*, a Springer publication in environmental science (to appear).

PI Hoeting, PI Davis, STARMAP-funded student Andrew Merton and S. E. Thompson (Pacific Northwest National Laboratory) developed important methodology for model selection in regression-like spatial models (called geostatistical models). In a paper that appeared in *Ecological Applications* these co-authors show that ignoring spatial correlation can result in models being selected that are not reflective of the variables that generated the data. This work also produced freely available software (<http://www.stat.colostate.edu/~jah/software/matern.R>)

that has already been used in several publications to select explanatory variables for geostatistical models.

In closely allied work, Davis and Merton derived the limiting behavior for the maximum likelihood estimator of the range parameter in an exponential covariance function under various scenarios including infill and increasing domain asymptotics. Limit behavior for the case when the sampling strategy within blocks was clustered, regular, or random was also considered. It was shown that for the exponential case in one dimensional, all three samplings paradigms produced asymptotically equivalent estimates.

Investigator Gitelman, in collaboration with PI Hoeting and STARMAP-funded student Irvine (at OSU), has submitted a manuscript in which the properties of spatial covariance are examined in situations with varying amount of spatial dependence, under different sampling designs and for different sample sizes. This work demonstrated that large sample sizes are needed to accurately model spatially-dependent data and that sampling pattern can impact the quality of parameter estimates.

Investigator Gitelman and STARMAP-funded student Megan Dailey developed new methodology reported in the paper “Habitat selection models to account for seasonal persistence in radio telemetry data,” to appear in *Environmental and Ecological Statistics*. In this work, the authors build a flexible hierarchical model for seasonal persistence and seasonal changes in habitat selection, all fit using Bayesian modeling. The model was applied in an attempt to understand habitat selection behaviors in fish in Oregon streams.

PI Hoeting worked with ecologists to investigate various factors affecting the accuracy of predicted species distributions in a paper that appeared in *Ecological Applications* in 2005 (co-authors G. Reese, K Wilson, and C. Flather) . In related work on species distributions, Hoeting served as the discussant for ground-breaking work on Bayesian models for species distributions (conference and journal article in *Bayesian Analysis* in 2006). In another paper that appeared *Ecological Applications* in 2006, PI Hoeting (and co-authors M. Farnsworth, N.T. Hobbs, and M. W. Miller) developed models to examine how animal movement can be linked to the spread of disease. In a manuscript that appeared in *Biometrics* in 2003, PI Hoeting and STARMAP funded student D. Johnson developed new models for capture-recapture data. While not directly related to aquatic resource monitoring, the models that appeared in these publications will help ecologists further understand where species live, why they live there, and how diseases impact these organisms. This work, in conjunction with aquatic resource monitoring, will help us further understand entire ecosystems.

STARMAP-funded student D.S. Johnson, PI Hoeting, and N.L. Poff (a researcher on EPA-funded STAR project R8286301), developed new models for monitoring aquatic resource data. The new models are for multiple variable, categorical data where researchers are interested in modeling the proportion of observations in each group as well as the relationships between these groups and various explanatory variables. These models were used to investigate the relationship between fish traits and environmental predictors of the presence of fish with these traits, using the EPA EMAP

MAHA data set. This work appeared in a recent book *Bayesian Statistics and its Applications* (2006).

Confidence Bounds for Map Contours

Josh French, a graduate student formerly supported by STARMAP, is working with Richard Davis devising confidence bands around level curves for a spatial field. The idea is that from a map produced via kriging one can display level curves of the predicted conditional mean. However, calculation of error bounds for these level curves are not so easy to construct or even to define in a probabilistic sense. Davis and French are developing procedures that allows one to put confidence bands, displayed as small rectangular boxes that have a preset confidence probability. In other words, these boxes can be constructed so that we are 95% confident the process takes the desired threshold value somewhere in the box. The boxes are then linked together to give a “confidence set” for the level curve. This work is still ongoing, illustrating that the effect of STARMAP’s funding from EPA is extending past its funding period.

Structural Breaks in Time Series

PI Davis worked with colleague Thomas Lee and postdoctoral fellow Gabriel Rodriguez-Yam, exploring the problem of detecting structural breaks in a time series. The key idea was to assume that the nonstationary time series can be well represented by piecewise autoregressions. The principle of minimum description length (MDL) was used to assess the quality of fit for various structural break locations and the genetic algorithm was used to find near optimal minima of the MDL. The number of structural breaks, their locations, and the orders of the respective piecewise AR models were assumed unknown. This paradigm seemed to work well in a variety of applications. This research was published in the *Journal of the American Statistical Association*.

Methodology for sampling

Investigators Ritter and associates of the Southern California Coastal Water Research Project (SCCWRP) developed spatially distributed sampling plans suited to wastewater oceanic outfalls. Their project investigated cost effective ways to distribute sample points in a near-coastal system to support estimation of the spatial pattern of various analytes and macroinvertebrate indices. The work is summarized in a paper that appeared in *Environmental and Ecological Statistics*. Ritter applied these methods to produce a design which was implemented by the San Diego Metropolitan Wastewater District.

Some of Director Urquhart’s investigations of components of variance concerned temporal and spatial matters so are reported under this Project. When field visits to aquatic sites are widely distributed in space, and occasionally in time, components of variance can be used to capture most of the spatial and temporal variation, but not to model its form. Nevertheless such characterizations have proved useful in evaluating the likely (statistical) power to detect trend. The developed methodology was used to compare temporal or revisit designs relative to their power to detect trend. Some are decidedly better than others, a fact which was communicated to various interested clients.

1b. Training future environmental statisticians

A significant outcome of this project included a large number of students trained in environmental statistics. A number of these students are now working in fields directly related to environmental statistics in the U.S. The students involved in Project 1 include:

Ones who have completed their degrees:

- ◆ Devin Johnson, PhD from CSU in Statistics, 2003. Thesis title: *Bayesian Analysis of State-Space Models for Discrete Compositions*. After working for two years on the faculty at the University of Alaska, Fairbanks, Johnson is now a statistician at the National Marine Mammal Laboratory, Alaska Fisheries Science Center, NOAA. Advisor: PI Hoeting.
- ◆ Steve Jensen, MS from OSU in Statistics, *Brief Introduction to Reversible Jump MCMC for Bayesian Networks and an Application* (Advisor: Investigator Gitelman). Jensen current work for a small graphical modeling software company which includes environmental applications.
- ◆ Brett Kellum, MS from CSU in Statistics, 2003. *Analysis and Modeling of Acid Neutralizing Capacity in the Mid-Atlantic Highlands Area*. Advisor: PI Hoeting.
- ◆ Andrew Merton, PhD from CSU in Statistics, 2006, *Geostatistical Models: Model Selection and Parameter Estimation under Infill and Expanding Domain Asymptotics*, Advisors: PIs Hoeting and Davis. Merton is currently working as a contract employee for the National Park Service. He is developing sampling plans for inventory and monitoring of vegetation, water quality and a number of other factors for a number of National Parks in the Western U.S.
- ◆ Julia Smith, MS from CSU in Statistics, 2005, *Modeling and Predicting Median Substrate Size in Oregon and Washington Streams Utilizing Geographic Information Systems*. This work was joint work with Brian Bledsoe, another EPA STAR-grant researchers. Ms. Smith teaches high school advanced placement statistics in Anchorage, AK, transmitting ideas of environmental statistics to future generations of environmental scientists.
- ◆ Sarah Williams, MS from CSU, 2006. *A Comparison of Variance Estimates of Stream Network Resources*. (Advisor: Director Urquhart).

Degrees currently in progress:

- ◆ Stephanie Fitchett, current MS student, CSU. Anticipated graduation date: 2007. Fitchett is extending work by Erin Peterson (STARMAP project 3) to develop user-friendly guidelines for GIS users as well as geostatistical models to be used to analyze stream monitoring data. (Advisors: Director Urquhart and PI Hoeting).
- ◆ Joshua French, current PhD student, CSU. Anticipated graduation date: 2008. French is developing models for uncertainty in contour lines for spatial maps, including contours for oceanic pollutants. (Advisor: PI Davis).
- ◆ Megan Dailey Higgs, current PhD student. Anticipated graduation date: 2007. Higgs is currently working on Bayesian models for ordered categorical spatial data and categorical habitat data. These models are being developed for analysis of a number of EPA data sets and will be particularly useful to model data on stream health and to predict health at unobserved sites. Advisor: PI Hoeting.
- ◆ Kathryn Irvine, current PhD student, OSU. Anticipated graduation date: 2007. Irvine's PhD work is in two separate, but related topics. She examined behavior of parameter

estimates in geostatistical models in a paper currently submitted to a peer reviewed journal. For a related paper, Irvine was awarded 2nd place honorable mention in the student paper competition sponsored by the Section on Statistics in the Environment of the American Statistical Association in 2006. Her current Ph.D. work extends the work of Gitelman and Herlihy on several features of graphical models that will allow simple-to-understand graphical model diagrams explaining relationships for aquatic data. In a position similar to Merton's described above, Irvine is also currently working as a contract employee for the National Park Service developing survey and monitoring plans for National Parks in the Western U.S.

Another outcome of the project is the post-doctoral training offered to Man Sik Park, who worked on the project from late 2005 through fall 2006. This work produced two manuscripts which have all been submitted to peer-reviewed journals and one working paper. Two of the manuscripts propose new ways to examine spatio-temporal data and one manuscript proposes new models for spatially-referenced data. The last manuscript, related to Gaussian Markov random fields, can be used to analyze very large data sets and is an improvement over existing methods.

The investigators on this project were widely scattered throughout the Western U.S. The project and the related STARMAP and DAMARS workshops allowed for additional interactions that would not have been possible without EPA funding. These links have and will continue to lead to the development of new methodology for to collect and analyze aquatic data. Interactions between Ritter and Urquhart; Hoeting and Gitelman; Merton, Theobald (Project 3), Urquhart, Ver Hoef and Peterson are just several examples of the new linkages that developed under this funding. All these interactions produced new methodology for the analysis of aquatic resource data.

2. SIGNIFICANCE OF ACCOMPLISHMENTS

A major accomplishment of Project 1 was the training of statisticians in environmental problems. As described above, a number of these students are already using the knowledge gained from working on the STARMAP project in various government agencies and private businesses.

The model selection component of the research accomplishments serves as a warning to scientists in selecting covariates in geospatial models. This process needs to be conducted in concert with the modeling of the error term. Often the error term can be used as a proxy for missing covariates or can be used as a correction factor for incorrectly selected covariates.

The asymptotic theory for the exponential covariance function is useful to the scientist for selecting optimal sampling strategies with the goal of producing the most efficient parameter estimates. In the exponential case, it is difficult to beat a uniform sampling plan. This might change for the Matern covariance function, which is a topic of future study.

The structural break detection research has shown great promise in segmenting a time series into stationary segments. The strategy developed, called AutoPARM for Automatic Piecewise AR Modeling, is a general procedure that overcomes many of the limitations and defects of previously proposed procedures. In addition, very few assumptions are made in this framework. We intend to explore versions of AutoPARM that would apply more directly in the geospatial context.

Ritter of the Southern California Coastal Water Research Project (SCCWRP) investigated cost effective ways to distribute sample points in near-coastal systems to support estimation of the spatial pattern of various analytes and macroinvertebrate indices. The resulting design was implemented by the San Diego Metropolitan Wastewater District. This design will likely serve as a prototype for many similar studies along the California coast, developed in collaboration with the Southern California Coastal Water Research Project.

The work on power to detect trend in aquatic surveys by Urquhart has been and is being used by designers of both aquatic and terrestrial surveys to make effective use of limited resources. This work is widely cited in publications concerned with the design of environmental surveys.

3. STAKEHOLDERS AND USERS OF RESULTS

Since Project 1 covered a wide variety of topics, the stakeholders and users of the results also vary widely.

The textbook *Computational Statistics*, has been adopted by a number of universities including Stanford University, Ohio State University, University of Minnesota, Bowling Green State University, and others. The book is also sold internationally. It is anticipated that as more universities adopt the textbook, this work will be disseminated throughout the U.S. and used to educate statisticians, with particular emphasis on the education future environmental statisticians due to the ecological examples used in the book.

This textbook has resulted in four short courses, to date. These courses have served a wide audience of U.S. based statisticians, including a number of statisticians working for Federal and State government agencies, including several from environmental agencies. The courses include:

- ◆ Statisticians attending the Joint Statistical Meetings, August 2006, Seattle, WA.
- ◆ Statisticians affiliated with the Alaska chapter of the American Statistical Association (Participants were mainly employed by U.S. Fish and Wildlife Service, Alaska Fish and Game Department, and affiliated with the University of Alaska, Fairbanks).
- ◆ Statisticians attending the Joint Statistical Meetings, [August 2005, Minneapolis](#).
- ◆ Statisticians attending the American Statistical Association Section on Statistics and the Environment, and University Chicago Center for Integrating the Statistical and Environmental Sciences. [October 2004, Chicago](#).

We expect that the modeling tools that we have developed will be useful to a wide range of users of statistics in the environmental sciences, geosciences, biology and medical professions. A current example of the structural break work deals with record sounds in the National Parks. There is interest in segmenting a long audio stream of recordings obtained from microphones strategically placed in many of the National Parks. One of the goals of this data collection process was to allow the US Park Service to measure and monitor noise pollution in the national parks. One measure of the pollution is the proportion of unnatural (man-made) sound heard in the parks. Auto-PARM, software developed by the investigators, can be used to help segment the audio tapes into homogeneous pieces of natural and unnatural (e.g., snow mobile and jet plane noise) sounds. After segmenting the sounds, we attempt to classify the individual pieces into various categories of known

sound types. This research is of value to various government agencies, including the National Park Service.

With regards to Ritter's work, the San Diego Metropolitan Wastewater District used Ritter's design. Other stakeholders include the people and other living organisms who utilize near-coastal waters and adjacent beaches. Her work shows how to design cost-effective studies of the consequences of oceanic wastewater outfalls.

The immediate users of Urquhart's work are agency personnel who have to design ecological surveys; these include state-level environmental scientists in many states, including Oregon, Wisconsin, and Maryland. Longer term we all benefit from better and more defensible information being gathered in cost-effective ways.

4. HOW PRODUCTS WILL FURTHER SCIENCE/ MANAGEMENT OF RESOURCES

The statistical methodology, software, textbook, papers, short courses and talks, all have and will continue to support the design of aquatic environmental studies and the analysis of the resulting data in diverse contexts. These tools and demonstrations will support the more accurate and defensible analysis of diverse environmental variables.

The training of statisticians versed in methods for modeling aquatic data have already resulted in new statisticians working in positions related to ecology and aquatic resources.

The design results of Ritter's work will allow better management of wastewater outfalls. The associated current work of French demonstrates the uncertainty associated with the sorts of contours often computed by GIS applications, and used in regulatory statements.

5. LISTING OF SPECIFIC COMMUNICATIONS RELATED TO COMBINING ENVIRONMENTAL DATA SETS

Note that the following list is a subset of the entire output list from STARMAP; the complete list, supplied as a separate document as a part of this final report, provides internal links to most of the presentation materials, technical reports, and some manuscripts. Published material ordinarily was copyrighted by the publisher, so access to it usually is restricted to subscribers of that publication. The subset below includes all communications related combining environmental data sets.

PUBLICATIONS and ACCEPTED MANUSCRIPTS:

- ◆ Ritter, K.J. and M.K. Leecaster (2007). Multi-Lag cluster enhancement of fixed grid sample designs for estimating the variogram in near coastal systems. *Environmental and Ecological Statistics* **14**: .
- ◆ Gitelman, A.I. and A.T. Herlihy (2007). Isomorphic chain graphs for modeling spatial dependence in ecological data. *Environmental and Ecological Statistics* **14**: .
- ◆ Dailey, M.C., A.I. Gitelman, F.L. Ramsey, and S. Starcevich. Habitat selection models to account for seasonal persistence in radio telemetry data. *Environmental and Ecological Statistics* **14**: .

- ◆ Brockwell, P.J., R.A. Davis, and V. Yang (2006). Continuous-time Gaussian autoregression. To appear in *Statistica Sinica* .
- ◆ Peterson, E.E., A.A. Merton, D.M. Theobald, and N.S. Urquhart (2006). Patterns of spatial autocorrelation in stream water chemistry. *Environmental Monitoring and Assessment* **121**: 569-594
- ◆ Thomas, D.E., D.S. Johnson, and B. Griffith (2006). A Bayesian random effects discrete-choice model for resource selection: Population-level selection inference. *Journal of Wildlife Management* **70**: 404-412.
- ◆ Farnsworth, M.L., J.A. Hoeting, N.T. Hobbs, and M.W. Miller (2006). Linking chronic wasting disease to mule deer movement scales: A hierarchical Bayesian approach. *Ecological Applications* **16**: 1026–1036.
- ◆ Andrews, B., R.A. Davis, and F.J. Breidt (2006). Maximum likelihood estimation for all-pass time series models. *Journal of Multivariate Analysis* **97**: 1638-1659
- ◆ Hoeting, J.A., R.A. Davis, A.A. Merton, and S.E. Thompson (2006). Model selection for geostatistical models. *Ecological Applications* **16**: 87-98.
- ◆ Davis, R.A., T.C.M. Lee, and G. Rodriguez-Yam (2006). Structural break estimation for nonstationary time series models. *Journal of the American Statistical Association* **101**: 223-239.
- ◆ Johnson, D.S., J.A. Hoeting, and N.L. Poff (2006). Biological monitoring: A Bayesian model for multivariate compositional data. pp 270-289 in *Bayesian Statistics and its Applications*, Eds. S. K. Upadhyay, U. Singh and D. K. Dey. Anamaya publishers: New Delhi.
- ◆ Hoeting, J.A. (2006). Some perspectives on modeling species distributions. Discussion of article by A.E. Gelfand, J.A. Silander, S. Wu, A. Latimer, P.O. Lewis, A.G. Rebelo, M. Holder. *Bayesian Analysis* **1**: 93-98.
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam (2005). Structural break estimation for nonstationary time series signals. Proceedings of IEEE/SP 13th Workshop on Statistical Signal Processing, Bordeaux, France, July, 2005.
- ◆ Davis, R.A. and G.A. Rodriguez-Yam (2005). Estimation for state-space models based on a likelihood approximation. *Statistica Sinica* **15**: 381-406.
- ◆ Givens, G.H. and J.A. Hoeting (2005). **Computational Statistics**. John Wiley & Sons, New York, 418 pages.
- ◆ Reese, G.C., K.R. Wilson, J.A. Hoeting, and C.H. Flather (2005). Factors affecting the accuracy of predicted species distributions: A simulations experiment. *Ecological Applications* **15**: 554-564.
- ◆ Kahl, J.S., J.L. Stoddard, R. Haeuber, S.G. Paulsen, R. Birnbaum, F.A. Deviney, J.R. Webb, D.R. DeWalle, W. Sharpe, C.T. Driscoll, A.T. Herlihy, J.H. Kellogg, P.S. Murdoch, K. Roy, K.E. Webster, and N.S. Urquhart (2004). How have U.S. surface waters responded to the 1990 Clean Air Act Amendments? Feature article, *Environmental Science and Technology* **38**: 484A-490A.
- ◆ Courbois, J.P. and N.S. Urquhart (2004). Comparison of survey estimates of the finite population variance. *Journal of Agricultural, Biological and Environmental Statistics* **9**: 236-250.

- ◆ Kincaid, T. M., D.P. Larsen, and N.S. Urquhart (2004). The structure of variation and its influence on the estimation of status: Indicators of condition of lakes in the Northeast, U.S.A. *Journal of Environmental Monitoring and Assessment* **98**: 1-21.
- ◆ Larsen, D.P., P.K. Kaufmann, T.M. Kincaid, and N.S. Urquhart (2004). Detecting persistent change in the habitat of salmon-bearing streams in the Pacific Northwest. *Canadian Journal of Fisheries and Aquatic Sciences* **61**: 283-291.
- ◆ Waite, I.R., A.T. Herlihy, D.P. Larsen, N.S. Urquhart, and D.J. Klemm (2004). The effects of macroinvertebrate taxonomic resolution in large landscape bioassessments: an example from the Mid-Atlantic Highlands, U.S.A. *Freshwater Biology* **49**: 474-489
- ◆ Johnson, D.S. and J.A. Hoeting (2003). Autoregressive Models for Capture-Recapture Data: A Bayesian Approach. *Biometrics* **59**: 341-350.
- ◆ Davis, R.A., W.T.M. Dunsmuir, and S.B. Streett (2003). Observation driven models for Poisson counts. *Biometrika* **90**: 770-790.
- ◆ Hoeting, J.A. (2002). Methodology for Bayesian model averaging: An update. Proceedings of invited paper presentations, International Biometric Conference, Freiburg, Germany, pp 231-240.
- ◆ Larsen, D.P., T.K. Kincaid, S.E. Jacobs, and N.S. Urquhart (2001). Designs for evaluating local and regional scale trends. *Bioscience* **51**: 1069-1078.

SOFTWARE

- ◆ Merton, A.A., J.A. Hoeting, and R.A. Davis (2004). Model Selection for Geostatistical Models. Software to compute AIC and MDL for geostatistical models for R.

SUBMISSIONS

- ◆ Park, M.S. and J.A. Hoeting. Spatial neighborhood order determination for gaussian markov random fields. Submitted to the *Journal of Statistical Planning and Inference* (December 1, 2006)
- ◆ Irvine, K.M., A.I. Gitelman, and J.A. Hoeting. Spatial designs and strength of spatial signal: effects on covariance estimation. Revision under review by *Journal of Agricultural, Biological and Environmental Statistics* (March, 2006); also awarded 2nd place honorable mention in the student paper competition sponsored by the Section on Statistics in the Environment of the American Statistical Association.
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Break detection for a class of nonlinear time series models. (Submitted, 2005).
- ◆ Park, M.S. and M. Fuentes. A new class of asymmetric spatio-temporal covariance models. Winner of the student paper competition sponsored by the Section on Statistics in the Environment of the American Statistical Association (Feb, 2006). Submitted to *Journal of Multivariate Analysis*.

MANUSCRIPTS

- ◆ Johnson, D.S., J.A. Hoeting. A note on marginalization in chain graph models. In prep for *Statistics and Probability Letters*.
- ◆ Johnson D.S., J.A. Hoeting, and B.S. Fadley. Random effects graphical regression models for multidimensional categorical data. In prep for *Scandinavian Journal of Statistics* 2006

- ◆ Irvine, K.M. and A.I. Gitelman. Multi-scale analysis: Implications for modeling presence/absence of species. Under revision.
- ◆ Rodriguez-Yam, G., R.A. Davis, and L.L. Scharf. Efficient Gibbs Sampling for constrained linear regression. Under revision (2006).
- ◆ Park, M.S. and M. Fuentes. Testing lack of symmetry in spatial-temporal processes, working paper. (2006).
- ◆ Jensen, S. and A.I. Gitelman. Fitting graphical models: Some computational consideration. working paper
- ◆ Johnson, D.S. and J.A. Hoeting. Random effects graphical models for multiple site sampling. Under revision. Available at

TECHNICAL REPORTS

- ◆ Williams, S.J. (2006). A Comparison of Variance Estimates of Stream Network Resources. Masters Project Report, Department of Statistics, Colorado State University.
- ◆ Smith, J.J. (2005). Modeling and Predicting Median Substrate Size in Oregon and Washington Streams Utilizing Geographic Information Systems. Masters Project Report, Department of Statistics, Colorado State University.
- ◆ Johnson, D.S. (2005). Bayesian Inference for Geostatistical Regression Models Technical Report, Department of Statistics, Colorado State University, Fort Collins, CO
- ◆ French, J. (2005). Exploring Spatial Correlation in Rivers. Masters Project Report, Department of Statistics, Colorado State University, Fort Collins. 60pp
- ◆ Johnson, D.S. (2003). Random Effects Graphical Models for Discrete Compositional Data. Doctoral Dissertation, Department of Statistics, Colorado State University.
- ◆ Kellum, B. (2002). Analysis and Modeling of Acid Neutralizing Capacity in the Mid-Atlantic Highlands Area. Masters Project Report, Department of Statistics, Colorado State University, Fort Collins. 69pp
- ◆ Johnson, D.S. and J.A. Hoeting (2001). Autoregressive Models for Capture-Recapture Data: A Bayesian Approach. Technical Report 2001-10, Department of Statistics, Colorado State University

PRESENTATIONS:

{Note: The first author listed in the citations below gave the presentation, unless subsequent author is marked with an * as the presenter.}

- ◆ Merton, A.A. Geostatistical Models: Model Selection and Parameter Estimation Under Infill and Expanding Domain Asymptotics. Doctoral Seminar, Department of Statistics, Colorado State University, October 30, 2006
- ◆ Higgs, M.D. Bayesian Models for Ordered Categorical Spatial Data and Categorical Habitat Data. Seminar, Department of Statistics, Colorado State University, September 28, 2006
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series Models. Seminar, National Center for Atmospheric Research, Institute for Mathematics Applied to Geosciences, September 15, 2006
- ◆ Ritter, K.J., K.C. Schiff, N.S. Urquhart, D. Olson, A. Groce, and T. Stebbins. Mapping Chemical Contaminants in Oceanic Sediments Around Point Loma's Treated Wastewater Outfall. California and the World Ocean Conference 2006, as part of the Seafloor mapping session. September 17-20, 2006

- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection for a Class of Time Series Models. Plenary speaker, International Conference on Statistics, Combinatorics, and Related Areas, Tomar, Portugal, September 1-4, 2006
- ◆ Hoeting, J.A., R.A. Davis, A.A. Merton and S.E. Thompson. Model Selection and Estimation for Geostatistical Models. (Invited) Joint Statistical Meetings, Seattle, WA, August 6-10, 2006
- ◆ Higgs, M.D., J.A. Hoeting, and B. Bledsoe. Bayesian Modeling for Ordinal Substrate Size Using EPA Stream Data: a Spatial Model for Ordered Categorical Data. Joint Statistical Meetings, Seattle, WA, August 6-10, 2006
- ◆ Park, M.S. and M. Fuentes. A new class of asymmetric spatio-temporal covariance models. Joint Statistical Meetings, Seattle, WA, August 6-10, 2006 (Winner of the student paper competition sponsored by the Section on Statistics in the Environment of the American Statistical Association.)
- ◆ Irvine, K.M., A.I. Gitelman, and S.E. Thompson. Spatial designs and strength of spatial signal: effects on covariance estimation. Joint Statistical Meetings, Seattle, WA, August 6-10, 2006 (2nd place honorable mention in the student paper competition sponsored by the Section on Statistics in the Environment of the American Statistical Association.)
- ◆ Jennifer Hoeting, a STARMAP Principal Investigator, and Geof Givens presented a short course entitled **Statistical Computing: Techniques for Integration and Optimization** two different places:
 - Alaska Chapter of the American Statistical Association (With R applications, two days), Juneau, AK, July, 2006, and
 - Joint Statistical Meetings (one day), Seattle, WA, August 6-10, 2006
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection for a Class of Nonlinear Time Series Models. IMS Western Regional Meeting, Flagstaff, Arizona, June 27-30, 2006
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. BIRS Workshop Statistics at the Frontiers of Science, Banff International Research Station, Banff, Canada, June 24-29, 2006
- ◆ Hoeting, J.A. presented two talks, Introduction to Bayesian Data Analysis Methods, and An Introduction to WinBUGS, to the PRIMES Workshop on Bayesian Methods in Wildlife Population Monitoring, Colorado State University, Fort Collins, CO, June 14-16, 2006
- ◆ Davis, R.A. Extremes of Space-Time Processes with Heavy Tails. Extremes in Action. Symposium for Georg Lindgren, Lund, Sweden, June 8-9, 2006
- ◆ Peterson E.E., D.M. Theobald, N.S. Urquhart, J.M. Ver Hoef, and A.A. Merton. Regional GIS-based Geostatistical Models for Stream Networks. Workshop on Modeling Salmon Habitat, hosted by the Alaska Department of Fish & Game and The Nature Conservancy, Anchorage, Alaska, May 17-19, 2006
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. Seminar, Department of Statistics, Columbia University, New York May 1, 2006

- ◆ Hoeting, J.A. Modeling in the Presence of Uncertainty. Invited discussant for papers by A. Gelfand and J. Breidt. Conference on Uncertainty in Ecological Analysis, Ohio State University, Columbus, OH, April 2006
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. Seminar, Department of Statistics, University of California, Davis, April 27, 2006
- ◆ Breidt, F.J., R.A. Davis, N.-J. Hsu, and M. Rosenblatt. Laplace Likelihood and LAD Estimation for Non-invertible MA(1). Waseda Workshop on Time Series Analysis and Its Related Topics, Waseda University, Tokyo, Japan, January 23-25, 2006
- ◆ Smith, J.J. Modeling and Predicting Median Substrate Size in Oregon and Washington Streams Utilizing Geographic Information Systems. Masters Seminar, Department of Statistics, Colorado State University, December 6, 2005
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. Statistics and Probability Conference in Memory of Ching-Zong Wei, Academia Sinica, Taipei, December 12-14, 2005
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. International Conference on Statistics, Combinatorics, Mathematics, and Applications, Auburn University, Auburn, Alabama, December 2-4, 2005
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. Charles University, Prague, Czech Republic, November 9, 2005
- ◆ Peterson, E.E., D.M. Theobald, N.S. Urquhart, J.M. Ver Hoef, and A.A. Merton. Predicting Water Quality Impaired Stream Segments Using Landscape-scale Data and a Regional Geostatistical Model. Statistical Society of Australia, St. Lucia, Queensland, Australia. October 18, 2005
- ◆ Breidt, F.J., R.A. Davis, N.-J. Hsu, and M. Rosenblatt. Laplace Likelihood and LAD Estimation for Non-invertible MA(1). NSF/NBER Workshop in Time Series, Heidelberg, Germany, September 22-24, 2005
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. Nonlinear and Nonstationary Time Series Workshop, Kaiserslautern, Germany. September 20-21, 2005
- ◆ Larsen, D.P. and N.S. Urquhart. Designs for Estimating Variability Structure and Implications for Detecting Watershed Restoration Effectiveness. American Fisheries Society, Anchorage, AK, September 11-15, 2005
- ◆ Merton, A.A. and E.E. Peterson. Using the Maryland Biological Stream Survey Data to Test Spatial Statistical Models: A Collaborative Approach to Analyzing Stream Network Data. Fourth Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, September 7 - 9, 2005
- ◆ Hoeting, J.A. Geostatistical Modeling: Model Selection and Parameter Estimation. Fourth Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, September 7 - 9, 2005
- ◆ Gitelman, A.I. and K.M. Georgitis. Connecting Correlated Predictors Using Graphical Models. Fourth Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, September 7 - 9, 2005

- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. Fourth Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, September 7 - 9, 2005
- ◆ Urquhart, N.S. Developments in Trend Detection in Aquatic Surveys. Fourth Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, September 7 - 9, 2005
- ◆ Peterson, E.E., A.A. Merton, N.S. Urquhart*, D.M. Theobald, and J.A. Hoeting. Using the Maryland Biological Stream Survey Data to Test Spatial Statistical Models. Second Maryland Stream Conference, Carroll College, Westminster, MD, August 10 - 13, 2005
- ◆ Gitelman, A.I. and K.M. Georgitis. Bayesian Network Models to Account for Correlation Across Scales. ESA/INTECOL, Montreal, Canada, August 8, 2005
- ◆ Hoeting, J.A. and D.S. Johnson. Bayesian Models for a Multivariate Discrete Response. Joint Statistical Meetings, Minneapolis, MN, August 7 - 11, 2005
- ◆ Hoeting, J.A. and G.H. Givens. Computational Statistics: Methods for Optimization and Monte Carlo Integration. Continuing Education Course. Joint Statistical Meetings, Minneapolis, MN, August 7 - 11, 2005
- ◆ Johnson, D.S. Bayesian Model Selection for Geostatistical Regression Data. Joint Statistical Meetings, Minneapolis, MN, August 7 - 11, 2005
- ◆ Davis, R.A., G.A. Rodriguez-Yam and T.C.M. Lee. Structural Break Detection in Time Series Models. 13th INFORMS Applied Probability Conference, Ottawa, Canada, July 6 - 8, 2005
- ◆ Gitelman, A.I. K.M. Georgitis. Connecting Correlated GIS Predictors in a Bayes Network Model. WNAR/IMS Meeting, Fairbanks, AK, June 21 - 24, 2005
- ◆ Georgitis, K.M., A.I. Gitelman, and J.A. Hoeting. Estimation and Model Selection for Geostatistical Models. WNAR/IMS Meeting, Fairbanks, AK, June 21 - 24, 2005
- ◆ Johnson, D.S. Bayesian Model Determination for Spatial Regression Data. WNAR/IMS Meeting, Fairbanks, AK, June 21 - 24, 2005
- ◆ Dailey, M.C., A.I. Gitelman, F.L. Ramsey, and S. Starcevich. Habitat Selection Models to Account for Seasonal Persistence in Radio Telemetry Data. 2005 WNAR/IMS Meeting, Fairbanks, AK, June 21 - 24, 2005
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Estimation in Time Series Models. CIRANO-CIREQ Financial Econometrics Conference, University of Montreal, Montreal, Canada. May 21-22, 2005
- ◆ Davis, R.A., T. Mikosch, and B. Basrak. Heavy Tails and Financial Time Series Models. Workshop on Heavy Tails and Long Range Dependence, Cornell University, April 22-24, 2005
- ◆ French, J. Exploring Spatial Correlation in Rivers. Spring Meeting, Colorado/Wyoming Chapter of the American Statistical Association, Boulder, CO, April 22, 2005;; Masters Seminar, Department of Statistics, Colorado State University, April 4, 2005
- ◆ Urquhart, N.S. Statistics and the Clean Water Act. Spring Meeting, Colorado/Wyoming Chapter of the American Statistical Association, Boulder, CO, April 22, 2005
- ◆ Hoeting, J.A. Model Selection for Geostatistical Models. Seminar, Department of Statistics, Oregon State University, April, 2005

- ◆ Hoeting, J.A. A Statistical Model for a Multivariate Compositional Response. Seminar, Department of Mathematics, Colorado State University, March 29, 2005
- ◆ Davis, R.A., G.A. Rodriguez-Yam and T.C.M. Lee. Thoughts on Model Selection. Inaugural Alaska Consortium for Environmental Statistics (ACES), University of Alaska, Fairbanks, Alaska, March 25, 2005
- ◆ Johnson, D.S. Bayesian Model Selection for Geostatistical Regression Data. Seminars, School of Statistics, University of Minnesota, Minneapolis, MN, January 31, 2005; Department of Statistics, University of Connecticut, Storrs, CT, February 16, 2005; and Statistical Sciences Division, Los Alamos National Laboratory, Los Alamos, NM, February 23, 2005
- ◆ Hoeting, J.A. and D.S. Johnson. Biological Monitoring: Bayesian Models for a Multivariate Response. International Workshop/Conference on Bayesian Statistics and its Applications, Banaras Hindu University, Varanasi, India, January 5 - 8, 2005
- ◆ Jennifer Hoeting and Geof Givens presented two short courses, based on their book which has since been published, in conjunction with Computational Environmetrics Workshop, Chicago, October 21, 2004 :
 - Methods of Integration for Environmental Problems in Statistics: Quadrature, Monte Carlo Integration and Markov Chain Monte Carlo Methods
 - Optimization Methods for Environmental Problems in Statistics: Numerical Maximum Likelihood, Combinatorial Optimization, EM Algorithm
- ◆ Davis, R.A., T. Mikosch, and B. Basrak. Regular Variation and Financial Time Series Models. INFORMS Annual Meeting 2004, Denver, CO, October 25-27, 2004
- ◆ Johnson, D.S. Bayesian Model Determination for Geostatistical Regression Models. Computational Environmetrics Conference, Chicago, IL, October 21-23, 2004
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series. Mathematics Colloquium, Washington University, St. Louis. October 21, 2004
- ◆ Davis, R.A., T. Mikosch, and B. Basrak. Regular Variation and Financial Time Series Models.. Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series Mini-course, sponsored by the Department of Statistics, University of Lisbon, Lisbon, Portugal. October 8, 2004
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series Models. Department of Mathematical Statistics, Lund University, Lund Sweden. October 5, 2004
- ◆ Davis, R.A. and T. Mikosch. Extreme Value Theory for Space-Time Processes with Heavy-Tailed Distributions. MaPhySto Workshop on "Nonlinear Time Series Modeling" sponsored by the Danish National Research Foundation Network in Mathematical Physics and Stochastics, Copenhagen, Denmark, October 1, 2004
- ◆ Davis, R.A. presented a series of 13 lectures at an advanced course on "Nonlinear Time Series Modeling" sponsored by the Danish National Research Foundation Network in Mathematical Physics and Stochastics, Copenhagen, Denmark, Sept 27-30, 2004
- ◆ Merton, A.A., J.A. Hoeting, and R.A. Davis. Model Selection for Geostatistical Models. Monitoring Science and Technology Symposium, Denver, CO, September 21-24, 2004; also presented at the Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004

- ◆ Ritter, K.J., M.K. Leecaster, N.S. Urquhart*, K.C Schiff, D. Olsen, and T. Stebbins. Multi-Lag Cluster Enhancement of Fixed Grids for Variogram Estimation in Near Coastal Systems. Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004
- ◆ Georgitis, K.M. and A.I. Gitelman. Multi-Scale Analysis: Implications for Modeling Presence/Absence of Bird Species. Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004
- ◆ Jensen, S. A Brief Introduction to Reversible Jump MCMC for Bayesian Networks and an Application. Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004
- ◆ Gitelman, A.I. Chain Graphs for Spatial Dependence in Ecological Data. Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004
- ◆ Dailey, M.C., A.I. Gitelman, F.L. Ramsey and S. Starcevich. Bayesian Models for Radio Telemetry Habitat Data. Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004
- ◆ Merton, A.A., J.A. Hoeting, and R.A. Davis. Model Selection for Geostatistical Models. Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004
- ◆ Johnson, D.S. and J.A. Hoeting. State-Space Models for Biological Monitoring Data. Third Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Fort Collins, CO, September 10 - 11, 2004
- ◆ Merton, A.A. Model Selection for Geostatistical Models. Joint Statistical Meetings, Toronto, Canada, August 8-12, 2004
- ◆ Dailey, M.C. Hierarchical Bayesian Models for Seasonal Radio Telemetry Habitat Data. Joint Statistical Meetings, Toronto, Canada, August 8-12, 2004
- ◆ Davis, R.A. and T. Mikosch. Extreme Value Theory for Space-Time Processes With Heavy-Tailed Distributions. International Symposium on Extreme Value Analysis: Theory and Practice, Aveiro, Portugal, July 19 - 23, 2004
- ◆ Davis, R.A., J.A. Hoeting, A.A. Merton, and S. Thompson. Model Selection for Geostatistical Models. Keynote address at the International Biometric Conference, Cairns, Australia, July 11 - 16, 2004
- ◆ Ritter, K.J., M.K. Leecaster, and N.S. Urquhart. Two-Phase Sampling Approach for Augmenting Fixed Grid Designs to Improve Local Estimation for Mapping Aquatic Resources. Graybill Conference, Colorado State University, Fort Collins, CO, June 17 - 18, 2004
- ◆ Gitelman, A.I. Chain Graphs for Spatial Dependence in Ecological Data. Graybill Conference, Colorado State University, Fort Collins, CO, June 17 - 18, 2004.
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Structural Break Detection in Time Series (Keynote address). International Workshop on Recent Advances in Time Series Analysis, Protaras, Cyprus, June 9-12, 2004
- ◆ Davis, R.A. and G.A. Rodriguez-Yam. Parameter and Observation-Driven State Space Models (Keynote address). International Workshop on Recent Advances in Time Series Analysis, Protaras, Cyprus, June 9-12, 2004

- ◆ Urquhart, N.S. Uses of Power in Designing Long-Term Environmental Surveys. Seminar, Alterra Institute, Wageningen University, Wageningen, The Netherlands, June 8, 2004
- ◆ Davis, R.A., T. Mikosch, and B. Basrak. Regular Variation and Financial Time Series Models. Second Lehmann Symposium, Rice University, Houston, Texas, May 19-22, 2004
- ◆ Ritter, K.J. Two-Phase Sampling Approach for Augmenting Fixed Grid Designs to Improve Local Estimation for Mapping Aquatic Resources. Southern California Academy of Sciences Annual Meeting, California State University, Long Beach May 14 - 15, 2004
- ◆ Davis, R.A., T.C.M. Lee, and G.A. Rodriguez-Yam. Estimation for a Class of State-Space Models with Application to Structural Break Detection. Seminar, Department of Statistical Science, Cornell University, March 31, 2004
- ◆ Urquhart, N.S. Uses of Power in Designing Long-Term Environmental Surveys. Seminar, San Diego Chapter of the American Statistical Association, March 29, 2004.
- ◆ Davis, R.A. Estimation for Generalized State-Space Models. International Workshop in Applied Probability, Piraeus, Greece, Mar 22-25, 2004
- ◆ Davis, R.A. and G.A. Rodriguez-Yam. Estimation for a Class of State-Space Models. International Symposium on Financial Time Series, Tokyo, Japan, February 28, 2004
- ◆ Hoeting, J.A, R.A. Davis, A.A. Merton, and S.E. Thompson. Model Selection for Geostatistical Models. Statistics in Ecology Workshop, Jackson Hole, Wyoming, December 4, 2003
- ◆ Urquhart, N.S. Designing Panel Surveys Specifically Relevant to National Parks in the Northwest. Temporal Sampling Workshop, Port Angeles, WA, November 12 - 14, 2003
- ◆ Davis, R.A. R-Estimation for All-Pass Time Series Models. University of Wollongong, Wollongong, Australia, November 12, 2003
- ◆ Davis, R.A. and G.A. Rodriguez-Yam. Estimation for State-Space Models: An Approximate Likelihood Approach. Department of Statistics, University of Copenhagen: October 15, 2003
- ◆ Davis, R.A. and G.A. Rodriguez-Yam. Estimation for Parameter-Driven State-Space Models. Plenary speaker, International Conference on Statistics, Combinatorics, and Related Areas, Portland, Maine, Oct 2-5, 2003
- ◆ Davis, R.A. and G.A. Rodriguez-Yam. Estimation for State-Space Models: an Approximate Likelihood Approach. NSF/NBER Workshop in Time Series, University of Chicago, September 19-20, 2003
- ◆ Hoeting, J. Case Studies in Bayesian Statistics, Workshop 7, discussion of Alan Gelfand's "Modeling Species Diversity Through Species Level Hierarchical Modeling," Carnegie Mellon University, Pittsburgh, September 12, 2003
- ◆ Davis, R.A. and G.A. Rodriguez-Yam. Estimation for State-Space Models: An Approximate Likelihood Approach. Seminar, Department of Statistics, University of New South Wales, September 3, 2003

- ◆ Gitelman, A.I. and S. Jensen. Causal Modeling for Aquatic Resources. Second Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, August 11 - 13, 2003
- ◆ Leecaster, M.K. and K.J. Ritter. Local Enhancement of Global Estimation. Second Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, August 11 - 13, 2003
- ◆ Johnson, D.S. And J.A. Hoeting. Statistical Models for Stream Ecology Data: Random Effects Graphical Models. Second Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, August 11 - 13, 2003
- ◆ Gitelman, A.I. Accounting for Spatial Dependence in Bayesian Belief Networks. Joint Statistical Meetings, San Francisco, CA, August 3-7, 2003
- ◆ Johnson, D.S. and J.A. Hoeting. Random Effects Graphical Models and the Analysis of Compositional Data. Contributed talk, Joint Statistical Meetings, San Francisco, CA, August 3-7, 2003
- ◆ Hoeting, J.A. Statistical Models for Stream Ecology Data. Seminar, Department of Statistics, University of Otago, Dunedin, NZ, March 20, 2003
- ◆ Leecaster, M.K., J.A. Hoeting, and K.J. Ritter. Optimal Lattice and Geostatistical Sample Designs for EMAP. First Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Colorado State University, Fort Collins, CO, September 21, 2002
- ◆ Kellum, B., J.A. Hoeting, and N.S. Urquhart. Predicting Acid Neutralizing Capacity. First Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Colorado State University, Fort Collins, CO, September 21, 2002
- ◆ Johnson, D.S. and J.A. Hoeting. Composition Models for Benthic Invertebrate Data. First Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Colorado State University, Fort Collins, CO, September 21, 2002
- ◆ Gitelman, A.I. Causal Modeling of Macro-invertebrate Data. First Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Colorado State University, Fort Collins, CO, September 20, 2002
- ◆ Johnson, D. S. and J.A. Hoeting, Autoregressive Models for Capture-Recapture Data: A Bayesian Approach. Joint Statistical Meetings, New York, August 13, 2002
- ◆ Hoeting, J.A. Methodology for Bayesian Model Averaging. Invited session at International Biometrics Conference, Freiburg, Germany, July 2002
- ◆ Hoeting, J.A. Autoregressive Models for Capture-Recapture Data. Invited session at WNAR/IMS meetings, Los Angeles, June 2002
- ◆ Gitelman, A.I., Preliminary Results on Causal Modeling and Bayes Networks. Seminar. WED/NHEERL/EPA, Corvallis, OR, March 14, 2002

POSTERS

- ◆ Davis, R.A., T.C.M. Lee and G.A. Rodriguez-Yam. Structural Break Detection in Time Series Signals. Displayed at IEEE Conference on Signal Processing, Bordeaux, France, July 17–20, 2005

- ◆ French, J. and N.S. Urquhart. Review of Geostatistics in Aquatic Systems. Poster displayed at the Fourth Annual Conference on Statistical Survey Design and Analysis for Aquatic Resources, Corvallis, OR, September 7 - 9, 2005.
- ◆ Davis, R.A., T.C.M. Lee and G.A. Rodriguez-Yam. Structural Break Detection in Time Series Signals. Displayed at IEEE Conference on Signal Processing, Bordeaux, France, July 17–20, 2005
- ◆ Dailey, M.C. and A.I. Gitelman, F.L. Ramsey. Hierarchical Bayesian Models for Seasonal Radio Telemetry Habitat Data. Displayed at the Graybill Conference, Colorado State University, June 16 - 18, 2004, The International Environmetrics Conference, Portland, ME, June 28 - July 1, 2004, and the Third Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Colorado State University, Fort Collins, CO, September 10 - 11, 2004.
- ◆ Georgitis, K., A.I. Gitelman, D.L. Stevens, Jr., N.P. Danz, and J.M. Hanowski. What Is a Multi-scale Analysis? Implications for Modeling Presence/Absence of Bird Species. Displayed at The International Environmetrics Conference, Portland, ME, June 28 - July 1, 2004, and at the Third Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Colorado State University, Fort Collins, CO, September 10 - 11, 2004.
- ◆ Kellum, B.R., J.A. Hoeting, and N.S. Urquhart. Analysis and Modeling of Acid Neutralizing Capacity in the Mid-Atlantic Highlands Area. Displayed at the Second Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Oregon State University, Corvallis, OR, August 11 - 13, 2003.
- ◆ Jensen, S. and A.I. Gitelman. Bayesian Belief Networks: Computational Considerations for the Environmental Researcher. Displayed at the Second Annual Conference on Statistical Survey Design and Analysis For Aquatic Resources, Oregon State University, Corvallis, OR, August 11 - 13, 2003.

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