

IN THE UNITED STATES DISTRICT COURT
FOR THE SOUTHERN DISTRICT OF TEXAS
CORPUS CHRISTI DIVISION

THE ARANSAS PROJECT,
Plaintiff,

v.

BRYAN SHAW, ET AL.,
Defendants.

CIVIL ACTION NO. 2:10-cv-00075

REPORT OF PLAINTIFFS' EXPERT KATHERINE ENSOR



July 28, 2011

INTRODUCTION (Work Requested and Overview)

I was asked to review and evaluate the relationship of freshwater inflow into San Antonio Bay and the death of whooping cranes. I understand that this is to be submitted as an expert report in advance of my testimony on behalf of Plaintiff in a federal lawsuit, *The Aransas Project v. Bryan Shaw, et al.*, Civil Action No. 2:10-cv-75 (S.D.TX., Corpus Christi).

I understand that others also will submit expert reports in this matter. To the extent allowed, I may supplement this report with additional information and opinions, particularly if additional information should be made available for my review.

QUALIFICATIONS, EDUCATION, & EXPERIENCE

My CV is attached as Exhibit A to this report, including a list of my publications. I have testified in court before, and the cases are listed in Exhibit B. I am receiving \$350.00 per hour for preparation of this report and for deposition and court time.

INFORMATION CONSIDERED

Materials provided to me include the paper *Grus Americana and a Texas River: A Case for Environmental Justice* by Dr. Ronald Sass, Fellow in Global Climate Change at the James A. Baker Institute for Public Policy, Rice University. In particular, I considered the statistical analysis presented on page 17 of this manuscript. Further, I was provided inflow and whooping crane mortality data covering the period of 1988 through 2009(see attachment 1). In preparing this report, the primary data considered were whooping crane winter mortality, annual inflow and inflows over selected months . I also referred to papers in the literature to support use of the statistical methodology I employed.

WORK UNDERTAKEN

Initially, I reviewed the paper completed by Dr. Sass and specifically reviewed his use of the Fisher Exact Test. Then, I utilized a different methodology to further review what I understand to be substantially the same inflow data to determine if Dr. Sass's result could be confirmed by another statistical method and to determine what additional conclusions, if any, could be reached from a statistical analysis of the data.

Inflow data was provided to me. It is my understanding that this inflow data had been vetted by the Texas Water Development Board. Whooping crane mortality data was also provided to me. This is the same data set as was used by Dr. Sass.

In my original work, a Poisson count regression methodology was used to determine if an association existed between inflow changes and whooping crane mortality. I considered both annual inflow and inflow from July through December in separate Poisson regression models. I also estimated the correlation between the July through December inflow and the percentage of winter deaths, the latter variable transformed by adding one and taking the natural logarithm. The analysis was conducted using the statistical software package R.

The estimated correlation between the July through December inflow and the percentage of winter deaths, the latter variable transformed by adding one and taking the natural logarithm is -0.37. When testing the null hypothesis that the true correlation is zero vs. the alternative hypothesis that the true correlation is less than zero, the null hypothesis is rejected at the 0.05 level of significance (p-value=0.044).

Several variations of the Poisson count regression model, including models for zero inflation and overdispersion, were tested against the basic model with log link function. Standard tests of model fits indicated the basic Poisson regression model was a suitable choice for estimating the influence of inflow level on crane mortality. For technical completeness, the resulting R output to the Poisson regression model fit is provided in Figures 1a and 1b, for the annual inflow and seasonal inflow, respectively.

```
Call:
glm(formula = wmt ~ 1 + ifl, family = "poisson", offset = log(pp))

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.7297  -1.6812  -0.5664   0.7528   4.0686

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -3.054257   0.197698  -15.449 < 2e-16 ***
ifl          -0.044600   0.009809   -4.547 5.45e-06 ***
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Figure 1a. Results of "glm" fit to crane mortality (wmt) using inflow (ifl) in 100,000 acre/ft as independent variable and peak population (pp) as offset. Inflow level is strongly associated with crane mortality (p-value<0.0001).

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Call:
glm(formula = wmt ~ 1 + sfl, family = "poisson", offset = log(pp))

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-3.5566  -2.0431  -0.6537   1.0452   4.2097

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept) -3.21938    0.18091  -17.795 < 2e-16 ***
sfl          -0.07870    0.01957   -4.022 5.78e-05 ***
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Figure 1b. Results of "glm" fit to crane mortality (wmt) using inflow from July through December (sfl) in 100,000 acre-ft as the independent variable and peak population (pp) as an offset. Inflow level is strongly associated with crane mortality (p-value<0.0001)

OPINION #1

I reviewed the work of Dr. Sass and determined that the use of the Fisher Exact Test was appropriate in his study and I concur with Dr. Sass' interpretation of the results. The Fisher Test is a well known and well accepted statistical technique; a test that I regularly teach in my courses.

OPINION #2

In my expert opinion, I find a strong statistical relationship between inflow and whooping crane mortality based on the results of the Poisson regression analyses. Further, the correlation of mortality with July-December inflows is significantly less than zero. Higher whooping crane mortality is clearly associated with low inflows.

Conclusion

Whooping crane mortality has been shown by Poisson regression techniques to be directly associated to increases or decreases in inflows. These findings are consistent with the statistical analysis presented by Dr. Sass on page 17 of his manuscript.

References

1. Czado, C., Erhardt, V., Min, A., Wagner, S. (2007) Zero-inflated generalized Poisson models with regression effects on the mean, dispersion and zero-inflation level applied to patent outsourcing rates. *Statistical Modelling* 7 (2), 125--153.
2. Erhardt, V (2009) ZIGP: Zero-Inflated Generalized Poisson (ZIGP) Models. R package version 3.6.
3. Lumley, Thoms, Richard Kronmal, Shuangge Ma (2006). Relative Risk Regression in Medical Research: Models, Contrasts, Estimators, and Algorithms. UW Biostatistics Working Paper Series, University of Washington, paper 293. <http://www.bepress.com/uwbiostat/paper293>
4. R Development Core Team (2009). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.
5. Sass, Ronald (2010). *Grus Americana and a Texas Rivre: A Case for Environmental Justice*. James A. Baker Institute for Public Policy paper series, Rice University. Novembe, 2010.
6. Shao, Jun (2003). *Mathematical Statistics*. Springer.
7. Zou, Guangyong (2004). A Modified Poisson Regression Approach to Prospective Studies with Binary Data. *American Journal of Epidemiology*. Vol. 159, pp 702-706.

EXHIBIT A

Curriculum Vitae

Katherine Bennett Ensor, Ph.D.
Professor and Chair
Department of Statistics
Rice University
Houston, TX 77251-1892

Office Phone: (713) 348-4687
e-mail address: ensor at rice.edu

EDUCATION:

- 1986 Ph.D., Statistics, Texas A&M University
- 1982 M.S., Mathematics, Arkansas State University
- 1981 B.S.E., Mathematics, Arkansas State University

ACADEMIC EXPERIENCE:

- 2007-09 Rice Leaders
- 2002-present Founding Director, Center for Computational Finance and Economic Systems, Rice University
- 1999-present Chair, Department of Statistics, Rice University
- 1999-present Professor of Statistics, Rice University
- 1995-99 Founding Director, Statistical Consulting Lab, Rice University
- 1993-98 Associate Professor of Statistics, Rice University
- 1993-94 Visiting Scholar, Department of Statistics, Stanford University.
(Summer, 1993; Fall, 1994)
- 1987-93 Assistant Professor of Statistics, Rice University.
- 1985-87 Visiting Assistant Professor, Texas A&M University
- 1985-86 Lecturer, Department of Statistics, Texas A&M University

AWARDS AND HONORS:

- 2006 Honoree, Association for Women in Computing - Houston
- 2000 Elected Fellow of the American Statistical Association
- 1998 H. O. Hartley Award, Department of Statistics, Texas A&M University
- 1998 Julia Miles Chance Award for Excellence in Teaching, Rice University
- 1998 Graduate Student Association Teaching Award, Rice University
- 1988-89-90 Outstanding Faculty Associate, Lovett College, Rice University
- 1985 Phi Kappa Phi
- 1981 Mathematics Award for Outstanding Senior, Arkansas State University

MAJOR RESEARCH INTERESTS:

Time series including categorical time series, spatial statistics, spatial-temporal methods, stochastic simulation, hierarchical modeling and information integration, stochastic process modeling and estimation. Application areas of financial modeling, risk management and environmental statistics

MEMBERSHIP IN PROFESSIONAL SOCIETIES:

2003-	American Society for Engineering Education
1983-	American Statistical Association <ul style="list-style-type: none">• Section on Computing and Graphics• Section on Statistics and the Environment• Section on Bayesian Statistics• Section on Business and Economic Statistics
1989-	Institute of Mathematical Statistics
1988-	CAUCUS for Women in Statistics
1987-	Houston Area Chapter of the American Statistical Association
1983-87	Southeast Texas Chapter of the American Statistical Association

NON EDITORIAL SERVICE TO THE PROFESSION:

- Organized two workshops on financial models and methods from the banking perspective with the Department of Treasury, Office of the Comptroller of Currency and the National Institute of Statistical Science.
- ASA committee on Federally Funded Research, Chair
- NSF Institute for Mathematics and Its Applications. Board Member 2004-2008.
- Lead member, NSF Review team for SAMSI, 2005
- Member NSF Review team of NCAR Geostatistics, 2002.
- NSF Review Panels (10)
- ASA Section on Business and Economic Statistics: Secretary-Treasurer (2002-2004)
- ASA Section on Statistics and the Environment: Awards, Chair (2003); Program Chair (2000); Program Chair-Elect (1999); Publications Chair (1995); Publications Chair-Elect (1994)
- Southern Regional Council on Statistics: President (2001-2003); President-elect (1999-2001); Co-organizer 1999 SRCOS/ASA Summer Research Conference (1999); ASA Representative to the Southern Regional Council on Statistics (1998-2000); Secretary (1998-2000); Departmental Representative to the SRC (1995-current).
- Council on Texas Statisticians: President (1996-1997); Organizer of 1996 Conference of Texas Statisticians.
- Houston Area Chapter of ASA: Past-President (1996-1997); President (1995-1996); President-Elect (1994-1995).
- Southeast Texas Chapter of ASA: Secretary (1983-1986).

EDITORIAL SERVICE TO THE PROFESSION:

Editorial Boards:

- (2010-2011) Encyclopedia of Environmentrics 2nd Edition; Section Editor, Stochastic Modeling
- Associate Editor, Journal of the American Statistical Association (2007-)
- Committee to select Editor for JASA-Reviews
- ASA-SIAM Book Series (2001-2003)
- Technometrics (1998-1999)
- Journal of Statistical Computation and Simulation (1993-1999)
- Communications in Statistics (1993-1995)

Multiple Reviews or Significant Reviews:

- Journal of the American Statistical Association
- Computational Statistics and Data Analysis
- Journal of Statistical Computation and Simulation
- Technometrics
- The American Statistician
- Army Research Office
- Prentice Hall
- Springer-Verlag

REFEREED PUBLICATIONS

- 2010, Estimating the Term Structure with a Semiparametric Bayes Population Model: An Application to Corporate Bonds. With Alejandro Cruz Marcelo and Gary Rosner. Available at SSRN: <http://ssrn.com/abstract=1521323>, to appear in *The Journal of the American Statistical Association*.
- 2010, Simple Method for Time Scaling Value-at-Risk: Let the Data Speak for Themselves. With Kamal Hamidieh. To appear *Journal of Risk Management in Financial Institutions*.
- 2009, Detecting Improvement in Ambient Air Toxics: An Application to Ambient Benzene Measurements in Houston, Texas. With Loren H. Raun, Elena M. Marks. *Atmospheric Environment*, Vol. 43, Issue 20, Pages 3259-3266.
- 2008, Multivariate Time Series Analysis with Categorical and Continuous Variables in an LSTR Model. *Journal of Time Series Analysis*. V 28, pp 867-885. With G. M. Davis.
- 2006, "Outlier Detection in Environmental Monitoring Network Data; An Application to Ambient Ozone Measurements for Houston, Texas." *Journal of Statistical Computation and Simulation*, V 76, pp 407-422. With G. M. Davis.
- 2004, "Dynkin Martingale Estimators for Discretely Observed Continuous-Time, Time-Inhomogeneous Markov Chains". *Proceedings of the 2004 NSF/NBER Time Series Conference; distributed in electronic format*. With R. D. Cramer and P. W. Glynn.

- 2003, "The Impact of Need Frequency on Service Marketing Strategy." *The Service Industries Journal*, V 23, pp 40-22. With Eileen Bridges and Kalyan Raman.
- 2002, "Statistical Analysis of Primary and Secondary Atmospheric Formaldehyde." *Atmospheric Environment*, V 36, pp 4767-4775 with S. Friedfeld, M. Fraser, S. Tribble, D. Rehle and F. Tittel.
- 2001, "Determination of Low-Flow Characteristics for Texas Streams." *Journal of Water Resources Planning and Management*. V 126, pg 310-319. With H.S. Rifai, S.M. Brock and P.B. Bedient.
- 2000, "Statistical Estimation and Visualization of Ground-Water Contamination Data." United States EPA, Office of Research and Development, EPA/600/R-00/034, pp 49. With R. K. Boeckenhauer, D.D. Cox, P.B. Bedient and A. W. Holder.
- 2000, "Simulating the Maximum of a Random Walk." *Journal of Statistical Planning and Inference*, 85(1-2) pp. 127-135. With P. W. Glynn.
- 1999, "Empirical Evaluation of Ambient Ozone Interpolation Procedures to Support Exposure Models." *Journal of Air and Waste Management Assoc.*, V49, pp. 839-846. With L. P. Hopkins and H. S. Rifai.
- 1998, "Evaluation of the Use of Empirical Ambient Ozone Pollutant Modeling and Subject Activity Logs as an Indirect Measurement of Ozone Exposure." *Proceedings of the 91st Annual Meeting of the A&WMA*, Paper # 98-MA12.01. With L. P. Hopkins, M. P. Fraser and H. S. Rifai.
- 1998, "A Test for Harmonic Components in Categorical Time Series." *Journal of Time Series Analysis*, V 19, pp. 309-324. With M. McGee.
- 1998, "Deterministic and Stochastic Forecasting of Marketplace Competition." *Advances in Business Management and Forecasting*, eds. Kenneth D. Lawrence and Michael D. Geurts. Vol 2 Greenwich CT: Jai Press, Inc., page 219-234. With E. Brdiges and John A. Norton.
- 1997, "Stochastic Optimization via Grid Search." *Lectures in Applied Mathematics, Mathematics of Stochastic Manufacturing Systems*, G. George Yin, Qing Zhang, Editors, Vol. 33, pp. 89-100. With P. W. Glynn.
- 1996, "Spatial Sampling for the Environment." *Environmental and Ecological Statistics*, Vol. 4, pp 219-233. With D. D. Cox and L. H. Cox.
- 1996, "Grid-based Simulation and the Method of Conditional Least Squares." *Proceedings of the 1996 Winter Simulation Conference*, pp 325-331. With P. W. Glynn.
- 1996, "Semi-rigid Instrumentation of Lumbar Spinal Conditions in Combination with Circumferential Fusion." *SPINE*, Vol. 21, pp 1918-1925. With S. Gertzbein.
- 1995, "Visualizing Ambient Ozone and Its Precursors." *Proceedings of the 88th Annual Meeting of the A&WMA*, Paper # 95-FA113C.04. With D. D. Cox, A. Miller-Gonzalez, and T. Porter
- 1995, "An Empirical Method for Prediction of Ambient Ozone Levels." *Proceedings of the 88th Annual Meeting of the A&WMA*. Paper # 95-FA113C.05. With D. D. Cox.

- 1994, "Properties of Simulation Based Estimators of Stochastic Processes." Proceedings of the 39th Conference on the Design of Experiments. ARO Report No. 94-2, 15-22.
- 1994, "Forecasting the Number of Competing Products in High-Technology Markets." *The International Journal of Forecasting* V 9, pp 399-405. With E. Bridges and John A. Norton.
- 1993, "Model Selection in Magnetic Resonance Imaging." *Communications in Statistics: Theory and Methods*. Vol. 22, pp 3419-34. With J. E. Ensor.
- 1993, "Simulation Based Estimation for Birth and Death Processes." Proceedings of the 38th Conference on the Design of Experiments. ARO Report No. 93-2, 343-52. With E. Bridges and M. Lawera.
- 1992, "Marketplace Competition in the Personal Computer Industry." *Decision Sciences* V 23, pp 467-477. With E. Bridges and J. R. Thompson.
- 1990, "A Recursive in Order Algorithm for Least Squares Estimation of an Autoregressive Process," *Journal of Statistical Computation and Simulation*, V 37, 115-126. With H. J. Newton.
- 1990, "SIMEST: A Technique for Model Aggregation with Considerations of Chaos." *Population Dynamics*, eds. A. Axelrode and M. Kimmel. Marcel Dekker, New York, pg 483-510. With J. R. Thompson and D. N. Stivers.
- 1988, "The Effect of Order Estimation on Estimating the Peak Frequency of an Autoregressive Spectral Density." *Biometrika* V 75, pp 587-589. With H. J. Newton.

OTHER SCHOLARLY WORKS:

- 2010, A Model-based Approach for Clustering Air Quality Monitoring Networks in Houston, Texas. With Sarah Thomas and Bonnie Ray. Submitted to *Environmetrics*.
- 2010, Multivariate Zero Inflated Poisson Regression with Application to Systemic Risk in the Bond Market. With Sarah Thomas and Bonnie Ray, in progress.
- 2010, Heart Attack Incidence and Air Quality Levels for Houston. With Loren Raun. In progress.
- 2009, Covariance Estimation in Dynamic Portfolio Optimization: A Realized Single Factor Model. With Lada Kyj and Barbara Ostdiek.
- 2008, Real-Time Estimation of Rainfall: A Dynamic Spatio-Temporal Model. Department of Statistics, Technical Report #TR2008-07, Rice University.
- 2008, Economic Value of Optimally Sub-Sampled Realized Covariance of Asynchronous and Noisy High-Frequency Data, Department of Statistics, Technical Report #TR2008-01, Rice University. With Lada Kyj.
- 2008, Ozone Forecasting in Houston: A Spatial-Temporal Real-Time Forecasting Tool for Ozone in Houston, TX. Developed for the City of Houston under purchase order PC88 00038001591.
- 2007, Evolving Structure in Multivariate Time Series with Application to Financial Systems, Rice Statistics Technical Report #TR2007-20. With G. M. Davis.

- 2005, Estimation of Marginal Survival Functions in the Presence of Dependent and Independent Censoring, Rice Statistics Technical Report #TR2005-14, with G. A. Fix and H. Xuelin.
- 2005, Estimation of the Distribution of Time from Incorporation to Dividend Initiation Accounting for Dependent and Independent Censoring, Rice Statistics Technical Report #TR2005-13, with G. A. Fix and X. Huang.
- 2005, "Inspection Models for Homeland Security: Thinking Outside the Box." *National Defense University White Paper*. (In Press) with R. Carleton and J. Thompson
- 2002, Review of Time Series Analysis and Its Applications, Authors Robert H. Shumway and David S. Stoffer, *Journal of the American Statistical Association*, V 97, pp 656-657.
- 1997, "Spatial-Temporal Modeling and Visualization of Environmental Data", Electronic Poster Session 1997 JSM. With M. Calizzi, R. Boeckenhauer, D. Andrews and D. D. Cox.
- 1996, "Estimation of Contaminant Concentration in Ground Water Using a Stochastic Flow and Transport Model." Proceedings of the Hydrocarbons & Organic Chemicals in Ground Water: Prevention, Detection and Remediation, pp 719-736. With E. M. Hauschel, D. D. Cox and H. S. Rifai.
- 1995, Review of Time Series Models, by Andrew C. Harvey. *Technometrics*, Vol. 37, pp 464-465.
- 1995, "Visualization of Groundwater Contamination Data." *Proceedings of the 27th Interface Between Statistics and Computing Science*. With R. K. Boeckenhaur, D. W. Scott and P. B. Bedient.
- 1995, "Visualizing Ambient Ozone and Its Precursors." *Video*. With D. D. Cox, A. Miller-Gonzalez, and T. Porter.
- 1992, "Air Quality in Houston: 1980-1990." *Proceedings of the American Statistical Association; Section on Statistical Graphics*, pp 39-48. With S. R. Sain and D. W. Scott.
- 1992, "Animation of Air Quality in Houston: 1980-1990." *Video*; presented at the 1992 JSM, Boston, M.A.
- 1991, "Automatic Magnetic Resonance Imaging." *Proceedings of the 23rd Symposium on the Interface Between Statistics and Computing*, pp 592-596. With J. Ensor and L. K. Misra.
- 1990, "On Autoregressive Model Selection and Estimation." *Technical Report # TR90-8*. Department of Statistics, Rice University.
- 1988, "A Recursive in Order Algorithm for Least Squares Estimation of an AR and VAR Process." *Proceedings of the American Statistical Association: Statistical Computing Section*, 192-196. With H. J. Newton.

FUNDING (PI OR CO-PI)

- Environmental Analysis and Decision Making program at Rice – developed and currently lead this professional masters program. Through the program I receive funding to be used for environmental research.

- National Science Foundation (2008-2011), Vertical Integration of Graduate Education and Teaching. Joint with Mike Wolf and Steve Cox. (\$5 million)
- CITI Innovation Fund (ERIT) (2006-2007), Informed Networking for the Economic Security of Our Nation.
- Army Research Office (2004-2007), Simulation and Estimation for Stochastic Processes. With J.R. Thompson.
- National Science Foundation (2003-2008), Vertical Integration of Graduate Education and Teaching. Joint with William Symes and Robin Forman. (\$4 million)
- National Defense University (2004). With J. R. Thompson.
- CoFES Gift Funds.
- Training program in Computational Biology and Medicine, National Library of Medicine and Keck Foundation, (2001-2006). Multiple participants, I was a key participant in the successful submission.
- National Science Foundation, Constructing Probability Models for Large Corpora of Well-informed but Probabilistically Incoherent Judgements. (2000-2004) with D. Osherson (PI), R Bixby, W. Cook, P. Hartley, D. Lane and J. Thompson.
- National Science Foundation, Computationally Tractable Estimation Methods for Markov Processes (1997-2001), with P. W. Glynn
- Statistical Consulting Lab, Rice University (1995-2001).
- Texas Natural Resource Conservation Commission, (1998). Subcontract through UT.
- Energy and Environmental Systems Institute. Rice University (1995-96), with D. D. Cox.
- Texas Natural Resources Conservation Commission. Air Quality in Texas (1994).
- Univ. of Texas IAC VID 37217217217000, Subcontract with the Texas Air Control Board to examine the air pollution problems in the greater Houston area, 1991, with D. W. Scott.
- National Science Foundation (DMS-9005783), "Scientific Computing Research Equipment for the Mathematical Sciences", 1990-91, with David W. Scott and James R. Thompson.
- National Science Foundation (DMS-8808852), "Mathematical Sciences: Joint Asymptotic Distribution of Autoregressive Coefficient and Order Estimators", 1988-1989.
- Brown Foundation Grant to Improve Undergraduate Teaching, 1989.
- Dean of Social Science Equipment Award, 1989.

LARGE AND SPECIAL FUNDING PROPOSALS OR PROJECTS (not necessarily funded):

- EPA STAR Air Center (2010-2015), Air Particulates and Human Health in a Multi-Pollutant Atmosphere. Lead the submission of an \$8 million proposal that spans five institutions and key offices in the City of Houston; this proposal received strong support of the Mayor of Houston but was not one of the four centers chosen by EPA.

- National Center for Clinical and Translational Science Award, joint Baylor College of Medicine, Rice University and Texas Children's Hospital. I served as Rice's primary representatives in this large collaborative effort. The CTSA proposal includes a collaborative program in biostatistics and bioinformatics between Rice, Baylor and Texas Children's Hospital. The collaborative program relies heavily on the Department of Statistics at Rice. The proposal was re-submitted in August.
- NSF Mathematical Sciences Institute Proposal for the International Institute for Statistics, Mathematics, and Energy joint with Iowa State. The proposal was declined, however the NSF review panel noted the originality of the inter-institutional institute and encouraged resubmission. We will re-enter the competition in the next round of institute proposals in 2011. We are also seeking seed funding through non-traditional funding sources.
- NSF DMS Vertical Integration of Research and Education. We submitted three proposals before winning on the fourth attempt. The Rice VIGRE program is highlighted as one of the huge successes of VIGRE; we were one of the very few universities to win a renewal second five year award.
- Developing an educational module of VIGRE related to sports statistics in collaboration with the Houston Rockets.
- Supported my department's successful efforts for the NIH T32 training grant in cancer biostatistics and bioinformatics. This grant supports our collaborative program with U.T. M.D. Anderson and Baylor College of Medicine.
- Supported the statistical efforts by the office of Mayor Bill White to address the air pollution challenges in Houston.
- CoFES proposal to JP Morgan Chase. I developed and lead a \$20 million development proposal to JP Morgan Chase to underwrite the Center for Computational Finance and Economic Systems. The proposal was not funded due to the downturn in the economy; however, it was well received by Chase leadership.
- Presented an alternative risk management model to President George W. Bush's energy task force, shortly before the fall of Enron. We anticipated the negative impact of Enron and presented this scenario to the task force. Unfortunately, we did not receive funding from the task force for the CoFES research platform; the integration of risk throughout the industry has been a primary theme of our research efforts – as well as the theme of the recent efforts with the Department of Treasury.

CONFERENCE PARTICIPATION AND COLLOQUIA (since 2003):

2011

- Invited Speaker, Estimating the Term Structure with a Semiparametric Bayes Population Model: An Application to Corporate Bonds. Collaborative work with Alejandro Cruz Marcelo and Gary Rosner. Brigham Young University, Department of Statistics, February, 2011

2010

- Invited Keynote Speaker, Expanding Your Horizons 2010, March 6, 2010.

- Invited Speaker, Joint Statistical Meetings, Vancouver, August 2009: Houston Air Quality: The interplay between science and policy.

2009

- The Fifth John C. and Susan Wierman Lecture: Houston Air Quality: A simultaneous examination of multiple pollutants. Johns Hopkins University, Department of Mathematics and Statistics. November, 2009
- NISS/ Department of Treasury OCC Exploration Workshop Exploring Statistical Issues in Financial Risk Modeling and Regulation Focusing on Success in Modeling of Systemic Risk and Market Risk. Program organizer and panelist. Oct. 2009
- Joint Statistical Meeting Late Breaking Invited Session: Organized, The Role of Statistics in the Nation's Financial Recovery and Stability, August 2009
- NISS/ Department of Treasury OCC Exploration Workshop Exploring Statistical Issues in Financial Risk Modeling and Regulation Focusing on Success in Modeling of Operational Risk and Credit Risk. Program organizer and panelist. Feb. 2009

2008

- Army Conference on Applied Statistics, October, 2008
 - Presented: Complex Dependence Structure and its Effect on Risk Assessment
- Joint Statistical Meeting, August, 2008.
 - Presented: Combining Measures of Risk Across Dependent Series
 - Co-author presented: A Model-Based Approach for Clustering Time Series Counts, with Sarah Thomas
 - Hosted Rice reception.

2007

- Army Conference on Applied Statistics, October, 2007
 - Hosted the conference at Rice University.
 - Presented: A 20 Year History of the Department of Statistics
- Joint Statistical Meeting, August, 2007.
 - Co-author presented: Economic Value of Optimally Sub-Sampled Realized Covariance of Asynchronous and Noisy High-Frequency Data, with Lada Kyj and Barbara Ostdiek.
 - Hosted Rice reception.

2006

- Army Conference on Applied Statistics. Presented: Outlier Detection in Monitoring Network Data, October 2006.
- Collaborative Research Center Symposium, November, 2006.
- Joint Statistical Meeting, August, 2006
 - Multiple leadership meetings.
 - Hosted and initiated Rice reception.

2005

- ASA/SRCOS Summer Research Conference, Clemson University, Georgia. The Future of Statistics, Invited Speaker, June 2005.
- Army Conference on Applied Statistics. Presented: Risk: Diversification and Performance Precursors for Stocks, October 2005.

- Computation and Applied Mathematics Department, November 2005.
Presented: Risk: Diversification and Performance Precursors for Stocks

2004

- Conference on New Developments of Statistical Analysis in Wildlife, Fisheries, and Ecological Research. Invited Speaker. Presented “Outlier Detection in Monitoring Network Data.” October, 2004.
- NSF/NBER Time Series Conference. Invited Speaker. Presented “Dynkin Martingale Estimators for Discretely Observed Continuous-Time, Time-Inhomogeneous Markov Chains”
- ASA/SRCOS Summer Research Conference 2004. Co-organizer. Student G. Davis won the best paper award for the co-authored paper “Outlier Detection in Monitoring Network Data.”

2003

- Sonya Kovalevsky High School Mathematics Day, Mississippi State University, April, 2003.
 - Key note speaker and presented: Statistics: The Language of Discovery; The Quantification of Risk.
- Joint Statistical Meetings, San Francisco, August, 2003.
 - Chaired and Organized invited session.

THESIS COMMITTEES (Ph.D.; directed fourteen):

2012 **Directing** Emilian Vankov and Xin Zhao

2011

- Beth Bower, Energy finance and risk based investing in wind power. **Directed.** Currently with Merrill Lynch Commodities.

2010

- Sarah Thomas, Model Based Clustering: Applications in finance and the environment. **Co-directed** with Bonnie Ray. Currently with the National Security Agency.
- Alejandro Cruz, Estimating the term structure of Corporate Bonds via Dirichlet process mixtures. **Directed.** Currently with Capitol One.
- Terrance Savitsky, Generalized Gaussian Process Models with Bayesian Variable Selection. Directed by Marina Vannucci. Will join RAND, in July.

2009

- Jamie Chatman, A clustering based approach to university admissions. Directed by Rudy Guerra. Currently a post-doctoral researcher at the University of Pittsburgh.
- Darrin Gershman, Ultra high-frequency data in finance. Directed by Rolf Riedi.

2008

- Talithia Williams, Real-Time Estimation of Rainfall: A Dynamic Spatio-Temporal Model. Department of Statistics. **Directed.** Currently an assistant professor, Department of Mathematics, Harvey Mudd.

- Lada Kyj, Estimating Realized Covariance using High Frequency Data. **Co-directed** with Barbara Ostdiek. Currently a post-doctoral researcher at Quantitative Products Laboratory in Berlin, Germany.

2007

- Krzysztof Rudnicki. A Dynamic Model for Survival Analysis Data with Longitudinal Covariates. Chair, Thesis Committee; Directed by Gary Rosner.

2005

- Ginger M. Davis, Topics in Multivariate Time Series. **Directed.** Currently with HP, Palo Alto.
- Gretchen Fix. Corporate Propensity to Pay Dividends. **Directed.** Currently with Apache Corporation.
- Xian Zhou, Bayesian Inference for Ordinal Data, Directed by Peter Mueller.
- Kalatu Davies. Inverse Decision Theory with Medical Applications, directed by D. D. Cox.

2003

- John Dobelman. Real Time Pricing of Non Storable Commodities, directed by J. R. Thompson.
- John Miller, Venture Capital, Entrepreneurship, and Long-run Performance Prediction: An Application of Data Mining. Department of Statistics, directed by J. R. Thompson.

2002

- Nancy Glenn. Robust Empirical Likelihood, Department of Statistics, directed by D. W. Scott.
- Jie Lin. Testing shade tolerance as a mechanism of dynamics in three forests of Big Thicket National Preserve, Southeast Texas. Department of Ecology and Evolutionary Biology, directed by P. Harcombe.
- Stephanie Glenn. Ground Water Modeling with Local Recharge Parameters. Department of Civil and Environmental Engineering, directed by P. Bedient.
- Stephen Friedfield. Statistical Analysis of Primary and Secondary Formaldehyde. Department of Civil and Environmental Engineering, directed by M. P. Frasier.

2001

- Roxy Cramer. Parameter Estimation for Discretely Observed Continuous Time Inhomogeneous Markov Chains. **Directed.** Currently a research scientist at Pros Strategic Solutions.
- Chad Shaw, Genealogical Methods for Multitype Branching Processes with Applications to Biology. Directed by M. Kimmel.

2000

- M. Calizzi, Multivariate Spatial-Temporal Modeling with Application to Air Quality Assessment. Department of Statistics. **Directed.** Currently a statistical consultant in the Chicago area.
- S. Baggett, Space-time Modeling with Applications to Sea Surface Temperatures. Department of Statistics. **Directed.** Currently a research statistician in the Jesse H. Jones Graduate School of Business and lecturer in Statistics.

1998

- L. Hopkins, Evaluation of the Relationship Between Ambient Air Pollution and Adverse Respiratory Health Effects Using an Indirect Measurement of Exposure. Department of Environmental Science and Engineering. **Co-directed** with H. Rifai and P. Bedient. Currently Scientific Advisor to Mayor Bill White of Houston and part-time lecturer in the Department of Statistics, Rice University.
- D. Andrews, Statistical Modeling of Vector-Valued Spatial Data using Gradient Processes. Department of Statistics. Directed by D. D. Cox.
- S. Bolks, Department of Political Science. Directed by R. Stoll.

1997

- J. Mukherjee, Productivity and Measurement Issues: An Application to Brazilian Agriculture. Department of Economics. Directed by R. Sickles.

1995

- Monnie McGee, *Tests for Harmonic Components in the Spectra of Categorical Time Series*. **Directed**. Currently at Associate Professor of Statistical Science at SMU.
- M. Elliott, Clustering. Department of Statistics. Directed by J. R. Thompson.

1992

- M. Minnottee, A Test of Mode Existence with Applications to Multimodality. Department of Statistics. Directed by D. W. Scott.
- M. Spears, Multi-Stage Designs in Dose-Response Studies. Department of Statistics. Directed by B. W. Brown and J. R. Thompson.
- P. Srinivasa Rao, Robust Continuous-Time Detection in Linear Process Noise. Department of Electrical and Computer Engineering. Directed by D. H. Johnson.

1990

- R. Kumar, Modeling and Analyzing Fractal Point Process. Department of Electrical and Computer Engineering. Directed by D. H. Johnson.

1989

- K. Huh, Multivariate Nonparametric Estimation of Censored Panel Data. Directed by R. Sickles.
- V. Ligeralde, Tests for Rational Expectations Revisited. Department of Economics. Directed by B. W. Brown.

THESIS COMMITTEES (M.A.; directed four):

- E. Brott (2005), An Unconditional Test for the Single Sample Binomial. Directed by B. Brown
- J. Deines (2004), Statistics, Directed by J. Thompson
- S. Brock (1998), ES&E, **Co-directed** with H. Rifai
- P. Nelson (1998), ES&E, Directed by H. Rifai
- L. Hauschel (1996), A Stochastic Investigation of BIOPULME II. Department of Statistics. **Directed**
- T. F. Hood (1994), Control Charts for Autocorrelated Data. Department of Statistics. **Directed**.
- J. C. Robinson (1992), The Effects of Representing Spatial Variability of Aquifer Characters on Numerical Ground Water Flow and Contaminant Transport

Modeling. Department of Environmental Science and Engineering. Directed by P. B. Bedient.

- T. D. Cravy (1992), Analysis of Groundwater Mounding Using a Surface Impoundment Database and Monte Carlo Simulation. Department of Environmental Science and Engineering. Directed by P. B. Bedient.
- G. L. Dittrich (1990), A Time Series Approach to Quality Control. Department of Statistics. **Directed.**
- L. Hopkins (1989). Department of Environmental Science and Engineering. Directed by P. B. Bedient.
- J. J. Kown (1988), A Time Series Analysis of the Japanese Yen. Department of Economics, Directed by R. Sickles.

UNIVERSITY SERVICE:

University Committees:

2010

- Chair, Department of Statistics
- Director, Center for Computational Finance and Economic Systems
- Director, Financial Computation and Modeling minor (undergraduate).
- Member, Engineering Leadership Team
- Co-Chair, Rice Advance Retention and Climate Committee
- Rice NSF-VIGRE Management Board
- Leader of NSF-VIGRE Research Group
- Managerial Studies Steering Committee and advisor for science and engineering students.
- Professional masters in Environmental Analysis and Decision Making Steering Committee, chair of management board and advisor. Lead a revision of the curriculum.
- Advisor, Financial Computation and Modeling minor.

2009

- Rice / Baylor merger committee.
- Rice / Baylor CTSA proposal committee.
- Rice Leaders
- Chair, Department of Statistics
- Director, Center for Computational Finance and Economic Systems
- Director, Financial Computation and Modeling minor.
- Member, Engineering Leadership Team
- Co-Chair, Rice Advance Retention and Climate Committee
- Rice NSF-VIGRE Management Board
- Leader of NSF-VIGRE Research Group
- Managerial Studies Steering Committee and advisor for science and engineering students.
- Professional masters in Environmental Analysis and Decision Making Steering Committee, chair of management board and advisor.

- Advisor, Financial Computation and Modeling minor.

2008

- Rice Leaders
- Chair, Department of Statistics
- Director, Center for Computational Finance and Economic Systems
- Director, Financial Computation and Modeling minor.
- Member, Engineering Leadership Team
- Rice NSF-VIGRE Management Board
- Leader of NSF-VIGRE Research Group
- Managerial Studies Steering Committee and advisor for science and engineering students.
- Professional masters in Environmental Analysis and Decision Making Steering Committee, management board and advisor.
- Advisor, Financial Computation and Modeling minor.
- Participated, Rice Development Program.

2007

- Rice Leaders
- Chair, Department of Statistics
- Chair, Urban Systems and Sustainability Strategic Planning
- Director, Center for Computational Finance and Economic Systems
- Director, Financial Computation and Modeling minor. Initiated.
- Member, Engineering Leadership Team
- Rice NSF-VIGRE Management Board
- Managerial Studies Steering Committee and advisor for science and engineering students.
- Professional masters in Environmental Analysis and Decision Making Steering Committee, management board and advisor.

2006

- Chair, Department of Statistics
- Chair, Urban Systems and Sustainability Strategic Planning
- Director, Center for Computational Finance and Economic Systems
- Member, Engineering Leadership Team
- Presidents Advisory committee for Faculty Women, and Advance Committee
- Rice NSF-VIGRE Management Board
- Managerial Studies Steering Committee and advisor for science and engineering students.
- Professional masters in Environmental Analysis and Decision Making Steering Committee, management board and advisor.

2005

- Chair, Department of Statistics
- Director, Center for Computational Finance and Economic Systems
- Presidents Advisory committee for Faculty Women

- Search Committee, Dean, George R. Brown School of Engineering
- Managerial Studies Steering Committee and advisor for science and engineering students.
- Professional masters in Environmental Analysis and Decision Making Steering Committee and advisor.
- EESI Executive Committee
- Rice NSF-VIGRE Management Board

2004

- Chair, Department of Statistics
- Director, Center for Computational Finance and Economic Systems
- Search Committee, Dean, George R. Brown School of Engineering
- Presidents Advisory Committee for Study of Women at Rice
- EESI Executive Committee
- Committee to Develop Sloan Professional Master's in Environment Decision Making.
- Managerial Studies Steering Committee
- Rice NSF-VIGRE Management Board

2003

- Chair, Department of Statistics
- Director, Faculty Advisory Board for CoFES
- Advisory Committee for Study of Women at Rice
- Keck Center for Computational Biology, Executive Committee, Rice Training Director
- EESI Executive Committee
- Committee to Develop Sloan Professional Master's in Environment Decision Making.
- Managerial Studies Steering Committee
- Rice NSF-VIGRE Management Board

2002

- Chair, Department of Statistics
- Director, Faculty Advisory Board for CoFES
- President's Lecture Series
- Keck Center for Computational Biology, Executive Committee, Rice Training Director
- EESI Executive Committee
- Committee to Develop Sloan Professional Master's in Environment Decision Making.
- Managerial Studies Steering Committee

2001

- Chair, Department of Statistics

- Director, CoFES
- President's Lecture Series
- Keck Center for Computational Biology, Executive Committee, Rice Training Director
- Energy and Environmental Science Institute (EESI) Executive Committee
- Committee to Develop Sloan Professional Master's in Environment Decision Making.
- Rice Alliance for Technology and Entrepreneurship Steering Committee.
- Environmental programs steering committee
- Managerial Studies Steering Committee

2000

- Chair, Department of Statistics
- Rice Alliance for Technology and Entrepreneurship Steering Committee.
- Environmental programs steering committee
- Managerial Studies Steering Committee

1999

- Chair, Department of Statistics
- Rice Alliance for Technology and Entrepreneurship Steering Committee.
- Environmental programs steering committee
- Managerial Studies Steering Committee

1998

- Environmental programs steering committee
- Search Committee for the Dean of the George R. Brown School of Engineering
- Managerial Studies Steering Committee
- Salary Equity Committee, Chair

1997

- Ad Hoc Committee on the Organization of the George R. Brown School of Engineering
- Provost's Graduate Fellowship Committee
- Strategic Planning Committee on the Environment
- Engineering Strategic Planning Committee
- Managerial Studies Steering Committee
- Salary Equity Committee, Chair

1996

- Provost's Graduate Fellowship Committee
- Strategic Planning Committee on the Environment
- Engineering Strategic Planning Committee
- Managerial Studies Steering Committee
- Salary Equity Committee, Chair

1995

- Engineering Strategic Planning Committee
- Managerial Studies Steering Committee
- Salary Equity Committee

1992

- University Council, Elected Office
- Faculty Council, Elected Office
- Managerial Studies Steering Committee
- Founder, Salary Equity Committee

1991

- University Council, Elected Office
- Faculty Council, Elected Office
- Managerial Studies Steering Committee

1990

- University Council, Elected Office
- Faculty Council, Elected Office
- Committee on Committees, Chair
- Deputy Speaker, Faculty Council
- University Review Board
- Managerial Studies Steering Committee

1989

- University Council, Elected Office
- Faculty Council, Elected Office
- Managerial Studies Steering Committee

1988

- University Council, Elected Office
- Faculty Council, Elected Office
- Managerial Studies Steering Committee

Undergraduate Student Advising and Research

2006-	Financial Computation and Modeling, Advisor
2003-	VIGRE/CoFES, 1-2 groups per year (approx. 30 students)
1999-04	Undergraduate Departmental Advisor
1992-94	Divisional Advisor, Engineering, Lovett College
1988-93	Undergraduate Departmental Advisor
1988-	Managerial Studies Advisor
1988-94	Faculty Associate, Lovett College
1988-90	Divisional Advisor, Social Science, Lovett College

1987-88 Resident Associate, Lovett College

TEACHING EXPERIENCE:

Short courses for industry:

- Statistical process control
- Basics of Bayesian models
- Forecasting and modeling in energy markets
- Forecasting, modeling and financial risk.
- Environmental modeling and risk assessment.

Graduate:

- Invited Short Course on Space-Time Modeling. La Sapienza, University of Rome.
- VIGRE Seminars on computational finance
- Graduate Seminar in Statistics
- Modern Applied Time Series
- Advanced Time Series
- Spatial Statistics
- Mathematical Statistics I, II and III
- Asymptotic Theory
- Sampling Theory
- Simulation
- Nonparametric Methods
- Introductory Statistical Methods

Undergraduate:

- VIGRE Seminars on computational finance
- Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering.
- Computational Finance: Time Series Methods
- Modern Applied Time Series
- Applied Regression Analysis
- Empirical Model Building
- Introduction to Mathematical Statistics
- Elementary Applied Statistics
- Sampling Techniques
- Introductory Statistical Methods for Engineers
- Elementary Statistical Methods for Non-Scientists
- Statistical Methods for Physical Sciences
- Statistical Methods for Biological Sciences

EXTERNAL ASSOCIATIONS since 2001:

- 2010 Bedient and Associates
- 2010 The Buzbee Law Firm
- 2007-08 State of Texas, Attorney General's office.

- 2006-08, City of Houston, Mayor's office
- 2007, Comcast
- 2006, Time Warner Cable
- 2005, Vieux and Associates
- 2001, BMC, Inc.
- 2001, Howrey, Simon, Arnold & White, Attorneys at Law. In the case of Union Carbide vs. Shell Oil.

EXHIBIT B

Former Expert Testimony

Civil Action No. C-1317-05-I, *Medrano v. Univ. of Texas-Pan American*, 398th Judicial District, Hidalgo County, Texas (February, 2009).