RM-CESU PROJECT COMPLETION REPORT

Cooperative Agreement H1200090004
Task Agreement FBMS# P10AC00186
Project number MSU-226

Project Title: Statistical assistance on sample design and data analysis for Vital Signs Monitoring in the Greater Yellowstone Network Inventory and Monitoring Program

Park/Unit: Greater Yellowstone I&M Network

Funding Source: Greater Yellowstone Network, Inventory and Monitoring Program, total = $23,941

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Original PI was Kathi Irvine, now with USGS NRMSC

Project Description:

This project with the Department of Mathematical Sciences provided specialized statistical assistance to the Greater Yellowstone Network on monitoring protocols and their implementation. More specifically, this project addressed power analysis and trend analysis tools for water quality monitoring, and also statistical analysis tools for Whitebark pine monitoring. A third component involved assistance as a consulting statistician on the project titled 'Pikas in Peril: multi-regional vulnerability assessment of a climate-sensitive sentinel species'.

Project Results and Citations:

Water quality analysis tools for status and trend reporting:

- A final (e.g. updated from previous work) power analysis, script and tutorial to determine the statistical power for detecting trends of varying magnitude over different lengths of sampling years was completed through this agreement.
- R-scripts and a step-by-step guide to using the scripts for periodic trend analysis of water quality. The R scripts can be used to perform a seasonal Mann Kendall test with and without flow adjustment. Also, the scripts automatically produce graphics relevant for appropriate trend analysis.

- The citation for the unpublished and final published report follows:

- Irvine, K. and K. Manlove. 2010. Water Quality Power Analysis for the Greater Yellowstone Network. Dated October 10, 2010. 21 pp.
- Irvine, K. 2011. Greater Yellowstone Network Water Quality Trend Analysis: instructions, R-scripts and example graphical outputs. Dated February 1, 2011. 17 pp.
- Irvine, K. M., K. Manlove, and C. Hollimon. 2012. Using Power Analysis and Trend Analysis to Detect Trends in Monitoring Data: An Example of Water Quality in the Greater Yellowstone Inventory and Monitoring Network. Natural Resource Report NPS/GRYN/NRR—2012/556. National Park Service, Fort Collins, Colorado. https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=451983&file=Water_Quality_NRR_Final_nrss.pdf.

Whitebark Pine analysis tools for status and trend reporting:

- Status estimates for the amount of whitebark pine infected with white pine blister rust were provided for the 2009 and 2010 monitoring years. On each occasion, the data were summarized in both tabular and graphical formats and the R-script provided. The results were reported in the Whitebark Pine annual reports for each year.
- Additional exploratory statistical analyses were performed to evaluate the strata used in the sample design and possible changes to the data analysis methods used. This work is on-going through an Interagency Agreement with the USGS.

- The citations for the published annual reports mentioned above follow:

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2011. Monitoring whitebark pine in the Greater Yellowstone Ecosystem: 2010 Annual Report. Pages 56–65 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear investigations: annual report of the Interagency Grizzly Bear Study Team, 2010. U.S. Geological Survey, Bozeman, Montana, USA. https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=434860&file=GYE_WBP_2010_Annual_Report_August.pdf.

Greater Yellowstone Whitebark Pine Monitoring Working Group. 2010. Monitoring whitebark pine in the Greater Yellowstone Ecosystem: 2009 Annual Report. Pages 63–71 *in* C.C. Schwartz, M.A. Haroldson, and K. West, editors. Yellowstone grizzly bear

investigations: annual report of the Interagency Grizzly Bear Study Team, 2009. U.S. Geological Survey, Bozeman, Montana, USA. https://irma.nps.gov/App/Reference/DownloadDigitalFile?code=429458&file=GYE_WBP_2009_Annual_Report.pdf.

Lessons Learned:

The single biggest lesson learned through this agreement is the importance of adequately informing statisticians, both student and profession, on the background sample design and data collection methods used by the I&M program.

Other RM CESU partners involved: USGS-NRMSC, University of Colorado Boulder and Rocky Mountain I&M Network