# GRAYBILL/ENVR CONFERENCE

# Modern Statistical Methods for Ecology

## September 7 - 10, 2014

## Colorado State University
## Fort Collins, CO

# Contents


Events at CSU Lory Student Center ........ 3
Foreword ........ 4
Organizing Committee ........ 5
    Arrangements ........ 5
Professor Franklin A. Graybill ........ 6
Program and Schedule of Talks ........ 8
    Sunday September 7 ........ 8
    Monday September 8 ........ 9
    Tuesday September 9 ........ 11
    Wednesday September 10 ........ 13
Abstracts ........ 14
    Keynote Speakers ........ 14
    Invited Speakers ........ 19
    Contributed Posters ........ 37
Past Conferences ........ 38
Fort Collins City Map ........ 40
Colorado State University Campus Map ........ 41
Lory Student Center Floor plans ........ 42
    Main Level ........ 42
    Upper Level ........ 43
Sponsors ........ 44

# Events at CSU Lory Student Center

Sunday, September 7

- Registration
- All day Short Course presented by Andrew Finley and Alan Gelfand – 9am, Rm 382
- Evening Social Mixer – 6pm, Rm 386

Monday, September 8

- Registration
- All day Conference Presentations - North Ballroom
- Poster set-up – all day, Rm 386

Tuesday, September 9

- Registration
- All day Conference Presentations - North Ballroom
- Speed Session Poster Introductions – 4:25pm, North Ballroom
- Poster Exhibit – 5:30pm, Rm 386
- Evening Banquet – 7pm, Cherokee Park Room

Wednesday, September 10

- Registration
- Conference Presentations which conclude at 11:25am - North Ballroom
- Wednesday excursion: Rocky Mountain National Park departs at 1:00pm from west entrance to Hilton, box lunch is included
- Wednesday excursion: Fort Collins Brewery tour in Fort Collins at 2:30.  Transportation on your own, Transfort or Hilton van.

# Foreword

On behalf of the Department of Statistics at Colorado State University and the ASA Section on Statistics and the Environment (ENVR), we are delighted to welcome all the participants to the 2014 joint Graybill/ENVR Conference on Modern Statistical Methods for Ecology. Our sincere thanks to the keynote and invited speakers, the instructor for the short course, and the poster presenters for their participation in this conference. We also thank our sponsors, both financial and institutional, for their assistance in making this conference possible.

Frank Graybill, founder and past Chair of the Department of Statistics at Colorado State University, passed away in 2012. The Graybill conference series was started in 2001 in his honor and is now supported by a university endowment. This joint conference also marks the 8th biennial ENVR workshop, and ENVR is enthusiastic in support of the event.

We hope you will find this conference interesting and stimulating, and we look forward to welcoming you again in Fort Collins at future Graybill conferences or at a future ENVR conference.

*Jean Opsomer, Chair*
*Department of Statistics*
*Colorado State University*

*Alix Gitelman, Chair*
*Section on Statistics and the Environment, ASA*

## Organizing Committee

- Geof Givens, Co-Chair, Colorado State University
- Alix Gitelman, Co-Chair, Oregon State University
- Alan Gelfand, Duke University
- Robert Dorazio, United States Geological Survey
- Janine Illian, University of St. Andrews
- Mevin Hooten, Colorado State University

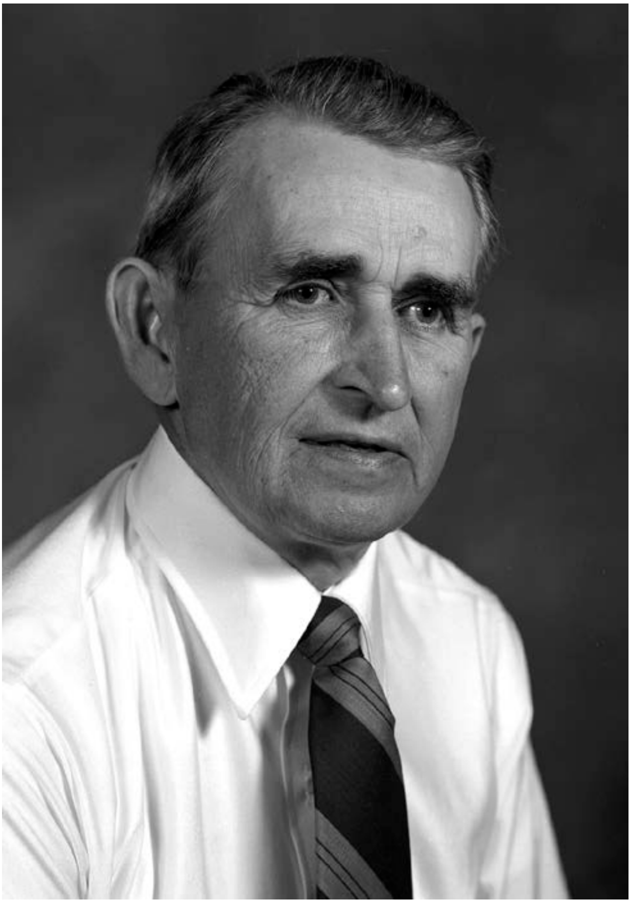
## Arrangements

- Kristin Stephens
- James zumBrunnen
- Colorado State University Conference Services
- Department of Statistics Graduate Students

## Help and Local Information

- The registration desk on the upper level of Lory Student Center can provide help as it is open during most of the conference.
- Feel free to ask any CSU faculty member or student for help or advice about the conference, the university, or Fort Collins
- Visiting our Campus: www.colostate.edu/visiting-campus.aspx
- Local mass transit via Transfort: http://www.ridetransfort.com/
- Free on-campus internet access information is in your welcome folder you received at the registration desk.

# Professor Franklin A. Graybill



**Department of Statistics**
**Colorado State University**

**The following graduates of the Department of Statistics at Colorado State University completed their degrees under the guidance of Professor Franklin A. Graybill**

Mohamed H. Albohali (MS '79)
Robert A. Ahlbrandt (MS '87)
Carmen E. Arteaga (MS '80)
James H. Baylis (MS '77)
David C. Bowden (MS '65, PhD '68)
Brent D. Burch (MS '93, PhD '96)
James A. Calvin (PhD '85)
Terrence L. Connell (MS '63, PhD '66)
Ruth Ann Daniel (MS '80)
Ali Mashat Deeb (MS '81)
Richard M. Engeman (MS '75)
Rana S. Fayyad (PhD '95)
Mark J. Grassl (MS '80)
Rongde Gui (PhD '92)
Paul A. Hatab (MS '77)
William C. Heiny (MS '81)
Sakthivel Jeyaratnam (PhD '78)
Dallas E. Johnson (PhD '71)
Thomas A. Jones (MS '67)
Yongsang Ju (MS '92)
Adam Kahn (MS '78)
M. Kazem Kazempour (PhD '88)
Albert Kingman (PhD '69)
Stephen L. Kozarich (PhD '71)
Ricardo A. Leiva (MS '82)
Tai-Fang Chen Lu (MS '79, PhD '85)
Sandra Mader (MS '77)
Farooq Maqsood (MS '84)
Louise R. Meiman (MS '67)
Ronald R. Miller (MS '76)
George A. Milliken (MS '68, PhD '69)
Michael E. Mosier (PhD '92)
William B. Owen (PhD '65)
Antonio Reverter-Gomez (MS '94)
Robert C. Rounding (PhD '65)
Bhabesh Sen (PhD '88)
Jeanne Simpson (MS '78)
Syamala Srinivasan (MS '84, PhD '86)
R. Kirk Steinhorst (MS '69, PhD '71)
Naitee Ting (PhD ’87)
N. Scott Urquhart (MS '63)
Antonia Wang (MS '82)
Chih-Ming (Jack) Wang (PhD '78)

# Program and Schedule of Talks

| Sunday September 7 | Time | Event | Speaker | Title |
|---|---|---|---|---|
| | 8:00 | Registration | | |
| | 9:00 | Short Course - Room 382 | Andrew Finley and Alan Gelfand | Hierarchical Random Effects Models Using Markov Chain Monte Carlo |
| | 10:15 | Break | | |
| | 10:30 | Short Course continued | | |
| | 12:00 | Lunch included with Short Course | | |
| | 1:00 | Short Course continued | | |
| | 2:15 | Break | | |
| | 2:30-5:00 | Short Course conclusion | | |
| | 5:30 | Registration | | |
| | 6:00 | Mixer - Room 386 | | |

| **Monday September 8** | **Time** | **Event** | **Speaker** | **Title** |
|---|---|---|---|---|
| | 8:00 | Registration | | |
| | 8:15 | Welcome - North Ballroom | | |
| | 8:30 | Keynote | Jim Clark | Forecasting the forest and the trees: climate interactions from individual to community |
| | 9:20 | Invited | Alan Gelfand | Stochastic Modeling for Climate Change Velocities |
| | 9:55 | Break | | |
| | 10:15 | Invited | Janine Illian | Flexible spatial models and their relevance in ecology |
| | 10:50 | Invited | Jennifer Hoeting | Nonparametric Convex Spatial Covariance Modeling |
| | 11:25 | Invited | Dale Zimmerman | Accounting for Flow Volume in the Estimation of Spatial Dependence on Stream Network |
| | 12:00 | Lunch-on your own | | |
| | 1:30 | Keynote | David Borchers | Survival models without mortality: casting closed-population wildlife survey models as survival or recurrent event models |
| | 2:20 | Invited | Andy Royle | Spatial Capture-Recapture Models Allowing Transience or Dispersal |
| | 2:55 | Break | | |
| | 3:15 | Invited | Bob Dorazio | Accounting for Imperfect Detection in Statistical |

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| | | | | Analysis of Presence-only Data |
| | 3:50 | Invited | Gurutzeta Guillera-Arroita | Accounting for detectability in species occupancy modeling is valuable |
| | 4:25 | Invited | M. J. Heaton | Spatial Modeling of Mountain Pine Beetle Damage |
| | 5:00 | End | | |

| Tuesday September 9 | Time | Event | Speaker | Title |
|---|---|---|---|---|
| | 8:00 | Registration | | |
| | 8:30 | Keynote - North Ballroom | Jun Zhu | Statistical Methods for Spatial Categorical Data Analysis in Ecology |
| | 9:20 | Invited | Roland Langrock | Nonparametric inference in ecological latent-state models |
| | 9:55 | Break | | |
| | 10:15 | Invited | David Warton | Valid community-level inferences from multivariate abundance data |
| | 10:50 | Invited | Geof Givens | Horvitz-Thompson abundance estimation adjusting for uncertain recapture, smoothed availability rends and interrupted effort, with application to a whale survey |
| | 11:25 | Invited | Lisa Madsen | Simulating Realistic Spatial Count Data |
| | 12:00 | Lunch-on your own | | |
| | 1:30 | Keynote | Anne Chao | Unifying species diversity, phylogenetic diversity, functional diversity and related similarity/differentiation measures through Hill numbers |
| | 2:20 | Invited | Juan Morales | Towards more realistic movement models: comparing simulated and observed movement |
| | 2:55 | Break | | |

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| | 3:15 | Invited | Mevin Hooten | Linking long-distance animal movement behavior and landscapes using multiscale functional models |
| | 3:50 | Invited | Devin Johnson | Estimating animal resource selection from telemetry data using point process models |
| | 4:25 | Speed Session: Poster Introductions | Poster Presenters | Various |
| | 5:30 | Poster Exhibit with presenters - Room 386 | Poster Presenters | |
| | 7:00 | Banquet and Awards - Cherokee Park | | |

| Wednesday September 10 | Time | Event | Speaker | Title |
|---|---|---|---|---|
| | 8:00 | Registration | | |
| | 8:30 | Keynote - North Ballroom | Jay Ver Hoef | The Hidden Costs of Multimodel Inference |
| | 9:20 | Invited | Alix Gitelman | Model Selection for Ecosystem Disturbance Pathways |
| | 9:55 | Break | | |
| | 10:15 | Invited | Megan Higgs | Resource selection by scientists: navigating the model selection and multi-model landscape toward question-focused modeling |
| | 10:50 | Invited | Brian Reich | Policy optimization for dynamic spatiotemporal systems |
| | 11:25 | Closing | | |
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| | 1:00 | Rocky Mountain National Park (Registration required) | Box lunch included | Depart from west entrance to Hilton |
| | 2:30 | Fort Collins Brewery (Registration required) | | Transportation on your own, Transfort or Hilton van at 2:15 |

# Abstracts

**Keynote Speakers**

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|---|---|
| • David Borchers<br>• Anne Chao<br>• James S. Clark | • Jay M. Ver Hoef<br>• Jun Zhu |

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| **David Borchers** | **Survival models without mortality: casting closed-population wildlife survey models as survival or recurrent event models** |
| | David Borchers, Roland Langrock, Darren Kidney, Greg Distiller and Ben Stevenson |
| | One can formulate closed-population wildlife surveys as survival models (in which individuals "survive" detection for some time) or recurrent event models (in which the events are detections). These models are characterized by the fact that they invariably have a spatial component, and therefore (a) mortality or event hazard rates depend on spatial covariates, and (b) they require a spatial model for individuals' locations in space, and when individual locations are not observed the spatial model acts as a latent variable distribution.<br><br>In this talk I develop a general model for wildlife surveys as survival or recurrent event models, consider some widely-used closed-population wildlife survey models from this perspective. I illustrate some of the advantages of formulating models in this way, using case studies that include aerial surveys of seabirds with high-definition video cameras, visual line transect surveys of marine mammals, camera-trap surveys of large cats and acoustic surveys of gibbons. |

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| **Anne Chao** | **Unifying species diversity, phylogenetic diversity, functional diversity and related similarity/differentiation measures through Hill numbers** |
| | Anne Chao, C.-H. Chiu and Lou Jost |
| | Hill numbers or the "effective number of species" are increasingly used to quantify species diversity of an assemblage. In this talk, I review Hill numbers and the advantages of using Hill numbers to quantify diversities. Hill numbers were recently extended to phylogenetic diversity, which incorporates species evolutionary history, and also to functional diversity, which considers the differences among species traits. I also review these extensions and integrate them into a framework of "attribute diversity" (or the "effective total attribute value") based on Hill numbers. This framework unifies ecologists' measures of species diversity, phylogenetic diversity, and functional diversity. It also provides a unified method of decomposing these diversities and constructing normalized taxonomic, phylogenetic, and functional similarity and differentiation measures, including N-assemblage phylogenetic or functional generalizations of the classic Jaccard, Sørensen, Horn and Morisita-Horn indices. A real example shows how this framework extracts ecological meaning from complex data. (This is a joint work with C.-H. Chiu and Lou |

| James S. Clark | **Forecasting the forest and the trees: climate interactions from individual to community** |
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| | James S. Clark, Bradley Tomasek, Chris Woodall, Kai Zhu |
| | Is the study of individuals sufficient to predict changing distribution and abundance of species? Alternatively, can the dynamics of interacting species be explained without knowledge of individual responses? From population viability to global warming, biodiversity predictions of change and vulnerability come from one scale or the other, but do not combine them.<br><br>Individual-scale models include matrix projection models (MPMs), integral projection models (IPMs), and partial differential equations (PDEs). These methods have in common a reliance on parameters estimated for independent responses (growth, survival, fecundity) of independent individuals. More aggregated models are spatially coarse and include species distribution models (SDMs). SDMs implement independent models for each species or functional type, then add them together to predict diversity and productivity. Neither approach is designed to address four-dimensional population structure across size, species, space, and time, where individuals and species respond to the environment as a joint distribution. Here I discuss how to combine data and processes across these scales to provide inference on the joint distribution of species in space, time, and size structure. The model can be viewed as a PDE, a MPM, or an IPM, but at the population, rather than individual scale. It is also a SMD, but implemented jointly over time, a dynamic joint species distribution model. A single model helps address long-standing questions concerning the demographic processes that determine species range limits, how distribution and abundance can change with |

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| | climate, and how competition and climate interact to affect distributions of species. With an application to long-term and spatially extensive forest plots in eastern North America we show which species respond most to climate, the extent to which local moisture gradients can alleviate negative impacts of increasing aridity, and how competition exacerbates effects of climate change in different ways for different species. |
| **Jay M. Ver Hoef** | **The Hidden Costs of Multimodel Inference** |
| | Jay M. Ver Hoef, Peter L. Boveng |
| | Multimodel inference accommodates uncertainty when selecting or averaging models, which seems logical and natural. However, there are costs associated with multimodel inferences, so they are not always appropriate or desirable. First, we present statistical inference in the big picture of data analysis and the deductive-inductive process of scientific discovery. Against this backdrop, some statistical models are presented as being correct and some others as incorrect but useful. Multimodel inference is used primarily when modeling processes of nature, when there is no hope of knowing the true model, so a useful one is used. However, even in these cases, a single model to meet an objective may be better. Additionally, researchers should consider model diagnostics when using multiple models. Some of the costs of multimodel inference include 1) developing competency in multimodel inference procedures and the models that compose them, 2) coding time, 3) computing time, and 4) contemplation time. An optimal strategy, when cost is included, may often be a single model. We recommend that researchers and managers carefully examine objectives and cost when considering multimodel inference methods. |

| Jun Zhu | Statistical Methods for Spatial Categorical Data Analysis in Ecology |
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| | Jun Zhu |
| | Modeling spatial categorical data in ecology and drawing statistical inference can be challenging when the number of categories is large and/or size of the sample is big. The motivating examples include data derived from the Public Land Survey System (PLSS) records in various parts of the United States, which require statistical methods for data analysis that balance modeling complexity, statistical efficiency, and computational feasibility. In this talk, some of the existing methodology for spatial categorical data is reviewed and new approaches are proposed. In particular, models for spatial ordinal data and spatial nominal data are described and both frequentist and Bayesian inference are considered. Comparisons and connections will be drawn between different data types and different modeling approaches. For illustration, the methods are applied to analyze PLSS forest cover data for mapping and inferring about the forest landscape structures. |

**Invited Speakers**

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| • Robert M. Dorazio<br>• Alan E. Gelfand<br>• Alix Gitelman<br>• Geof H. Givens<br>• Gurutzeta Guillera-Arroita<br>• Matthew Heaton<br>• Megan Higgs<br>• Jennifer Hoeting<br>• Mevin B. Hooten<br>• J.B. Illian | • Devin Johnson<br>• Roland Langrock<br>• Lisa Madsen<br>• Juan Manuel Morales<br>• Brian Reich<br>• J. Andrew Royle<br>• David I. Warton<br>• Dale Zimmerman |

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| **Robert M. Dorazio** | **Accounting for Imperfect Detection in Statistical Analysis of Presence-only Data** |
| | Robert M. Dorazio |
| | During the past decade ecologists have attempted to estimate the parameters of species distribution models by combining species presence locations observed in opportunistic surveys with spatially referenced covariates of occurrence. Several statistical models have been proposed for the analysis of presence-only data, but these models have largely ignored the effects of imperfect detectability, which can bias the predicted distribution of a species. In this paper I describe a model-based approach for the analysis of presence-only data that accounts for errors in detection of individuals.<br><br>I develop a hierarchical, statistical model that allows presence-only data to be analyzed in conjunction with data acquired independently in bona fide surveys. One component of the model specifies the spatial distribution of individuals within a bounded, geographic region as a realization of a spatial point process. A second |

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| | component of the model specifies two kinds of observations, the detections of individuals encountered during opportunistic surveys and the detections of individuals encountered during planned surveys.<br><br>Using mathematical proof and simulation-based comparisons, I demonstrate that biases induced by imperfect detectability can be reduced or eliminated by using this model to analyze presence-only data in conjunction with counts observed in planned surveys. I show that a relatively small amount of high-quality data (from planned surveys) can be used to leverage the information in presence-only observations, which usually have broad spatial coverage but may not be informative of both occurrence and detectability of individuals. Because a variety of sampling protocols can be used in planned surveys, this approach to the analysis of presence-only data is widely applicable. In addition, since the point-process model is formulated at the level of an individual, it can be extended to account for biological interactions between individuals and temporal changes in their spatial distributions. |
| **Alan E. Gelfand** | **Stochastic Modeling for Climate Change Velocities** |
| | Alan E. Gelfand, Erin Schliep |
| | The ranges of plants and animals are moving in response to change in climate. In particular, if temperatures rise, some species will have to move their range. On a fine spatial scale, this may mean moving up in elevation; on a larger spatial scale, this may result in a latitudinal change. In this regard, the notion of velocity of climate change has been introduced to reflect change in location corresponding to change in temperature. If location is viewed as one dimensional, say x and time is denoted by |

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| | t, the velocity becomes dx/dt. In the crudest form, given a relationship between temperature (Temp) and time as well as a relationship between Temp and location, we would have dx/dt=[dTemp/dt]/[Temp/dx].<br><br>The contribution here is to extend this simple definition to more realistic models, models incorporating more sophisticated explanations of temperature, models introducing spatial locations, and, most importantly, models that are stochastic over space and time. With such model components, we can learn about directional velocities, with uncertainty. We can capture spatial structure in velocities. We can assess whether velocities tend to be positive or negative, and in fact, whether and where they tend to be significantly different from 0. Extension of the model development can be envisioned to the species level, i.e., to species-specific velocities. Here, we replace a temperature model as the driver with presence-only or presence/absence models. We can make attractive connections to customary advection and diffusion specifications through partial differential equations.<br><br>We illustrate with 118 years of data at 10km resolution (resulting in more than 21, 000 cells) for the eastern United States. We adopt a Bayesian framework and can obtain posterior distributions of directional velocities at arbitrary spatial locations and times. This is joint work with Erin Schliep. |

| Alix Gitelman | Model Selection for Ecosystem Disturbance Pathways |
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| | Alix Gitelman, Kathryn M. Irvine |
| | Applications of causal analysis are becoming more common in both aquatic and terrestrial ecosystems as scientists try to understand pathways of ecosystem disturbance. This approach requires synthesizing current scientific knowledge such that connections among ecological indicators and key ecosystem states or processes can be conveyed using a directed acyclic graph. Measured variables are represented as nodes in these graphs, and edges between nodes can be direct (suggesting possible cause-effect relationships) or indirect (suggesting more complicated, or mediated, cause-effect relationships.) Together, these pathways can provide a nuanced understanding of ecological mechanisms by harnessing a ``network of predictors." We describe several methods for model comparison in this context---where the question isn't about discovering edges, but rather about deciding between different ecologically plausible pathways. This work is motivated by recent interest in how climate drivers (e.g., drought, reduced snowpack) may effect intermediate stressors (e.g., disease, insect outbreaks, invasive species) which in turn impact species or biological communities of interest. Alternatively, the primary drivers effecting stressors and ultimately biota may be nthropogenic (e.g., land use change, urbanization, deforestation). We describe several methods for model comparison in this context---where the question isn't about discovering edges, but rather about deciding between different ecologically plausible pathways. |

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| **Geof H. Givens** | **Horvitz-Thompson abundance estimation adjusting for uncertain recapture, smoothed availability trends and interrupted effort, with application to a whale survey** |
| | Geof H. Givens, Stacy L. Edmondson, and 8 more coauthors |
| | We examine the use of an unusual Horvitz-Thompson type estimator developed for the estimation of total population abundance of the Bering-Chukchi-Beaufort Seas population of bowhead whales in 2011 based on visual sightings and acoustic locations obtained from ice-based visual observation stations and submersed marine acoustical units. What makes this analysis unique is the derivation of three estimated correction factors required to account for complexities presented by the survey protocol and resulting features of the dataset. The first factor adjusts for detectability using uncertain recapture data to estimate detection probabilities and their dependence on offshore distance, ice condition, and whale group size. The second correction adjusts for availability using the acoustic location data to estimate a time-varying smooth function of the probability that animals pass within visual range of the observation stations. The third correction accounts for missed visual watch effort. Uncertainty in the estimates of these corrections is propagated into the final abundance estimate and an associated estimate of population trend that incorporates a time series of past estimates. Although some of the particulars of the approach are closely connected to the bowhead application, adjustments for detection, availability and effort are common and some of the methods discussed here could be adapted for abundance surveys facing similar challenges |

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| **Gurutzeta Guillera-Arroita** | **Accounting for detectability in species occupancy modeling is valuable** |
| | Gurutzeta Guillera-Arroita |
| | It has long been recognized that field detection is often imperfect in wildlife surveys, and that this can bias the estimators of ecologically relevant state variables. In recognition of this problem, models that are developed in statistical ecology often include the description of two distinct processes: a system process that describes the biological system and an observation process that reflects the characteristics of data collection. Examples based on this general structure include models that estimate demographic parameters or abundance from capture- recapture data, and the estimation of abundance from distance-sampling records.<br><br>The last decade has seen particularly rapid development of models aimed at estimating species occupancy probability while accounting for imperfect detection. Whilst initially developed for wildlife monitoring applications, these models are starting to be recognized as relevant tools for species distribution modelling too. However, even as the interest in "detectability-aware" occupancy methods and their application continues to rise, there has been recently published work questioning their utility. These include suggestions that these models only provide very modest performance improvement (Rota et al. 2011), as well as stronger criticisms claiming that the models are difficult to fit and that disregarding detectability can be better than trying to adjust for it, with authors even concluding that |

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| | adjusting for non-detection "is simply not worthwhile" (Welsh et al. 2013).<br><br>In this talk, I will explain why I think that these conclusions and related recommendation are not well founded and may have a negative impact on the quality of statistical inference in ecology. In particular, I will show how it is the choice of specific scenarios used to support these negative claims (Guillera-Arroita et al., in review), as well as confusion regarding how to assess the predictive performance of the models (Lahoz-Monfort et al. 2014), that provides a distorted picture of the true value of accounting for detectability. |
| **M. J. Heaton** | **Spatial Modeling of Mountain Pine Beetle Damage** |
| | M. J. Heaton, K. A. Kaufeld, and S. R. Sain |
| | Forest composition in the western region of the United States has seen a dramatic change over the past few years due to an increase in mountain pine beetle damage. In order to mitigate the pine beetle epidemic, statistical modeling is needed to predict both the occurrence and the extent of pine beetle damage.  Using data on the front range mountains in Colorado between the years 2001-2010 from the National Forest Service, we develop a zero-augmented spatio-temporal beta regression model to predict both the occurrence of pine beetle damage (a binary outcome) and, given damage occurred, the percent of the region infected.  Temporal evolution of the pine beetle damage is captured using a dynamic linear model where both the probability and extent of damage depend on the amount of damage incurred in neighboring regions in the previous time period.  A sparse conditional autoregressive model is used to capture any spatial information not modeled |

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| | by spatially varying covariates. We find that the occurrence and extent of pine beetle damage are positively associated with slope and damage in previous time periods |
| **Megan Higgs** | **Resource selection by scientists: Navigating the model selection and multi-model landscape toward question-focused modeling** |
| | Megan Higgs |
| | Ecological researchers are often faced with navigating the myriad of potential statistical methods and models, and in recent history have gravitated toward model or variable selection techniques to address a huge variety of research questions. For many, this has become a default choice, with little explicit justification based on research questions and study design. Here, we appeal to the basic foundations of regression to demonstrate potential mismatches between questions of interest and the use of selection techniques. We explore differences between variable selection and model selection, the common fear of multicollinearity, and connections between multi-model inference and regularization techniques such as the adaptive lasso. We offer practical strategies to aid researchers in deciding whether techniques are appropriate for their scientific questions and study design. For example, we propose a graphical method for assessing whether model averaged regression coefficients are practically meaningful for a particular study. These investigations do not criticize particular methods, but instead present work meant to help researchers implement a more question-focused, rather than method-focused, approach to carrying out statistical inference. |

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| **Jennifer Hoeting** | **Non-Parametric Convex Spatial Covariance Modeling** |
| | Jennifer Hoeting, Nick Cummings, Mary Meyer |
| | We propose a constrained, non-parametric, stationary, isotropic, spatial covariance model. The model allows for greater flexibility than parametric models, makes fewer assumptions, and is relatively easy to fit. The model is based on reversed C-spline basis functions which are calculated in closed form. The log likelihood of the data model is maximized using constrained optimization to find the coefficients of the basis functions that best fit the covariogram curve.  This fit, in turn, determines the covariance matrix. We demonstrate the efficiency and effectiveness of this method via simulation study and an example. This is joint work with Nick Cummings<br>and Mary Meyer. |
| **Mevin B. Hooten** | **Linking long-distance animal movement behavior and landscapes using multiscale functional models** |
| | Mevin B. Hooten |
| | Advances in animal telemetry data collection techniques have served as a catalyst for the creation of statistical methodology for analyzing animal movement data.  Such data and methodology have provided a wealth of information about animal space use and the investigation of animal-environment relationships.  While the technology for data collection is improving dramatically over time, we are left with massive archives of historical animal telemetry data of varying quality.  However, many contemporary statistical approaches for inferring movement behavior are designed for newer data that are very accurate and high-resolution.  From a |

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| | scientific perspective, the behaviors we are interested in learning about may be nonstationary and occur across multiple scales. We describe a statistical modeling approach that uses multiple historical data sources in an explicitly multiscale framework to better understand animal spatial behavior. The models we describe are fast to implement, accessible to ecologists, easily generalized, and properly account for the uncertainty associated with telemetry data and the movement process. We apply this methodology to the study of Colorado predators for the identification of corridors and barriers to long-distance movement events. |
| **J.B. Illian** | **Advancements in Sample Data Augmentation** |
| | J.B. Illian, , T.G. Martins, A. Riebler, H. Rue, D. Simpson, S.H. Sørbye |
| | In a Bayesian context, choosing an appropriate prior distribution should ideally form an integral part of the modelling process. The prior distribution should encode prior knowledge about the parameters; however translating existing prior knowledge into a prior distribution often seems to be unattainable in practice. As a result, users resort to a "default" prior without explicitly discussing its choice.<br><br>At the same time, models typically rely on a number of distributional assumptions, which might or might not be met in practice - with all the implications on the validity of the conclusions drawn from the model. This is particularly relevant in ecology; however surprisingly few flexible methods are available that are directly linked to a standard model. The approach we discuss here addresses both the issue of prior choice and that of deviation from a standard model by explicitly incorporating deviation |

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| | from a standard model into the modelling process. This is done within an extended family of models that has a basic standard model at is centre.<br><br>This family is constructed by introducing an additional flexibility parameter that controls the deviation from the basic model. Instead of parameterising the flexibility parameters directly, we base the distance between the base and the flexible model. Based on this distance we derive meaningful prior distributions for the flexibility parameters. These allow us to interpret the flexible model as a flexible version of the basic model. Shrinkage to the base model is warranted when supported by the data, but moderate deviations from the base model are properly captured if required.<br><br>Further, the approach can directly be integrated into the R-INLA software. Hence we are able to work with more flexible models without loosing the usual benefits of integrated nested Laplace approximation (INLA; Rue et al. 2009), i.e. short computation times and high accuracy. This extends the toolbox of models available in R-INLA and makes these models accessible to a wide audience of users. We illustrate the methodology with a number of relevant ecological examples primarily discussing the approach in the context of complex spatial models. |
| **Devin Johnson** | **Estimating animal resource selection from telemetry data using point process models** |
| | Devin Johnson |
| | Analyses of animal resource selection functions (RSF) using data collected from relocations of individuals via remote telemetry devices have become commonplace. Increasing technological advances, however, have produced statistical |

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| | challenges in analysing such highly autocorrelated data. Weighted distribution methods have been proposed for analysing RSFs with telemetry data. However, they can be computationally challenging and cannot be aggregated (i.e. collapsed) over time to make space-only inference. We take a conceptually different approach to modeling animal telemetry data for making RSF inference by considering the telemetry data to be a realization of a space¡Vtime point process. Under the point process paradigm, the times of the relocations are also considered to be random rather than fixed. We show the point process models we propose are a generalization of the weighted distribution telemetry models. By generalizing the weighted model, we can access several numerical techniques for evaluating point process likelihoods that make use of common statistical software. Thus, the analysis methods can be readily implemented by animal ecologists. In addition to ease of computation, the point process models can be aggregated over time by marginalizing over the temporal component of the model. This allows a full range of models to be constructed for RSF analysis at the individual movement level up to the study area level. |
| **Roland Langrock** | **Nonparametric inference in ecological latent-state models** |
| | Roland Langrock |
| | Latent-state models typically comprise two stochastic processes, only one of which is observed. The observed process is in some way driven by the unobserved process, and the latter exhibits temporal correlation. Corresponding models, such as hidden Markov models, general state-space models or Markov-modulated Poisson processes, have many applications in ecology, where the unobserved |

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| | process might correspond, for example, to the behavioural state of an animal, to an animal's condition or to the not directly observable size of an animal population. In these modelling classes even parametric inference is often challenging, since the likelihood involves either a summation or an integration over all possible values of the unobserved process, which can render its evaluation very computationally demanding. Nonparametric techniques for flexible modelling, which are nowadays routinely used for example in regression models or in density estimation, have hardly ever been incorporated in latent-state models. In this talk, I will first demonstrate how the relatively simple yet very powerful hidden Markov model machinery can be exploited in different ecological latent-state models. I will then show how the corresponding techniques can be combined with the general advantages of spline-based modelling to allow for nonparametric inference. The methods are applied to animal movement and capture-recapture data. |
| **Lisa Madsen** | **Simulating Realistic Spatial Count Data** |
| | Lisa Madsen |
| | I will present a method to simulate count-valued dependent random variables that mimic an observed data set consisting of weed counts observed in a field. The method simulates a correlated normal random vector, then transforms to the desired marginal distributions. The difficulty is in characterizing the desired dependence and determining the normal correlations that lead to this dependence. I argue that Spearman's rank correlation is an appropriate characterization and show how to |

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| | determine the normal correlation matrix that will lead to the specified Spearman correlation matrix. |
| **Juan Manuel Morales** | **Towards more realistic movement models: comparing simulated and observed movement** |
| | Juan Manuel Morales |
| | Computer intensive methods are allowing us to fit increasingly detailed movement models to data. These models usually include the effects of habitat features and even past experiences on movement decisions. However, once the fitted models are simulated (if this is done at all), the trajectories produced by the models rarely look like the observed ones. Here I argue that this problem is mainly due to current models paying too much attention to small-scale features of movement trajectories. A possible way around this issue is for researchers to first define what features of movement they wish to capture and then use posterior predictive checks on such features to assess model performance. Alternatively, Approximate Bayesian Computation based on selected movement features can be used from the outset. I will illustrate these ideas highlighting their potential, challenges and limitations. |
| **Brian Reich** | **Policy optimization for dynamic spatiotemporal systems** |
| | Brian Reich |
| | Interventions performed in space and time subject to resource constraints are common in ecology and many other fields. For example, we consider intervention strategies to slow the spread of white nose syndrome (WNS) in hibernating bats. WNS has dire consequences for both the bat population and agriculture production in affected areas. A policy is required to determine where and when |

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| | interventions such as cave closings should be implemented. Finding an optimal policy in this case is challenging because data are sparse, disease dynamics are complex, and the state and action spaces are extremely high dimensional. We propose a general framework for policy optimization in dynamic spatiotemporal systems. The key features of our approach are that it ensures an interpretable policy, exploits scientific knowledge of the disease, adapts to changes in the system, properly accounts for many sources of uncertainty, and can be applied to high-dimensional problems. In our analysis of WNS, we show that the proposed approach can lead to substantial improvements over competing methods. |
| **J. Andrew Royle** | **Spatial Capture-Recapture Models Allowing Transience or Dispersal** |
| | J. Andrew Royle, Angela K. Fuller,Christopher Sutherland |
| | Spatial capture-recapture (SCR) models are a relatively new development in ecological statistics, and they show promise in addressing a large number of ecological modeling problems related to spatial ecology, including studying movement and dispersal, resource selection and landscape connectivity from ordinary encounter history data. SCR models hypothesize that space usage in the vicinity of an animal's home range is concentrated around a stationary point, its home range or activity center. A prominent assumption is stationarity of these individual activity centers. While this may be reasonable for territorial animals, especially over short time periods, it is not always true. Indeed, many biologists are skeptical of the relevance of SCR models for species that are distinctly non-territorial, or in situations when it is difficult to |

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| | determine the exact timing of dispersal and subsequent territory establishment.<br><br>The purpose of this paper is to evaluate the robustness of estimators of abundance and density using closed population SCR models in the presence of transience and dispersal. To do this we devise a simulation study based on several forms of random and Markovian movement, in which the activity center of an individual potentially changes between each sampling occasion. We fit ordinary SCR models to the resulting data, and summarize the bias of the MLEs of model parameters. While our main objective was to evaluate robustness under non-stationarity regimes, we also demonstrate it is possible to fit Markovian models of transience in which the activity center changes during each sample occasion. We fit such models using the JAGS software, and we provide an example using data from a black bear study conducted on Fort Drum, NY. |
| **David I. Warton** | **Valid community-level inferences from multivariate abundance data** |
| | David I. Warton, Yi A. Wang |
| | Multivariate abundance data are commonly and often erroneously analysed using distance-based algorithms (and  techniques related to correspondence analysis), which typically cannot be used to make valid inferences concerning changes in community composition, nor concerning interactions between environmental predictors in their effects on communities.  Model-based approaches provide a way forward, but a key challenge is to account for correlation between different taxa, made difficult because there are typically many more possible pairwise inter-species |

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| | correlations than there are observations that could be used to estimate them. We describe a design-based inferential tool which circumvents the issue, by block-resampling residuals constructed via the probability integral transform (which we call a "PIT-trap"). This approach can ensure valid inference even when the species correlation model has been misspecified. Time-willing we will also discuss model-based inferential tools currently under development, via more parsimonious covariance model specifications, including factor analytic approaches and graphical modelling. Methods will be illustrated by example, including a study of how species traits mediate changes in environmental response across species (the "fourth corner problem"). |
| **Dale L. Zimmerman** | **Accounting for Flow Volume in the Estimation of Spatial Dependence on Stream Networks** |
| | Dale L. Zimmerman |
| | Statistical methods for spatial prediction have long been available for environmental variables on Euclidean domains. A key precursor to prediction of such a variable is the characterization of the statistical dependence among observed values of the variable over space. The most celebrated and important tool for this purpose is the sample semivariogram. Recently, ecologists have begun applying similar methods to variables on non-Euclidean domains, including stream networks. The Torgegram has been proposed as an analogue of the Euclidean sample semivariogram for characterizing spatial dependence on stream networks. However, it does not account for flow volume, which, if unequal across tributaries, leads to biased estimation of spatial dependence and makes the nugget and range difficult to discern. I |

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| | propose modifications to the Torgegram that adjust for flow volume and essentially eliminate this bias. An example illustrates the methodology |

## Contributed Posters

| Student Competition | Non-Competition |
|---|---|
| 1. Ignacio Alvarez & Natalia Da Silva | 21. Matthew E. Aiello-Lammens |
| 2. Maeregu Arisido | 22. Kristin M. Broms |
| 3. Ben Brintz | 23. Daniel Heersink |
| 4. Brian M. Brost (not in competition) | 24. Juha Heikkinen |
| 5. Frances E. Buderman | 25. Nels G. Johnson |
| 6. Joshua Goldstein | 25. José J. Lahoz-Monfort |
| 7. Andrew Hoegh | 26. Joseph M. Northrup |
| 8. (withdrawn) | 28. Viviana Ruiz-Gutiérrez |
| 9. Whitney Huang | 29. Erin Schliep |
| 10. Christopher Ilori | 30. Jared Stabach |
| 11. Clint Leach | 31. Chris Sutherland |
| 12. V. Leos Barajas | |
| 13. Joe Maurer | |
| 14. (withdrawn) | |
| 15. Letícia Soares | |
| 16. John Tipton | |
| 17. Bradley J. Tomasek | |
| 18. Lynn Waterhouse | |
| 19. Christopher Wolf | |
| 20. Robert Yuen | |

Please see our website for abstracts of Contributed Posters. The above numbers (1-20) are the order in which the students in the completion will present during the Tuesday afternoon Poster Introductions beginning at 4:25. The numbers 1-31 are the locations of the posters in Room 386.

# Past Conferences

**Graybill Conference 2001** – June 13-15
Inaugural Graybill Conference on Linear, Nonlinear, and Generalized Linear Models
Program Chair: Hari Iyer

**Graybill Conference 2003** – June 18-20
Microarrays, Bioinformatics, and Related Topics
Program Chair: Hari Iyer
Short course on "Microarray Data Analysis" by Dr. Steen Knudsen

**Graybill Conference 2004** – June 16-18
Spatial Statistics: Agricultural, Ecological & Environmental Applications
Program Chair: Scott Urquhart
Short Course on "Applied Spatial Statistics" by Dr. Jay Ver Hoef

**Graybill Conference 2005** – June 1-2
Statistics in Information Technology
Program Committee: Bin Yu (Chair), Thomas Lee (Co-Chair), Mark Hansen, Hari Iyer
Short Course on “Minimum Description Length” by Professors Bin Yu and Mark Hansen

**Graybill Conference 2006** – June 11-13
Multi-scale methods and Statistics – A Productive Marriage
Program Committee: Thomas Lee (Chair), Xiao-Li Meng, Patrick Wolfe
Short Course on “Multiscale methods” by Professors Xiao-li Meng, Patrick Wolfe, Thomas Lee

**Graybill Conference 2007** – June 12-15
Workshop on Bioinformatics and a Symposium on Applied Probability and Time Series in honor of Professor Peter J. Brockwell.
Program Committee: Duane Boes (honorary chair), Richard Davis, Jay Breidt, Asa Ben-Hur, Hari Iyer
Short Course on BLAST by Professor Warren Ewens

**Graybill Conference 2008** –June 11-13
Biopharmaceutical Statistics

Program Committee: Alfred Balch, Scott Evans, Brian Wiens, Jim Whitmore

Short Course on Hot Topics in Clinical Trials by Professors L.J. Wei, Marvin Zelen, ScottEvans and Lingling Li

**Graybill Conference/EVA 2009** –June 22-26

Extreme Value Analysis

Program Committee: Dan Cooley , Richard Davis, Paul Embrechts, Anne-Laure Fougères, Ivette Gomes, Jürg Hüsler . Rick Katz, Claudia Klüppelberg, Thomas Mikosch, Philippe Naveau, Liang Peng, Holger Rootzén

Short Course: An Introducton ion to the analysis of extreme values using R and extRemes Eric Gilleland, and Mathieu Ribatet

**Graybill Conference 2011** – June 22-24

Modern Nonparametric Methods

Program Committee: Mary Meyer, Jean Opsoner, Rui Song, Ray Carroll, Thomas Lee, Matt Wand, Jane-Ling Wang

Short Course on Semiparametric Regression by Matt Wand

**Graybill/WNAR Conference 2012 –** June 17-20

Program Committee: John Kittleson (Chair), Mathias Drton, Elizabeth Brown, Brandie Wagner

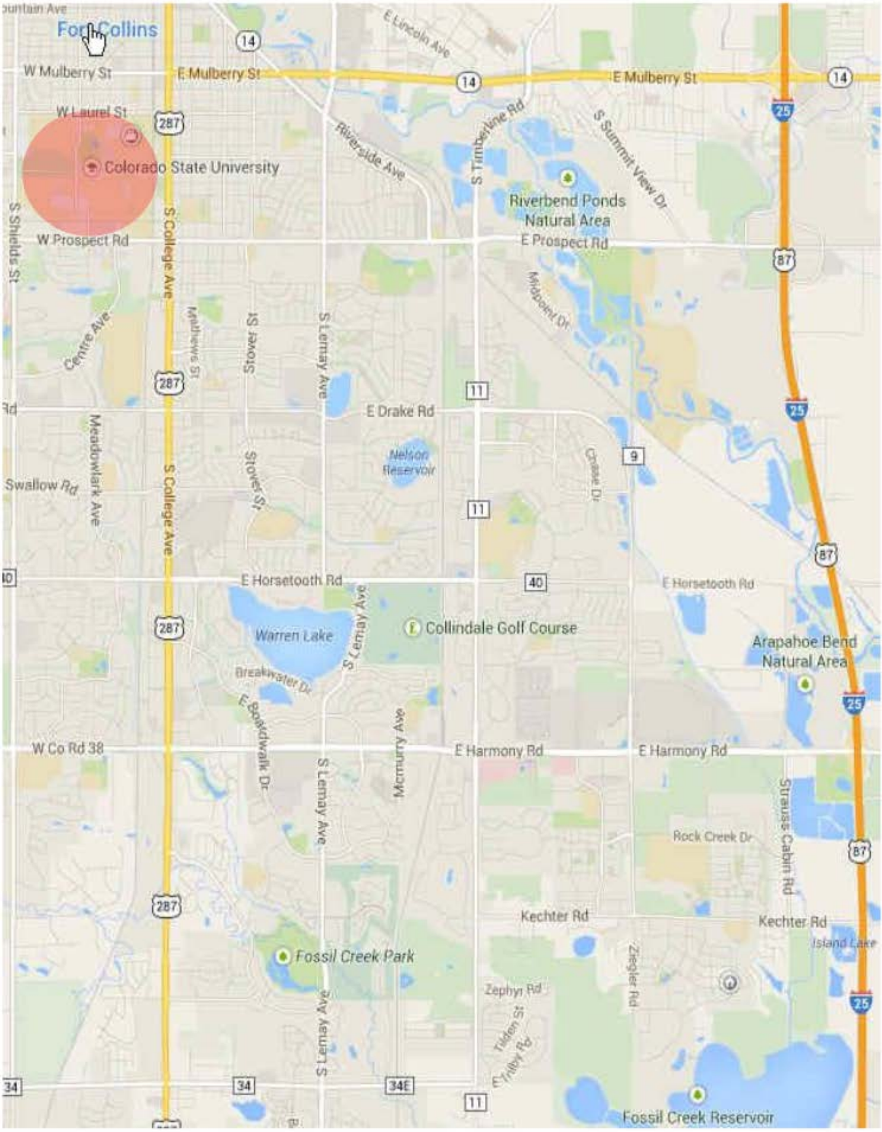
Short Course on Fundamentals of Bayesian Analysis with Examples by Mike Patetta, SAS®

**Graybill Conference 2013 –** June 9-12

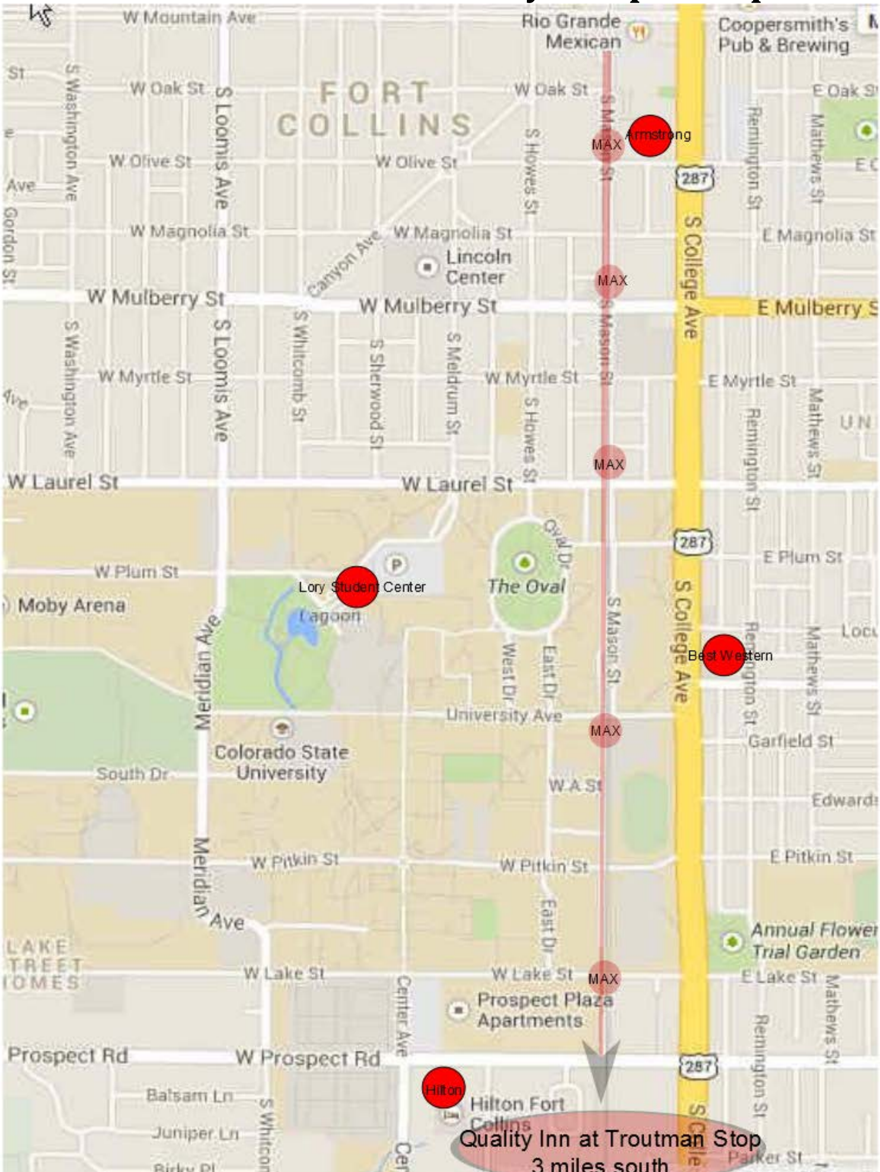
Program Committee: Jay Breidt (Chair), John Eltinge, Jean Opsomer, Giovanna Ranalli

Short Course on Analysis of Probability Surveys using SAS® by Robert Lucas

# Fort Collins City Map



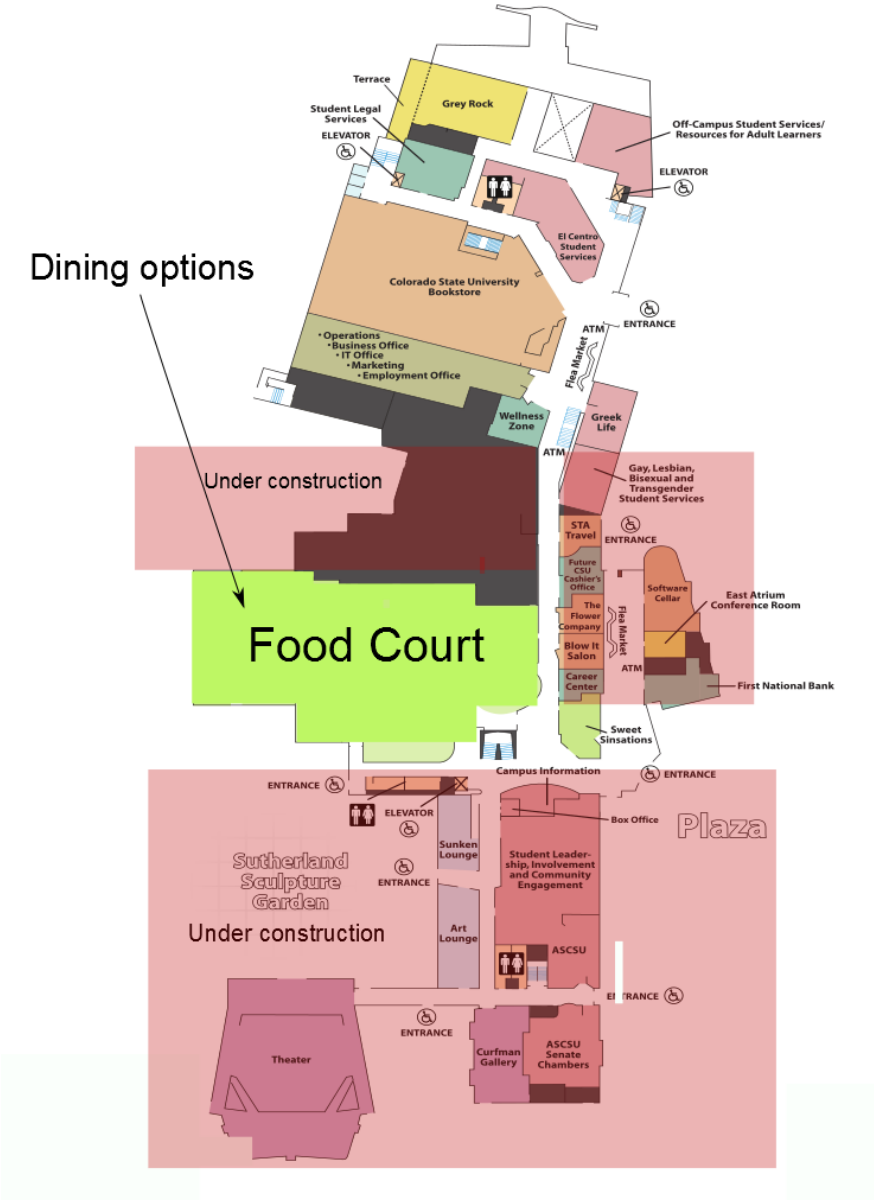
# Colorado State University Campus Map




Red Dots: Lory Student Center and nearby hotels
Pink Dots: MAX stops. See RideTransfort.com: $1.25/ride, $3/Day, $10/7 Days
Note: Quality Inn is about 3 miles south of the Lory Student Center and 3 blocks north of the Troutman (nearest) MAX stop

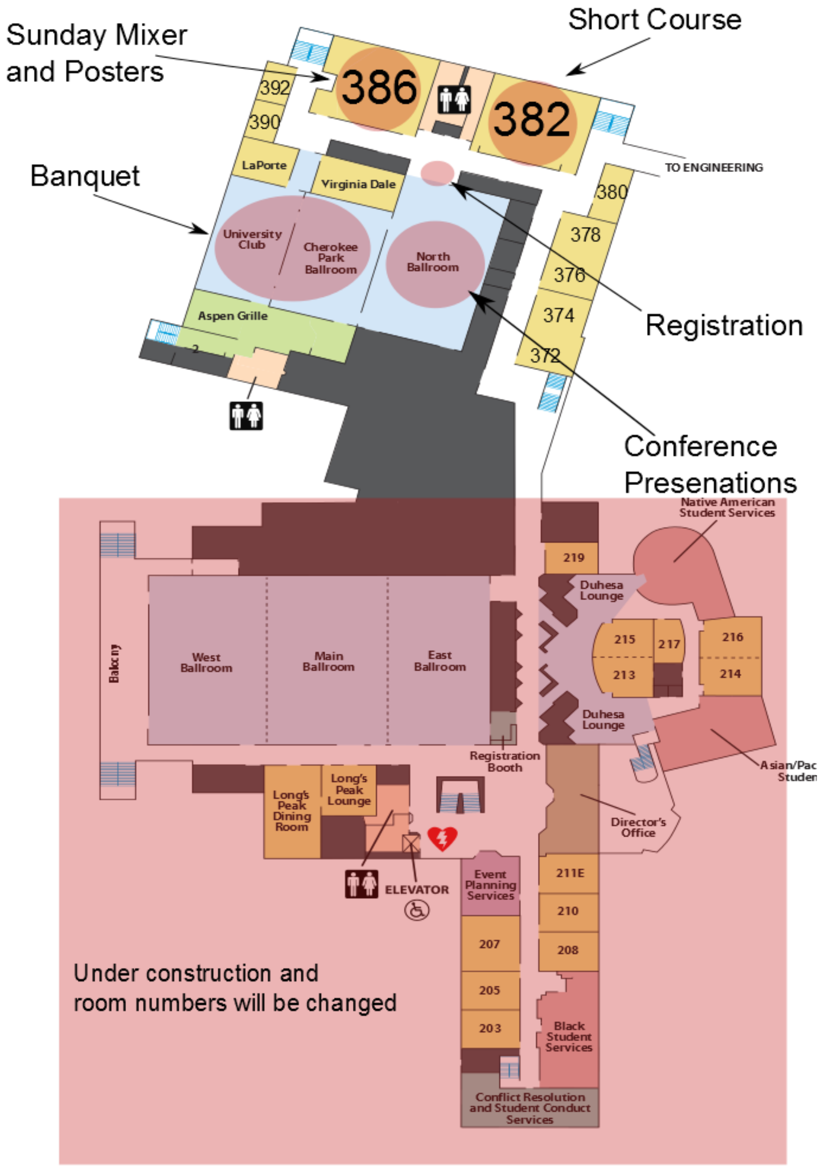
# Lory Student Center Floor plans

## Main Level




**Ask about the many other restaurants within walking distance.**

## Upper Level


Sunday Mixer and Posters
Short Course
386
382
392
390
LaPorte
Virginia Dale
TO ENGINEERING
380
Banquet
University Club
Cherokee Park Ballroom
North Ballroom
378
376
374
372
Registration
Aspen Grille
Conference Presenations
Native American Student Services
219
Duhesa Lounge
215
217
216
213
214
Balcony
West Ballroom
Main Ballroom
East Ballroom
Duhesa Lounge
Registration Booth
Asian/Pac Studen
Long's Peak Lounge
Long's Peak Dining Room
Director's Office
211E
ELEVATOR
Event Planning Services
210
207
208
205
203
Black Student Services
Conflict Resolution and Student Conduct Services
Under construction and room numbers will be changed

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- ***CSU College of Natural Sciences***
- ***National Science Foundation***