GIS IN THE ROCKIES

2015 TODAY'S VISION: TOMORROW'S REALITY

Abstract Book

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This document contains the abstracts for the presentations contributed at the 28th Annual GIS in the Rockies Conference, September 23-24, 2015 at the Cable Center in Denver, Colorado. The presentation files will be gathered and uploaded to slideshare.com for viewing from the GIS in the Rockies website.

Kerry Shakarjian and Mike Johnsen
2015 GIS in the Rockies Program Chairs

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Workshops

Workshops Coordinator – Lisa Ward

UAS and GIS Ground School and Hands-On UAV Flying and Data Collection

Primary Instructor: Joe Falconer, CEO, Aerial Data Systems

Ground school and hands-on UAV flying and data collection. UAS has been prolific in the news and is extremely relevant to the GIS professional. Big industry is lining up to do business in this market space, to name a few: Esri, Leica, Trimble, USGS, USDA, BLM, CU, DU more. To be ready for the future and to take advantage of these technological breakthroughs it is paramount that we all operate legally, safely and respect the national airspace system (NAS). Some of the Topics Covered:

1. Regulations applicable to small UAS operations
2. Airspace and Flight restrictions
3. Camera settings
4. Planning a mission

Primary Instructor Biography: Joe is the CEO of Aerial Data Systems and a FAA certified commercial flight instructor with over 20 years' experience flying and training pilot's, and now brings his expertise to the UAS industry. He has over 20 years' experience building, designing and flying UAVs. He is a subject matter expert in this market as an Adjunct Professor at the University of Denver, teaching the first UAVs and GIS course in the country, and as a free-lance writer, for industry magazines such as Robot and MultiRotor magazines. Along with being a pilot and having a love for all things that fly, Joe started his career as a computer programmer and established himself in the IT Industry working for Fortune 500 companies. He received his Bachelors or Science degree from Colorado State University and Masters of Business Administration from the University of Denver.

Working with Lidar Data in ArcGIS Desktop

Instructor: David Vaillancourt, Solution Engineer, Esri

This hands-on workshop introduces users to the tools and workflows available in ArcGIS for visualizing, analyzing, and sharing Lidar data. ArcGIS Desktop experience required.

Topics to be covered include:

- Introduction to Lidar – what is Lidar Data and how is it used in GIS?
- Working with LAS Datasets to manage and analyze Lidar data
- Introducing Terrain Datasets, using Lidar in terrains
- Using Mosaic Datasets to share Lidar data.

Instructor Biography: David Vaillancourt has worked as a Solutions Engineer in Esri's Denver Regional Office for more than 10 years helping state and local government users understand and apply geospatial technologies to solve organizational challenges and promote better decision making. David has a Master's degree in Geography, and has worked in geospatial sciences for more than 15 years in roles including application developer, instructor, and professional services. In his current position, he shares best practices, educates prospective and existing GIS users on new and cutting-edge technology, and works closely with GIS user communities to support successful implementations. Key areas of interest and specialization include Imagery, 3D visualization, and web mapping applications.

Incorporating No-Cost Landsat Data and Products for Natural Resources Monitoring and moMapping Applications

Instructor: **Ramesh Sivanpillai, Research Scientist, University of Wyoming**

Landsat data constitute the longest collection of remotely sensed earth observations and provide invaluable information for natural resource monitoring and mapping applications. Since 2008, the US Geological Survey (USGS) had made the entire Landsat data archive available to users at no-cost, and more recently derived products which has created an unprecedented opportunity for monitoring and mapping land cover changes. This lecture and demonstration-style workshop will introduce remote sensing concepts and characteristics of Landsat data and products such as vegetation indices, burn severity products etc. Participants will learn how to search and download these data and products from USGS archives, view these images in no-cost software, and estimate changes using two or more images. This workshop will be useful for those GIS practitioners interested in incorporating remotely sensed in their workflow. Upon successful completion participants will receive a completion certificate.

Instructor Biography: Ramesh Sivanpillai is a research scientist at University of Wyoming. He has more than 25 years of experience in working with remotely sensed and other geospatial data in the US and abroad. He manages the WyomingView program (www.uwyo.edu/wyview) whose primary goal is to promote remote sensing science and applications through education and applied research

Esri Hands-on Learning Lab (HOLL)

The HOLL consists of a group of laptops with headphones where students can work through lessons at their own pace. A lesson consists of a recorded presentation followed by a hands-on exercise. Each lesson typically takes about 45 to one hour to complete and students can generally come and go as they please. Ed Services instructors are on hand to assist with questions and to discuss Esri products, other training opportunities and Esri Technical Certification.

Poster Presentations

Track Chair: Kristina VanDenBosch

The Poster Session is a great way to visually present current or past projects and/or cartographic productions without having to sign up for a full presentation in a designated room. Poster topics range all across the board on subject matter and are a great visual tool to present projects and maps.

** Abstract also presented as a talk in a technical session*

Anisotrophy and the Apus: Exploring Inter-Regional Travel in Southern Peru During the Andean Middle Horizon (circa 500 – 1050 AD) **by Beth Scaffidi**
Archaeologists rely on visibility analysis, site suitability models, and cost-surface or cost-path modeling in order to model human interactions with cultural or geographic landscapes. In particular, least-cost path analysis has been a robust computational strategy for predicting human movement throughout the landscape as it would have been constrained by geographic characteristics. However, recent versions of ArcMap (since 9.3) have been unable to run cost-paths based on Tobler's walking function (often used in archaeological cost path modeling), due to errors in generating the anisotrophic raster layer. This project uses traditional criteria (vegetative land cover, distance from water, and slope) to plot least-cost paths from the Middle Horizon capital of the Wari Empire at Huari, to other key Middle Horizon sites in southern Peru, and evaluates the efficacy of ArcMap 10.3.1 for modelling human movement in the Andes.

Bringing ArcGIS into the Adobe Suite for Better Cartographic Design **by Stephanie Oliver ***
Ever found yourself frustrated by the cartographic design functions of ArcGIS? This presentation will provide a quick primer on how to input data from ArcGIS into the Adobe Suite. It will go over the capabilities of the Adobe Suite and when to use which component. We'll discuss some best practices and how to avoid some common pitfalls in the process, and feature a step-by-step demonstration of how to take data from ArcGIS to the next cartographic level.

Continental Divide National Scenic Trail Map **by Jeff Orlowski**
I've created a map/poster of the Continental Divide National Scenic Trail that features a custom shaded relief and hipsometric tinting to bring out the terrain features, and stunning symbology to show the trail and other features relevant to those interested in the 3,100 mile trail.

CO-TreeView: The First Statewide Online Urban Tree Inventory Application **by Ian Hanou, Angel Poulson ***
CO-TreeView is a web-based tree inventory and mapping tool built on Esri and Open Source technologies used by Colorado foresters and arborists to record and visualize the location, species, and condition of the trees that make up Colorado's urban forests. This user-friendly tool, which allows users to view tree and planting site data at a variety of scales, enables proactive, data-driven forest management planning, grant solicitation, and public outreach in support of the conservation and enhancement of the state's community forests. While designed for utility in a broad range of applications, the CO-TreeView tool was created in response to the discovery of Emerald Ash Borer (EAB) in Boulder in late 2013. The Colorado State Forest Service and the Colorado Tree Coalition, who funded the development of the tool, recognized the potential value in having a statewide system to house, aggregate, and display tree inventory data from diverse sources, encouraging Colorado communities to work together to build and protect urban forests.

Generating PDF Map Books to Support Emergency Action Plans for the Tennessee Valley Authority **by Thomas Ferebee**
The poster will display the process steps that it took generate PDF map books displaying the flood extents due to dam failures based on hydraulic model simulations within the Tennessee Valley Authority region. This includes the creation of standard geodatabases and feature classes to facilitate updates when needed, python scripts to export multiple map books at one time, and python scripts to automate creating hyperlinks within the map books to make them user friendly in navigating through them.

The Geodemographics in Location Intelligence: A Study in Craft Brewery Placement **by Abiah Shaffer ***
Since the late eighties, an ever increasing number of American craft breweries have opened up across the United States. Although the industry has a relatively high success rate, there are still a number of craft breweries that fail. As craft brewing is an inherently location based business, the sites selected for new brewery locations are important to that business's success. This research aims to examine how geodemographic information plays a role in strategic location decisions for craft breweries. By building a consumer profile for Phoenix craft brewery customers and comparing the results to the actual demographics of trade areas surrounding craft breweries, we begin to get a picture of geodemographics role in the site selection process. The research looks specifically at two locations; An existing brewing company location and a site they are interested in acquiring. An analysis is performed to compare the geodemographics and behaviors of craft beer consumers in Phoenix, Arizona and those of the current brewing company location under evaluation and their potential new site. This analysis ultimately results in intelligent business information related to location. The information compiled in this study can be used to make informed site selection decisions.

Hydrology Analysis with ArcMap's Spatial Analyst Extension **by Michael Heirendt**
The hydrology tool set from spatial analyst gives the user a multitude of analytic possibilities. In order to perform these analyses, a DEM and and NHD raster must be retrieved from USGS' National Hydrology Dataset website. From there a slope grid, flow direction, and flow accumulation raster can be constructed. With the flow direction raster, stream ordering within watersheds can be constructed, or streams can be converted into a feature layer. Flow accumulation and direction can also be used in conjunction to create a raster representation of watershed boundaries.

Hyperspectral and LiDAR Aid in Desert Tortoise Habitat Evaluation **by Brian Raber**
The poster will highlight a project that was located on Edwards Air Force Base (EAFB) in the middle of the vast Mojave Desert in California. This desert environment is also home of several protected and threatened species. Of most significant is the desert tortoise (Gopherus agassizii). Additionally, the Yucca (brevifolia) which is the taller member of the Joshua tree and the Desert Cympterus plant are also located in the region.
For many years the Air Force monitored progress of mitigation and habitat recovery using traditional mapping and field inventory approaches. Over the most recent years hyperspectral and LiDAR remote sensing technologies have been utilized for more cost effective methodologies to collect, manipulate, and analyze spatial data related to the habitat of these unique desert species. Under a United States Army Corp of Engineers Sacramento District contract with Johnson-Frank & Associates (JFA), Merrick coordinated all of the flights, sesor integration and collected Light Detection and Ranging (LiDAR) while Galileo collected hyperspectral imagery (HIS). The end-user at EAFB used the advanced data sets created under this contract to determine how plant

communities change spatially over time, model ecosystem health, identify the spatial distribution of noxious weeds, determine where disturbance has occurred, and predict sensitive species habitat.

Integrating Demographics with Conservation Strategies Where It Matters Most
by Kimberly Struthers

Rapid development of land and growing populations pose increasing conversion risks for habitats and associated fauna managed by conservation agencies such as the National Park Service. Urbanization along the borders of protected areas impacts species by creating fragmentation of habitat, introducing non-native species, and contributing to sources of sound and light pollution. While landscape-scale developments have significant impacts to resources, those closest to protected area borders are most direct. Promoting stewardship along these protected area-neighborhood boundaries requires a community oriented conservation ethic that considers the needs and values of all constituencies based on mutually beneficial and collaborative goals. Knowing the demographics of those living in surrounding communities can assist conservation organizations improve their communication and education strategies for achieving conservation goals. In this study, spatial analysis was used to examine demographic characteristics of the population within a one-mile area surrounding Saguaro National Park Rincon Mountain District's boundary using three decades of U.S. Census data. Findings from this study will help focus conservation messaging and identify new partnership opportunities based upon the socio-economic profiles of the communities surrounding the park.

Mapping Google Docs Using ArcGIS Online by Ted Howard

The Colorado Dept of Transportation has several hundred Maintenance Patrol locations throughout the state that house personnel, equipment, and materials used to respond to weather events. The inventory and availability of these assets is being tracked using a series of Google sheets shared among a set of users. Making this data spatially aware would be an obvious advantage in managing and coordinating available resources. This was accomplished by publishing a Google sheet to the web and allowing an ArcGIS Online Map to consume the data. This quickly and efficiently created a working web mapping application with a live connection to the source data.

Mapping Past Denver - A Web-GIS Approach by Ricardo Oliveira *

In the past few years the web has reached a point where it vastly expands the possibility for users to interact with the content being displayed, and this brings a whole new set of opportunities in GIS. Mapping Past Denver is a project developed at the University of Colorado at Denver where the main goal is to create an interactive framework that allows users to explore the past urban geography of Denver. Although historical GIS still a fairly new field in the discipline, we believe that one of key steps for this to achieve its full potential is to allow users to interact with the data being displayed. Given the fact that temporal data presents a fourth a dimension, that is time, the challenge now is to create ways of how users will explore this new facet of data. Mapping Past Denver focuses heavily on the end user experience, but also on the potential to expand the database in the future. The entire application is set-up using well established open-source technologies, thus given us the opportunity to expand its dataset without having to rely on proprietary licensing issues or update barriers.

Monitoring Headcut Erosion: Aerial Imagery and 3D Models by Sam Cox

Warming climate, shifting precipitation patterns and chronically-diminished snowpack are straining water resources in the western United States. Properly functioning riparian systems slow runoff and store water, thus regulating extreme flows; however, riparian areas across the west are in a degraded condition with a majority of BLM-managed riparian systems not in proper functioning condition.

Headcuts are the leading edge of channel erosion that results in lost organic soil and water-holding capacity. We used 1.4-mm GSD aerial image surveys of riparian areas in the Sweetwater Subbasin of central Wyoming to identify 163 headcuts that were undetectable from 1-m GSD imagery, and only detectable from 30-cm GSD imagery when their location was already known. We used ground-based photography of 19 headcuts with ground control to create 3-dimensional structure-from-motion (SfM) models from which we measured total soil loss of 425-720 m3, or about 1.1-1.8 m3 m-1 channel. These headcut terrain models provide baseline position/elevation for trend monitoring.

The National Map by TNM) Vector Web-Edit: Common Web Solutions to Support Multiple TNM Themes **by James Coble, Kevin McNinch**

In 2014, the National Geospatial Technical Operations Center (NGTOC) began a development initiative to create a common suite of web-based editing tools to support the multiple data themes of The National Map. A development team, Vector Web-Edit (VWE), was assembled to support this endeavor. The goal of the project was to develop a suite of editing tools that take advantage of common functionality, modular software design, open source solutions, and leverage the power of crowd sourced Volunteered Geographic Information (VGI); as well as allowing users to work in a web-based application without the need for special software.

The NHDPlus for Colorado - Stream Flow Volume Estimates **by Jeff Simley ***

The NHDPlus is a version of the National Hydrography Dataset in which flow volume estimates have been calculated for every stream segment. This adds considerable intelligence to the NHD dataset because it is now possible to understand stream networks from the standpoint of how much water is flowing through the streams and rivers. The makes the NHD more useful in the study of hydrology, pollution control, resource management, fisheries, emergency management, and cartography. The NHDPlus is accomplished by integrating hydrography and elevation data along with other landscape characteristics. From this data, a drainage catchment is calculated for every stream reach. This can then be aggregated to calculate upstream drainage area with characteristics suitable for estimating stream flow volume. This data has been calculated for the nation using a stream representation of 1:100,000-scale mapping. Work is now underway to calculate this information using a stream representation of 1:24,000-scale. The waters of the state of Colorado will be used to examine this information in detail. From this review, a better understanding of Colorado's streams and rivers will be gained, and the quality of the results can be judged based on a logical understanding of Colorado's rivers.

Seasonal Glacier Speedup Observed from Correlation of Optical Satellite Imagery and Modeled Numerically **by William Armstrong**

The mechanical link between glacier hydrology and glacier motion is a poorly understood system that has implications for glacier dynamics, projecting glacier change, and for polar and alpine landscape evolution over geologic time. We present data to constrain the spatial and temporal distribution of the ice surface speedup and associated basal motion on Kennicott Glacier, southeast Alaska, USA. We use COSI-Corr, a free image cross-correlation package, to estimate velocity fields from repeat ~0.5 m pixel WorldView2 optical satellite imagery over the 2013 melt season. We find the glacier speeds up in early summer and then slows, following the characteristic pattern where glacier velocity is controlled by the interplay between meltwater availability and the glacier's ability to transmit water subglacially. Times of high meltwater input and/or low transmission ability result in pressurized water at the glacier bed, inducing fast basal motion.

We perform further analysis in ArcGIS to document the spatiotemporal pattern of glacier speedup (summer minus spring speed) and find the speedup is remarkably uniform, despite significant

variability in the total ice surface speed. This contradicts work that has suggested glacier speedup should scale with its deformation velocity.
We employ a two-dimensional transverse cross-sectional glacier flow model to estimate the spatial distribution of basal motion from our observed surface speedup. Our model provides an estimate of the subglacial topography from matching the spring velocities. We find the model is relatively insensitive to different patterns of basal motion, reflecting the importance of viscous ice coupling for determining glacier surface velocity.

Spatial Modeling of the COGCC's Surface Regulations on Drilling and Facilities **by Emily Hueni ***

Regulations laid down by the Colorado Oil and Gas Conservation Commission (COGCC) stipulate that drilling and facility locations must adhere to specific geographic constraints. These constraints are based on proximity to, and density of, various types of natural and cultural features. Examples of such features include 100 year flood plains, wildlife habitats, surface occupation/use, and population density within 1000 ft of an area of interest. With the dramatic rise in population in Colorado and wide scale development happening along the Front Range these regulations are playing an increasingly important role in determining drill site locations within the Denver-Julesburg Basin. Using data collected from state and federal agencies, or created using remote sensing techniques, a model was built to map all of the COGCC regulations with spatial components for a Township in Adams County, Colorado. This model demonstrates the potential that GIS has for understanding and navigating the COGCC regulatory landscape on a large scale.

Use of a Continuous Simulation, Process-Based Model to Predict Sediment Inflow in Unsurveyed Reservoirs **by Joel Murray**

Expected lifetimes of reservoirs are affected by many factors, none more significant than sediment capture. Failure to measure or estimate sediment inflow has numerous detrimental effects including: loss of storage capacity, burial of outlet works and/or recreational facilities, downstream erosion and habitat loss. Regular surveys provide estimates of annual sediment inflow, however, surveys are labor intensive and expensive undertakings.
Currently the Bureau of Reclamation manages over 400 storage facilities, but only thirty percent have had resurveys conducted since initial filling. It may be possible to use hydrologic models to estimate sediment inflows based on watershed size, sediment mobility and wildfire susceptibility. This will provide a reasonable estimate of sedimentation rates for unsurveyed reservoirs that will aid in the development of reservoir sedimentation strategies, mitigating the detrimental effects of unaccounted sediment deposition.

Using GIS to Visualize and Analyze Environmental Time-Series Data as Raster Maps **by Richard Koehler ***

A time -series dataset plotte
researchers and scientists, business managers, agency and program directors, and other professionals an alternative approach to visualize and examine large time-series datasets. The techniques can integrate data from numerous sources such as scientific observations and model output, business related data, and other time s based data. Example applications and

Utilizing ArcGIS Online to Track the Trash in the Fountain Creek Watershed **by Jerry Cordova ***

In 2014, The Fountain Creek Watershed Flood Control and Greenway District sponsored a week long litter cleanup program known as Creek Week. The goal of Creek Week was to raise awareness

about the littering issue, collect litter, and make Fountain Creek and its surrounding communities cleaner and safer.
ArcGIS Online (AGO) was utilized to map cleanup segments. 625 volunteers participated in the program cleaning 41 miles of creeks, 188 acres of parks, trails and open spaces, which resulted in 7 tons of litter.
Although Creek Week was a positive program, there is the opportunity for a public/private awareness campaign to address those areas that the cleanup did not cover. Private lands are greatly impacted by public lands. Flooding increases the amount of trash and debris that flows downstream. These items end up on private lands but have not been included in local or county level cleanups. Who is responsible for the cleanup and who will cover the associated costs? Do we know who's been impacted? To answer these questions, an ArcGIS Online Story Map was created to identify locations that have been impacted by the increased flows, flooding, and the vast amounts of debris and trash. It is the hope of many local landowners that the Story Map will bring about awareness of the problems and foster discussions that may lead to solutions of the unresolved opportunities in the public/private dilemma.
This presentation will address: litter, erosion, sedimentation, flooding, changes in creek centerlines, watersheds, and public/private land issues.

UAVs, The Photogrammetric Challenges

Society: ASPRS-Rocky Mountain Region
Track Chair: Harold Schuch

UAV operations essentially consist of three parts: One is the actual collection of data (in the form of remote sensing in general or photogrammetric in particular), the second is subsequent data processing, and the third is geo-referencing of results. Given that UAVs represent new types of platform, old and new challenges come to the foreground. This year's ASPRS-RMR's contribution to GISITR will be a better understanding on what these challenges are, and what is being done to address them.

The Photogrammetry of UAVs by Harold Schuch

Much is being said about UAVs, but their actual use stems from photogrammetric mapping. This presentation is geared toward outlining the various support systems, how they historically were developed for photogrammetry, and how their presence as automated systems is taking shape. In addition, there really is a professional aspect to all this, complete with precision and accuracy issues.

UAV Solutions Using Remote Sensing and Photogrammetry Applications by Joe Mostowy

The Unmanned Aerial Vehicles (UAV) market is blowing up in the North America, especially with more lenient US FAA regulations already undergoing comment, which means positive changes are imminent. The need exists for a UAV solution to process the image data using Remote Sensing and Photogrammetry applications with possible service to a web client. Hexagon Geospatial has the technology to put together the complete solution from hardware to the internet from one single vendor. In this session we will discuss some of the problems to overcome with these UAV solutions and show many different ways of producing value added data from these UAV's. Currently in the US you need a pilot license and a certificate of Authorization or 333 to fly in accordance to the FAA. With basic rules in the US being flying under 400 feet, 5 miles from any airspace and line of sight of the UAV must be less than 1 mile. Attend this session and become more equipped to handle the UAV solution explosion.

New Options for Imagery **by David Siddle**
Satellite, aerial and now UAV imagery is getting better and better. Learn what resolution and accuracy is possible today, and what you can do with these amazing images.

Best Practices in Imagery Selection for Comparative Analysis of Image Products **by Jon Proctor**
There are several cases where we want to compare 2 sets of imagery. For example:
• comparing the clarity of 30 cm data to 50cm data
• change detection – urban growth over 5 years
• change detection – assess damage after an event
There are many factors with satellite and aerial imagery that can complicate a project. Some of these factors are: Collection geometry, age of imagery, seasonal difference, shadows, processing parameters, and project organization.
This presentation will explore these factors and provide practical guidance to minimize their impacts, and improve your results.

Esri Full Motion Video: Data Collection, Metadata Extraction, and Advanced Analysis **by Alex Muleh**
UAV technology is expanding at a rapid pace and presents many challenges and opportunities. In an effort to support video and video analysis in fields such as public safety, oil and gas, agriculture, state and local government, defense, intelligence, and others, Esri has developed a Full Motion Video (FMV) toolset. The latest release of the Esri Full Motion Video software runs within Esri ArcMap and offers users an easy-to-use set of video analysis tools, which fully integrates video and GIS. The FMV toolset provides map-to-video and video-to-map transformations, which allow features to be directly digitized onto a video, for map features to be directly shown on a video while it plays, and the ability to measure distances directly on a video. The toolset also allows users to play and record live UDP, RTSP, and Motion JPEG feeds within ArcMap. This presentation will focus on the currently available Esri FMV technology, live demonstrations, and where Esri will be going with UAV and FMV technology in 2016 and beyond.

Use Case: Incorporating Ground Surveys for Project Suitability and Accuracy Assessment of UAS Passive Point Clouds **by Rebecca Lasica**
Collecting hundreds of overlapping images with each UAS flight – it's no wonder that image-derived point clouds are some of the most prolific new data sources available for remote sensing analyses. But what can one really do with these point clouds, what's the best way to perform accuracy assessments, and how will image-derived surfaces augment existing workflows to reduce costs and generate actionable information?
This presentation will demonstrate end-to-end processing of an image-derived point cloud beginning with ingest and processing. The points will be used to not only derive a surface model of the above-ground features, but also to estimate the bare-earth surface. Additionally, raster and vector derived products will be projected to align with survey-grade ground truth to enable an apples to apples comparison.
After the surfaces and contours are extracted – an accuracy assessment will be performed to determine the horizontal and vertical accuracy relative to survey ground control.
Once accuracy is established one can determine the suitability of augmenting ground survey workflows with UAS image-derived point clouds relative to the project specifications.

High-Resolution 3-D Mapping from a Balloon-and-Camera Platform **by Kendra Johnson and Lia Lajoie**

High-resolution topographic mapping is a powerful tool for addressing geoscience questions, but remains hampered by cost and practical limitations. For the past few years, the most prevalent means of topographic surveying have been airborne and terrestrial laser scanning. However, a more affordable and simpler means of collecting topographic data has recently gained popularity: structure from motion (SfM). SfM builds upon traditional stereophotogrammetry, using loosely structured, overlapping photographs from varying viewpoints to reconstruct the topography and texture (color) of a scene. This method requires only a camera, open-source or inexpensive software, and a means of georeferencing (e.g., GPS photo-tagging or deployment of ground control points). Here, we present a balloon-based SfM mapping system, which produces dense point clouds and sub-decimeter resolution digital elevation models (DEMs) over sparsely vegetated field sites. Our approach is divisible into two phases: (1) fieldwork and (2) processing. The fieldwork phase uses a tethered helium balloon or helikite to gain an aerial perspective; this increases photo footprint size, expediting photo collection and enabling coverage of larger sites, and improves the camera perspective for near-horizontal surfaces. Although the tethered platform covers ground at walking pace, and is thus slower at mapping than many UAVs, it requires no FAA approval can map continuously for hours at a time. For the processing phase, we choose the semi-automated and user-friendly Agisoft Photoscan Pro package, which completes all processing steps internally. We demonstrate our workflow on various sites in western North America, including several young Rocky Mountain fault scarps.

The Role of GIS in Starting and Sustaining a UAS Business **by Christopher Leatherman**

Unmanned Aircraft Systems (UAS), aka Unmanned Aircraft Vehicles, aka drones are having a profound impact on many aspects of our society. Obvious effects include public safety, the media, and natural resource management to name only a few. The potential applications of this technology will become more apparent as the industry matures. Agriculture particularly crop production will greatly benefit from UASs. This platform will give farmers a new tool for monitoring crop health increasing productivity and their bottom line.

This paper is a narrative of the role GIS has played in laying the foundation for my small UAS crop consulting business in South Dakota. It begins with a general outline of how GIS was used to analyze the states agriculture industry with a focus on the more profitable crops. Next, I discuss how Business Analyst was used to identify potential clients based on geographic location and sales. Finally, I will give some examples of UASs being used to generate high quality GIS maps of crop fields. Should all goes according to plan this final portion of the presentation will include examples of my own work.

UAS for Agriculture - Fast Challenges, Rapid Results **by Christopher Rice**

Colorado Cartographics LLC is pleased to have been granted a Section 333 Exemption by the FAA for commercial UAS usage. The company has invested in two UAS, and is actively engaged in agricultural health assessments, using NDVI, NIR/CIR and RGB imaging systems.

The UAS is a multi-rotor configuration, with an onboard flight controller, barometer, GPS, and telemetry module. These components allow us to design automated flight missions using ground control software. Once the mission is planned, the UAS takes off, moves about the planned route, and lands on its own, all hands free!

The primary data collection we're interested in is NDVI, to allow agricultural stakeholders to analyze crop health, so they can address issues during the growing season, and at harvest time. The imagery itself is overlapped by 60-80%, and is georeferenced for use in a GIS. The NDVI formula is derived

from the amount of NIR value reflected from the leaves of plants. A healthy leaf will return higher NIR values, where stressed plants will return lower ones. This incredibly compelling visual allows farmers to see firsthand where they are experiencing crop stress.
The applications we are also working on using UAS are: air quality monitoring using onboard sensors and geolocation, infrastructure assessments utilizing thermal imaging, and surface modeling applications derived from point clouds and high-resolution imagery.

Colombia South America UAV Integration for Railroad Rehabilitation Planning and Design
by Ricardo Sanchez

The USGS states that coal mining for export is booming in Colombia, with production having increased by 80% since 1999 in the mountainous regions of the country which makes it the 4th largest exporter of this raw material in the world. Moreover, the infrastructure improvements related to mining, processing, transporting, environmental considerations, and shipping this natural resource will be necessary to increase the value of this raw material.
In order to transport this important natural resource and vital source of revenue for the country's economy, the Colombian government has several railroad projects underway that will include new construction of railways and rehabilitation of many existing railroad lines. This is where Merrick & Company's technology comes in, assisting with one of the first rail rehabilitation projects taking place from Bogotá to Belencito. The project is 263 kilometers (164 miles) in length with a mix of dense urban, mountainous, and very rural areas.
These technologies included in this project were GPS for photo-control and construction monumentation, mobile LiDAR mounted on the railroad track, and orthophotography and digital surface models from a Merrick's Hawkeye Unmanned Aerial System (UAS). The presentation will focus on the integration of the above mentioned technologies and how Merrick produced the continuous digital surface model (DSM) within the rail right-of-way that includes engineering design level terrain data and digital ortho.

From the Plains to the Mountains: GIS Colorado Beyond the Horizon

Society: GIS Colorado
Track Chair: Andrea Grygo

Like Colorado, GIS is vast and diverse yet tied together by common interests. Learn how your colleagues are advancing GIS technologies and applying unique geospatial solutions to challenges across the state and beyond.

Local Government:

Going Mobile, Aurora Water Empowers Field Staff with Tablets and Collector for ArcGIS
by William Keever, Sarah Young, and Marisol Medina

The City of Aurora Water Department recently purchased 90 tablets to replace the paper mapbooks used daily by the operations and maintenance staff in the field. The initial intent of the tablets was to not only keep the O&M staff up to date on the latest utility changes without having to reprint the cumbersome $400 16'x20' mapbooks, but also to get GIS data corrections from the field directly into the GIS data. This direct connection between the field staff and GIS data is the most practical way to correct the various location and attribute errors in the 3,000 miles of pipe and 175,000 appurtenances throughout the City of Aurora's water, wastewater and stormwater utilities. An additional benefit to the electronic mapbooks is the ability for the O&M staff to see and track more

information about assets than was allowed in a static format. The software application being utilized for the mapbook interface is Esri's Collector for ArcGIS. A number of administrative staff also have licenses on their personal devices so they can refer to specific utility infrastructure while at meetings away from their office. The technology hardware and software has become very affordable which provides an excellent cost/benefit to the purchase.

Challenges Standardizing and Implementing Metadata **by Diego Portillo**
Having metadata as well as a catalog of all GIS related data, is fundamental to the success of any organization. There is not a right or wrong approach, but any approach is challenging. This is how Denver Water approached the problem and found a solution.

GIS Support Methods for Community Outreach: The City of Centennial's Land Development Code Rewrite Project **by Derek Stertz**
In 2009 the City of Centennial began an exhaustive legislative rewrite of its land development code. The City endeavored to rezone over 40,000 properties over three phases. A large amount of Community Outreach was necessary to accomplish the task and it required substantial GIS support. The rewrite and the public outreach was conducted over six years. GIS technology and products evolved over time to support the three phases of the outreach. This presentation will detail the methods, systems and applications that were used to enhance the planning research and public outreach need to rewrite the City of Centennial's Land Development Code.

Migrating the City's Intranet to Geocortex **by Bruce Reagan**
The City and County of Denver has used an award winnineg ArcIMS based intranet soution for 10 years. The software is still very robust and useful, but unsupported. Geocortex was chosen as a platform to replace this internal tool. A discussion of the process of migrating including changes in the approach, requirement discovery and technical obstacles that were encountered and (sometimes) overcome in this year long process.

Colorado Applications:

Utilizing ArcGIS Online to Help Feed the Need: A Care and Share Food Bank Case Study **by Jerry Cordova**
Hunger and inadequate food supplies are of growing concern in many communities. Care and Share Food Bank provides food to a number of partner agencies and operates several distinct programs that provide food to those in need. One of the challenges that Care and Share faced was being able to view its agencies and program locations on a single map. To solve this problem, ArcGIS Online (AGO) was utilized to create a web map that identifies 172 partnering agencies, areas of poverty, food deserts, and food insecurity in El Paso County, CO.
Care and Share's agency network serves diverse populations of the hungry across southern Colorado, including impoverished children, the working poor, low-income seniors, the sick, the disabled, the homeless and other at-risk populations. The recent Feeding America and Mathematica Policy Research study, Hunger in America 2014, found that:
51 percent of client households have annual incomes of $10,000 or less.
62 percent of households chose between paying for food and paying for transportation at least once in the last 12 months.
The AGO map enables Care and Share to better serve the community by analyzing spatial patterns

and areas of need. This presentation will demonstrate how to create an ArcGIS Online map, incorporating spreadsheets, REST endpoints, and web development tools that were utilized to create the Care and Share map. The presentation would be beneficial to those interested in food insecurities, demographics; youth, family and senior, ArcGIS Online and creating web mapping applications.

Finding the McManus': GIS Applications in Mountain Search and Rescue **by Loren Pfau**
In April 2014 a father and son from Minnesota on a spring break road trip disappeared on a hike in the vicinity of Mount Evans, Colorado. The resulting search managed by the Alpine Rescue Team was one of the largest and longest-running SAR missions in the state, spanning 107 days and involving over 5000 man-hours of SAR team member search efforts.
This mission incorporated clues from a wide variety of sources: team knowledge of the Mount Evans area; traditional investigative work analyzing the subjects' possessions; computer forensics of the subjects' laptops; and then a new type of investigation for the Team in the analyzing of the cellphone record forensics with GIS tools.
In this session you will hear from the Alpine Mission Leaders responsible for the planning and management of formal and informal search activities, and gain an understanding of the potential for geospatial tools to aid in solving wilderness search and rescue challenges.

Why Did We Climb Denali? **by Blaine Horner**
What would cause a mild mannered Colorado company to climb the highest mountain in North America? How did it go?
You gotta show up to find out.

CO-TreeView: The First Statewide Online Urban Tree Inventory Application **by Ian Hanou and Angela Poulson**
CO-TreeView is a web-based tree inventory and mapping tool built on Esri and Open Source technologies used by Colorado foresters and arborists to record and visualize the location, species, and condition of the trees that make up Colorado's urban forests. This user-friendly tool, which allows users to view tree and planting site data at a variety of scales, enables proactive, data-driven forest management planning, grant solicitation, and public outreach in support of the conservation and enhancement of the state's community forests. While designed for utility in a broad range of applications, the CO-TreeView tool was created in response to the discovery of Emerald Ash Borer (EAB) in Boulder in late 2013. The Colorado State Forest Service and the Colorado Tree Coalition, who funded the development of the tool, recognized the potential value in having a statewide system to house, aggregate, and display tree inventory data from diverse sources, encouraging Colorado communities to work together to build and protect urban forests.

Surveying: Past, Present, and Future

Society: PLSC
Track Chairs: Steven Parker, Heather Lassner

The modern land surveyor's legacy is rich with history, but our eyes are always on the horizon. Join us to expand your knowledge of surveying and engage in stimulating geospatial

discussions relating specifically to the ways land surveyors employ GIS technology and what contributions land surveyors make to the GIS community, both now and in the future.

***Grid-to-Ground* by Chuck Hutchins**

This session will focus on the inherent problems with geodetic coordinate systems that affect measurement professionals on a daily basis. Chuck will deep dive in to past & current ellipsoids, datums, projections, grid values, ground values and the relative scaling issues that are present when dealing with different geodetic coordinate systems. Chuck will also cover many different methods of scaling from grid-to-ground with a specific focus on the Colorado State Plane coordinate system. This session will provide a fundamental understanding of these issues as well as how to conquer them. This session is perfect for anyone interested in bridging the gap between Land Surveying & GIS.

***Denver is a Mile Above What Exactly?* by Andrew Carey**

Have you ever stopped to think about where sea level is? Is it high tide or low tide, or even based on the tide? Understanding the models used for elevation could help explain why your GIS elevation data is 80 feet different from that the survey data you just got, or the brass cap you are standing on.

***Why Did We Climb Denali?* by Blaine Horner**

What would cause a mild mannered Colorado company to climb the highest mountain in North America? How did it go?
You gotta show up to find out.

***Reality Capture: Technical Approaches & Use Cases* by William Emison**

With the recent advances in reality capture (aka remote sensing) technologies, many potential users are confused by the myriad of hardware, software and data processing tools that can be used to support mapping, infrastructure and commercial applications. In addition, scores of new applications are being driven (and developed!) by "non-traditional" consumers who are finding ways to apply these technologies to support basic, "everyday" solutions in new, non-geospatial markets. This presentation will review existing and new "as-built" capture technologies, including airborne, mobile and static (aka terrestrial) hardware products. Presentation topics will include a discussion of spatial accuracies, derivative products, user workflows, data processing throughput times, and the advantages / disadvantages of each approach. The presentation's data demonstration will include imagery (raster) products, point clouds (derived from laser scanning), as well as options for sharing and distributing 3D spatial products across the enterprise.

GIS Analysis: A Map for Local and Regional Sustainability

Society: RM-URISA
Track Chair: Vince Rosales

A forum to share your success in applying spatial analytical techniques for local and regional development to enhance prosperity, improve wellbeing and increase living standards.

Environment and Natural Resources:

Using GIS to Visualize and Analyze Environmental Time-Series Data as Raster Maps **by Richard Koehler**

A time-series dataset plotted as a "raster time map" and analyzed in a GIS elikanner offers researchers and scientists, business managers, agency and program directors, and other professionals an alternative approach to visualize and examine large time-series datasets. The techniques can integrate data from numerous sources such as scientific observations and model output, business related data, and other time -based data. Example

GIS Modeling to Prioritize Mitigation of Avian Electrocution **by Paul Petersen**

Reports of avian electrocutions indicate conservation concerns for breeding, migrating, and wintering birds. Although concerns are widespread, mitigation is implemented primarily at local scales of individual electric utilities. By not considering landscape-scale patterns, conservation strategies may fail to focus mitigation where efforts are needed most.

We used ArcGIS, Spatial Analyst, and R to developed a regional model of distribution power pole density throughout Colorado and Wyoming to enable resource managers to consider electrocution risk at larger scales. When the GIS model is viewed together with species-specific habitat maps, locations where high power pole densities overlap high-quality habitat suggest key areas where mitigating electrocution risk, or perching, could be prioritized.

For example, we compared predictions from the GIS model with Golden Eagle nesting territories in the Bighorn Basin of Wyoming to identify key areas of relatively high electrocution potential. If power poles in these key areas were not built or previously retrofitted to minimize electrocution risk, retrofitting measures focused there may offer the greatest conservation impact per dollar spent. Thus, the model provides a framework for systematic spatial prioritization in support of regional conservation planning.

Non-Forest Vegetated Land Cover Classification **by Katy Waechter**

Assessing land use and land cover change requires accurate mapping of major land cover types, a persistent challenge in the dynamic environments of the Amazon River floodplains. Previous vegetation maps of the lower Amazon River floodplain show enormous differences in vegetation cover between the upstream and downstream regions as well as the significant influence of human activities in vegetation distribution in the lower floodplain. This study assesses non-forest vegetation in the Lower Amazon River floodplain at low water levels using three Quickbird scenes and corresponding Landsat 5 TM scenes. Object-based image analysis is used to classify woody vegetation using image texture. The spatial relationship of woody vegetation image objects to the surrounding landscape patches is used derive a hierarchical land cover classification. Additionally, best fit endmember fractions from Multiple Endmember Spectral Mixture Analysis are incorporated into the hierarchical classification to distinguish between shrub and tree lifeforms. The fused object- and pixel-based classification produced the highest overall accuracy over single mapping unit classifications. Using information from multiple mapping units allows for greater confidence in identification of detailed vegetated land cover classes, providing a basis for improved estimates of floodplain ecological contributions and evaluating the impacts of household land use decisions. This

method or similar methods have potential to be used with archival image series to increase understanding of land cover change through the past hundred years in the Amazon River floodplain and other complex landscapes.

Utilizing ArcGIS Online to Track the Trash in the Fountain Creek Watershed by Jerry Cordova

In 2014, The Fountain Creek Watershed Flood Control and Greenway District sponsored a week long litter cleanup program known as Creek Week. The goal of Creek Week was to raise awareness about the littering issue, collect litter, and make Fountain Creek and its surrounding communities cleaner and safer.

ArcGIS Online (AGO) was utilized to map cleanup segments. 625 volunteers participated in the program cleaning 41 miles of creeks, 188 acres of parks, trails and open spaces, which resulted in 7 tons of litter.

Although Creek Week was a positive program, there is the opportunity for a public/private awareness campaign to address those areas that the cleanup did not cover. Private lands are greatly impacted by public lands. Flooding increases the amount of trash and debris that flows downstream. These items end up on private lands but have not been included in local or county level cleanups. Who is responsible for the cleanup and who will cover the associated costs? Do we know who's been impacted? To answer these questions, an ArcGIS Online Story Map was created to identify locations that have been impacted by the increased flows, flooding, and the vast amounts of debris and trash. It is the hope of many local landowners that the Story Map will bring about awareness of the problems and foster discussions that may lead to solutions of the unresolved opportunities in the public/private dilemma.

This presentation will address: litter, erosion, sedimentation, flooding, changes in creek centerlines, watersheds, and public/private land issues.

Determining National Park Service Museum Vulnerability by Eric Delynko

The National Park Service (NPS) cares for some of the largest and most diverse natural and cultural history collections in the world. For the parks in the Intermountain Region (IMR) of the NPS, these precious collections are kept in facilities across the country to maintain the context in which they were found as well as be accessible to research and park staff. NPS conducted an exercise to look at the vulnerability of these museum collection due to climate change. This presentation discusses the methods and data techniques used to determine museum vulnerability from flooding, drought, wind, biology, permafrost, as well as human-caused risks such as HVAC and staffing issues.

NHD and Water Resources:

The Power of a Flow Network in Hydrographic Datasets by Cynthia Ritmiller and Michael Tinker

The National Hydrography Dataset(NHD) is used to portray the drainage network of surface water. The network connectivity built into the dataset allows for the use of a diverse range of analytic techniques. For example, the flow network can be analyzed to show how a contaminant upstream can affect a fish population downstream, or the total upstream network affected by construction of a

new dam can be calculated. Attributes such as mean stream flow and velocity, can be attached to a hydrographic network enabling further analyses such as real-time assessments of the travel and dispersion of contaminants in streams and rivers. The U.S. Geological Survey has spent nearly a decade creating and enhancing a robust hydrographic network for the high resolution NHD. The near-term is to also create a High Resolution NHDPlus nationwide dataset. Creating and maintaining these hydrographic networks involves a process of quality control checks and examining the data feature by feature. Some of these quality control checks will be illustrated. Finally, the medium resolution NHDPlus will be used to demonstrate several useful analytical techniques that are only possible with a networked dataset.

***Wide-Area Automated Stream Line Collection from High Resolution QL2 Lidar* by Robert Dzur and Erle Wright**

After severe flooding in 2013, Santa Fe County, New Mexico embarked on an ambitious watershed-based effort to acquire and process more the 3,000 square miles of high resolution USGS QL2 LiDAR. These data are facilitating rapid and automated collection of vector stream flow lines over wide geographic areas. This paper outlines the county-wide approach used to generate stream data. The 1 ft. contour-interval vertical resolution of these data processed on high performance computing (HPC) infrastructure enabled the development of a contiguous database of more than 25 million stream features. In the Southwest, these techniques are detecting the finest of details on multiple stream courses within braided arroyo channels. Furthermore, the landscape-level stream network data were hierarchically ordered according to Strahler methodology. Stream ordering by feature attribution is helpful in data management and consumption strategies making data available at a range of scales relevant to particular analysis needs. Results from GIS analysis of these data enabled the County to identify more than 2,000 road / stream intersection points for culvert detection along primary streams (greater than Strahler 4). These data will enhance a number of the County's on-going efforts to build high fidelity geospatial data infrastructure in support of community resiliency planning and mitigation assessments that respond to a wide array of environmental hazards and threats such as drought, fire and flooding.

***The NHDPlus for Colorado - Stream Flow Volume Estimates* by Jeff Simley**

The NHDPlus is a version of the National Hydrography Dataset in which flow volume estimates have been calculated for every stream segment. This adds considerable intelligence to the NHD dataset because it is now possible to understand stream networks from the standpoint of how much water is flowing through the streams and rivers. The makes the NHD more useful in the study of hydrology, pollution control, resource management, fisheries, emergency management, and cartography. The NHDPlus is accomplished by integrating hydrography and elevation data along with other landscape characteristics. From this data, a drainage catchment is calculated for every stream reach. This can then be aggregated to calculate upstream drainage area with characteristics suitable for estimating stream flow volume. This data has been calculated for the nation using a stream representation of 1:100,000-scale mapping. Work is now underway to calculate this information using a stream representation of 1:24,000-scale. The waters of the state of Colorado will be used to examine this information in detail. From this review, a better understanding of

Colorado's streams and rivers will be gained, and the quality of the results can be judged based on a logical understanding of Colorado's rivers.

Metadata in the National Hydrography Dataset **by Michael Tinker**
Metadata for datasets used in a GIS are essential and integral to the dataset. Most metadata in the world today describes GIS data at the dataset-level. However, feature-level metadata is becoming increasingly important to GIS datasets. Feature-level metadata can describe detailed information about individual features in a dataset, can be used to track the edit history of features, and can be used to search for features. The National Hydrography Dataset (NHD) was an early adopter of feature-level metadata, implementing feature-level metadata in 2006. Feature-level metadata in the NHD will be demonstrated to show how users can discover edit histories of features, search for particular features, and illustrate how feature-level metadata and dataset-level metadata can work together to provide rich information about a GIS dataset.

Free and Open Source Software for Geospatial Applications (FOSS4G) Advantages and Challenges

Track Chair: Rafael Moreno

The creativity, dynamism and high-profile success stories of the Free and Open Source Software for Geospatial applications (FOSS4G) movement are attracting increasing attention from end users, developers, businesses, governments, educators and researchers around the world. This track will offer the opportunity to see several FOSS4G projects and developments highlighting the advantages and challenges in using FOSS4G technologies in diverse contexts and applications.

What is Free and Open Source Software for Geospatial Applications (FOSS4G)? Why Should You Consider It? **by Rafael Moreno**
This talk presents an overview of FOSS4G and the issues and characteristics that makes it a mature alternative in the geo-technologies arena. The following questions will be addressed: What is FOSS4G? What is its history and current state of the art? Why you should consider it as an alternative to private/proprietary software options? What are the common concerns regarding the use of FOSS4G? Are they true? What mature FOSS4G is available for every geo-technology niche (Desktop GIS; Remote Sensing, etc..)? Is there a conflict between private/proprietary geospatial software and FOSS4G?

Getting Started with FOSS4G: The Newbie's Perspective **by Marcelle Caturia, Ricardo Oliveira, and Jonathan Duckworth**
You've heard some buzz about Free and Open Source Software for Geospatial (FOSS4G) technology. You're intrigued to know more, but hesitant because it seems a bit overwhelming. What is a newbie to do – how do you even know where to start? Taking the first step can be very intimidating, especially if you don't feel "qualified", e.g. no programming experience. We've been there! This session will present a collection of perspectives and experiences from non-techie newbies who are going through the process of learning FOSS4G software from scratch. We'll cover common

questions and doubts about how to get started, obstacles to avoid, and strategies and helpful resources to help you succeed.

Building Lightweight Mapping Apps with Esri Leaflet by Andy Gup

Learn how to use Esri Leaflet to quickly develop fun, lightweight web mapping applications. Esri leaflet is built as a series of API plugins for the hugely popular Leaflet open source mapping library. In this introductory session you'll learn how to use this simple and intuitive API to work with basemaps, mash up data and consume ArcGIS feature services. You'll also walk away with an appreciation of how easy it is to apply basic cartography and custom styling to features.

Mapping Past Denver - A Web-GIS Approach by Ricardo Oliveira

In the past few years the web has reached a point where it vastly expands the possibility for users to interact with the content being displayed, and this brings a whole new set of opportunities in GIS. Mapping Past Denver is a project developed at the University of Colorado at Denver where the main goal is to create an interactive framework that allows users to explore the past urban geography of Denver. Although historical GIS still a fairly new field in the discipline, we believe that one of key steps for this to achieve its full potential is to allow users to interact with the data being displayed. Given the fact that temporal data presents a fourth a dimension, that is time, the challenge now is to create ways of how users will explore this new facet of data. Mapping Past Denver focuses heavily on the end user experience, but also on the potential to expand the database in the future. The entire application is set-up using well established open-source technologies, thus given us the opportunity to expand its dataset without having to rely on proprietary licensing issues or update barriers.

Developing, Exploring, and Utilizing a National Web-Based Forest Carbon Application by Ian Hanou

The USFS Forest Inventory and Analysis (FIA) program provides a systematic protocol for forest field data collection to serve as the census for forest information and support proper management. This wealth of data has been analyzed to provide wall-to-wall spatial GIS coverage of forest carbon estimates across the lower 48 U.S. states to support Greenhouse Gas (GHG) inventory. Through a research agreement and collaboration with the University of Minnesota (UMN), this project provided a 21st century "digital experience and distribution" of the Forest Carbon Estimation in the FIA program rather than static maps and tables by developing an online, mobile/web browser map application (app).

This web and mobile software tool enables the public to learn about carbon and how much is stored in a nearby forest. The data is presented to the user interactively on a map along with charts, graphs, and links to related resources. The intended audience is anyone interested in exploring forest carbon information.

The tool is a web browser map application for smartphones, tablets, and desktop use. It primarily works online but also offline with simplified functionality. This provides any range of users with access to the carbon summaries in the field and at the desk. The app also provides education links to NFS carbon assessment whitepapers and FIA protocols.

Join this session to learn about the development of this exciting new database and app and how to explore carbon in forests near you or nationally.

Open Specifications for the Storage, Transport and Processing of Geospatial Data by Rafael Moreno

This talk presents an overview of some of the most important Open Specifications (OS) for the storage, transport and processing of geospatial data and why they matter for the development of the next generation of geospatial systems and data infrastructures. What is the importance of being Open? What is the relationship of OS and geospatial software (both FOSS4G and private/proprietary software)? A Web-based system architecture based on OS and FOSS4G will be presented.

The Spatial Database - Lessons from the Enterprise and PostGIS by Matthew Baker

What is a spatial database as oppose to a geodatabase? In this talk, Matthew Baker will discuss the advantages of using spatial objects in a relational database to accomplish spatial, demographic, and statistical analysis at Denver Public Schools. This talk will also discuss how the Open Source IT stack teaches a new way of thinking about spatial data, and will also cover the ongoing research and challenges of moving to an open source spatial IT framework.

Spatiotemporal Interface Development: Using Web Technologies to Bring Complex Data to Life by Jonathan Duckworth

Communicating patterns in large spatiotemporal datasets can be a challenging and complicated task. While a variety of tools are available to visualize these data on the desktop, web technologies offer a unique opportunity to create interfaces that allow users to interactively explore complex multivariate datasets. In this presentation we outline a process for building spatiotemporal visualizations on the web. From data processing through architecture and development we describe technologies and languages you should know to get off the ground and walk through other important considerations in developing intuitive data exploration interfaces.

Determining Optimal Post Spacing for Lidar DEM Creation Using Open Source and Commercial Software by Kristina Yamamoto and Frank Velasquez

A Digital Elevation Model (DEM) has bare-earth z-values at regularly spaced intervals in the horizontal directions. Although DEMs all contain a constant grid resolution, the grid spacing, datum, coordinate systems, data formats, and other characteristics may vary widely (Heidemann, 2012). This interval, known as point spacing or grid resolution, becomes pixel size in raster data representations. There is no consistent, clear methodology to determine optimal post spacing from the nominal point spacing (NPS) of raw lidar data. Literature consensus seems to be that the DEM point spacing size (grid resolution) should be at least equal if not greater than the NPS. This presentation reports on methods used to help determine post spacing primarily using open source software.

Raw lidar point clouds over the Great Smoky Mountains and Grand Canyon National Parks were used to test DEM spacing scenarios gleaned from literature. Ground points were filtered using LP360. Approximately 5% of these were reclassified to act as control points and create a shapefile

(using open source lasthin and las2shp). DEMs were created from the ~95% remaining points using Global Mapper. Then the DEM and shapefile z-values were used to calculate RMSE. The results show a general relationship of RMSE to the optimal post spacing scalar and RMSE to DEM post size follow generally a power law curve. Ongoing analysis continues. We believe this analytical approach can shed light on the NPS/ DEM problem by empirically deriving a recommended scalar from various published techniques and two different study areas.

FOSS4G Adoption in Local Government – Opportunities and Challenges **by Dave Murray**
Across the globe Free and Open Source for Geospatial applications have gained increasing popularity among public and private sectors. In America, the adoption of FOSS4G has not been as prevalent as in Europe, Asia and South America. Proprietary GIS vendors have served our markets well but there may be new opportunities available to those that might consider integrating FOSS4G into their geospatial portfolios. This presentation will review the opportunities and impediments to FOSS4G adoption in local government and give the attendees options for further investigation. No prior knowledge of GIS or FOSS4G is required, only an open mind and a sense of adventure.

Integrating FOSS4G Into a Government Web-Editing Application **by Kevin McNinch and James Coble**
U.S. Geological Survey National Geospatial Technological Operations Center is building a suite of vector web-editing (VWE) applications for data collection and maintenance of The National Map (TNM) data. Initially built with a proprietary geospatial software architecture, VWE has integrated FOSS4G into the software architecture, including Leaflet, Esri-Leaflet, and GeoServer. Instead of entirely replacing proprietary geospatial software, VWE has adopted a hybrid architecture, mixing open and proprietary software products. This hybrid approach allows VWE to leverage the strengths of each software product for specific requirements and business rules in the different VWE applications and work within pre-existing TNM data management processes and workflows.

Analyzing Aspen's Community Forest with Lidar, Object-Based Image Analysis, and Open Source GIS Software **by Andrea Santoro and Laura Atkinson**
The city of Aspen has a diverse and extensive community forest comprised of natural forested areas, street and park trees, yard trees, and riparian corridors. Trees are a key asset to experiencing downtown Aspen.
In this study, we utilized several open source GIS software to analyze the tree canopy extent as well as new tree planting areas. Several land cover metrics were calculated using geoprocessing routines across a variety of spatial planning scales including city limits, parcels, and zoning categories. The data informs planning and development, stormwater modeling, education/outreach, and natural areas monitoring.
Methods, tools, and results will be presented.

Visualization and Analysis of Spatiotemporal Data using Free and Open Source Software at the National Renewable Energy Laboratory **by Dan Getman**
Geospatial data science at the National Renewable Energy Laboratory incorporates a wide range of activities including the creation of large spatiotemporal resource datasets, modeling the technical

potential of renewable energy at the national level, web based visualization of complex scenario based modeling, and sharing of both datasets and analysis methods with industry, academia, and the public through web services. In this presentation, we describe an integrated system in which all of the steps from data acquisition through analysis and collaborative research to sharing results with the public are accomplished using free and open source software and frameworks. Technologies used include R, Python, GDAL, OGR, Geoserver, Postgres, PostGIS, Mongo, Q GIS, NodeJS, Leaflet, OpenLayers, Ruby on Rails, CKAN, D3, and several other analysis and web based visualization libraries.

Massive Utility Inventory: Open Source Applications for Complex, Multi-Site Projects
by Kathleen Huse

Long term, multi-site projects with repetitive deliverable cycles present a complex task coordination situation. Today's internet based app market offers multiple free, open source solutions for effectively organizing staff and tasks throughout the project cycle. Join us as we discuss a multi-year, multi stage project to assess utility inventory status for Navy bases across the US and Far East, and the processes that were implemented to streamline analysis and deliverables. Time frames for converting data to sending maps to the client for field verification were sometimes as short as several weeks, requiring structured and active communication. Various applications were field tested to coordinate geodatabase standardization and deliverable generation between staff all over the country. Two apps, Trello and Todoist, were selected as the forerunners for simplicity of use, cleanliness of display, and comprehensiveness of information management.

GIS in Government

GIS applications in government span a wide variety of disciplines. The government track will be broken out into five focus areas this year; each area touches on a different aspect of governmental services.

Track Chair: Nettie Ginocchetti

Plugged In: Managing Utilities, Communications and Sanitation with GIS

Employing GIS-Based Mobile and Cloud-Based Technologies to Support Asset Management by Michael Schultz and Sydney Kase

With advancements in hardware and software technologies, governmental agencies and utilities have an increasing number of tools that can support more effective asset management, capital planning, and project execution. Key among these tools are GIS-based mobile, web, and cloud solutions that allow utilities to more effectively develop accurate asset inventories, assess condition of assets, and provide key data to staff in any location, at any time, using any device. Through the implementation of these tools, agencies gain the benefit of maximizing their investment in technology by providing critical information to staff using hardware tools (iPhones, iPads, Android, etc.) that fit their specific needs and work environment. During this presentation, case studies detailing the use of GIS-based web, mobile, and cloud computing environments will be presented. Specifically, tools that support

GIS-based mobile data collection, data collaboration, asset management, and visualization of real-time system conditions on devices such as the iPad, iPhone, Panasonic Toughbook Tablet, and Android tablet will be demonstrated. Software environments, such as ESRI's ArcGIS Server, ArcGIS Online, and iPad-based mapping and data collection applications will also be discussed along with strategies for ensuring data security and integrating GIS-based web and mobile solutions with key agency systems.

***Smart Device Data Acquisition Accuracy Assessment* by Daniel Estrada**

Field operations for data collection is a crucial aspect to obtaining information to provide data for use in GIS Analysis, asset management, and other aspects that is needed. Though the equipment used to obtain quality data collection can be expensive and require specialized training. For government agencies, the acquisition of new equipment can be problematic in a financial standpoint. The advent of mobile technology has allowed for the advancement of Geospatial Locational services in the mobile devices such as what is called smart devices to be used for Geospatial Data Collectors. These devices are much cheaper than the traditional hand held GPS receivers used for data collection. Are these smart device accurate enough to meet the needs of data collection for GIS use in comparison of the traditional hand held receivers.

An accuracy assessment of Apple's iPhones, iPad and Bad Elf's GNSS Surveyor will be analyzed side by side with Trimble's GeoXT Explorer to determine the utility of mobile devices for data collection needs for the New Mexico Office of the State Engineer Water Resources Allocation Program.

***Python and* GIS Asset Management by Kayla Andersen**

A well-developed geographic information system (GIS) of their assets is an incredibly valuable data source for all types of utilities. Accurate, detailed GIS data provides utility professionals with the information needed to make decision and plan in a significantly more efficient manner. But what about the efficiency of building a quality GIS? Due to the nature of the utility data, the GIS model for any network will be large and highly detailed, and requires many hours and often multiple editors to create. Due to the high volume of data present in GIS utility models, Python is often the ideal tool for performing data quality control checks, data source conflation, and asset analysis in a way that is efficient, documented, reproducible, and free of human-error. This presentation will focus on water network examples to show Pythonic solutions to common GIS asset management problems.

Getting There: GIS in Transportation, Navigation and Public Works

***Geospatial Data Complexity in electronic Airport Layout Plan (eALP)* by Shyam Parhi**

Airports GIS program collects Airports data, validate and verify it, and stores it in specific database. Airports GIS allows authorized users to submit changes to airport data. The verified data is used to develop several engineering applications. One of these applications is electronic Airport Layout Plan (eALP) whose primary aim is to move from paper to digital form of ALP. The first phase of development of eALP was completed recently and it was tested for a few pilot program airports across different regions. We conducted gap analysis and noticed that a lot of development work is needed to fine tune at least six mandatory sheets of eALP. It is important to note that significant

amount of programming is needed to move from out-of-box ArcGIS to a very customized ArcGIS which will be discussed. The ArcGIS viewer capability to display essential features like runway or taxiway or the perpendicular distance between them will be discussed. An enterprise level workflow which incorporates coordination process among different lines of business will be highlighted.

Development and Analysis of GIS-Based Freight Networks by Sydney Kase and Janna Rosenthal

The federal transportation legislation, Moving Ahead for Progress in the 21st Century (MAP-21), encourages states to create comprehensive freight plans in order to be eligible to receive additional federal funding. As such, there has been an increased focus on freight planning over the past few years. A critical component in completing a freight plan is the development of a statewide freight network. Intelligent freight networks empower states and other governing bodies to make informed decisions concerning freight infrastructure prioritization and funding through analysis of future and existing commodity movement and assets. This presentation provides an overview of best practices and guiding principles for developing GIS-based statewide freight networks. Topics covered will include aggregating multi-modal GIS data, commodity flow analysis, integration of inter-modal facilities into linear models, as well as a discussion of stakeholder outreach and community engagement.

Analyzing Snow Plowing Performance on Colorado Highways by Gary Aucott

The Colorado Department of Transportation (CDOT) is beginning to track and analyze their snow plowing performance across the state using GIS. Data logging is done through maintenance work orders in the SAP accounting system, which results in the calculation of costs and level-of-service scores for the maintenance patrols. Early analysis and mapping required manual data extraction from SAP into spreadsheets, then into desktop GIS. Eventually a more automated process was needed. In 2014 CDOT scripted a method to pull data from the work orders and brought on a consultant to build a GIS web mapping application. The 2014-15 snow season was the beginning of statewide work order tracking and the use of web mapping. This first season had its challenges, but overall this automated process has been a successful first step for CDOT's Division of Maintenance in reducing manual work and improving snow plowing performance.

Thriving in Place: GIS for Recreation, Health, Welfare and the Environment

Digital Mobile Sketch Map (DMSM) Android Offline Mobile Data Acquisition Application for US Forest Service by Don Parkison

The Forest Health Protection (FHP) program of the USDA Forest Service faces a daunting task - to map forest health issues in all 50 states and US Territories through the use of aerial surveys from small fixed wing aircraft. The end-user community is largely comprised of federal and state employees who have expertise and responsibilities for monitoring forest damage caused by insects, disease, and other factors (e.g.,bears, frost, draught).

To support this challenging work, MB&G has been working with FHP to develop their next generation mobile mapping solution - Digital Mobile Sketch Map (DMSM). The beta application to be presented includes implementation of the full data life-cycle to support end-user collection of aerial survey data.

Built upon Esri's ArcGIS Runtime SDK for Android and leveraging the latest in consumer-grade

and tablets, the DMSM application pushes the limits of mobile mapping by providing support for: display of high resolution base maps, collection of large and complex field data sets, rapid updates to map orientation under high speeds and changing directions, and operation in a disconnected, direct-sunlight environment. This presentation we will cover the DMSM application, it's underlying technology and some of the challenges and successes in developing the prototype solution.

***Glacier Monitoring in Grand Teton National Park* by Jeff Orlowski**

Grand Teton National Park has recently implemented a glacier monitoring program for the park using GIS. In early September 2014, park climbing rangers and GIS staff conducted a 4 day/3 night field visit to the Schoolroom Glacier deep in the rugged Teton Range. The goal of the field work was to map the glacier using a survey-grade GPS device. The next step was to convert the survey points to a Digital Elevation Model of the glacier. Multiple statistical interpolation methods were explored in an effort to produce the most precise DEM possible. The methods and next steps in the glacier monitoring program will be discussed.

GIS in Government Continued

Track Chair: Nathan Lowry

Mission First: Geospatial Support for Homeland Security and Defense

***Benefits of an Interagency Emergency Common Operating Picture* by Craig Gooch**

GIS is a vital component of a regional Emergency Operations Center to serve as a Common Operating Picture for disparate data. Alameda County Sheriff is using Esri GIS within the Emergency Operations Center to monitor live data feeds from law enforcement, fire, and EMS activities. This dynamic display of resource availability and locations is presented with active incident locations and informative detail.

Prior approaches for accessing the diversity of interagency data resulted in multiple display screens and the inability to perform spatial analysis across the multiple data sources. The computer aided dispatch information, GIS layers, and information from other agencies were difficult to correlate to understand the complex nature of incidents as well as the available resources.

The Sheriff's Common Operating Picture not only tracks real time incident information but also can retain historical incident data, is used to define and present event scenarios for response planning, and provides a multi-discipline based access to diverse information on buildings, disaster plans, urban infrastructure, and real time traffic feeds.

This presentation will describe the objectives for an EOC based Common Operating Picture and present benefits of using the Esri GIS as a framework for data and systems integration across multiple agencies

***Generating Actionable Intelligence Spatial Visualization at the Daytona Beach RTCC* by Johnell Olsson**

The Daytona Beach Police Department's Real Time Crime Center is developing actionable intelligence by combining traditional data such as RMS, CAD, and Sex Offenders with internal databases such a off-duty/outside detail assignments, locations of evidence collection and field

interview cards. This presentation showcases how the RTCC combines fast data access and detailed analysis to generate action plans leading to increased efficiencies in intelligence gathering and police resource utilization.

Prospective Hot Spotting of Violent Crime in a Fast Growing Canadian Municipality
by Scott Bennet

Predicting the location of future crime events is of growing interest to law enforcement agencies. With the greater availability of crime events geocoded to the incident level, it has become possible to perform spatial analysis of crime and use the results of the spatial analysis to predict where future crime may occur. We create hot spot maps using Kernel Density Estimation (KDE) by month for five years of violent crime data (2010 to 2014). We then use the hot spot maps to see if we can predict where violent crime events will occur in 2015. User-defined parameters have an effect on the resulting KDE surfaces and the success of forecasting future crime events. We use the Predictive Accuracy Index and the Recapture Rate Index to assess the effect the user-defined parameters have on the ability to predict the location of future crime events. Our study area is Edmonton, Alberta, Canada. Edmonton is a large, fast growing and sprawling municipality, which is good for testing the assumption that locations of past events are good predictors of future events. Additionally, Edmonton allows us to see the spatial variability in violent crime in a municipality with large increases in population and housing starts. We find that the combined hotspot maps do predict a proportion of violent crime and could be useful for forecasting future crime events. This technique is presented using violent crime, but it has also been tested using property crime and resulted in similar conclusions.

Civic Duty: GIS and Core Government Services

The National Map – Evolution of a Modern Mapping Program by David Brostuen

The National Map concept was originally proposed in 2001 with a goal to provide a nationally consistent set of integrated, current topographic information that supports national needs for basic spatial data. Advancements in geospatial data acquisition, processing and distribution technology have been dramatic since the original concept report in 2001, but the goals of The National Map are largely unchanged and still highly relevant. The National Map has evolved into a robust suite of geospatial data, derivative products and services for the Nation. This presentation will provide both insight into the original intent of The National Map and an update to its' continued progression in regards to new feature content, functionality, derivative products and current methods for data maintenance and distribution.

Crowdsourcing The National Map: Volunteer Engagement and Data Quality
by Erin Korris

The mapping crowdsourcing program, known as The National Map Corps (TNMCorps), encourages citizens to collect man-made structures data for the U.S. Geological Survey (USGS) National Geospatial Program's web-based The National Map. Through their participation volunteers are able to make significant contributions to the USGS's ability to provide the Nation with accurate mapping information. Over the past two decades the USGS has promoted several

citizen mapping projects, including TNMCorps, with some success. The results of several pilot projects from 2010 to 2012 led to a phased, nation-wide expansion of the crowd sourcing/volunteer project. As of August 2013, all 50 states were available for volunteers to collect and update 10 structure feature types including schools, fire stations, cemeteries, and others. Volunteers can add, modify, delete, and verify structures data through a customized OpenStreetMap (OSM)-based online map editor. A preliminary quality study in January, 2013, showed that TNMCorps volunteers were improving the data across all quality measures: positional accuracy, attribute accuracy, errors of commission, and completeness. As of May, 2015, over 1,000 users have made more than 140,000 contributions through TNMCorps. This presentation will explore volunteer engagement and recognition, as well as looking at quality study results and the quality control and assurance processes that have been implemented.

Retrieving Census Data for Use in Geographic Information System (GIS) **by Angeles Ortega and Jim Castagneri**

The U. S. Census Bureau is the leading source of quality data about the nation's people and economy. This presentation is designed for those involved in community planning, program design, proposal writing and needs assessments. This presentation focuses on extracting online Census data such as poverty rates, racial breakdown, family types, etc. for use in Geographic Information System (GIS) to create maps to show detailed data.

A well-organized Geographic Information System (GIS) enables decision-makers to visualize spatially referenced population patterns, trends and relationships. Accurate maps are fundamental to the policy process, especially in the planning, implementation and evaluation of development initiatives.

Quality Control and Distribution of Lidar Point Cloud Data at the National Geospatial Technical Operations Center, USGS **by Kimberly Mantey**

The availability of standardized high resolution elevation data is a growing need for Federal, state, and local governments, as well as the public. The Department of the Interior's U.S. Geological Survey and other Federal agencies are launching a 3D Elevation Program (3DEP) to meet this need. The primary technology for collecting 3DEP data over the conterminous US is airborne lidar. After the data are collected and processed by a contractor, they are delivered to the USGS National Geospatial Technical Operations Center (NGTOC.) The required deliverables currently are swath point cloud, tiled and classified point cloud, digital elevation models (DEM) as rasters, independent checkpoints (used to test vertical accuracy of the point cloud and DEM), and additional products used in the creation or supplemental improvement of the DEM.

To ensure lidar data are acceptable for ingestion into The National Map (TNM), the NGTOC performs a thorough quality control (QC) process on the lidar source data, the derived DEMs, and supplemental products that are obtained through USGS contract and/or partner supported contracting mechanisms.

Upon final acceptance, the project DEMs and lidar point cloud data are ingested into The National Map (TNM), processed into deliverable products, and subsequently used as source data for derived cartographic products such as topographic maps, as well as input data for many other applications.

After the data are loaded, the items become available to the public through The National Map Viewer and Download Platform, and are also discoverable through the Geospatial Platform.

3DEP Product Generation and Data Management System **by Kristina Yamamoto**
The USGS has implemented a modernized system - Lev8 [el-ev-ate] - that updates the seamless national elevation dataset and prepares all 3D Elevation Program (3DEP) products for delivery. The system has undergone major enhancements to increase automation of the seamless DEM production process and to manage the storage and processing of additional 3DEP data into final products for delivery, such as the lidar point clouds. One important system improvement is the deployment of a dynamically updated one-meter resolution raster elevation dataset, similar to the one-ninth arc-second data layer. Other capabilities include the ability to manage and deliver the point cloud files associated with lidar datasets and the packaging for release of digital surface models (DSMs) and orthorectified radar image (ORIs) that accompany ifsar DEMs for Alaska. An overview of the system and its resulting products will be presented.

Using GIS Tools for the Evaluation of a Weather Forecasting Model **by Theresa Foley**
The output of the Weather Research and Forecasting model (WRF) is either a netCDF file or Gridded Binary file (GRIB). The National Center for Atmospheric Research (NCAR), which maintains WRF, has created a suite of tools for verifying the output of WRF. These NCAR tools do not have the capability for analyzing model performance as a function of differing terrain characteristics. For the first time in Version 10.3, ArcGIS has the ability to import GRIB files directly into the GIS. This presentation will discuss how the powerful spatial analysis tools available in GIS can be used to evaluate the model performance over more homogeneous sub-regions as determined by terrain variables. GIS can also be used for a statistical analysis that compares the relative contribution to the model bias from each terrain variable.

Evaluating Magnitude of Change in The National Map's Vector Databases **by Andrew Stauffer**
The U.S. Geological Survey is evaluating change detection tools and processes to help minimize resources associated with maintaining 1:24:000-scale US Topo Maps and other derived products. Changes within The National Map vector databases are identified regularly through database synchronization operations. However, not every data change drives a product change and deeper analysis is required. Feature geometry and attribution are both evaluated to determine if a change will be represented on an updated map or in a derived product. Feature geometry is evaluated using a similarity metric to determine if a changed feature's current instance is significantly different from its previous instance. Changed attributes are compared against cartographic specifications to identify whether an attribute drives a visible change (e.g. symbology change or label style change) on a map. We will discuss the methods of automatically evaluating magnitude of change, why the types of change are important to understand, and how change detection can focus resources on areas of change while reducing the number of products that need to be updated.

The National Solar Radiation Database (NSRDB) **by Anthony Lopez**
The National Solar Radiation Database (NSRDB) is a publically available serially complete collection of solar irradiance and meteorological datasets created and distributed by the National Renewable Energy Laboratory (NREL). This presentation will cover the evolution of the NSRDB from discrete stations with empirical models to continuous spatial coverage using physics-based methods. It will also cover some of the technical details of the data processing including using parallel methods of Python (MPI4Py, SCOOP, and Multiprocessing), Hierarchical Data Format (HDF), and NREL's high-performance computer. Lastly, a demonstration of the new NSRDB Viewer - a multidimensional data exploration and extraction interface – built on NREL's retooled OpenCarto platform will be given.

GIS in Education

The education track will be broken out into two focus areas this year: Essential Lifelong Learning and Applied Student Research. See below for more information on each focus area.

Essential Lifelong Learning
Track Chair: Esther Worker

Spatial literacy and geospatial technologies evolve quickly, so how and when does one begin their GIS journey? How does one decide what training, education, or lifelong learning works best in this ever-changing field? What about internships, the job of your dreams, or retirement? This track will discuss how GIS professionals can keep their skills up-to-date and how we can all contribute back to the long-term societal impact of spatial learning at the elementary, post-secondary, and university levels.

Building Better Mappers: Cross-Curricular Integration of Geo-Spatial Skills in Geography and Earth and Space Science at the High School Level Using ArcGIS Online **by Steve Cline**
Geo-spatial thinking skills are critical for development of global citizens. Over the last few years the Geography team at Windsor High School has continued to look for engaging mapping lessons for use in our classes. The department strongly believes that learning is enhanced through hands-on, inquiry lessons. Geography provides vast opportunities to analyze spatial data. Mapping activities have always been used to build critical thinking skills.
Thanks to a grant from the Colorado Geographic Alliance and the Gill Foundation eight teachers at Windsor High School have been able to develop a curriculum aimed at improving geo-spatial learning. These teachers included both World Geography and Earth and Space Science instructors. The students were given a pre-test based on two separate spatial thinking assessments. Over the course of the school year the teachers involved in the project used ArcGIS Online in their instruction to varying degrees. The number of days using the accounts were tracked by student. At the end of the year students were given the assessment again in order to measure grown in geo-spatial thinking as compared to number of days using the online mapping applications.
This presentation will give an overview of the project including the structure of the classes, the assessment and examples of the activities used in class. Preliminary results of the assessment will be presented as well.

What are Your Misconceptions about Maps? by Rebecca Theobald

As part of professional development workshops for elementary and secondary teachers, the Colorado Geographic Alliance conducts surveys that request participants, "Think about your students and how they interact with maps. What do you think are the most common misconceptions students have about spatial patterns and spatial analysis when using maps?" This question has resulted in a wide variety of responses, including concerns about understanding scale, observations about interpreting distortion, and statements confirming that many students are unaware of spatial patterns. Whether interpreting or creating maps, students of all ages and abilities need to be able to understand the features illustrated and the intended purpose of a map, as well as to analyze the motivation of the cartographer and assess the sources and choices for the data. This presentation will offer information from teachers in Colorado, Arizona, Nevada, and Oregon who have identified key deficiencies that need to be addressed in the classroom from a variety of perspectives and through multiple disciplines. "I think it is hard for students to grasp the sheer size of what they are looking at; they see maps as something separate from where they live." Geospatial technology offers an entry point for teachers and students to use and learn from maps in the classroom.

The South Platte River Project - Englewood Schools by Bill Gilmore

Englewood Schools is in the process of designing and implementing units of study that cross all content areas and grade levels that utilize the South Platte River as a point of relevance.
The use of a GIS lies at the heart of the this Project.
Englewood Schools, in cooperation with COGA and Esri have begun the process of training all teachers in the relevance, use, and importance of GIS in education. As the knowledge base of educators regarding GIS increases, and the students begin to utilize GIS to explore and express their learning, it is anticipated that GIS will become a common educational tool utilized throughout the district.
Elementary level projects will be comprised of experiential learning opportunities. Middle school projects will be teacher led with student input. High school underclassmen will create projects which are student led with teacher input. High school upperclassmen will create and drive their own research projects with support from our university and professional partners.
Students will have access to, and learn how to use technological tools such as GPS; photographic and video equipment; sampling equipment; remotely operated vehicles; remote sensing equipment; and GIS to conduct research investigations and the reporting of results related to their local community.
This project is designed to engage students in the process of thinking about the issues that will shape their future. As students are better able to identify issues, it will hopefully become self-evident that it will be they who will be the ones to solve these problems.

Geo-Awareness, Geo-Enablement, Geotechnologies, Citizen Science, and Storytelling: GIS on the World Stage by Joseph Kerski

Five converging global trends – geo-awareness, geo-enablement, geotechnologies, citizen science, and storytelling– are combining to offer GIS output and GIS professionals a world audience. Issues central to GIS professionals are now part of the global consciousness. Everyday objects are rapidly becoming locatable, and thus able to be monitored and mapped. Many tools and data sets that were

formerly used and examined only by GIS analysts are now in the hands of the general public. Ordinary citizens are becoming involved in contributing data to the scientific community. Multimedia and cloud-based GIS have greatly multiplied the attraction that maps have had for centuries to tell stories. But despite these trends bringing opportunity, is geoliteracy becoming increasingly valued? How can educators, researchers, and GIS practitioners seize the opportunity that these trends seem to present to actively promote core content knowledge, GIS skills, and the spatial perspective throughout education and society?

Oh, the Places You'll Go! **by Esther Worker**
How can you steer yourself in the right direction and make the best choices that will empower you to become a skilled and talented plus person to build upon the foundation of your abilities in order to live your spatial career to your full potential. We'll explore the multiple paths and opportunities of building a spatial career from Kindergarten through retirement: education, degrees, certifications, GIS career jobs and personal aspirations.

Analyzing College and University Recruitment with Huff Model **by Yu Zhou and Jie Wu**
Many colleges and universities are now using GIS to map student sources with enrollment and demographic data. These maps provide a great way to visualize the current student locations and the potential recruiting targets. Most time, however, such maps do not provide an analytical result of recruitment effectiveness. This study demonstrates that the Huff Model can be used to achieve this task. The Huff Model is a popular method in retail site analysis. It is a spatial interaction model that calculates distance-based probabilities of consumers. In this sense, the college and university student recruitment is very same to the market area analysis: both are based on the distance and the probabilities of consume behavior. Student enrollment data from Ohio Board of Regents and ArcGIS software from Esri is used in this study.

Enabling On-Campus Situational Awareness Through 3D GIS **by Paddington Hodza, Sitian Xiong, Cameron Sloan, Wendy Berelson, and Jeffrey Hamerlinck**
Recent acts of terror like the massacre at Virginia Tech in the US render situational awareness more important than ever for students to stay safe, learn more effectively and better respond to emergencies on campus. Situational awareness is about perceiving and understanding the significance of features in space and time including thinking about what might happen and how to respond. This study exemplifies the capabilities of 3D GIS in facilitating on-campus situational awareness. The examples include a visually-compelling 3D representation of the University of Wyoming campus, viewshed analyses of on-campus emergency phones and automated external defibrillators (AEDs), as well as least-cost path and network analyses. 2D/3D geospatial and geovisual analyses helped in identifying and effectively visualizing the potential locations of additional phones and AEDs. The dynamically-linked 2D and 3D display windows of the 3D GIS present an engaging and intuitive framework upon which users can better comprehend campus environments including the whereabouts of critical infrastructure and least-cost navigational pathways. The study concludes that 3D GIS mimic the interactive, dynamic and multidimensional nature of our complex world which greatly aids in developing situational awareness in effective and efficient ways while limiting the user's cognitive load.

Applied Student Research
Track Chair: Alicia Tyson

For the first time, GIS in the Rockies will be featuring student presentations in a special session focusing on applied student research. This unique opportunity connects government and private agencies and research institutions with students entering the field of GIS or looking to share unique ways to apply geospatial technologies to a variety of problems. Come and see how our future GIS leaders are using GIS tools and analyses to better understand our environment and benefit our communities. Presentations addressing any aspect of geospatial technologies are welcome.

Spatial Modeling of the COGCC's Surface Regulations on Drilling and Facilities
by Emily Hueni

Regulations laid down by the Colorado Oil and Gas Conservation Commission (COGCC) stipulate that drilling and facility locations must adhere to specific geographic constraints. These constraints are based on proximity to, and density of, various types of natural and cultural features. Examples of such features include 100 year flood plains, wildlife habitats, surface occupation/use, and population density within 1000 ft of an area of interest. With the dramatic rise in population in Colorado and wide scale development happening along the Front Range these regulations are playing an increasingly important role in determining drill site locations within the Denver-Julesburg Basin. Using data collected from state and federal agencies, or created using remote sensing techniques, a model was built to map all of the COGCC regulations with spatial components for a Township in Adams County, Colorado. This model demonstrates the potential that GIS has for understanding and navigating the COGCC regulatory landscape on a large scale.

ColoradoView Internship: Students Using GIS to Address Environmental Issues in CO
by Maxwell Cook

ColoradoView, in partnership with the Colorado State University Geospatial Centroid, provided an opportunity for several student interns to work on geospatial research projects during the Spring 2015 semester. ColoradoView is part of a national consortium called AmericaView that focuses on furthering the use of remote sensing data. The broad objective of ColoradoView is to facilitate innovative uses of Landsat and other USGS remotely sensed data in academia and government agencies. ColoradoView interns at the Geospatial Centroid worked on three separate remote sensing projects: assessing Colorado's grazing lands, improving modeling and prediction of invasive plant species distribution in Colorado, and working with the UV-B Monitoring and Research Program at CSU to improve its methodology for reporting UV and solar radiation. This presentation will provide further details about both the experience of the internship and the status of the projects with a focus on the habitat suitability modeling of an invasive fly species across Colorado.

Integrated Lidar, Aerial, and Satellite Data Analysis for Municipal Project Support
by Valerie Dooley

The Remote Sensing class at FRCC-Boulder County was given the unique opportunity to design and implement a service-learning project with the City of Loveland, Department of Information

Technology. The project involved the processing and analysis of selected areas from a large, ~800 Gb, archive of LiDAR, aerial, Landsat, and WorldView data. The primary goal was to identify and characterize tree canopy within the municipal area and specifically the City right-of-way. Other applications, such as building footprints and heights, drainage basin and channel modeling, and ditch network analysis were considered. Teams of students developed models, explored processes and applications, created workflows, and processed data in pilot project areas. The team approach resulted in highly innovative and diverse solutions involving combinations of LiDAR and multi-spectral image processing and analysis that yielded tree count, tree canopy dimensions, and other tree characteristics. The workflows were carefully documented and reports written by each team. The work was reviewed at several stages by the City of Loveland and the project considered very successful. The work will continue with the creation of an optimized workflow for the entire study area and expansion into new areas and applications. The service-learning project also demonstrated the high quality of learning experience for the students and the high technical value to the client that can result from combining the resources of an educational institution with the needs of a community.

Geospatial Decision Support System for Integrated River Basin Management: Russian River Tributaries Case Study by Christopher Fields, John Labadie, and Lynn Johnson

The arid climate in the western United States requires agriculture to rely heavily on water storage and irrigation projects for the redistribution of natural system flows to meet demands. At the same time, stream ecosystems depend on a natural pattern of both the timing and volume of flows to thrive. While there may be adequate supply to satisfy both agricultural and environmental demands within a stream ecosystem, the disparities in both the timing and quantity of required flows creates conflicts between the two uses. These conflicts present opportunities where detailed modeling can be used to develop effective water management solutions.

The Russian River valley in northern California provides an ideal case study to analyze the relationship between irrigated agriculture and environmental concerns. The primary agricultural demand in the region is the cultivation of grapes, while the Russian River and its tributaries provide important habitat for multiple threatened and endangered fish species.

This study describes the development of a geospatial decision support system (geoDSS) that combines the gridded hydrologic model Hydrology Laboratory-Research Distributed Hydrologic Model (HL-RDHM) with the network based water management model Geo-MODSIM. HL-RDHM model outputs are integrated into the Geo-MODSIM network structure to evaluate the coincident effects of water management decisions. Using this approach, alternative management options can be incorporated into the geoDSS and evaluated, thereby enhancing water resources reliability in the Russian River tributary system.

Spatial and Temporal Analysis of Rabid Wild Terrestrial Animals Along the Colorado Front Range by Teri Vlasak

Rabies is a virus transmitted to humans through the saliva of unvaccinated wild and domestic animals. In 2010, 92% of animals that contracted the virus in the United States were wild animals (CDC, 2011a). Like the majority of the United States, the Colorado Front Range (Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Elbert, El Paso, Jefferson, Larimer, Teller and Weld

counties) is not immune to the spread of rabies. The purpose of this study was to explore the spatial and temporal distribution of rabies incidence in the Colorado Front Range.
Rabies data was acquired from Larimer County, Weld County and the Colorado Department of Public Health and Environment for 2007 to 2014. Geographic Information Systems was used to explore the spatial and temporal distribution of rabies incidences and examine the correlation of rabies with land cover.
Ninety-one percent of rabies in the Colorado Front Range occurred in skunks. The majority of cases occurred between April and July in the foot hills of the Front Range and the plains. No cases were reported in the Rocky Mountains. Rabies was predominantly found in areas with land cover types such as open space, grassland, low/medium development, pasture, cropland and shrub. Between 2007 and 2011 the majority of rabies cases occurred in southern counties (El Paso, Elbert, Douglas and Arapahoe), while between 2012 and 2014 there was an increase in cases reported in northern counties (Larimer and Weld).
The findings from this study indicate that rabies varies spatially from year to year as well as temporally.

Evolution of Forest Fragmentation in Temperate and Tropical Forests in Mexico by Elizabeth Clay

This paper presents a national level assessment of the fragmentation of the temperate and tropical forests in Mexico for three dates 2002, 2008 and 2013 (corresponding to the land use/cover layers known as Series III, IV and V created by the Instituto Nacional de Estadística, Geografía e Informática INEGI in Mexico). Then, the forest fragmentation classes identified for a date (e.g. 2002) are cross-referenced with: a) The forest fragmentation classes identified for the next date (e.g. 2008); and b) the land use/cover reported for the next date. The same cross-reference process was carried out for 2008 to 2013. This analytical process explores the trends in the relationship between: a) fragmentation levels and changes in fragmentation of the forests over time; and b) the changes in land use/cover that occur in different forest fragmentation classes over time. The Morphological Spatial Pattern Analysis (MSPA) method and the GUIDOS Toolbox were used to identify the forest fragmentation classes. The INEGI Series III, IV and V were used to extract forest areas and the land use/cover information. A raster overlay with unique identifiers technique and the Tabulate Areas Tool in ArcGIS were used to carry out the cross-reference processes.

Spatial Assessment of BLM Public Lands Dependence in Colorado by John Gioia

The Bureau of Land Management is responsible for managing resources for multiple uses, including grazing and recreation, and climate change is placing novel challenges on decision-making processes. While 'Public Lands Dependence' and 'Resource-Dependency' is most commonly examined through the lens of community wellbeing and socioeconomic indicators at the community scale, 'Public Lands Dependence' in the BLM context requires examining specific user groups for which socioeconomic and wellbeing indicator data are less readily available. Grazing and recreation permitting data are used to examine 'Public Lands Dependence' on BLM land in the state of Colorado. Data are analyzed spatially using ArcGIS to (1) drive further research on social vulnerability of user groups to climate change and (2) offer a decision-making tool to the BLM.

Grazing and recreation user groups' dependence on BLM-managed resources in Colorado varies spatially at the Field Office level. This project demonstrates how permitting and other natural resource data can be used to evaluate spatial variations in Public Lands Dependence and use the information in a decision-making context. Ultimately, spatial representations of Public Lands Dependence will inform social vulnerability assessments and climate change adaptation strategy-development.

The Geodemographics in Location Intelligence: A Study in Craft Brewery Placement **by Abiah Shaffer**

Since the late eighties, an ever increasing number of American craft breweries have opened up across the United States. Although the industry has a relatively high success rate, there are still a number of craft breweries that fail. As craft brewing is an inherently location based business, the sites selected for new brewery locations are important to that business's success. This research aims to examine how geodemographic information plays a role in strategic location decisions for craft breweries. By building a consumer profile for Phoenix craft brewery customers and comparing the results to the actual demographics of trade areas surrounding craft breweries, we begin to get a picture of geodemographics role in the site selection process. The research looks specifically at two locations; An existing brewing company location and a site they are interested in acquiring. An analysis is performed to compare the geodemographics and behaviors of craft beer consumers in Phoenix, Arizona and those of the current brewing company location under evaluation and their potential new site. This analysis ultimately results in intelligent business information related to location. The information compiled in this study can be used to make informed site selection decisions.

"How To" Mashup

Track Chair - Caitlin Reusch

Mobile HTML5 Geolocation - Advanced Topics **by Andy Gup**

This session is a deep dive into what's possible and what's not with developing geolocation apps for the mobile web. We'll dig into the browser's JavaScript-based Geolocation API with a focus on the optional properties and how to use those to get the most accurate location possible. We'll also draw comparisons between browser and native smartphone GPS capabilities. You'll walk away with a greater understanding of how to use browser-based geolocation based on real-world scenarios and whether or not native device SDK or browser-based geolocation is the way to go.

Bringing ArcGIS into the Adobe Suite for Better Cartographic Design **by Stephanie Oliver**

Ever found yourself frustrated by the cartographic design functions of ArcGIS? This presentation will provide a quick primer on how to input data from ArcGIS into the Adobe Suite. It will go over the capabilities of the Adobe Suite and when to use which component. We'll discuss some best practices and how to avoid some common pitfalls in the process, and feature a step-by-step demonstration of how to take data from ArcGIS to the next cartographic level.

Project and Workflow Management

Track Chair - Caitlin Reusch

Building Intelligence from the Ground Up: Lidar, Imagery, and Automated Feature Extraction for GeoINT by Jonathan Gale

One of the most common problems that we as GIS and Remote Sensing practitioners face today is that we lack streamlined workflows for processing and exploiting geospatial data. Often times we are using a variety of different data from various sources along with a host of tools and software applications that are designed to do many things so understandably, there aren't really any step-by-step instructions or best practices for doing this kind of work . This presentation will explore the possibilities of using GeoINT Operational Processing methodology as a frame work for processing and exploiting data such as LIDAR and 8 band imagery. Attendees will be introduced to the key concepts and components of GeoINT and GeoINT workflow methodology and then be guided through a real-world, scenario-based example to demonstrate each of the 5 steps of this process. Attendees will also learn how to configure their system, process intelligence data and create finished products and reports using industry standard tools and workflow concepts.
Participants will also learn about

- The role of LIDAR and Imagery in the GeoINT Operations Process cycle
- Cataloging and querying data resources for quick data discovery
- Integrated processing workflow using ArcGIS and RemoteView
- Automated Feature Extraction
- Creating operational overlays
- Quality control and accuracy assessment
- Creating fused GeoINT products and reports

Project Management: The Work Breakdown Structure by Robert Crawford

The Work Breakdown Structure provides a number of benefits to the Project Management Process. While sometimes misidentified and misunderstood, the Work Breakdown Structure (WBS) can provide a better understanding of project work requirements, more accurate cost/time estimates, improved project progress tracking, and a higher probability that minor work elements will be accounted for. This presentation will review the preparation and benefits of the WBS.

Vendor Showcase

Track Chair - Mark Bowersox

The Vendor Showcase is an opportunity for businesses, small or large, to demonstrate to conference attendees new products and/or existing products related geospatial technologies and information science.

Low-Cost GIS for Today's GIS Professionals by Mike Childs

Formerly considered beyond the reach of many budgets, GIS technology is now part of the daily workflow for local government departments and businesses of every size. No longer constrained by overly complex software requiring highly skilled technicians, or by expensive acquisition and maintenance costs, GIS professionals are learning the value of GIS self-sufficiency. In this presentation, we will take a look at a low-cost GIS software alternative that are ideally suited to the

challenges of today's GIS professionals. Using Global Mapper we will demonstrate some of the basic principles of GIS development, where to find data, and efficient spatial data management.

Esri's Living Atlas of the World by Shane Matthews

ArcGIS includes a Living Atlas of the World with useful and authoritative maps on hundreds of topics. It combines reference and thematic maps with rich content relating to people, earth, and life. This presentation will describe the living atlas with a focus on how to participate by building and sharing web maps and applications or contributing your organization's content with the world through Esri Community Maps.

By joining Community maps, you become part of the global living atlas community, and your authoritative data will enrich a widely-available cloud-based platform comprised of ready-to-use maps, applications and topics that include demographics, imagery, oceans, streets, topography, the natural environment and urban systems.

Bolstering "BYOD" Devices for Accurate, Repeatable, and Easy Field Data Collection by Zach Edwards

For a few years now in the data collection arena, we have been using the term "BYOD" or Bring Your Own Device in the workplace and data collection environment. The problem is that there haven't been affordable, accurate, repeatable, and easy-to-use solutions built around an external GNSS receivers and consumer-grade BYOD devices. In recent months, we've tested and sold many of these solutions and proven many viable workflows for folks looking to collect sub-meter data all the way down to one centimeter or two with very few caveats. Let's take a look at these GNSS receivers, BYOD devices, and the software solutions in depth. Perhaps we'll discover some ways to improve upon your accuracy and/or efficiency in your current data collection workflow? How to leverage Smart-Phones and Tablets as high accuracy devices through GNSS Technology.

Collector and Operations Dashboard by Jeremiah Lindemann

These applications help users improve data collection in the field and support common operation picture workflows. Designed with field crews in mind, Collector is used to capture and update both tabular and spatial information via smartphones/tablets using the built-in GPS capabilities of the device, or by tapping on the map. Offline (disconnected) editing will also be discussed. Operations Dashboard provides a common operating picture for monitoring events. Operations Dashboard integrates maps and a variety of data sources to create comprehensive operational views that can include charts, lists, gauges, and indicators which update automatically as underlying data changes.

Using Photogrammetry to Measure From Photos in the Office by Mel Philbrook

In recent years, there have been some exciting developments in the surveying and mapping industry with the advent of new receivers and various software packages. However, what if I told you that you can measure and draft very accurately from an image using a consumer-grade high megapixel digital camera? What if you could measure to better than two centimeters from photos taken up to 150 meters away and have a three-fold increase in productivity in both the field and the office? Let's take a deep dive into getting geodetic measurements using three fundamental steps.

Augmented Reality for Hidden Assets **by Brady Hustad and Ken Hetlinger**
Every utility and government has millions invested in buried and hidden assets. With the advancement of GIS we have more accurate location and information on these assets than ever before. However, still in the field, the assets can be hidden by snow, vegetation, or even purposely in people's property for aesthetics. Additionally, despite accurate data, helping the field workers to find the right asset can be challenging, causing repairs and replacements to happen on the wrong assets. Technology has made another leap that can help, Augmented Reality. We will introduce you to a new technology solution that can empower your field workers 'in the last mile' to find the correct hidden asset, plan their job, and effectively save time and effort. We will also discuss how you can implement this into your organization. Additionally, we will discuss the rapidly changing field of augmented reality and what the future might hold.
Augmented Reality is no longer a subject of science fiction and superhero movies. It is here and available to improve all of our day to day jobs!

Managing Asset Condition with Mobile Field Inspections and Cityworks **by Matt Harman**
Cityworks is a GIS-Centric asset management system that uniquely and directly leverages the GIS. This presentation will show the benefits of directly connecting a GIS to an asset management as related to doing inspections. Using multiple devices in the field with real time updates. From the office, GIS spatial analysis and other Cityworks tools can then be used to manage assets using historical maintenance and condition scores.

The HERE Map: Many Sources, One Map **by Cindi Kalb**
Location-based devices and services are all around us—they've become a vital part of our culture. From smart phones to navigation devices to enterprise applications, all are likely powered by a commercial map. And because the public uses these devices and services, they're relying on the accuracy and validity of commercial maps. As a result, more and more communities and government entities are contributing their local knowledge and sharing information with commercial data vendors, in order to maximize the use and application of the data and make the map in their locale as accurate as possible.
Perhaps the most well-known and trusted commercial map vendor today is HERE, formerly known as NAVTEQ. The HERE Map is found in a wide variety of places, including online map applications, in-dash and personal navigation systems and is used by companies in all walks of life, ranging from fleet management operations to emergency management. In this session Cindi Kalb from HERE will discuss their map and how it is updated through contributions via their community program, field data and local GIS data collection and acquisition channels.

Precision Mapping Using Street Level Imagery **by Christopher Aldridge**
Street level imagery can be a valuable source of information for asset management, providing the ability to map, classify, and inspect physical assets from the desktop. It can also be remarkably accurate. This session will explore results from mapping projects that have provided accuracies adequate for resource grade mapping as well as for design level mapping.

Developing Custom Applications with Web App Builder **by Bill Grow**
Demonstrating how to use the Web App Builder from Esri to create custom applications and leverage the tools available in the JavaScript API. With the new Esri Web App Builder it is easy to create custom applications and use predeveloped widgets and tools along with creating custom widgets and tools.

MetStorm™: Near Real-time Storm Precipitation Analytics **by Alyssa Hendricks**
MetStorm™ is a new GIS-based analysis system that produces gridded precipitation at 5-minute and 1-hour intervals over a specified domain using a unique combination of Perl, GRASS GIS and R software. The relative spatial patterns are largely governed by Weather Decision Technologies Polarimetric Radar Identification System (POLARIS) quantitative precipitation estimates (QPE). The POLARIS QPE is a mosaic of dual-pol radar-estimated precipitation at a spatial resolution of 250-m or 1-km. Meanwhile, the precipitation magnitudes of MetStorm™ grids are influenced by quality-controlled rain gauge data from our strategic partner, Synoptic Data Corp. MetStorm™ has the ability to integrate both hourly and daily reported precipitation data, thereby providing a high degree of gauge density. Satellite data, though at a coarser spatial resolution (4-km), influences areas void of rain gauge or radar data; this is especially valuable in the western United States where radar and gauge data are sparse due to complex terrain. Innovative algorithms blend the precipitation estimates from the different sources into a seamless GIS grid, which provides the basis for summary statistics, maps, tables and plots.
MetStorm™ generates a unique set of storm precipitation analytics, including an average recurrence interval map, depth-area-duration table and plot, and mass curve table/plot for the storms' center, in addition to a total storm precipitation map. This presentation will include a brief overview of MetStorm™ and examples of recent significant events in Colorado and across the US.

Configuring the Local Government Solution **by Jeremiah Lindemann**
ArcGIS for Local Government is a set of configurable software components from Esri which include maps and applications built on a common information model to help support many of the responsibilities of government agencies. Included are tools to help aid decision making, transparency, accountability, and planning tasks. This session will provide an overview of these tools, and demonstrate how to configuring solutions to meet departmental business needs.

Thank you
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We couldn't have made the
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a success without you!!