GIS Helps Grizzly Bear Researchers

Oil and gas exploration, forestry, the construction of new roads, and increased recreational use of the land all have the potential to have a negative effect on grizzly bear habitat in western Alberta. Grizzly bear researchers and GIS specialists at the Foothills Model Forest (FMF) are working together to further their understanding of the grizzly bears’ habitat use and response to changing landscapes, and to ensure the long-term conservation of the bears in their natural habitat. Since the Grizzly Bear Research Project began in 1999, the Foothills Model Forest has been using GIS to analyze grizzly bear movements and answer questions about the bears’ habitat use. The resulting knowledge and tools are provided to land and resource managers to aid in the planning process for projects such as choosing the location for a pipeline.

The FMF covers an area of 2.75 million hectares, including Jasper National Park. It is centred in the town of Hinton, Alberta, a resource-based community with a population of approximately 10,000, located 285 kilometres west of Edmonton. The FMF is a unique group of partners dedicated to conducting research and implementing results on the ecological, economic, and social values of the forest. Since its inception in 1992, FMF has been using GIS as a core analysis tool in creating models to assist resource managers in making better development decisions. GIS is the cornerstone of all data collection, management, and analysis for the on-site research projects conducted at the FMF, and the Grizzly Bear Research Project is no exception.

This project is a five-year multi-disciplinary endeavour aimed at determining the impacts of human activities on bear habitat and populations, and providing land managers with tools to integrate grizzly bear “needs” into their decision-making framework. The grizzly bear project area is 9,752 km², and includes the eastern portion of Jasper National Park, which is 24 per cent of the total project area. Several diverse partnerships were formed for the Grizzly Bear Research Project and include both financial and in-kind contributions from industry, government, and academia.

“From the beginning of the project, GIS was recognized as a critical technology component that would allow researchers to tie all the pieces together and answer the location-based questions,” said Gordon Stenhouse, Provincial Grizzly Bear Specialist and Project Manager, FMF. “We wanted to address questions such as where, in relation to roads, cut blocks, old growth, well sites, and mine sites do the bears make their home; do grizzly bears cross heavily used roads, and do they do so during the day or night or both; how large of an area does an individual bear cover (its home range); and what are the landscape characteristics of that home range.”

One of the key elements of the Grizzly Bear Research Project is the study and analysis of grizzly bear movements. To collect data about their movements, each year of the five-year project, grizzly bears are captured and equipped with GPS radio-telemetry collars. During the time the bears are immobilized for the collar fitting, a variety of other information is also collected including weight, sex, tooth samples to determine the animal’s age, and blood samples for laboratory analysis. Hair and fecal (scat) samples have also been collected throughout the project and undergone DNA testing to identify individual animals and familial relationships.

In the first four years of the project, over 31,000 grizzly bear GPS locations and associated information (time, date, etc.) were acquired from 33 individual grizzly bears. Most collars are programmed to collect six locations per day (every four hours) but some are programmed to collect a location 12 times per day (every two hours). Data is typically collected from early May when the bears emerge from their dens to late November when they enter their dens.

“The GPS radio-telemetry technology is a great improvement over earlier techniques of wildlife data collection where researchers had to get in a plane every few weeks to obtain a single location from a VHF radio collar,” said Julie Dugas, GIS Specialist, FMF. “Even though factors such as dense forest cover and bears that have managed to remove their collars influence the total number of locations acquired, the amount of data collected has increased substantially as compared to previous methods.”

To avoid data entry errors, the process of adding the coordinate data retrieved from the collars into the database has been programmatically automated in ArcInfo. This includes the transformation of the GPS coordinates, most of which are in the latitude/longitude WGS84 coordinate system, to UTM 11N NAD83, the coordinate system used by FMF. Once the data has been cleaned and prepared, it is “pushed” into the Microsoft Access database using ODBC connections, and the information in the appropriate tables is updated.

In addition to the data captured by researchers, several other datasets are
used to create models and perform analysis. These layers include Alberta Vegetation Inventory (AVI), digital elevation models (DEM), Ecological Land Classification (ELC), hydrography, and landuse zones.

The data is accessed and analyzed using ArcGIS, ArcGIS extensions, and ArcView GIS. One of the key ways this data is used is in the creation of a grizzly bear probability of occurrence layer. This layer is based on the Resource Selection Functions (RSF) model, which describes grizzly bear habitat use. Two additional datasets must be specifically created for use in this model.

A linear access density grid is required to show the concentration of human linear disturbance features, such as roads, on the landscape. The density grid is created with ArcGIS Spatial Analyst, based on a grid of ones and zeros where one indicates the presence of an access feature and zero indicates the absence of an access feature. Roving window analysis is used to calculate a density grid that represents the length of the access feature, in kilometres, in a square kilometre area. The resulting density grid is an input layer for the RSF model.

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The model also requires a habitat classification map showing distinct areas that are suitable and unsuitable for grizzly bear habitat. These maps are created with remote sensing software, using an Integrated Decision Tree Algorithm (IDTA). IDTA incorporates Landsat Thematic Mapping (TM) imagery, DEM, slope, and shaded relief data for the area and involves partitioning a dataset into smaller classes. In this case, several different classification algorithms are used within a single tree structure to split the habitats into distinct classes.

These two datasets are incorporated into the RSF model along with a correction for GPS collar bias, grizzly bear location data, harvest information, a greenness map, streams, DEM, slope, aspect, and hillshade. The model considers all of the information and outputs a map layer showing the relative probability of occurrence of the grizzly bear population, in a range from low to high. Landscape managers are able to integrate the resulting layer in their planning processes, and would plan to stay within the low areas and avoid the high areas as much as possible. This information can be used for facilities management, planning future roads, and proposing a location for a feature such as a pipeline.

“Spatially explicit predictions of grizzly bear occurrence, made possible by the combination of GIS and GPS technology and recent advances in statistical modeling, have helped us understand grizzly bear ecology,” said Scott Nielsen, Ph.D. Candidate, Department of Biological Sciences, University of Alberta. “In addition, the application of this technology for critical management and conservation needs is extremely important. In the past, science and management have each been concerned with supporting their own needs. Today, these technologies and methodologies not only support science but also effective management, thus bridging historic gaps.”

The movement data collected with the GPS collars and analyzed using GIS also helps researchers explore other elements of the project including analyzing bear movement; tracking mortality and reproduction; observing health status and trends; linking landscape conditions to population status; defining bear habitat; and measuring and quantifying landscape change over time.

“Broad scope wildlife research projects present a challenge in spatial and non-spatial data management,” said Christian Weik, GIS Coordinator, FMF. “We are able to meet this challenge by applying the data integration tools provided by GIS to facilitate timely, accurate analysis of data and distribution of information.”

FMF has also started using ArcGIS 3D Analyst to display the data in a 3D perspective in ArcScene. They find this especially useful for visualizing the grizzly bear habitat locations and patterns in the Rocky Mountains and Jasper National Park. In addition, the FMF is currently moving all ArcView 3.x users to the ArcGIS platform, and intends to migrate the spatial data in the database to a geodatabase schema in the near future.

Although the Grizzly Bear Research Project is ongoing, many patterns and models of movement and habitat are currently being used in planning initiatives to keep surroundings safe and secure for the bears. FMF will continue to find new uses and applications for the results of their research to allow grizzly bears to persist in their natural environment. They plan to expand communication efforts surrounding the project in order to convey the research findings to more resource managers and to the general public. The more people who are aware of and make use of the information about grizzly bear habitat, the closer they will be to achieving the objective of ensuring the long-term conservation of grizzly bears in the west-central region of Alberta.

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