# Tera Environmental Consultants Go Where the Caribou Roam

With JMP®, energy development and wildlife protection go hand in hand

### CHALLENGE

To assist government and industry planners in developing roads and natural gas pipelines that have no negative impact on native caribou populations.

### SOLUTION

Consultants use JMP® to manage and analyze huge amounts of data, including five years of global positioning system (GPS) data representing more than 50 individual caribou and 120,000 caribou locations accurate to within a few meters.

### RESULTS

TERA Environmental identifies biophysical features that are important to caribou and describes predator and prey dynamics across the herd range to help government and industry plan for new energy development.

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STATISTICAL DISCOVERY.™ FROM SAS.

## Where the Caribou Roam

Life at the top can be tough. At the top of the world, that is. Particularly if your name is *Rangifer tarandus*, you live in a harsh climate, and are not well adapted to a modern world full of roads and natural gas pipelines. Most people would say they aren't familiar with *R. tarandus*, until you point out that Santa's reindeer are just one of the seven subspecies found in the barrens and boreal forests of Eurasia, Alaska, northern Canada and Greenland.

Three subspecies found in northern Europe and Asia are referred to as reindeer, while the four North American subspecies are called caribou, from the Micmac word "xalibu," meaning "the one who paws." All of the Rangifer subspecies are facing huge challenges in a world of climate change, an increasing human population with a seemingly insatiable need for fossil fuels, and continuing encroachment of development into the remote wildlands of the planet. Fortunately for North American caribou populations, there is a great deal of research and effort being made to ensure their survival in the face of such threats.

JMP caught up with Alex Creagh, an Environmental Statistician with TERA Environmental Consultants of Calgary, Alberta, Canada, to talk about a caribou research project with which he has recently been involved. TERA Environmental is an independent firm that provides environmental consulting services for the energy and forestry sectors, addressing a diverse and ever-changing array of projects and environments. A niche Creagh is carving out for himself at TERA is providing statistical consulting services to companies conducting research in the field of wildlife ecology–research in which JMP software plays a critical role.

Creagh is describing the statistical analysis he's running for wildlife biologists Brad and Diane Culling of Diversified Environmental Services, Fort St. John, British Columbia, modeling resource selection of the Snake-Sahtaneh caribou herd in the northeast corner of the province. As if seven subspecies were not confusing enough, caribou are further categorized into ecotypes, locally adapted populations of a widespread species or subspecies based on characteristic ecology. The Snake-Sahtaneh herd belongs to the boreal ecotype of woodland caribou, which make their homes within a striking swath of Canadian landscape that stretches from the Mackenzie Mountains along the Yukon-Northwest Territories border, south and east to encompass the boreal forests of

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**Alex Creagh**
Environmental Statistician
TERA Environmental Consultants

northeastern British Columbia across to Labrador on the Atlantic coast.

## Making contact

To collect baseline data on the Snake-Sahtaneh boreal caribou herd, a joint project was initiated in 1999 between the British Columbia Ministry of Environment and Slocan Forest Products Ltd., and carried out by Diversified Environmental Services. Midway through the project, Slocan was purchased by another leading forestry products supplier, Canadian Forest Products Ltd. (Canfor), which continued support of the study through to its completion in 2005.

Caribou location data collected with global positioning system (GPS) telemetry was used to define the range of the Snake-Sahtaneh herd, identify key habitats and movement patterns, and describe seasonal habitat selection. Samples of gray wolves and black bears were also monitored using GPS telemetry to assess predator distribution and habitat selection during the caribou calving season.

Finding the caribou is the first step in gathering telemetry data. Creagh explains: "The collars are put on the caribou by my colleagues at Diversified Environmental Services. What that involves is flying around in the northeast corner of British Columbia in a helicopter at treetop level in search of caribou." Individual female caribou are capturing using a "net gun" fired from the helicopter.

Once captured, each caribou is measured, a blood sample is collected for pregnancy analysis, and the animal is fitted with a GPS collar and released. Then the caribou goes about its business, oblivious to the fact that every four hours for the next year or two the GPS collar will use a network of satellites sweeping high overhead to calculate and record its location on the globe.

The beauty of capturing large mammals using a net gun is that no sedative drugs are required. As soon as the hobbles and blindfold used to protect both the caribou and the researchers from injury are removed, the animal jumps up, occasionally gives a playful little kick at the nearest human, and runs off to rejoin her comrades. The whole process, from the moment the net gun is fired to the caribou's release, typically takes less than 20 minutes. Understandably, the capture process is a bit different for the wolves and black bears. A tranquilizer gun is used so that the researchers can work safely around big teeth and claws.

## Layer upon layer

JMP software helps statisticians manage massively large data sets in a user-friendly, efficient manner, and then presents that data via an easy-to-interpret interface. And a massively large data set is exactly what was collected during this project. "We knew we had an exceptional data set," says wildlife biologist Diane Culling, "five years of GPS data representing over 120,000 caribou locations accurate to within a few meters and more than 50 individual caribou. Working with a data set like this is both a privilege and a huge responsibility. You want to make sure every aspect of the project is well executed. Failure is not an option.

"Conducting a research project like this is analogous to running a 4-by-4 relay race," Culling adds. "It's all about teamwork and bringing together the right people with the right skill sets to meet your objectives. That's where Alex [Creagh] and the JMP software came in. We knew where we wanted to go with the resource selection modeling, and Alex had the statistical expertise to help us get there."

Even after a collar has served its tour of duty traveling through scrubby black spruce and tamarack forests, the data still has a long way to go before the statistical analysis stage. The downloaded data is cleaned up, outliers removed, then imported into a global information system (GIS) platform. While the collars were still in the field, Culling and her team were working with GIS specialist Teresa Raabis of Borealis Enterprises, Fort St. John, to build the GIS project—layer upon layer of information that describe various biophysical landscape features of the Snake-Sahtaneh caribou herd range. These layers include hydrological features (rivers, lakes and wetlands), habitat features (vegetation classes) and topographical features (slope and elevation). The caribou data is then associated with the biophysical layers. So now you've got thousands of dots on a map depicting caribou movement across all the different types of biophysical features

within the caribou herd range. The caribou telemetry points become the "use" component of the binary variable.

The next step is model-building, which involves both GIS and statistical analyses. Creagh describes the process: "For each individual caribou, we generate a database of random locations across the landscape. These randomly generated locations become the 'available' component of the binary variable. Randomly generated 'available' locations are assumed to be potential areas of 'use' in the resource selection modeling process."

Resource selection models make use of logistic regression to predict the probability of "use" versus "available" given the independent variables that describe the biophysical features of the caribou herd range. "So in following these animals for five years, we know that the probability of use of coniferous woodland vegetation communities is, let's say, three or four times higher in spring to late summer than late winter." Creagh continues, "We ask, 'Why are they seen in these areas rather than the others? Do they prefer these areas? And, if so, why?'

"So we've got a biophysical resource selection model for caribou; that's the first step," Creagh adds, explaining that now consideration must be given to caribou predators, namely wolves and black bears.

And here, as Creagh says, is where the research gets very interesting: Resource selection models for wolves and bears are constructed using the same tracking, GIS layering and statistical techniques as with the caribou. The results are closely examined to determine whether caribou avoid certain biophysical features during sensitive times of the year –such as calving season–to reduce the chance of predation.

Hydrological features, particularly rivers, are prime movement corridors for wolves. The team examined caribou movement in relation to nearby rivers and other important features, such as lakes and muskeg bog. Understanding where female caribou retreat to during calving season to avoid predation from wolves or bears is critical to understanding predator/prey ecology throughout the Snake-Sahtaneh caribou herd range.

## The right tools

The ultimate aim of all this research is to identify biophysical features that are important to caribou, understand predator/ prey dynamics across the herd range, and assist government and industry in planning for new development.

"We bought JMP specifically for this project," says Creagh. "I've had several years experience using SAS in Brisbane [Australia]. I've found JMP to be very useful. "

Dealing with large data sets is very user-friendly and efficient with JMP, particularly with the logistic regression models that we run–the ability to review residuals and probabilities of use or probabilities of avoidance, or the selection of various biophysical features via the graphing programs that JMP has built into it.

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Creagh also finds JMP quite useful in presenting data to his clients. "The ability to graphically demonstrate results is very important. Visually demonstrating what all those numbers mean is really excellent."

"Throughout the statistical analysis stage, Alex and I had many discussions on the merits of different software packages," Culling says. "In fact, we had used other products in the preliminary analysis phases, but Alex introduced us to JMP, which proved to have the strength and flexibility to complete the task at hand."

Meanwhile, other caribou telemetry projects in Alberta and British Columbia are also using JMP software, including two new projects that have just recently begun.

It's pretty compelling work. And ultimately, one trusts, good news for the caribou.

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