Mike Doyle is the President of the CAGC - the Canadian Association of Geophysical Contractors - representing the business interests of the seismic industry within Canada. The CAGC website may be found at www.cagc.ca.

Recently I was contacted by Jesse Tigner, a student at the University of Alberta, conducting the Northern Boreal Seismic Line Recovery Project. The mandate initially came from the Territorial Government in the NWT, but interest has rapidly spread. Working in partnership with biologists from the GNWT, Environment Canada (CWS), MOE in British Columbia, and industry, this project has attracted funding and support from a variety of donors including government agencies, NGOs, large industry-supported grants like ESRF, many small grants, and even directly from various energy companies and industry groups. A brief synopsis follows outlining the full breadth of concepts included within threshold management surrounding the simple question "*when is a seismic line not a seismic line*".

Continued demand for energy resources has led to concerns regarding how exploration, extraction, and transport of these resources can be done in an economically-viable yet ecologically-sustainable manner. Increasingly a threshold-based management approach, whereby development is limited at designated intensities or densities to protect other valued natural resources, is seen as the best way to balance economic and ecological needs. The impact of linear features, and especially seismic lines, on wildlife has become a common metric for setting these thresholds: seismic line density should be limited so as not to negatively impact wildlife. Unfortunately we do not currently have a good understanding of the short term impacts of seismic lines on most species of wildlife, nor do we understand the long term recovery trajectories of seismic lines. Without this information it becomes difficult to determine appropriate thresholds for seismic lines that protect wildlife assets while also allowing economically-viable energy sector development. Specifically, there are three key uncertainties surrounding the efficacy of these thresholds: a) which lines actually impact wildlife, and what are these impacts, b) when is a line a "disturbance" and when has it recovered sufficiently to be taken off the books, and c) how many lines are too many. If these questions are not addressed and all seismic lines ever created are treated equally within a threshold framework, lines will quickly accumulate on a landscape and the ability of the energy sector to conduct their business becomes severely restricted. However, limited data from the northern boreal forest suggests that line recovery there is dynamic and relatively rapid. We propose thresholds should account for these dynamic recovery rates and that line impacts and recovery trajectories can be accurately measured using a set of 4 ecologically-based criteria: resistance, facilitation, species occupancy, and community similarity.

The impacts and recovery of seismic lines will be measured for red squirrel, snowshoe hare, grouse, marten, black bear, moose, and limited data are also collected for wolves and caribou using:

- Resistance: do disturbances create "fence effects" impeding movements across landscape?
- Facilitation: do disturbances create "sidewalk effects" providing a conduit for predators or invasive species?

We propose that as lines regenerate and become narrower both resistance and facilitation will decline.

The impacts of overall line density will be measured for the above species, and specifically for marten, black bear, and moose using:

- Species Occupancy: do species show a numerical response to line density at broad spatial scales? For example, is there a threshold line density that marten avoid, or that moose select?
- Community Similarity: a) are species on or near disturbances the same and at similar levels of abundance as in forest interior locations, b) are species within areas of low disturbance density the same and at similar levels of abundance as areas of high disturbance density?

We propose that some species will show a positive response to increasing line density and others a negative one, but that an "equilibrium" line density exists below which community similarity is not greatly affected.

SAMPLING METHODS

Before we go into the field we identify all sampling locations using a GIS. We define dominant forest types and calculate total seismic line density across our study site at several spatial scales. We then classify seismic lines by width, orientation, and state of recovery (amount of woody vegetation growing on the line). By understanding this information before we go into the field, we ensure that we are sampling in the right areas, to collect the right data with which to answer these questions.

In the field we measure habitat use in undisturbed "baseline" locations and compare this to use of our several categories of seismic line types, and to total seismic line densities. We use remote cameras on and off lines to detect the presence of bears, marten, and squirrels; and we count pellets and scats on and off lines to detect wolves, moose, and snowshoe hare. By comparing detections between the on and off line cameras or pellet/scat counts, we can determine which lines are disturbances to which species, and what responses species are showing (use or avoidance). Further, we conduct detailed vegetation surveys to track the regeneration trajectories of seismic lines and to determine how vegetation influences observed mammal responses. We also cluster cameras and transects in different areas to measure species presence or absence relative to total seismic line density. By comparing which species are detected and how often those species are detected in different areas, we can determine how total line density influences both species occupancy and community similarity.

RESULTS, RELEVANCE AND FUTURE DIRECTION:

During the 2008 field season we deployed 330 cameras and conducted 224 individual pellet/scat counts. Our results suggest that larger bodied mammals use the lines whereas smaller bodied animals avoid them. Also those species sensitive to disturbance, such as the marten, decline with increasing line density and those less sensitive, such as bears, show a positive or no response.

Our most interesting results are for the marten, a species highly sensitive to habitat disturbance and often used across Canada as a target management species and indicator of forest health. We see that marten avoid open and semi-open lines compared to forest interiors, but that they use closed lines at similar rates to forest interior locations. Our data also show the specific vegetation attributes that likely triggering the re-use of lines, including the total number of stems and the hiding cover present on a line. Further marten are detected less frequently in home ranges with higher total line density, but when they are detected there

it is often in pockets of lower line density. This suggests marten are responding to line density at multiple scales (i.e., total density and configuration), although more data is required for conclusive results.

These data suggest that seismic lines recover even from the prospective of a species that is highly sensitive to habitat disturbance, and that we are able to pinpoint that specific "recovery point". Further, it shows mammals may be responding to seismic line density at multiple spatial scales, and it may be important to accurately define the spatial scales at which line density thresholds are set. Ultimately this research will be able to suggest where and at what scale appropriate line density thresholds should be set, and when lines should and should not be counted in those threshold considerations.

Due to the success of last field season we hope to expand our research efforts in the coming 2009 field season. Specifically, we intend to target data collection in 2 key areas. First, we will focus on collecting data for the 2-3m and 4-5m. Several studies for birds suggest narrow lines are ignored by birds and we want to know if this pattern holds for mammals. Second, we will focus on sampling a wider range of total line density including very dense locations to determine where density thresholds may exist. All field work will continue in our study site roughly bounded by High Level AB and Fort Nelson BC to the south, and Fort Simpson and Hay River NWT to the north.

Ultimately this research provides powerful, tested, and ecologically relevant methodology with which to assess the impacts of oil and gas development in the northern boreal forest. More importantly, it facilitates a concrete way to assess disturbance recovery trajectories for both individual species and wildlife communities across habitat types. This ensures our research finding can be used for a variety of applications: for single or multi-species management plans across a range of forest types and locations. Ultimately these data facilitates informed decision making, appropriate use of thresholds, and the use of best practices to ensure energy sector development can continue in an economically-viable and ecologically-sustainable manner.

If you or your company has any interest in the project the best first step would be to contact Jesse Tigner at tigner@ualberta.ca or office phone 780-886-0943 AND the project supervisor Dr. Erin Bayne, bayne@ualberta.ca or office phone 780-492-4165.

From the Thursday Files

It is a common experience that a problem difficult at night is resolved in the morning after the committee of sleep has worked on it.

-John Steinbeck