Does mulching do the trick?

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That seismic lines and other types of linear features can impact wildlife in undesirable ways is not news. Instead, that idea is so completely understood that significant time, money and effort is now spent trying to mitigate the impacts of linear features on wildlife in precise and targeted ways. Mitigation efforts for seismic lines in forested ecosystems largely fall into one of two categories:

1. Undo existing impacts by actively reclaiming existing lines, and,
2. Prevent future impacts by preparing new lines using low-impact seismic (LIS construction practices.

Both approaches likely play important pieces in the land management puzzle in Canada.

We know that open and semi-open conventional lines 6m wide or wider that are highly dissimilar to the surrounding land cover can trigger behavioral responses in wildlife that in turn can contribute to reduced animal populations. Although impacts can dissipate with the recovery of woody vegetation, conventional construction practices have, in some cases, imposed unexpected and extremely long recovery trajectories thereby maintaining some conventional lines as long term liabilities. A variety of reclamation efforts are now underway to jumpstart the recovery of and restore the habitat function (functional restoration, in the management parlance) along open conventional lines. You have no doubt heard recent government and energy company initiatives to restore old seismic lines.

Far less attention has been paid to the efficacy of LIS construction practices. These practices (though the threshold for what constitutes LIS and rational for these techniques have changed over the years to some degree) are focused on two primary methods. The first is to cut lines so narrow that they do not trigger behavioural responses in wildlife, and the second is to prepare lines in such a way that even if they do trigger wildlife responses the lines recover very quickly and any impacts to wildlife are ephemeral. Most of the emphasis in industry over the past decade has gone to the latter. Currently, most LIS lines are cut using mulchers. While it is possible to mulch lines sufficiently narrow to prevent impacts to wildlife, few actually are (a result of a variety of constraints ranging from survey parameters to logistics to HSE concerns to available equipment to expertise). Conventional wisdom says mulching lines dramatically expedites line recovery because elevated mulching drums remove vegetation above the ground surface while eliminating ground disturbance. This seems like a reasonable assumption because we know the

intensity of disturbance to the ground surface, soil layers, plant roots and permafrost can all negatively affect the recovery of conventional lines. However, ask a forester and you'll hear that some ground disturbance is probably beneficial to stimulate recovery - scarifying cutblocks is common practice - or ask a gardener and you'll hear that mulch is an excellent way to prevent plant growth.

While few data are available to quantify real recovery trajectories of mulched lines, conventional wisdom has begun to work its way into management discussions. In British Columbia and Alberta, mulched lines are being considered differently than conventional lines with regard to the current management hammer applied to industrial land uses: caribou. Is mulching achieving an intended management goal to expedite line recovery and ensure any impacts to wildlife are ephemeral, or are we simply prepping lines that will require active reclamation in the future? The costs of reclaiming conventional lines is currently extremely high – estimates range from $9,000 - $15,000 per km. While there may be a large number of old, conventional lines that require at least some amount of active reclamation, it is a fixed number because conventional lines haven't been cut in Canada in approximately 20 years. Adding to those numbers now by improperly mulching lines is not in the best interest of our industry. Adding any reclamation costs to the cost of a seismic program would cut into already razor thin margins for seismic operators and expecting E&P companies to reclaim orphan lines as a cost of doing business is not exactly an incentive. Nor is adding to the number of lines requiring reclamation in the future in the best interest of caribou or other ecological values that are negatively impacted by long lasting habitat disturbances. This is especially true given the trend toward higher densities of seismic lines. With the industry shift to producing hydrocarbons from shale packages and the continued evolution of high resolution survey parameters needed to image the rock properties capable of improving drilling efficiency in Canada, seismic line density is slated to increase, not decrease. As such, understanding the ecological lifecycles and functional recovery trajectories of mulched lines is now ever more pressing.

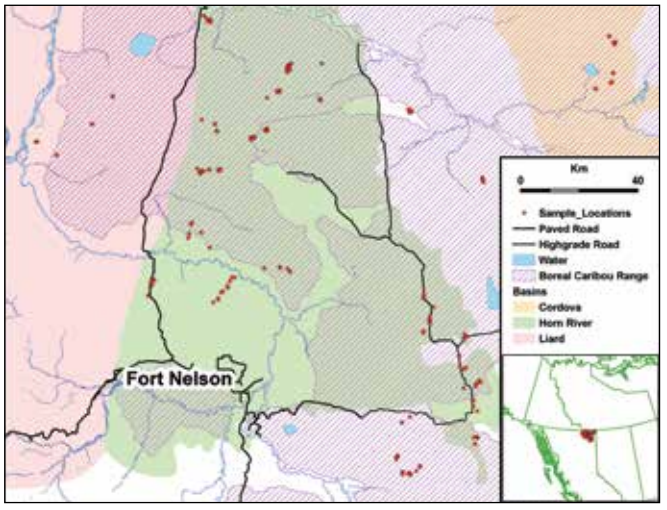

Figure 1. Explor, Golder, and the Fort Nelson First Nation Lands Department collected data at 206 sampling location along mulched seismic lines in in the Horn River, Liard, and Cordova Basins in NE BC. All sampling occurred near and north of Fort Nelson, BC in July and August of 2016.

Research to fill the knowledge-gap

To answer this question – does mulching expedite line recovery – Explor teamed with Golder Associates and submitted a proposal to the BC Research and Effectiveness Monitoring Board (REMB) and BC Oil and Gas Research and Innovation Society (BC OGRIS) to conduct a research project in the Horn River and Liard Basins in NE BC. BC OGRIS is a group with membership including the BC Oil and Gas Commission, CAPP and EPAC that funds applied research in several subject areas in order to fill knowledge-gaps to better inform the regulations governing oil and gas exploration and production in BC.

Our goal in this research is two-fold. First we want to measure how mulched lines recover and why. Because funding was awarded through the Boreal Caribou funding envelope of BC OGRIS, our measurement and interpretation of recovery is framed within the caribou story. We know that wolves' tendency to select for and travel more quickly along open lines begins to weaken and slow, respectively, even with relatively small amounts of recovery. Thus, we are less interested in comparing online to offline conditions and more interested in quantifying what lines of various ages look like and testing different reasons for why they look like they do. Second we want to provide clear and practical guidance to operators and managers for how best to mulch lines in the future. All too often excellent research is conducted without a firm understanding of upstream operations or constraints. As a result well intentioned management recommendations often fall somewhat flat as mitigation strategies. In this work we hope to generate clear, easy to implement and research-based guidance to operators that could inform decision making around survey type, or source and receiver orientation and preparation method, and to regulators that could better track estimates of line recovery timing.

The nuts and bolts

Once awarded the grant we spent the winter and spring identifying sampling locations and developing data collection protocols. We used Vegetation Resources Inventory (VRI) (land cover data in BC) to classify land cover into stand types important for wolves and caribou (i.e., upland forest, muskeg, etc.), and we used data available from the BC Oil and Gas Commission to classify seismic lines by age, cut type and chronology, orientation and width. We used those classifications as groups, or treatments, and identified a number of sample locations in each treatment to visit in the field.

To sufficiently sample whether a line may impede movement for wolves we had to figure out how to measure all the "stuff in the way" from the perspective of a wolf trying to travel along the line. We measured a litany of structural attributes like the height and density of woody vegetation, the presence of fallen logs and live trees leaning in from line edges, ground conditions and the density and height of stubs left over from mulching. Besides measuring the "travelability" of a line for a wolf, we were also interested in understanding whether mulched lines were recovering along expected trajectories. As such we also measured compositional attributes like height and species of individual stems to quantify basic indices of plant succession like species richness and evenness. Finally, to measure why lines were recovering the in ways they were, we measured a number of attributes like soil type and moisture, intensity of disturbance to ground surfaces, and the

Figure 2 NE BC is rich in wildlife and we were fortunate to see a lot of it while in the field. A bison watches traffic along Highway 77 near the Petitot River. Cranes imitating statues. A great grey owl oversees data collection. A lynx kitten stashed by mom up in a spruce tree. Taking the lead of a cow moose and her two calves we often swam in borrow pits to wash-up. A red squirrel takes a closer look. A lone white wolf pauses for a last look along the Kiwigana Road. Wolf pups howl while an adult supervises on the Nogah Road. A wood frog attempts invisibility while sitting atop a field book.

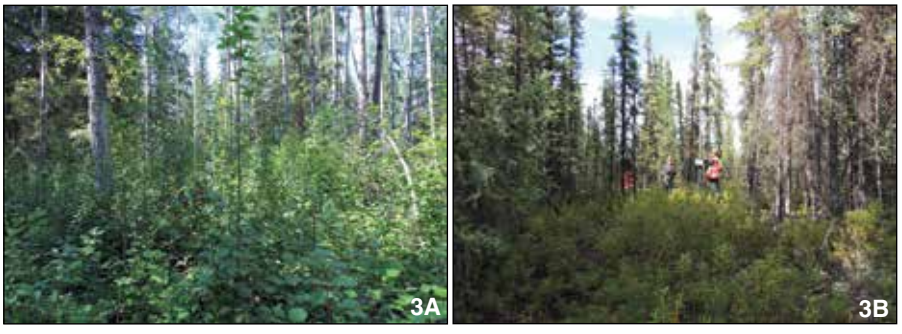

Figure 3 Recovery after 5 growing seasons in (A) an Aspen – Green alder – Highbush cranberry forest (BWBSmk/101$6B.1), a common upland stand type in NE BC, and (B) a Black spruce – Lingonberry – Peat moss bog (Wb03), a common lowland stand type (i.e., muskeg) in NE BC. Recovery is generally more rapid in upland than in lowland stands, but recovery trajectories in both stand types appears to occur more quickly for mulched lines than conventional ones.

Figure 4 Healthy black spruce seedlings growing from a well preserved organic mat along a mulched seismic line in a muskeg stand. These sampling are growing from the same lowland line shown in Figure 3B.

amount of canopy cover over lines. These metrics, along with the treatments, can provide a mechanistic understanding of how environmental and operational factors influence recovery.

Past research has shown conventional lines can recover inconsistently. Recovery trajectory and outcome can vary within a given stand and from stand to stand of the same forest type. This is particularly problematic for upstream operations and management because inconsistency makes it difficult to development practices with a high likelihood of achieving intended outcomes. While there may be several causes for inconsistency of conventional recovery, quantifying consistency of mulched recovery was important here. To do so we collected data in a nested design to compare recovery at specific points to recovery patterns across broader segments of line. Specifically, we located each sample location in a single, discrete stand; at each location we then estimated general recovery pattern along a 100m segment of line and collected detailed recovery information at 3, 2m × 2m subplots (1m × 4m on lines < 2m wide) spaced equidistant along the 100m line segment.

The data

In July 2016 Explor and Golder embarked on a data collection blitz with field support from the Fort Nelson First Nation Lands Department. Over the month-long field season we collected data at 203 locations in the Horn River, Liard, and Cordova Basins. We sampled lines evenly across seismic surveys from 2005/6 through 2014/5, and lines in a N-S and E-W orientation across a continuum of widths from 1.6m to 4.5m wide.

Initial impressions and next steps

We are just back from the field and currently crunching through a mountain of data. Looking back to our time in the field a few things jump out that will be of high interest during analyses:

Mulched woody material is quickly incorporated into the soil and covered by vegetation. We were anticipating thick mats of mulch lasting as semi-permanent features along lines. However, in some forest types, like many lowlands and muskeg stands, this was not the case with little mulch having been created in the first place.

Recovery is remarkably consistent along a given line and among stands of the same forest type. Unlike some conventional lines where patches of dense and tall recovery occur next to open patches, recovery attributes appeared consistent within a sampling location.

The density of conifer seedlings appears high on lines in lowland forest types. This is important because one of the main reclamation strategies to restore ecological function along conventional lines is to plant conifers.

In the months ahead we will analyze our collected data and produce a report on vegetation recovery of mulched, low-impact seismic lines. We hope to report on these findings in an upcoming issue of The Source. In the meantime, if you have any further questions or comments feel free to get in touch with me directly. If you are interested in the BC Oil and Gas Research and Innovation Society, you can find more information here: **http://www.bcogris.ca/**. S