Review of North Yukon Disturbance Tracking Concepts

Final Report (August 19, 2016)

Prepared for Yukon Land Use Planning Council
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1. PURPOSE

As part of the North Yukon Regional Land Use Plan (the Plan) implementation activities, the Parties and Yukon Land Use Planning Council (YLUPC) are determining how to track human surface disturbances, and how these results will be used to determine the conformity of project proposals with the Plan. S. Francis Consulting Inc. (S. Francis) was contracted by YLUPC to provide advice on the definitions and methods outlined in recent disturbance tracking discussion papers and proposals developed by YLUPC, and how they compared with concepts developed by the North Yukon Planning Commission (the Commission).

2. METHODS

S. Francis reviewed the *Draft North Yukon Surface Disturbance Tracking Proposal* (April 29, 2016) prepared by YLUPC (Skinner 2016) and other supporting documents. Results of the review were discussed with YLUPC and are reported here.

3. RECOMMENDATIONS

3.1. Revised Definitions

The level of direct human-caused disturbance is an underlying concept supporting the cumulative effects management strategies and Integrated Management Area zone definitions (IMA Zone I – IV) of the Plan. A detailed review of the Plan has determined the definitions for human-caused disturbance were in some cases not well defined, or were potentially not used consistently. Revisiting and clarifying the definitions related to human-caused disturbance is therefore required.

3.1.1. Functional Disturbance

In the Plan, the term **functional disturbance** is intended to mean “disturbance that counts”. During development of the Plan, the Commission required a definition for direct disturbance that was relevant to the major issue addressed by the Plan, namely potential human-caused impacts on barren-ground caribou. Historical or new access, primarily resulting from trails, seismic lines, and roads (i.e., linear disturbances), was considered to be the major management concern. While it was recognized that some human disturbances may be visible for long periods of time, after a certain amount of vegetation re-growth these disturbances may have minimal impacts or effects on caribou—either through avoidance, use as travel routes, or from increased predation or mortality risk. Challenges with the functional disturbance definition used in the Plan are: 1) it did not address the cutting of standing dead trees, and 2) how the disturbance was to be measured.

The definition of **functional disturbance**, and the types of human activities that do not contribute to functional disturbance in the Plan, is suggested to be revised as follows:

Functional Disturbance is defined as:

Human-caused physical disturbance that results in the disruption of soil and/or hydrology, or that requires the cutting of trees (both live and standing dead). For practicality, functional disturbance is human-caused disturbance visible in imagery with at least 1.5 m resolution. Activities or human disturbances that do not contribute to functional disturbance creation are: 1) new linear features less than 1.5 m in width; 2) land use activities that occur on frozen water-bodies; 3) winter work with no required clearing of trees; and 4) winter work that utilizes existing disturbances and linear features.

Due to the relatively rapid re-vegetation rate of shrubby vegetation (e.g., willows, alders and shrub birch) (Seccombe-Hett & Walker-Larsen 2004), only the cutting of trees (both live and standing dead) is considered in this definition of functional disturbance. However, shrubby vegetation is considered in the definition of disturbance recovery. Concepts regarding disturbance recovery are discussed in Section 3.1.3, below.

It should also be noted that in **Table 3.1 of the Plan**, the concept of functional disturbance was intended to be applied to all zones (Zones I – IV) of the Integrated Management Area (IMA). In Table 3.1 of the Plan, the footnote regarding functional disturbance was applied only to IMA Zone I, which is incorrect. The revised definition of functional disturbance should apply to the entire IMA.

3.1.2. Surface Disturbance and Linear Density

The Plan utilizes two cumulative effects indictors—surface disturbance and linear density. **Surface disturbance** is a generic term describing all types of human-caused physical disturbances, while linear disturbance is a specific type of surface disturbance. **Linear disturbances** are human land use features such as roads, trails and seismic lines that facilitate surface access[1]. **Linear density** is the measure of the total length of all linear features in a given area, expressed as kilometres of linear features per square kilometre of area (km/km^2). In the Plan, the definitions of surface disturbance and linear disturbance did not incorporate the term "functional disturbance". Without inclusion of this term, the surface disturbance and linear density definitions implied that all human-caused disturbances were to be tracked by the Plan, regardless of their width or re-vegetation status. This was not the intent of the Commission (in the Plan, some types of disturbances/activities are exempt from disturbance tracking - see revised definition of functional disturbance in Section 3.1.1, above).

[1] Linear disturbances (or linear features). Note that while some surface disturbances, such as airstrips may be 'linear' in appearance, they are not considered linear features. Linear features are roads, trails, seismic lines, powerline right-of-ways, pipeline clearings, and similar. These features facilitate surface access by people and wildlife, and form the surface transportation network across the landscape.

The definitions for **surface disturbance** and **linear density** are suggested to be revised as follows:

Surface disturbance is defined as:

The area of functional disturbance resulting from human activities. Human features such as settlements, gravel quarries, mine sites, seismic lines, access trails and similar create physical *footprints* on the land, resulting in direct habitat impacts.

Linear Density is defined as:

The total length of all functional disturbances resulting from linear features (roads, seismic lines, access trails, etc.) in a given area, expressed as kilometres of linear features per square kilometre of area (km/km^2).

3.1.3. Functional Disturbance Recovery

In the Plan, the concept and definition of when a functional disturbance is considered **recovered**, and can be subtracted from the total amount of functional disturbance, requires increased clarity. Additional considerations for wildfire and soil and/or hydrology are needed.

The definition for **functional disturbance recovery** is suggested to be revised as follows:

Functional disturbance recovery is defined as:

As a guide, human-caused functional disturbance (both surface and linear disturbance) is considered recovered when it no longer facilitates travel or access by wildlife and people. In forested areas, a feature can be considered recovered when it contains woody vegetation (trees and shrubs) approximately 1.5 metres in height. Similarly, in non-forested areas, a feature can be considered recovered when disruptions to soil and/or hydrology are no longer apparent. As human-caused functional disturbances recover through natural re-vegetation or active reclamation, they are subtracted from the total amount of disturbed area.

Currently, the time (number of years) before a functional disturbance can be considered recovered is uncertain. The amount of time required for woody vegetation to reach a height of 1.5 metres is variable and dependent on the pre-disturbance vegetation and site conditions, the intensity of the disturbance (e.g., amount of soil and permafrost disruption), the timing and intensity of subsequent wildfire, and the level of use the disturbed area receives by humans and/or wildlife. In the Mackenzie Delta, Seccombe-Hett and Walker-Larsen (2004) reported abundant shrub regeneration on 5-8 metre wide seismic lines within 30 years. The ALCES cumulative effects modeling conducted in support of the Plan assumed that seismic line recovery (i.e., when woody vegetation attains a height of 1.5 metres) ranged from 10 years for lines less than 3 metres in width to 30 years for lines 5 metres or greater in width (Francis and Hamm

2009). The rationale for width-modified recovery was that larger, heavier equipment has a higher likelihood of creating soil and/or hydrology disturbance, resulting in longer recovery times.

While shrubs may revegetate relatively quickly, in northern environments similar to Eagle Plain the length of time for trees to reach a height of 1.5 metres may be lengthy. While there is limited relevant data on aspen and birch tree recovery rates, Seccombe-Hett and Walker-Larsen (2004) noted a 17-year lag in black spruce seedling establishment on 1970s and 1980s era 5-8 metre wide seismic lines in the Mackenzie Delta. This study also noted the mean time for black spruce to reach breast height (1.3m tall) was 33 years on flat terrain with a site index of 5 (average). Extrapolating the Yukon black spruce growth curves for site index 5 (Quenet and Manning 1990), it may take an additional three years for black spruce to grow from 1.3 to 1.5 metres. Therefore, in an environment similar to Eagle Plain the expected recovery time for black spruce on average site conditions may be approximately 50 years (17-year lag + 35 years to reach 1.5 metre height = 53 years).

The Role of Wildfire in Functional Disturbance Recovery

The interaction between disturbance, wildfire and recovery is complex. Relevant studies attempting to quantify the effects of wildfire on disturbance recovery include Jacobsen (2007) and Seccombe-Hett and Walker-Larsen (2004). From the Plan's perspective, the creation of new or improved access, largely through development of linear features, is considered to be the major management concern associated with anticipated human land uses in North Yukon. The removal of living trees from a forest that subsequently burns may still facilitate improved human access or use by wildlife and/or predators (i.e., the linear corridor will remain as a cut line through the burnt area). As such, wildfires may not immediately remove disturbances such as seismic lines. However, fires may accelerate their recovery to a tall shrub stage (Seccombe-Hett & Walker-Larsen, 2004). Similarly, seismic lines through recently burned areas with large amounts of standing dead trees would count as disturbances, but the rapid post-fire shrubby vegetation re-growth could also accelerate their recovery.

3.2. Options for Disturbance Tracking

As described in the YLUPC draft disturbance tracking proposal (Skinner 2016), there are two general options for tracking human-caused disturbance in support of Plan implementation and conducting conformity checks:

1. Image interpretation
2. Spatial modeling

Image interpretation requires the periodic purchase of imagery and interpreting/classifying the recovery status of human-caused disturbances within the IMA of the North Yukon Planning Region. Spatial modeling uses rule-based GIS approaches to remove functional disturbances from the IMA based on detailed assumptions regarding recovery times and factors affecting recovery (e.g., topographic position, pre-disturbance vegetation conditions, intensity of disturbance, etc.).

Recommendation:

At this time, periodic image interpretation is the recommended option for the following reasons:

1. Image interpretation is a relatively simple and cost-effective approach to periodically determining the recovery status of functional disturbances.
2. Through the use of training sites, both manual and automated classification approaches can be used to make the disturbance classification repeatable and consistent.
3. The imagery purchased for this purpose will also have utility for other activities or management initiatives (e.g., access management planning, environmental assessment, etc.)
4. It may take a large amount of effort to create and define reliable inputs in order to conduct spatial modeling and estimate disturbance recovery. Even with an empirically-derived disturbance recovery model, the ability to accurately predict disturbance recovery may be limited.

Given the definition of functional disturbance and recovery, imagery with a minimum resolution of 1.5 metres would be required to interpret/classify the recovery status of the disturbances. It should also be noted that this same detailed satellite imagery would be a necessary input for spatial modeling. Therefore, the image interpretation approach to classifying disturbance recovery does not preclude spatial modeling at a later date, and the interpreted imagery purchased could be utilized as a key data input for spatial modeling.

Unless the level of land use activity increases substantially, the frequency of image re-interpretation is suggested to be approximately every 10 years. This activity could be conducted in support of the Plan Review.

3.2.1. North Yukon Ecological and Landscape Classification

It should also be recognized that a broad predictive ecosystem map was developed in support of the Plan. A generalized 90m digital elevation model was used to characterize slope position and topographic conditions. This was then combined with 30 metre resolution Landsat satellite imagery (EOSD) to create a generalized ecological and landscape classification (ELC) representing different ecological communities and site potentials. This product is available and could be used an in input to spatial modeling, or for other purposes such as developing a landscape stratification based on sensitivity in support of the access management planning initiative currently being contemplated.

3.3. Human Feature Mapping Standards

The human feature mapping classification (i.e., the name and definition of mapped features) used in North Yukon was created in 2005. The same classification was also used in the Peel Watershed Planning Region. Since this time, a number of human surface disturbance mapping exercises have been completed in different parts of Yukon, including the Dawson Planning Region, Freegold Road area, and the Whitehorse/Southern Lakes region. All of these human disturbance mapping exercises have applied a slightly different feature classification and used varying methods. In response, Environment Yukon has developed a version 1.0 Human Disturbance Mapping Standards and Guidelines document.

Recommendation:

When additional work is performed to update/determine the status of functional disturbance recovery in the North Yukon Planning Region, the human feature classes and definitions should be made consistent with the Environment Yukon version 1.0 Human Disturbance Mapping Standards and Guidelines. If it is found that some feature definitions or codes from the version 1.0 Standards and Guidelines require modification, or if new feature classes are required, these should be incorporated into a new version 2.0 Standards and Guidelines document. Ideally, such activities should be coordinated by a land use working group with the goal of developing a consistent human feature mapping database for most areas of Yukon.

3.4. Validating the Surface Disturbance Impact Hypothesis Model

As described above, the amount of direct human-caused disturbance is an underlying concept supporting the cumulative effects management strategies and Integrated Management Area zone definitions (IMA Zone I – IV) of the Plan. The surface disturbance and linear density cumulative effects indicators in the Plan provide a quantifiable measure of habitat impacts and landscape change. Habitat impacts may result in direct and indirect effects on wildlife. For Porcupine caribou, the key wildlife value in the region, this may include avoidance of human features, reduced use of areas around human features, changed travel patterns (i.e., utilizing the human features for travel), or increased mortality risk resulting from natural predators or people. Linear features were identified as being the highest management concern—while they result in relatively low direct habitat impacts, they facilitate human access and can potentially affect large areas through their associated indirect effects.

This impact model between human disturbance and Porcupine caribou was developed through literature reviews and discussions with various Plan Partners. However, additional input from Old Crow land users may improve our understanding of the relationship between human disturbance, habitat impacts, and wildlife in North Yukon.

Recommendation:

As part of ongoing Plan implementation activities, or as part of the Plan Review, **Old Crow land users should contribute to developing an improved understanding of the relationship between human disturbance, habitat impacts, and wildlife.** Special emphasis should be placed on linear features. Potential questions may include:

- Do caribou preferentially use or avoid linear features?
- Do wolves or other predators preferentially use or avoid linear features?
- Do caribou have a higher mortality risk on or near linear features?
- Do people preferentially use linear features?
- What factors contribute to the use of linear features by people?

4. REFERENCES

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