Current levels of accumulated surface disturbance in the range of a Yukon caribou herd are reaching critical levels

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Abstract

The progress of industrialization across the boreal forests of Canada has come at the expense of caribou (*Rangifer tarandus*). Northern Mountain Woodland Caribou herds in the Yukon are mostly stable, but pressures from disturbances resulting from expanding industrial activity are rising. We examined cumulative disturbances in the range of the Clear Creek Caribou Herd in central Yukon using the Yukon Environmental and Socio-Economic Assessment Boards online registry. We found that cumulative disturbances have likely reached the point of jeopardizing the future of the herd.

Introduction

Caribou (*Rangifer tarandus*) are an iconic species, deeply rooted in the cultural and ecological fabric of the North. The Yukon is home to three caribou ecotypes: barren-ground (*R. t. grantii*), boreal woodland (*R. t. caribou*), and northern mountain woodland (*R. t. caribou*) (Hegel and Russel 2013). Woodland caribou (boreal and northern mountain) are often considered an environmental indicator species because they are sensitive to disturbances and their health is considered to reflect that of the overall ecosystem (Environment and Climate Change Canada 2018). Woodland caribou are also an umbrella species as they have specific habitat requirements and their conservation has cascading effects, supporting populations of a variety of other species that depend on the same ecosystem (Environment and Climate Change Canada 2018).

In northern regions, surface disturbances associated with mining and mineral exploration make up the bulk of disturbances within caribou ranges. This is counter to patterns in southern regions where the main disturbance to caribou habitat is clear cut logging, a large but relatively concentrated disturbance (Lockhead et al. 2021). Surface disturbances alter habitat via changes to the successional stage of the landscape and a reduction in the availability of caribou forage (COSEWIC 2014). Surface disturbance also alter caribou behaviour including increased rates of predation and decreased ability to tolerate other stresses (Environment Canada 2012). The effects of habitat alterations and disturbances are exacerbated when combined with other stressors such as climate change (Johnson et al. 2020).

While disturbances throughout the entire habitat-disturbance complex are of concern, two types of areas are particularly disturbing due to their disproportionate influence on caribou activity. Caribou behaviour is altered in zones of influences (ZOIs), the area surrounding the direct footprint of the surface disturbances. These altered behaviours can include things such as

being more alert, feeding less, or avoiding the area altogether (Boulanger et al. 2021). Wildlife Key Areas (WKAs) facilitate critical seasonal and life functions (Environment Canada 2012) and have disproportionate value to the caribou (Department of Environment 2014). In the Yukon, publicly available WKAs are classified in three different levels: 1) points from wildlife surveys; 2) polygons reflecting animal locations; and 3) generalized ranges (Department of Environment 2014). Level 2 WKAs are further separated based on the life functions that they support. In the case of Northern Mountain Woodland Caribou (NMWC), these are a herd's winter and rutting ranges. Caribou's avoidance of disturbances changes with seasons and life stages (Polfus et al. 2011; Francis and Nishi 2016). Understanding the distribution of human-caused disturbances within WKAs is therefore critical in order to better evaluate threats that caribou face.

Disturbance Thresholds

Throughout Canada, thresholds of caribou's tolerance to disturbance have been identified using two metrics. For woodland and southern mountain caribou, official recovery strategies indicate that if 65% of habitat is undisturbed, populations have a 60% chance of persisting and being self-sustaining (Environment Canada 2014; Government of Canada 2018). Boreal caribou herds in Saskatchewan were identified to be self-sustaining if only 40% of the habitat remained undisturbed (Johnson et al. 2020).

The density of linear surface disturbances within a herds' range can also be used as a marker of population stability. For the À La Pêche herd in Alberta (a Southern Mountain Woodland Caribou herd), increases in cutblock or road densities by 0.07 km^2/km^2 or 120 m/km^2 respectively, are projected to result in a decline of the herd by at least 20% (COSEWIC 2014). Similarly, the density of barren-ground populations near Prudhoe Bay, Alaska, are demonstrated to decline with increasing road density. Road densities up to 0.3 km/km^2 reduced caribou density

by 63%, while road densities ranging from 0.6 - 0.9 km/ km^2 reduced caribou density by 86% (Nelleman and Cameron 1998). There are currently no established linear disturbance thresholds for NMWC populations in the Yukon.

The Yukon has 25 NMWC herds, including the Clear Creek Caribou Herd (CCCH). The CCCH annual range is within the traditional territories of the Tr'ondëk Hwëch'in and Na-Cho Nyak Dun First Nations and lies east of Dawson City, and northwest of Mayo. The two most recent herd surveys (2001 and 2018) indicate that the herd is either stable or slowly declining (O'Donoghue et al. 2001; Russel 2019). There is no official recovery strategy or disturbance threshold for NMWC (listed as *Special Concern* under SARA).

Caribou population concerns are typically addressed through recovery programs rather than pro-active or precautionary programs which seek to prevent the initial decline. This project was undertaken to investigate existing disturbances and to provide a rationale to take preventative measures in protecting this herd before dramatic recovery programs are warranted. This is a preliminary study assessing only publicly listed projects within the Territorial environmental assessment registry. The purpose of the study is to raise awareness of the ongoing threats to a caribou herd whose range is likely influenced by the significant mining and exploration activity in the area. We hypothesized that disturbances within the annual, rutting, and winter range of the CCCH have already surpassed sustainable levels, signifying population-wide threats to this herd. We predict that further investigations will confirm that disturbances and linear disturbances in the CCCH range have surpassed published thresholds.

Methods

To calculate area of surface disturbances, we used the online registry of the Yukon Environmental and Socio-Economic Assessment Board (YESAB, 2021). We used Environment Yukon's delineation of the CCCH annual range and considered all projects listed within the herd's range. Using the data from the YESAB land use projects, we summarized the details of the proposed disturbances for each project including roads (built and refurbished), trenches built, cut lines, helicopter pads, clearings, etc. (Appendix 1). From the Government of Yukon's WKA data, we used only Level 2 WKAs as they are more specific than the generalized Level 3 WKAs (Department of Environment 2014).

We aimed to calculate direct habitat loss as a result of (i) footprints of human disturbances and (ii) indirect habitat loss from ZOIs. Direct habitat loss was calculated using data directly from YESAB projects (*Direct habitat loss* = $\sum$ *area of individual disturbances in each application*). Indirect habitat loss involves far more variables; this preliminary investigation therefore had to make some assumptions to simplify the calculation of the amount of habitat effectively lost to caribou as a result of avoidance of disturbances. The evidence is unequivocal that caribou respond negatively to the zones around disturbances (avoidance behaviour), but the exact amount varies drastically depending on a number of variables. We therefore decided it was appropriate to work with a range of ZOIs, that is, a range of areas around the linear disturbances that caribou may avoid. Using values from literature and local studies (Francis and Nishi 2016) as our guide, we employed a lower ZOI bound of 0.250 km and a higher ZOI bound of 4 km. The higher ZOI is less than the maximum ZOI observed in the Klaza Caribou Herd Range Assessment (Francis and Nishi 2016), Alberta (James and Stuart-Smith 2000), and the Northwest Territories (Boulanger et al. 2021). However, given that not all YESAB projects are active and

most have seasonal closures, we determined that this reduced ZOI was appropriate. We therefore consider our estimations of ZOI to be conservative.

We calculated the area of each disturbance as follows. For Quartz mining, *direct* disturbance was calculated as the sum of the footprints for each disturbance (i.e., YESAB project). Placer mining applications tended to be less complete (e.g., rarely included the dimensions of the area used/disturbed, the roads built, previously existing roads, area of overburden removal and storage, etc.,), likely as a result of lower standards of thoroughness in placer mining land use applications. We therefore assumed, based on personal observations and informal inquiries that 75% of the area of each claim would be developed (i.e., disturbed).

For each disturbance type, *indirect* disturbance was calculated using the measurements proposed for linear disturbances in the YESAB application (length and width); to incorporate the ZOIs, we increased the width of the disturbance by both the lower ZOI and the upper ZOI. This resulted in lower and upper bounds of percent of area disturbed in the annual range and each WKA (rutting and winter ranges). Total disturbed area (km^2) was calculated as the sum of direct and indirect disturbances from quartz mining, placer mining, and transportation corridors, divided by total area of the annual range or WKA (Table 1). These were further separated based on type of disturbance (Quartz and Placer mining; Table 2).

We calculated the linear density of disturbances (km/km^2) by dividing the sum of linear disturbances in YESAB projects by the total area of the annual range or WKA. We used a conservative estimate of 0.1 km/km^2 as the maximum linear density threshold before the herd begins to avoid an area. We assessed our disturbance values relative to thresholds published for other populations of caribou. That is, we assumed that the CCCH required at least 65% of their range to remain undisturbed for them to persist unassisted.

For the purposes of this report, projects in the YESAB database were treated in a binary fashion: they were either inside or outside of the CCCH annual range and WKAs. Due to logistical constraints, we were unable to calculate the degree of overlap between a project and the CCCH annual range and WKAs; however, we note that this is an important step for future analyses (See *Discussion*). Similarly, we were not able to account for off-claim developments such as roads and trails that may pass through the annual range or WKAs. We only used Level 2 WKAs (winter and rutting ranges), but we note that post-calving areas are also considered WKAs for woodland caribou.

Results

We found that 13 - 112% of the CCCH annual range was directly or indirectly disturbed (Table 1). Linear feature density in the annual range was 0.27 km/km^2. Disturbance in the rutting and winter WKAs were 22 - 122% and 32 - 108% respectively, with corresponding linear densities of 0.24 km/km^2 and 0.2 km/km^2 (Table 1). Separated by disturbance type, placer mining disturbed less of the herd annual range (7.2 - 29%; linear density = 0.06 km/km^2) than quartz mining (5.1 - 81%; linear density = 0.2 km/km^2). Breakdown of disturbances in the annual range and the WKAs are found in Table 2.

Table 1. Lower and higher estimates of the percent area disturbed and linear density in the annual, rutting, and winter range of the Clear Creek Caribou Herd (CCCH), calculated using the Yukon Environmental and Socio-Economic Assessment Board (YESAB) online registry. Lower (0.25km) and upper (4km) bounds of Zones of Influence (ZOI) were applied to linear features reported in YESAB projects. See Appendix 1 for calculations; results have been rounded to the nearest whole percent or one tenth of a kilometer.

CCCH Range	Percent Area Disturbed (Lower bound)	Percent Area Disturbed (Higher bound)	Linear Density (km/km^2)
Annual Range	13%	112%	0.27
Rutting Range	22%	112%	0.24
Winter Range	32%	108%	0.20

Table 2. Breakdown of area disturbed and linear density by quartz and placer mining applications from the Yukon Environmental and Socio-Economic Assessment Board online registry in the herd, rutting, and winter range of the Clear Creek Caribou Herd. See Appendix 1 for calculations; results have been rounded to the nearest whole percent or one tenth of a kilometer.

CCCH Range	Mining Sector	Percent Area Disturbed (Lower bound)	Percent Area Disturbed (Higher bound)	Linear Density (km/km^2)
Annual Range	Quartz	5%	81%	0.20
	Placer	7%[1]	29%	0.06
Rutting Range	Quartz	21%	100%	0.21
	Placer	1%	10%	0.02
Winter Range	Quartz	26%	95%	0.19
	Placer	6%	13%	0.02

[1] Quartz and placer disturbances in Table 2 appear to be inconsistent with total disturbance in Table 1 because placer and quartz projects sometimes overlap.

Discussion

The objective of this project was to test the hypothesis that disturbances in the Clear Creek Caribou Herd annual range and Wildlife Key Areas have already exceeded disturbance thresholds outlined by various regional caribou recovery strategies. We used lower and upper bounds of Zones of Influence to reflect the variability in caribou behaviour of avoidance. Our findings indicate that the upper bound ZOI significantly exceeded disturbance thresholds. This suggests that current alterations to habitat via human-caused disturbances likely lead to significant avoidance of these features and further alterations to caribou behaviours. These results are especially concerning because the ZOIs employed here are likely conservative estimates.

The most recent population estimate for the CCCH in 2018 indicated that the herd was either stable or slowly decreasing (Russell 2019). Given that our results surpassed the suggested disturbance threshold prior to herd decline, our findings corroborate this pattern of decline. High linear densities such as the one identified for the CCCH (0.27km/km^2) are often indicative of increased predator access to the herd and increased hunting pressure (James and Stuart-Smith 2000). Conversely, if the degree of disturbance is closer to the lower bound of the ZOI, then the CCCH is less likely to experience significant population declines or avoidance behaviours because only 13% of the annual herd range is disturbed. We separated disturbances based on industries (placer and quartz mining). Placer mining had a larger impact in all ranges except the winter range, likely due to its relative intensity and concentration in the riparian zones of valleys.

Limitation in data collection

Due to the preliminary nature of this study, there were some logistical limitations that we could not avoid. However, we acknowledge them and urge that where possible, they be addressed in future studies.

1. By relying on projects in the YESAB database, we must assume that all applications are accurate. Many applications were missing dimensions for common features such as camps or helicopter pads. Off-claim features (e.g., access roads) were generally missing from the applications and therefore could not be considered. Due to the lack of publicly accessible inspection reports on permit compliance, there may be significantly more (or less) development than that considered here.
2. Some linear features (e.g., trails and cutlines <1.5 m wide) are not required to be included in the YESAB applications and therefore we have no way to include these in the present methods. Trails such as these can provide increased access to caribou for predators and/or hunters and therefore may be crucial in accurately predicting the health of the population.
3. We only accounted for disturbances proposed since the inception of the YESAB Online Registry in 2005. Human activity and habitat alterations have almost certainly taken place prior to 2005. Our data must therefore be seen as a conservative estimate, especially since many projects since 2005 state that they are expanding on existing features which were not included in the footprints reported in the YESAB projects.
4. We applied ZOIs to listed linear disturbances (dimensions provided in YESAB projects) but not to footprints of area disturbances because there were no dimensions provided. This likely means that ZOIs were under-accounted for and that our calculations underestimate the area influenced.

5. We were limited by the mapping technology available and projects were therefore assessed visually. We could not account for overlap between WKAs or features intermittently passing through the herd range or WKAs.

Follow-Up Studies

Following from our results and the data limitations discussed above, we have identified the following research or knowledge gaps which, if filled, would significantly further our understanding of the relationship between caribou populations and human disturbances in the Yukon.

1. Compare area measurements extrapolated from YESAB projects to existing satellite imagery to investigate the validity of applications and to further verify methods used here.
2. Use existing satellite collar data for caribou to map their movements relative to existing disturbances to identify which features are being avoided more or less regularly. This knowledge can be useful for planning disturbances with a goal of avoiding certain features or WKAs.
3. Similar studies should be conducted for other caribou herds, specifically those without recent population censuses or those facing new or increased human disturbances. We propose the Finlayson and Klaza herds as initial candidates given the pressures these herds face from planned large mines and their associated exploration.

References

Boulanger, J., Poole, K.G., Gunn, A., Adamczewski, J., and Wierzchowski, J. 2021. Estimation of trends in zone of influence of mine sites on barren-ground caribou populations in the Northwest Territories, Canada, using new methods. *Wildlife Biology* 2021:wlb.00719. doi:10.2981/wlb.00719.

COSEWIC. 2014. COSEWIC assessment and status report on the Caribou Rangifer tarandus, Northern Mountain population, Central Mountain population and Southern Mountain population in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxii + 113 pp. (Species at Risk Public Registry).

Department of Environment, Government of Yukon. Yukon Wildlife Key Area Inventory User's Manual. [Online] April 2014. ftp://ftp.geomaticsyukon.ca/GeoYukon/Metadata/Wildlife_Key_Areas_250K_Manual.pdf+&cd=3&hl=en&ct=clnk&gl=ca.

Environment and Climate Change Canada. 2018. Action Plan for the Woodland Caribou (Rangifer tarandus caribou), Boreal Population, in Canada – Federal Actions. Species at Risk Act Action Plan Series. Environment and Climate Change Canada, Ottawa. vii + 28 pp.

Environment Canada. 2012 Management Plan for the Northern Mountain Population of Woodland Caribou (Rangifer tarandus caribou) in Canada. Species at Risk Act Management Plan Series. Environment Canada, Ottawa. vii + 79 pp.

Environment Canada. 2014. Recovery Strategy for the Woodland Caribou, Southern Mountain population (*Rangifer tarandus caribou*) in Canada. Species at Risk Act Recovery Strategy Series. Environment Canada, Ottawa. viii + 103 pp.

Francis, S., and Nishi, J. 2016. A range assessment for the Klaza caribou herd in the Dawson range of west-central Yukon. Prepared for Environment Yukon. Yukon Fish and Wildlife Branch Report MRC-16-01, Whitehorse, Yukon, Canada.

Hegel, T. M. and Russell, K. 2013. Status of northern mountain caribou (*Rangifer tarandus caribou*) in Yukon, Canada. Rangifer Spec. Iss. 21: 59–70.

James, A.R.C., and Stuart-Smith, K.A. 2000. Distribution of caribou and wolves in relation to linear corridors. *Journal of Wildlife Management* 64(1): 154-159.

Johnson, C.A., Sutherland, G.D., Neave, E., Leblond, M., Kirby, P., Superbie, C., and McLoughlin, P.D. 2020. Science to inform policy: Linking population dynamics to habitat for a threatened species in Canada. *Journal of Applied Zoology* 57(7): 1314-1327. https://doi.org/10.1111/1365-2664.13637.

Lochhead, K. D., Kleynhans, E. J., and Muhly, T. B. 2021. Linking woodland caribou abundance to forestry disturbance in southern British Columbia, Canada. Journal of Wildlife Management 1– 20. https://doi.org/10.1002/jwmg.22149

Nellemann, C., and Cameron, R.D. 1998. Cumulative impacts of an evolving oil-field complex on the distribution of calving caribou. Canadian Journal of Zoology 76(8).

O'Donoghue, M., Farnell, R., Fraser, V., and Larberge, L. 2001. Clear Creek Caribou Herd: Summary of March 2001 Survey. Yukon Fish and Wildlife Branch, Department of Renewable Resources. Mayo, YT.

Polfus, J.L., Hebblewhite, M., and Heinemeyer, K. 2011. Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou. *Biological Conservation* 144: 2637-2646.

Russell, K. 2019. Internal Memorandum *Re:* Updated population estimate for the Clear Creek caribou herd – 2018. Government of Yukon.

YESAB 2021. Yukon Environmental and Socio-economic Assessment Board. www.yesab.ca.