HABITAT CONSERVATION TRUST FOUNDATION

# Caribou Habitat Restoration Fund

## Project Monitoring Guidance

For 2021-22 Cycle

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Cover photo: Upper Bigmouth restoration site (submitted by Cory Bird)

# CHRF Project Monitoring Guidance

## Purpose of this Document

The Caribou Habitat Restoration Fund is a component of the province's Caribou Recovery Program. The primary purpose of the Caribou Habitat Restoration Fund (CHRF) is to fund on-the-ground habitat restoration work for caribou resulting from anthropogenic actions. Monitoring is an important component of the program. Both HCTF and the Province of BC want to collect information that can be used to evaluate effectiveness of treatment. This Monitoring Guide will help project proponents develop a monitoring program to enable this evaluation.

For individual CHRF projects, this effectiveness assessment is to be focused on the site or treatment scale. The monitoring plan for your project should be designed to evaluate whether the treatments you used were successful in achieving the site-level outcomes you identified in your proposal. For example, has the vegetation you planted reached a height/density considered to deter predator movement rather than a larger strategic question of "is there decreased predation on caribou as a result of the treatment"? By collecting standardized information on the work you are doing, the program will be able to consolidate it and contribute to answering some larger questions about the effects of habitat restoration on caribou populations.

This guide provides suggestions for selecting monitoring methods to evaluate the effectiveness of treatment to achieving your restoration goal. We understand that all restoration sites are unique and your monitoring plan may not completely align with the recommendations in this guide. If so, be sure to provide a rationale for these differences in your application.

A few things to keep in mind:

- In order to maximize the amount of work we can fund for caribou, project leaders should select methods that will provide the necessary information at the least cost.
- Project leaders should also be mindful that the methods they select will not require re-disturbing treatments designed to decreased access.
- As your application for CHRF funding can cover a 5-year time period, we suggest that you use the recommended timelines in this guide to create a monitoring plan that will fit within that 5-year project timeframe.

As this is the first iteration of this document, we hope to add to it and improve upon it in future years. Feedback and suggestions can be emailed to Shannon West at **shannon.west@hctf.ca** . Updated versions of this document will be made available at https://hctf.ca/grants/caribou-habitat-restoration-grants/

## Background

Human-caused disturbances can negatively impact populations of woodland caribou through a number of mechanisms, including direct habitat loss and facilitating an increase in predation. Identifying these mechanisms can help to set goals for a particular restoration project and these goals, in turn, can be used to monitor the short-term and long-term effectiveness of the restoration project.

The type of human-caused disturbance can influence how it affects caribou. Human-caused disturbances can be broadly classified into two categories: linear and polygonal. Linear disturbances such as roads, seismic lines and pipelines are thought to change the movement behaviour of predators (e.g., wolves and bears), leading to increased predation of caribou by increasing caribou-predator encounters. These behavioural changes include increasing predator movement speed and directing predators into caribou habitat. Linear disturbances may also increase human use of caribou habitat, which may displace caribou from preferred areas. Polygonal disturbances such as cutblocks and well pads are thought to negatively impact caribou by mechanisms that are more food-based. These disturbances increase preferred forage for other ungulate species (e.g., moose and deer), leading to an increase in their numbers, which in turn can result in an increase of predators. These abundance changes result in more caribou-predator encounters. Also, because caribou generally avoid areas used by other ungulate species and predators, both polygonal and linear disturbances can result in a functional loss of habitat for caribou.

## Restoration Goals

Using the mechanisms linking habitat disturbances to caribou population declines, three restoration goals can be broadly defined:

1. Reduce caribou-predator encounters by changing predator movement behaviour
    a. Reduce predator movement efficiency along the feature
    b. Reduce predator use of the feature
2. Reduce human access to reduce disturbance to caribou
3. Increase habitat intactness and quality to a state where it supports sustained use by caribou (and lowers use by other ungulates)

Achieving these goals can be accomplished by techniques that focus on functional and/or ecological restoration. Functional restoration refers to techniques that focus on rapidly disrupting the mechanism(s) contributing to caribou declines but may not result in an area being restored to its pre-disturbance state. This type of restoration is primarily used to achieve Goal 1 and 2. For linear disturbances, examples of functional restoration include physical barriers (fences or berms) and vegetation barriers (felled trees and hinged trees). Ecological restoration, in contrast, aims to structurally restore areas to their previous, undisturbed state or towards a desired future condition. Methods for ecologically restoring linear features include tree planting and soil mounding. Ecological restoration is primarily used to achieve Goal 3, but the long-term recovery of a site to its pre-disturbance state can result in Goals 1 and 2 also being achieved.

## Treatment Information

Collecting standardized information on the implementation of restoration treatments can be used to inform future restoration efforts. Treatment information should include the categories listed below (also shown in Table 1); however, depending on the project and its objectives, additional information may be necessary.

i. Restoration Method
   - Functional or ecological restoration

ii. Treatment Type
   - Brief description of the treatment type(s) used

iii. Timing of Treatment Deployment
   - The date(s) of treatment deployments

iv. Site Preparation
   - Brief description of methods to prepare the site prior to treatment deployment (may not be applicable for some projects)

v. Tree and/or Shrub Species
   - List all tree and shrub species used in restoration

vi. Treatment Intensity
   - Describe the intensity of treatment. For functional restoration, this could include the number of trees felled or hinged over a given distance. For ecological restoration, this could be the stocking rate.

vii. Length
   - The length of the treated area. This could include the total length of treatments, the length of treatment at each site, and/or the spacing of treatments (if gaps are left)

viii. Width
   - The width of the treated area

ix. Average Height
   - The average height of the treatment applied in the treated area. For functional restoration, this can be the average height of the physical barrier. For ecological restoration, this can be the average height of transplanted vegetation.

**Table 1**: Examples of required basic information describing deployed restoration treatments

| Restoration Method | Treatment Type | Timing of Treatment Deployment | Site Preparation | Tree / Shrub Species | Treatment Intensity | Length* | Width | Average Height |
|---|---|---|---|---|---|---|---|---|
| Functional | tree-hinging | April | none | black spruce, paper birch | 30 stems / 100 m | 200 m | 5-7 m | 1.25 m |
| Ecological | tree planting | May | mounding | black spruce | 1500 stems / ha | 1 km | 5-7 m | 25 cm |

*Specify whether the listed length is of a sample unit or the entire project

## Monitoring Framework and Information

The role of monitoring is to determine if a project has been successful in achieving one or more of the above restoration goals; consequently, proponents should clearly link monitoring metrics to one or more of these goals. Because of its importance, monitoring should be an integral component to the project's overall design. When developing an appropriate monitoring approach, proponents should consider:

i. The project's goals and objectives
ii. Identifying what to monitor (the monitoring metric(s))
iii. The spatial scale at which a response is expected. As noted in the introduction, proponents are expected to monitor the response at the site scale.
iv. When a response is expected (i.e., temporal scale)
v. How long to monitor
vi. Logistical feasibility of the monitoring program
vii. Long-term costs

These considerations should inform the project's study design, the data that will be collected and how the data will be analyzed.

### *Study Design and Statistical Considerations*

Developing robust inferences on a project's outcomes inherently depends on the project's study design and the statistical approaches used to analyze the monitoring data. Proponents should provide rationale for their choice of design and statistical analyses. Below are some general guidelines and recommendations to consider when developing a monitoring framework:

i. Before-after-control-impact (BACI) designs[1] generally provide the strongest inferences
    - BACI designs involve randomly assigning sample units (see #2 below) to treatment and reference (or "control") groups prior to treatment deployments. Reference groups allow for the control of environmental effects (e.g., annual weather changes) that may confound interpreting treatment effects
    - Treatment and control units should be similar in their environmental attributes (e.g., land-cover type) to further isolate treatment effects
    - Both groups are monitored before and after treatment deployment
    - The BACI approach allows for multiple lines of evidence to evaluate treatment effects (before-after comparisons and treatment-control comparisons)
    - For ecological restoration projects at a single site, a before-after design may be sufficient, particularly if only vegetation growth is monitored

ii. Clearly define sample units
    - The size and shape of sample units should be biologically relevant and/or have relevance from a management perspective.

iii. Sample units should be independent

- Sample units need to be independent to avoid pseudo-replication. For example, if the response metric is wolf use of a linear feature, remote cameras placed 250-m apart on the same line cannot be considered independent because a wolf captured on one camera will have a high probability of being captured on the other camera. Proponents should provide rationale as to how sample units are independent from each other.

iv. Consider power analyses to determine appropriate sample size(s)

- Power is the probability of detecting a treatment effect, given that the effect truly exists
- General recommendation is to have power be ≥0.80, meaning there is an 80% probability of detecting a statistically significant effect, given that the effect truly exists
- The type of power analysis depends on the study design and the statistical framework for analyzing the data (see next point)
- For BACI designs, power analyses can provide sample size estimates for treatment and control groups

v. Consider using the simplest statistical analyses to achieve the monitoring objective

- For BACI designs, t-tests and/or chi-square tests may be sufficient for evaluating treatment effects
- For remote camera studies, more sophisticated statistical techniques may be required to account for low rates of occurrence and/or a high number of sites where the focal species never occurred (e.g., zero-inflated regression models)
- If predator use is the response metric, occurrence or occupancy modelling may be required. See Tattersall et al.[2] and Steenweg et al.[3] for examples.

vi. Notes on remote cameras

- Project teams should carefully consider whether remote cameras provide the most efficient way of monitoring effectiveness of treatment compared to other techniques. Although cameras are increasingly being used in wildlife studies, for species such as wolves that are relatively rare, rates of occurrence at a given camera will be low (e.g. 1 occurrence per 300 days [4]). These low rates of occurrence will require large sample sizes of cameras (e.g., >40 cameras) with long monitoring times (e.g. >1 year) to robustly evaluate for treatment effects. See Steenweg et al.[3] for further information on conducting power analyses for camera studies. Alternatively, see DeMars and Benesh [5] for a remote camera design that uses independent tests rather than occurrence as the response metric.
- Cameras should be serviced in the spring (after snowmelt) and fall to ensure sufficient battery coverage during the snow-free season when predator use of linear features is highest and to avoid leaving compacted snow trails which may facilitate predator use of caribou habitat.
- To prevent damage and theft, consider using camera locks in areas used by the public.

In the following tables, examples of monitoring techniques to achieve each of the three restoration goals are presented. For each goal, the techniques are ordered from easiest to most challenging in terms of their implementation. Potential advantages and disadvantages for each technique are listed along with general considerations for study design and statistical analysis. Note that these considerations are necessarily general because projects will vary in their objective/goals, the response metric monitored, logistical feasibility and costs.

## Restoration Goal 1a: Reduce predator movement efficiency along the feature

**Table 2:** Examples of monitoring techniques to evaluate effectiveness of restoration treatments in reducing predator movement efficiency

| Monitoring Technique | Purpose | Required Monitoring Data | Suggested Monitoring Frequency | Advantages | Disadvantages | Study Design and Statistical Considerations |
|---|---|---|---|---|---|---|
| **Vegetation height and cover surveys** | Proxy of predator movement speed<br>• Requires vegetation or barrier heights on the feature(s) to be >0.50 m, on average—see Dickie et al.[6] | Average vegetation or barrier height (in meters) and vegetation or barrier density on restored feature | For functional restoration projects, monitoring should be done on a yearly basis to assess changes in the physical barrier over time<br><br>For ecological restoration (e.g., tree-planting), monitoring can be done at Year 2 and Year 5 to assess vegetation recovery/growth | Conceptually simple as it requires measuring vegetation heights and cover (or density) within sample plots | Changes in predator movement speed have been correlated with vegetation height but not with vegetation density (though height and density are often correlated) | Does not require before-after or treatment-control comparisons (unless comparing effects of different treatment methods on vegetation growth) |
| | | | | | | |
| **Movement trials using dogs** | Proxy of predator movement speed | Estimated movement speed of dog on and off the feature (can also consider measurements before and after treatments)<br><br>Speed should be calculated over a distance of at least 100-m | For functional restoration projects, monitoring should be done on a yearly basis to assess changes in the physical barrier over time<br><br>For ecological restoration (e.g., tree-planting), monitoring can be done at Year 2 and Year 5 to assess vegetation recovery/growth | Conceptually simple: time taken over a fixed distance | Unknown how dog movement behaviour correlates to the movement behaviour of wolves or other predators | Sample multiple sites within treatment and control areas (but keep distance travelled fixed for each sample) |
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| **Remote cameras** | Monitor changes in predator movement speed | Estimated movement speed of predators on the feature before and after restoration (see Study Design and Statistical Considerations column for information on camera spacing) | Cameras provide continuous sampling; however, cameras should be serviced and data collected twice per year | Conceptually simple: time between photos taken on successive cameras / distance between cameras = movement speed | Requires recognition of individual animals<br><br>Requires the same animal to be captured on successive cameras (may be rare if restoration also limits use of feature)<br><br>Low rates of occurrence may limit sample size | May require extensive monitoring (e.g. >1 year) if predator use of feature(s) is rare, which may be an expected outcome if treatments also limit predator use of the feature(s)<br><br>Camera spacing at a site needs to be short enough to capture the same animal on the feature (because animals might use the feature for short distances), but long enough to robustly compared differences in movement speed |

## Restoration Goal 1b: Reduce predator use of the feature

**Table 3**: Examples of monitoring techniques to evaluate effectiveness of restoration treatments for reducing predator use of selected features

| Monitoring Technique | Purpose | Required Monitoring Data | Suggested Monitoring Frequency | Advantages | Disadvantages | Study Design and Statistical Considerations |
|---|---|---|---|---|---|---|
| **Vegetation height and cover surveys** | Proxy of predator use of a given feature<br>• Requires vegetation heights on the feature(s) to be >3.0 m, on average—see Dickie et al.[6] | Average vegetation height (in meters) and vegetation or barrier density on restored feature | For ecological restoration (e.g., tree-planting), monitoring can be done at Year 2 and Year 5 to assess vegetation recovery/growth<br><br>[Note: functional restoration is unlikely to be used for creating barriers >3.0 in height] | Conceptually simple as it requires measuring vegetation heights and cover (or density) within sample plots | Changes in wolf use of linear features have been correlated with vegetation height but not with vegetation density (though height and density are often correlated)<br><br>Correlations between predator use and vegetation height are unknown for polygon features<br><br>Correlations between vegetation height and use are unknown for other predators (e.g., bears) | Does not require before-after or treatment-control comparisons (unless comparing effects of different treatment methods on vegetation growth) |
| | | | | | | |
| **Natural sign and track surveys** | Monitor changes in predator use | Natural sign and track data collected from line transects or track stations—see Long et al. [7] for a discussion of potential methods and survey designs | Monitoring frequency will depend on the survey design and objectives—see Long et al. [7] for a discussion of potential methods and survey designs | Low cost<br><br>Relatively easy to incorporate community involvement | Useful for detection (presence / absence) and occupancy<br><br>Less reliable for estimating relative abundance because of unknown relationships between sign/track abundance and species abundance | Allowing sufficient time for sign/track accumulation is critical to study design (for snow, we recommend 3-4 days after a track-obliterating snowfall event)<br><br>If relative use is the objective, a minimum distance threshold between detections should be set to limit |

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| | | | | | Potential ambiguity in species identification<br>If estimating occupancy or relative use, repeated site visits will be required, which may be costly<br><br>Ability to detect tracks may be impacted by weather conditions<br><br>Scat surveys can also be impacted by decomposition rates, which can vary with weather and by season and site conditions | repeat counting of individuals (threshold can be based on estimated daily movement rate)<br><br>Occupancy and relative use studies critically depend on defining what constitutes a sample unit and the monitoring interval between site visits (consider power analyses and simulation analyses to determine appropriate sample unit size and monitoring interval) |
| | | | | | | |
| **Remote cameras** | Monitor changes in predator use | Depends on study design but may include:<br>• Rate of occurrence (i.e., no. of pictures per day)<br>• Occupancy (detected/no detected in a defined interval)<br><br>See Burton et al. [8] for a discussion of camera survey designs and recommendations | Cameras provide continuous sampling; however, cameras should be serviced and data collected twice per year | Can use multiple statistical approaches including occurrence rate (i.e., no. of pictures per day), occupancy (presence/absence within a defined interval), or independent tests | Low rates of occurrence by focal species may impact ability to assess for statistical differences<br><br>May require a high number of cameras, which increases costs | If the monitored response is occurrence rate or occupancy, low rates of occurrence will require a large sample size of cameras (e.g. >40 cameras)<br><br>Occupancy studies critically depend on independence among cameras and defining an appropriate interval between site visits (consider power analyses and simulation analyses to define the monitoring interval)<br><br>An approach using independent tests can remove 'time' from statistical analyses, |

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| | | | | | | though extensive monitoring time (e.g. >1 year) may still be required to attain a sufficient sample size of tests. See DeMars and Benesh[5] for an example. |

## Restoration Goal 2: Reduce human access to reduce disturbance to caribou

**Table 4:** Examples of monitoring techniques to evaluate effectiveness of restoration treatments in reducing human access to caribou habitat

| Monitoring Technique | Purpose | Required Monitoring Data | Suggested Monitoring Frequency | Advantages | Disadvantages | Study Design and Statistical Considerations |
|---|---|---|---|---|---|---|
| **Questionnaire survey** | Monitor changes in human use | Questionnaire data and summaries | Before and after treatment deployment<br><br>Depending on target group(s), allow at least one full season to transpire after treatment deployment before re-surveying | Low cost | Potential low response rate<br><br>Respondents may be biased or have a hidden agenda<br><br>Respondents may be reluctant to be surveyed on multiple occasions (may be required for before-after comparisons) | Identify mode of survey (telephone, mail, online, etc.)<br><br>Identify target group(s), e.g. snowmobile clubs, hunting organizations, backcountry ski operators<br><br>Use simple, direct questions that clearly answer the project's objectives |
| | | | | | | |
| **Track surveys (e.g., footprints, tire tracks)** | Monitor changes in human use | Track data collected from line transects or track stations—see Long et al. [7] for a discussion of potential methods and survey designs | Monitoring frequency will depend on the survey design and objectives—see Long et al. [7] for a discussion of potential methods and survey designs | Low cost | Useful for detection (presence / absence) and occupancy but limited effectiveness in estimating rate of use (e.g., few tests assessing track abundance and relative use)<br><br>If estimating occupancy, will require repeated site visits, which may be costly<br><br>Ability to detect tracks may be impacted by weather conditions | If done in the snow-free season, may require the set-up and maintenance of a track plot<br>Allowing sufficient time for sign/track accumulation is critical to study design (time will be dependent on estimated use of feature) |
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| **Remote cameras** | Human use | Depends on study design but may include:<br>• Rate of occurrence (i.e., no. of pictures per day)<br>• Occupancy (detected/no detected in a defined interval)<br><br>See Burton et al. [8] for a discussion of camera survey designs and recommendations | Cameras provide continuous sampling; however, cameras should be serviced and data collected twice per year | Can use multiple statistical approaches including occurrence rate (i.e., no. of pictures per day) and occupancy (presence/absence within a defined interval) | Public should be advised that the area is monitored by remote cameras, which may lead to an increase in camera damage and/or theft<br><br>If occurrence rates are low, may require a high number of cameras to detect a change in use | Power analyses should be conducted to determine the number of cameras to detect expected change in use<br><br>See Burton et al.[8] for a review of potential study designs |

## Restoration Goal 3: Increase habitat intactness and quality to a state where it supports sustained use by caribou

**Table 5**: Examples of monitoring techniques to evaluate effectiveness of ecologically restoring areas to functional caribou habitat

| Monitoring Technique | Purpose | Required Monitoring Data | Suggested Monitoring Frequency | Advantages | Disadvantages | Study Design and Statistical Considerations |
|---|---|---|---|---|---|---|
| **Vegetation surveys** | Monitor vegetation growth and recovery | Vegetation height and density; survival assessment; establishment survey | In Alberta, provincial recommendations for monitoring restoration of seismic lines suggests that survival assessments be performed 2-4 years after transplanting or 3-5 years after seeding and establishment surveys be conducted after 8-10 years | Tracks vegetation recovery to ensure the trajectory is moving toward functional caribou habitat<br><br>Control-treatment comparisons can help optimize restoration techniques | Labour intensive if ground-based sampling plots are used<br><br>Requires long-term monitoring (e.g. >10 years) to track return to functional caribou habitat | Consider a stratified sampling design to account for different land-cover types, soli type and moisture regimes |
| | | | | | | |
| **Lichen surveys** | Monitor lichen growth and recovery | Lichen % cover and/or biomass<br><br>Percent cover can be visually estimated in sample plots, which can placed systematically along line transects. See Dunford et al.[9] for an example<br><br>Biomass can be modelled by regressing the weight of clipped subsamples against height. See Dunford et al.[9] for an example | Survival and % cover assessments should be performed at 2 and 5 years<br><br>Slow growth of lichens (3-6 mm per year; Duncan et al. [10]) requires long-term monitoring | Low cost<br><br>May not require control areas if the objective is simply to monitor survival and growth over time | Requires long-term monitoring (e.g. >40 years) to track return to functional caribou habitat | Requires careful consideration of site selection (e.g. soil type and moisture regimes) and site preparation—see Duncan et al.[10] |

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