Alberta Wilderness Association

BIGHORN BACKCOUNTRY REPORT

OHV use in the Bighorn

ABSTRACT

Results of the 15 years of research and monitoring of trails in the Bighorn.

Alberta Wilderness Association

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AWA is grateful for the many individuals, foundations and corporations who have been instrumental in this project. Throughout the fifteen-year (2004 – 2019) span of Alberta Wilderness Association's on-the-ground research and monitoring in the Bighorn several individual donors, corporations and supporters have helped. From equipment donations, sponsorship and the most valuable of gifts - personal time - this project has benefited from grassroots support and a belief in AWA's vision that inspires people to care.

AWA is particularly grateful for the support we receive from TRAFx Research Ltd. for our on-the-ground monitoring work in the Bighorn. Since 2004, AWA has successfully used TRAFx vehicle counters to monitor motorized vehicle traffic levels in our study area. Learn more about the TRAFx Vehicle and Off-Highway Vehicle Counters at http://www.trafx.net/.

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EXECUTIVE SUMMARY

Since the 1970s, when the Bighorn Backcountry (also known as the Bighorn Wildland) was identified as a provincially significant wilderness area, management priorities have focused on watershed protection, wildlife habitat conservation, and dispersed non-motorized recreation activities. Alberta Wilderness Association (AWA) has actively supported these priorities and, for nearly 50 years, has sought protected area designation for the Bighorn area.

In 2002, through the *Bighorn Backcountry Access Management Plan* (AMP), the then-Alberta Ministry of Sustainable Resource Development (SRD) formally permitted motorized recreation of Off-Highway Vehicles (OHVs) in areas where these activities were previously not allowed.

Research in other areas suggests that unregulated use of an area by OHVs over the long term negatively affects water quality, vegetation, historical trails, and wildlife. Such activities may also drive away many non-motorized recreationists from the same trails.

In this document we evaluate management success in the Bighorn Backcountry seventeen years after the implementation of the AMP. “Success” here is defined by how well current management guidelines and enforcement of those guidelines protect “sensitive resources such as fish and wildlife habitats, vegetation, soils and watersheds” (SRD 2002; 10) from serious damage caused by OHV use.

The Government of Alberta (GoA) divides the Bighorn Backcountry into six Public Land Use Zones (PLUZs). Starting in 2004, AWA embarked on a monitoring study focusing on the 76 km network of trails designated for motorized and non-motorized use in the Upper Clearwater/Ram PLUZ (**Figure 1**) where we evaluated management success in the context of:

1. The impacts of OHVs on and around trails; and,
2. The illegal use of trails by OHVs.

This study encompassed two components:

1. A 13-year observational survey where the trails were walked, and records made of impacts on the landscape from OHV use; and
2. A 15-year traffic count where vehicle counters embedded next to the trails recorded levels of OHV traffic, both when trails were open and when closed to OHV use.

Key Findings

1. **Trail damage has increased significantly.** Between 2012 and 2017, 344 observations of trail damage, including rutting, widening, erosion, braiding, and secondary trails, were recorded in the focus area. This is a 247 percent increase, on the equivalent 2003-2008 period. In addition, damage was exacerbated during extremely wet conditions, and the ad hoc reconstruction and rebuilding did little to repair the recorded damage sites and in many cases appear to have caused additional damage.

2. **Water bodies were not adequately protected.** We documented 46 instances where a trail water crossed a stream or other water body, throughout the trail network in 2017, the last year of monitoring. Only 13% of these had a bridge or some other form of crossing structure in place.

3. **The particular topography, soil types, and plant communities found in the Bighorn are unable to support intensive motorized recreation.** The extreme trail erosion observed throughout the monitoring period, particularly after high rainfall events and ad hoc reconstruction, confirmed that motorized recreation is incompatible with protection of the pristine wilderness values of the Bighorn Backcountry.

4. **Illegal use of trails was detected consistently.** Our observations clearly show that although there is some reduction in OHV traffic when a trail is closed, many OHV drivers regularly broke the rules in the following ways:

    - Trails were still used by OHVs even when the trails were closed or when out of the designated season, and
    - OHVs were regularly driven in areas that were not designated trails.

    It is clear to us that:

    - Education of OHV drivers on designated trail rules is not effective, and
    - The enforcement of those rules is not adequate.

5. **Protection of ecological values in the Bighorn is the top management priority of Albertans.** Albertans consistently rank healthy environment and ecosystems as the number one priority for land use planning (SRD 2007, Advanis 2019).

Recommendations

These findings suggest current access management in the Bighorn Backcountry is not adequate in protecting the environment from degradation caused by OHV use. The main reasons are:

1) enforcement of PLUZ regulations is inadequate and not sufficient to reduce the amount of illegal activity on trails, and

2) current levels of recreational OHV activity are causing severe environmental degradation,

With an increasing population in Alberta these problems will likely grow in the future.

Changes to current access management practices and PLUZ regulations in the Bighorn Backcountry could improve the GoA's ability to meet the environmental objectives of the PLUZ and its obligation to protect the ecological values of this landscape. We recommend the following actions be taken:

1. **Restrict motorized recreation in the Prime Protection Zone to trails that can support it.**

2. **Increase enforcement in backcountry areas, including substantial fines for illegal activities, especially OHV riding during closure periods and riding on areas that are not designated trails.**

3. **Ensure that all non-designated (i.e.: illegal) trails are physically blocked and signed at the junction, with language indicating that motorized users proceeding off the trail are in violation of PLUZ regulations.**

4. **Ensure that amateur stewardship efforts to repair damaged trail sections are overseen by professional engineering and construction personnel.**

5. **Address water quality and fisheries objectives by improving water crossings on designated trails through the construction of bridges for permanent streams and hardened fords for ephemeral streams.**
6. **Increase management response to changing trail conditions by closing flooded and damaged trail sections until repairs have been made or the area has naturally regenerated.**
7. **Site and design trails appropriately and enforce a three-metre designated trail width.**

CONTENTS

INTRODUCTION

The Bighorn Wildland (Bighorn) is a large wilderness area within the Rocky Mountains and Foothills of Alberta, nestled in a gap between Banff and Jasper National Parks (**Figure 1**). This intact wilderness forms an important piece of Alberta's Eastern Slopes and retains its ecological integrity largely due to the absence of roads and industrialized access. The area is now managed under the regulations of six Public Land Use Zones originally put in place by the implementation of the 2002 *Bighorn Backcountry Access Management Plan* (SRD 2002).

In this report we evaluate management success in the Bighorn's Clearwater/Ram PLUZ eighteen years after the implementation of the Government of Alberta's Access Management Plan (AMP). "Success" here is defined by how well current management guidelines designate and enforce appropriate recreational use, to protect "sensitive resources such as fish and wildlife habitats, vegetation, soils and watersheds" (SRD 2002; 10) from serious damage caused by OHV use.

The Bighorn Wildland

Since the 1970s the Bighorn has been identified as a provincially significant wilderness area. The region comprises important headwaters habitat; almost 90 percent of the water flow of the North Saskatchewan River originates in the region, primarily supplied by a network of gravel-bed river floodplains. These gravel-bed floodplains extend far beyond the riverbanks, moving and changing channels frequently.

Described as the "ecological nexus" of mountain landscapes, gravel-bed river floodplains support critical habitat for native fish, bird diversity, aquatic insects, amphibians, and various flora communities. They are also important wildlife migratory corridors. Given its suite of ecological features and services, the Bighorn is an important source of water and refuge for aquatic and terrestrial species in the face of climate change.

Conservation Issues in the Bighorn

The landscapes of the Bighorn are composed of public lands that have remained largely free of roads and industrial development primarily due to *A Policy for Resource Management of the Eastern Slopes*, which indicated that the protection of watersheds, native vegetation, and wildlife habitat were the top management priorities for this area. The Bighorn was slated for protection by the provincial government in 1986 and again in 2019, but both times these designations never enacted.

In 2002, the Bighorn was placed under new access management regulations through the designation of the six Forest Land Use Zones – later renamed Public Land Use Zones (PLUZs). These regulations enabled the GoA to legally designate recreational trails for specific uses and seasons. The GoA also publicized access to the Bighorn area with an annually updated map, brochure, and website, and officially permitted motorized access on designated trails in areas where these activities were previously not allowed.

Research in other study areas suggests that unregulated use of an area by OHVs over the long-term negatively affects water quality, vegetation, historical trails, and wildlife.

Monitoring Recreational Activity in the Bighorn

In 2002 Alberta Sustainable Resource Development (SRD) was responsible for the management of the Bighorn and it recognized that mixed recreational use of the area will be a challenge for the task of protecting sensitive resources (SRD 2002b).

Concerned about these challenges, in 2003 AWA planned the ***Bighorn Wildland Recreational Trail Monitoring Program*** **(BWRMP)**, a five-year program to monitor OHV and other recreational activities. We aimed to assess how well the new PLUZ regulations protect the sensitive ecosystem of the Bighorn.

Over time, the original five-year time span was extended to fifteen years. During this time, three interim reports were produced, in 2006, 2008 and 2012 (AWA 2006, AWA 2008, AWA 2012). This comprehensive final report summarizes the three earlier studies and presents the findings and results of the BWRMP throughout the entire study period from 2004 to 2019. This report evaluates the impacts of a designated OHV trail system and its success in the context of the objectives laid out in the 2002 Access Management Plan.

AWA believes that access management regulations can be improved through monitoring studies that address changes to environmental conditions. The purposes of this report are to:

- provide complementary data and analysis to government agencies responsible for access management decisions in the Bighorn;
- compare the 2017, (when monitoring ended) health of the trail network against baseline data to identify recreational impacts on the environment and landscape; and
- report on the observed levels of motorized traffic and on the condition of the trail network.

Monitoring activities undertaken as part of the BWRMP fall into two broad categories:

1. Observational data from sites and “hotspots” found throughout the trail network from 2004-2017. These sites include any place where the trail network has significantly impacted the landscape. They comprise damage sites where erosion, trail braiding, vegetative damage, off-trail use, and similar impacts have occurred. Also included are water crossings and campsites.
2. Counts of vehicle passes recorded by TRAFx vehicle counters embedded beside the trails at strategic points in the network from 2004-2017. The data, including number of counts and timestamps, were downloaded from these units every year, and analyzed to determine trends in traffic volumes, usage during closure periods, and more.

Accordingly, the methods, results and discussion sections for this report will be described in two parts. In Part I, trail monitoring results are presented, including a discussion of the recreational impacts of OHV use, and looking at trends throughout the thirteen-year period from 2004-2017. In Part II, trends in motorized vehicle traffic and illegal activity on trails are assessed.

STUDY AREA

The Bighorn Wildland is adjacent to Jasper and Banff National Parks, consisting of approximately 5,000 km^2 of public land. It extends from the Red Deer River in the south to the Brazeau River in the north (**Figure 1**). The Forestry Trunk Road (Highway 734) approximately defines the eastern boundary, and the David Thompson Highway (Highway 11) running along the north shore of Lake Abraham bisects the Bighorn in a broad SW-to-NE manner. Within the Bighorn, the Upper Clearwater/Ram PLUZ is the largest of the six PLUZs, comprising an area of approximately 2,000 km^2.

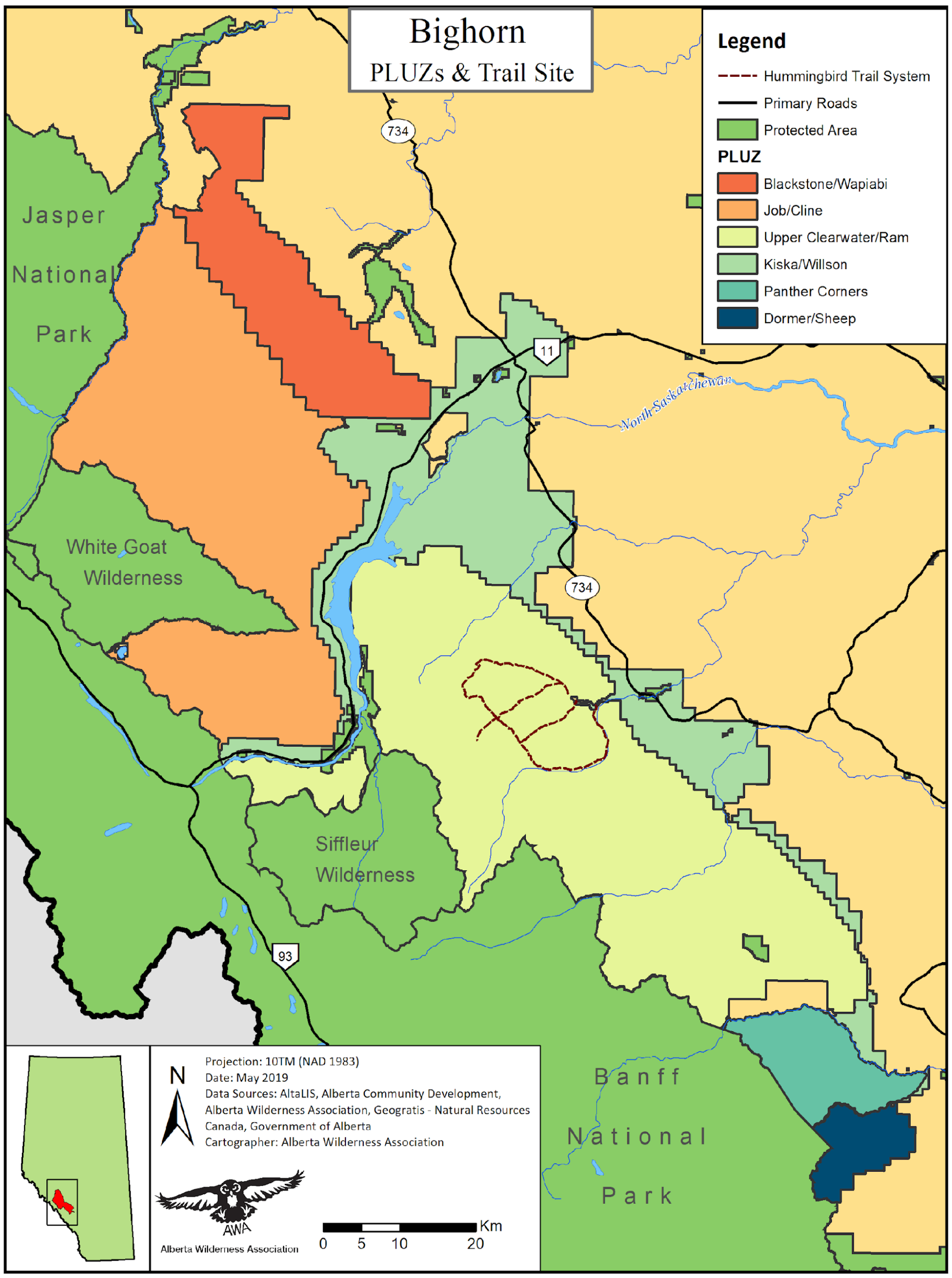

Figure 1 Bighorn PLUZs and Trail Site

Sampling Location

The largest OHV trail system established in 2002 under the *Bighorn Backcountry Access Management Plan* (AMP) was created in the Hummingbird Area of the Upper Clearwater/Ram PLUZ. This contravened the intentions of the Eastern Slopes Policy which explicitly stated that motorized recreation was incompatible with the area (AENR 1984).

This PLUZ consists of Alpine and Subalpine subregions of the Rocky Mountain Natural Region. Most of the trails we focused on occur within the Subalpine, an area characterized by forests of lodgepole pine (*Pinus contorta*), Engelmann spruce (*Picea engelmannii*), and subalpine fir (*Abies lasiocarpa*); high elevation meadows comprising hairy wild rye (*Elymus villosus*), june grass (*Koeleria cristata*), and bearberry *(Arctostaphylos uva-ursi*); wetlands; and shrub areas. Large carnivores (e.g., bears, wolves, cougars), ungulates (e.g., deer, elk, bighorn sheep), songbirds, and cutthroat and bull trout are also prevalent here. Since the 1970s, there has been no industrial activity in the Upper Clearwater / Ram PLUZ, in contrast to adjacent lands on the Bighorn's eastern boundary.

The Hummingbird Area contains a network of eight trails, located within the Prime Protection Zone identified in the Eastern Slopes Policy (AENR 1984). We divided the network into seven sections based on the names identified on the Bighorn PLUZ maps published by the GoA starting in 2003. Where designated trails were not named, we added complementary names to specific sections (**Figure 2**).

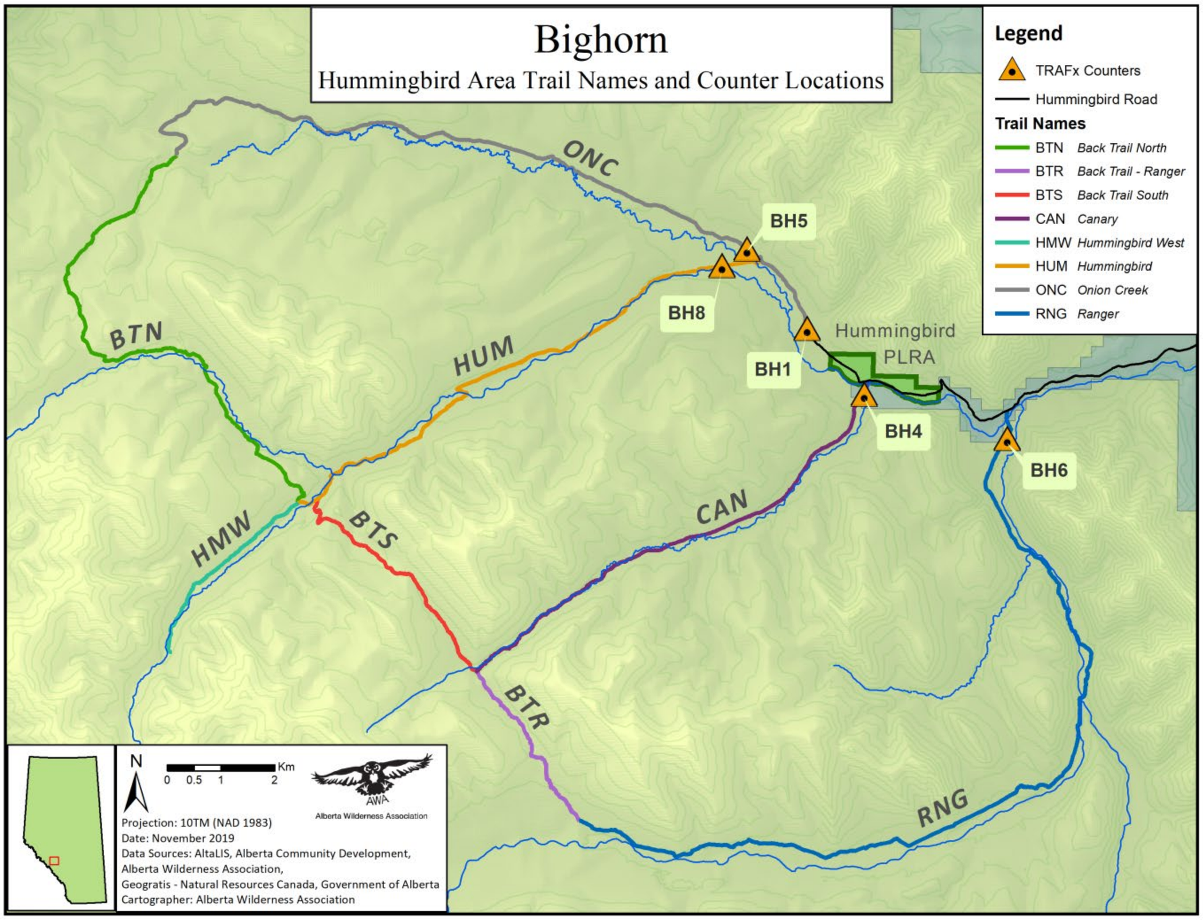

Figure 2

Five of these trails follow the routes of former resource exploration roads: the 14.4 km *Onion Creek Road* (ONC), 10.9 km *Hummingbird Creek* trail (HUM), 4.0 km *Hummingbird Creek West* trail (HMW), 9.7 km *Canary Creek* trail (CAN), and 18.1 km *Ranger Creek* trail (RNG). The remaining three trails, the 12.0 km *Back Trail North* (BTN), 5.1 km *Back Trail South* (BTS) and 3.8 km *Back Trail - Ranger* (BTR), appear to have been established originally as equestrian trails and they are generally less developed and more remote.

While CAN, HUM, ONC and the various back trails are all OHV trails (although CAN was closed to OHV use in 2017; see results and discussion sections under Part I), RNG is unique within this network in that it is primarily an equestrian-only trail. Part of RNG is open to snowmobile use when there is sufficient snow cover, however this activity has had a relatively minor direct effect on the landscape.

History of Monitoring Initiatives

The original scope of the BWRMP was a five-year monitoring program, during which activity in the Hummingbird trail network was to be observed and recorded, along with observations of the effects of this use on the landscape and wilderness areas surrounding the trails. To accomplish this, the monitoring activity was divided into two types:

Monitoring Type 1: Damage Site Survey Observations

The first type of monitoring consists of observational data surveyed from sites found throughout the trail network. These sites include any place where the trail network – and usage of that network – has significantly affected the landscape. They comprise damage sites where effects such as erosion, trail braiding, vegetative damage, off-trail use, and more, have occurred, as well as water crossings and campsites. The initial focus was specifically on four types of recreational activity impact. We surveyed the trail network for four types of recreational activity impact: 1. damage sites, 2. water crossings, 3. campsites, and 4. secondary trails.

These sites were geo-referenced by GPS, then visually measured and recorded, along with photographic evidence, by volunteers walking the trail network at the beginning, and again at the end of the initial five-year period. The change in trail and landscape condition over the course of the project was to be analyzed in the context of the second type of monitoring.

Monitoring Type 2: Vehicle Traffic Counts

The second type of monitoring pertains to vehicle traffic counts. With the assistance of TRAFx Research Ltd., TRAFx vehicle counters were embedded in the trail at eight strategic spots in the network (**Figure 3**). One traffic counter was placed on each of ONC, HUM, CAN, and RNG trails near the most likely access point of the trail. A fifth was placed near the combined trailhead of ONC/HUM before this trail bifurcated roughly 1 kilometre past the monitoring point, and a sixth counter was placed south of Onion Lake where ONC feeds into BTN. A final two traffic counters were placed on secondary trails near Onion Lake to capture potential illegal use of non-designated trails in those areas.

The data, including number of counts and timestamps, was to be downloaded from these units every year and analyzed to determine trends in traffic volumes, usage during closure periods, and usage of non-designated trails. This would provide context for the observational results from the damage site monitoring. TRAFx data was typically downloaded three times a year: once in May shortly after the spring thaw, again in mid-summer during our trail survey, and finally in October shortly before the first significant snowfall.

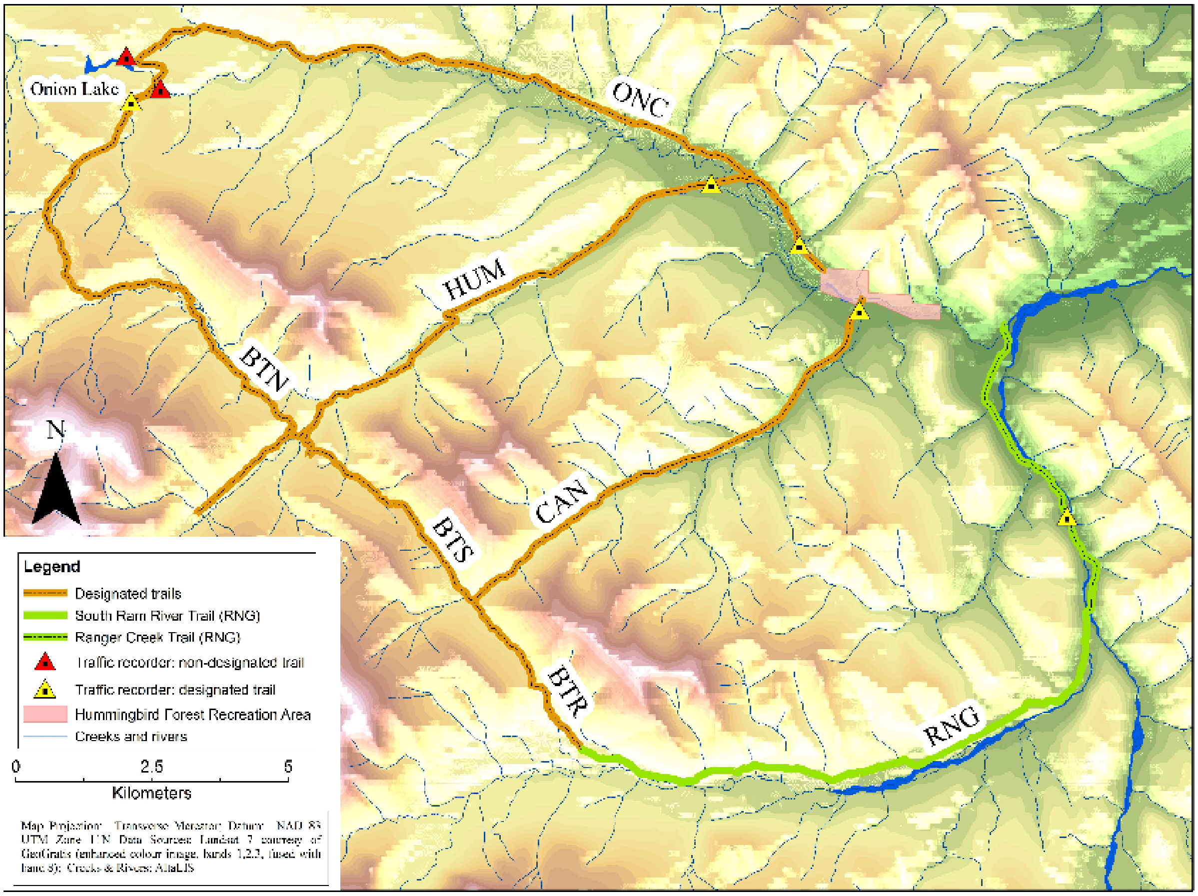

Figure 3 Location of TRAFx vehicle counters

Evolution of Monitoring 2006-2017

As the BWRMP progressed past its initial years, several things became apparent:

1. Walking the trails to perform the damage site survey was more time-consuming than initially anticipated. While the initial intent was to perform the survey once in 2003 and again in 2008, the initial survey ended up taking three years to complete. A new survey was started again beginning in 2006, at which point a representative selection of "hot spots" was identified. The BWRMP was extended indefinitely at this time, beginning a program of re-surveying these hot spots by volunteers every summer beginning in 2009.

2. Survey observations were initially written and geo-referenced by hand and re-entered into the computer once back at the AWA office. Photographs were likewise taken on film camera and needed to be scanned digitally at a later time. Starting in 2012, with the assistance of the Google Earth Outreach Program (see: https://www.google.com/earth/outreach/), AWA purchased two tablet computers with built-in camera and GPS technology, and developed an Open Data Kit (ODK) database allowing survey observations to be uploaded from the tablets automatically.

   The efficiency gain derived from this initiative allowed AWA to expand our monitoring. We chose to adopt CAN, BTR and BTS—as those trails that most readily exhibited effects of OHV use—as our primary area of focus, along with HUM and BTN as a secondary area. Thus, beginning in 2012, the entirety of CAN, along with portions of BTS and BTR, were re-surveyed every year. This survey continued to expand with the help of additional volunteers until 2016 and 2017, when the entirety of both our primary and secondary focus areas were surveyed (**Table 1**, and **Figure 4**).

Year	CAN	BTS	BTR	HUM	BTN	HMW	RNG	ONC	Hotspots Only
2003	✗	✗	✗	✗	✗	✗	✓	✓	✗
2004	✗	✗	✗	✓	✗	✓	✗	✗	✗
2005	✓	✓	✓	✗	✓	✗	✓	✗	✗
2006	✗	✗	✗	✓	✗	✗	✗	✓	✗
2007-2011	✗	✗	✗	✗	✗	✗	✗	✗	✓
2012	✓	✓	✓	✗	✗	✗	✗	✗	✗
2013	✓	✓	✗	✗	✗	✗	✗	✗	✗
2014	✓	✓	✓	✓	✗	✗	✗	✗	✗
2015	✓	✓	✗	✓	✓	✓	✗	✗	✗
2016	✓	✓	✓	✓	✓	✗	✗	✗	✗
2017	✓	✓	✓	✓	✓	✗	✗	✗	✗

Table 1

3. Extensive damage from flooding events, especially in 2012-2014, caused significant sections of trail—notably along CAN, HUM and BTR—to be closed and rerouted, in some cases substantially. This made it difficult to directly compare damage sites, as access to the previous survey location was no longer possible. However, we chose to survey the new, rerouted trails, as effects of this trail rerouting and construction were visible (see discussion section under Part I).

4. Over time, we discerned that certain types of survey sites were not showing significant evidence of a change in condition. For example, with the decline of multi-day equestrian use in favour of OHV day-trips, campsites began to receive very little use and their condition remained effectively unchanged. Thus, we chose to de-emphasize monitoring this type of site in favour of those where a change in condition could be determined, such as damage sites, erosion events, water crossings.

5. Access to some of the more remote TRAFx units—particularly those near Onion Lake—was time-consuming, and we determined that the data from those units did not contribute substantially to our analysis. As a result, those three units (seen in **Figure 4**) were removed following the 2008 season, and we continued the project with the five remaining units (as shown in **Figure 2**).

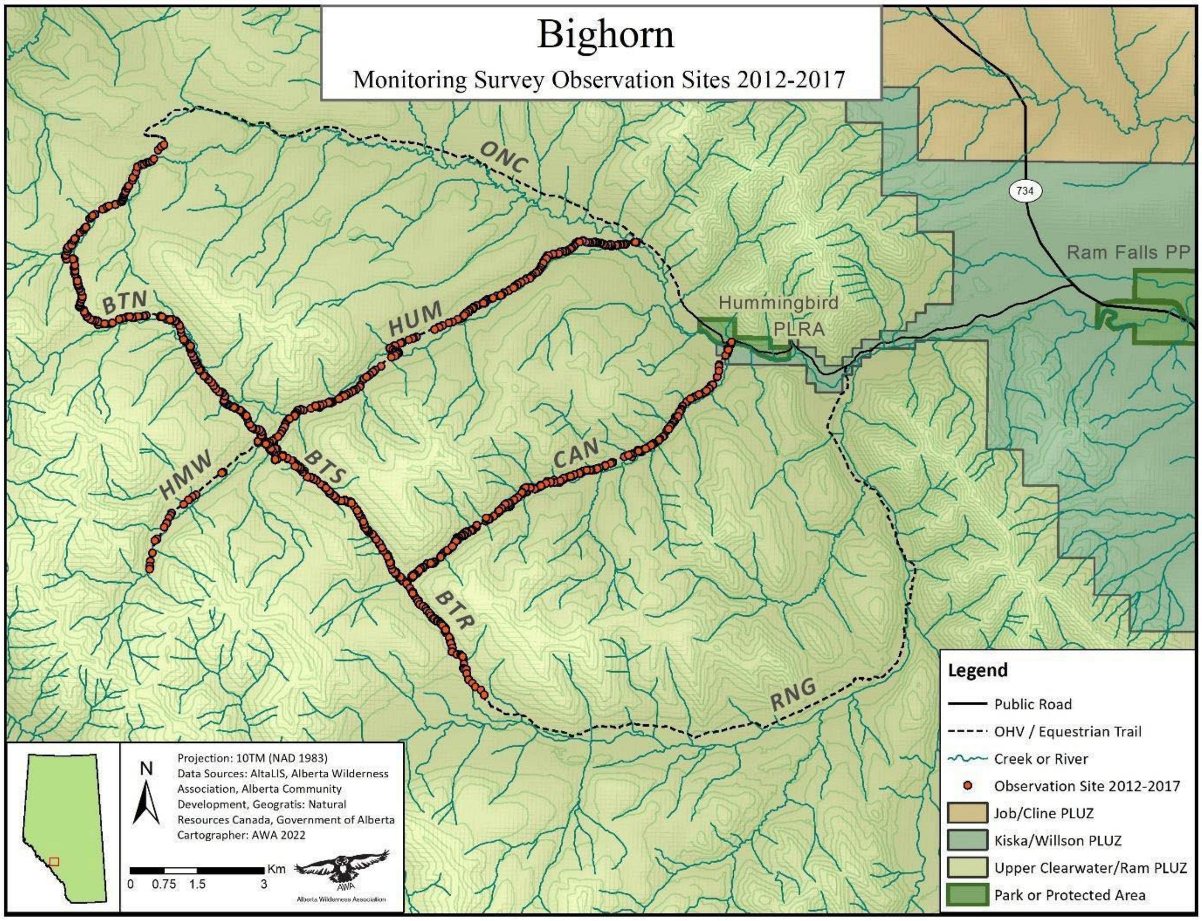

Figure 4

Following the 2017 season, AWA determined that our analysis would not benefit from continuing the project, especially with the closure of CAN to non-winter use, and we brought the project to a close. The TRAFx units remained in the field for an additional two years, then were retrieved and their data downloaded a final time in 2019.

Trail Opening Schedule

The seven trail segments, ONC, HUM, HMW, CAN, BTN, BTS and BTR, are all generally open to OHV traffic year-round, except for May and June when the network is closed to all motorized use for wildlife conservation reasons (**Table 2**). Starting in 2017, CAN was closed to non-winter use due to ongoing issues with erosion and flooding.

RNG is primarily an equestrian trail, although part of its length (from the trailhead until the point where it splits from the Ram River) is also open to winter-only use.

Over the years there were very slight variations in the precise opening and closing dates, however apart from the closure of CAN, this regime stayed broadly consistent across the length of the project.

Years	BTS, BTR, BTN, HUM, HMW, ONC	CAN	RNG (Trailhead – Ram River split)
2003-2009	OHVs: July 1 – March 15 Snow vehicles: July 1 – April 30	OHVs: July 1 – March 15 Snow vehicles: July 1 – April 30	OHVs: December 1 – March 15 Snow vehicles: December 1 – April 30
2010-2016	OHVs: July 1 – February 1 Snow vehicles: July 1 – April 30	OHVs: July 1 – February 1 Snow vehicles: July 1 – April 30	OHVs: December 1 – February 1 Snow vehicles: December 1 – April 30
2017-2019	OHVs: July 1 – February 1 Snow vehicles: July 1 – April 30	OHVs: December 1 – February 1 Snow vehicles: December 1 – April 30	OHVs: December 1 – February 1 Snow vehicles: December 1 – April 30

Table 2

From 2003-2017, there were also several shorter closure periods, generally due to flooding or other weather-related events. Notable examples of this occurred in July 2012, July-August 2013, and again in July 2016. Most such closures lasted between two to five weeks.

PART I: DAMAGE SITE SURVEY OBSERVATIONS

Methods

When performing 'damage site' surveys, we surveyed the trail network for four types of recreational activity impact: 1. damage sites, 2. water crossings, 3. campsites, and 4. secondary trails. Damaged sites were defined as part of a designated trail where the rutted depth exceeded five centimetres and where vegetation damage exceeded a width of three metres. We chose this depth as it signifies enough soil loss or compaction to affect plant regeneration (Godefroid, et al. 2003). The three-metre width we chose is similar to trail design guidelines in British Columbia (2.2 m; BCMoF 2000), Newfoundland (4 m; ECGNL 2004) and Ontario (2.5 m; CDCSSMA 2003). It is also reflected in the GoA's definition of a designated trail (3 m; SRD 2002a). Note, however, that Alberta Forestry and Parks (FP) guidelines for monitoring trail damage (SRD 2003) are inconsistent with these definitions. On hardened sections of some trails (i.e., ONC, CAN, HUM, RNG), we were less strict with these definitions to account for the presence of historical roads, which in many cases were already more than three metres wide. In these cases, damage was assessed as obvious vegetation trampling or trail widening beyond the roads' historical boundaries.

Once a damaged site was identified, we geo-referenced it, photographed the area, measured the depth of the rut at the deepest point with a tape measure, measured the width of the site at its widest point with a tape measure, and pace-counted the length of the damaged site. When measuring the depth of ruts, we noted when a rut was deeper than 25 cm for three metres or more, as this qualifies the site as an Erosion Event (EE) (**Figure 5**). The EE designation is based on FP standards for trail integrity. Under current objectives, the number of EEs per kilometre of trail is expected to stay the same or decrease over time (SRD 2003). We also classified each damaged site and EE by the type of tracks present: motorized, equestrian, or mixed. Motorized vehicle tracks are characterized by two parallel ruts formed by the wheels, approximately 1.0 to 1.6 m wide, with tire tread marks showing in moist soil conditions. Equestrian tracks are characterized by a single track, roughly 45 cm wide, with crescent-shaped marks from horseshoes present in moist soil conditions. Mixed tracks are characterized by the presence of both motorized and equestrian tracks. We also looked for evidence of hikers, mountain bikers, and horse-drawn wagon tracks at all sites. Interpretation of user group association at a site by the presence of tracks is most indicative of recent use rather than total use of that trail. We are most likely underestimating the amount of equestrian use on mixed-used trails since OHV tracks can easily mask horse tracks.

Figure 5 Erosion event

Where relevant, damage sites were further assigned attributes of braiding, education, stewardship, frolic area or vandalism. *Braiding* indicates a site in which a trail had branched off and ran parallel to the original trail, only to return back to the trail (**Figure 6**). In cases where braids overlapped, the number of braids was determined by counting the number of "diamonds" formed by overlapping braids. The overall dimensions were then recorded by measuring the width of the braids at their widest point, and pace-counting the length of the main trail to the point where all braids collapsed back to the original trail. *Education sites* indicate an attempt to inform users about the area, such as signage and flagging. *Stewardship sites* are areas in which attempts to improve the trail were made through the placement of culverts, landscape fabrics, diversion ditches, water bars, and other forms of trail maintenance (**Figure 7**, right). *Frolic sites* are areas in which OHV tracks are noted to have intentionally gone off trail (e.g., run up and down slopes, run through muddy areas, etc.). *Vandalism* indicates suspected deliberate destruction or damage to the trail or surrounding environment.

Figure 6 Braiding

Water crossings were defined as areas along designated trails where at least one of the following features was found: a physical crossing structure (e.g., a bridge or ford), water in a visibly permanent stream bed, water running on the trail, or an impermanent stream bed (e.g., ephemeral stream). At each water crossing, we photo-documented the site, geo-referenced the coordinates, and recorded the type of structure present, if any. We also treated the water crossing similar to a damage site, noting presence of ruts and/or erosion, and measuring depth, width and length where appropriate.

Campsites were defined as areas where overnight camping activities likely occurred and where at least one of the following was found: one or more fire pits, camping furniture (e.g., tables, chairs, storage, latrines), tielines or corrals for horses. We photographed, geo-referenced, collected garbage if present, and pace-measured the length and width of each site.

Secondary trails were defined as spur lines from the main trail with evidence of recent activity by hikers, bikers, horses, or OHVs that extend beyond 10 m from the junction of the main trail. We assigned recreational activity based on track evidence (see above) for the first 10 m of each secondary trail, as measured from the junction of the secondary trail and the designated trail. We chose 10 m as the minimum length of a spur following the original monitoring program developed by Alberta Sustainable Resource Development (SRD). Furthermore, this classification allows us to quantitatively differentiate between a trail braiding or widening (i.e., a damage site) and a secondary trail. At each junction of the main trail and the secondary trail, we photographed and geo-referenced the site.

Initially the recording was done using hand-held GPS units, film cameras and a pencil and notebook. The survey observations were later re-entered into the computer and the photos scanned back at the AWA office. This process was time-consuming and error prone. Thus, starting in 2012, AWA purchased two tablet computers with built-in camera and GPS technology, and developed an Open Data Kit (ODK) database allowing survey observations to be uploaded from the tablets automatically.

We summarized the total number of damaged sites, water crossings, random campsites, and secondary trails for each trail. Using GIS software, we divided each of the eight trails into unit lengths of 500 m and added up the total number of EEs and secondary trail junctions within each section. This information was then mapped to provide a qualitative assessment for the location of environmental degradation throughout the trail network.

Figure 7

Following the conclusion of the original 2003-2008 BWRMP project scope, it was decided that continued visual monitoring would be limited to a representative subset of the trail network (AWA 2008). This decision was dictated by constraints on AWA's availability of staff/volunteers and other resources at that time. CAN, BTR and BTS were selected as monitoring priorities because they contained examples of all the various damage and other observation types (braiding, erosion, water crossings, etc.), a cross section of terrain types, and a number of the "hot spots", identified in the 2004-2008 report (see also: section on Evolution of Monitoring 2006-2017).

Changes in Site Condition Over Time

A GIS program was developed to correlate and compare observations from the same site over successive years. The sensitivity was set such that observations made within 10 m of one another were considered to be from the same site. This was done to improve efficiency and consistency (i.e., to remove a potential source of bias arising from matching sites manually). All automated results were manually verified. Observations that were not thought to be for the same site or did not include the most recent data were removed.

The change in a site's condition over time was ranked as "Better", "Worse", "Same", or "N/A" (no answer) using the following criteria:

- Rut depth: Rut depth measurements taken at the same site were compared across years, to determine if the rut depth was "Better" (shallower over time), the "Same" (no change), "Worse" (deeper than before), or "N/A" (no answer: no information available for depth) compared to 2017.
- Vegetation/Erosion Progression: Visual inspections were done to try to gauge signs of vegetation loss, loss of topsoil (rocks/gravel showing) and undercutting of water banks. Inspections were ranked as "Worse" if they deteriorated, "Better" if they improved, and "Same" if there was no change. Where it was not possible to compare sites visually it was ranked as "N/A".
- Severity Change: All observations made from 2012-2017 were given a severity rating in the database from 1 (light) to 5 (severe). The methodology from the pre-ODK monitoring program (2004-2008) differed in that only three categories were assigned to observations – light, moderate, or severe. In order to compare with the newer datasets, these were assigned ratings of 1, 3 and 5, respectively.

Changes in site condition were considered definitive if at least two out of the three categories aligned; for example, if a site was considered to have gotten "Worse" over time in the Rut Depth and Severity Rating categories, then the change in site condition was ranked as "Worse" (**Table 3**, Example 1). If no two conditions aligned with each other, the overall site rating was ranked as N/A (**Table 3**, Example 2).

Example	Severity Change	Vegetation/Erosion	Rut Depth (cm)	Change in Site Condition (Better, Worse, Same or N/A)
1	Worse	Same	Worse	Worse
2	Same	Better	N/A	N/A

Table 3

Results

In the initial 2003-2005 survey, we monitored approximately 76 km of designated trails (i.e., not including RNG) and found 453 sites of concern. These features were not distributed equally among trails or sections of trails. The sum length of damaged trail sections varied from 7% of the BTN to 64% of the BTR, for an overall length of 20% of the 76 km trail network. The number of Erosion Events (EEs) was highest on BTR (5.58 EE/km) followed by BTS (3.13 EE/km), while CAN (0.93 EE/km) and HUM (0.91 EE/km) had the lowest density of EEs. Overall, we found roughly one EE for every 600 m of trail in the network. The number of EEs associated with OHV tracks was proportionally higher than the number of EEs associated with equestrian tracks on every trail except for RNG16. On RNG, equestrian tracks were associated with 86% of the EEs. The maximum width of damage sites on all trails was an average of 8.87 m (n=223), with the two widest damage sites on ONC (50 m) and RNG (50 m). The mean maximum depth was greatest on BTR (0.45 m) and BTN (0.44 m), and the deepest site we found was 1.6 m on BTR.

In the final years of 2012-2017, we monitored an approximately cumulative 96 km of CAN, BTS and BTR (our chosen primary focus area) recording a total of 646 observations (**Table 5**). Among all trail segments surveyed, the number of damage sites, the total length of damaged trail and the total length of damaged trail with observed erosion events went up significantly between the initial 2003-2005 survey, and the final survey years (**Table 4**). The difference was particularly notable on the CAN and HUM trails, a fact that merits further consideration (see section on Summary and Discussion / Trail Conditions, below).

Trail	Length (km)	Damage sites per km		Total length of damage sites (m)		Percent of trail damaged	
		2003-2005	2016	2003-2005	2016	2003-2005	2016
CAN	9.68	2.17	11.36	2,983	9,648	31%	100%
HUM	13.15	1.06	9.35	1,684	6,743	13%	51%
BTS	5.12	4.69	4.10	1,188	1,468	23%	29%
BTN	11.04	1.54	4.17	826	5,333	7%	48%

Trail	Length (km)	Erosion events per km		Percent of damage sites with an erosion event	
		2003-2005	2016	2003-2005	2016
CAN	9.68	0.93	7.44	43%	43%
HUM	13.15	0.91	8.06	86%	45%
BTS	5.12	3.13	3.32	67%	22%
BTN	11.04	1.18	3.53	76%	45%

Table 4

Overall, observations fluctuated across trails and years with the highest recorded in 2017 and 2012 except for CAN which had the highest in 2016 (2017 ranked second in CAN number of observations, 2012 ranked third). Over the entire monitoring period, virtually all the trail damage observed appeared as damage sites, braiding, secondary trails, water crossings and stewardship attempts: 98% for CAN, 99% for BTS and 98% for BTR (**Table 5**). Few damaged sites were linked to education, frolic, and vandalism on trails across years. No stewardship attempts were recorded for BTR. The trend was the same among trails for all years.

The severity and density of damage varied among years with the greatest density of severe damage recorded in 2012 (an exceptionally wet year) for all trails. The sum of such observations/km on BTS was 3.13/km, CAN was next with 2.90/km and BTR was third with 1.46 severe damage observations per km of trail (**Table 6**). The pattern was similar for extreme damage.

In our secondary focus area, we monitored an approximate cumulative 73 km of HUM, HMW and BTN. We recorded a total of 610 observations across these surveys. The number of observations and type of damage observed was similar between the trails, with an increase in most observations over time.

Trail	Year	Damage	Braiding	Secondary Trails	Water Crossings	Stewardship Attempt[2]	Education Attempt[2]	Frolic	Vandalism
CAN	2012	45	5	6	7	3	0	1	2
	2013	6	2	0	2	6	0	0	0
	2014	26	2	0	9	3	0	0	0
	2015	23	0	2	5	4	1	0	0
	2016	64	15	11	14	6	0	0	0
	2017	33	15	1	18	3	2	0	2
Total		**197**	**39**	**20**	**55**	**25**	**3**	**1**	**4**
BTS	2012	32	8	4	0	4	1	0	0
	2013	2	2	0	0	0	0	0	0
	2014	20	1	0	1	1	0	0	0
	2015	25	3	0	0	11	0	1	0
	2016	37	3	1	1	0	0	1	0
	2017	45	2	0	5	4	0	0	0
Total		**161**	**19**	**5**	**7**	**20**	**1**	**2**	**0**
BTR	2012	19	1	4	2	0	2	0	0
	2014	3	5	0	1	0	0	0	0
	2016	17	3	0	1	0	0	0	0
	2017	23	3	0	3	0	0	0	0
Total		**62**	**12**	**4**	**7**	**0**	**2**	**0**	**0**
HUM + HMW	2014	1	0	0	1	0	0	0	0
	2015	28	11	8	5	4	0	0	0
	2016	103	4	1	7	1	0	0	0
	2017	109	10	0	11	4	0	0	0
Total		**241**	**25**	**9**	**24**	**9**	**0**	**0**	**0**
BTN	2015	16	20	5	3	3	1	0	0
	2016	96	10	0	3	2	0	0	1
	2017	125	5	0	9	3	0	0	0
Total		**237**	**35**	**5**	**15**	**8**	**1**	**0**	**1**

Table 5

Trail	Year	Length (km)	Number of Trail Observations	Density of Severity Level (#/km)				
				5	4	3	2	1
CAN	2012	9.64	69	1.45	1.45	2.08	1.25	0.83
	2013	9.64	16	0.93	0.52	0.21	0.00	0.00
	2014	9.64	40	1.35	0.62	1.04	0.93	0.21
	2015	9.87	35	0.30	0.30	0.81	0.91	1.22
	2016	9.87	110	0.10	0.71	3.55	4.97	1.82
	2017	9.87	74	0.51	0.71	2.23	2.43	1.62
BTS	2012	5.11	49	0.98	2.15	2.93	3.13	0.39
	2013	2.38	4	0.00	0.42	0.42	0.84	0.00
	2014	5.11	23	0.00	0.20	2.15	1.76	0.39
	2015	5.11	40	0.00	0.20	1.37	2.15	4.11
	2016	5.34	43	0.00	1.50	3.37	3.00	0.19
	2017	5.34	56	0.37	2.06	2.81	3.93	1.31
BTR	2012	3.42	28	0.29	1.17	2.63	3.80	0.29
	2014	1.54	9	0.00	1.30	1.95	1.95	0.65
	2016	1.83	21	0.00	0.55	3.83	4.92	2.19
	2017	2.31	29	0.00	1.30	2.60	5.64	3.03
HUM + HMW	2014	0.27	2	3.68	0.00	3.68	0.00	0.00
	2015	14.88	56	0.40	0.74	1.34	0.74	0.54
	2016	10.80	116	0.09	0.46	2.78	5.28	2.13
	2017	10.80	134	0.46	1.11	4.42	4.15	2.21
BTN	2015	11.97	48	0.00	0.50	1.34	1.25	0.92
	2016	11.98	112	0.00	0.75	2.84	4.09	1.67
	2017	11.98	142	0.67	2.17	3.84	3.59	1.59

Table 6

We noted trail re-routing on HUM in 2014, the first year this trail was re-surveyed. The re-routed section showed a lot of instability, with loss of the trail likely in a high-water event. In 2015, AWA monitored the entire length of HUM and BTN, which had not been surveyed since 2008. In a few locations, the old HUM trail had slumped, and a new trail was built adjacent to it, and on one section Hummingbird Creek ran along the length of the trail. We also observed an absence of signage to identify the correct route in areas where HUM was re-routed. In many cases the trail was only marked with pieces of flagging. Where signage was present, fresh tire tracks during trail closures indicated illegal trail use (**Figure 8**).

Other notable observations made during the monitoring period include areas with pooled water along long sections of HUM and BTN after the July rains in 2016, as well as deep rutting along BTN. Deep rutting (>40 cm) and braiding were also observed along BTN in 2017. Finally, several bridge installations were noted along the trails in 2016. A large bridge was constructed over Hummingbird Creek at the intersection of HUM and BTN and materials for two new bridges were noted at two crossings along BTN, with the bridges complete/constructed by 2017.

Figure 8

Water Crossings

Over the entire monitoring period, 0.64 crossings per kilometre of trail were recorded across the trail network. CAN trail had the highest number of water crossings recorded, followed by HUM and BTN, with relatively few crossings observed on BTS and BTR (**Table 4**). CAN also had the highest density of water crossings at 0.94/km, with BTR coming in second at 0.77/km, and HUM third at 0.65/km. In general, there was an increase in the number of water crossings and density of water crossings for all trails from 2012 to 2017.

In 2017, 46 water crossings were encountered along the monitored trail system, six of which had formal bridge structures in place. There were nine water crossings on BTN (four of them bridged), three on BTR, five on BTS, 18 along CAN (one bridged) and 11 along HUM (one bridged) (**Figure 9**). With 40.28 kilometres monitored in 2017, this averaged 1.14 water crossings per kilometre of trail monitored. The highest density of water crossings was encountered on CAN (1.82/km) and BTR (1.30/km), followed by HUM (1.01/km), BTS (0.94/km) and BTN (0.75/km).

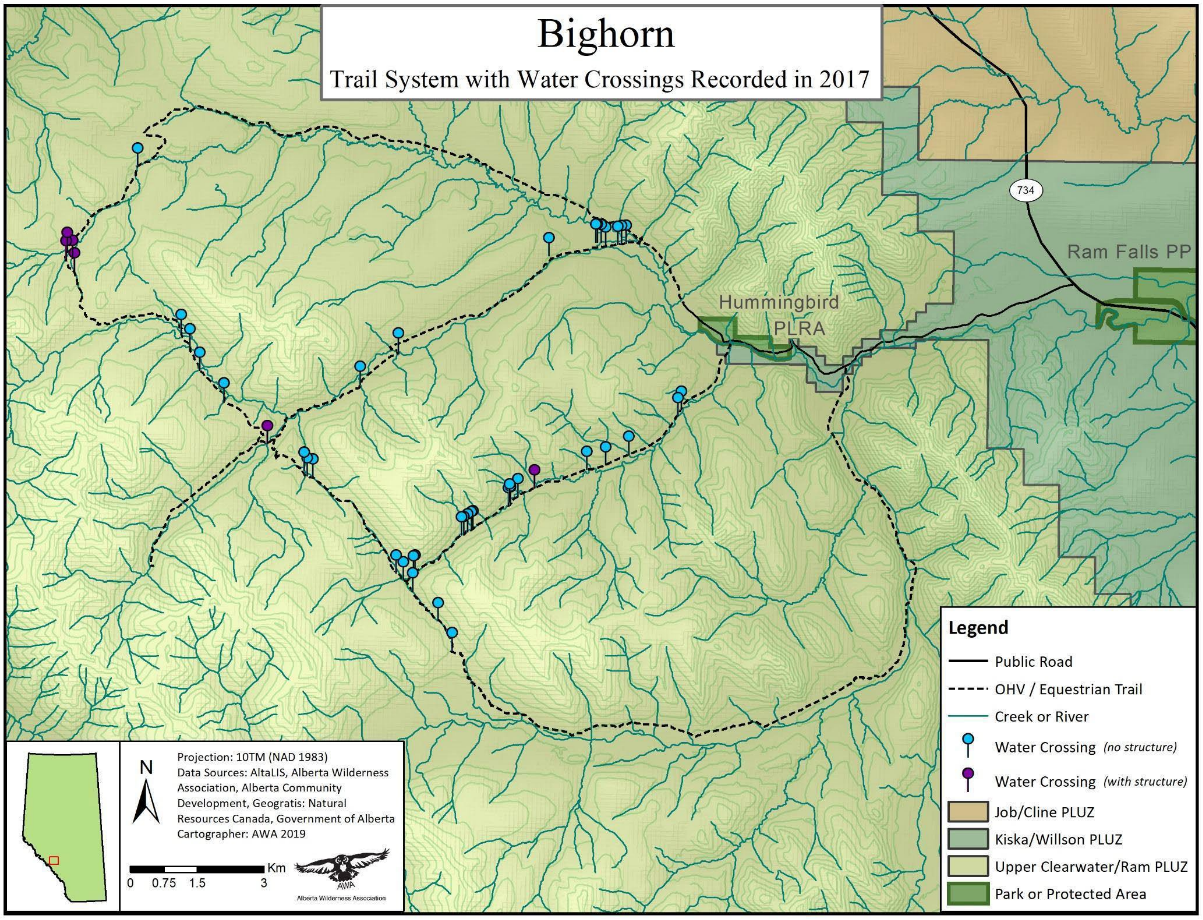

Figure 9

Trail Erosion

To visualize the average depth of ruts along the trail system, trails (CAN, BTR, BTS, HUM, BTN) were split into 500 m long segments, with the final segment, if shorter than 500 m, constituting the remaining length of the trail. All damage sites were assigned to a segment based on their location along the trail, and any records that overlapped between two segments were split into multiple records. The average erosion depth ($\underline{dd}$) of each trail segment (S) was calculated by taking the sum of the linear depths (length x depth) of each damage site (ds), and dividing the linear depth by the total length of that segment (which in most cases was 500m):

$$\overline{\mathrm{dd}}(S) = \sum_{ds \in S} \frac{\mathrm{len}(ds) \times \mathrm{depth}(ds)}{\mathrm{len}(S)}$$

Google Earth was then used to generate a visualization of these average erosion depths for 2016, which we determined to be a representative year (**Figure 10**).

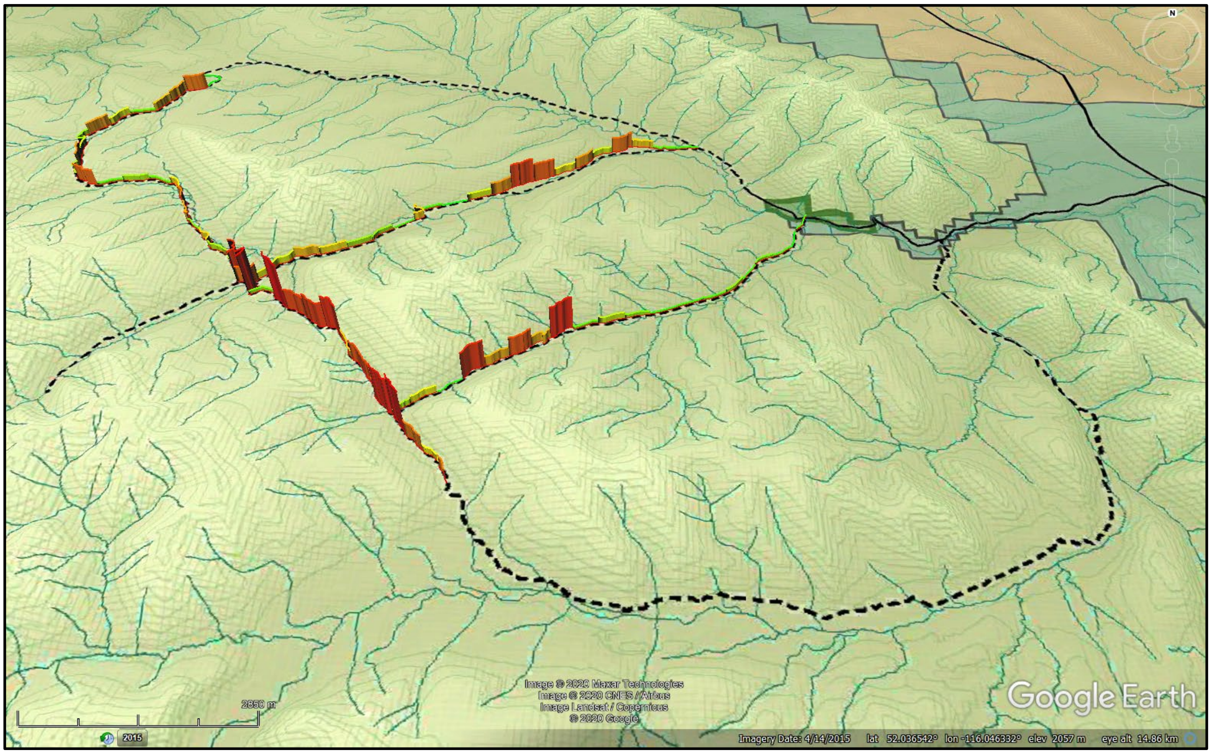

Figure 10

Changes in Trail Condition Over Time

The following table (**Table 7**) contains a representative selection of pairs of images of observation sites taken across two or more survey years. The photos were selected such that they show a cross-section of different observation types, trails, and years.

Table 7

	
CAN water crossing Taken 2014-08-12 Severity: 2 L: 8m, W: 14m, D: 50cm	CAN water crossing Taken 2017-07-24 Severity: 4 L: 15m, W: 15m, D: 52cm

BTS braiding
Taken 2013-08-23
Severity: 3
L: 30m, braids: 1

BTS braiding
Taken 2016-07-07
Severity: 2
L: 30m, braids: 1

HUM water crossing
Taken 2004-09-29
Severity: 1

HUM water crossing
Taken 2017-08-15
Severity: 1
L: 5m, W: 5m, D: 37cm

CAN damage site
Taken 2014-08-12
Severity: 2
L: 40m, W: 3m, D: 40cm

CAN damage site
Taken 2017-07-24
Severity: 5
L: 72m, W: 3m, D: 55cm

CAN damage site
Taken 2012-07-18
Severity: 4
L: 30m, W: 3m, D:130cm

CAN damage site
Taken 2016-07-06
Severity: 4
L: 15m, W: 3m, D: 120cm

HUM damage site
Taken 2004-09-29
Severity: 5

HUM damage site
Taken 2016-08-03
Severity: 3
L: 50m, D: 25cm

BTN damage site
Taken 2015-07-16
Severity: 3
L: 80m, W: 1m, D: 100cm

BTN damage site
Taken 2016-08-04
Severity: 3
L: 76m, W: 1m, D: 60cm


CAN water crossing
Taken 2014-08-13
Severity: 5
L: 40m, W: 12m, D: 120cm


CAN water crossing
Taken 2015-08-15
Severity: 5
L: 54m, W: 12m, D: 100cm


CAN water crossing
Taken 2005-08-03
Severity: 5


CAN water crossing
Taken 2014-08-12
Severity: 5
L: 15m, W: 3m, D: 250cm


BTR damage site
Taken 2005-08-11
Severity: 1
L: 76m, W: 5m, D: 24cm


BTR damage site
Taken 2012-07-19
Severity: 2

Summary and Discussion

Damage sites were observed throughout the Hummingbird trail network, with the highest density of damage sites, and the highest density of severe and extreme damage sites (i.e., severity levels of 4/5 and 5/5) occurring at higher elevations where river valleys are narrowest and have the steepest sides. The number of damage sites was highest in years of, and following, significant rainfall events, many of which saw closures of some trails.

After such occurrences, trail re-routings typically occurred to bring trails out of heavily eroded locales, which resulted in lower damage site numbers in following years: representative examples being re-routing of western (upper) sections of CAN in 2014 following the 2012 and 2013 floods, and re-routing of eastern (lower) sections of HUM at the same time. BTR was also re-routed sometime in the years after it was first surveyed and found to have long sections of extreme-severity erosion events in 2005.

In almost every such case, however, the newly re-routed trails themselves began to exhibit similar scale and types of damage, increasing in severity, within a few years of their construction. CAN again provides a good example of this, necessitating the permanent closure of the trail in 2017, three years after its last major rerouting and construction of new water crossing structures.

Similar progression of damage was not observed on the Onion Creek Road, which is an old, hardened resource road that mostly runs along a wide lower valley and is not readily affected by erosion. Likewise, upper stretches of HUM, mostly following a straight cutline, do not exhibit the same effects seen on other higher-elevation trails. Indeed, it is the lower section of HUM - which leaves the cutline to follow a creek bed more closely - where the most severe erosion necessitated re-routings.

Trail Conditions

The primary objective of the BWRMP is to provide complementary data and analysis to government agencies responsible for access management decisions in the Bighorn. This is accomplished through assessing recreational impacts from OHV use in the Bighorn by examining trail damage conditions and assessing damage severity over the thirteen-year monitoring period 2003-2017. AWA's monitoring work found that OHV use had severely negative effects on the Hummingbird trail system, as evidenced by observations taken across the trail network. Damage was common, and in many cases extreme (severity 5) or severe (severity 4 & 5 combined), particularly after heavy rainfall and with continued use of trails over time.

Figure 11

Extensive damage was found throughout the network with roughly six to ten observations for every kilometre, depending on the trail. The bulk of the damage (98-100%) was associated with damage sites, braiding, secondary trails, water crossings and stewardship attempts on all trails monitored. Incidence of extreme damage sites across the trails in the network ranged from 0.11/km to 0.77/km, with CAN having the highest density of sites at 0.77/km. CAN and BTS exhibit the highest density of severe damage, with other trails showing levels of severe damage not far below. The highest levels of extreme and severe damage occurred in 2012 for CAN, BTS, and BTR, 2014 for HUM, and 2017 for BTN.

The damage observed across the trail network is significant. Most of the observed damage was visibly attributable to OHV use. Deep, wide rutting at damage sites, braiding, and damage observed at water crossings would likely not occur from equestrian use or foot traffic. It is also important to note that stewardship attempts in many cases contributed to the damage on trails.

Figure 12

Although BTR had the highest density of damage observations, the greatest density of extreme and severe damage occurred on CAN. The damage on CAN was corroborated by visual evidence of deep rutting, soil erosion and degradation, and a high number of water crossings along the trail (**Figures 11 and 12**). OHV trails can alter watershed processes; ruts intercept the water table and re-route groundwater flow to the surface, particularly in wetlands and at stream crossings (Arp and Simmons 2012). Much of the damage observed on CAN, particularly in 2012 and 2013, could be attributed to this phenomena, as OHV ruts provide a path of least resistance for water flow. When coupled with heavy spring rains and flooding, as was the case in these years, OHV activity may have channeled surface and groundwater water flow, accelerated erosion processes, and contributed to the dramatic, sinkhole-like damage.

Severe damage was also noted on CAN in 2014, which was likely a result of the extreme erosion events from the previous years coupled with damage from re-routed trails, which were often placed immediately adjacent to the original eroded trail (**Figure 12**). Recreational trails located within the floodplain or close to groundwater sources, on steep slopes, or on wet soils are most susceptible to erosion. Trails located on a side-hill that follow the contour and cut into a slope are generally more sustainable because of better drainage (Marion and Olive 2006). At the time, AWA predicted additional slumping and erosion of the re-routed trail segments on CAN, noting they were still located within the floodplain. In addition, stream bank erosion and channel widening were observed at water crossings.

Figure 13

Trails with higher levels of motorized use and with wet soils are more likely to experience trail rutting and erosion (Howard 2018, Liu et al. 2009). This calls into question the management decision to leave HUM and BTN open, despite evidence of highly saturated soils after a peak of rainfall in July 2016. When extremely wet conditions occurred in previous years all trails were closed, and after the July 2016 rainfall the other trails were closed (CAN, BTS, BTR). The severity of damage decreased on most trails from 2014 to 2016 where damage sites were surveyed in those years, but the heavier rain in July 2016 caused increases in damage in 2017. Although the damage was lower than the first year on all trails except for BTN, this demonstrates how cumulative effects can occur from damage already present. This result also highlights the lack of recovery time afforded to trails that remain open and see continued use when conditions are too wet.

As discussed, heavy precipitation and wet conditions were a significant contributor to the damage and patterns observed in certain years. The ad hoc nature of trail reconstruction and rebuilding efforts and continued OHV use over time contributed to the damage observed in later years.

OHV trails that have been closed for several years can continue to erode and cause stream impacts such as channel widening (Marion et al. 2014, Meyer 2002). This appears to have occurred on CAN as the closed section had not only failed to recover, but it also eroded considerably. Even with perfect compliance, recovery from OHV damage can take years, as removal of the organic soil layer and soil compaction prevents vegetation growth (Ouren et al. 2007). Evidence of ongoing OHV use on closed trail sections suggests that recovery of those sections was inhibited. When considering OHV damage alongside the impacts from trail re-routing that occurred, the disturbance footprint on the landscape has effectively doubled in size for a number of sections along the Hummingbird Area trail system.

The cumulative effects of floods, erosion, and trail reconstruction have caused extensive damage to the Canary Creek Valley. Photographic evidence from the GoA confirmed that OHV trails have augmented erosive and hydrological processes along CAN (**Figure 13**). Evidence on other trails leads to the same conclusion. Impacts can include increased sediment and contaminant delivery to local waterways, as well as an increase in the rate at which the watershed is drained by stream channels. Increased runoff reduces the ability of the watershed to act as a sponge, absorbing water during floods and releasing it during periods of water scarcity. As such, AWA fully supports the decision of government staff to prohibit summer OHV use on CAN and other trails given the level of extreme erosion events observed.

Water Crossings

There was a high density of creek crossings across the trail system in 2017, with an average of 1.14 crossings per kilometre of trail, which has likely caused both direct and indirect impacts to watershed health and function. Most water crossings (87%) did not have any kind of structure. There was evidence of OHV's fording the streams which can cause several deleterious impacts. The predominant effect is increased sediment delivery in the water; however, eroding banks, widening of stream channels, coating creek beds in mud and silt, and changing creek bed gravel size are other detrimental effects that can occur (Kidd et al. 2014, Marion et al. 2014). Increased sedimentation is harmful to fish, particularly to Alberta's native trout species, which can experience physiological stress, reduced feeding rate, and even death following exposure. Additionally, sediment delivery to water is intensified following precipitation events (Boyer and Mayhood 2018).

Bridges can help minimize direct impacts to the surrounding bank and riparian vegetation, as one bridge located on BTN demonstrates (**Figure 14**). Recovery of riparian vegetation is important since this recovery increases streambank stability and reduces sediment delivery to streams (Simon and Collison 2002, McKergow et al. 2003). However, all stream crossings can and do deliver sediment regardless of structure; furthermore, bridges can also cause other impacts such as channel constriction and alteration (Kidd et al. 2014, Erdle and Mayhood 2014).

Figure 14

Furthermore, structures once installed need to be maintained. Over the years, several water crossings within the Hummingbird trail network were improved by the addition of structures, particularly along BTN, and at the conclusion of the monitoring project we also observed materials being staged in apparent preparation of further such construction. However, we also observed that existing structures often suffered from a lack of maintenance. Over time as these structures deteriorate, trail users begin detouring around them, creating braids and secondary, unimproved water crossings that further contribute to the types of landscape and stream degradation problems discussed above.

Trail Erosion

The primary pattern that emerged from erosion depth analysis was that in areas where the trail was constricted, such as between mountain valleys, there was a greater potential to have deeper erosion depth. As a connector over a mountain pass, BTS contained many steep gains in altitude, which were interspersed by a few meadow systems; correspondingly, this trail contained many of the more deeply eroded trail segments.

The western half of CAN also contained more deeply eroded segments. Its location within a narrow valley likely restricted water movement and the high number of water crossings observed along that portion of the trail (**Figures 11 and 12**) aggravated the problems. Proximity to a high-water table is a strong predictor of rut depth, as soils with high moisture content have lower strength and are less resistant to penetration and shearing. Conversely, BTN had light to moderately eroded trail segments compared to the rest of the trail system, which may be partially attributed to a more open topography.

The effects of erosion intensify other types of damage occurring on the trails. Erosion is exacerbated by water crossings and contributes to sediment flow into those streams. It contributes to vegetation damage and hillside slumping. It is in evidence nearly everywhere that a trail exists within the Hummingbird network.

It is thus concerning to note that spikes in trail erosion depth noted along the western half of CAN and the eastern half of HUM both corresponded to re-routed trail sections. This type of reconstruction, much of which was undertaken under the auspices of the Backcountry Trail Flood Rehabilitation Program (2014-2019) has in many cases seen trails re-sited—sometimes at significant cost—to a new location that is nevertheless within the same landscape that caused the damage in the first place. Consequently, the new trails often show the same type of damage within a few years and thus contributed to a doubling of the original damage footprint (**Figure 15**).

Figure 15

Changes in Site Condition Over Time

Comparison of the same sites over time indicates that the majority of sites have deteriorated (**Figure 16**). There were 127 matches between observed locations in 2017 and locations from previous years. Of these, 17 sites improved in condition over time ("Better"), 20 were classified as having stayed the same ("Same"), and 58 sites were classified as having deteriorated over time ("Worse"). Thirty-two sites had insufficient information or conflicting results ("No Answer").

Of the 98 sites where a definitive assessment on site condition could be made, 59 percent of the sites deteriorated over time ("Worse"). Of the sites that were considered "Worse," eight were located along CAN, six on BTS, 16 on HUM, two on BTR, and 23 on BTN.

The high number of "Worse" sites observed at BTN and HUM suggests that these trails are worth close monitoring in the future. Several patterns emerged upon visual examination. Water crossings with no formal structure, trail segments that contained standing water and/or were located within poorly draining areas, and trails located within soft meadows were more likely to degrade over time. In addition, trails on wet and organic soils that receive high use, contain a low slope alignment angle, or that are in close proximity to water (such as wetlands and floodplains) are more susceptible to erosion processes and surrounding environmental damage. Conversely, many of the sites that improved or remained the same over time tended to be situated on compact, dry soil that had good drainage.

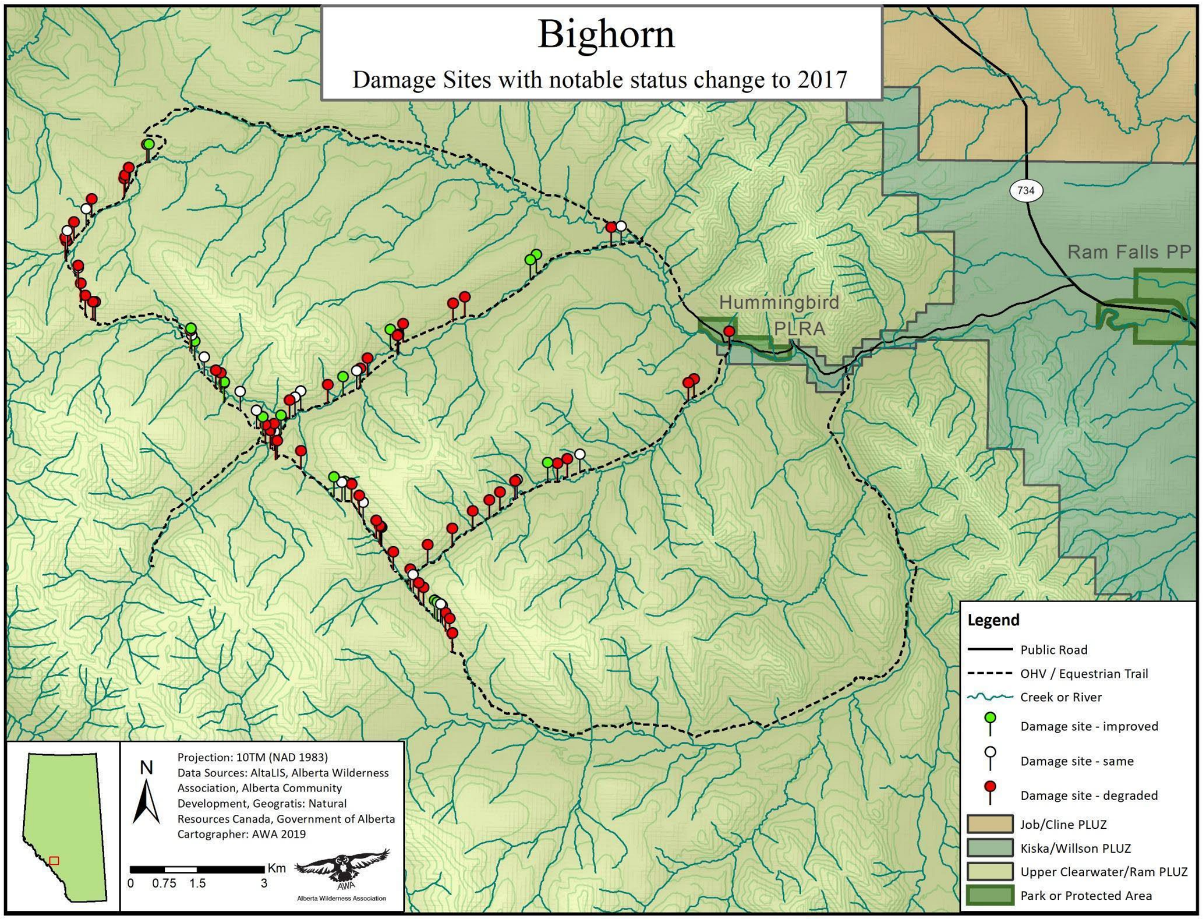
Bighorn
Damage Sites with notable status change to 2017
734
Ram Falls PP
Hummingbird PLRA
Legend
Public Road
OHV / Equestrian Trail
Creek or River
Damage site - improved
Damage site - same
Damage site - degraded
Job/Cline PLUZ
Kiska/Willson PLUZ
Upper Clearwater/Ram PLUZ
Park or Protected Area
N
Projection: 10TM (NAD 1983)
Data Sources: AltaLIS, Alberta Wilderness Association, Alberta Community Development, Geogratis: Natural Resources Canada, Government of Alberta
Cartographer: AWA 2019
0 0.75 1.5 3 Km
AWA
Alberta Wilderness Association

Figure 16

PART II: VEHICLE TRAFFIC COUNTS

Methods

OHV traffic was monitored year-round using TRAFx counters. Counters were buried with a shallow cover near the trail with the sensitivity set to enable detection of passing vehicles. Given that the vehicle counters cannot differentiate between snowmobiles and other types of OHVs, all counts during OHV and snowmobile "open" times were assumed to be legal, and all counts that fell outside open periods were considered illegal use.

In 2004, TRAFx vehicle counters were placed at eight strategic spots in the trail network. One traffic counter was placed on each of ONC, HUM, CAN, and RNG trails near the most likely access point of the trail. A fifth was placed near the combined trailhead of ONC/HUM before this trail bifurcated roughly 1 kilometre past the monitoring point, and a sixth counter was placed south of Onion Lake where ONC feeds into BTN. Two traffic counters were placed on secondary trails near Onion Lake to capture potential illegal use of non-designated trails in those areas.

In 2008, we determined that data from some of the more remote TRAFx units did not contribute substantially to our analysis and did not warrant the time and effort required to access them regularly. Consequently, the three units near Onion Lake were removed following the 2008 season. These three units, BH2, BH3, and BH7, were the two counters placed on secondary trails, and the one at the transition point from ONC to BTN. Thereafter we continued the project with the five remaining units at the trailheads (as shown in **Figure 2**):

- Counter BH1, located at the combined head of ONC and HUM trails;
- Counter BH5, located at the head of ONC, past the fork;
- Counter BH8, located at the head of HUM, past the fork;
- Counter BH4, locate d at the head of CAN; and
- Counter BH6, Located at the head of RNG (a non-designated trail).

The data, including number of counts and timestamps, was downloaded from these units several times each year, and analyzed to determine trends in traffic volumes and usage during closure periods.

Results

Overall, several conclusions can be reached by analyzing the vehicle pass counts recorded by the TRAFx units.

First, motorized use of the Hummingbird trail network continued and has increased significantly over time from when the trail system was first opened until the TRAFx units were withdrawn (**Figure 17**) in 2019.

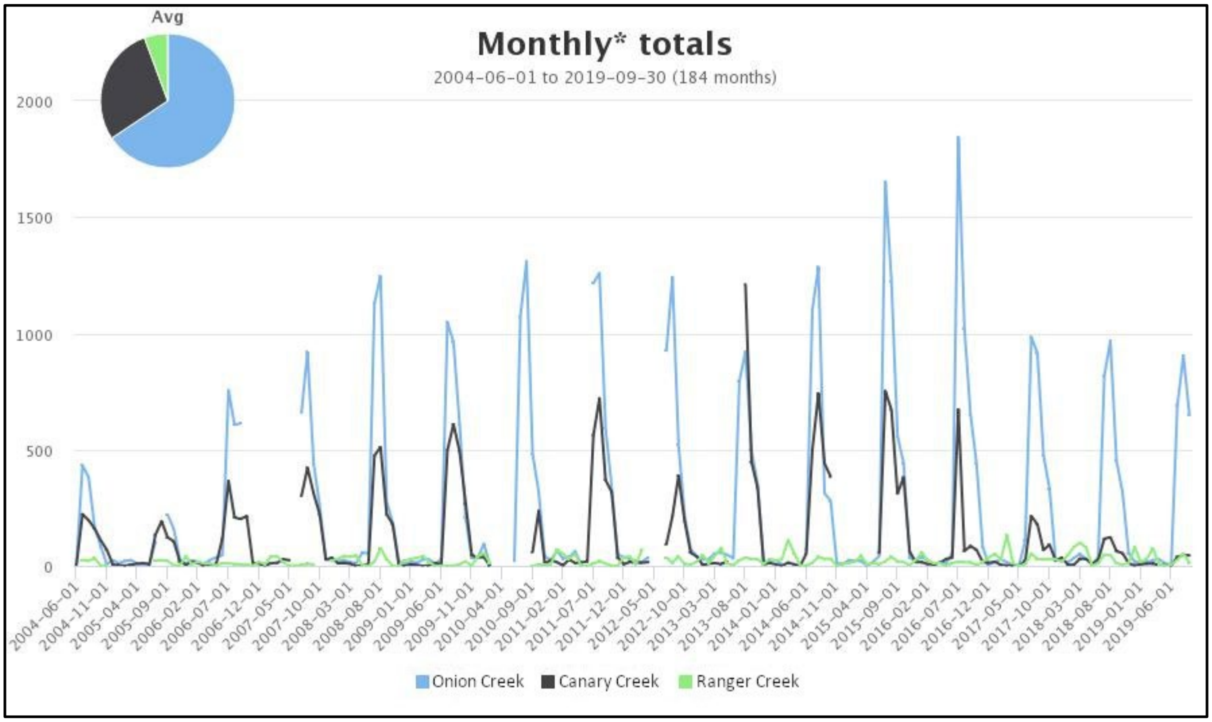

Figure 17

Second, use has dropped off during periods of heavy rainfall when site conditions made trails impassable and dropped off much more steeply starting in 2017 when CAN was permanently closed to non-winter use (**Figure 17**). This fact confirms that trail closures are an effective measure to address damage caused by inappropriate OHV use.

Finally, while traffic during closure periods does decrease, illegal use of the trail network (defined as vehicle passes during closure periods) continues and is significant, especially on the now-closed CAN trail (**Figure 18**). Clearly, trail closures need to be accompanied by active enforcement.

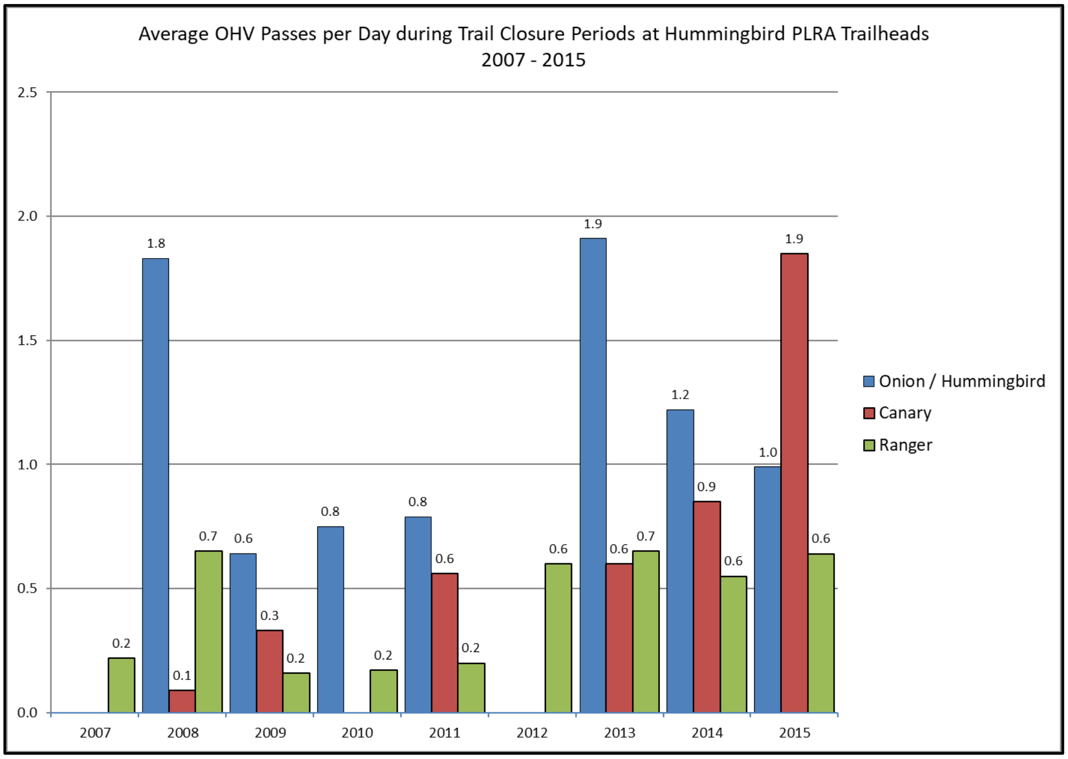

Figure 18

Summary and Discussion

We have in general only reported data in the previous section from counters BH1, BH4, and BH6, mostly for the sake of clarity in comparison. It nevertheless remained useful to have BH5 and BH8 in place as they were embedded near BH1, on the same part of the trail network (**Figure 2**). This allowed us to check the data by querying whether the number of passes counted by BH1 corresponded (roughly) to the sum of passes recorded by BH5 + BH8. This check was helpful in detecting and mitigating for faulty readings and other data gaps.

Over the course of the project, we experienced some problems - such as battery and equipment failures, flooding, high moisture, and disturbance by wildlife - that have resulted in data gaps. Thus, the vehicle counts downloaded from the TRAFx counters did not always allow detailed statistical analysis but still provided sufficient data for analyzing trends with sufficient confidence.

The data shows that traffic decreased when trails are closed but we found that there is still illegal OHV traffic on closed trails, and that the incidents of illegal use are generally increasing over time. Trail closures can be effective but they must be accompanied by enforcement.

SUMMARY OF FINDINGS

AWA's primary finding is that the overall condition of the Hummingbird Area trail system has declined since the initiation of monitoring in 2004. Comparisons across years indicate that the majority of sites have deteriorated in condition (**Table 4**) providing concrete evidence that this area cannot withstand continued OHV traffic.

Over the most recent six years of the observational study, two years (2012 and 2013) had elevated precipitation levels and slightly higher than average levels also occurred in July 2016, leading to trail closures due to flooding or extremely wet conditions. Increased precipitation exacerbated OHV damage by softening the soil; moisture content reduces soil strength which in turn makes it more susceptible to damage by OHVs. There were several examples where only a few recorded vehicle passes were correlated with extensive damage on wet soils. In addition, damage was intensified when wet trails were subjected to OHV use, as demonstrated on CAN, and BTS in 2012 and on BTN in 2017 when they had the highest density of severe erosion events following wet conditions. Therefore, it was crucial for OHV trails to be closed during those wet conditions.

An important predictor of observed damage appeared to be the location of a trail relative to surrounding landscape features, which is consistent with findings in other jurisdictions (Olive and Marion 2009). Trail segments with the greatest rut depth were generally located in areas with high numbers of water crossings, within valley bottoms, or on steep hills (**Figure 15**). For instance, the deep rutting observed along BTS (**Figure 10**) was likely a result of steep trail grade. OHV trails can alter watershed processes near stream crossings and at wetlands, as ruts create a "trough that intercepts the water table" and re-routes groundwater flow to the surface (Arp and Simmons 2012). This helps to explain many of the erosion processes observed across the trail network, such as the extreme erosion that occurred on CAN in 2012 and 2013 and the "capture" of Hummingbird Creek down the OHV trail. In short, this is an inappropriate location for a trail network of this nature.

There were no strong trends in annual average daily traffic, other than a decrease in traffic levels following periods of trail closures. During the years when observed erosion was highest (such as 2012 and 2017 on CAN), the Hummingbird Area had partial or complete trail closures due to extremely wet conditions, limiting OHV use during these periods. In some cases, the erosion was so extreme that some trail sections were physically impassable by motorized vehicles.

While most OHV users generally appeared to respect trail closures, there was evidence of ongoing illegal use, suggesting that recovery was being inhibited. Since recovery from OHV damage can take years, and trails that have been closed can continue to erode, field managers should consider a more hands-on approach to restoration of closed trail portions by reducing ease of travel and planting cuttings of local hardwood vegetation (Dias de Andrade Silva 2019, Pigeon et al. 2016). Bioengineering using willow cuttings has worked well in damaged streambank locations further south.

Although designated trail systems are a preferred management approach over random, non-designated systems, the success of such systems is contingent upon effective trail design, user compliance and enforcement by the regulator. There is ample evidence of increased disturbance and habitat fragmentation in the area. Even relatively few OHV passes will cause soil compaction which in turn can reduce vegetation growth and diversity and increase the risk of ongoing erosion.

OHV use in the Hummingbird Area has caused direct and indirect impacts to ecosystem and watershed health and function. Therefore, our findings call into question the sustainability of the Hummingbird Area trail system. The Canary Creek valley is incapable of supporting motorized recreation, and our evidence suggests this is also the case for the other trails in this network. AWA fully supports the decision of GoA staff to periodically close trails to summer OHV use, particularly CAN and BTS given the level of extreme erosion events observed.

In addition, the extensive re-routing observed on HUM and increasing rut depth and damage on the back trails are particular areas of concern. AWA would also recommend the closures of HUM and BTN to summer OHV use to prevent more damage. This trail system is located within gravel-bed river floodplains which have ecological importance for wildlife, water production, and have the capacity to act as a buffer in the face of critical climate change, providing refugia for many aquatic and terrestrial species (Hauer 2016). These landscapes are also invaluable for water production.

The Hummingbird trail network, as it stands, is inappropriately sited, poorly designed, and offers insufficient protection for native fauna and flora. Its presence is a violation of the intent of the Bighorn Backcountry Access Management Plan and the PLUZ regulations. Allowing recreational activities to continue at current levels is wholly inconsistent with the vision of the Prime Protection Zone designation under the Eastern Slopes Policy. Furthermore, it is inconsistent with the views of many Albertans who wish to see this area's wilderness and natural values given the greatest priority. This attitude is also reflective of Albertans who, during the public consultation process for the Land-Use Framework (LUF), ranked healthy environment and ecosystems as the number one desired outcome for the LUF almost four times as often as the other two goals of well-planned places to live and play, and sustainable prosperity supported by our land.

As access management issues continue to dominate backcountry land management, policy and management plans need to better reflect the importance of these areas for non-motorized recreation like hiking, skiing, horseback riding and mountain biking, especially in the context of increased pressures from a fast-growing population. The GoA must establish clear and enforceable regulations that will ensure the protection of wildlife, watersheds, and all ecosystem services.

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