Mapping recreational linear features beyond documented trails in southwestern Alberta and southeastern British Columbia

Yellowstone to Yukon
Conservation Initiative

UNBC UNIVERSITY OF NORTHERN BRITISH COLUMBIA

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Executive summary

Outdoor recreation can benefit our physical, mental, and emotional health, as well as bring great value to communities and the economy. However, outdoor recreation can also have negative direct and indirect effects on plants and animals, and conflicts among recreation user groups sometimes decrease user experiences. To manage, plan for, and mitigate these impacts, we need to know where people are recreating and which activities they participate in. Unfortunately, essential information on how many and what kinds of trails recreationists use is lacking. This information gap prevents land managers, planners, and other interested parties from making evidence-based decisions, despite governments highlighting it as a key issue.

To fill these gaps, we gathered information from multiple sources on recreational trails and linear features that have been shown to attract recreational use (including resource roads that were not paved and gravelled, cutlines, pipelines, and transmission lines) with three objectives:

1) Create a comprehensive database of recreational trails and linear features using government-based sources (documented) and other sources (undocumented);
2) Classify features by potential recreational activities (motorized, non-motorized, etc.) and type (trail, resource road, cutline, transmission right of way);
3) Calculate densities of trails and linear features based on watershed units.

Our study area was centred in southwestern Alberta and southeastern British Columbia, Canada, covering roughly 63,000 km^2. This area included Kananaskis Country, which contains five Provincial Parks and four Wildland Provincial Parks, the Ghost Public Land Use Zone, National Parks including Banff, Yoho, Kootenay, Glacier, and Mount Revelstoke, and the Purcell Wilderness Conservancy. We compiled spatial and attribute data from government databases, recreational websites, and linear feature data from seismic lines, transmission lines, and rough resource roads that were neither paved nor gravelled but accessible to recreation. Spatial data were presented to public land managers to verify the GIS processing steps and trail and classification accuracy. We also assessed geospatial inaccuracies based on a 5 × 5 km grid.

In total, we mapped 53,436 km of trails and potential recreation features (i.e., linear features). Trails contributed 22,040 km, rough resource roads 20,956 km, while cutlines, pipelines, and transmission lines totalled 10,439 km. Of all features, 18,611 km were documented, 5,932 km came from undocumented sources, while the remaining 28,892 km were linear features with no recreational information. A total of 27,234 km of trails and linear features we mapped had the potential for motorized use (including cutlines and resource roads), 10,897 km were accessible for non-motorized use, 8,070 km were in areas where motorized activity is prohibited, 4,315 km were accessible for both motorized and non-motorized use, while 2,919 km were of unknown activity. Densities by watershed for all linear features ranged from 0.12 km/km^2 to 3.34 km/km^2 for all recreation types. Linear density for potential motorized recreation ranged from 0 km/km^2 to 1.63 km/km^2, while non-motorized linear density ranged from 0.01 km/km^2 to 0.96 km/km^2.

Our findings provide a baseline reference of where and what type of recreational features are available across our study area. An inclusion of unofficial trails suggests that the recreational footprint may be vastly underestimated when only documented data sources are used. Management of resource roads and cutlines that provide access for recreation may be challenging due to how widespread and remote these features are. Our results underline outdoor recreation's extensive and dynamic nature and the importance of recreation access planning and land management. Our results are immediately useful for land managers as they provide relatively current trail location data, including undocumented routes that can help identify areas that may be experiencing negative ecological impacts or user conflicts. This study is part of a larger project to establish a baseline for recreation use intensity and model functional disturbance to wildlife.

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Background

Participation in outdoor activities is increasing worldwide, and together with improved technology and equipment, people can go farther and faster into nature than ever before (Simpson and Terry 2000, Balmford et al. 2015, Government of Alberta 2018, Forest Practices Board 2021). Electronic access to recreational maps and information through user-generated platforms (e.g., AllTrails, Trailforks, STRAVA) and detailed online databases is unprecedented (Teles da Mota and Pickering 2020). Additionally, modes of transportation for recreation access and activities continue to diversify, from the more traditional hiking, skiing, biking, and other non-motorized activities to the use of power-driven technologies such as electric bikes (e-bikes) to helicopter-assisted snowmobiling, hiking, and biking (Simpson and Terry 2000, Naidoo and Burton 2020, Mitterwallner et al. 2021).

Recreation impacts can vary depending on the type of activity, timing, intensity, location, and duration, and (can) lead to concerns about the negative effects recreation can have on wildlife. These effects can include habitat degradation, water quality reduction, and noise and physical disturbance that can elicit a fear response in wildlife and their displacement (Cooper 1995, Carothers et al. 2001, Reed and Merenlender 2008, Albritton et al. 2009, Rogala et al. 2011, Wolf 2012, Larson et al. 2016, Farr et al. 2017, Heinemeyer et al. 2019, Naidoo and Burton 2020). Research has shown that recreational activities can affect wildlife differently. For example, mountain biking and motorized recreation prompted a stronger avoidance response by wildlife compared to other non-motorized recreation (Stokowski and LaPointe 2000, Naidoo and Burton 2020). Motorized activity may also lead to elevated sediment runoff into streams and rivers (Boyer and Mayhood 2018) and prevent habitat recovery (Pigeon et al. 2016). Since the impact of recreation on different habitats and wildlife varies, it is important to understand where and what types of activities occur across the landscape.

However, there are knowledge gaps in where and when a full suite of mechanized and non-mechanized outdoor recreation can occur (Government of Alberta 2018, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development 2020). Provincial governments highlighted this gap among key issues in creating recreation and land use planning systems (Government of Alberta 2018, BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development 2020). The British Columbia Trails Strategy highlighted that "*hundreds of thousands of recreational trails in BC are undesignated and unmanaged*" and suggested creating and maintaining an inventory of trails as well as integrating the recreational use of resource roads into resource road management (Ministry of Forests, Lands, and Natural Resource Operations 2013). Indeed, where motorized access is permitted, seismic exploration cutlines and resource roads in Alberta and British Columbia are frequently used by off-highway vehicles (OHV) in summer and snowmobiles in winter at a range of intensities (Ministry of Forests, Lands, and Natural Resource Operations 2013, BC Forest Safety 2016, Pigeon et al. 2016, Proctor et al. 2020, Forest Practices Board 2021). In Alberta, the South Saskatchewan Regional Plan identified the need to create an "*inventory of trails categorized by type and use*" and analyze recreation use to create an "*integrated, efficient and effective planning system*" (Government of Alberta 2018).

This report aims to provide managers and land use planners with a baseline reference of where trail-based recreation occurs. Our objectives were to: 1) create a comprehensive database of recreational trails and linear features using government-based sources (documented) and other sources (undocumented), 2) classify features by potential recreational activities (motorized, non-motorized, etc.), and type (trail, resource road or cutline), 3) calculate densities of trails and linear features based on watershed units.

To meet these objectives, we identified official government and unofficial online spatial datasets from recreation group websites, smartphone recreation trail applications that connect to social media, and other open-source, user-generated sources. In addition to searching traditional recreation data resources, we included cutlines, seismic lines, and rough resource roads (roads that were not paved or gravelled) as linear features available for recreational use.

Study area

The study area encompasses 63,000 km^2 of rugged mountain terrain in and along the North American continental divide. It extends from the Eastern Slopes of Alberta to west of Revelstoke, British Columbia, and from the Purcell Wilderness Conservancy, north to Valemount, British Columbia (Figure 1). The study area contains approximately 20,259 km^2 of protected areas, including Banff, Glacier, Mount Revelstoke, Yoho, and Kootenay National Parks, Provincial Parks in both Alberta and British Columbia (Peter Lougheed, Bugaboos, Purcell Wilderness Conservancy, Elbow-Sheep, and Spray Valley), wilderness areas, and heritage rangelands. Our study area includes the communities of Canmore and Banff (Alberta), Golden, Revelstoke, Nakusp, and Invermere (British Columbia), as well as Public Land Use Zones, grazing leases, recreational areas, public and private lands, forestry, mining, and oil and gas extraction and exploration (Figure 1). The Trans-Canada Highway bisects the study area. The study area is found within the traditional territories of the Okanagan/Syilx, Sinixt, Ktunaxa, Secwépemc, Niitsitapi (Blackfoot) Nations of Siksika, Kainai, Piikani, and Aamskapi Pikuni; the Îyârhe (Stoney) Nakoda Nations of Goodstoney, Bearspaw, and Chiniki; Tsuut'ina First Nation; Mountain Cree. It also includes lands within Treaties 6, 7, and 8 and regions 2 and 3 of the Metis Nation of Alberta.

The study area encompasses a diverse set of ecosystems. From east to west, they include aspen parkland, fescue grassland, boreal transition, western Alberta upland, northern continental divide, eastern and western continental ranges, southern Rocky Mountain trench, and the Columbia mountains and highlands (Government of Canada; Agriculture and Agri-Food Canada; Science and Technology Branch 2021). In British Columbia, the study area is dominated by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*) in the east, and cedar (*Chamaecyparis nootkatensis and Thuja plicata*) and hemlock (*Tsuga heterophylla, T. mertensiana*) in the west. In Alberta, the dominant tree species in the mountainous portion of the range are subalpine fir, white spruce (*Picea glauca*), and Engelmann spruce. In the foothills, dominant species include lodgepole pine (*Pinus contorta*), black spruce (*Picea mariana*), white spruce, balsam fir (*Abies balsamea*), balsam poplar (*Populus balsamifera*), and trembling aspen (*Populus tremuloides*).

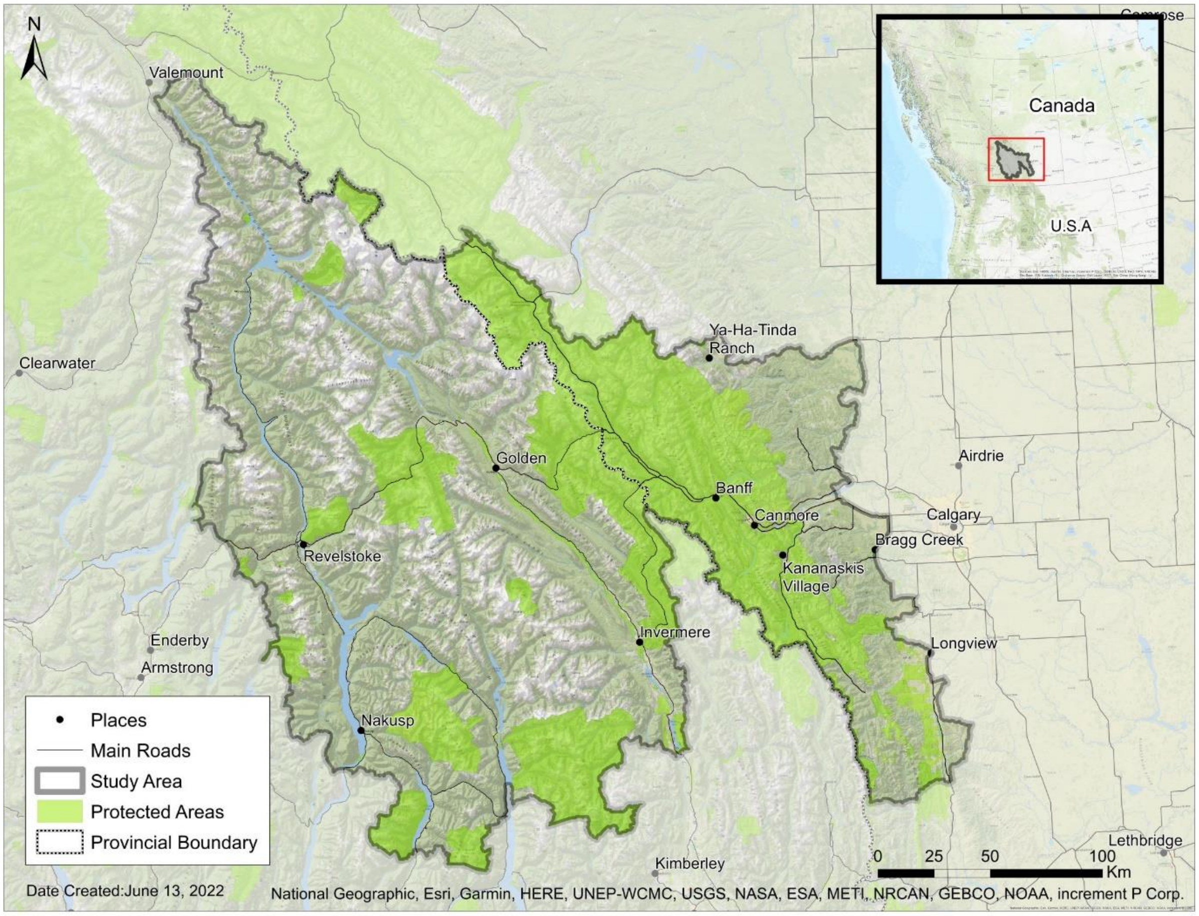

Figure 1. Study area in southwestern Alberta and southeastern British Columbia, Canada.

Resource development activities vary across the study area. East of the continental divide, there is extensive oil and gas development and a prominent forestry industry and mining operations. Motorized recreation is popular in designated areas, such as McLean Creek and Cataract Creek, as well as in Public Land Use Zones (PLUZ), such as the Ghost PLUZ (Government of Alberta 2018). Non-motorized recreation is common in the provincial and national parks, especially those within Banff National Park and Kananaskis Country (Government of Alberta 2018). West of the Continental Divide in British Columbia, extensive areas are used for forestry, contributing to the large number of resource roads (Forest Practices Board 2021). Motorized recreation is common, and the extensive resource road network provides many access points for both motorized and non-motorized activities (Forest Practices Board 2021). Commercial snowmobiling and heli-assisted activities are popular, with heli-skiing especially prominent, facilitating access to areas not serviced by roads during the winter. In addition, there is a network of backcountry skiing traverses and commercial and non-commercial backcountry huts.

Methods

Data were acquired both from government datasets as well as from non-government sources. The sections below describe each step in detail. We combined and collated datasets, classifying them by surface and activity type and validating each trail and linear feature layer (Figure 2). We calculated watershed-level linear densities using validated data.

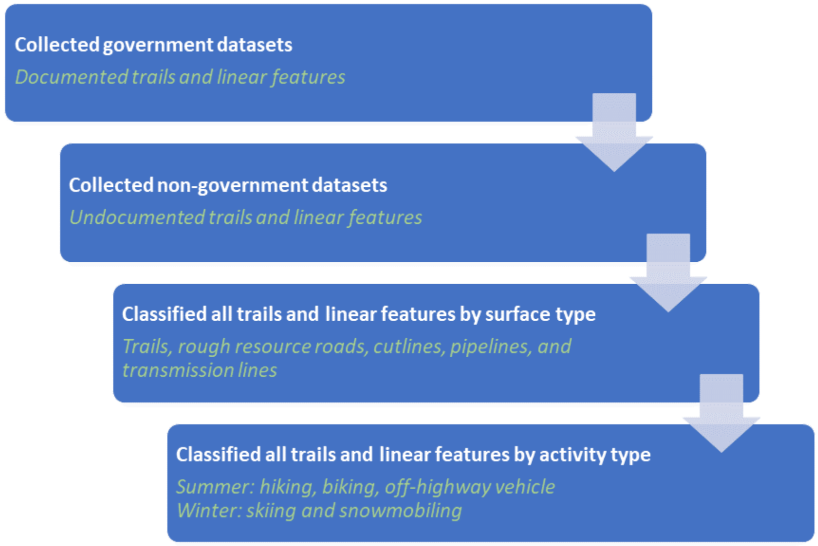

Figure 2. Workflow describing the process for data acquisition and classification of trails and linear features in southwestern Alberta and southeastern British Columbia.

Data acquisition

We acquired spatial and attribute data from provincial and federal government sources (Table 1), including Alberta Environment and Parks (AEP)[1], BC Parks, Recreation Sites and Trails British Columbia (RSTBC), Banff Field Unit (BFU), and Lake Louise, Yoho, Kootenay (LLYK), Mount Revelstoke, and Glacier (MRG) Field Units. We acquired datasets via public data portals or by direct communication with government staff.

In addition to acquiring datasets from government organizations, we searched for datasets within regional recreation user groups (e.g., snowmobiling, mountaineering, hiking) and trail mapping and management websites (e.g., Southern Alberta Trail Mapping Project) that contained spatial information on recreational use of linear features. We also included trails digitized from non-georeferenced paper or PDF maps. We defined **documented** features as any linear features identified for recreational use in government databases, recreation management plans, and recreation club maps, which are all subject to government management. In some instances, documented trails included unsanctioned, unofficial, informal, or undesignated trails. We also included features that were classed as recreational trails in the Digital Road Atlas, a comprehensive source of authoritative road data for the Province of B.C. In contrast, we defined **undocumented** features as any linear feature identified for recreational use but did not originate from a source managed by government organizations. The “documented” or “undocumented” classification does not reflect the legal status or the level of management of a feature but simply the origins of the information. All data were downloaded, processed, and stored on secure servers and networks.

[1] Alberta Environemtn and Parks changed in October 2022 to Alberta Ministry of Environment and Protected Areas (https://www.alberta.ca/environment-and-protected-areas.aspx) and Ministry of Forestry, Parks and Tourism (https://www.alberta.ca/forestry-parks-and-tourism.aspx).

We further classed the recreation data as trails, rough resource roads or cutlines, pipelines, and transmission lines. We defined a **trail** as any linear feature with trail-based information, such as activity type, trail name, or trail classification type (Figure 3). **Rough resource roads** were not paved or gravelled, had an unknown surface type or were unclassified, and did not have trail-based information. Gravelled and paved resource roads, such as some forestry service roads in BC, were excluded from this study unless they were used as a trail in winter (e.g., snowmobiling or cross-country ski trails;

Table 2) since they generally have higher non-recreational traffic. **Cutlines, pipelines, and transmission lines** included high-voltage power lines, seismic exploration cutlines, and oil and gas pipelines. Rough resource roads and cutlines, pipelines, and transmission lines often facilitate motorized and non-motorized recreation but do not have trail-based information. These are defined as **linear features** (Figure 3). We obtained linear feature data from Alberta GeoDiscover, Alberta Biodiversity Monitoring Institute (ABMI), BC Data Catalogue, and the fRI Research (Table 3). Data sources also included various recreation groups, trail management websites, publicly available sources, and user-generated spatial data.

Table 1: Sources of documented linear features with recreational use from databases managed by federal and provincial governments in southwestern Alberta and southeastern British Columbia. The update or download year is either the year the dataset was updated, or the year the dataset was downloaded if the update year was unavailable.

Data source	**File name**	**Description**	**Update or download year**
Alberta Environment and Parks	DogSled	Dog sledding trails.	2012
Alberta Environment and Parks	OHV	OHV trails and other non-motorized trails. Includes season of use, surface, and activity allowances.	2018
Alberta Environment and Parks	OHV_Designated	Designated OHV trails including trail type (cutline, unimproved road), vehicle class (4x4, quad, motorbike, etc.).	2020
Alberta Environment and Parks	OHV_Informal	Informal trails — includes non-official linear features that had evidence on OHV use — low reliability.	2017
Alberta Environment and Parks	OHV_McLean	Designated OHV trails of McLean Creek, including type of trail (cutline, unimproved road, etc.), vehicle class (4x4, quad, motorbike, etc.).	2018
Alberta Environment and Parks	Snow vehicle	Snow vehicle trails, designation, and maintenance.	2015
Alberta Environment and Parks	SkiJoring	Designated skijoring trails.	2020
Alberta Environment and Parks	Trail	Name, type and activity on trails, maintenance, season used, surface, allowance (permitted, prohibited, etc.) of activities and temporal restrictions.	2019

Data source	File name	Description	Update or download year
Alberta Environment and Parks	TrailInformal	Informal trails, activities, temporal restrictions, maintenance and allowance of activities.	2019
Alberta Environment and Parks	Trails_Bighorn	OHV trails in the Bighorn region, including trail name and temporal restrictions for OHV use restrictions.	2009
Alberta Environment and Parks	Designated_Trails	Name, type and activity on trails, maintenance, season used, surface, allowance (permitted, prohibited, etc.) of activities and temporal restrictions. The most current layer so it took precedence over other layers if conflicts existed.	2021
Banff Field Unit	AbandonedTrails	Historic trails that are growing over, should see little human use.	2020
Banff Field Unit	LegacyRouteRoads	Recommended route for Legacy trail for cycling through the town of Banff. Includes municipal roads, not trails.	2020
Banff Field Unit	OfficialTrails	Official trails in BNP.	2020
Banff Field Unit	UnofficialTrails	Trails developed through repeated use, or trails that existed historically but are not maintained. This ranges from trails in closed, to known routes where use is accepted but trails are not maintained.	2020
Banff Field Unit	Trails_mtn_formal	Formal trails in BNP.	2022
Banff Field Unit	Trails_mtn_informal	Informal trails in BNP.	2022
Lake Louise, Yoho and Kootenay Field Unit	LLYK Official Hiking Trail	Official hiking trails in LLYK, only contains trail names.	2022
Lake Louise, Yoho and Kootenay Field Unit	LLYK Winter Trails	Winter trails in LLYK. Includes trail name, status, and winter activity type.	2022
Town of Banff Trails	TownofBanffTrails	Trails within the town of Banff.	2022
Mount Revelstoke and Glacier Field Unit	MRG_Trails	Trails from Mount Revelstoke and Glacier National Parks.	2020
Mount Revelstoke and Glacier Field Unit	MRG_SkiTouringRoutes	Ski touring routes from Mount Revelstoke and Glacier National Parks.	2020
BC Data Catalogue	H_TRAILS	Historic rail trails in BC.	2020
BC Data Catalogue	FTN_REC_LN	Recreation trails, contains name and status.	2020
BC Data Catalogue	SNWM_Trail	Regulated snowmobiling trails including seasonal closures.	2020
BC Data Catalogue	DGTL_ROAD_ATLAS	Rough resource roads.	2020
BC Data Catalogue	ATESAvalancheTerrainExpousreScaleLines	Winter trails including avalanche terrain exposure scales.	2020
BC Data Catalogue	Recreation management plans	Polygons describing motorized, non-motorized, summer and winter activities.	2021

Data source	File name	Description	Update or download year
BC Parks	Digitized maps from BC Parks website	Trails in BC parks.	2020
Revelstoke Snowmobiling Club	Digitized maps from Club websites	Snowmobiling trails and areas in BC (sledrevelstoke.com).	2021
Valemount Snowmobiling Club	Digitized maps from Club websites	Snowmobiling trails and areas in BC (ridevalemount.com).	2021

Table 2: Sources of undocumented linear features with recreational use in southwestern Alberta and southeastern British Columbia. The update or download year is either the year the dataset was updated, or the year the dataset was downloaded if the update year was unavailable.

Data source	Name	Website	Description	Update or download year
OpenStreetMaps		www.openstreepmaps.org	Publicly accessible and contributed website. Includes roads and trails categorized as cycleway, bridleway, trail, track, pathway, etc.	2020
Trailforks		www.trailforks.com	Publicly accessible and contributed website with trail data, descriptions of trails and comments.	2021
Southern Alberta Trail Mapping Project		www.albertatrailmaps.ca	Publicly accessible and contributed website aiming to map trails in Southern Alberta. Data is regularly updated and checked for accuracy. Only includes sanctioned trails.	2020
Back Country Skiing Canada	KokaneeGlacierPark, Trans Canada Trail	www.backcountryskiingcanada.com	Website providing information specific to backcountry skiing.	2020
Mountain Sense	Wapta_Traverse, AbbotsPassTraverse	www.mountainsense.ca	Website focusing on track data for Wapta traverse and AbbotsPassTraverse.	2020
Chatter Creek	ChatterCreek	www.chattercreek.ca	Website for Chatter Creek, including– tracks for cat ski runs.	2020
Columbia Valley GreenwaysTrail Alliance	Cvtrails_Ca	www.cvtrails.ca	Organization dedicated to recreational trail management in the Columbia Valley.	2020
Geoback Country	DawsonLoop, TupperAccess	www.geobackcountry.com	Backcountry recreation website selling books and skiing guides. Included spatial data for the Tupper ski route and Dawson loop.	2020
Backroad Mapbooks	Snowmobiling trails	www.gaiagps.com	Snowmobiling trails from Backroad Mapbooks and accessed via GaiaGPS.	2021
Summit Trail Makers Society		www.summittrailmakers.ca	Spatial data for trails in the Columbia Valley.	2021

Figure 3. Documented non-motorized mountain biking trail near Cedar Lakes, British Columbia (A); B) hiking trail near Thompson Falls, British Columbia; C) undocumented biking trail near Cedar Creek, British Columbia; D) cutline used by motorized recreation, Alberta (Mayhood 2015); E) rough resource road used by recreational vehicles, and; F) undocumented motorized trail near Thompson Falls, British Columbia.

Table 3. Data sources of linear features. Linear features can provide recreational access for motorized and non-motorized activities. The update or download year is either the year the dataset was updated, or the year the dataset was downloaded if the update year was unavailable.

Data source	**Name**	**Description**	**Update or download year**
Alberta Biodiversity Monitoring Institute	o19_Pipelines_Centerlines_HFI2018	Pipeline centerlines for Alberta	2018
Alberta Biodiversity Monitoring Institute	o03_Roads_Centerlines_HFI2018	Road centerlines for Alberta	2018
Alberta Biodiversity Monitoring Institute	o20_SeismicLines_Centerlines_HFI201	Seismic and cutline centerlines for Alberta	2018
fRI Research	OilandGasPipelineArc8	Oil and gas pipeline features for Alberta	2020
Alberta Environment and Parks	Cutline	Cutline features for Alberta	2020
Alberta Environment and Parks	Road	Road features for Alberta	2020
BC Data Catalogue	Pipeline_Rights_Of_Way_Permitted_Centerlines	Pipeline centerlines for British Columbia	2020
BC Data Catalogue	New_Pipeline_Segment_Permits	Pipeline centerlines for British Columbia	2020
BC Data Catalogue	BC_Transmission_Lines	Transmission centerlines for British Columbia	2020

Data processing steps

Combining and collating data sources

Once acquired, we combined and collated datasets. Many had overlapping spatial information, both within and among datasets. Government datasets took precedence, and we joined additional attribute data to them. When there were spatial overlaps between government datasets, we identified which layer had the highest spatial resolution by comparing it to satellite imagery and used it as the priority layer. For example, the blue line shown in Figure 4 provides more detail than the red line; thus, we selected the blue line layer. In most cases, the government-based datasets had the highest resolution and were therefore the base layer to which other information was added. If two datasets had similar spatial resolution and data origins (i.e., both government-based), we used the dataset with the larger spatial extent as the priority layer. If linear feature resolution could not be determined by examining satellite imagery (e.g., trail obscured by forest or located on rocky ground), we used government-sourced, or Global Positioning System (GPS) based data as the priority layer over other sources. All data were processed using ArcMap (Version 10.8.2; Environmental Systems Research Institute (ESRI) 2021).

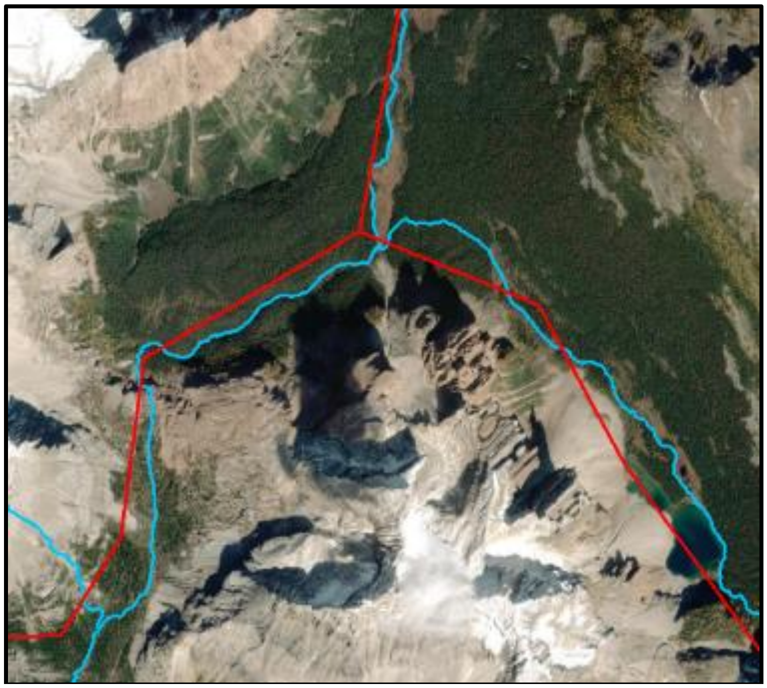

Figure 4. One trail mapped at different spatial resolutions in two datasets. The blue line maps the trail with a higher spatial resolution, while the red line maps at a lower spatial resolution. In this case, the dataset with the blue line would be selected.

To improve processing speed, we worked with a subset of linear features within 30 m of features in another layer using the "Select by Location" tool and the relationship "within a distance" of 30 meters. After selecting the spatial layer with the highest resolution (e.g., the blue line in Figure 4), we created a 30 m linear buffer on either side of the linear feature. We assessed buffered trail coverage using varying buffer widths (5 m, 10 m, 20 m, 30 m, and 50 m) in areas of high and low trail density. We determined a 30 m buffer to be optimal as it provided good coverage of overlapping lines but preserved the trail network structure in areas of high trail density. Using the buffered trails layer, we used the "Erase" tool to remove overlapping features from the layer with the lower resolution and the "Clip" tool to isolate overlapping features (Figure 5).

If both layers contained information important to our study, attribute data for overlapping linear features were joined. To do this, we created a 30 m buffer around the clipped low-resolution layer and conducted a Spatial Join between the buffer and the original high-resolution layer (Figure 5). We joined attributes using the centroid (line midpoint) within the buffer instead of the closest feature, as it improved the accuracy of the transfer when the lines did not precisely overlap. We merged the Spatial Join output back to the Erase output (Figure 5). As a result of the clip, some lines had 30 m of line removed, so we used the "Extend Line" tool (set to a maximum of 30 m) to extend the clipped lines from the endpoint to the nearest line. For overlapping features, we combined similar attribute fields into one column (e.g., trail names) or left them as separate columns if the data were unique (i.e., one layer had surface information, and the other had trail difficulty). To run a visual check and ensure the accurate transfer of information, we symbolized joined attributes with unique colours and compared them to the segments in the original layer.

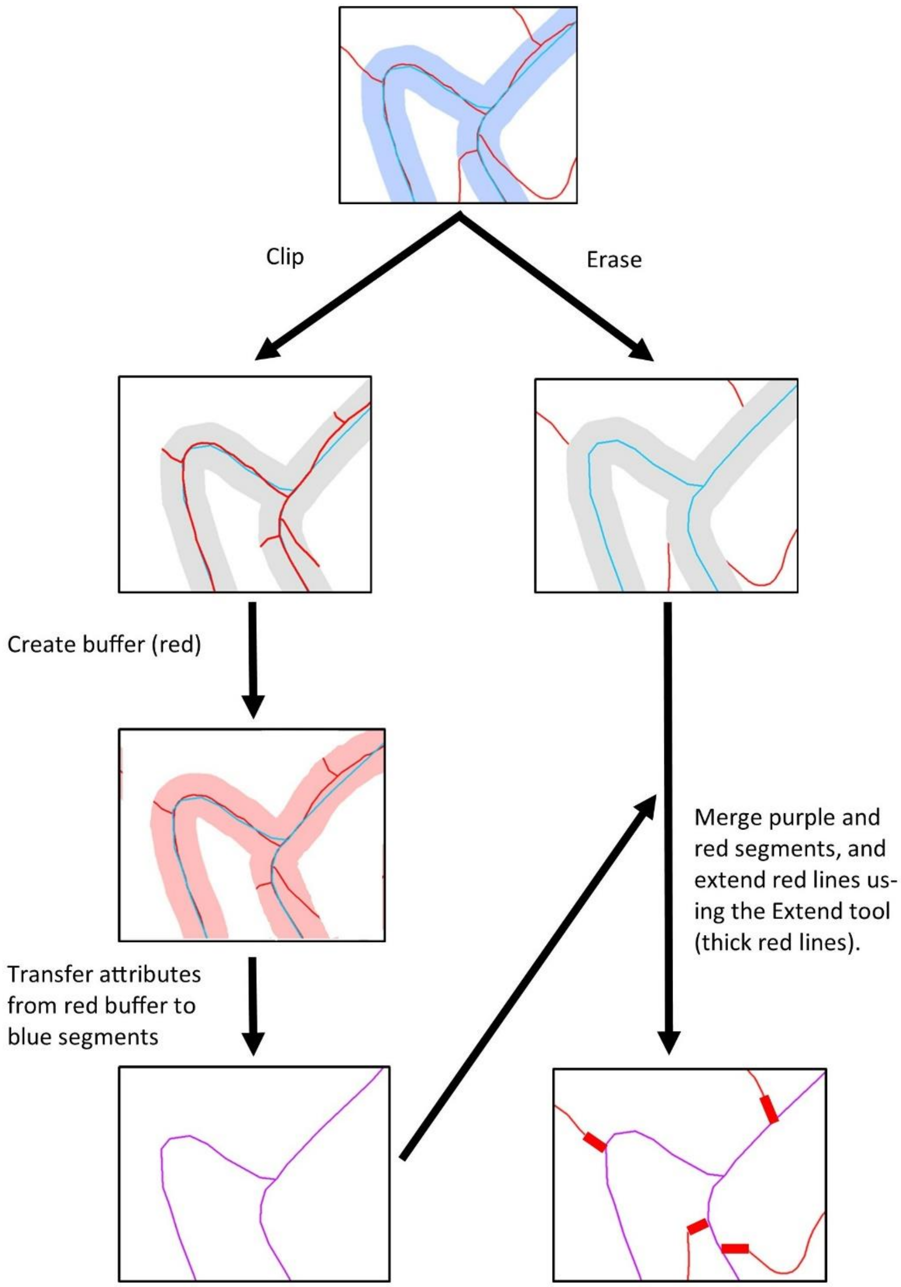

Figure 5. Workflow of the steps to combine and collate datasets with overlapping spatial features. We created a buffer for the priority trails (e.g., high-resolution and/or government trails; blue) and clipped or erased overlapping segments of the low-resolution trails (red). For clipped features, we created a 30 m buffer for the red segments to transfer the attributes from red to blue segments. This resulted in the creation of a new purple line that had attributes from the red and blue segments. Finally, we extended the clipped 30 m line segments using the "Extend Line" tool (thick red lines).

We repeated this process as new layers were added. If trails and linear features were greater than 30 m apart (i.e., buffers did not overlap), we assumed these represented unique trails and retained features from both layers.

Due to differences in shape among linear features, the 30 m buffer occasionally resulted in “floating” line segments (Figure 6). We converted the spatial data from multi-part to single-part features to remove floating segments using the “Multi-part to Singlepart” tool. We then searched by location to find the segments among the singlepart features that shared a line segment with the multi-part features. We deleted line segments less than 10 m from the dataset but retained segments over 10 m to prevent the removal of valuable information. This resulted in some isolated, longer floating segments. These inaccuracies were quantified through random sampling (see the validation section below for more details). Finally, we used “Topology Check” to identify spatial overlaps and then the “Planarize” tool to remove any overlaps.

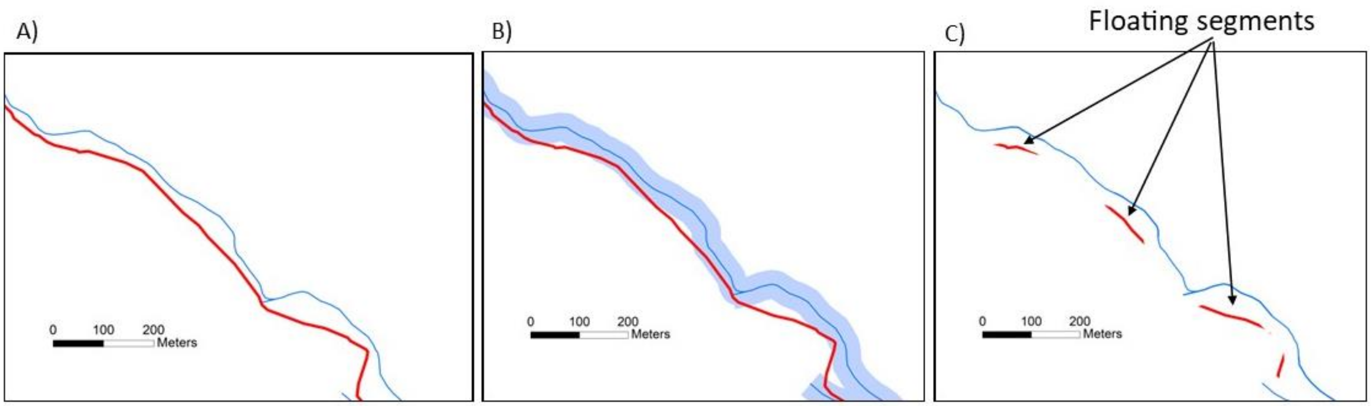

Figure 6. Examples of a) high (blue) and low (red) resolution linear features, b) the 30 m buffer of the high-resolution linear features, and c) floating segments.

Classifying trails and linear features

We used the trail layers described above to assign recreation activity and feature type (Objective 2; Figure 2). We classified trails by winter and summer motorized and non-motorized activities. Summer activities included hiking, biking, horseback riding, and OHV use. Winter activities included snowshoeing, backcountry and cross-country skiing, fat biking, and snowmobiling. For activity types, we used the following definitions:

- **Motorized**: designated OHV or snowmobile trails and any linear feature that was a cutline, powerline, or transmission line. It was also not specified if motorized activities were prohibited (snowmobiling or OHV).
- **Non-motorized**: any linear feature identified in a database specifically for hiking, biking, horseback riding, skiing, snowshoeing and/or winter (fat) biking **and** motorized activities that were either prohibited or not specified. It also included features without activity information but within a national park, where all motorized recreation activity is prohibited.

- **Motorized and non-motorized**: any linear feature classified with at least one motorized and non-motorized activity.

- **Motorized prohibited**: any linear feature with no specific activity type information occurring within a unique land use zone where motorized activities were not permitted, such as protected area, recreation or motor vehicle closure area, grazing disposition, or non-motorized designated recreation area.

- **Unknown**: any linear feature without activity type information.

We also included the maintenance status, designation, temporal restrictions, and whether the feature was used as an on-highway vehicle road in the summer but as a trail in winter (e.g., snowmobile trail). Trails and linear features were also classified using spatial data from recreation closure areas, recreation management plans, grazing allotments, and georeferenced and digitized maps (e.g., Backroad Mapbooks for snowmobile trails; Table 4). See Appendix A for further details on how data sources were used to inform our trail classification.

Table 4. Additional data sources used to assign trails and linear features with generalized activity types.

Data Source	Name	Description
BC government data portal	Recreation management plans	Motorized, non-motorized, summer and winter activities.
Backroad Mapbooks (via GaiaGPS)	Backroad Mapbooks - snowmobile trails	Georeferenced maps of snowmobile trails.
BC government data portal	Recreation closure areas	Areas where no motorized activity is permitted (motorized and snowmobiles).
BC government data portal	Motor vehicle closure	Areas where no motorized activity is permitted.
Government of Alberta	Grazing dispositions	Areas where no motorized activity is permitted.
World database on protected areas	Protected areas	No motorized activity unless it is on an official trail.
Revelstoke snowmobile club	Revelstoke snowmobile trails overview	Snowmobiling trails
Valemount snowmobiling club	Valemount snowmobiling trails	Snowmobiling trails

If trail information between sources did not agree, such as differing activities, we used the government-based source and/or the most recently updated or created feature. In all cases, the government dataset was given precedence over undocumented datasets.

Validating the trails and linear feature layer

We approached the validation of trails and linear features using multiple sources, mainly consisting of qualitative feedback. First, we visually compared portions of all layers to relevant satellite imagery (0.3 – 1 m resolution, depending on location; ArcGIS 10.8.2 imagery: ESRI, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community) in areas where there were spatial overlaps to determine how well each layer represented the feature (Figure 4). For example, trails in steep terrain would likely follow a contour rather than a straight line across steep elevation gradients, while other linear features are more visible in satellite imagery. We used satellite imagery to verify that linear features were in a location that made sense based on their surroundings or matched the imagery. Second, we requested feedback on trails and linear feature layers from provincial and federal government agency staff, including wildlife biologists, lands and habitat ecologists, land use planners, GIS technicians, and managers. We sought qualitative feedback via online presentations and discussions and incorporated this into our data acquisition, processing, and clean-up steps. Finally, we manually checked a subset of the study area for any spatial inaccuracies resulting from the combination of multiple data sources.

We quantified the geospatial accuracy of the linear features layer by creating 5 × 5 km grids that overlapped our study area (n = 2,761 grid cells). We identified the grid cells containing trails from more than one data source (i.e., indicating a potential for duplicate trails or floating segments; n = 1,761) and randomly selected 19% (n = 336) of these cells for manual assessment. We visually checked for geospatial inaccuracies in each grid cell, such as floating and duplicate trail segments. We focused on floating (see combining and collating data section above; Figure 6) and duplicate trail segments as these would increase the total lengths of linear features and contribute to double-counted features. Duplicated segments were parallel or had similar, but not identical, trajectories (Figure 7). We compared the total length of trails and linear features marked as inaccuracies (i.e., duplicate features or floating segments) to the total linear features mapped to calculate an error percentage and assumed this error rate represented total error.

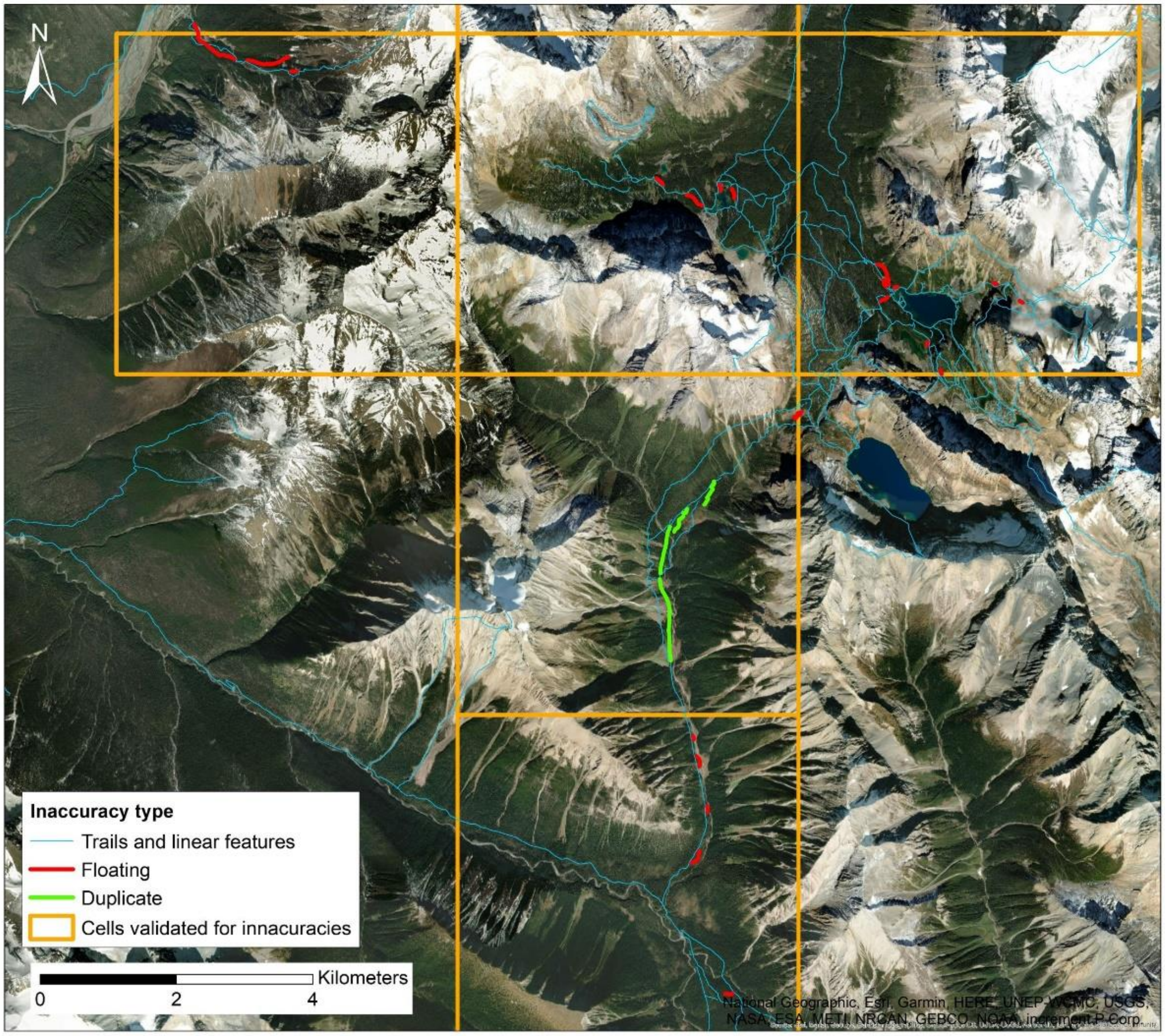

Figure 7. Example of quantitative validation of spatial inaccuracies resulting from combining multiple data sources: duplicate trail segments (red) and floating segments (green). Blue represents linear features without duplicate or floating segments. The orange lines represent the 5 × 5 km grid.

Linear density calculations

We calculated linear densities for each National Hydrographic Network 3rd-level watershed boundary (hydrologic unit code 6 equivalent in AB; hereafter referred to as "watershed") in the study area (Natural Resources Canada 2018; Figure 8). We did this by intersecting the trail and linear feature layer with the watershed polygon, dissolved the output by watershed identification and divided the total length of trails and linear features (km) within each watershed by the total watershed area (km^2).

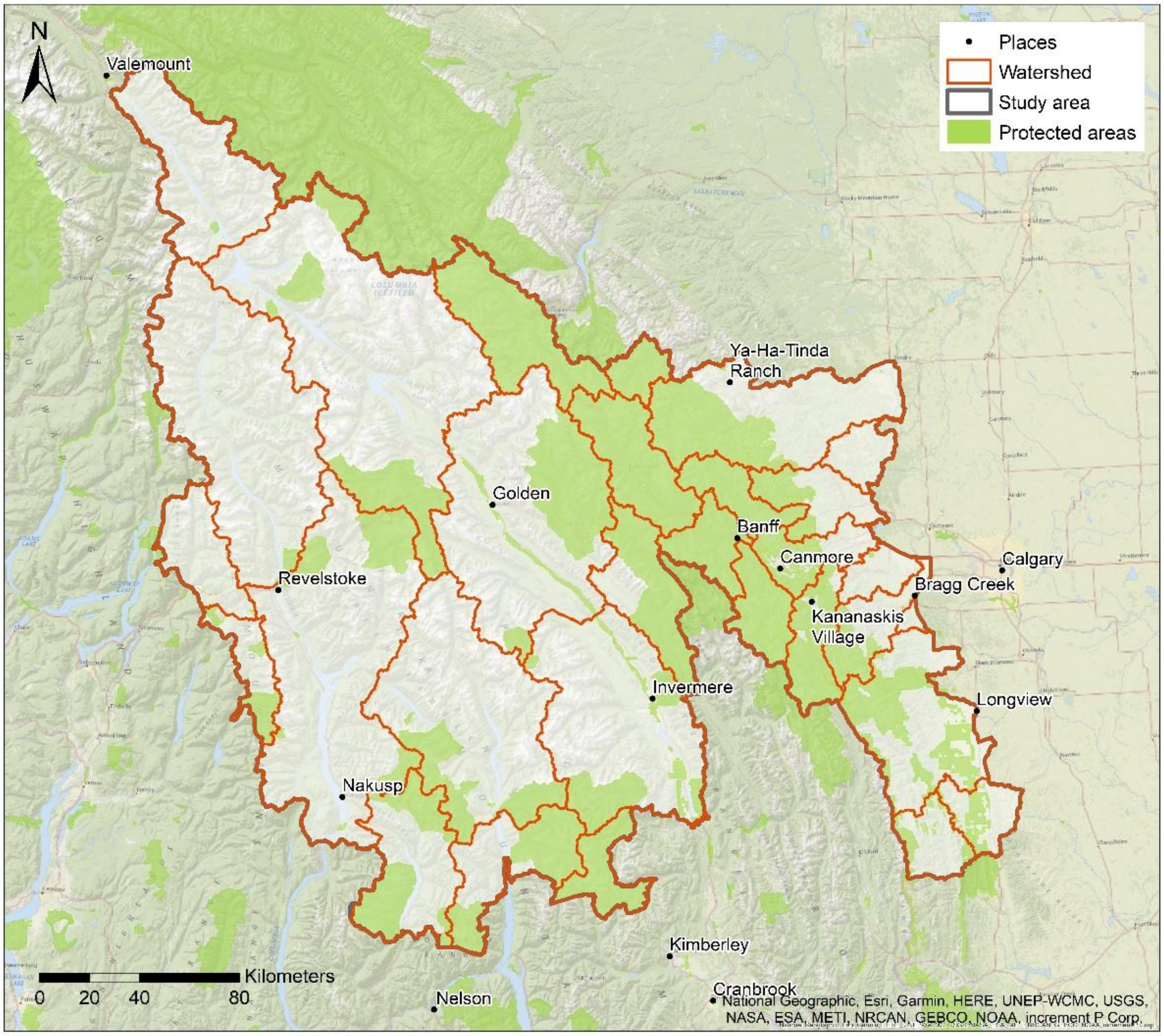

Figure 8. National Hydrographic Network 3rd-level watershed boundaries (HUC 6 equivalent) were used to calculate linear densities for the study area in southwestern Alberta and southeastern British Columbia.

Results

Mapping trails and linear features

We collected and collated 53,436 km of trails and linear features in our study area (Figure 9). From the total, 10,439 km (19.5%) were cutlines, pipelines or transmission lines, 20,956 km (39.2%) were rough resource roads, and 22,040 km (41.2%) were trails (Figure 10). Most rough resource roads were located in BC, while most cutlines were found in AB (Figure 11).

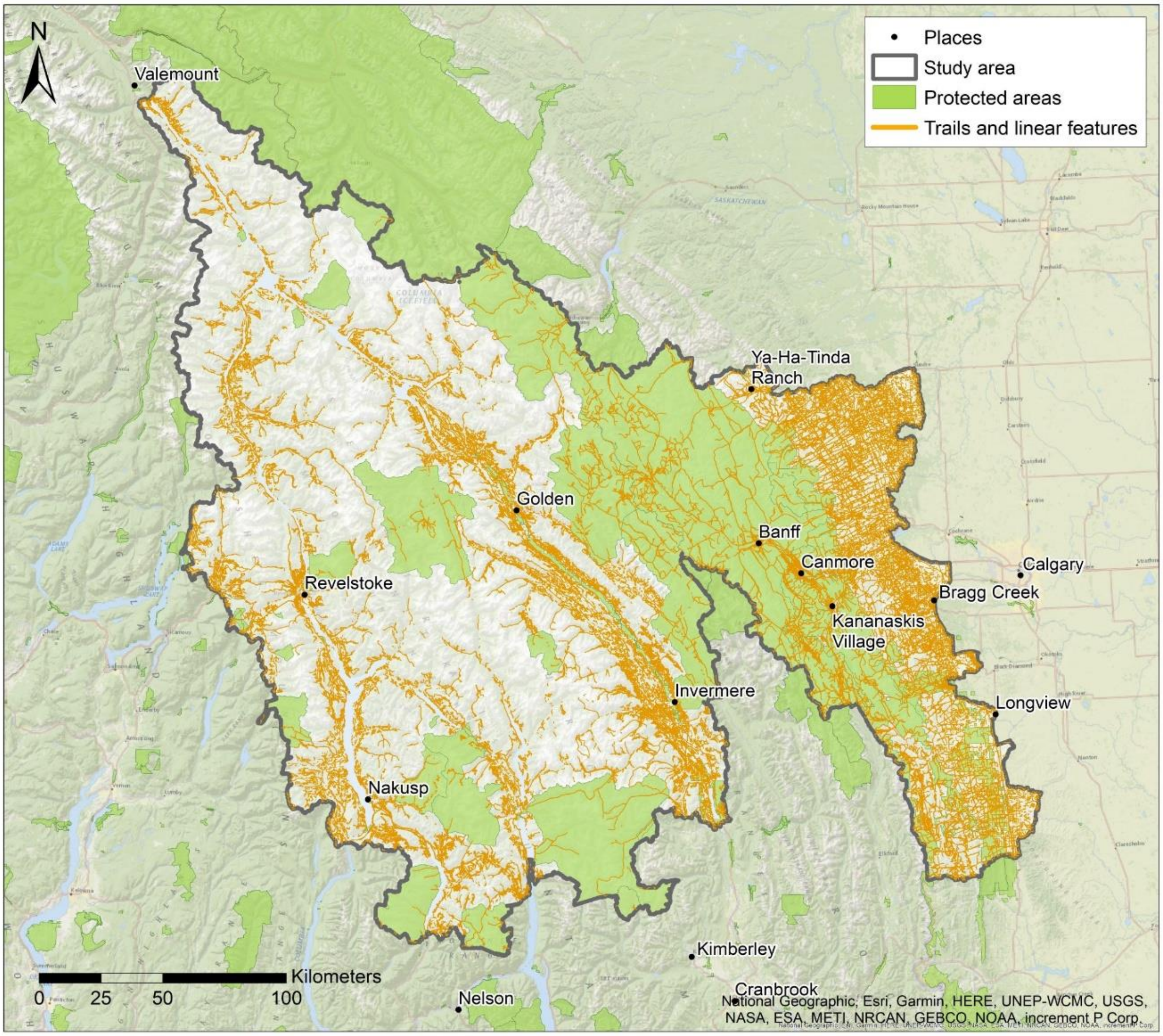

Figure 9. All recreational trails and linear features (53,436 km) in southeastern British Columbia and southwestern Alberta. Note that linear features provide a potential for recreational access, and use levels should be further validated.

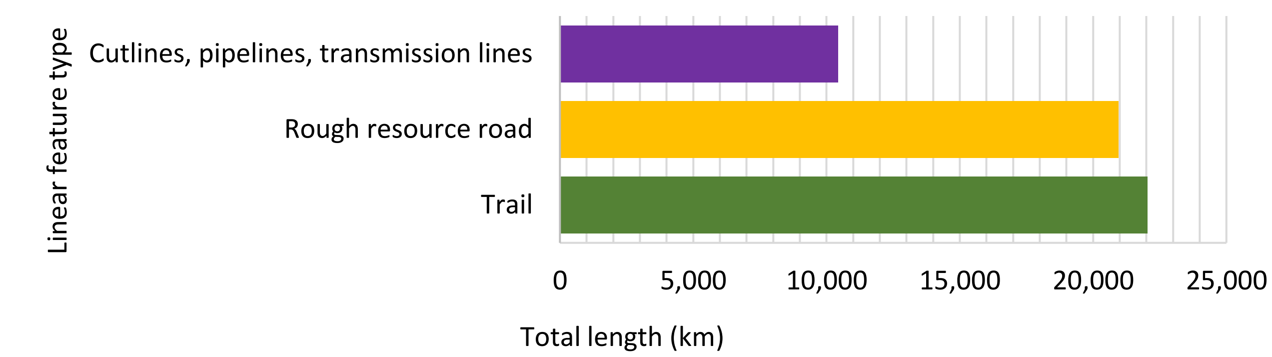

Figure 10. Total length (km) of each type of linear feature in southeastern British Columbia and southwestern Alberta, including rough resource roads, trails and cutlines, pipelines, and transmission lines.

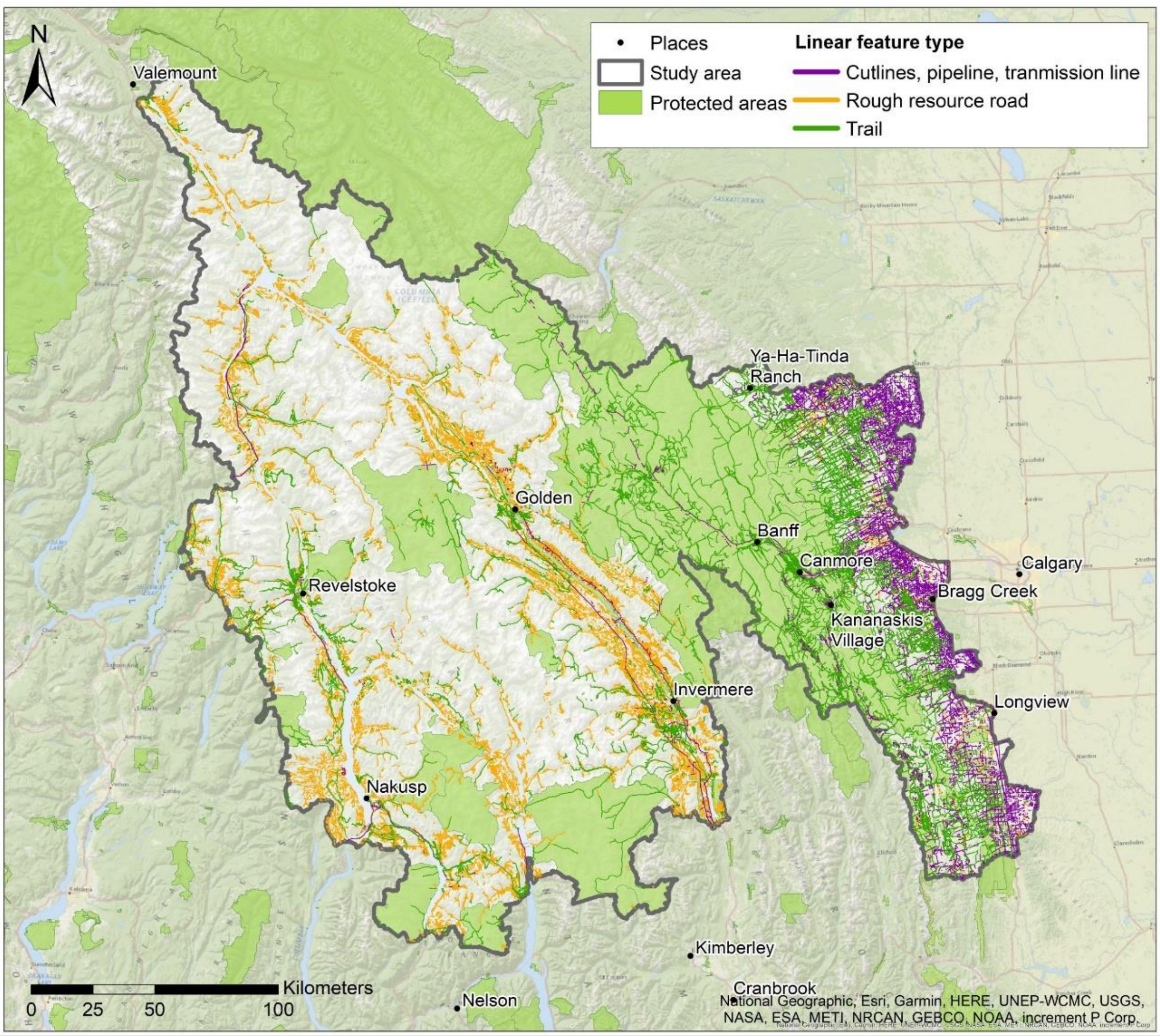

Figure 11. Types of linear features in southeastern British Columbia and southwestern Alberta including trails (green), rough resource roads (orange) and cutlines, pipelines, and transmission lines (purple). Note that linear features provide a potential for recreational access, and use levels should be further validated.

Motorized and non-motorized trails and linear features

Of all the trails and linear features mapped, 27,234 km (51.0%) were motorized (including cutlines and resource roads), and 10,897 km (20.4%) were non-motorized. Motorized activities were prohibited on 8,070 km (15.1%) of linear features, and 4,315 km (8.1%) were both motorized and non-motorized, while 2,919 km (5.5%) were of unknown activity (Figure 12, Figure 13).

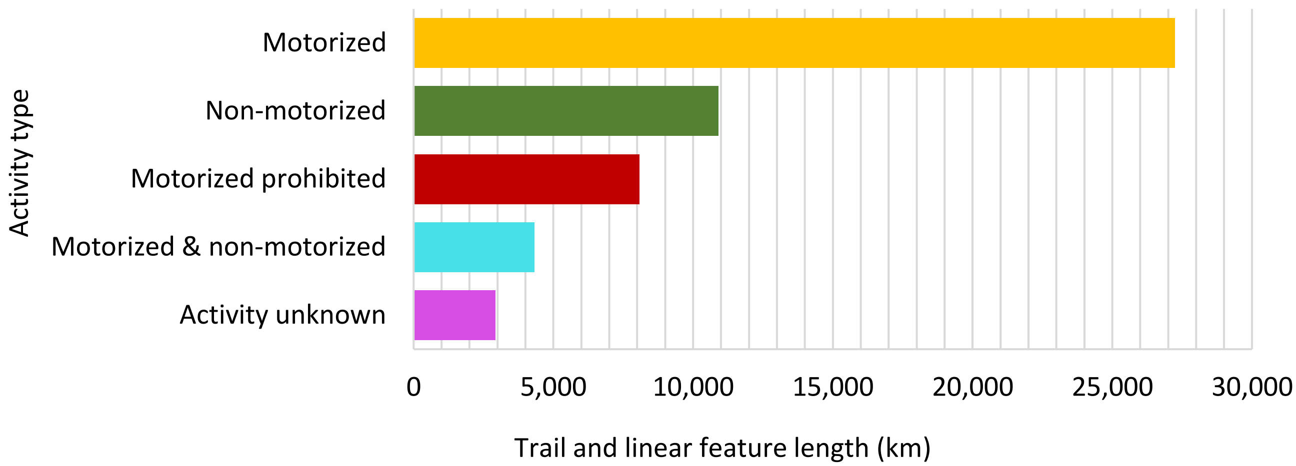

Figure 12. Total trail and linear feature length (km) for generalized activity types including motorized, non-motorized, motorized and non-motorized, motorized prohibited, activity unknown in southeastern British Columbia and southwestern Alberta.

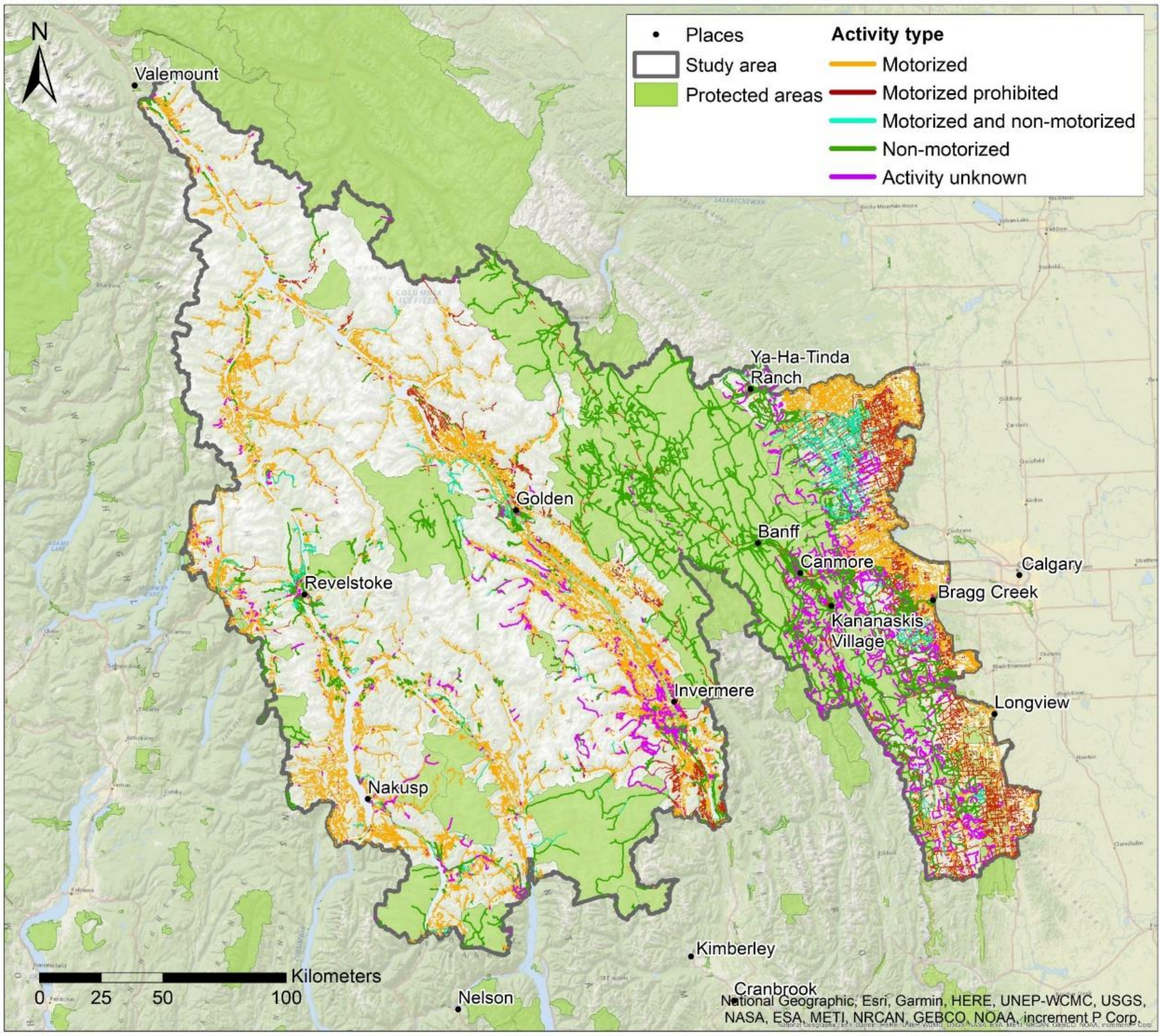

Figure 13. Motorized, non-motorized, shared motorized and non-motorized trails, linear features, and features with unknown and prohibited motorized activity in southeastern British Columbia and southwestern Alberta. Note that linear features provide a potential for recreational access, and use levels should be further validated.

Documented and undocumented trails and linear features

Of the total 53,436 km mapped, 24,543 km (45.9%) had recreation information; 18,611 km originated from government databases, and 5,932 km came from undocumented sources (Figure 14). Of the undocumented trails, OpenStreetMaps (OSM) contributed the greatest length (4,155 km, 70.0%), while other online sources (867 km, 14.6%), the Southern Alberta Trail Mapping Project (546 km, 9.2%), and Trailforks (365 km, 6.2%) contributed less (Figure 15).

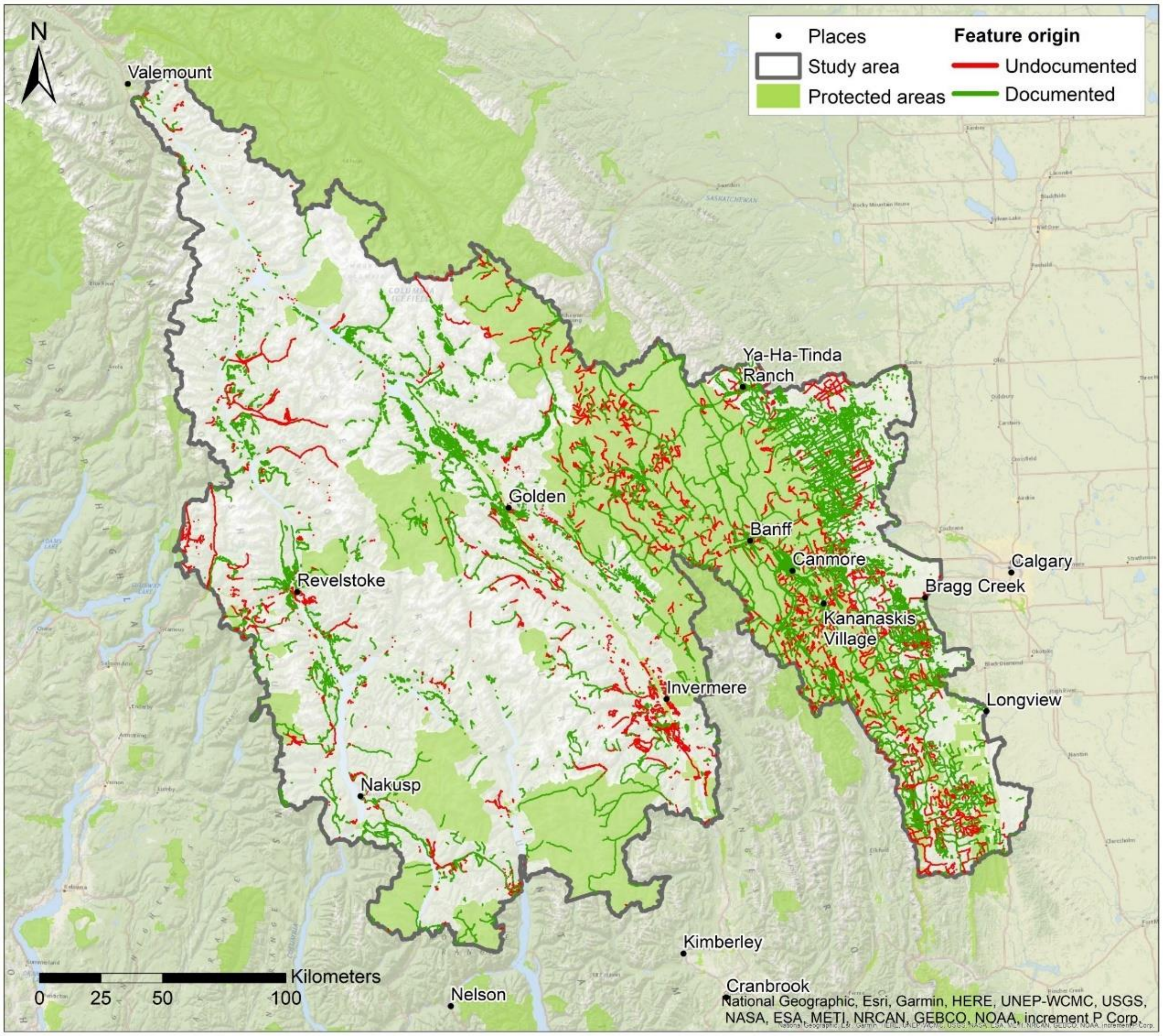

Figure 14. Recreational trails and linear features sourced from government databases (documented, green), features from other sources (undocumented, red) in southeastern British Columbia and southwestern Alberta. Note that linear features provide a potential for recreational access, and use levels should be further validated.

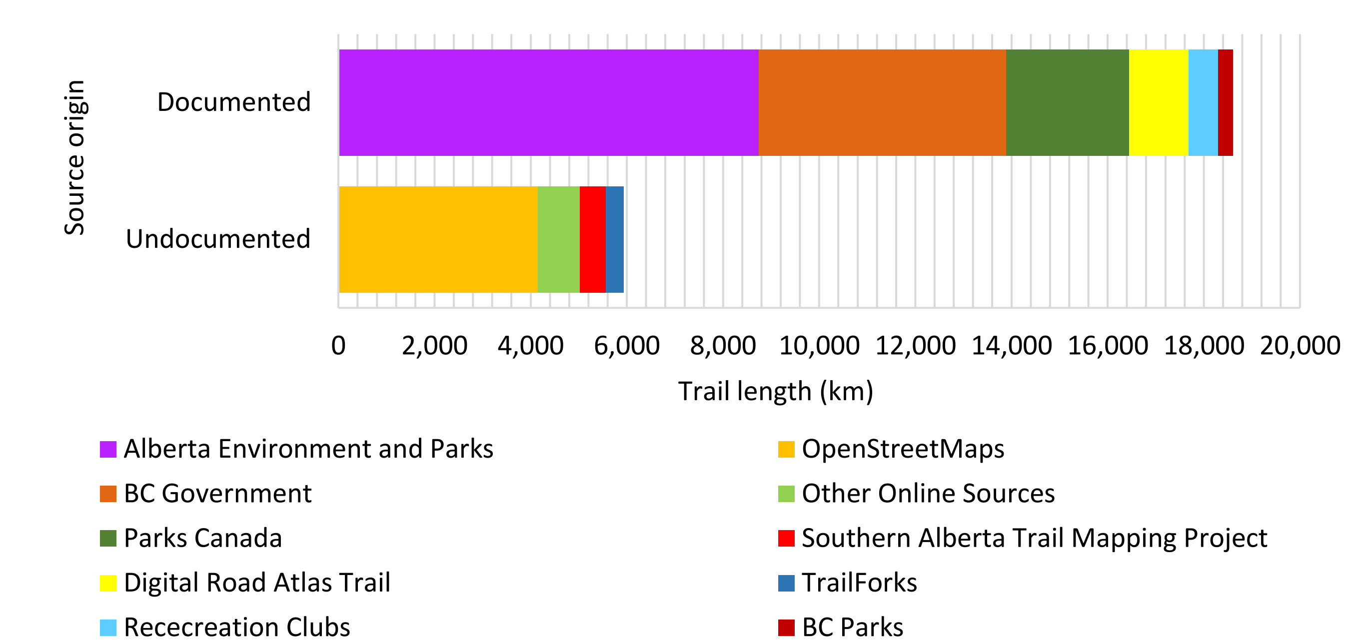

Figure 15. Total trail lengths (km) derived from documented and undocumented trails in southeastern British Columbia and southwestern Alberta.

Validating trails and linear features

The qualitative validation provided specific feedback on missing spatial data and steps we could take to improve our validation method (e.g., a validation grid).

We identified 238 km (2.5%) of inaccuracies from the quantitative validation: 167 km of floating segments and 71 km of duplicated features. Among linear features assessed for inaccuracies, we found that 105 km (1.1%) of trail segments, 59 km (0.6%) of resource roads, and 74 km (0.8%) of cutlines, pipelines, or transmission lines were duplicated or floating segments. Extrapolating these results to the entire dataset (52,488 km of trails and linear features with multiple data sources), we estimated that 1,312 km of features mapped were floating segments or duplicates: 577 km of trails, 315 km of resource roads and 420 km of cutlines, pipelines or transmission lines.

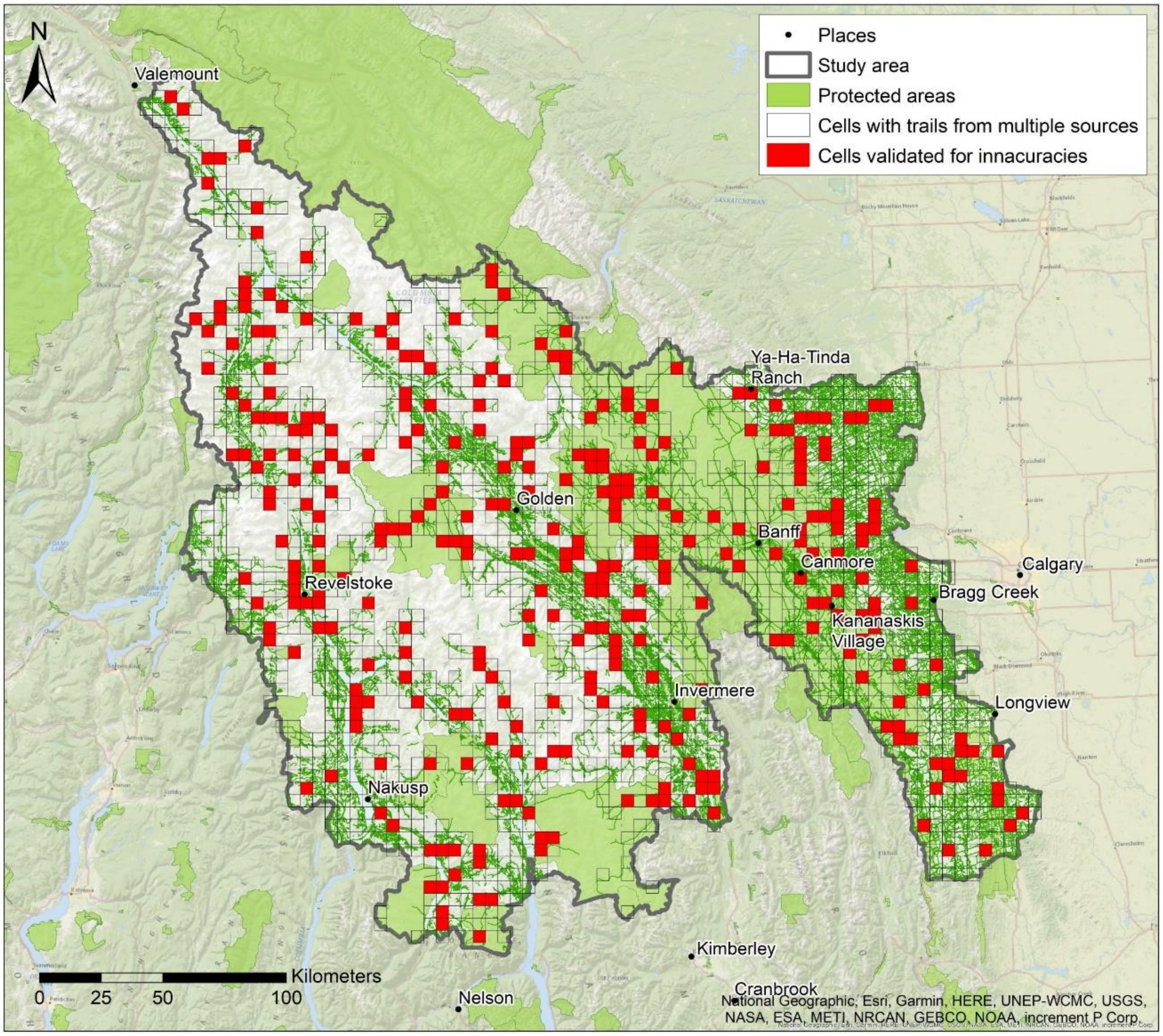

Figure 16. Recreational trails, linear features and 5 × 5 km grid cells used to manually quantify inaccuracies in southeastern British Columbia and southwestern Alberta. Grids were generated over linear feature segments with >1 source (green lines), and 19% of these cells (red cells) were selected to validate for inaccuracies. Note that linear features provide a potential for recreational access, and use levels should be further validated.

Linear density

The linear density of all recreational trails and linear features within the study area was 0.85 km/km^2 — in BC, it was 0.63 km/km^2 and 1.42 km/km^2 in AB. For all protected areas, linear density was 0.54 km/km^{2,} while it was 1.00 km/km^2 outside of protected areas. At the watershed level, linear densities of recreational trails and linear features ranged from 3.34 km/km^2 south of Bragg Creek (Watershed ID number 8; Table 5) to 0.12 km/km^2 at the southern end of the Purcell Wilderness Conservancy (Watershed ID number 4; Table 5, Figure 17). Activity types differed in density throughout watersheds, but watersheds in the northwest generally had lower linear activity densities than those in the eastern portion of the study area (Figure 17). Motorized trails and linear features, which include motorized trails, rough resource roads, and cutlines, had the highest linear densities in watersheds with resource development compared to watersheds containing protected areas (Figure 17). The lowest motorized trail and linear feature densities (< 0.16 km/km^2) were found along the Continental Divide in the protected areas. The highest densities of motorized and non-motorized trails and linear features were found around Bragg Creek, north of Canmore, and around the Ya Ha Tinda Ranch in Alberta. In comparison, the entire study area in BC had very low (> 0.16 km/km^2) motorized and non-motorized densities (Figure 17). Higher densities of non-motorized trails and linear features (0.50 – 0.98 km/km^2) were found along the Continental Divide and the Alberta foothills near Canmore and Banff (Figure 17).

Table 5. Linear densities for each watershed by activity type in southwestern Alberta and southeastern British Columbia. The left column (Watershed ID) matches polygon labels in Figure 17. All densities are reported in km/km^2.

Watershed ID	Watershed area (km^2)	Total linear density	Motorized density	Motorized and non-motorized density	Non-motorized density
1	719	0.52	0.00	0.02	0.46
2	473	2.49	1.22	0.08	0.25
3	6475	0.68	0.54	0.04	0.08
4	721	0.12	0.02	0.00	0.10
5	662	1.91	0.53	0.06	0.11
6	433	0.23	0.00	0.00	0.23
7	878	1.94	0.46	0.24	0.63
8	83	3.33	1.63	0.84	0.06
9	943	1.83	0.57	0.72	0.25
10	701	1.82	0.74	0.07	0.15
11	1479	0.68	0.00	0.00	0.61
12	4448	1.27	0.84	0.04	0.12
13	5649	0.87	0.54	0.06	0.16
14	1851	0.29	0.00	0.00	0.25
15	3176	1.62	0.72	0.33	0.23
16	2602	1.64	0.35	0.09	0.42
17	920	1.68	0.06	0.00	0.80
18	517	2.61	0.81	0.33	0.01
19	4760	0.37	0.31	0.02	0.03
20	1596	0.60	0.42	0.07	0.10
21	2563	0.36	0.33	0.01	0.02
22	7866	0.38	0.28	0.02	0.02
23	708	0.53	0.36	0.01	0.13
24	1987	0.73	0.57	0.07	0.08
25	1115	0.91	0.76	0.07	0.04
26	784	1.03	0.00	0.00	0.67
27	814	2.43	0.98	0.00	0.97
28	742	0.85	0.00	0.00	0.77
29	5630	0.51	0.42	0.06	0.03
30	1468	0.54	0.14	0.01	0.24

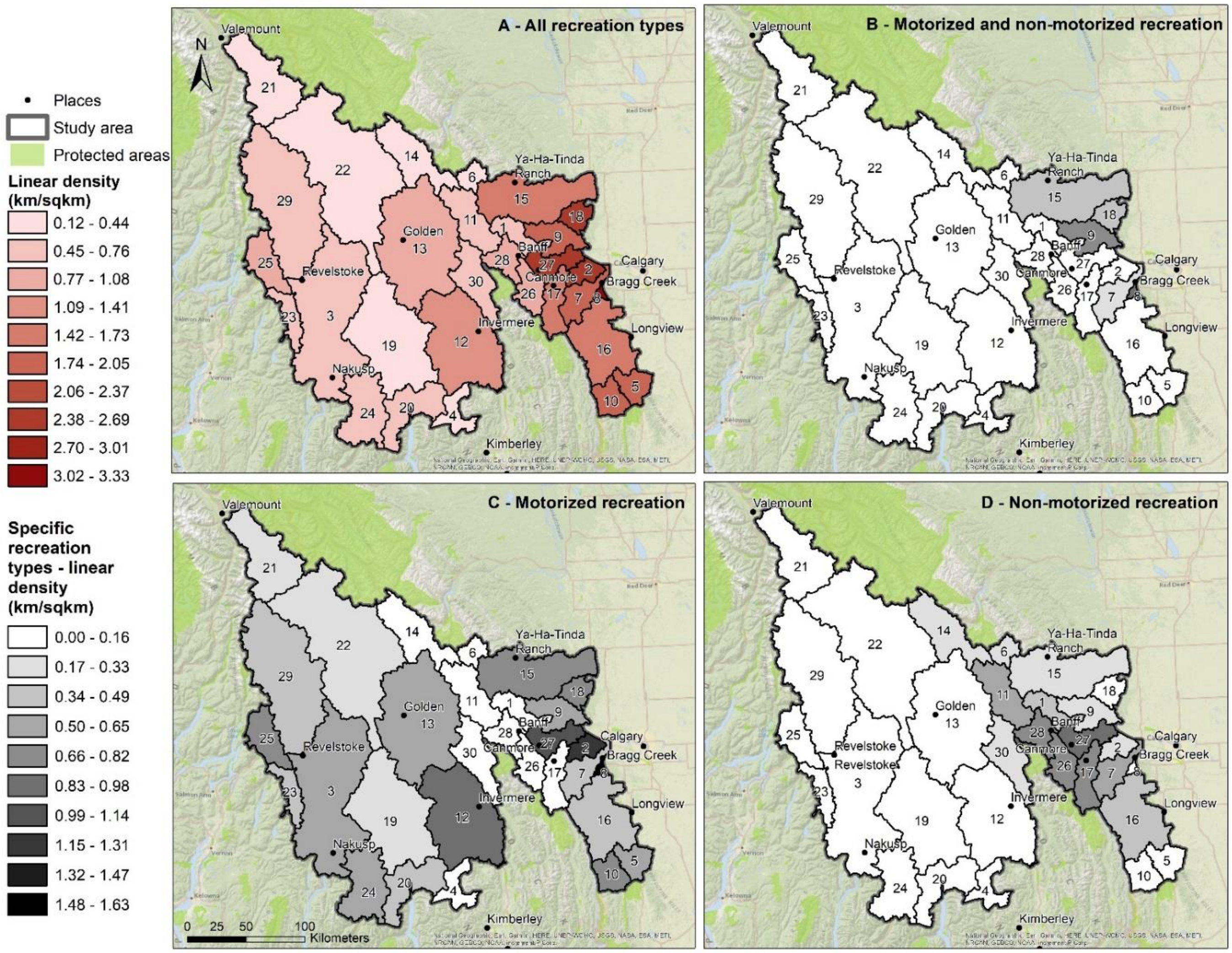

Figure 17. Linear density of recreation trails and linear features for A) All recreation types; B) Motorized and non-motorized recreation; C) Motorized recreation; and E) Non-motorized recreation at the watershed level in southeastern British Columbia and southwestern Alberta. Exact density calculations of numbered polygons match the 'Watershed ID' column in Table 5. Note that linear features provide a potential for recreational access, and use levels should be further validated.

Discussion

The southern Canadian Rockies and Columbia Mountains landscape is increasingly becoming a recreation hub in western Canada. Although some federal and provincial management plans and strategies are in place for recreation (Government of Alberta 2002, 2008, 2018, Ministry of Forests, Lands, and Natural Resource Operations 2013, Parks Canada Agency 2021), there is less known about where people are going and what activities are occurring in those areas. Increasing outdoor recreation and accessibility could increase negative effects on nature and people (Gaines et al. 2003), supporting the need to understand the recreation footprint for successful management. Without advanced planning and management, recreationists can inadvertently access sensitive ecological areas, engage in activities that may damage vegetation and trails, disrupt wildlife, and come into conflict with other users. This pattern might lead to areas exceeding their capacity to sustain recreation (Dertien et al. 2021), degrade habitats, stress wildlife species, and diminish recreational experiences (Pilcher et al. 2009, Mayhood 2013, Gutzwiller et al. 2017, Miller et al. 2017).

We collected and collated data on recreational trails and linear features as a first step to understanding the extent and intensity of the human recreation footprint. We found a total of 53,436 km of trails and linear features in our study area. About 45.9% were trails with recreation information, of which a noteworthy 24% originated from undocumented sources. Undocumented trails typically do not appear in management-based databases, so they are likely not included in management decisions. Yet, they contribute to the overall recreation footprint of the area. These trails are likely unmaintained, thus creating a public safety risk (Anchan 2022). Since undocumented trails such as those found on OpenStreetMaps (OSM) are the basis of smartphone recreation apps such as Gaia, STRAVA and AllTrails, information on their existence is widely available and may attract future use. As agencies advance legislation aimed at managing trails, such as the Alberta Trails Act, that aims to "align trails and their management with how trails are currently used" (Government of Alberta 2022), it is important to incorporate information added by undocumented sources to determine if, and how, those trails are being used.

The amount each data source contributed to undocumented trails varied. For example, OSM was the largest data source for undocumented trails (70%), but the activities occurring on each trail type were unclear. Because OSM is an open-source, user-generated dataset, we were not comfortable using its data to classify activities — its definitions varied widely and could be subject to different interpretations (e.g., does "trail" mean non-motorized? Does "cycleway" mean only bikes?). Additionally, 53% of the undocumented trails originating from OSM were classed as a "route" that may see very little recreational use or simply be wildlife trails. In comparison, the information gathered by the Southern Alberta Trail Mapping project (SATMP; 9% of undocumented linear features and trails) was also user-generated but administered by the website manager to ensure accurate trail information. These data had enough detail and consistency to distinguish motorized from non-motorized activities. Gathering data from Trailforks (6% of undocumented features) required a subscription, and features could only be downloaded one at a time, which was useful for concentrated areas but time-consuming for large areas. However, large-scale data scraping from social networks can be used to collect recreational geospatial data and contribute towards modelling human recreational use (Goodbody et al. 2021). These efforts, however, were beyond the scope of this study.

In contrast to undocumented sources, documented data sources provide greater reliability. Data gathered from Alberta Environment and Parks contributed the largest amount of documented recreational trails and linear features (47% of documented trails). For example, AEP and Parks Canada data often contained the most detailed data regarding activities, designation, trail names, and temporal restrictions. However, the spatial extent of documented sources is often limited to parks and protected areas and excludes large areas that are heavily used by recreation users.

We occasionally found conflicting information when using multiple data sources in identical spatial extents. For example, the SATMP dataset classified a paved road near the Banff townsite — a feature type we did not include as part of the recreational footprint — as a non-motorized trail. Upon further investigation, we found these linear features were used for both non-motorized (walking and biking, as seen on STRAVA and AllTrails) and motorized activities that included highway (passenger) vehicles. Including multiple sources of information, such as documented and undocumented datasets, can enrich data and reduce knowledge gaps in where, when, and what type of recreation occurs throughout the landscape.

Resource roads and cutlines classified for motorized use represented > 50% of all mapped trails and linear features, which indicates they contributed extensively to the recreation footprint (Figure 10). Recreation management can be especially challenging when recreation occurs on linear features not designed for recreation (e.g., OHV use on cutlines or resource roads) and can contribute to increased erosion, damage to vegetation communities, and wildlife disturbance (Hornseth et al. 2018). Species sensitive to human recreation, like grizzly bears (*Ursus arctos)*, may be displaced from areas used for motorized recreation activities (Ladle et al. 2018). Past studies suggest that motorized recreational activities increase soil compaction, erosion, and stream sedimentation resulting in depressed/reduced vegetation regeneration and fish survival (e.g., bull trout (*Salvelinus confluentus*); Ouren et al. 2009, Mayhood 2013). Considering the potential negative effects that recreation can have on habitats and wildlife, the large spatial extent of linear features, and the increased access these features provide into remote areas, it is imperative to include them as part of recreation management. Linear feature reclamation is one tool that can minimize the negative effects of recreation, and knowing the classification of linear features can help identify the required management actions. For example, physically deactivating resource roads or managing them for specific uses can limit motorized access (Forest Practices Board 2021). Cutlines no longer in use can be treated to regenerate trees, de-compact soil, or reduce prey-predator encounters by disrupting sightlines and introducing measures to manage access (Dickie et al. 2017, Dabros et al. 2018).

Documenting the density of linear features available for recreational activities in an area helps to understand the distribution and intensity of recreation across a landscape. We found watersheds in the northwest portion of the study area had lower linear densities (0.12 – 0.44 km/km^2) compared to the centre-east region in Alberta (2.07 – 3.34 km/km^2). Understanding linear density thresholds at which wildlife is negatively affected can aid in adaptive management and planning for recreation. Research on grizzly bears shows road densities above 0.6 – 0.75 km/km^2 may result in population declines (Mace et al. 1996, Boulanger and Stenhouse 2014, Farr et al. 2018, Lamb et al. 2018). Ripley et al. (2005) found individual bull trout were rare in rivers adjacent to areas with road densities > 0.4 km/km^2 and absent where road densities > 1.6 km/km^2. Since these studies focused on motorized roads only, we directly compared them with motorized trails and linear features. The motorized linear density observed in our study area exceeded the minimum threshold for grizzly bears in 8 of the 30 watersheds (> 0.6 km/km^2). It surpassed the bull trout threshold (0.4 km/km^2) in 16 of 30 watersheds. Areas with high linear feature density include the northeast, southeast, Canmore, and west of Revelstoke (watersheds ID: 2, 10,12, 15, 18, 25 and 27; Figure 17). It is important to note that our linear density analyses did not include paved and gravelled roads, so overall linear densities would be higher if roads with higher vehicle traffic had been included. While linear density thresholds can vary based on many parameters (e.g., context, season, wildlife age class and reproductive state; Boulanger and Stenhouse 2014, van der Marel et al. 2020, Dertien et al. 2021), linear feature thresholds are a common management tool for mitigation. In our study area, motorized linear densities ranged from 0 km/km^2 in watersheds entirely within protected areas to 1.6 km/km^2, where linear densities of both motorized and non-motorized features were also the highest. For comparison, non-motorized linear densities ranged from 0.005 km/km^2 to 0.97 km/km^2. We recommend that future studies include thresholds for linear features that support both motorized and non-motorized activities to better estimate disturbance thresholds for wildlife.

This study was based solely on information available from digital sources. An advantage of the combined dataset that this created is that it allows for extensive spatial coverage at minimal expense and effort relative to a field-based survey. However, this comes at the cost of potentially undetected errors. For example, a reclaimed cutline with mid-seral vegetation growth has a low probability of recreational use (Pigeon et al. 2016, Hornseth et al. 2018). In such cases, our approach could overestimate the recreation footprint. Further, determining spatial inaccuracies arising from combining different sources is challenging with our data-gathering approach since it remains unclear if these inaccuracies result from spatial errors among sources or multiple trails at high density on the ground. Thus, we recommend future studies to verify spatial layers in the field to validate the configuration, recreation use and activity type. Future research could also work towards the automation of new trail-based information.

Demands for outdoor recreational opportunities are increasing, and people are travelling deeper into remote areas. This has created an urgent need to identify where people go and what activities occur to effectively manage and limit the negative effects of recreational activities on wildlife, sensitive habitats, and other recreationists. Identifying undocumented trails provided our study with a deeper understanding of the activities occurring in recreation areas and, critically, their potential to affect wildlife and/or sensitive habitats. We found that including documented trails, undocumented trails, and linear features was paramount to understanding the recreational footprint. Our findings contribute to the growing body of recreation research and information, which can help adapt practices managing sustainable recreation activities to minimize negative effects on wildlife populations and other sensitive habitats.

Management implications

We found a substantial amount of trail and linear feature data missing from government (documented) datasets. Indeed, 24% of trail data originated from undocumented sources, highlighting that the recreation footprint is underestimated when only government data sources are used — recreationists may be unexpectedly accessing protected or sensitive wildlife areas. We also found that, of all the trails and linear features mapped, 51.0% were motorized, indicating an unequal representation of activity types in our study area.

Our results filled a data gap and highlighted that traditional methods to monitor recreation don't match the pace at which recreation is expanding. Findings from this study support continued enforcement by federal, provincial, and Indigenous governments to ensure recreation only occurs in intended locations. We recommend that managers focus on increasing signage, education, and monitoring but also place increased emphasis on land use and recreation planning. Planning for recreation activities will reduce conflict between recreation user groups, wildlife, and sensitive habitats.

For data collection efforts like those documented in this report to be relevant, they require continuous updates, a need that provincial and federal managers have identified. While this project was a one-time effort, it lays the foundation for future analyses that could occur at similarly large landscapes. Future research should include a way to automate or ensure the incorporation of new and emerging trail-based information.

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Appendix

Table 6. Trail and linear feature field dictionary. For the attributes column, we used binary and no data levels. A zero (0) equals no, a 1 equals yes, and 99 indicates no information.

Field Name	Attributes	Description
Winter_YN	0,1,99	Whether trail is used in winter (1) or not (0) or unknown (99)
Summer_YN	0,1,99	Whether trail is used in summer (1) or not (0) or unknown (99)
SummerRd_YN	0,1,99	Whether features are a road in the summer, but closed to vehicles in winter and used as a trail (1) or not (0) or unknown (99)
Temporal_Restriction_YN	0,1,99	Whether trail has any temporal restrictions where access/activity is prohibited (1) or not (0) or unknown (99)
TimeRestriction_Start	Date	Date temporal restrictions starts
TimeRestriction_End	Date	Date temporal restrictions ends
Sanctioned_YN	0,1,99	Whether trail is sanctioned/official/designated (1) or not (0) or unknown (99)
Name, Trail name etc.	Various names	Name of trail
DataSourceDate	Dates	Date of data source
DateUpdate	Dates	Date data source was updated
FileSharingStatus	RESTRICTED or null	If information is sharable or not (shared by partners, not for public)
FeatureYear	Year	Year digital feature created — from source data
UpdateYearName	Year_Name	Year and name of updated layer at RecEcol Project
PhysicalYear		Year trails/linear features were physically created if information is available
RecEcol_TrailID		ID number attributed to each trail segment
Activity_Type	Motorized; non-motorized; motorized prohibited; motorized & non-motorized; activity unknown	Generalized activity classification for linear features based on detailed source information

LinearFeature_Type	Trail; resource road; cutline, pipeline and transmission line.	Generalized linear feature type based on source information
General_Source	Various names	Generalized name of source based on original organization information source
Documented_Type	Documented; undocumented; resource road, seismic, pipeline	Generalized classification for source of feature information based on general source
Inaccuracy_Type	Floating; parallel	Identifies inconsistencies from validation of 20% of 5 × 5 km cells
Original_RecEcolSources	Various names	List of all original sources contributing information to trail segment