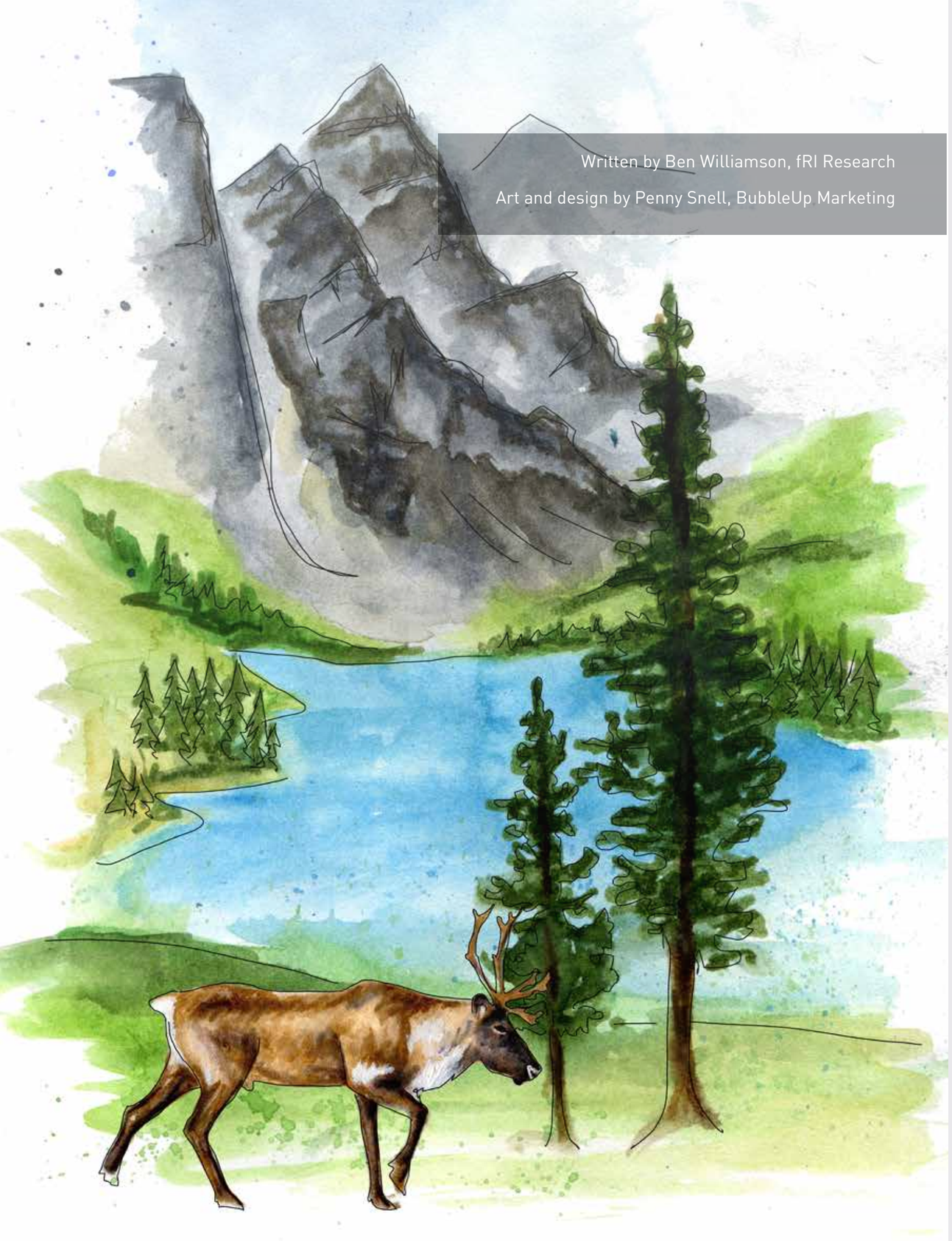
2020–2021 ANNUAL REPORT

fRI Research
Informing Land & Resource Management



Written by Ben Williamson, fRI Research

Art and design by Penny Snell, BubbleUp Marketing

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PRESIDENT'S MESSAGE

By Jesse Kirillo

To say that 2021 has been a challenge would be an understatement, not only as an organization but as a society. However, it is encouraging to see how well fRI Research has adapted and done so in a safe manner.

At each board meeting it is clear that our shareholders are proud to see how well each program has completed their work plans, no matter the wave we have had to ride. Not only have our programs shown they can complete the research our partners are pursuing, but the organization has also added new partners and shareholders in 2021. To those that are new on the Board, all of us at fRI Research are excited to work with you.

We are encouraged that our associations—the new ARCKP, FGrOW, FLMF, and FSCP—are growing and finding productive partnerships with programs such as the Caribou Program. Work is also underway to create our next five-year strategy as this is a critical focus for our shareholders and partners going forward.

It's clear that the way land is managed, and natural resources are developed, are changing. With that, we see an opportunity to engage with new partners, take on the challenges it presents, and make a positive impact in the years to come.

GENERAL MANAGER'S MESSAGE

By Ryan Tew

The times that we can be most proud of are when challenges come in from all directions and we excel anyway. 2020–2021 was that kind of year. Our staff were able to adapt to the pandemic and continue delivering on our research commitments, and our partners never wavered in their support for us.

The Forest Resource Improvement Association of Alberta, and the forest industry at large, have continued to stay engaged with us and our work throughout. I'd like to particularly thank our energy industry partners for standing by their commitments during these extraordinarily difficult economic times.

The resilience of our employees, from administration to program leads to field crews, has been remarkable, and that has allowed us to continue steadily fulfilling the goals set out in our 2017–2022 Strategic Plan. With some adjustments, we were able to continue our data collection efforts in the field, and by leveraging our long-standing investments in our IT infrastructure, we were able to quickly shift to remote work.

But 2020–2021 wasn't just a year where we were content to keep our head above the water. We welcomed a new association onboard, the Alberta Regional Caribou Knowledge Partnership, which will fund new research on Alberta's threatened caribou herds and help mobilize the knowledge already generated so that industry and government can make the best decisions possible.

The Board of Directors also recognized that water remains a fundamental focus as industry and government ensure that resource development is carried out responsibly. To this end, our partnership has provided critical backing, including funding, to keep the fRI Research Water and Fish Program moving forward to meet partner's research needs

My gratitude goes out to all our partners, staff, and contractors for their dedication and commitment to fRI Research during a year of adversity. We've met tough challenges many times in our history, and we've always come out stronger and more motivated, but this year marks a new high point. It's something we should all be tremendously proud of.

2020–2021 BOARD OF DIRECTORS

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HERE BE BEARS

Until 2021, for anyone looking at a map of grizzly bear populations in Alberta, one area was blank. For the Swan Hills bear management area, like certain maps from older times, we could say nothing more definite than Here Be Bears. Today, Swan Hills, the easternmost area and last to be scientifically surveyed, has been filled in.

This effort by the Grizzly Bear Program, plus a simultaneous recount in the Clearwater area, has allowed the province to estimate the total number of resident bears in Alberta with much greater certainty. This can be the basis for making management decisions for this threatened species and evaluating their success.

The Grizzly Bear Program's first population survey was in 2004 and deployed the gold-standard method of estimating grizzly bear numbers. The crew set up 180 scent lures in the forest – a pile of branches doused in rotten cattle blood and surrounded by a string of barbed wire. They revisited each site regularly to collect tufts of hair left behind by curious bears. This let the team collect bear DNA, identify individuals, and use statistics to estimate the total population size in the area.

In the years since, the team kept refining the method while surveying six of the seven provincial Bear Management Areas, plus two recounts to see how the populations are changing. We tested different scent lure locations


Isobel Phoebus


Isobel Phoebus

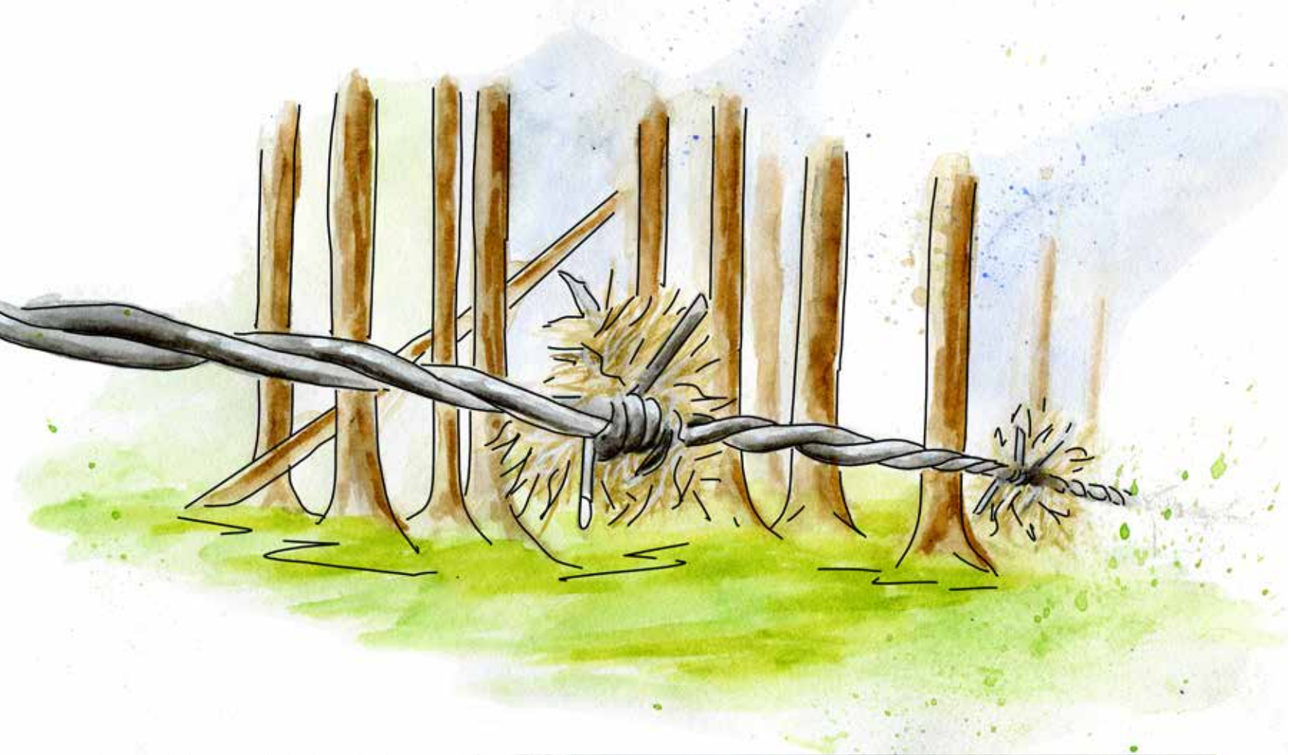

Isobel Phoebus

The Grizzly Bear Program is Hibernating

As of April 2021, the Grizzly Bear Program is not currently starting new research projects. We are continuing to publish papers and maintain our long-term dataset and GIS tools for our academic, government, and industry partners.

Over 23 years, the Program has helped train 51 graduate students, published hundreds of papers, and pioneered new scientific methods in conservation biology.

See page 16 or more accomplishments.



and upgraded our statistical methods. And meanwhile, those estimates were showing lower grizzly bear populations than previously thought. The Government of Alberta set a moratorium on hunting grizzly bears in 2006 and, in 2010, officially listed them as threatened.

In 2014, the Grizzly Bear Program returned to the first area we surveyed, and found some encouraging signs. The Yellowhead population had approximately doubled in a 10-year period, increasing at 7% per year. And now with the latest results, we have found a second area with growing populations.

The Clearwater area is over 7,000 km^2 of foothills stretching from Banff National Park until the forest fades into farmland approaching Highway 22. In 2005, we found about 42 bears in that area. Now we estimate 88, or an increase of 6% per year. This is a very fast growth rate for a large animal like a bear.

The other population estimate we released in 2021 was more complicated.


Karine Pigeon

In the nearly 10,000 km^2 Swan Hills area, we identified 39 unique grizzly bears, but we got low redetection rates, where the same bear leaves hair samples on more than one occasion. This leads to a wide range of estimates and different statistical methods give somewhat different ranges. For this reason, we recommended using an estimate of 62 bears for management purposes, as this is a conservative number that falls in the ranges of the two main statistical methods studies like this use.


Isobel Phoebus

Despite the better part of two decades of doing these giant population surveys, and even more experience studying grizzly bears in general, it isn't clear why redetection rates were so much lower in Swan Hills. Another key question is why did the Yellowhead and Clearwater populations increase? One thing we can say: it's probably not just one thing. The hunting moratorium and limiting roads and human access to their habitat reduces bear mortality. But the landscape has also been changing, industrial activity tends to replace old forest with young, and that offers a lot more food for grizzlies.

We may not be the ones to answer these questions. For 23 years, we've found answers to urgent grizzly bear management questions, delivered planning tools to government and industry, and we've seen this iconic species begin to recover.

We're proud of this legacy, but we're just as proud to have helped equip other research groups to explore the next great blank spot on the map—by field testing and improving scientific methods and even directly training over 50 great grad students and many more biologists.

Ultimately the mission has always been the long-term conservation of grizzly bears so Albertans can always say, "here be bears."

A story about Gord Stenhouse's career by Michelle Cyca appeared in the November 2021 issue of Maclean's*, with the same headline. The coincidence was unintentional.*

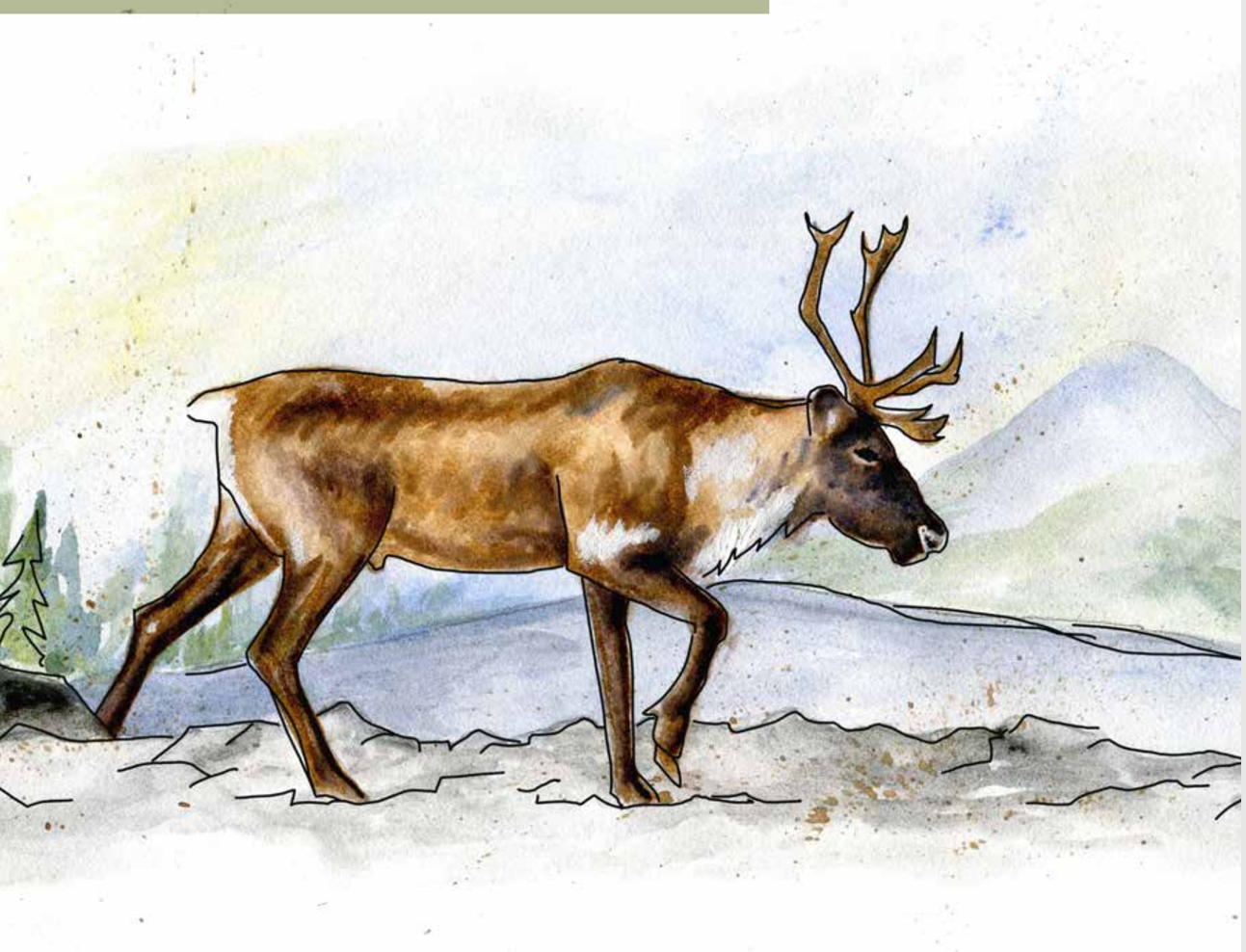
Our 3-pronged Approach to Caribou Conservation

The Caribou Program is an fRI Research run program that conducts scientific research on woodland caribou behaviour, habitat, and health.

The Caribou Patrol is an Indigenous run program that reduces caribou mortality on highways through education for drivers and herding techniques for caribou near the road.

The newly formed ARCKP is government and industry run, and acts as a forum and funding source for knowledge generation and mobilization.

ARCKP



INTRODUCING
THE ALBERTA REGIONAL CARIBOU KNOWLEDGE PARTNERSHIP

In late 2020, fRI Research became the hosting organization for the Alberta Regional Caribou Knowledge Partnership (ARCKP), a new association. The government and industry partnership is part funding agency for caribou research, and part forum for the translation of science into on-the-ground practice.

Like our other three associations, the Foothills Stream Crossing Partnership, the Foothills Landscape Management Forum, and the Forest Growth Organization of Western Canada, the ARCKP is independently governed. The partnership currently consists of 12 companies from Alberta's forest industry and the Government of Alberta.

Each association is working on big land use issues that necessitate collaboration, and the ARCKP is no exception. The plight of Alberta's threatened caribou herds urgently demands new knowledge and management practices that reduce the impacts of human activity now and over the long-term. To that end, the forest industry allocated an initial $5 million for research projects, and the ARCKP awarded its first three projects in November 2020.

Selected projects address one of the four key areas that currently guide the partnership: silviculture and harvest systems, harvest planning, integrated land management, and restoration. The first project uses models to explore how harvesting strategies that emulate nature might be better for caribou and other values of interest. The second investigates ways that harvested stands can be regrown to create good caribou habitat and how these compare to similarly aged stands disturbed by fire. The third project looks at policies that promote or prevent industries from working together to reduce cumulative effects on caribou and other wildlife. By synthesizing the policy landscape in Alberta and looking at other jurisdictions, they hope to find opportunities for more integrated land management.

The ARCKP will fund more projects and expects results in the coming months and years. But they aren't waiting to begin fulfilling their other mission, which is to act as a forum for knowledge mobilization. The Exchange: sharing knowledge, inspiring solutions, is a regular collection of scientific summaries and infographics to make it easier for stakeholders to start applying relevant research. The first issue was distributed in early 2021.

While more research is critical in the long-run, Alberta's caribou herds need government and industry to come together and begin acting on the knowledge we already have. The quick start that the ARCKP is off to reflects the Partnership's resolve to meet its mandate. If we keep up the momentum and implement on-the-ground solutions, we'll be able to preserve this Canadian icon for generations to come.

CROSSING CROWDSOURCING

The last pickup truck pulled over and a grinning volunteer stepped out, coffee in hand, to join the group. The sun was already taking the chill out of the morning air as a dozen cheerful volunteers hiked down an ATV track to the river. They had come to practice using the Alberta Watercourse Crossing Inventory app, a tool for every Albertan who cares about their watersheds.

Watershed health is an issue well suited to a crowd-sourced solution. The hundreds of thousands of stream crossings in Alberta, from bridges to fords, are too many for any one department or organization to regularly inspect and maintain. Simply finding them all and flagging any that are causing obvious problems is a key first step towards improving fish habitat and water quality.

That morning, Water Program technician Caitlin Tomaszewski led the group down to a bridge where they took out their phones. The app asked them four questions: what is the crossing type, is there erosion at the site (and where is it coming from), are there problems with the crossing structure, and are there fish passage issues?

This inspection was a lucky choice for training. It was a beautiful example of a permanent quad bridge. Like most bridges, it was not shedding a lot of sediment into the stream, and the structure was in good shape. All straightforward so far. But despite looking like a model stream crossing from the bridge deck, the final question sparked a lively discussion because a beaver dam between the concrete abutments was completely blocking the way for fish.

We don't really know how many other obstructions are cutting fish off from vital habitat. Hanging and blocked culverts are frequent offenders, but many were installed decades ago and forgotten. Another common issue is erosion, particularly when rain carries silt, sand, and gravel off a road and into the stream, but it can also come from banks that were disturbed when building a crossing, stripped of vegetation.

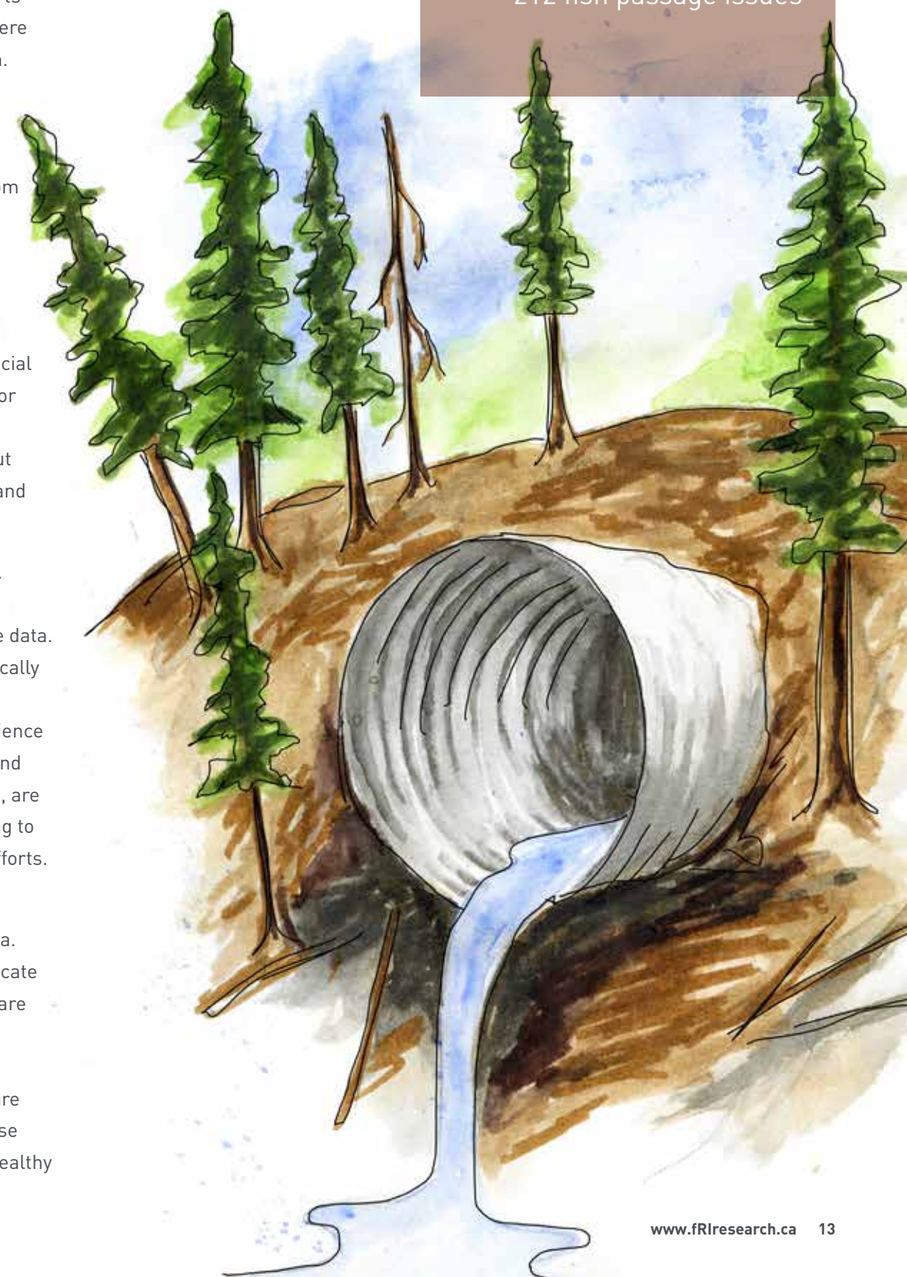
And then there are fords, shallow spots crossed by trails, many unofficial and unknown except to a few outdoor enthusiasts. This is why watershed stewardship groups are reaching out to anglers, ATV rider associations, and backcountry hikers.

A broad coalition is tackling the job. Alberta Environment and Parks maintains the app and manages the data. Alberta Transportation is systematically cataloguing crossings. Stewardship groups are spearheading citizen science efforts. And scientists from NGOs and universities, including fRI Research, are providing mapping and GIS modeling to help those groups prioritize their efforts.

Three species of trout are listed as threatened or endangered in Alberta. Although the inspections so far indicate that 55% of watercourse crossings are in good shape, there are still many maintenance and erosion issues in critical fish habitat. But Albertans are working together to find and fix these issues so that everyone can enjoy healthy watersheds.

Trained **50** People
- 10 organizations

Completed **1407** Surveys
- 981 erosion issues
- 1069 structural issues
- 212 fish passage issues



The Foothills Landscape Management Forum

The FLMF is a group of forestry and energy industry companies working together to practice integrated land management. The independent association recently demonstrated the benefits of this collaborative approach in a pilot project and is consulting with the government on next steps. While that process is underway, the FLMF continues to support the Caribou Patrol Program and the Aseniwuche Winewak Nation that runs it.

CARIBOU PATROL: SEASON 9

There are four caribou herds around the mountain town of Grande Cache, and all are in trouble. This is the traditional territory of the Aseniwuche Winewak Nation of Canada and cutting straight through it is Highway 40, a busy industrial corridor.

Unlike their more numerous cousins, the barren ground caribou that thunder by the thousands across the tundra, southern mountain caribou pick their way warily through dense boreal forest in the winter when not up in their summer alpine refuges. Unfortunately for the A la Peche herd, migrating between these seasonal habitats means a perilous crossing of the highway. Every vehicle collision is a terrible blow to the herd's chance of recovery. So, in 2012, the Nation decided to do something.

They have found an effective two-pronged approach. During the spring and fall migrations, they patrol Highway 40 to take the role of crossing guard for caribou. In the 2020–2021 season, they took action 82 times to either stop traffic and use stockmanship techniques to get the animals across or, if it's in a particularly dangerous place, diverting the caribou away from the road so they will cross somewhere safer. These low stress techniques are probably as old as domesticated livestock, and work with some success on all herding animals.

The Patrol also collects animal sighting data to keep tabs on all wildlife using the corridor and inform the times and locations of future patrols. Another activity is replacing road signs alerting drivers of when migrations are in effect and putting up informational billboards to educate visitors to the area.

These activities have been able to continue without much disruption from the pandemic. However, the second main activity of the Caribou Patrol – educating the public – has had to adapt to new circumstances. In normal years, they participate at festivals and go to classrooms around the province. But with the cancelation of nearly all in person events and school moving online, the program hasn't been able to chat with the hundreds of people they usually do.

What they have been able to do is present at online events, such as a fall 2020 Inside Education webinar for enthusiastic teachers looking to share a love of outdoors with their students. They've also been invited by teachers to their class's "zoom school" and presented to industry groups and academics at the virtual North American Caribou Workshop. They also produce educational materials for industry, the public, and students called the Caribou Edukit that continues to be widely used.

All of these efforts have paid off. Awareness among Albertans of the plight of caribou has never been higher, and vehicle fatalities are at their lowest. Before, a bad year might see 17 caribou die on the highway. Since the Aseniwuche Winewak Nation began patrolling, most years don't see a single fatality, and no caribou has ever been struck when the patrol is in action. This outstanding record should give all Albertans hope that these herds can survive and recover.

ADVANCES OF THE GRIZZLY BEAR PROGRAM

Since 1998, the program has added immensely to our understanding of grizzly bears and improved the methods that biologists use to study many species and ecosystems.

CAPTURE

Minimally Invasive

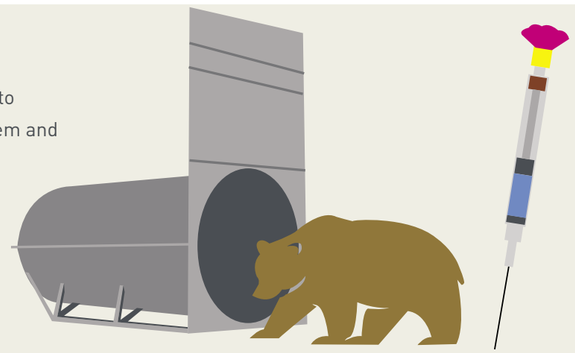
There is no way to understand grizzly bears without capturing a few, to gather health data and to fit them with tracking collars. But it must have as little impact on the animal as possible, both ethically and for good science.

Improvements

We discovered that using snares can cause long term harm to bears and affects results. We immediately stopped using them and other groups soon followed.

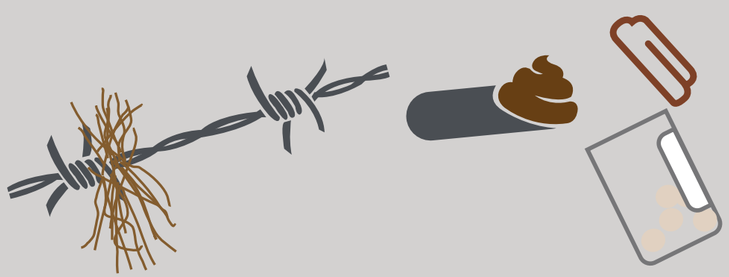
We designed better culvert traps to replace snares. These don't injure the bear and automatically alert us so we can collar and release the bear as quickly as possible.

We showed that rapid injection tranquilizer darts cause hidden tissue damage and switched to slow injection darts.



The Future

A major focus of the program has been to pioneer non-invasive methods such as hair and scat collection to answer some of the questions that, formerly, we had to have a live bear for.



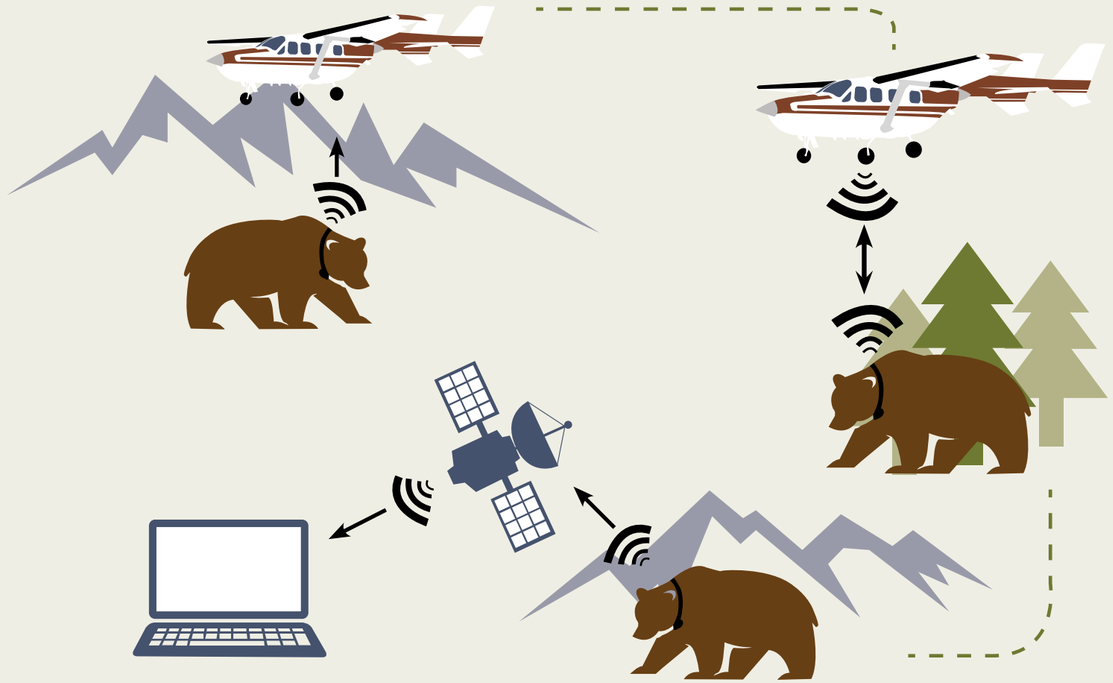
COLLARS

Big Benefits

By getting a bear's GPS locations for a year or two, we can know its homerange, its behaviour, what habitat it likes, and much more.

Staying on the Cutting Edge

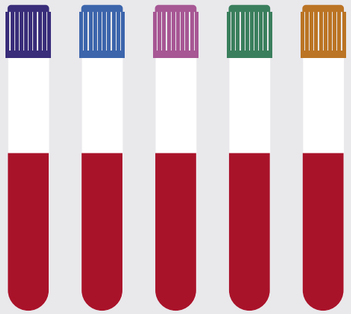
The collars used to transmit the data at a set time every month and we'd have to find the bear to intercept the data. Upgraded collars were more forgiving: we could find the bear any time and tell the collar to transmit the data. Today, it all happens automatically by satellite, no flying needed!



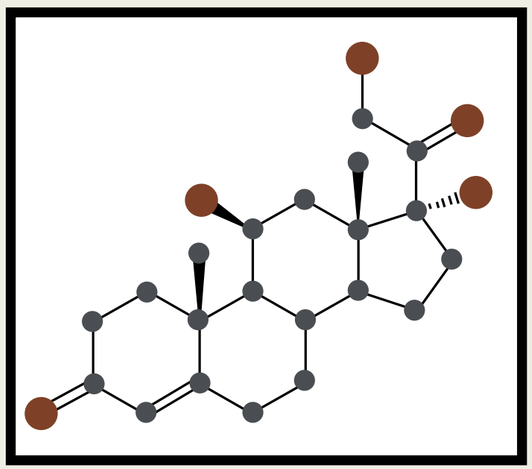
HEALTH

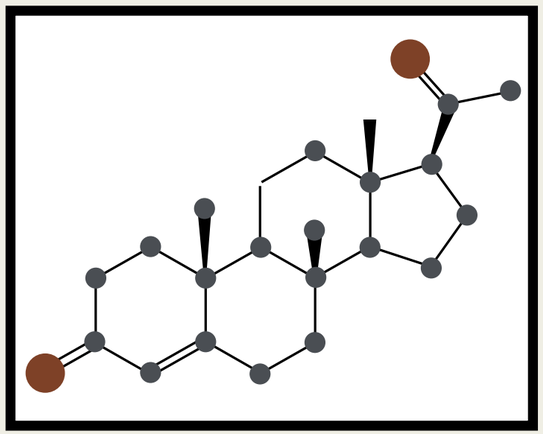
Making the Most of a Capture

When we catch a bear, we fit them with a GPS collar to track their movements, and do a health checkup. We measure and weigh them and take a tiny blood and skin sample.



We have learned which molecules in our samples are good markers of bear health and developed efficient lab tests for them. From this we can measure its metabolism, stress, and reproductive status, all key indicators of the individual bear's – and its population's – health.



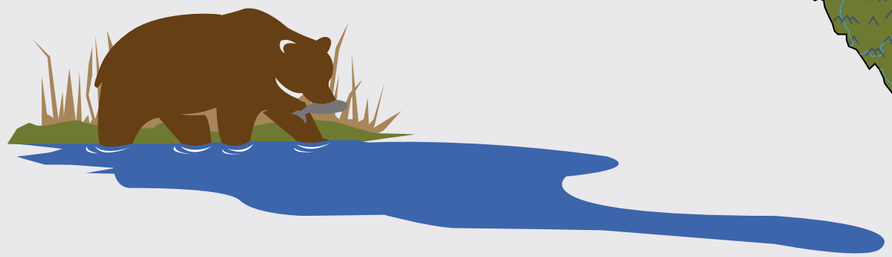


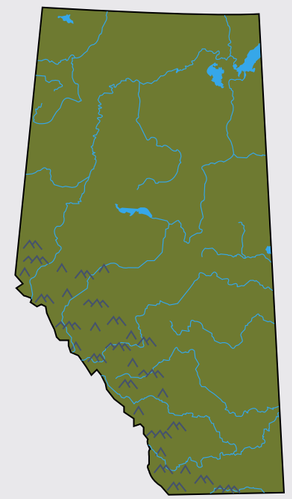
GIS TOOLS

Questions

From the beginning, the program has been on the cutting edge of GIS technology because many of the most important ecology questions are also geography questions.

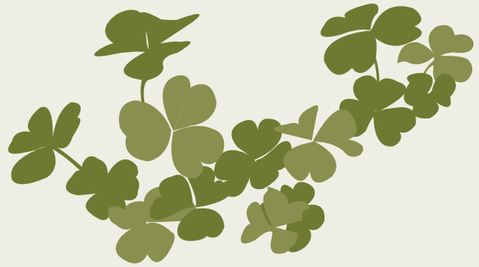
Where is the best grizzly bear habitat?
How is the landscape changing?
How do grizzly bears move and use habitat?





Gathering Spatial Data

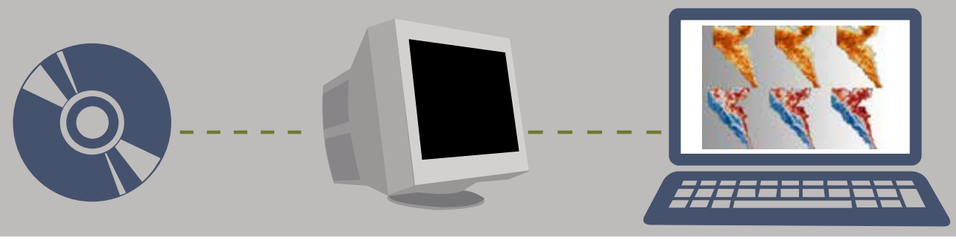
Answering these questions takes a lot of spatial data. We laboriously identified and mapped grizzly bear foods throughout their home ranges, and combined that with years of grizzly bear locations.



GBTools

To help make this new knowledge useful, we created GIS tools for government and industry partners that let them model the impact of forest harvesting and road building on bears.

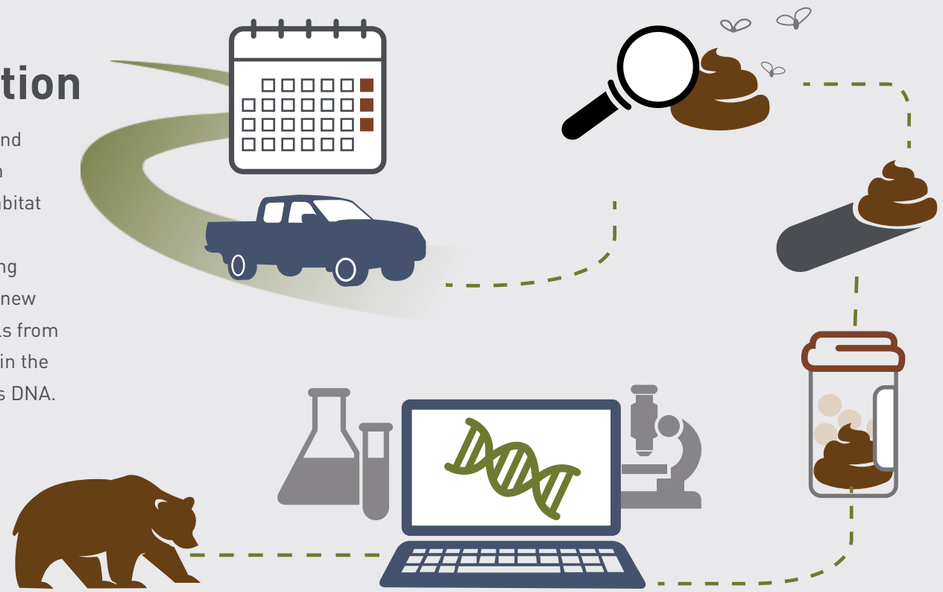
The Program kept building its database and partners requested helpful features and every year or two we release an update with new analysis tools, updated data, and models that cover larger areas of the province.



NON-INVASIVE METHODS

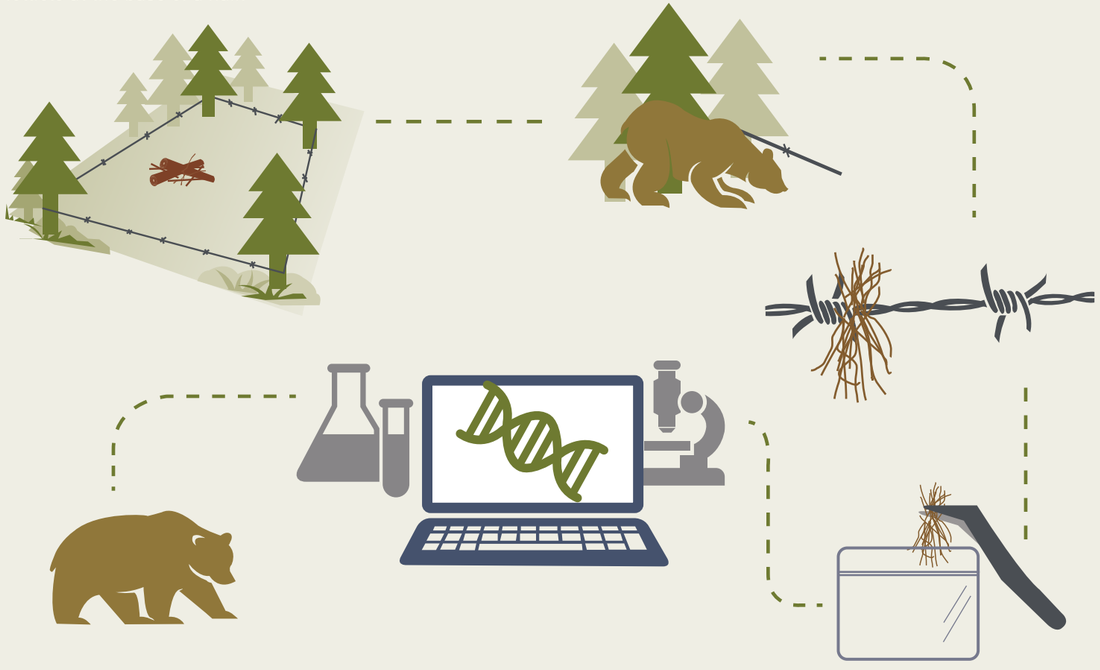
Scat collection

We drive dirt and gravel roads in grizzly bear habitat on a repeating schedule, taking samples from new scat piles. Cells from the bear's gut in the scat contain its DNA.



Hair collection

We surround a scent lure with a strand of barbed wire that snags a tuft of hair from curious bears. We get DNA from the follicle at the base of a hair.



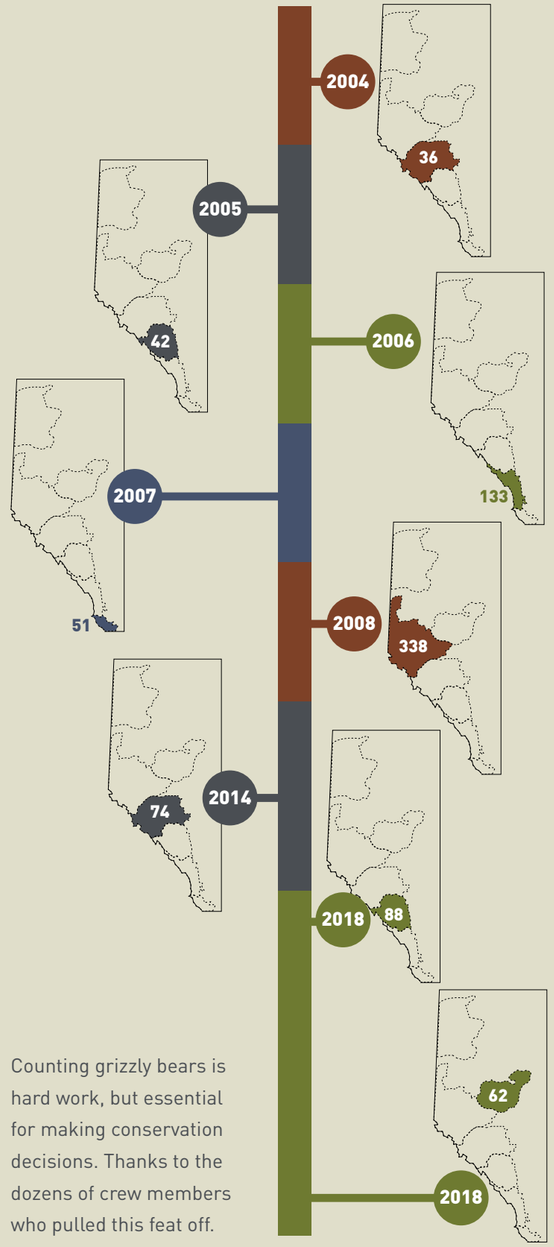
POPULATION COUNTS

Population Inventories Are a Huge Effort

We set up hundreds of scent lures in remote grizzly bear habitat. Curious bears leave tufts of hair that we use to identify individuals and estimate the population size.

The Inventories

In 2004 we did the first survey on this scale in Canada. We figured out what worked and what didn't. The next summer we did it all over again. And again...



Counting grizzly bears is hard work, but essential for making conservation decisions. Thanks to the dozens of crew members who pulled this feat off.

THE JOURNEY TOWARDS MANAGING FOR ECOSYSTEMS

The status quo is powerful. Resistance to change is a reality faced by researchers developing an innovative land use approach called ecosystem-based management—EBM for short.

The system we have today too often makes land and resource decisions in isolation. Energy development is regulated by one department and forestry by another. When wildlife is threatened, governments develop a recovery plan for individual species. The problem is that nature doesn't respect these arbitrary boundaries; disturbances ripple and refract through the ecosystem in unexpected ways. There are exceptions, but the rule is a piecemeal approach that inevitably results in cumulative effects—unintended consequences that emerge from policies that were planned in separate silos but inevitably meet in the real world.

However, it isn't enough to identify shortcomings in the current paradigm and offer a solution. It takes steady effort to build consensus among stakeholders—from grassroots to government.

The Healthy Landscapes Program has been putting in this work since the 90s, but EBM is a far older idea. A holistic view of nature is familiar to Indigenous peoples. Its scientific roots go back to the 1930s when forward thinkers in ecology advocated for larger-scale management plans rather than sectioning off small parcels of protected land, and for managing ecosystems rather than focusing on individual species.

Many elements of EBM just sound like common sense. Of course fires and mountain pine beetle cross political boundaries and these jurisdictions should coordinate. Of course climate change is affecting many different human activities simultaneously. Of course industries should share infrastructure rather than building redundant roads.

But there are thorny reasons why EBM hasn't just happened. Neighbouring provinces and territories don't always see eye to eye. Companies might be hesitant to share their plans with competitors and other industries. Indigenous peoples may not trust the claims and promises of governments. The challenges and opportunities of EBM are as much about relationships between these groups as they are about science.

Moving towards EBM means continually developing new partnerships with groups interested in understanding nature's complex relationships and using them to guide management. Like all partnerships, these will take work to build and maintain, and will never be really finished. Happily, this is a road that many groups have already started down.

The Healthy Landscapes Program has hosted a series of dialogue sessions that brought together environmental NGOs, forestry companies, Indigenous groups, government regulators, and local landowners to discuss EBM and begin building trust.

EBM is a collaborative, integrated, science-based approach to the management of natural resources that focuses on the health and resilience of entire ecosystems — while allowing for sustainable human use of the goods and services they provide.

Independently, and with support from our Program, many have been experimenting with elements of EBM in their policies and operations. We have identified dozens of case studies from nearly every province in Canada that implement at least some elements of EBM.

For example, in 2001, the Mistohay Trial in Saskatchewan made an early effort to harvest timber in a way that emulated the natural disturbance of wildfire. EMEND, now in its 24th year, is a partnership between the University of Alberta, government, and industry to study the effects of harvesting and fire on the whole boreal ecosystem, at a large scale and over the long term.

The Healthy Landscapes Program collected these case studies into a new website (healthylandscapesebm.ca) to learn as much as we can from each other's efforts, and also to make the point that the concept is progressing. The other purpose of the website is to clearly communicate what EBM is—a big need that we identified during the dialogue sessions.

Journeys can pass through unfamiliar places, and that's certainly the case here, since no one knows exactly how practicing ecosystem-based management will look. Each year, more people learn about EBM and become champions for the concept in their organizations, and more science and tools support new management practices. Every small step along this path takes us past the status quo and towards a vision for better land management.

BEYOND THE FOOTHILLS

A sign of a good idea is its steady adoption. Since its inception in 2006, the Foothills Stream Crossing Partnership has grown to 26 companies working up and down the foothills in Alberta. This year, it expands into a new phase – the vast Alberta Boreal.

The Partnership brings government regulators and private stream crossing owners together with a common protocol for inspecting and maintaining their bridges and culverts. This improves the health of watersheds for fish and people by reducing sediment in streams, removing blockages for fish passage, and repairing deteriorating and unsafe infrastructure.

The membership has completed thousands of inspections, and reconnected hundreds of kilometers of fish habitat in the foothills, the area that the province classifies as Priority 1. That work will continue – there are still many uninspected crossings, and crossings should be revisited periodically – but the Stream Crossing Partnership is building on its success and setting a more ambitious target for the next five years.

The goal by 2025 is for 85% of members to have a complete inventory of their crossings. By getting data on every crossing, the members will be able to make better decisions on how to fix sedimentation and fish passage issues. This means setting out beyond the east slopes, and into the Alberta Boreal.

To do this, the Partnership is updating its protocol and training local inspectors so that the data that is collected is useful for the ecological priorities of the Boreal. These watersheds are very different ecosystems than in the foothills. Because the land flattens, streams are slower moving, warmer, and have more fish in general. Inspectors will be able to record the slope at the crossing so that members can quickly sort crossings by that fundamental characteristic.

Another sign of a good idea is that it works. The Foothills Steam Crossing Partnership is a model of effective action that is tackling an environmental issue one crossing at a time. Partnership is the only way for the scale of the solution to meet the scale of the problem. And that Partnership is still growing.

FSCP Membership
2021 Crossing Owners

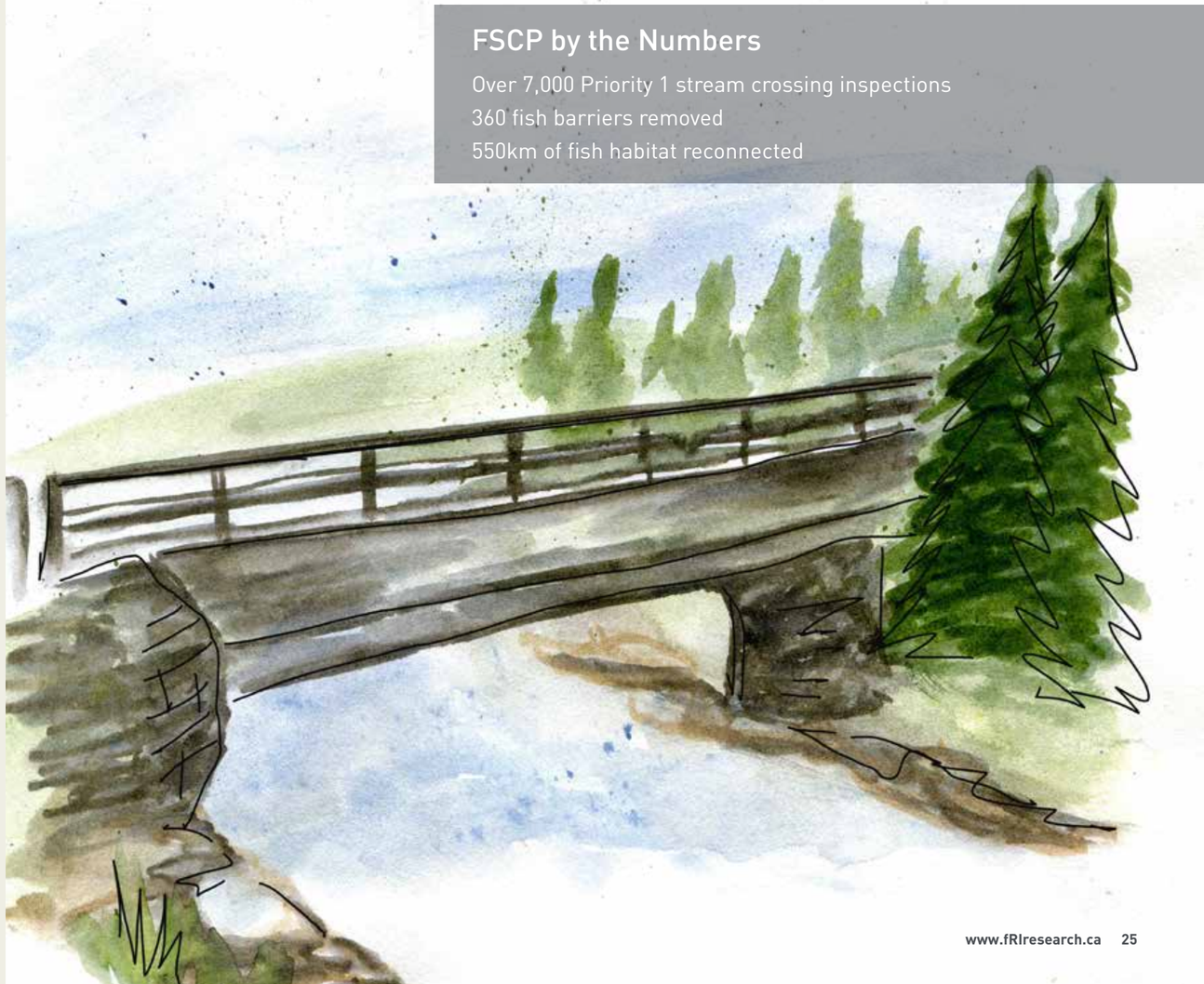
1. Arc Resources Ltd.
2. Athabasca Oil Corp.
3. Baytex Energy Corp.
4. Canfor Corporation
5. Cardinal Energy Ltd.
6. Canlin Resources Partnership
7. Chevron Canada Corporation
8. Cenovus Energy Inc.
9. Energy Transfer Canada ULC
10. Hammerhead Resources Inc.
11. Keyera Corporation
12. Millar Western Forest Products Ltd.
13. Nuvista Energy Ltd.
14. Outlier Resources Ltd.
15. Paramount Resources Ltd.
16. Petrus Resources Ltd.
17. Peyto Exploration & Development Corp.
18. Pieridae Energy
19. Repsol Oil and Gas Canada, Inc.
20. Shell Canada Limited
21. Strath Resources Ltd.
22. Tangle Creek Energy
23. Taqa North Ltd.
24. Tidewater Midstream and Infrastructure Ltd.
25. West Fraser Mills Ltd.
    - I. Slave Lake Pulp
    - II. Blue Ridge
    - III. Hinton Wood Products
26. Weyerhaeuser Company

Advisory Partners

Alberta Environment and Parks
Alberta Energy Regulator
Fisheries and Oceans Canada
Alberta Conservation Association
Trout Unlimited Canada

FSCP by the Numbers

Over 7,000 Priority 1 stream crossing inspections
360 fish barriers removed
550km of fish habitat reconnected



This Story is Based on Recent Research for the Mountain Pine Beetle Ecology Program by:

Dr. Nadir Erbilgin
Dr. Maya Evenden
Guncha Ishangulyyeva
Kelsey Jones
Dr. Jennifer Klutsch
Dr. Rahmatollah Rajabzadah
Dr. Aziz Ullah
Dr. Shiyang (Violet) Zhao

CHEMISTREE

One hot July day, a lodgepole pine tree sways and creaks in the breeze. A scent, familiar to anyone who has walked in pine forests, infuses the air. It's a complex molecular mixture containing dozens of different compounds. Every tree species makes a different recipe, but subtle differences between individual lodgepole pines also communicate health, stress, and a thousand other undeciphered meanings.

In the western boreal forest, a swarm of mountain pine beetles, like rice grains with wings, have detected the tree's aroma, and like a sommelier, picked out particular notes: alpha-pinene, some beta-phellandrene, and what's that—yes—myrcene as well. Just as importantly, there is no trace of the nonanol or benzyl alcohol produced by aspen trees that would deter the beetles. The first to smell it has no doubt that this will make an excellent host.

She alights about halfway down the trunk and begins chewing through the first few layers of bark. A few others have also been attracted, and as the females eat, they convert the alpha-pinene that the tree makes into trans-verbenol a powerful call to arms that brings more of the swarm.

Soon dozens of beetles have joined the attack, sensing each other and the tree, weighing instinctively the number of attackers against the vigor of this tree. Not enough and they will fail in their assault. Too many and their offspring will not get enough to eat this winter. When there are enough, the insects switch to producing verbenone and frontalin. Any other nearby beetles get the message: this tree is full.

As soon as the beetles get through the bark, the tree floods the area with resin, trying to push the pests back out. This tree has many large resin ducts that are helping in its defense. The tree is also deploying other chemicals that are toxic to mountain pine beetles. These molecules are part of this individual tree's signature scent, and it contains camphene, borneol, and cymene. While deleterious to the attacking beetles, this is not the most potent poison.

A more toxic mix would have contained at least 30% limonene, a fair bit of gamma-terpinene, and more beta-phellandrene. Even that might not have been enough to save the tree against so many attackers, but it would have given it a better chance, or failing that, perhaps have reduced the number of surviving beetle offspring. As it is, the tree soon succumbs. Its sap

leaks out, vascular tissue cut, energy stores depleted, and begins drying from the inside out.

With the battle won, the females cut galleries for their eggs and mate. A couple weeks later, the larvae hatch: tiny, delicate, almost see-through. The larvae feed on the tree and grow all fall and winter long, building up energy for their transformation into pupae and then adult beetles.

The tree that the new generation of beetles emerge from in the summer still looks strong and green, remarkable only for being speckled by light-coloured entrance wounds and traces of sawdust at its base. But it is doomed. Its needles will turn red and fall off, and eventually, the dead roots will rot enough to allow the tree to be blown down.

Before the mountain pine beetles take flight, they sense their environment, and this seems to influence the journey they will take. It could be a short hop to a neighbouring tree, a more thorough perusal of the stand up to a few kilometers in length, or a long range, wind-aided dispersal to parts unknown. High concentrations of trans-verbenol, the chemical indicating a mass-attack already underway, seems to predispose them to a longer flight. On the other hand, detecting the aromas of unsuitable hosts like aspen appear to make them play it safe and settle more quickly on an acceptable pine.

The boreal is a chemical ecosystem. Molecules are both weapons and words in an unspoken language. Compounds drift on air currents through the branches, presenting as vividly to a beetle's antennae as a symphony to our ears. We're beginning to learn how to tune in.

PREPARATION PAYS OFF

Before a forest company replants a stand they have harvested, managers have to decide how best to prepare the site so that, decades in the future, timber volumes and wildlife habitat will be most effectively restored. There are several widely used site preparation methods in Alberta, as in many other provinces, because they do seem to help regrow harvested stands. But until now, forestry companies couldn't say exactly how much of a benefit each method has here in Alberta.

Happily, a researcher from the University of Alberta, Simon Landhäusser, had set up the perfect study years ago. Landhäusser only collected data four years after replanting, in order to learn how the site preparation methods affect seedling densities, but the plots were still out there, quietly awaiting another visit.

The first method of mechanical site preparation was mounding, and as you might expect, this means making hundreds and hundreds of little hills, just a foot high, all over the cutblock as if it had broken out in goosebumps. Imagine you take a shovel out to a field and drive it into the ground all the way. Then you pull back on the handle and lever out a big plug of earth with the grassy layer on top intact. As it lifts up, the roots at the top hold together and act like a hinge, flipping the plug over so the layer of mineral soil is now on top, sitting a foot above the rest of the field. Then you plant your seedling on that. The idea is that your seedling won't be drowned since it's guaranteed to be above the water table, and it's got a good head start above the competition so it should get plenty of sunlight.

It might be harder to guess what drag scarification is, but the concept is similar to a garden claw cultivator, or a farmer's harrow. By dragging a heavy, spiky thing through the cutblock, you will break up the soil and expose deeper mineral soil to make a better seedbed. This is especially helpful for natural regeneration from fallen cones. One way to do this is to tow several large metal drums with fins sticking out that cut and turn the ground as they pass.

The third method the study tested was no mechanical site preparation at all. They just planted the seedlings in the old cutblock and watched to see what happened, as a control. In addition, all three mechanical site preparation methods were tried with another variable: slash removed or retained.

New Endowed Chair at U of A

Dr. Robert Froese is the University of Alberta's first Endowed Chair of Forest Growth & Yield. He'll build a practical research program in the School of Forest Science and Management.

Froese and his colleagues will build new forest models that look many decades into the future to help government and industry plan for wildlife, climate change, and wildfires.

FRIAA, the Forest Resource Improvement Association of Alberta, contributed $4.125 million to establish the chair. Having Froese, a licensed forester and respected researcher with plenty of boots-on-the-ground experience, sets the new program up well to continue the long tradition of collaboration between the university and Alberta's forestry industry.

Froese's first order of business after getting out of travel quarantine: a weekslong tour of Alberta's working forests with FGrOW.

Slash removal means they took away a lot of the old branches from the cutblock, as if the trees had been cut, taken to the road, and de-limbed there. The other way is to do that processing at each tree (stump-side) before hauling it out to the road, leaving lots of slash on site.

The Forest Growth Organization of Western Canada and the Canadian Institute of Forestry revisited those stands in 2017, 15 years after they were replanted. They found a lot of trees. The tree planters had put in 2,000 seedlings per hectare, and even on sites without any dragging or mounding, natural regeneration from stray cones had raised the density to an average of about 3,500. On sites with mounding, it was double that, just over 7,000 "stems per hectare" and dragging doubled it again, to about 14,000.

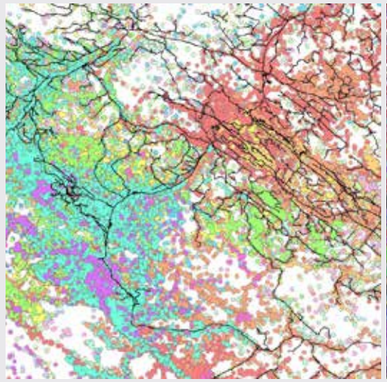
Based on those numbers, choosing to drag after harvesting might seem like a no brainer, but there are always other things to consider. For one, overcrowding will leave you with a lot of little trees. The average tree on a dragged site was both shorter and skinnier. When you combine the average tree size with the density of trees into one number to get the amount of new wood that grew, dragging and mounding come out quite close, but both are significantly higher than no site preparation at all.

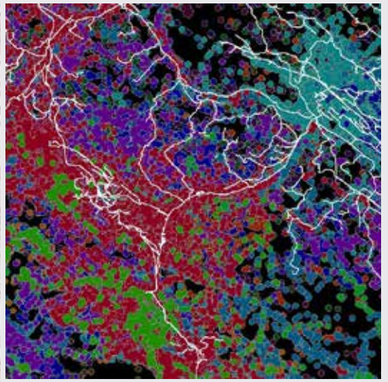
Then there's the question of whether slash is good or bad. Here the choice is somewhat less complicated, but still important: while the overall density of trees doesn't change much, more of the planted seedlings die when slash is retained on-site through stump-side processing. Since it's a lot cheaper to do road-side processing, that will generally be the preferred option.

The exact numbers are important for knowing if a particular practice pays off. It turns out that even ignoring the value of growing more timber with site preparation, the costs of mounding or dragging are less than what you would spend if you had to go back and plant more seedlings on un-prepared sites that don't get enough natural regeneration. But more than that, these results will help government and industry with their long-term planning, ensuring that harvest and replanting are in balance.

Processing system	Site preparation	Projected MAI (m^3 / ha / year)		Relative reforestation cost per ha		Planted stock mortality %
		Unadjusted	Adjusted	With planting	With planting + fill	
Roadside (slash removed)	None	2.72	2.50	1.00	1.53	41.2
	Drag	2.86	2.92	1.20	1.74	19.8
	Mound	3.03	2.86	1.31	1.84	13.2
Stump-side (slash retained)	None	2.59	2.38	1.96	2.49	54.4
	Drag	2.72	2.78	2.16	2.70	32.8
	Mound	2.89	2.72	2.27	2.80	31.7

GIS SERVICES: MORE ESSENTIAL THAN EVER





Our programs have always taken advantage of the GIS technology of the day, but over the decades, spatial data has become increasingly central to all our research. The expertise built up by our GIS Services is benefiting more of our programs and associations than ever before. They have built and updated tools, created maps for field work, and helped summarize and communicate data through interactive websites.

The Grizzly Bear Tools, for the first time ever, now cover the entire province's grizzly bear habitat, plus a little in BC. We've been delivering this premiere suite of models to our partners since 2007. It has grown in scope and power year after year, beginning with just part of one Bear Management Area. The purpose of the tools is to maintain an accurate and up-to-date model of grizzly bear habitat quality, and to allow land managers to compare the forecasted effects of different planning scenarios.

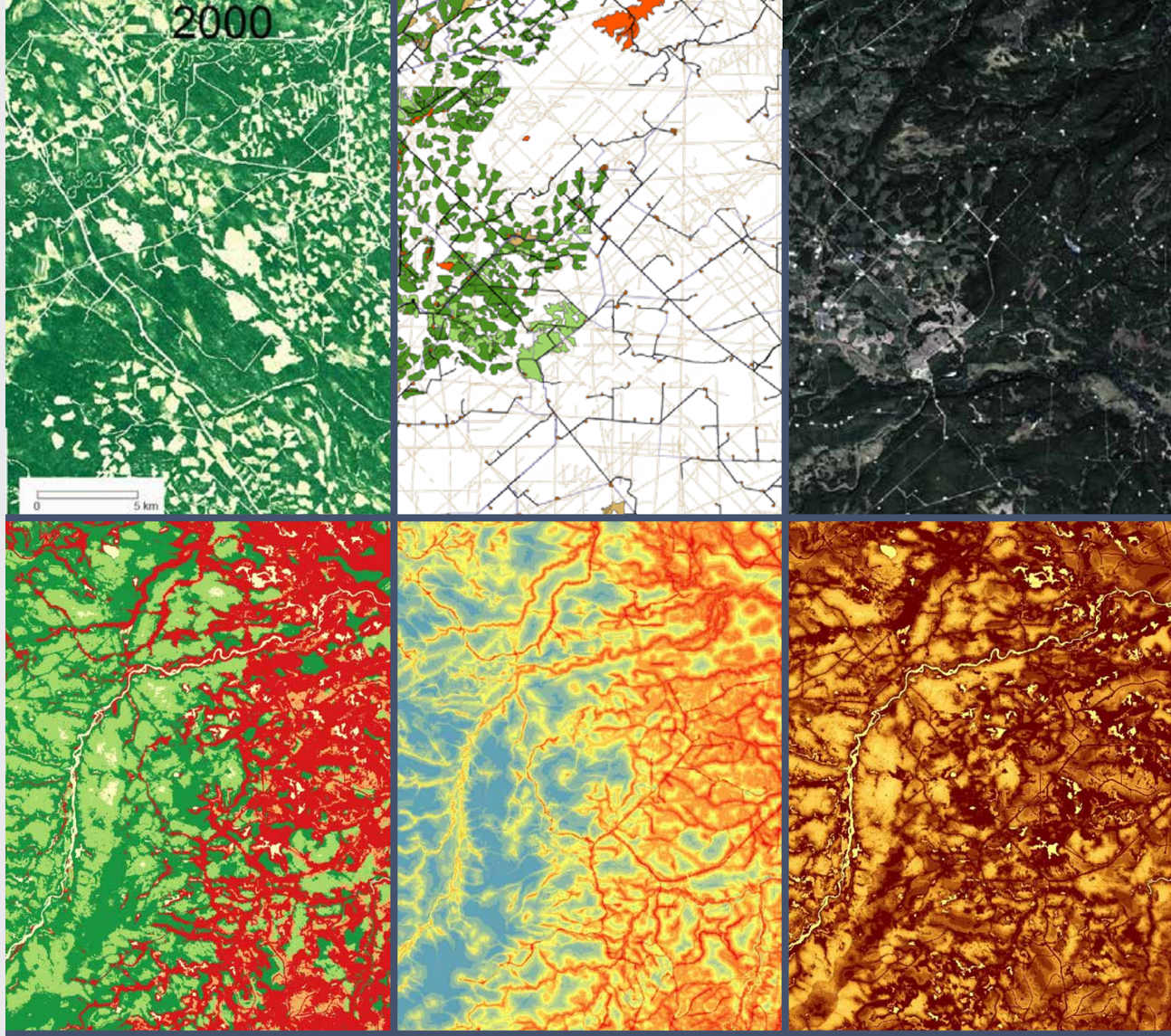
To do this, GIS Services has built resource selection functions, food abundance models and a road density layer. Working closely with Grizzly Bear Program biologists, they have also created a composite model called Habitat States that factors in both food availability and mortality risk. By developing a consistent methodology to stitch together all the different datasets that cover the province like pieces of a quilt, the Grizzly Bear Tools allow analysis of habitat change from 2000 until 2018, and can be backcasted and forecasted out further to run scenarios and find plans that contribute to grizzly bear population recovery.

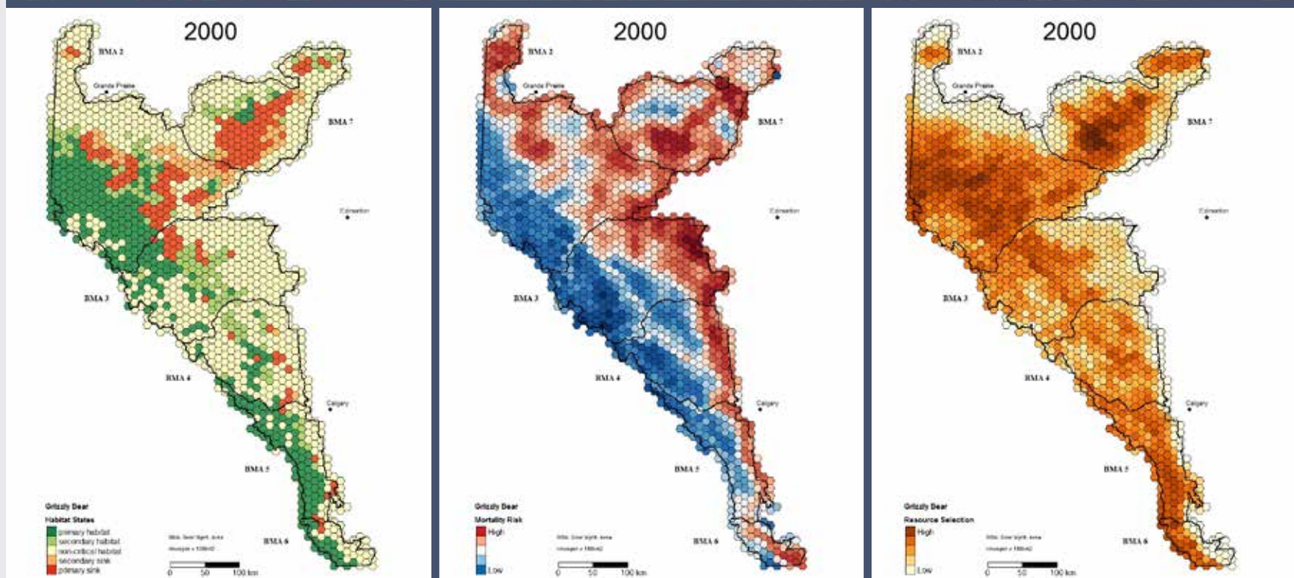
The "Shiny" new tool developed by GIS Services is the Caribou Webtools, a fully cloud-based set of habitat, predation, and connectivity models for Alberta's caribou herds. Since their first release a in 2018, they have been steadily refined and extended to be easier to use and capable of tackling more questions.

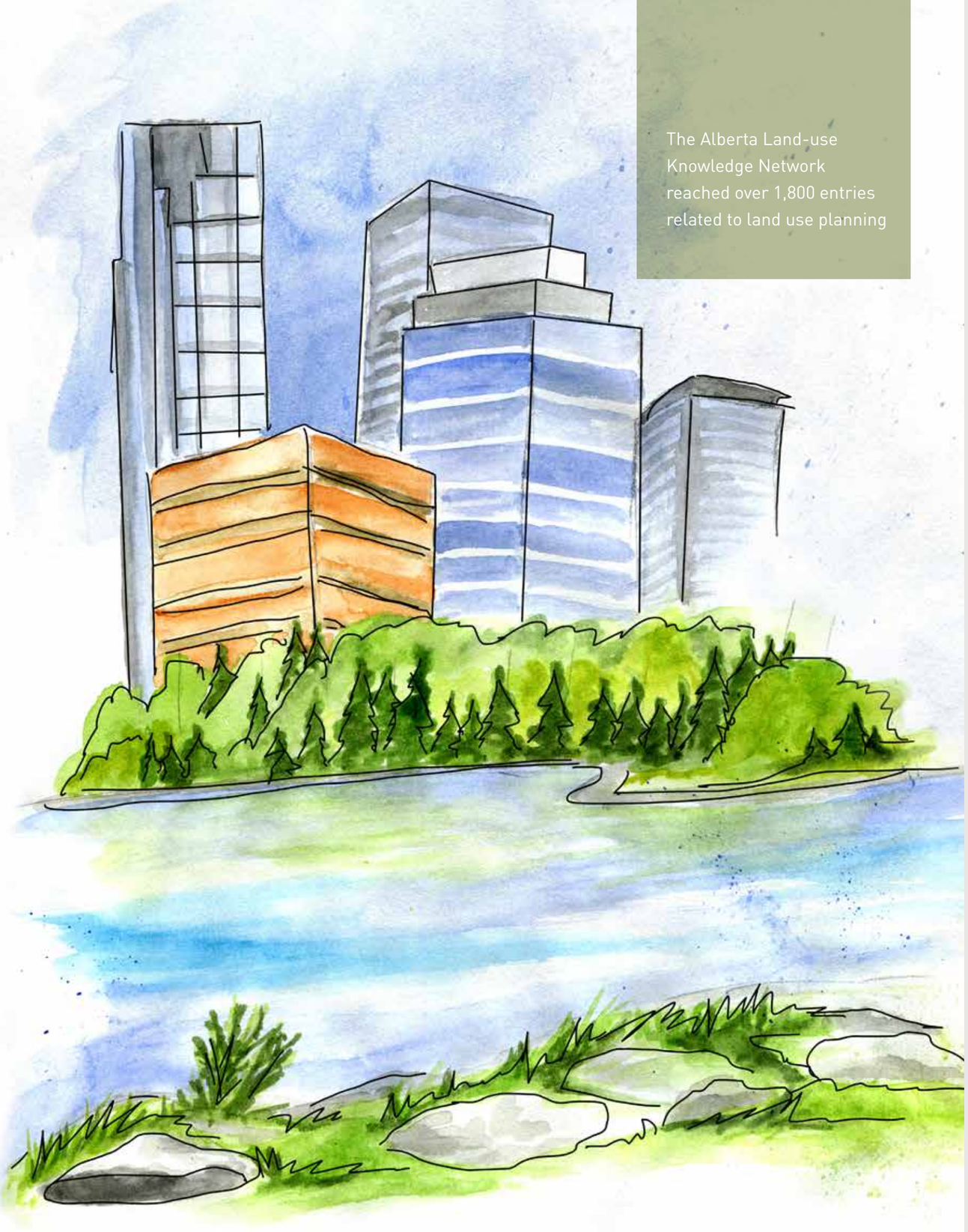
The team also restored an old model for patterns of natural disturbances. This was a useful tool for comparing the result of an activity like forest harvesting to the sizes and shapes of wildfires in Alberta and Saskatchewan. However, it hadn't been updated in over a decade and GIS Services had to rebuild it to work as a python script within modern versions of ArcGIS. Now it can also use new research on how complex the disturbance shapes are and characteristics of islands of surviving trees in the midst of a burn or harvest.

One of our independent associations, the Forest Growth Organization of Western Canada, also made use of GIS support. We prepared heavily customized databases for their field crews to record measurements for their Regenerated Lodgepole Pine trial. GIS Services then ran quality control on that data so that it could be used for analysis.

GIS has always been one of our main strengths. Because GIS Services has always stayed ahead of the technology curve for spatial data and analysis, all of our programs have been able to make use of state-the-art methods to tackle the hard science questions.







The Alberta Land-use Knowledge Network reached over 1,800 entries related to land use planning

TRAILBLAZING ONLINE KNOWLEDGE EXCHANGE

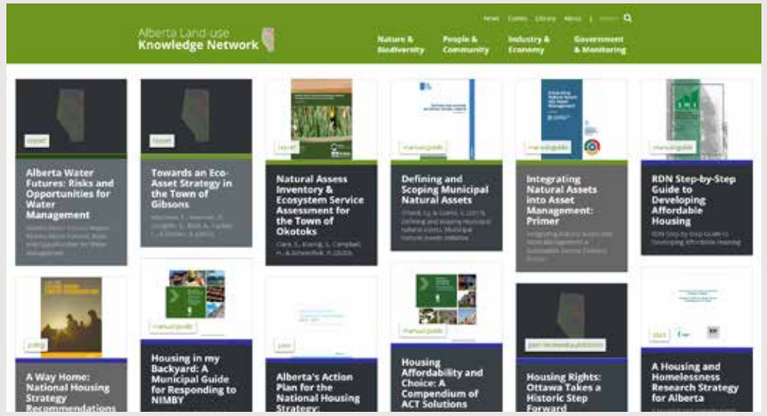
By Jeff Wiehler

For over a decade, the Alberta Land-use Knowledge Network has been the go-to source of information related to land use planning in the province. The next step for the knowledge portal is a partnership with a national knowledge exchange website, which is expected to be completed in the upcoming year.

The Alberta Land-use Knowledge Network was launched in 2011 with the goal of collecting and sharing a comprehensive library of research. A companion website, the Land Use Planning Hub, was launched in 2018 to provide information and resources on regional planning in the province.

Together, the Alberta Land-use Knowledge Network and Land Use Planning Hub now have 1,892 entries. Researchers, scientists, policy makers, planners, practitioners, and organizations with an interest in land use issues rely on the two websites for finding resources and information that contribute to land use decisions. The next steps for the websites will ensure information remains assessable and updated through collaboration.

The Canadian Conservation and Land Management portal has agreed to accept the Land-use Knowledge Network into its partnership group. The CCLM partners collect and share content related to boreal caribou conservation, wetland best practices and land management in Canada. The merger will not only extend the reach of both knowledge networks, but it will boost the quality by leveraging two different yet complementary databases.



The merger of information will begin in late 2021. When complete, it will ensure the information on both the Alberta Land-use Knowledge Network and Land Use Planning Hub remain accessible and relevant.

CUTBLOCK STORIES FOR CARIBOU CONSERVATION






Nothing. Nothing. Snowshoe hare. Nothing. Nothing. Small unidentifiable blur. Nothing. White-tailed deer. Nothing. We are scrolling through the memory card from trail camera 17, documenting all the wildlife that pays a visit to a young cutblock in west-central Alberta. Day and night, sun and rain. It's one view in a database that contains over 100,000 photos from over 100 cutblocks for a project that could help caribou and forestry co-exist.

Just as it starts getting tedious, something amazing will happen—a series of photos of a family of black bears frolicking, or a train of deer hastening past followed a minute later by a wolf. Many of these images tell a story on their own, but taken all together, the Caribou Program biologists are hoping they can reveal whether different species pick different cutblocks and why.

The idea is that if a particular set of forestry practices attracts a lot fewer moose, deer, elk, and their predators, that could be a way to help Alberta's dwindling caribou herds by reducing their predation risk. While the team were setting up the trail cameras, they also carefully noted a host of characteristics for each cutblock, such as the presence of wild plant species that might act as forage and the amount of hiding cover. Back in the office, they also looked at the surrounding area to see how many roads, cutblocks, and other disturbances are nearby.

This camera data tells us which cutblock characteristics different species like, and which they avoid. But that's just half of this project. The other half provides a kind of reality check for these results by giving us an indication of how much these effects really matter. For example, deer might make the occasional appearance in front of our cutblock cameras, but if they (and their predators) are far away in other habitats 95% of the time, then changing forestry practices to chip away at that 5% won't move the needle much for reducing how often caribou encounter predators.

The best way to compare deer selection of cutblocks versus selection of other habitat is to track a bunch of deer for months and see where they go. And that means fitting them with GPS collars. And that means wrestling live deer. And that means hockey pads. In the end, 27 extremely offended white-tailed and mule deer were released with a collar that records a location every hour.

Collaring deer has never been done in this study area, so there's a lot we'll be able to learn from this data in future years. But for the purposes of this study, the GPS locations confirm that deer do have a preference for selecting young cutblocks —at least in the summer. During winter, they either avoided or didn't respond to cutblocks one way or the other.



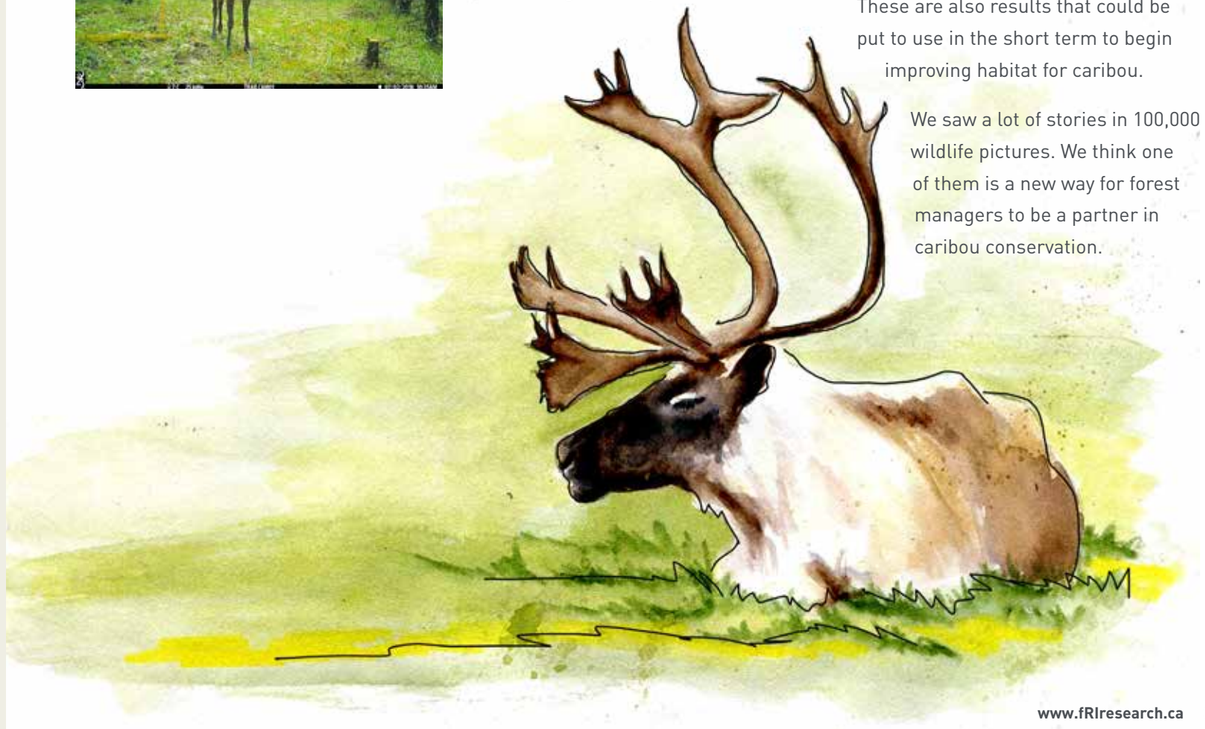
So we know that the idea we started with is plausible: making forestry less deer-friendly could meaningfully benefit caribou by reducing the number of predator encounters. And in fact, the camera data gave extra support by showing that the cutblocks chosen by white-tailed deer were also chosen by black bears, and the cutblocks chosen by mule deer were also chosen by grizzly bears. Essentially, if foresters can avoid making cutblocks like those in caribou ranges, they could reduce the odds of caribou encountering predators.

Unsurprisingly, there wasn't just one or even a handful of cutblock characteristics that drew in moose, deer, and elk. Each species seemed to be responding to slightly different sets of characteristics: different forage species, different silvicultural methods, and different surrounding landscapes. Without minimizing the complexity of the boreal ecosystem, there are also simple results that could be used in forestry operations.

For example, controlling specific wild shrubs and grasses, and planting pine at higher densities would make cutblocks less attractive to moose, deer, and elk. One finding that was a bit of a surprise was that elk and white-tailed deer prefer cutblocks that are in less disturbed areas —that is, fewer cutblocks and roads in the surrounding area. This and other characteristics show how important it is to consider the wider landscape when making management decisions.

Some of these findings suggest that activities foresters find beneficial, like controlling ingress of grasses and shrubs, could also help caribou by attracting fewer primary prey and predator species into caribou ranges. These are also results that could be put to use in the short term to begin improving habitat for caribou.

We saw a lot of stories in 100,000 wildlife pictures. We think one of them is a new way for forest managers to be a partner in caribou conservation.



PARTNERS

Partnerships are the foundation of fRI Research. They identify and analyze issues, assemble resources, and integrate research into land and resource management. Without our partners' commitment, we would not be the strong, effective source of knowledge and tools that we are today. fRI Research offers flexible and inclusive ways of partnering that we group into the three broad categories below, though many partners find more than one role for themselves.

Shareholders

fRI Research shareholders provide stable core funding and in-kind contributions to support the overall operation of the entire organization. In 2020–2021 shareholders are: Alberta Agriculture and Forestry; Canfor Corporation; Parks Canada, Jasper National Park; Millar Western Forest Products Inc., Norbord Inc.; Repsol Oil & Gas Canada Inc.; Suncor Energy Inc.; Hinton Wood Products, a division of West Fraser Mills Ltd.; and Weyerhaeuser Company.

Program and Association Partners

These partners provide funding or in-kind contributions to directly support our programs and associations. Many of these partners are also responsible for land, resource, or forest management, and are interested in using fRI Research knowledge and tools in their operations.

Alberta Indigenous Relations
Alberta Agriculture and Forestry
Alberta Biodiversity Monitoring Institute
Alberta Conservation Association
Alberta Energy Regulator
Alberta Environment and Parks
Alberta Forest Products Association
Alberta Innovates
Alberta Newsprint Company
Alberta-Pacific Forest Industries Inc.
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BC Oil and Gas Research and Innovation Society
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Canadian Association of Petroleum Producers
Canadian Institute of Forestry
Canadian Natural Resources Limited
Canadian Wildlife Health Cooperative
Canfor Corporation
Canlin Resources Partnership
Cardinal Energy Ltd.
Cenovus Energy Inc.
Chevron Canada Resources
County of Grande Prairie No. 1
Denali National Park and Preserve
Devon Energy Corporation
Ducks Unlimited Canada
Energy Transfer Canada ULC
Environment and Climate Change Canada
Foothills Forest Products
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Forest Resource Improvement Association of Alberta
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Kicking Horse Oil & Gas Ltd.
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Mercer International Inc., Peace River Pulp
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Nuvista Energy Ltd.
Outlier Resources Ltd.
Ovintiv Canada Inc.
Paramount Resources Ltd.
Peregrine Helicopters
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Petrus Resources Ltd.
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Pieridae Energy
Project Learning Tree Canada
Repsol Oil & Gas Canada, Inc.
Scandinavian Brown Bear Research Project
Seven Generations Energy Ltd.
Shell Canada Limited
Spray Lake Sawmills Ltd.
Strath Resources Ltd.
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TAQA North Ltd.
Tangle Creek Energy
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Town of Hinton
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Weyerhaeuser Company
Woodland Operations Learning Foundation
XTO Energy Inc.
Yellowhead County

Alignment Partners

These partners provide informal support for fRI Research.

Alberta Fish and Game Association
Forest Genetic Resources Council
Alberta Labour and Immigration
Alberta Professional Planners Institute
Alberta Riparian Habitat Management Society
Alberta Society of Professional Biologists
Association of Alberta Forest Management Professionals
Banff National Park
British Columbia Institute of Technology
Council of Forest Industries
Ember Research Services Ltd.
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Forest History Association of Alberta
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Golder Associates
Government of British Columbia: Ministry of Environment; Ministry of Forests, Lands, and Natural Resource Operations
Government of Northwest Territories: Ministry of Environment and Natural Resources
Inside Education
International Model Forest Network
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Municipality of Jasper
NAIT Boreal Research Institute
Nature Conservancy of Canada
Northern Rockies Museum of Culture and Heritage
Saskatoon Forestry Farm Park & Zoo
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Watershed Alliances and Councils: Athabasca, Beaver River, Bow River, Lesser Slave, Milk River, Mighty Peace, North Saskatchewan, Oldman, Red Deer River, South East Alberta
Wildlife Habitat Canada

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1176 Switzer Drive, Hinton, Alberta, Canada, T7V 1V3
Tel: 780.865.8330 | www.fRIresearch.ca | info@friresearch.ca