AI for Earth Grantee Profile

Clayton Lamb

Massively parallel computing for grizzly bear conservation

Summary

Grizzly bears only occupy a fraction of their historic range and many remaining populations now face increasing pressure due to a changing landscape. Clayton Lamb, a Vanier Scholar and PhD researcher at the University of Alberta in Canada, is using Microsoft Azure and machine learning tools to create a comprehensive analysis of the many human and environmental factors limiting grizzly bear density in British Columbia, in order to help inform collaborative conservation efforts for this iconic species.

Understanding what drives grizzly bear density in a changing landscape

Grizzly bears were eradicated throughout much of the non-mountainous areas of North America in the 18th and 19th centuries. While new regulatory protections for this apex omnivore have allowed grizzly populations to slowly rebound in recent decades, their numbers are still low in many areas. Current estimates figure about 26,000 grizzly bears live in Canada. Most of that population now lives in British Columbia, since their territory—which used to stretch from the Rocky Mountains to the far-flung prairies of Manitoba—has shrunk significantly due to a variety of changes to the landscape over time.

> Most of Canada’s 26,000 remaining grizzly bears now live in British Columbia, due to landscape changes that have drastically reduced their native territory.

Clayton Lamb, a PhD candidate and researcher at the University of Alberta, is a tireless advocate for improving evidence-based measures to help sustain grizzly bears and their habitat. Not only is he busy in the field, checking traps and flying in helicopters to collar bears and monitor their activity in the wild; he’s also an active data scientist. Lamb says he taught himself to code in R Script (a common programming language for advanced statistical computing) during university because, like many of his peers, he realized that advanced computing skills would be essential for running the complex statistical data analyses he needed to augment his research.

Now, Lamb is using these skills and his Microsoft AI for Earth grant to complete the most comprehensive analysis to date of how factors like climate and human impact are affecting grizzly populations. Armed with this meta-analysis, he'll be able to work more effectively with local governments, such the Province of British Columbia, to improve collaborative, data-driven conservation efforts between scientists, government agencies, First Nations, recreationists, and industry partners.

To start, Lamb collects data on the bears' ages, weights, reproductive rates, and lifespans through a combination of genetic tagging (via hair samples collected from about 2,200 bears) and tracking collars (which allow researchers to follow an additional 450 bears with fine-scale precision, using GPS radio telemetry). But analyzing grizzly bears' vital rates is just the beginning. Lamb must also map those outcomes against a variety of "top down" and "bottom up" pressures to determine which ecological factors are most important, or most threatening, to the species' survival.

Wild huckleberries are a staple of the grizzly bear's diet. [Image: courtesy of Clayton Lamb]

At the top, Lamb looks at the human footprint on the landscape, evaluating spatial data on things like city, road, and hunter densities. At the bottom, he evaluates environmental pressures on the bears' food supply, such as diminished salmon runs, decreased forest vegetation, and changes to the growing seasons and availability of wild berries, which bears eat in abundance to build and maintain their fat stores through the winter.

All these variables can affect the vitality of grizzly bear populations, but there's still a lot that researchers don't know about how they interact, or which are most harmful. That's why Lamb's exhaustive field research—from sampling berry shrubs over 1 million square kilometers of British Columbia to capturing and collaring about 100 individual bears in the wild—and cloud-enabled spatial mapping is so crucial. He's hoping his results, expected to be published later this year, will become the leading authority on what, ultimately, drives grizzly bear density in British Columbia.

Clayton Lamb captures and collars Canadian grizzly bears in order to track their movement across the landscape. [Image: courtesy of Clayton Lamb]

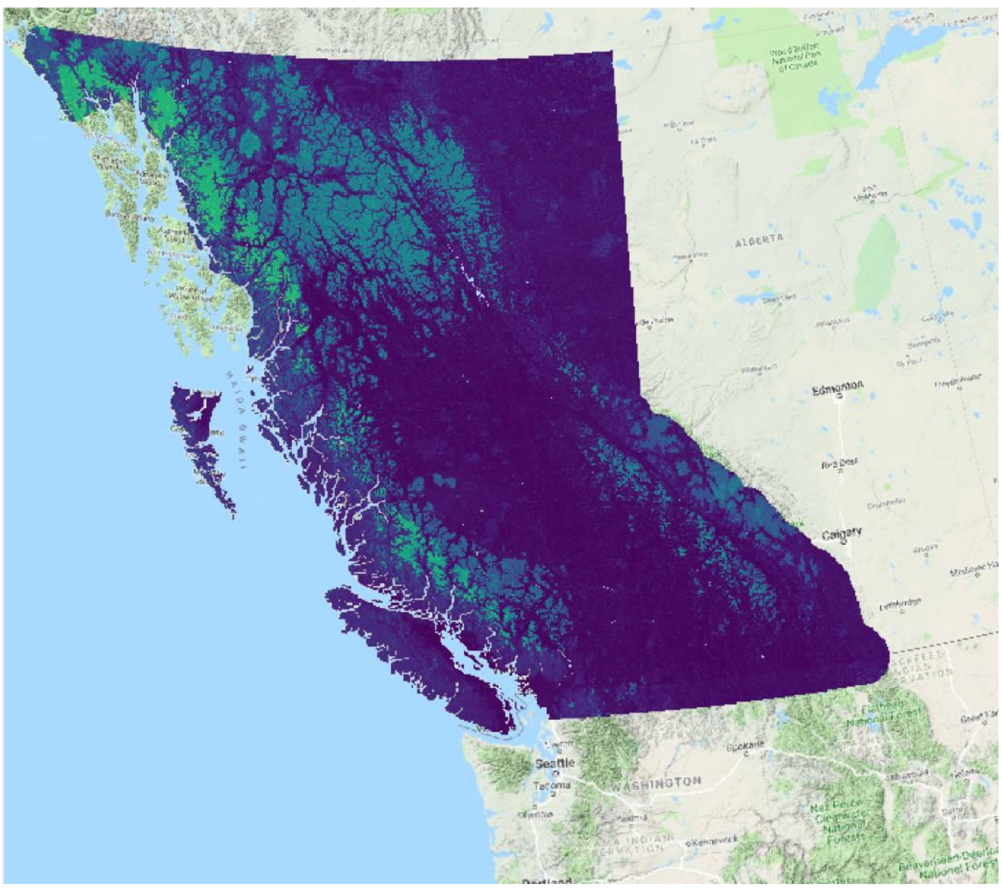
Keeping both bears and humans safe

Of course, healthy grizzly populations must also be balanced with the need to keep people safe. Human encroachment on the wilderness—in the form of mountainside communities, ski resorts, eco-tourism, hunting, and other recreational activities—not only reduces the bears' natural habitat, but also increases the risk of potentially dangerous encounters. The insights generated from Lamb's research will help the Province of British Columbia make a variety of important decisions about how to balance these competing needs, in everything from land use and road access to recreational planning and wildlife management.

For example, Lamb's research revealed that a local dumping ground for roadkill had become a popular feeding site for grizzlies. He trapped and collared nine bears (including two 600-pound males) at the carcass pit, which was located right alongside the highway, about 300 meters from a rest stop where travelers play and walk their dogs. Armed with his observational data, Lamb was able to get support from a team of stakeholders (including the local mayor, the provincial government, and environmental groups) to close these pits and move them to a safer location. His findings are also informing the province's approach to road access management. Beginning in Spring 2019, the government will close dozens of kilometers of wilderness roads in the southern British Columbia Rocky Mountains with the aim of getting closer to a road density threshold that, based on Lamb's research, is more conducive to protecting key habitat for grizzlies, elk, and other wild animals.

Mapping berry distribution with the power of cloud computing

The scale of Lamb's research wouldn't be possible without a background in coding and the massive parallel computing power of Microsoft Azure. To create his initial model for mapping the prevalence and fruit production of key plant species in a bear's diet was a substantial undertaking on its own.



Map of the percentage distribution of wild huckleberries across British Columbia, produced by Lamb's custom machine learning model for berry projection. [Image: courtesy of Clayton Lamb.]

Although grizzlies do prey on young ungulates, like deer or elk calves, they generally aren't very good hunters. Their size gives them poor endurance, so in the Rocky Mountains they must rely heavily on the consumption of berries that are high in sugar to get enough calories. This makes having an accurate assessment of the growing range, fruiting seasons, and potential output of species, like black huckleberries, an important factor for understanding what drives overall grizzly bear density.

But to develop his berry model, Lamb had to project more than 1 billion pixels of landcover data (at 30-meter resolution) across 88 layers of additional data about the many variables that affect berry production—such as latitude and longitude, slope and elevation, tree cover, temperature, weather, and much more. This data-intensive work was necessary to produce a series of maps that project berry distribution for 16 native plant species across the landscape.

> "I got really into it. I was firing up 800 computers at a time. I felt quite productive sitting at my computer watching 800 CPUs working." – Clayton Lamb

Lamb estimates that without the exponential computing power of Microsoft Azure, it would have taken him 30 to 40 days of runtime to produce each map, and he needed dozens. But with his AI for Earth grant, he was able to complete the berry mapping stage of his research quickly and easily, along with additional calculations to improve the accuracy of current grizzly population estimates by applying a technique called "spatial capture-recapture" to the genetic tagging data.

Going forward

Now Lamb is beginning the final stage of his research, as he works to complete his PhD this year. That entails bringing together all the data layers he's been collecting to create one conclusive meta-analysis that accurately explains all the human and environmental drivers of grizzly bear density in British Columbia. This research will primarily help inform how human-bear coexistence should play out in the future, but it can also be applied to other species, like wolves or elk, providing researchers with a much more comprehensive view of how changes to the landscape affect local wildlife.

About Clayton Lamb

Clayton Lamb is a PhD candidate, Vanier Scholar, and Weston Fellow at the University of Alberta in Canada, working at the interface of population ecology, carnivore co-existence, and wildlife management to protect grizzly bears. He does this by combining traditional field techniques, such as genetic tagging and capturing and collaring bears in the wild, with advanced data modeling and statistical analysis. His goal is to provide rigorous and insightful research that maximizes conservation gains for wildlife and wild places.

Resources

Websites

Clayton Lamb's website
AI for Earth

Documentation

Lamb, C.T., Ford, A.T., Royle, A.J., Proctor, M., Boutin, S. 2019. "Genetic tagging in the Anthropocene: scaling ecology from alleles to ecosystems." *Ecological Applications*.

McLellan M.L., McLellan B.M., Sollmann, R., Lamb, C.T., Apps, C., Wittmer, H.U. 2019. "Divergent population trends ten years after ending the legal grizzly bear hunt in southwestern British Columbia, Canada." Biological Conservation.

Additional citations available on Lamb's website.