Yukon Conservation Society Parliamentary Brief

To The Standing Committee on Indigenous and Northern Affairs

Northern Infrastructure Projects and Strategies

Prepared on the traditional territories of the

Kwanlin Dün First Nation

and

Ta'an Kwäch'än Council

Mike Walton, PhD
Executive Director

Cody Reaume, EIT
Energy Analyst
November 27, 2018

"It's the great, big, broad land 'way up yonder,
It's the forests where silence has lease;
It's the beauty that thrills me with wonder,
It's the stillness that fills me with peace."
Excerpted from "The Spell of the Yukon" by Robert W. Service

Infrastructure and Biodiversity Loss

The Yukon is one of the last places in the world where wilderness in its wildest sense remains. The Yukon is also one of the few remaining places on the planet where ecosystems function relatively unimpaired. It is a place where big predators still thrive and large migrations occur on land, in waters and in the sky. However, the permanent loss of plants and animals around the world continues at increasing rates. This loss of biodiversity is threatening natural systems and processes that support all life on the planet; clean air, clean water and clean land are no longer a certainty. In the Yukon and across the North, there remains opportunity to address the root causes of biodiversity loss.

Drawing from the Committee's definition of infrastructure, namely, "roads, rail, bridges, airports, ports, energy infrastructure, housing, telecoms and any components of broader regional infrastructure strategies", the Yukon Conservation Society, through this brief, draws the Committee's attention to why a landscape-scale perspective is necessary to ensure wildlife and community values are protected. We draw attention to the significant effects that linear disturbances – particularly roads – have on wildlife, and how energy storage is showing promise as an opportunity to address the challenges that accompany a clean energy transition.

Background

The Yukon Conservation Society recognizes infrastructure development, particularly roads and the access to land that comes as a result of roads, as one of the greatest challenges facing the Yukon over the next decade. This is not a conservation issue nor is it a development issue. Roads are a societal issue wherein choices about what might be lost, saved or introduced are at play. Decisions about roads affect the quality of life of all the people who call the Yukon home and particularly involve Indigenous rights.

Roads, a key part of northern infrastructure, seem to last forever. Few jurisdictions have been able to remove them once on the landscape. Private roads become public roads. Public roads demand a level of maintenance that tends to ensure consistent, if not increasing traffic. Road speeds increase as vehicles become more safe and drivers press governments to improve road safety and surfacing, leading to more vehicles using improved roads at higher speeds.

Dulac (2013) reported, "Global roads are likely to grow by nearly 25 million paved lane-km by 2050". Most recently, Lawton (2018) points out, "since 2000, the world's legal road network has lengthened by 12 million kilometres, enough to encircle the globe 300 times". Worryingly, new roads are pushing into areas where previously, roads have not existed. This taking up of lands for development purposes directly affects rates of biodiversity loss, so much so, Lawton (2018) reports, that "conservation biologists regard infrastructure development as the principal agent of biodiversity decline. An analysis of 35 years of research on habitat fragmentation caused by such development concluded that it reduces biodiversity by anything from 13 to 75 per cent".

Scientists and governments from around the world warn that climate change and loss of biodiversity are the two greatest threats facing our planet (Bernauer, 2013; Government of Canada, 2018a; Watson et al., 2016). Both are human caused. While climate change has captured the attention of the world in a way that biodiversity loss has not (Legagneux, 2018). Biodiversity is the natural network, systems and fabric that supports all life on the planet. The choices Northerners make to ensure the greatest variety and amount of wild biodiversity persists in the north will have long and far-reaching implications to cultures, societies, and individuals. Infrastructure development and particularly roads are significant threats to Canada's commitment to protect biodiversity.

Landscape-Scale Conservation – Why a landscape-scale perspective is necessary

"Larger than Life" is Yukon's tourism pitch to the world. It captures the idea of "big", "vast", "whole", and "complete". These are the same ideas that landscape-scale conservation is based on. It too, fundamentally recognizes the need for "big", "vast", "whole" and "complete". These qualities reflect definitions of ecological integrity, where "whole" and "complete" describe complex ecological systems and functions – all of which are supported by an approach to land management that places ecosystems central to decision-making. Why? Because everything is connected and what we do to one we do to all. Clean air, clean land and clean water are not achievable in isolation and won't be achieved without thinking big, across landscapes, and seeing the interconnections. Coristine (2018) and others write:

> The world's biological diversity is facing a substantial threat of loss due to human activity (Barnosky et al. 2011; Ceballos et al. 2015; De Vos et al. 2015; Urban 2015; Ceballos et al. 2017). Globally, it is estimated that humans have raised the rate of species' extinction 1000 times over background rates (Ceballos et al. 2015; De Vos et al. 2015), with these rates expected to rise with future climate change (Thomas et al. 2004; Urban 2015). Protected areas—national parks, reserves, special management zones—are one effective tool to protect biodiversity (Chape et al. 2005; Le Saout et al. 2013). Protected areas reduce the scale or intensity of negative human activities and are most effective when identified through ecological assessment (Locke 2015; Belote et al. 2017; Saura et al. 2017). The decision-making criteria and processes used to locate new protected areas dramatically affect biodiversity outcomes (Svancara et al. 2005; Venter et al. 2017), future land-use patterns (Ellis and Ramankutty 2008; Ellis et al. 2010; Venter et al. 2016), and human well-being (e.g., where tied to ecosystem services such as pollination and flood control; see Naidoo et al. 2006; Kaplan-Hallam and Bennett 2017), thereby altering conservation efficacy. (p. 532)

Landscape-scale conservation initiatives such as Yellowstone to Yukon, Adirondacks to Acadia, Baja to Bering, and most recently the first new Indigenous protected area in Canada – Edéhzhíe Protected Area, in the NWT, protecting 14,218 square kilometres (more than twice the size of Banff National Park) – remind us what needs to be done to protect wildlife and build infrastructure. We must keep ecosystems that are intact – intact! Making decisions about the landscape and the species that rely on it for their existence requires that we place ourselves in the ecosystem as opposed to outside of it. With this distinction, we have enormous responsibility to understand the unintended consequences of our decisions.

Significant effects of linear disturbances on wildlife

Every road, every rail line, every power line, and each land use that interrupts the usual free roaming of species, and access by community members for food and medicines, destabilizes relationships that have been interdependent forever. It is not only the individual project that radiates effects, it is also the cumulative effects of all projects over space and time that must be considered. The massing of effects and their consequences on ecosystems is hard to measure but not impossible to discern. For example, an unintended consequence of a road is that where a road goes, development follows. One road becomes two, becomes four, becomes eight, and so on until the landscape, once thought to be vast, is functionally shrunk to a size where big animals are walled in by crisscrossing roads.

It is known that where animals live without connection to other animals of their own species, they cease to exist. Dr. Hillary Cooke's 2017 Wildlife Conservation Society Canada report, "Securing a Wild Future", addresses this point in a Yukon context:

> Planning for the long-term persistence of biodiversity, meanwhile, takes conservation design beyond just capturing representative species and ecosystems in conservation areas. It requires protection of populations large enough to persist through natural fluctuations, such as swings in prey abundance, and the full range of habitats and conditions necessary for reproduction and survival, including sufficient area for seasonal movements and annual migrations. It also requires preserving the ecological processes that maintain ecosystems, such as cycling of nutrients, flow of water, and natural disturbance regimes, such as fire and wind. For many species and processes, a landscape-scale approach to conservation is required to ensure such long-term persistence. (p. 4)

For many, roads just are; they are there and they always have been. They get you to where you want to go and for the most part, people don't remember being asked if they wanted them or not. But roads cost millions to build and millions to maintain: they are an expensive on-going societal cost. Now, we also understand that roads pose key barriers and costs to wildlife too. But they don't have to. If the proper planning goes into anticipating, understanding and addressing wildlife movements, wildlife mortality as a result of collisions with motor vehicles can be reduced substantially and the space needed for wildlife to go about their business uninterrupted can be realized.

The Yukon remains one of only a few places in the world where large landscapes remain that can support full species structure and function. However, this is not guaranteed without immediate action focused on protecting wildlife – and enacting interventions that respect the unique governance arrangements that exist and are coming into existence, between First Nations governments and the governments of the Yukon and Canada.

Why parks and protected areas are not enough

That biodiversity loss continues around the world and at increasing rates indicates that parks and protected areas are not enough to safeguard against the loss of species. A recent report (WWF, 2018) indicates 60% of biodiversity has been lost in the past 40 years. Pointedly, the precarious plight of caribou populations in Canada is reported in a recent *Canadian Geographic* article (Ray, 2018) and media (Chung, 2018) is drawing attention to the world's biodiversity crisis. Researchers from multiple disciplines are calling for the establishment of large interconnected parks spanning landscapes as one way to address the issue. Saura (2018, p.144) writes:

> Protected areas (PAs) are critical for biodiversity conservation. Well designed and managed PA systems can effectively safeguard species and ecosystems, and deliver essential ecosystem services to people (Rands et al., 2010; Watson et al., 2014; UNEP-WCMC and IUCN, 2016). Connectivity of PA systems is necessary to facilitate large-scale ecological and evolutionary processes such as gene flow, migration and species range shifts. These processes are all essential for the persistence of viable populations, especially when facing climatic and environmental changes in increasingly transformed and fragmented landscapes (Kuussaari et al., 2009; Krosby et al., 2010; Beale et al., 2013). Improving or sustaining PA connectivity is therefore a primary concern for the effective conservation and management of biodiversity (Ervin et al., 2010; Laurance et al., 2012; Juffe-Bignoli et al., 2014).

The Standing Committee on Environment and Sustainable Development came to a similar conclusion recommending that the Government of Canada "develop a 'corridors of connectivity' and 'buffer zone' strategy to protect and enhance ecologically valuable networks of protected areas and regions on the periphery of protected areas" (Government of Canada, 2017, p. 27). In tangible support, the federal government's budget 2018 committed financial resources to "establish a coordinated network of conservation areas working with provincial, territorial and Indigenous partners" (Government of Canada, 2018b, p. 150). Both documents recognize that leadership and collaboration by the federal government are needed in order to secure a future where development and conservation are attainable.

Unless parks are large enough to sustain genetic flow (in and out) of species, the end point is extinction. Most parks in Canada are not large enough to ensure gene flow and predator-prey relationships, or protect the necessary habitats to support species diversity. However, connecting existing parks and where possible, setting aside large areas for new parks, achieves life-saving design and improves the likelihood that the future will include a variety of plants and animals – each unique in their existence and collectively delivering essential ecosystem services for everyone's benefit.

Conclusion

Across Canada's North, the opportunity exists for infrastructure development and conservation to occur seamlessly but not without urgent change in how infrastructure planning takes place, who is involved and how decision-making occurs. Approaching the challenge as an opportunity to create prosperity through knowledge creation and knowledge sharing enables us to rethink how development in the North might occur. To conclude this section of the brief, we offer the following recommendations.

Recommendations addressing biodiversity loss and infrastructure development

1. Biodiversity loss and infrastructure development are one issue. It should be treated, questioned and addressed as one issue.

2. Linear disturbance planning and engineering require the input of Indigenous Ecological Knowledge and western scientific research that are unique to the social and ecological needs of the area. Baseline species inventories must form an initial step that informs subsequent decision-making. Federal funding for infrastructure projects must include conditions that ensure a process for initiating species inventories is in place at a scale supported by local Indigenous and non-Indigenous communities and governments.

3. Infrastructure and biodiversity conservation planning must take place prior to development assessments. The necessary funding and a facilitating body or model is required to coordinate discussions about infrastructure planning and landscape scale conservation planning. Coordination and capacity is needed at the local level and from a pan-Northern vantage. In this instance a shared public-private partnership approach should be considered.

4. Interconnected parks and protected areas including Indigenous Conserved and Protected Areas should be established across the North at sizes necessary to protect ecosystems and the species that rely on them to survive.

5. People and communities most affected by decision-making about infrastructure development and loss of biodiversity must be involved in the decision-making process.

Energy Infrastructure

Background

Technology for energy storage is a critical piece of information necessary for Northern communities to fully realize energy efficiencies through green technologies. Knowledge created and shared from necessary research, monitoring and application toward the viability of thermal storage addresses a key barrier for energy alternatives in the Yukon and across the North. Yukon Conservation Society's energy analyst will address this topic in the following section.

On the topic of northern infrastructure, energy consumption and generation are key issues that the Yukon Conservation Society is engaged with. There are two separate energy scenarios that most northern communities can be categorized by:

- Diesel powered communities
- Hydro powered grids with fossil fuel "top-up"

Each of these scenarios presents unique challenges and opportunities for greenhouse gas (GHG) reductions, environmental stewardship, and long term cost savings. The Yukon Conservation Society's expertise is centered around Yukon's independent electrical grid which generates most of its electricity from hydro power, with liquefied natural gas (LNG) and diesel being burned through the winter to meet demand. As such, this document will touch on solutions for diesel powered communities, but will focus on the Yukon context recognizing that the challenges and solutions in NWT and Nunavut are unique to their jurisdictions.

Context for Diesel Powered Communities

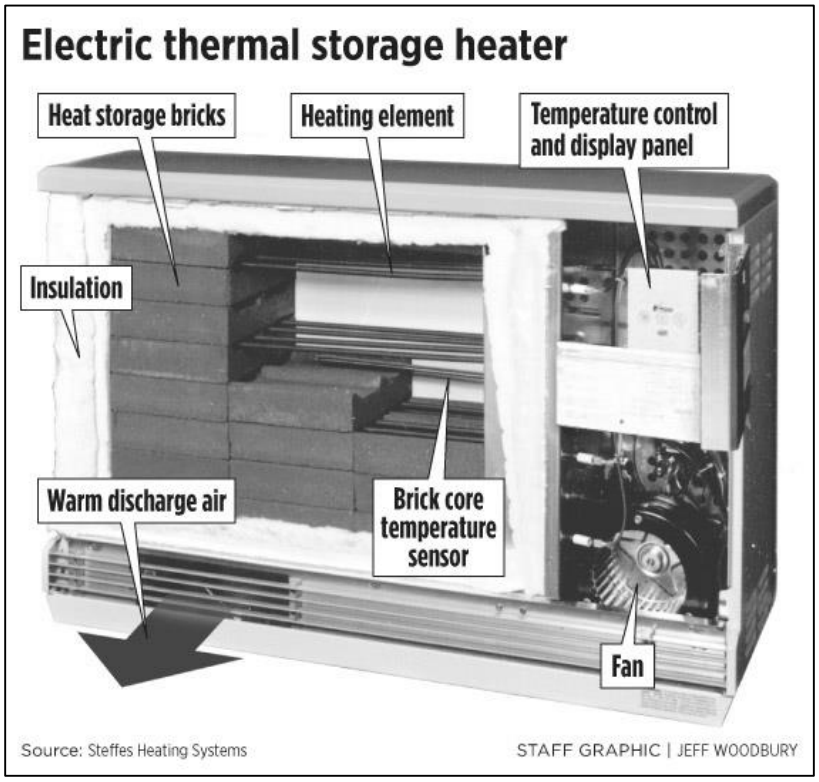
There are nearly 300 "off-grid" communities in Canada[1], and roughly 86% of them are primarily dependent on diesel fuel for electricity generation[2]. Many (if not most) of these also rely primarily on fossil fuels for home heating. In some communities the fuel is barged or even flown in and is extremely expensive. The generators are noisy, dirty, and GHG-intensive.

[1] https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/canmetenergy/files/pubs/2013-118_en.pdf#page=4
[2] https://thenarwhal.ca/canada-s-commitment-220-million-transition-remote-communities-diesel-mere-drop-bucket/

Wind, Diesel and Electric Thermal Storage

A unique strategy to simultaneously reduce diesel and heating oil consumption has been employed successfully by our neighbours in Alaska.

Several isolated Alaskan villages have installed wind turbines at high penetration (30-40% of grid capacity[3]) to greatly reduce their diesel fuel consumption. In addition to the wind turbines, a heating system called Electric Thermal Storage (ETS) was installed in a number of residences in the communities. These ETS units act as thermal batteries so that when there is more wind energy than the electrical grid requires, that energy can be sent instantaneously to the ETS units. The ETS units store the energy as heat and then release the heat into the home when it is needed. In this way, the wind turbines are able to reduce the use of diesel for both electricity consumption and home heating.



These Wind-Diesel-ETS systems are one type of “hybrid micro-grid”. The other common strategy is a solar-diesel hybrid, as done in Old Crow, Yukon.[4] Wind and solar can also be combined to diversify across energy resources and reduce both daily and seasonal energy fluctuations. At this stage, hybrid micro-grids appear to be one of the best ways to reduce diesel fuel consumption in off-grid communities; however, they unfortunately do not fully eliminate diesel fuel reliance.

The Islanded Grid Challenge

Most of Yukon’s population is serviced by the Yukon Integrated System (YIS), an electrical grid primarily consisting of three hydro power plants with LNG and diesel generators to meet peak loads. The YIS is not connected to Alaska or to the North American electrical grid, so we are unable to import or export

[3] http://www.iesconnect.net/category/projects/
[4] http://www.energy.gov.yk.ca/installing-solar-systems-in-old-crow.html

electricity. In the summer, meltwater from the mountains swells the rivers and the water spills past the dams because the electricity isn't needed. In winter, the river flows are reduced and heating loads nearly double our electrical demand.[5] Electrical heating has become nearly ubiquitous in new home construction[6] so winter electrical loads are increasing much faster than summer loads, exacerbating the seasonal disparity. Tackling this seasonal demand variability is a major challenge, as Yukon only needs new electrical capacity for roughly half the year.

Continental Interconnection

Starting in 2014, the Yukon Development Corporation (under direction from Yukon Government) began exploring a transmission line interconnection to British Columbia. This connection would allow Yukon to use the North American grid as a "bank" to sell power to in the summer and buy from in winter. The idea was researched in depth by the Yukon Development Corporation (YDC) and found to be decidedly uneconomical, with an estimated capital cost of $1.7 billion.[7] Despite this result, Yukon Government is and YDC are again investigating a transmission line connection to British Columbia, with the thought of taking advantage of low cost energy from the Site C dam.[8]

Economics of the Transmission Line

In July of 2015 Midgard Consulting released a report commissioned by Yukon Development Corporation and titled: Yukon - Transmission Market Benefits Assessment. This report focused on the net economic benefits of connecting Yukon's electrical grid to BC's or Alaska's. The results were unequivocal. The Yukon-BC connection had a negative $1.47 billion economic impact, and the Yukon-Alaska connection came in at negative $1.19 billion.

> Both scenarios demonstrate significantly negative net economic benefits and are therefore uneconomic strategies. – Midgard Consulting, 2015[9]

To justify the project, it would require an average electricity export of:

> 227MW for 60 years in order to defray the cost of a transmission interconnection to British Columbia…. The quantum of export volume exceeds the design capacity of the transmission line by 2x or more...

Further, the report reads:

> Importing electricity into the Yukon is similarly unattractive with required import volumes exceeding the forecast need for electricity beyond 2065…

According to the report, Yukon would need to import 150MW per winter peaking hour for 60 years to pay for the BC interconnection.[10] For context, as I write this (November 14, 2018), the entire Yukon grid

[5] http://resourceplan.yukonenergy.ca/media/site_documents/Yukon_Energy_2016_Resource_Plan.pdf (page 2-3)
[6] http://www.energy.gov.yk.ca/pdf/Shifting-Demand-in-Yukon-Heating.pdf
[7] http://nextgenerationhydro.ca/documents/ (NGH_Transmission Value Assessment)
[8] https://www.yukon-news.com/news/yukon-government-mulls-power-line-to-site-c/
[9] http://nextgenerationhydro.ca/documents/ (NGH_Transmission Value Assessment)
[10] http://nextgenerationhydro.ca/documents/ (NGH_Transmission Value Assessment)

is currently using just 58MW.[11] Yukon Energy's 20 year forecast for electricity demand growth shows a worst case peak demand of 109MW reached in 2028.[12] Considering that Yukon's existing hydro resources can generate about 70MW[13] of this throughout the winter, there simply isn't a foreseeable scenario in which Yukon would have sufficient electrical demand to justify interconnection with BC.

A Self-Sufficient Solution

Rather than selling our excess electricity in the summer and buying it back again in the winter, that energy can be stored locally and released as needed through the winter. In similar fashion to a transmission line, energy storage provides a place to send excess energy, and a source to draw from when there is a deficit. The technology to do so has been around for decades. Pumped hydro systems store energy by pumping water from a low elevation to a higher elevation reservoir. The water sits in the high reservoir until it is needed, at which point it flows back down through a turbine, generating electricity. Pumped hydro is by far the most abundant and mature energy storage technology available today, accounting for 95% of all utility scale energy storage in the United States.[14]

In another study commissioned by Yukon Energy, Midgard Consulting performed a high level study of a local pumped storage hydro project. They estimated a grand total cost of $262.9 Million to build a storage facility that could store 70GWh of energy,[15] an amount considerably more than what spills over our dams in the summer. This project would provide the same service as a transmission line to the south, cost only 15% as much,[16] and would bolster rather than hinder the economics for local clean energy production.

Impacts on the Local Energy Economy

Once built, a government subsidized transmission line to British Columbia (or Alaska[17]) would link Yukon to low cost energy. Local wind, solar, biomass, geothermal, and small hydro projects would have no chance of competing with the southern mega-dams on a cost per kWh basis, stagnating the recent and growing surge in local energy independence and community resiliency. The transmission line would effectively subsidize major mines and industrial projects with cheap electricity while stripping communities of the opportunity to develop local solutions and build their own green economies.

Conversely, an energy storage system removes a major barrier to wind and solar development; it enables excess electricity to be stored and used when needed, thus reducing fossil fuel use not only when the wind is blowing, but on the calm days as well. Additionally, solar and wind power generated in

---

[11] https://yukonenergy.ca/energy-in-yukon/electricity-101/current-energy-consumption - Yukon Energy Publishes a live feed of their electricity generation, including the share of hydro and thermal (fossil fuel) energy

[12] http://resourceplan.yukonenergy.ca/media/site_documents/Energy_and_Peak_Demand_Forecast_-_2016_-_2035.pdf (page 28)

[13] https://yukonenergy.ca/media/site_documents/Yukon_Energy_2016_Resource_Plan.pdf (page 2-3)

[14] https://www.energy.gov/eere/water/pumped-storage-hydropower

[15] https://yukonenergy.ca/media/site_documents/Appendix_5.17_Moon_Lake_Pumped_Storage_Conceptual_Study_Report_(Midgard_2015).pdf

[16] $262.9M for the pumped hydro compared to $1700M for the transmission line

[17] There is a proposed connection to Alaska's main grid at Fairbanks. A shorter, smaller connection to Skagway Alaska may have merit as Skagway has large electrical demand in summer due to the influx of cruise ships and much less demand in winter.

the summer currently have very little value, as we already have more than enough hydro power in those months. Having long term energy storage would create a market for summertime renewable energy which then could be stored until needed in the winter. The number one argument against renewables is that they aren't dispatchable sources; an energy storage project would tackle exactly that issue, making renewables increasingly competitive against GHG intensive fossil fuels.

Conclusion

The development of energy infrastructure will always come with environmental impacts. It is an unfortunate reality that we must weigh the global impacts of GHG emissions against local impacts such as hydro infrastructure and linear disturbances (power lines). Wind and solar energy stand out as being emissions free and having less environmental impact compared with other options, but they are intermittent and thus energy storage in some form is required for these resources to be comparable to hydro and fully replace fossil fuels. As it stands currently, pumped hydro appears to the be the most economical and practical option for bulk energy storage in Yukon. A transmission line to BC would provide a similar service, but the capital cost (and operating cost) is astronomical and the availability of imported electricity would cripple Yukon's growing clean energy economy. The federal government can have the most positive impact on clean energy infrastructure in Yukon by contributing to projects such as energy storage systems that are beneficial in their own right, but also set the stage for further clean energy investment by local communities.

Recommendations Addressing Energy Infrastructure

6. The Yukon Conservation Society recommends that a seasonal energy storage project be prioritized as a more economical and sustainable option for Yukon energy security than a major transmission line to British Columbia

7. YCS also recommends that the federal government support the development of Wind-Diesel-ETS hybrid micro-grid systems in diesel powered communities as soon as possible. This system type presents an opportunity to reduce winter diesel consumption more effectively than solar-diesel hybrid systems.

The Yukon Conservation Society

The Yukon Conservation Society (YCS) is a grassroots environmental non-profit organization, established in 1968. Through a broad program of conservation education, input into public policy, and participating in project review processes, we strive to ensure that the Yukon's natural resources are managed wisely, and that development is informed by environmental considerations.

Our Energy Program is focused on reducing Yukon's greenhouse gas emissions, improving local energy security, and minimizing environmental impacts through conservation, efficiency, and adoption of low-impact renewable energy technology.

References Cited

Bernauer, T. (2013). Climate Change Politics. *Annual Review of Political Science, 16*(1), 421-448. doi:doi:10.1146/annurev-polisci-062011-154926

Chung, E. (2018). 60% of world's wildlife has been wiped out since 1970. Retrieved from https://www.cbc.ca/news/technology/living-plant-wwf-2018-1.4882819

Cooke, H. (2017). Securing a Wild Future: Planning for Landscape-Scale Conservation of Yukon's Boreal Mountains. Conservation Report No. 9. Toronto, Ontario, Canada: Wildlife Conservation Society Canada.

Coristine, L. E., Jacob, A. L., Schuster, R., Otto, S. P., Baron, N. E., Bennett, N. J., . . . Woodley, S. (2018). Informing Canada's commitment to biodiversity conservation: A science-based framework to help guide protected areas designation through Target 1 and beyond. *FACETS, 3*(1), 531-562. doi:10.1139/facets-2017-0102

Dulac, J. (2013). Global land transport infrastructure requirements: Estimating road and railway infrastructure capacity and costs to 2050. Paris, France: International Energy Agency.

Government of Canada. (2018a). Canada's Conservation Vision: A Report of the National Advisory Panel. Ottawa, Canada.

Government of Canada. (2018b). Equality and Growth: *A Strong Middle Class*. Ottawa, Ontario, Canada: Government of Canada.

Governmnet of Canada. (2017). Taking Action Today: Establishing Protected Areas for Canada's Future *Report of the Standing Committee on Environment and Sustainable Development, 42nd Parliament, 1st Session*. Ottawa, Canada: House of Commons.

Lawton, G. (2018). Road Kill. *New Scientist, September* (3193), 36-41.

Legagneux, P., Casajus, N., Cazelles, K., Chevallier, C., Chevrinais, M., Guéry, L., . . . Gravel, D. (2018). Our House Is Burning: Discrepancy in Climate Change vs. Biodiversity Coverage in the Media as Compared to Scientific Literature. *Frontiers in Ecology and Evolution, 5*(175). doi:10.3389/fevo.2017.00175

Ray, J. (2018). At risk of extinction. Retrieved from https://www.canadiangeographic.ca/article/risk-extinction

Saura, S., Bertzky, B., Bastin, L., Battistella, L., Mandrici, A., & Dubois, G. (2018). Protected area connectivity: Shortfalls in global targets and country-level priorities. *Biological Conservation, 219*, 53-67. doi:https://doi.org/10.1016/j.biocon.2017.12.020

Watson, J. E. M., Jones, K. R., Fuller, R. A., Marco, M. D., Segan, D. B., Butchart, S. H. M., . . . Venter, O. (2016). Persistent Disparities between Recent Rates of Habitat Conversion and Protection and Implications for Future Global Conservation Targets. *Conservation Letters, 9*(6), 413-421. doi:10.1111/conl.12295

WWF. (2018). Living Planet Report - 2018: Aiming Higher. Grooten, M., Almond, R.E.A. (Eds). Gland, Switzerland.