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Case Study

Indigenous Guardianship and moose monitoring: weaving Indigenous and Western ways of knowing

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Abstract: Increasing global rates of wildlife species extinctions, extirpations, and declines warrant improvements to population monitoring and management approaches. To address regional environmental and wildlife issues, Indigenous communities globally are re-establishing traditional roles as stewards of the land through emerging Indigenous Guardianship Programs (IGPs). By providing the opportunity for community-level participation in monitoring and management, IGPs help foster cohesive solutions for long-term conservation of species while promoting environmental stewardship at the community level. Addressing challenges in monitoring and management of wildlife is especially critical for species that are of cultural and ecological importance at both community and distribution-wide scales. Herein, we describe IGPs in Canada with a focus on moose (*Alces alces*), an important species to many Indigenous Peoples across the species' distribution. We outline common Western approaches to moose monitoring applied across Canadian jurisdictions and discuss ways in which weaving Indigenous knowledge systems and information gathered through local participation from Indigenous communities enhances monitoring initiatives at regional levels. We elaborate on a case study on moose monitoring and co-management in the community of Gitanyow in British Columbia, Canada to highlight the value of Guardianship to communities and species conservation in relation to moose. Our study reveals how IGPs and the weaving of Indigenous and Western knowledge systems can contribute to the maintenance of both ecological and cultural integrity to strengthen wildlife monitoring and management under changing global environments.

Key words: Aboriginal, *Alces alces*, Canada, First Nation, Indigenous knowledge, moose, population monitoring, stewardship, traditional ecological knowledge, wildlife management

The disappearance and decline of global wildlife warrants improvements to population monitoring and management, but funding and resources can often be limited (Gilchrist et al. 2005). An important issue involving human–wildlife interactions is how changes in wildlife population numbers and their distributions are impacting communities that rely on wildlife for sustenance and to maintain their way of life. To address such challenges, Indigenous communities globally are re-establishing traditional roles as stewards of the land and reasserting Indigenous laws through emerging Guardianship programs (Kirby and Kotaska 2018, Reed et al. 2020).

Embracing multiple ways of knowing, Indigenous Guardian Programs (IGPs) assist with bridging gaps among Indigenous communities/nations/organizations, industry, nongovernmental organizations, and non-Indigenous governments to facilitate the use of holistic wildlife monitoring approaches. There

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are well-recognized benefits to including multiple ways of knowing (i.e., Indigenous and Western knowledge systems) in environmental research and management (Bartlett et al. 2012, Alexander et al. 2019). Ways of knowing consist of the process through which knowledge is gained, from observation to the understanding of information, and can be shaped by culture, values, and way of life (Berkes 2009). Indigenous knowledge systems (i.e., traditional ecological knowledge, Indigenous traditional ecological knowledge, etc.; McGregor 2004) are place-based (Aikenhead and Michell 2011) cumulative bodies of knowledge, practice, and belief about ecological relationships handed down through generations by Indigenous Peoples (Berkes 2012) that reflect Indigenous understanding of relationships with Creation (McGregor 2004). Further, two-eyed seeing (the word *Etuaptmumk* in Mi'kmaw) is a concept described by Albert Marshall, Mi'kmaq Elder, as the process of learning to see from two eyes—an Indigenous eye, encompassing Indigenous ways of knowing, and a Western eye, encompassing Western ways of knowing (Bartlett et al. 2012). The weaving of multiple ways of knowing through two-eyed seeing can support inclusive environmental co-management and establish holistic-based monitoring approaches. Central to IGPs is local participation in community-led environmental monitoring. Indigenous Guardians work on the land, typically carrying out daily activities or promoting community-centered participation in monitoring and enforcement of Indigenous laws. Guardians have been defined as the "eyes and ears" of traditional territories, lands, and waters and have taken on leadership roles in information gathering, designing management plans, and fostering intergenerational knowledge transfer and cultural revitalization (Kirby and Kotaska 2018). As IGPs (i.e., Indigenous Rangers, Indigenous Watchmen) are emerging globally and have been implemented in countries including Australia, Aotearoa/New Zealand, and the United States, an Indigenous Guardians Pilot Program has been recently developed in Canada to support IGPs through an investment of $26 million over 4 years (Reed et al. 2020).

Through the inclusion of both Indigenous and Western ways of knowing, IGPs promote holistic solutions to monitoring wildlife and the environment. Indigenous knowledge systems are holistic forms of understanding that encompass all areas of human existence and do not separate humans from ecology (McGregor 2008). By approaching wildlife monitoring and Guardianship in a holistic manner, or one that embraces interconnectivity, environmental sustainability that contributes to the preservation of wildlife and the maintenance of ecological and cultural integrity in environmental management can be reached (Berkes 2009). Holistic approaches to monitoring and management can especially benefit the sustainability of species that play important roles in the way of life of Indigenous Peoples.

Moose (*Alces alces*) provide an example of a species that is important in both Indigenous and Western cultures and that can benefit from a holistic approach to management. Moose is an important species to many Indigenous communities, providing food and materials as well as fostering social relationships and cultural traditions (LeBlanc et al. 2011). Currently, moose populations are declining in many regions across North America (Laliberte and Ripple 2004, Demarchi and Schultze 2011, Murray et al. 2006), threatening the important role moose play in Indigenous communities while posing a risk to food security in many regions (Parlee et al. 2012, 2014). Because of their wide distribution, monitoring strategies for moose are typically difficult and cost-extensive, leaving uncertainty and gaps in population information (Boyce et al. 2012). The inclusion of localized monitoring through IGPs would therefore greatly benefit the ability to track moose population change and inform collaborative management at local scales.

In this paper, we highlight how IGPs can provide localized solutions for improving knowledge gaps in moose monitoring while engaging the community and improving collaborative management. We outline common Western approaches to moose monitoring applied across Canadian jurisdictions and describe advantages and disadvantages to each approach. We further discuss how emerging IGPs can strengthen moose monitoring and weave Indigenous and Western ways of knowing and information gathering. We lastly provide a case study that elaborates on moose co-management in the

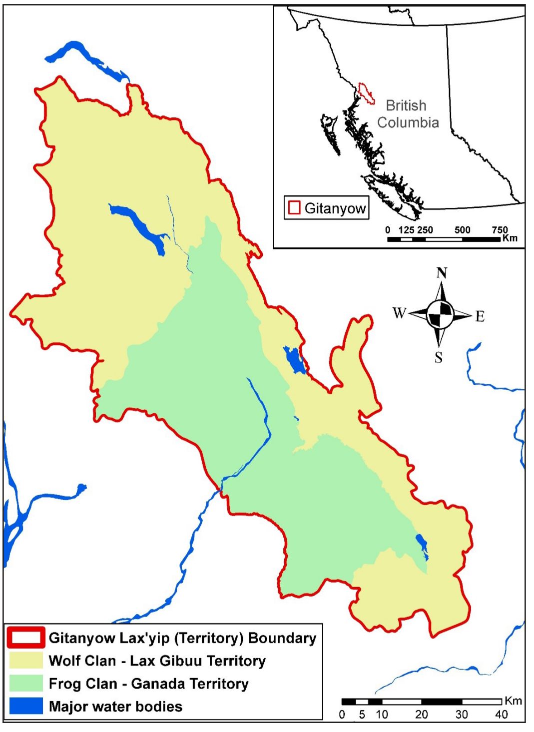

Figure 1. Map of Gitanyow Lax'yip (Territory) on the west coast of British Columbia, Canada.

community of Gitanyow in British Columbia, Canada, documented in a previous article by Popp et al. (2019) to showcase a real-world example of the value that IGPs can provide to enrich both communities and environmental management in relation to moose.

Study area

Our evaluation of common methods used to monitor moose in Canada included provinces and territories in which moose reside and where government-led moose monitoring occurred regularly. Our case study focused on Gitanyow, an Indigenous nation located within the jurisdictional boundaries of British Columbia, Canada (Figure 1). The Gitanyow Lax'yip (traditional territory) spans an area of >6,000 km^2 and is found within the Nass and Skeena River watersheds in northwestern British Columbia. The Skeena and Nass River watersheds are the second and third largest, respectively, in British Columbia, and both support a high diversity of fish and wildlife (Moore et al. 2014).

The Gitanyow are governed by a collective of 8 hereditary chiefs and are organized into 2 clans (Gibuu [Wolf] and Ganeda [Frog]; Figure 1), each with 4 Wilp (house group) territories. Many members of each Gitanyow Wilp actively fish and hunt and rely heavily on both salmon (*Salmo salar*) and moose to supplement their diet. In addition to providing a source of food, fishing and hunting is important to the Gitanyow for supporting their spiritual connection to the Lax'yip.

Methods

In this study, we identified the main and secondary methods of moose monitoring employed by provincial and territorial governments in Canada based on the jurisdictional scan by Young and Popp (2017*a*). The jurisdictional scan was conducted by collecting information from publicly available sources including provincial/territorial government websites, documents (e.g., annual hunting regulation summaries), and moose management plans. Most of the information was collected online; however, direct communication with government staff also took place to collect missing information. Provinces and/or territories that did not frequently monitor moose or have an established moose monitoring program were excluded from our assessment. Further, we outlined advantages and disadvantages to each of the monitoring methods identified based on the review by Young and Popp (2017*b*). Information was collected using an online database (Google Scholar) of peer-reviewed literature on moose monitoring. We additionally described ways in which Indigenous knowledge can be interwoven to benefit each monitoring approach. Our case study expanded on the previously documented co-management of moose in Gitanyow (see Popp et al. 2019) to highlight how an IGP in Gitanyow was established and has been successful to conserve and manage the moose population in the Nass portion of the Gitanyow Lax'yip, including through the perspective of a Gitanyow Guardian.

Common moose monitoring methods

Moose population monitoring methods varied across Canadian provinces and territories. The most common moose population monitoring method was aerial surveys, followed by land user surveys and fecal pellet surveys (Table 1); however, other methods exist including camera traps (Frey et al. 2017), collection of roadkill

Table 1. Common methods of moose (*Alces alces*) population monitoring used across Canada and the jurisdiction (province or territory) in which they are used as a main, or secondary (*) source of monitoring. Advantages and disadvantages of each method are outlined, along with how Indigenous knowledge systems can be interwoven to enhance monitoring. Adapted from Young and Popp (2017*a, b*).

Method	Jurisdiction	Advantages	Disadvantages	Possible ways to weave Indigenous knowledge systems
Aerial surveys	Alberta	Obtain measure of population size and/or sex ratios	Involves observation error	Stratification of high, medium, and low moose density areas
	British Columbia	Obtain information on habitat use and distribution	Weather dependent	Prioritizing areas and/or years to monitor populations
	Manitoba	High precision	Safety risk associated	
	New Brunswick*	Can survey large areas	Resource and time consuming	
	Newfoundland and Labrador	Requires minimal data processing	Safety training required	
	Northwest Territories		Observational skills required	
	Nova Scotia*			
	Ontario			
	Saskatchewan			
	Yukon			
Land user surveys (hunter harvest or sighting reporting)	British Columbia*	Community involvement possible[a]	Involves observation error	Inform on harvest success
	New Brunswick	Obtain measure of population size and/or sex ratios	Variable participation	Inform on moose habitat use and distribution
	Nova Scotia	Obtain information on distribution		Inform on health of moose seen or harvested
	Ontario*	Can be used in concealing habitats		Inform on long-term population trends
	Saskatchewan*	Less sensitive to weather		
		Inexpensive		
		Can be calibrated by aerial surveys to determine accuracy over time		
Fecal pellet surveys	Nova Scotia*	Community involvement possible	Involves observation error	Identify (seasonal) areas with high moose density to monitor
		Simple training required	Localized	

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Can be combined with other sign (e.g., tracks)	No direct measures of population, or costly (e.g., genetics)
Can be used in concealing habitats	Limited sampling period
Less sensitive to weather	Requires consistent sampling at the same time each year
Relatively inexpensive	Difficult to survey remote areas
Can be calibrated by aerial surveys to determine accuracy over time	

[a]Smartphone apps make this approach more accessible and increase participation.

data (Rolandsen et al. 2011), and harvest data (Månsson et al. 2011, Boyce et al. 2012). In some cases, multiple methods were employed by a province or territory (Table 1) and were used to supplement the main method of monitoring. Common monitoring methods also differed in their advantages and disadvantages (Table 1), and some may be better suited to the needs of communities or jurisdictions than others.

The most common method of monitoring moose, aerial surveys, involves direct counts of populations. Aerial surveys are typically conducted either along line transects or using a plot/block-based system (Peters et al. 2014). Both types of surveys require stratification (i.e., grouping) of the landscape based on animal density before the survey takes place and random sampling of transects or plots to be surveyed (Peters et al. 2014). Aerial surveys can be conducted as either manned, using fixed-wing or helicopters, or unmanned, using unmanned aerial vehicles (UAVs). The UAVs are also referred to as drones, unmanned aerial systems, or remotely piloted vehicles. Manned aerial surveys are the most frequently used method to census moose populations (Timmermann and Buss 2007, Ronnegard et al. 2008, Månsson et al. 2011); however, both methods can provide information on population composition, including sex structure and reproductive rates (Timmermann and Buss 2007, Ronnegard et al. 2008). Although there are several benefits to unmanned aerial surveys, the utilization of UAVs in environmental monitoring is a relatively new technique that is still being explored (Koh and Wich 2012, Dulava et al. 2015, Johnson et al. 2015), and current legislation restricts use under certain conditions (Watts et al. 2010, Wing et al. 2013, Whitehead and Hugenholtz 2014, Whitehead et al. 2014, Chrétien et al. 2015, Vincent et al. 2015).

Land user surveys include the public where individuals record observations or harvests per unit effort of time (Ronnegard et al. 2008, Boyce and Corrigan, 2017). Observation-based population indices can also provide population composition information including sex ratio and reproductive rates (Ronnegard et al. 2008) as well as include Indigenous knowledge (Popp et al. 2019). There is a variety of existing land survey data collection methods (e.g., phone, internet, mail, in person, smartphone applications, etc.) with several arguments supporting each (e.g., Steinert et al. 1994, Hansen et al. 2006, Lukacs 2007, Gigliotti 2011). A successful approach is likely one that utilizes the most preferred method identified by harvesters and land users to maximize engagement and participation.

Fecal pellet surveys, also known as pellet group counts or fecal pellet transects, is a technique that counts fecal pellet groups over a given area and time period and combines animal defecation rate, decay rate, and fecal accumulation period to produce an estimate of relative abundance (Timmermann and Buss 2007, Ronnegard et al. 2008). Fecal pellet surveys are considered best used for analyzing population trends rather than providing density estimates (Ronnegard et al. 2008). Although the accuracy of fecal pellet indices have been questioned (Fuller 1991, Alves et al. 2013), researchers in various countries have been using this method in cervid population surveys since the 1940s (Neff 1968, Forsyth et al. 2007, Alves et al. 2013).

Depending on the capacity, available funds, experience, size of sampling area, and objectives within a community or jurisdiction, a particular moose population monitoring method may be preferential over another (Ronnegard et al. 2008, Månsson et al. 2011). Although moose monitoring methods used in Canadian provinces and territories can inform population estimates, limitations do exist. Weaving Indigenous and Western ways of knowing can provide additional holistic insight and improve moose monitoring initiatives.

Weaving ways of knowing in moose monitoring

While Western methods used to monitor wildlife allow a systematic and scientific approach to track population changes, weaving multiple ways of knowing can offer a way to enhance monitoring efficiency and maximize information gained to understand changes in species and local environments (Moller et al. 2004). By providing holistic and localized approaches to wildlife monitoring, the inclusion of Indigenous knowledge systems can be especially valuable to monitor widely distributed species such as moose. Multiple ways of knowing can be incorporated into the frameworks of monitoring, including for aerial surveys, land user surveys, and pellet counts (Table 1).

Aerial surveys require knowledge of the landscape to be used to derive an estimate of moose population size. The landscape for an area being surveyed is typically stratified based on information on habitat and moose density, and expert knowledge is commonly sought (Peters et al. 2014). Indigenous people who know the land being surveyed, including hunters, land users, and Guardians, can be valuable sources of information to inform on moose habitat use and density and to aid in the stratification of areas on the landscape. Additionally, due to high associated costs, aerial surveys are typically flown on a per-needs basis that is decided by regional managers and biologists (Boyce et al. 2012, Peters et al. 2014). Feedback from Indigenous land users and Guardians on population changes, uncertainties, or low harvest success rates can inform the need to survey and highlight important areas where surveys should take place (Knapp et al. 2013). This information may be particularly critical in communities that rely heavily on moose to sustain a way of life.

Furthermore, land users and Guardian observations can be used as a monitoring source to inform management decisions. Resident harvest is used in some jurisdictions as an index of moose population trends but has been criticized to not provide accurate information (DeCesare et al. 2006, Priadka et al. 2020). Alternatively, previous studies have identified that the typically less selective harvest practices by Indigenous hunters, compared with government-regulated resident harvest, can deliver indices of moose population size that are more representative of moose population sex and age ratios (Lynch 2006). Previous studies have also highlighted that Indigenous knowledge holds important information on moose habitat use and health that may have been otherwise overlooked if populations were monitored using strictly Western science approaches (Jacqmain et al. 2008; Brook et al. 2009; Parlee et al. 2012, 2014; Tendeng et al. 2016). An important distinction between Indigenous knowledge systems and Western science is that Indigenous knowledge systems typically encompass a more holistic view of the environment, while Western science typically focuses on pre-determined objectives (Berkes and Berkes 2009). Further, Indigenous knowledge systems span temporal scales that may not be available if relying on Western science, providing an opportunity to estimate long-term trends in populations (Moller et al. 2004, Knapp et al. 2013). Similarly, pellet counts require knowledge of areas on the landscape with high animal density and rely on sampling that takes place at the same time each year (Timmermann and Buss 2007, Ronnegard et al. 2008). Areas to sample can be informed by Indigenous land users who know the seasonal patterns of animal habitat use (Knapp et al. 2013) to both improve monitoring efficiency across the landscape and consistency over time.

As uncertainties surrounding wildlife population change and distribution continue, the weaving of Indigenous and Western ways of knowing may be key to solving challenges in monitoring of widely distributed species such as moose. Although improvements to relationships and meaningful engagement are still needed (Eckert et al. 2020), holistic solutions that embrace multiple ways of knowing are on the rise globally, ultimately supporting cultural inclusivity in science and wildlife management (Moller et al. 2004, Gilchrist et al. 2005, Adams et al. 2014, Popp et al. 2019). Through use, respect, and reliance, moose have been locally monitored by Indigenous Peoples since time immemorial, resulting in knowledge that provides information not as accessible through Western approaches (Parlee et al. 2012). By applying both Indigenous and Western approaches to monitor wildlife, new perspectives, methods, and knowledge can arise that strengthen our ability to understand changes in the natural world (Moller et al. 2004, Adams et al. 2014, Popp et al. 2019). Additionally, local knowledge can often provide information at much larger temporal scales and inform management on locally important issues and changes to wildlife (Moller et al. 2004, Knapp et al. 2013, Adams et al. 2014). The weaving of multiple ways of knowing therefore has great potential to improve understanding of moose population dynamics and to optimize conservation goals while benefiting all those who rely on moose.

To facilitate the weaving of multiple ways of knowing, emerging IGPs can provide the framework for inclusivity of both Indigenous and Western approaches to monitoring. Through the application of multiple ways of knowing, wildlife issues can be addressed holistically while fostering environmental stewardship in communities to provide community-wide benefits (Kirby and Kotaska 2018, Reed et al. 2020). The IGPs can also ensure successful application and longevity of monitoring approaches by tailoring to needs specific to each community, an important trait that can contribute to the maintenance of both ecological and cultural integrity in wildlife management.

Case study: moose monitoring and Guardianship in Gitanyow

Moose (*Ha-daa/Xa'da* in Gitxsanimaax) play an important part in the way of life of Gitanyow people. Moose hunting is essential for providing food and spiritual and physical health benefits while contributing to the maintenance of intergenerational relationships and knowledge exchange among Gitanyow peoples (Koch 2016, Popp et al. 2019). By the mid-2000s, Gitanyow hunters were having difficulty finding moose. In 2007, the British Columbia government documented a moose population decline of approximately 70% since 2001 in the Nass portion of the Gitanyow Lax'yip (Demarchi 2007). This decline was scientifically determined through 2 consistently conducted stratified random block aerial surveys. Correspondingly, 2 sociocultural needs assessments of Gitanyow Wilp members indicated moose meat was difficult to access and most respondents desired more moose meat to supplement their diets (Marsden 2010, 2014).

The Gitanyow Moose Monitoring and Permitting Program was started in 2011 to address the moose population decline and the corresponding difficulty of Gitanyow people to access moose (Marsden 2010). As part of the program, Indigenous Guardians provided a much-needed monitoring presence to document harvest by Nisga'a hunters through their treaty rights granted through the Nisga'a Final Agreement (Nisga'a Nation, Government of Canada, and Government of British Columbia 1999), which covered 84% of the Gitanyow Lax'yip. Further, Gitanyow hereditary chiefs were adamant that Gitanyow and Gitxsan hunters who wished to hunt on the Gitanyow Lax'yip followed the Gitanyow Ayookxw (Law), which requires asking and being granted permission by the head chief of the Wilp territory where a hunter wishes to hunt (Koch 2020).

Since 2011, the Gitanyow Lax'yip Guardian (GLG) Program has evolved and expanded from 2 part-time Guardians working seasonally and focused on moose to approximately 3 full-time Guardian positions with staff trained in a wide variety of wildlife, fisheries, hydrology, and ecological monitoring techniques. The Guardians collect data systematically each season on moose harvest locations, sex and timing of harvest, moose roadkill and live moose and wolf (*Canis*

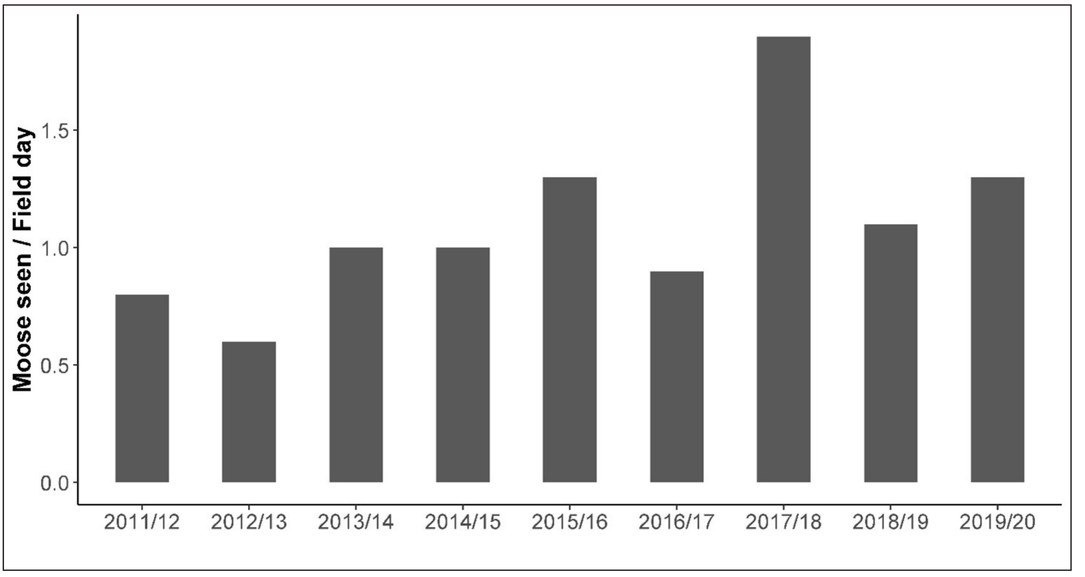

Figure 2. Recorded number of moose (*Alces alces*) seen per field day over 9 years of moose observational monitoring by Gitanyow Lax'yip Guardians following the establishment of the Gitanyow Moose Monitoring and Permitting Program, British Columbia, Canada.

lupus) observations. Guardians produce metrics such as live moose observed per field patrol day that can be compared over time to moose aerial survey estimates. Guardian roadkill monitoring dataset, which includes locations, timing, and sex of moose killed on Highway 37 and 37A has been used by the British Columbia Ministry of Transportation and Infrastructure to place warning signage along the highways as well as for planning out roadside brushing to increase visibility for drivers, with a goal of reducing moose–vehicle collisions.

In 2019, GLG staff received training from a wildlife veterinarian in conducting mortality assessments and in collecting samples from moose carcasses for health analysis. For the 2020 to 2021 season, the Guardians will be expanding their moose monitoring program and engaging with hunters to collect samples from moose that are harvested or carcasses found in the field, to monitor for things such as body fat indices, stress hormone levels, winter ticks, mineral deficiencies, and other health parameters. For the 2020 to 2021 season, Guardians will be switching completely from using hardcopy paper field forms to iPad forms created with Filemaker Pro Advanced software and tracking their patrol routes each day using the GPS Kit app. This will allow calculations of live moose observed per km traveled and/or per hour spent monitoring, which may prove to be a more appropriate metric for monitoring of moose populations through daily patrols.

For the GLG moose program, each year starts with a pre-season series of meetings with a Gitanyow wildlife biologist, Guardians, and hereditary chiefs, where information is reviewed on any updates to moose populations and results from the previous season's monitoring. A moose harvest resolution developed and signed by all 8 hereditary chiefs in 2016 forms the foundation for the permitting program, and each year a moose harvest strategy is developed to outline the specifics for the upcoming season, including harvest season opening and closing dates, Wilp territories that are closed, harvest reporting requirements, and other parameters. The harvest strategy gets posted to the GLG Facebook page (https://www.facebook.com/groups/gitlyg) and often holds community meetings to discuss the harvest permitting program. The GLG staff work closely with the British Columbia Conservation Officer Service and provide the harvest strategy to the service each year, which then helps enforce the harvest strategy.

Additionally, protection of moose and moose habitat by Gitanyow started before the 2007 observed moose population decline. After 3 successful court cases (Gitxsan and other First

Nations v. British Columbia [Minister of Forests] 2002, BCSC 1701; Gitanyow First Nation v. British Columbia [Minister of Forests] 2004, BCSC 1734; Wii'litswx v. HMTQ 2008, BCSC 1620 and Wii'litswx v. British Columbia [Minister of Forests], 2008 BCSC 1139), the British Columbia government agreed to work with Gitanyow on a land use plan for their Lax'yip. The Gitanyow Lax'yip Land Use Plan (GLLUP) contains legal protection for ecosystem networks and ungulate winter range (Gitanyow First Nation 2012). After several decades of intensive forest harvesting, having the GLLUP meant that moving forward, animal movement corridors and moose winter range identified by Gitanyow chiefs and elders would be interwoven into the land use planning process, providing legal protection to not only moose but the ecosystems where moose reside. It is important to note that Guardians are not just those on the land but include the leaders that are willing to spend years in court and at land use planning tables to protect their Lax'yip.

Between 2011 and 2017, the moose population in the Nass portion of the Gitanyow Lax'yip increased an estimated 50% (Demarchi 2017). The harvest of cow moose has declined an estimated 65% when compared to the early 2000s (Hamelin 2012, Koch 2020), and live moose observed per field day by Guardians has been increasing (Figure 2). Between 2011 and 2012 to 2019 and 2020, Guardian patrol field days have also increased from 28 to 85 days a year (Koch 2020). Having the Gitanyow Lax'yip Guardians patrolling the territory not only helped enforce the Gitanyow Ayookxw as it relates to hunting but is believed to have been a major factor in reducing unregulated hunting by non-Gitanyow people. Gitanyow people have always fiercely protected their territories, as their survival depended on the abundance of resources. Recent history has shown that without Guardians serving this critical and age-old role, the resources and the territory itself will suffer.

Perspectives on the IGP were provided by Gitanyow Guardian James Morgan (personal communication), including how it has encouraged community engagement to support moose conservation:

> "I truly believe that we were all born as monitors. We not only see and hear; but we feel what is right and wrong, then as a community we adjust accordingly to better preserve what is our precious culture. Monitoring our territory started out as a large idea fueled by very little funds. It has quickly accelerated to the point now where not only community members inform but, outside community members that pass through our territory are now calling us and letting us know what is going on. If it's concerning to them, they feel that the Gitanyow Guardians can find a way. That is very big in any place, let alone small communities."

Additionally, the proven benefit of weaving multiple ways of knowing for species conservation is recognized by Guardians who are on the land monitoring:

> "Western scientific monitoring methods work best when combined with Indigenous knowledge. Maybe [this is] because [Indigenous knowledge] helps to feel what Western science sees and hears."

Despite starting as a small initiative, the establishment of Gitanyow Lax'yip Guardians has had a positive impact on the Gitanyow community. By supporting stewardship at the community level, Guardianship has allowed members of Gitanyow to monitor and protect their traditional territory while reconnecting people with the land. Guardians are regarded highly within the community, which encourages information on local changes or challenges surrounding wildlife to be shared by community members and aid in monitoring and conservation planning. The weaving of Indigenous and Western ways of knowing to monitor moose further provides a system that works for the community and enhances local monitoring and management that promotes moose conservation and sustainability for the long term. As Indigenous nations re-establish traditional roles as stewards on the land, emerging IGPs offer an effective way to solve localized issues and challenges surrounding wildlife while enriching community and wildlife management. The future of Guardianship in Gitanyow is promising, and more fish and wildlife species are likely to benefit from continuance of this program within the community.

Management implications

Our Gitanyow Lax'yip Guardians case study demonstrates how weaving Indigenous and Western ways of knowing to monitor moose, an important species to many people, can strengthen and contribute to ecological and cultural integrity. The establishment of Indigenous Guardians resulted in regulated moose harvest and localized management solutions that led to an observed increase in the local moose population. By bringing Indigenous and Western ways of knowing together, cohesive solutions for long-term species conservation were made possible while promoting environmental stewardship at the community level. Our study reveals how IGPs and the weaving of Indigenous and Western knowledge systems can strengthen wildlife monitoring and management with positive outcomes under changing global environments.

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