

# Children's Perception of Wolverine in the North Slave Region of the Northwest Territories, Canada

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**ABSTRACT.** The public's level of knowledge and opinions towards certain species can greatly impact their willingness to support present or future conservation or management programs. When public opinion is mixed, as is often the case with wild carnivores, an accurate assessment of perceptions and knowledge can identify areas of concern and help guide public outreach efforts. When such outreach programs focus on children they can be particularly effective for two reasons: 1) the opinions of children towards wild animals are often more flexible than the ingrained beliefs of adults, and 2) it is the younger generation that will be called upon to support long-term conservation efforts in the future. To assess the degree of knowledge and the current state of opinion among children towards a little known and often negatively perceived Arctic species, the wolverine (*Gulo gulo*), we conducted surveys with school children between the ages of 8–12 years old in seven schools within the North Slave Region of the Northwest Territories. Results from 151 completed surveys confirm that the majority of children lack general knowledge about this species, though the overall level of knowledge was higher in small, rural communities than the larger capital city of Yellowknife. Negative values were among the most commonly expressed values we observed, but so too was an appreciation for the ecological role that wolverines play in nature. The results of this study can be used to implement new educational programs aimed at increasing the overall level of acceptance of the wolverine and similar carnivores, and to encourage the public's willingness to support conservation efforts for this often negatively perceived species.

**Key words:** human-animal relationships; wolverine; *Gulo gulo*; First Nations, value orientations; youth

**RÉSUMÉ.** Le niveau de connaissances et d'opinions des populations au sujet d'une espèce donnée peut avoir une grande incidence sur les programmes de gestion ou de conservation actuels ou futurs de l'espèce en question. Lorsque l'opinion publique est mixte, comme c'est souvent le cas avec les carnivores sauvages, l'évaluation précise des perceptions et des connaissances peut permettre de déterminer les sujets de préoccupation et de guider les efforts de sensibilisation du public. Quand de tels programmes de sensibilisation visent les enfants, ils peuvent être particulièrement efficaces pour deux raisons : 1) les opinions des enfants envers les animaux sauvages sont souvent plus flexibles que celles détenues par les adultes, et 2) c'est la jeune génération qui sera appelée à soutenir les efforts de conservation à long terme. Pour évaluer le degré de connaissances et les opinions actuelles des enfants envers une espèce arctique peu connue et souvent négativement perçue, le carcajou (*Gulo gulo*), nous avons mené des enquêtes auprès d'élèves de huit à douze ans dans sept écoles de la région North Slave des T.N.-O. Les résultats des 151 questionnaires remplis confirment que la majorité des enfants possèdent peu de connaissances générales sur cette espèce, bien que le niveau global de connaissances était plus élevé dans les petites collectivités rurales que dans la capitale de Yellowknife. Les valeurs négatives figuraient parmi les valeurs les plus courantes exprimées dans le cadre des enquêtes, bien que la valeur écologique du rôle du carcajou dans la nature ait également été mise en évidence. Les résultats de cette étude peuvent être utilisés pour mettre en œuvre de nouveaux programmes éducatifs visant à accroître le niveau général d'acceptation du carcajou ou d'autres carnivores de ce genre, ainsi que pour encourager le public à soutenir les efforts de conservation de cette espèce souvent mal comprise.

**Mots clés :** relations humains-animaux; carcajou; *Gulo gulo*; Première Nation; valeurs; jeunes

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## INTRODUCTION

Tolerance, acceptance, and understanding by the general public are among the most important requirements of biological conservation programs, especially those dealing with controversial species such as carnivores (Kellert, 1985; Bath and Enck, 2003). At the individual level, these qualities

develop from one's culture and firsthand experiences and have a strong influence on the perceptions, affection, sympathy, and ultimately the attitudes of people towards wild animals (Serpell, 2004; Prokop and Tunnicliffe, 2010). Initially, these attitudes develop during childhood and are malleable, shifting and changing as new experiences are accumulated (Paul and Serpell, 1993). Over time, however,

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certain opinions are reinforced and can become ingrained as adults (Bjerke et al., 1998).

When attitudes towards a particular species are primarily positive, conservation efforts for that species can be facilitated by widespread public support in the form of financial donations or volunteer participation in conservation programs (Bagchi and Mishra, 2006; Stokes, 2007; Knight, 2008; Ceriaco, 2012). When public opinion is negative, however, common distrust/dislike or negative experiences with a particular species (Kretser et al., 2009), regardless of its ecological importance, can hinder each step of a conservation program (Treves and Karanth, 2003). This negative opinion is more common among rural than urban populations (Schwartz et al., 2003), as the financial cost associated with wild animal interactions—the loss of livestock to a wild carnivore for example—is felt more strongly by rural ranchers and farmers than urban residents (Treves and Karanth, 2003). When the costs or perceived risks associated with the presence of wild carnivores exceed some threshold, public resistance to conservation efforts may escalate from complaints to poaching or poisoning efforts (Oli et al., 1994; Treves et al., 2004).

An example of the impact that negative public opinion can have on conservation efforts can be seen with the reintroduction of gray wolves (*Canis lupus*) into Yellowstone National Park in Wyoming, USA. In an effort to control local herbivore populations and restore ecological balance to the park, the National Park Service (NPS) began a wolf reintroduction program in 1995 (Brian, 2004). Though considered by many to have ultimately been a success, this reintroduction program was highly controversial (Fritts et al., 1997) and initially met with strong resistance and hostility from local inhabitants who expressed concerns for the safety of their families and livestock through various media outlets (Williams et al., 2002). As a result, reintroduction efforts were at first unpopular and were occasionally hindered by local inhabitants taking direct action to prevent wolves establishing themselves (i.e., poaching and poisoning; Sacks et al., 1999; Treves et al., 2004). For reintroduction efforts to ultimately succeed, it was necessary for the NPS to spend considerable financial resources on media coverage and public outreach programs to improve public opinion towards gray wolves in the area (Wilson, 1997). Such scenarios are not unique to Yellowstone National Park, however, and similar situations have occurred elsewhere (e.g., the reintroduction of wolves into Algonquin National Park, Ontario, Canada; Musiani and Paquet, 2004).

Negative public opinion towards carnivores not only arises from negative direct experiences, it can also stem from beliefs rooted in myths or stories (Ceriaco, 2012). Such beliefs, though not necessarily based on the species' biology, can similarly result in their persecution (Kellert, 1994; Kellert et al., 1996; Morzillo et al., 2007; Ceriaco, 2012). When traditional legends, myths, and stories falsely imply that a species represents a threat to public safety, livestock, or property, this idea can become ingrained

among the beliefs of local populations (Bjerke et al., 1998). In such situations, negative beliefs about a species can influence public opinion to the same extent as negative firsthand experiences.

For these reasons, understanding public opinion towards a species of conservation concern, and the underlying causes for such beliefs, is crucial when planning and implementing conservation efforts. Past studies have shown that knowledge of people's beliefs, values, and attitudes can be a valuable tool for predicting their future behaviour (Kellert and Westervelt, 1984; Fulton et al., 1996; Bright et al., 2000; Dayer et al., 2007; Herrmann et al., 2013). Indeed, some studies have developed typologies or categories to quantify the expression of value orientations towards animals or even biodiversity among local populations (e.g., Kellert and Westervelt, 1984; Vermeulen and Koziell, 2002). Conducting such public opinion studies prior to planned species reintroductions can help biologists avoid costly and counterproductive mistakes (Kellert and Westervelt, 1984; Fulton et al., 1996). Additionally, in the event that negative public opinion towards an at-risk species is present among the local population, identifying the underlying causes for such beliefs can help with the planning of public outreach and education programs (Linnell et al., 2001). Currently, education and habituation during adolescence are believed to be the most effective means of modifying public opinion towards carnivores and dispelling the fears associated with such species (Davey, 1994; Münchhausen and Herrmann, 2008; Mannelqvist, 2010). For this reason, identifying demographic groups among the younger generations where public opinion is more malleable may improve the chances of successfully raising public opinion prior to conducting costly, but necessary, species conservation programs.

In rural southern regions, where human population densities are higher and much of the wild landscape has been converted for agricultural use, the public opinion towards reintroducing wild carnivores tends to be low (Michalski et al., 2006; Treves et al., 2006; Campbell and Alvarado, 2011). In more northern latitudes, however, public opinion is more often mixed as the mostly rural populations view wild carnivores as anything from a threat to livestock or valuable wild herbivores (e.g., reindeer and caribou), to a valued natural resource themselves (e.g., fur trade or ecotourism). Coincidentally, as environmental changes and anthropogenically driven habitat loss continue to cause demographic declines in many northern species (Ogada et al., 2003; Woodroffe et al., 2005; Vors and Boyce, 2009), the need for conservation programs at the northern latitudes is growing (Woodroffe, 2001; Weir et al., 2007)—emphasizing the need to better understand public opinion towards species at risk.

The wolverine (*Gulo gulo*), a northern species with an important ecological role, is in need of human intervention (e.g., management and conservation programs) in order to prevent the loss of additional populations and restore its density throughout historic ranges (Fortin et al., 2005).

Entire populations have already disappeared from their historic distributions in eastern Canada (Krebs and Lewis, 1999; Fortin et al., 2005; Gallant et al., 2016). Elsewhere, information on their actual numbers is lacking and wolverines are often considered to be a “species of least concern,” which permits hunting and trapping activities to continue despite the undetermined sustainability of these actions. Presently, conservation efforts for wolverines suffer from low public support due, in part, to their elusive nature—making them largely unknown to most Northerners (Banci, 1994); as well, an abundance of stories, myths, and second-hand encounters exist, which place wolverines in a negative light (Woodford, 2014). As few people know much about the biology and ecology of wolverines, and fewer still have encountered one, much of what people believe about this solitary creature originates in stories. Many such stories reinforce misconceptions about wolverines being dangerous and ferocious beasts (Seton, 1953), stealing from traplines, raiding food caches, and damaging unoccupied cabins (Hash, 1987; Banci, 1994). This reputation is particularly common among trappers (Banci, 1994), who may feel that wolverines threaten their livelihoods (Fortin et al., 2005).

Among people who have heard of wolverines, opinions can range from wolverines being a threat to the economically important and dwindling caribou stocks (Lindén et al., 1994; Oli et al., 1994) to being viewed as a valued fur resource (Banci, 1994). Among the Dene First Nations in Canada's Northwest Territories (NWT), the wolverine is an important species that appears in many traditional stories that highlight its ability to survive, steal, or play tricks on people (Moore and Wheelock, 1990). Along with playing an important role in many myths and legends, the wolverine has economic value to the Dene (Benson, 2014), and its frost-resistant fur is sought after by makers of parkas throughout the North. As a result, many Dene and other northern Indigenous peoples show a deep respect towards wolverines.

With the possibility of a new conservation program for wolverines in the NWT in the near future, we attempt to assess public opinion among northern residents towards this species in order to provide biologists, conservation practitioners, and decision makers with a means of identifying areas of concern where beliefs and opinions are particularly negative, and assist with tailoring educational programs to address any shortcomings in public knowledge. Generally, as firsthand encounters with wildlife are more common in rural areas, we hypothesize that rural inhabitants may be more knowledgeable about wolverine biology and ecology than their urban counterparts. Conversely, as rural populations in the North tend to be more closely connected with the local wildlife through hunting and trapping—activities with which wolverines are believed to interfere—we also expect rural inhabitants to express a more negative opinion towards wolverines relative to urban populations. Moreover, with many of the above-mentioned stories exalting the wolverine's strength,

determination, and aggressive behaviour, it would not be surprising if the general public opinion towards wolverines tended to be negative.

To this end, we surveyed school children in the North Slave region of the NWT, in both rural and urban settings, to assess their levels of knowledge about wolverines and the value orientations they express towards this species. Since public outreach programs have been shown to be more effective among children than among adults (Paul and Serpell, 1993; Bjerke et al., 1998), school children were chosen to complete the survey. A second reason we choose to work with children was the fact that their sensitivity to the environment, their experiences, and their actions in the environment are all early childhood processes that contribute to the formation of life values (Eloranta and Yli-panula, 2005). Similarly, Palmer et al. (1996) highlighted the role of experiences and activities in nature as being a key source of environmental responsibility, especially in early childhood. Using semi-descriptive statistical techniques, we assessed the relationships between demographic covariates and knowledge-value orientations towards wolverines. We similarly assessed the relationships between the value orientations expressed by students and their knowledge of wolverines. By quantitatively characterizing these relationships, we provide federal and territorial conservation agencies with information to assist them in protecting this little known and often negatively perceived, but important scavenger.

## METHODS

### *Study Area*

Classroom surveys were conducted in the North Slave Region of the NWT, an area extending northward from Great Slave Lake (Fig. 1) and which encompasses seven small, rural communities (< 2500 inhabitants) of predominantly First Nations people, and the urban capital of Yellowknife, with over 20 000 inhabitants. While the entirety of the North Slave Region falls within the species distribution range of wolverines, they are rarely seen in the vicinity of Yellowknife, though exceptions do occur: a wolverine was seen close to an elementary school in 2016 (Brockman, 2016). Such entries into the city are rare, however, and firsthand encounters are far more common near smaller communities, especially in winter when the lakes and rivers freeze over, facilitating movement.

Between April and June 2014, school directors and teachers at the third, fourth, and fifth grade levels were asked whether their students would enjoy participating in a study about wolverines. Participation involved students (between 8–12 years old) completing a voluntary survey to assess their knowledge of wolverines as well as their value orientations towards this species. Following the survey, all students within a participating class were given a short multimedia presentation about wolverines,



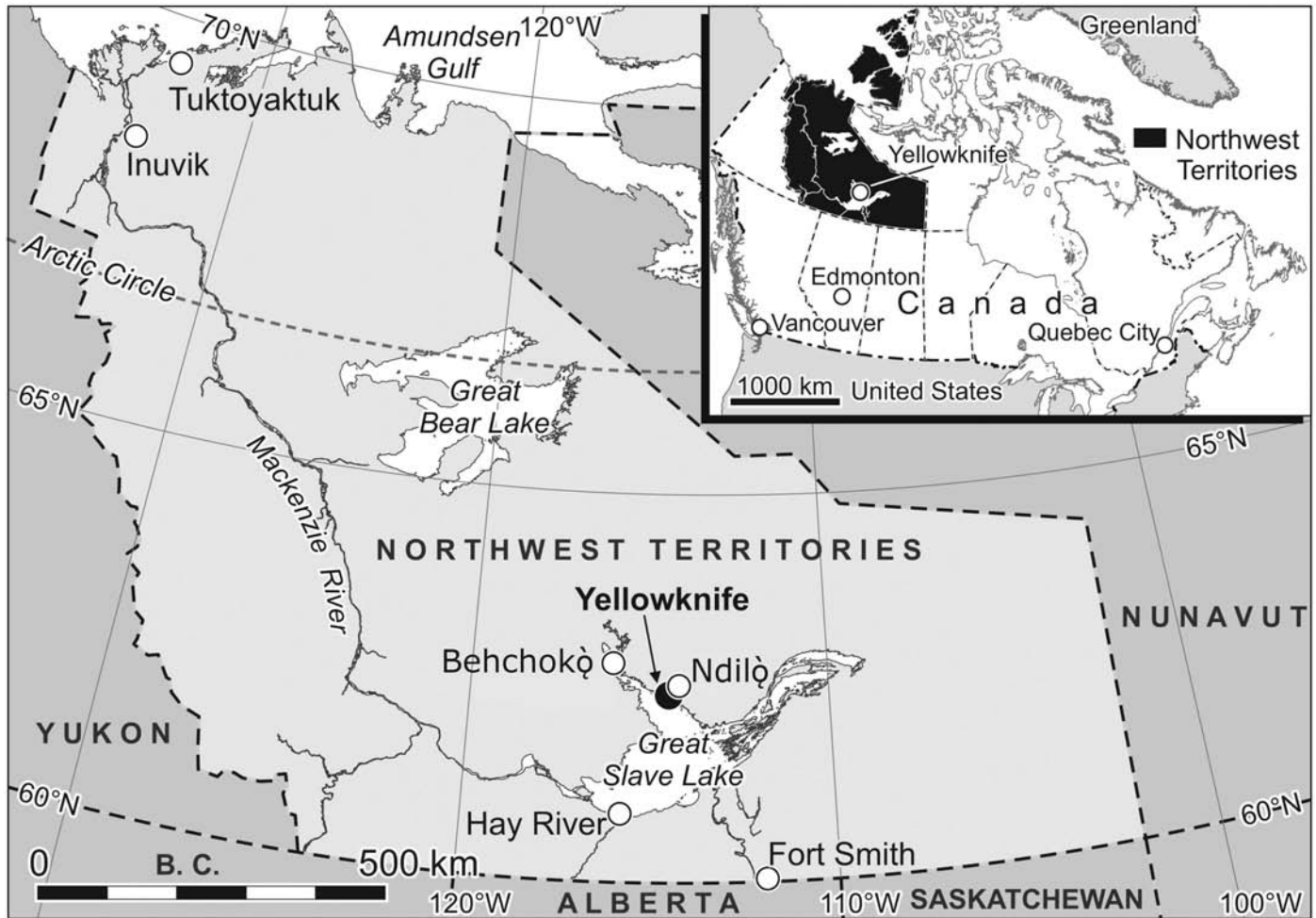


FIG. 1. Location of the three communities in the NWT—Yellowknife, Behchokò, and N'dilò—in which elementary school children participated in the wolverine survey. (Cartography: Marc Girard, University of Montréal, 2015.)

which included a 10 min documentary film and a question and answer period with a biologist (the lead author). Of the nine elementary schools we contacted, seven agreed to have classes participate in the study. Because of the greater concentration of elementary schools in the capital, five of the seven schools that agreed to participate were in Yellowknife: Mildred Hall, École Allain St-Cyr, N.J. Macpherson, J.H. Sissons, and Weledeh. The final two schools were in outlying rural communities: Elizabeth Mackenzie school (Behchokò, 70 km from Yellowknife, < 2500 people), and K'alemi Dene school (N'Dilò, 3.5 km from Yellowknife, ~ 200 people). While a balanced design incorporating an equal number of rural and urban schools would have been preferable, participation in our study was voluntary and at the discretion of the individual students and teachers. The following results should therefore be treated with some degree of caution, though measures were taken to limit the effect of unequal sample sizes on our statistical tests. The rural areas (N'Dilò and Behchokò) are known to contain a larger proportion of hunters than Yellowknife, as many families in these communities actively maintain their historic trap lines.

In accordance with our ethical permits issued by the

University of Montréal ethics committee in February 2014 (CERFAS-2013-14-D) and Aurora College in April 2014 (license 15456) in Yellowknife, the names of participating schools have been replaced by letters in the following analyses to maintain anonymity.

#### *Study Species*

Wolverines, along with badgers, ferrets, otters, and weasels are members of the Mustelidae family. They are carnivorous mammals whose adult weight ranges between 10–18 kg (Banci, 1994). Wolverines are native to the circumpolar regions and are most often found in tundra, taiga, and boreal forest ecozones (Banci, 1994; Ruggiero et al., 2007) where human activity and landscape transformation is minimal (Banci, 1994; Copeland, 1996; Weaver et al., 1996). They are opportunist carnivores that regularly feed on both live prey as well as the carcasses of dead animals (Persson, 2003). During winter, ungulates like caribou are their principal food source (Mulders, 2001; Van Dijk et al., 2008; Mattison, 2011; Inman et al., 2012), while in summer their diet shifts towards small rodents (Dalerum et al., 2009) and eggs (Myhre and Myrberget, 1975).

TABLE 1. Demographic breakdown of classes (Grades 3–5) surveyed within the NWT about wolverine and northern species in general. Identification as being Indigenous or not was at each student's discretion.

School	Location	Class size	Male (%)	Indigenous (%)
A	Yellowknife	15	53.3	0
B	Yellowknife	26	46.2	7.7
C	Yellowknife	22	45.5	0
D	Community	11	63.6	100.0
E	Yellowknife	21	47.6	81.0
F	Yellowknife	43	41.9	7.0
G	Community	13	30.8	84.6

### Survey

Children in classes that participated in the study (Table 1) were each given a questionnaire and informed that participation was not mandatory and the results would not affect their school grades. Children were then told that the purpose of the survey was to determine their feelings and knowledge about animals in general, but specifically about wolverines. Among the classes that chose to participate in the study, the student participation rate was 100%.

The questionnaire was composed of four sections, the first of which collected demographic information about each participant. This information included their location (rural or urban), age, sex, identity (Indigenous or non-Indigenous), school (A through G) and whether they had a domestic pet at home (yes or no). These data, along with the scores earned on the “general knowledge of northern species” section of the questionnaire, served as covariates for models that attempted to explain variation in knowledge and the expression of value orientations related to wolverines.

The next two sections of the questionnaire were the basis for assessing the students' knowledge levels about northern species and wolverines. The second section of the questionnaire asked students to identify the names of several northern species found within the NWT, ranging from large charismatic species like the polar bear (*Ursus maritimus*) and caribou (*Rangifer tarandus*), to less known and cryptic species such as the lynx (*Lynx lynx*) and Arctic

fox (*Vulpes lagopus*). These questions required students to, among other things, match the names of species to their pictures. The third section dealt specifically with wolverines and quizzed the students' understanding of general wolverine biology (diet, habitat, mode of locomotion, and physical appearance), asking students to identify pictures of wolverine anatomy, prey items, tracks, and habitat from among several choices.

The final section of the survey assessed the children's value orientation towards wolverines and consisted of 10 closed-ended questions requiring one-word or one-sentence answers intended to address eight specific value orientations, based on Kellert's (1984a) study on children's attitudes towards wild species (Table 2). Though multiple empirical studies have developed typologies of attitudes towards animals (e.g., Ramsey et al., 1989; Teel and Manfredo, 2010), we found Kellert's values to be the most consistent with what we hoped to examine. As has been pointed out by Lutz and Srogi (2010) and Dietz et al. (2005), Kellert and Westervelt's (1984) work is not without criticism, as it stems from disciplines that do not traditionally address values research and is not grounded in the same theoretical or empirical literature. As a result, the biological basis for Kellert's hypotheses may be difficult or impossible to test. Despite these criticisms, we have found that Kellert's values typology provides a useful tool to analyse how children's value orientations influence opinion towards an endangered species.

Alterations to Kellert's original typology were made for the current study to increase its appropriateness for the populations we surveyed (populations with a high proportion of First Nation people). Instead of Kellert's original nine values, we employed eight value orientations (Table 2) that omitted Kellert's *humanistic* and *moralistic* values and replaced them with a single, new environmental protection and awareness value (EPA) to assess the children's willingness to protect wildlife and their habitat. Additionally, Kellert's *ecological* and *scientific* values were combined into a single ecological/scientific value. Finally, a spiritual/cultural value, based on the *spiritual* and *cultural values* described in Herrmann et al. (2013) was added.

TABLE 2. Value classification scheme used to assess the values and opinions of children in Grades 3 to 5 in the North Slave region of the NWT towards wolverines. Adapted from Kellert (1984a) and Herrmann et al. (2013).

Aesthetic	• The individual finds this animal visually appealing.
Spiritual and Cultural Importance	• The individual acknowledges (is aware of) the importance or role of this animal in, for example, stories, legends, and art.
Dominionistic	• The individual believes that this animal plays the role of a resource over which humans have the inherent right to use (i.e., a game hunting species).
Ecological/Scientific	• The individual appreciates the role of this species in terms of biodiversity, showing appreciation for most species and acknowledging the importance of wildlife and their interactions.
EPA	• The individual believes that animals and their habitat should be protected and shows motivation to assist in their protection.
Naturalistic	• The individual shows respect and/or affection for this species and nature in general and is interested in observing or interacting with this species in a natural setting.
Negativistic	• The individual displays a willingness to avoid the species because of dislike or fear and finds the species to be dangerous.
Usefulness	• The individual recognizes a practical use for the species (e.g., as a source of fur).

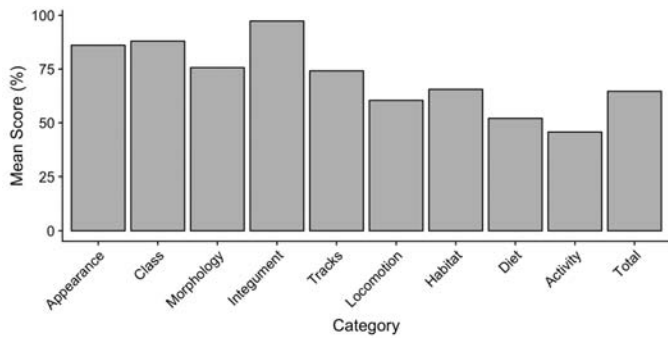


FIG. 2. Students' average scores. The survey was designed for students in grades 3–5 in the NWT. The survey covered all aspects of wolverine biology, including appearance, phylogenetic class (mammal, reptile, fish, etc.), aspects of their morphology (teeth shape, etc.), integument (fur, scales, etc.), means of locomotion, and paw shape. The survey also covered more general aspects of wolverine ecology, including habitat, diet, and whether the animals are diurnal or nocturnal (activity).

### Statistical Analysis

Surveys were first manually digitized and checked for completeness. Of the 171 surveys collected, 151 were complete and were used in the subsequent analyses. Following digitization, a knowledge score was then calculated for each student by summing the total number of points achieved over the 12 knowledge-based questions about wolverines in the third section of the survey. A maximum of 24 points was possible and students could score partial marks for most questions. The questions designed to assess the eight value orientations of interest did so by requiring binomial responses (yes or no) and explanations in which words or phrases consistent with the value in question were identified.

As our goal was to describe relationships between the demographic covariates and both the knowledge scores and value responses, as well as the direct relationship between knowledge scores and values themselves, the Akaike information criterion (AICc) was used to identify sets of generalized linear models with comparable explanatory potential (Akaike, 1987). The identification of model sets was done by first constructing a global model containing each of the explanatory covariates and, in the case with demographic covariates, pertinent interactions. The MuMIn package in R (Barton, 2019) was then used to contrast corrected AIC values (AICc) for the global model and all possible subset models nested within the global model, including univariate models and the null model.

Subsequently, model sets were then ranked according to their respective AICc values and filtered down to only those models within two  $\Delta$ AICc units of the best model. This subset of models was then further filtered by identifying and removing models that contained uninformative covariates, nested models whose additional covariates failed to improve their AICc score (Arnold, 2010) or did not significantly reduce residual deviance as determined by likelihood ratio tests. This process was conducted on the models of wolverine knowledge scores as a function of

demographics as well as for each of the models relating the expression of value orientations to demographics. In each case, the final model subsets were compared to the null model using likelihood ratio tests; the implications of the best fit models were explored.

In each case where demographic covariates were used to model observed variation, the initial global model always included an interaction between sex and age and an additive effect of the remaining six covariates. When the variation among knowledge scores was modelled as a function of the expression of value orientations, all possible two-way interactions among values were considered.

## RESULTS

### Knowledge of Wolverines

When students were asked to identify each of the wolverine's modes of locomotion from among several options, most children (94%) correctly answered that wolverines can walk, 57% recognized that wolverines can also climb, and 41% knew that wolverines are able to swim. When asked to identify which tracks belonged to a wolverine, 76% of the surveyed children (Fig. 2) answered correctly.

When students were asked to identify physical attributes of wolverines from photos of possible answers, 97% chose the correct type of integument (fur), 75% of the children correctly identified the type of eyes a wolverine has, while 89% correctly recognized the jaw and teeth of a wolverine. Despite displaying a commendable understanding of the physical attributes of a mammalian predator, fewer than half (47%) were able to identify the claws of a wolverine.

When asked to identify the main food sources of a wolverine from nine images, most students identified small rodents (69% chose lemming and 67% chose mice). Only 60% chose caribou despite caribou being the wolverine's primary food source in the NWT. Only 24% of the students correctly identified that wolverine eat carcasses, which suggests that the wolverine's role as a scavenger may not be well understood among students in the North. Overall, the average score obtained by children on the diet section was 50% (Fig. 2).

When four pictures of different habitats were shown to the students and they were asked to identify in which habitat they were most likely to find a wolverine, most children correctly answered that wolverine live in the tundra (68%) or the mountains (59%), which indicates that most students recognized the wolverine to be a northern species.

### Knowledge as a Function of Demographics

Including the global and null models, a total of 160 models were compared to one another in this analysis. From these, one best fit and 18 additional models within two  $\Delta$ AICc units were identified. The best fit model was an additive model containing the points received on the general



knowledge section (points), and where the student lived (location, urban or rural) as explanatory covariates. The remaining 18 models contained both the points and location covariates, indicating that any contribution to improving the overall fit by additional covariates was marginal. For this reason, only the best-fit model is discussed further (Table 3).

A likelihood ratio test indicated that the best-fit model was a significant improvement over the null model ( $p < 0.01$ ). In this model, scores on the general knowledge section of the survey were positively correlated with knowledge of wolverines in particular, such that each 1-point improvement on the northern species section raised the mean wolverine score by 1.4 points ( $p = 0.02$ ). In addition to the effect of points on the wolverine scores, students in urban locations scored an average of 7.61 points lower than students in the outlying communities (Fig. 3). This result is consistent with our expectation that students living in outlying communities experienced greater exposure to the wild and may therefore be more knowledgeable about wolverines than students in the capital city.

#### Value Orientations

Of children surveyed, 73.7% expressed the aesthetic value (Table 4). Comments by the students typically concentrated on the fur of the wolverine, which many students described as being nice, soft fur with a beautiful coloration.

The wolverine is a pretty cool species.  
(9-year-old boy, non-Indigenous)

TABLE 3. Model selection table showing generalized linear models of student survey scores on general knowledge of wolverines. Covariates included are the number of points received by participants on general knowledge of northern animal species (points), and whether participants lived in the capital city or outlying communities (location). The number of parameters (K) and the log likelihood (LL) of each model have been included along with their corrected AIC values (AICc), the difference between each model and the best-fit model ( $\Delta\text{AICc}$ ), and the AIC weights (w) assigned to each model based on the total set of models considered.

Model	K	LL	AICc	$\Delta\text{AICc}$	w
Points + Location <sup>1</sup>	2	-592.13	1192.53	0.44	0.04
Null Model	1	-599.38	1202.83	10.74	0.00

<sup>1</sup> Indicates a significant difference from the null model based on likelihood ratio tests ( $p < 0.05$ ).

Wolverines have a good color fur.  
(10-year-old girl, Indigenous)

Despite the majority of students identifying as non-Indigenous, the spiritual and cultural value was expressed by 73.7% of the children surveyed (Table 4). In most cases, the expression of this value was through mentioning legends about wolverines interacting with people.

The Dene people used to live on the land. One day, a group of people was walking on the trail and [a]

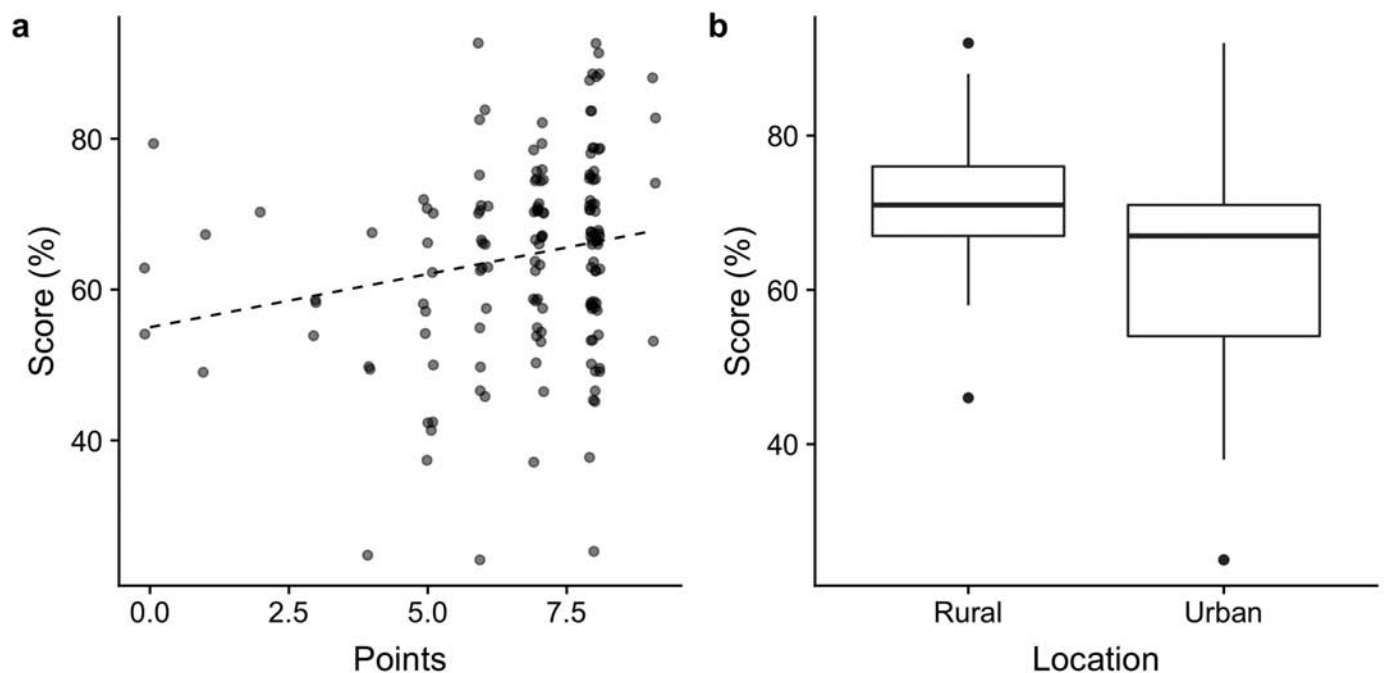


FIG. 3. The scores (%) obtained by children living in the NWT (grades 3 – 5) on a survey assessing general knowledge about wolverines, graphed as a function of general knowledge of northern species (out of 9) and whether the student lived in the capital city or an outlying rural community. Lines represent values predicted by a fitted generalized linear model outlined in Table 3. Box-and-whisker plots include the median, first and third quartiles, and 1.5 times the inter-quartile range. Outlying points beyond this range were still included in the analysis.

TABLE 4. The overall expression (Exp) of values by the children surveyed about wolverines in the NWT. Best-fit models explaining variation in the expression of the value are included along with the number of variables included (K), their log likelihood (LL), Akaike value corrected for small sample sizes (AICc), the difference between each model and the best-fitting model ( $\Delta$ AICc), and each model's AIC weight (w) based on the different models assessed in each case.

Value	Exp	Model	K	LL	AICc	$\Delta$ AICc	w
Aesthetic	73.7%	Null Model	0	-82.79	167.61	0.00	0.04
Spiritual/Cultural	73.7%	Age + School <sup>1</sup>	2	-71.64	160.36	0.00	0.09
		Null Model	0	-83.79	169.61	9.25	0.00
Dominionistic	28.7%	Location + Points <sup>1</sup>	2	-73.24	152.65	0.87	0.06
		Age + Location <sup>1</sup>	2	-73.47	153.11	1.32	0.04
		Null Model	0	-88.15	178.32	26.54	0.00
Ecological/Scientific	85.0%	Location <sup>1</sup>	1	-59.61	123.31	0.00	0.09
		Identity <sup>1</sup>	1	-60.27	124.62	1.31	0.04
		Null Model	0	-61.72	125.48	2.17	0.03
EPA	78.3%	School <sup>1</sup>	1	-66.79	148.40	0.00	0.05
		Location <sup>1</sup>	1	-72.39	148.87	0.47	0.04
		Identity <sup>1</sup>	1	-72.98	150.05	1.65	0.02
		Null Model	0	-76.53	155.08	6.69	0.00
Naturalistic	33.8%	Sex	1	-92.07	188.23	0.00	0.04
		Null Model	0	-93.16	188.35	0.12	0.04
Negativistic	89.0%	Age + Location <sup>1</sup>	2	-45.04	96.25	0.00	0.11
		Null Model	0	-50.23	102.49	6.24	0.00
Usefulness	83.3%	Pet	1	-63.34	130.77	0.00	0.06
		Null Model	0	-64.70	131.42	0.66	0.04

<sup>1</sup> Models with a significant reduction in residual deviance relative to the null model as determined by likelihood ratio tests ( $p < 0.05$ ).

wolverine chase them. One man climb[ed] up in the tree and the wolverine tried to climb up the tree to get him and the man has a stick and hit the wolverine's toe. As he hit its toe [...] it [wolverine] turned to spruce gum. It is one of the many wolverine legend stories told by the Dene people. My grandpa told me this story.

(11-year-old boy, Indigenous)

The dominionistic value, or the idea that wolverines exist to be used by humans for their needs, was by far the least common value expressed by children in the survey at 28.7% (Table 4). The respondents expressed this value typically through mentioning that humans can impose their desires on wolverines.

Humans need to teach the wolverine to not go inside cabins.

(11-year-old boy, non-Indigenous)

The ecological/scientific value scored highly among the children surveyed with 85% expressing this value (Table 4). Most students expressed that wolverines were somehow important to nature and the environment or that their interactions with other animals were important or necessary in some way.

I knew wolverine is important, but I don't remember [why]...maybe for the environment.

(9-year-old girl, non-Indigenous)

Wolverine is important for other animals.

(11-year-old girl, non-Indigenous)

Like the ecological/scientific value, the EPA value also scored highly among children surveyed (78.3%) (Table 4). This value suggests that even young children understand the importance of various animals and that they believe the wolverine is a species that should be protected. Some even expressed concerns that without human intervention, wolverines may disappear.

If we don't protect the wolverine, it will die...

(12-year-old girl, non-Indigenous)

Despite the tendency for surveyed students to understand the importance of biodiversity and nature and to show an appreciation for the wolverine's role in nature, 33.8% of the children expressed the naturalist value in relation to wolverine (Table 4). This result suggests that their appreciation of this species does not extend to a willingness to encounter a wolverine firsthand and is potentially matched by a fear of them, due to the stories they have heard.

The wolverine is a big animal, it kills animals, his claws are very sharp.... The wolverine is big as a wolf.

(9-year-old girl, Indigenous)

Perhaps unsurprisingly because of the reputation of wolverines, surveyed students commonly expressed the negative value toward wolverines (Table 4). The expression



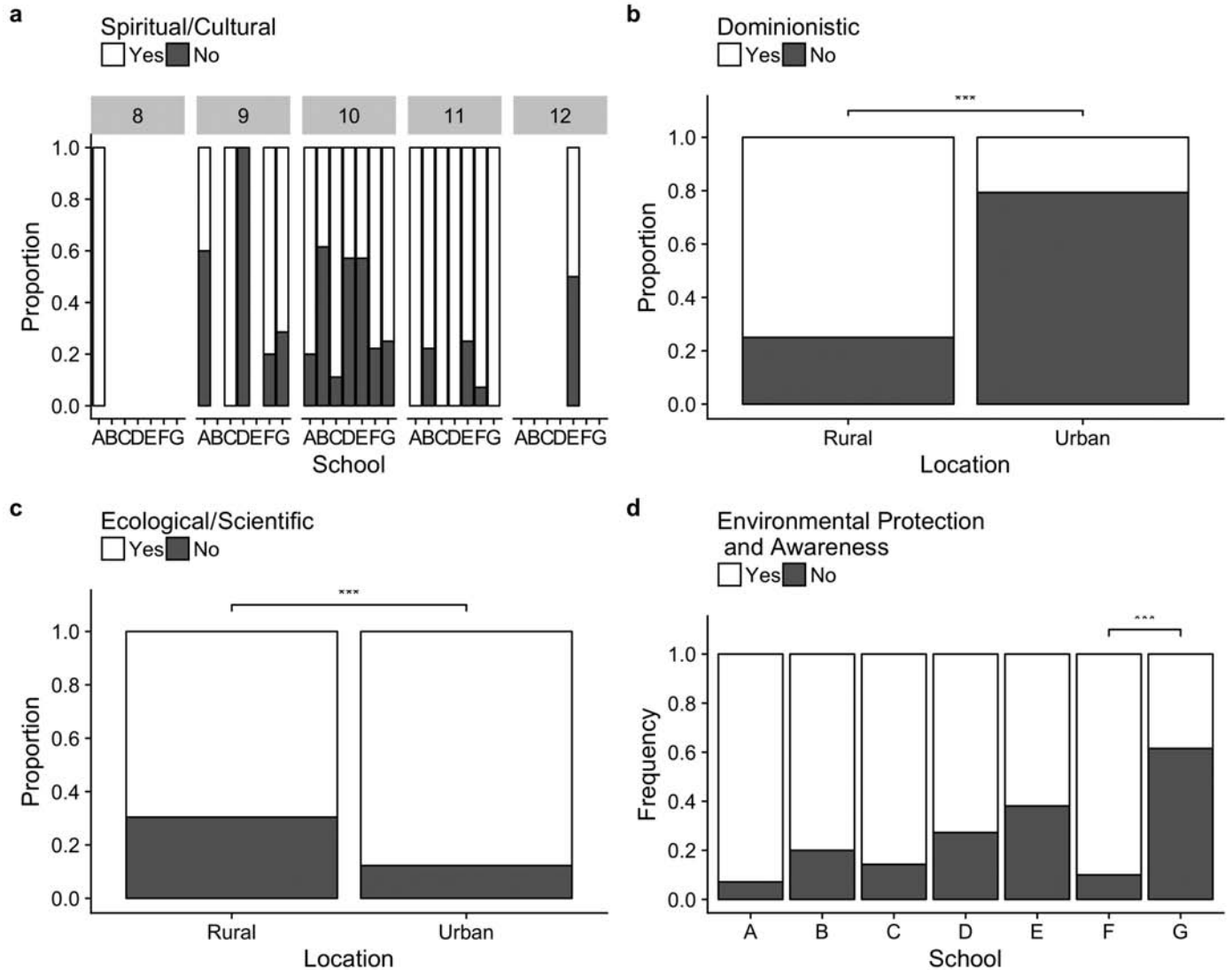


FIG. 4. The expression of values among children in the NWT towards wolverines. The spiritual/cultural value is shown in a) as a function of age and school location in Yellowknife or in the two rural communities; b) and c) the dominionistic and ecological/scientific values as a function of location in the rural outlying communities or urban capital city (\*\*\*) signifies  $p < 0.05$  according to post hoc Tukey test; and d) the environmental protection and awareness value as a function of school. In each case, binomial generalized linear models were used to identify significant differences in the proportions of students expressing a value. In a), the significant effect was associated with the age variable.

of this value ranged considerably among schools, however, from 30% to 100%. Students who expressed this value most often referred to the danger that wolverines can pose to human life, though few students actually mentioned direct attacks by wolverines against humans. Instead, most students commented on the wolverine's ability to steal food from humans.

Back then, they would keep their food and the wolverine would steal their food like sugar, salt, meat and, while they sleep, they would steal their food.

(9-year-old boy, Indigenous)

Four-fifths of the students surveyed expressed the usefulness value (Table 4). The most common comment related to the usefulness of wolverines was in regards to the quality of the wolverine's fur and its practicality for making clothing.

A wolverine's fur is thick. It has black and brown fur on it. We use wolverine's fur for clothing. We use wolverine's bones to make Indian medicines.

(11-year-old girl, Indigenous)

#### *Value Orientations as a Function of Demographics*

Despite a wide range of models being assessed, some of the values we tested displayed no significant interactions with any of the demographic variables we measured. One such value was the aesthetic value, for which none of the 160 assessed models outperformed a simple intercept model (the null model, Table 4). Similarly, while our analysis of the naturalist value returned a best-fit model with a lower (better) AICc score than the null model, this univariate model containing the sex variable was not a significant improvement over the null model according to

likelihood ratio testing ( $p = 0.14$ ) and was not considered further. Along with the previous two values, none of the demographic variables assessed were significantly correlated with the usefulness value. Of the 160 models assessed, only one scored a better AICc value than the null model, a univariate model containing pet, though this did not represent a significant improvement ( $p = 0.09$ ).

The spiritual/cultural value, however, was associated with a demographic variable. The best-fitting model was a multivariate model containing the student's age and their school as explanatory covariates. A total of four out of 160 models were within two  $\Delta$ AICc units of the best fit; the remaining three models within two  $\Delta$ AICc units were all variations of the best model that included additional covariates deemed to be uninformative and were not considered further. A likelihood ratio test indicated that the best-fitting model statistically outperformed the null model ( $p = 1.01 \times 10^{-3}$ ) as well as univariate models containing either age or school alone ( $p = 7.93 \times 10^{-4}$  and  $0.01$  respectively). Within the best-fit model, only age had a significant effect on the expression of the spiritual and cultural value, resulting in children being 117% more likely to express this value with each additional year of age, regardless of which school they attend ( $p = 0.01$ , Fig. 4a).

Of the 160 models fitted to the expression of the dominionistic value, eight were within two  $\Delta$ AICc units of the best-fitting model. Among these, only two represented potential minimally adequate models without uninformative covariates: a multivariate model containing the location and points, and another containing location and age (Table 4). Both models represented a significant improvement over the null model ( $p = 3.36 \times 10^{-7}$  and  $4.21 \times 10^{-7}$ , respectively) and in both, the location variable indicated that students in urban settings were 93% less likely to express the dominionistic value ( $p = 1.11 \times 10^{-6}$ ) than students in rural settings (Fig. 4b). In the best-fitting model, the points variable indicated that for each increase of one point received on the general knowledge section of the survey, the expression of the dominionistic value decreased by 19%, a significant drop ( $p = 4.8 \times 10^{-2}$ ). The additional covariate in the second-best model, age, did not have a significant effect on the expression of the dominionistic value.

Model selection on the variation in the ecological and scientific value indicated six models within two  $\Delta$ AICc units of the lowest AICc value. Of these, the univariate models containing location or identity were the only two minimally adequate models (Table 4). The strongest support was for a model containing location, which explained the observed variation significantly better than the null model ( $p = 0.04$ ). In this model, students in urban locations were 212% more likely to express the ecological/scientific value than those in more rural settings ( $p = 0.03$ , Fig. 4c). In the second-best model, students' identities as Indigenous or non-Indigenous were correlated with the expression of this value, though this relationship was not significant and the

model did not represent a significant improvement on the null model ( $p = 0.09$ ).

With the EPA value, nine models were within two  $\Delta$ AICc units of the lowest AICc score, though only three represented minimally adequate models without uninformative covariates. Among those remaining models, the strongest support was for a univariate model containing schools (Fig. 4d). This model was significantly better than the null model ( $p < 0.01$ ), though subsequent post-hoc testing (Tukey's honest significant difference) only identified a single significant difference among schools in the expression of the EPA (F vs. G, Fig. 4d). The second-best model was a univariate model containing location, which also represented a significant improvement over the null model ( $p = 3.4 \times 10^{-3}$ ). In this model, students in urban settings were 300% more likely to express the EPA value ( $p = 3.3 \times 10^{-3}$ ). Finally, as with the previous two models, the third-best model was a univariate model that explained significantly more variation than the null model ( $p = 7.7 \times 10^{-3}$ ). In this model, identity was the only explanatory variable, indicating that non-Indigenous students were over 300% more likely to express the EPA value.

Finally, for the negativistic value, only three of the 160 models tested fell within two  $\Delta$ AICc units of the lowest AICc value, with two of these representing nested versions of the third and best model. This best-fit model (Table 4) contained age and location as explanatory variables and represented a significant improvement on the null model ( $p = 0.01$ ). Despite this improved explanatory ability, both explanatory variables had non-significant relationships with the expression of the negativistic value.

## DISCUSSION

Our results indicate that among the younger generation of northern residents, as has been seen elsewhere throughout the wolverine's historic home range, this solitary species is largely unknown and maintains a negative reputation (Banci, 1994; Fortin et al., 2005; Ruggiero et al., 2007; Woodford, 2014). While certain aspects of this species' biology and ecology (e.g., appearance and habitat) seem to be fairly well understood, what makes up the wolverine's diet is much less well known. Knowledge of wolverines was correlated with knowledge of northern species in general, but was also greater in rural communities than in the more urban capital city of Yellowknife. Similar differences were observed between rural and urban students in terms of the expression of values towards wolverines, with a more generally negative outlook being more common in rural than in urban settings. These results are consistent with past studies on human interactions with wild carnivores, such as Heberlein (2012), who noted that people in urban areas of Sweden have a more positive attitude towards wolves than people in more rural areas where wolves have attacked or killed pets, livestock, and hunting dogs. Kleiven et al. (2004) similarly found that social acceptance of large

carnivore behaviour is higher among urban than rural residents. The findings of this study therefore support the idea that any successful conservation effort for this often negatively perceived species will first need to address public opinion through education and outreach programs.

#### *General Knowledge about Wolverines*

The level of knowledge demonstrated by the students we surveyed about wolverines was closely related to how much they knew about northern species in general, such as the caribou, polar bear, and Arctic fox. This correlation may reflect some students having a greater interest in biology and ecology in general, with wolverines making up a part of their environment, like any other northern species. Incidentally, knowledge about wolverines was also strongly linked to whether students lived and went to school in smaller communities or in the capital city. Children in smaller communities scored higher than those living in the capital city, despite all schools in the NWT following the same curriculum, which suggests that they may be benefitting from external sources of education. The higher scores of children in small communities may arise from the closer physical proximity of these children to nature or the greater connection that close acquaintances may have with local wildlife (e.g., trapping or hunting), elevating their overall knowledge of northern species through the direct or indirect transfer of knowledge (Bjerke et al., 1998; Ericsson and Heberlein, 2002; Patenaude et al., 2002; Lescureux et al., 2011).

In fact, in one of the rural schools surveyed, a local trapper had recently (earlier that school year) been invited to present his work to the students. Children in this school had therefore had a recent, albeit indirect, exposure to northern furbearing species. By interacting with someone who has regular, direct contact with wolverines and other northern species, the children increased their level of knowledge. Indeed, this school demonstrated the highest scores on the knowledge section of all the schools we surveyed (data not shown). Alternatively, the small sample size in this school ( $n = 13$ ) could have resulted in a few children with a strong interest in wolverines having a larger overall effect on the class average relative to larger classes with 20+ students. This possibility is unlikely to explain the effect of location, however, as both of the schools in the rural communities scored higher than the overall average.

Interestingly, whether a child had a family pet at home, a common proxy for interest in animals (Bjerke et al., 2003; Prokop and Tunnicliffe, 2010), did not influence the degree of knowledge that children expressed towards wolverine and other Arctic animals in general. This lack of a relationship was unexpected and contradicts previous works (Bjerke et al., 2003; Prokop and Tunnicliffe, 2010), which found that owning a pet increases a child's interest in nature and animals in general. While our study was not designed to address how interested a child is in nature, we can confirm that any impacts there may be from owning

a pet do not result in increased knowledge about wild animals. One possible reason for this result may be that the children we surveyed were between 8–12 years old, while the Bjerke et al. (2003) study surveyed adults, and Prokop and Tunnicliffe (2010) surveyed children between the ages of 10–15 years old. There may, therefore, be an important effect of age, with older children drawing more similarities between household pets and wild animals than younger children. Future studies will be needed to confirm whether the impact of owning a pet on one's level of knowledge about wild animals is affected by age.

#### *Value Orientations Assigned to Wolverines*

The most common values expressed toward wolverines among the children surveyed were the negativistic value and the ecological/scientific value, while the dominionistic and naturalistic values were expressed least often (Table 4). In another study, Kellert (1984b) also found that the dominionistic value was relatively infrequent; however, unlike our study, Kellert also found little support for the ecological/scientific value. One reason for this difference may be a rise in cultural popularity of the ecological/scientific value over the last 30+ years, reflected among our survey respondents. As the culture in North America changes with time, themes such as global warming and the importance of an ecological, holistic perspective of nature find their way into the curriculum, resulting in students having a better understanding about the key roles that various animals play in their environment. The differential expression of the EPA across schools (Fig. 4), however, suggests that the school curriculum may not be the only factor influencing the expression of these values.

One key factor that influences the values children express towards wolverines is the children's location. Whether children lived in a rural or urban environment was associated with the expression of the dominionistic, ecological/scientific, EPA, and the negativistic values. This result is perhaps due to the greater likelihood of having family members who hunt or trap fur-bearing animals in rural communities (Bjerke et al., 1998; Krangle and Skogen, 2007). The importance of place for value orientation formation is also highlighted in the study by Hunter and Brehm (2004:17), which "revealed substantial linkages between rural residence, wildlife interaction, and development of perspectives with regard to local species."

If current and future wolverine conservation efforts are to be successful, place-based value orientations and wildlife education programs will be needed, particularly among the younger generation, in order to increase knowledge and improve attitudes toward this species (Morgan and Gramann, 1989; Wilkinson, 1997). The needs of children will not be the same all over though, and efforts to improve overall knowledge should be focused in urban areas while efforts to improve public opinion should be concentrated in rural communities. The NWT, where concerns have been raised about the lack of information regarding wolverine

densities and the potential need for new conservation programs (Boulanger and Mulders, 2013), can benefit from such a program in the coming years. If concerns regarding the decreasing abundances of wolverine in the area are validated, understanding the current level of knowledge and opinions of NWT residents towards this species would be a valuable initial step in the effort to conserve this ecologically important scavenger. Such knowledge, in regards to the younger generations is perhaps even more valuable, as the opinions of younger generations are more open to change and today's youth will be responsible for maintaining and supporting any new conservation programs in the future.

In most situations, more education does result in less fear and potentially more appreciation of a species; it is not always enough to raise public opinion though. One potential solution could be to shift education from the biology of a species to its ecology. Currently, many education programs only focus on the basic biology of a species, rather than its ecological role. When children are taught to think more about the role of a species in terms of biodiversity, it has been found to have a beneficial effect on the formation of positive attitudes (Prokop and Tunnicliffe, 2010). Our results may therefore represent an example, similar to that found by Reading and Kellert (1993) and Kleiman (1989), where very negative attitudes can be difficult to change, but by explaining the ecological role of wolverine in the food chain, children may learn to appreciate the importance of wolverines and be more positive about this species.

## CONCLUSION

This paper explored knowledge and attitudes towards wolverines among children in the NWT in rural and urban landscapes. The results of this study show that knowledge about wolverine in the NWT by children is not evenly distributed among children in small communities and those in the city. Despite our sample sizes in the communities being lower than in the urban settings, the consistency of these findings with past studies support the idea that children living in small rural communities interact more with local wildlife and their environment, improving their knowledge about animals in general. These interactions, however, do not guarantee that wolverines are seen in a positive light. Indeed, the negative value was more often expressed towards wolverine in rural communities, suggesting that the interactions between rural inhabitants and wildlife may not always be a positive force for conservation, particularly when interactions include wolverines stealing food and bait from trappers (Banci, 1994). Though the children we surveyed were not trappers and did not experience negative conflicts directly, their opinions were still influenced by the stories they heard and the passage of information.

In cities, where the values expressed towards wolverine were generally positive, but knowledge was lacking,

educational programs may be the most effective means of raising public support for wildlife conservation programs. For example, Bogner and Wiseman (2004) describe the positive impacts of a weeklong outdoor environmental education program on pupils' knowledge of conservation. They report shifts in adolescents' attitudes towards nature conservation with a higher preservation view on nature. Alternatively, in smaller rural communities where access to nature and the relationships with local wildlife are higher, knowledge may not be lacking and efforts should instead focus on improving the overall public opinion towards conflictive species. Improving our knowledge of and, in some cases, public opinion towards sensitive species, as may be the case for wolverines, will be important in order to resolve conservation tensions and make management plans more socially acceptable. How best to achieve this will likely vary from case to case and from culture to culture, and action plans should be adapted to each particular case and take into account that value orientations are place-based (Hunter and Brehm, 2004). Future research on this subject should expand on the sample size and locations, including more urban areas like Edmonton or Calgary, and more remote towns like Inuvik, Gamètì, or Whatì. Care should be taken to account for the new potentially confounding variables such an expansion would create however, like the effect of latitude or whether students lived within or outside of the wolverine's natural range.

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