

DOG POPULATION MANAGEMENT AND DOG BITE PREVENTION IN RURAL AND  
REMOTE NORTHERN SASKATCHEWAN ABORIGINAL COMMUNITIES

A Thesis Submitted to the College of  
Graduate Studies and Research  
In Partial Fulfillment of the Requirements  
For the Degree of Doctor of Philosophy  
In the Department of Large Animal Clinical Sciences  
University of Saskatchewan  
Saskatoon

By

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## *Abstract*

Communities employ a wide variety of methods to reduce critical encounters and dog population numbers. However, systematic studies evaluating the success of approaches and techniques are currently lacking. Nor has significant consideration of community decision-making processes and policy development, or of the long-term sustainability of these programs been completed. Therefore, to assess the perception of dog-related issues, methods of policy creation and implementation, and true within-community dog demographic characteristics and rate of aggressive encounters a community-based research project was developed. A multiphase, convergent mixed methods study design in four separate northern Saskatchewan communities was implemented to evaluate these concerns.

Methods of community-driven policy creation and implementation were recorded, management plans and strategies were monitored, and options were evaluated for successful reduction in dog bites and violent encounters. Community-based participatory methods created exchange and discussion with all levels of society, providing in-depth two-way channels for knowledge translation for researchers and community members.

Policy creation and implementation was found to vary significantly between communities. Policies surrounding dog ownership and bite prevention are often dependent upon perceived risks for imminent human-canine aggressive encounters. Regrettably, sustainable interventions require sustained key community partner support and resource access. Community engagement and knowledge translation creates long-term, trusting relationships permitting more in-depth understanding of group choices.

In addition, involving community members in research and data collection provides public appreciation of the scope and breadth of community issues and opinions. Enabling and empowering communities entails constant communication and education of all parties. No single model can be effective in all situations. Although enforceable legislation and widespread canine sterilisation are key aspects for community dog issues, comprehensive all-inclusive community education is indispensable. Wide-spread education and communication have the potential to dramatically decrease the number of aggressive dog:human encounters and fulfil goals for dog-human relationships that occur in indigenous communities in Canada.

Keywords/Topics: dogs, bites, zoonotic, population management, indigenous, epidemiology

## *Sommaire*

Les communautés autochtones utilisent une variété de méthodes afin de réduire les interactions critiques et les populations canines. Cependant, des études systématiques évaluant le succès de ces approches et techniques font défaut. Une prise en compte des processus décisionnels et communautaires et du développement de politiques de même que la pérennité de ces dits programmes n'ont pas été réalisées non plus. Donc, afin d'évaluer la perception des problématiques canines, des méthodes de création et de mises en œuvre des politiques, ainsi que des démographies canines réelles et des taux d'interactions agressives intra-communautaires, un projet de recherche implanté en communauté a été créé. De ce fait, une étude multi-phase avec méthodes mixtes convergentes impliquant quatre différentes communautés nordiques de la Saskatchewan est décrite ici.

Les méthodes de création et de mise en œuvre de politiques communautaires ont été consignées, les plans de gestion et les stratégies ont été suivis et les différentes options ont été évaluées pour la réduction fructueuse des morsures canines et des interactions agressives. Des méthodes participatives communautaires ont créé des échanges et discussions dans tous les niveaux de la société, permettant un dialogue bilatéral approfondi pour la transmission de connaissances entre les chercheurs et les membres de la communauté.

La création et la mise en œuvre de politiques s'est avérée varier significativement entre les communautés. Les politiques régissant la propriété des chiens et la prévention des morsures dépendent souvent des risques perçus pour des interactions agressives imminentes entre les chiens et les humains. Malheureusement, des interventions pérennes requièrent l'appui des parties prenantes communautaires clés et d'un accès aux divers moyens. L'engagement communautaire ainsi que la transmission des connaissances créent des relations durables basées sur la confiance et permettent une compréhension approfondie des choix de groupe.

De plus, impliquer des membres de la communauté dans la collecte et la recherche de données résulte en une reconnaissance publique du spectre et de l'ampleur des problématiques et opinions communautaires. Habilitier et émanciper les communautés nécessite une communication et une instruction constante des différents partis. Bien qu'une législation parfaitement applicable et que la stérilisation canine à large échelle soient des aspects déterminants des problématiques canines communautaires, l'éducation communautaire complète et ouverte à tous est indispensable. L'éducation et la communication à grande échelle ont le potentiel de réduire substantiellement le nombre d'interactions agressives chien-humain qui se déroulent dans les communautés autochtones au Canada.

Mots-clés/Sujets: Chiens, morsures, zoonotique, gestion de population, autochtones, épidémiologie

## *Acknowledgements*

Thank you to everyone taking the time to read this work. Hopefully the story has been told in such a way as to facilitate the use of multiple types of knowledge in their own contexts.

Thank you to my supervisor Tasha Epp for being a guide, a friend, a mentor, a shoulder, and a colleague. Your patience has been inspirational, and your example something to strive towards.

Thank you to my committee members Lalita Bharadwaj, Karen Morrison, and Karen Semchuk for your insight, suggestions, expertise and interest. Your continuing support and curiosity regarding results made the journey worthwhile even when the ‘cogs’ were failing to function.

Thank you to my grad chairs Joe Stookey and John Harding for keeping me on the straight and narrow. It’s quite a job reining in an enormous project, in addition to an enthusiastic group of professionals in order to maintain a semblance of timeliness.

Thank you Nelly Lakestani for being willing to act as my external examiner. This was no light decision or undertaking. Your time, suggestions and input are very much appreciated.

Thank you to my communities for all of their interest, patience, friendship and understanding. Through you I truly discovered the reality behind Marcus Garvey’s statement “*A people without knowledge of their past history, origin and culture is like a tree without roots.*”

Thank you to Brian Quinn from Health Canada, Trina Cottingham from the Northern Inter-Tribal Health Authority, and Maggie Sim and Judith Wright from the Saskatoon Health Region for all of your work combing through databases, and spending time cleaning and organising raw data for me. Like a fraction without a denominator, without your help this story would have had only one side to it.

Thank you to all of you who for the sake of anonymity cannot be named, but who provided countless suggestions on this manuscript in order to make it more ‘user-friendly’. Thank you for helping the story be told, and assisting in my development as a ‘writer’.

Thank you to Jocelyn Bartsch and Jessica Hoopes for the countless hours assisting with survey data entry and categorisation. I likely would have had a complete melt-down if I’d had to deal with all of the articles and data sets on my own.

Thank you to all of those professors who provided feedback on study design and analysis, suggestions on project scope, and general pats on the back – Cheryl Waldner, Sarah Parker, John Campbell, Hugh Townsend, Claire Card... without your guidance I would likely still be sinking in the quicksand of journal scoping and caught in the quagmire of data regression. Cheryl, your trust that I had something valuable to say if I could only ‘get it out’ gave me faith to ‘do it my way’. Claire, the constant smiles, unwavering support and enthusiastic encouragement lifted my spirits when things seemed to be consistently going in the wrong direction. And John, without those early words “there’s more than one way to go around the tree”, I probably would have walked away before even finishing vet school, let alone this enormous project!

Thank you to Ted Leighton and David Waltner-Toews - two of my most cherished mentors, heroes, and cheerleaders. Thank you for providing amazing examples to aspire to, and constant words of wisdom, encouragement and blarney – the two former gave me inspiration and hope, and the latter laughs (without which everything else might have fallen on deaf ears!).

Thank you to Nicole Callihoo, Jessica Demeria and Katherine Michin for your invaluable friendships, and unique abilities to be sounding boards for delicate community conversations. Your feedback consistently made me feel less self-conscious, and more energised and optimistic.

Thank you to all of my co-‘hell’ and fellow epi grad students (in alphabetical, not ‘importance’ order!): Adam, Anatoliy, Andreia, Bobbie, Chad, Colleen, Dallas, Elise, Emma, Felicity, Haley, Ibrahim, Julian, Lianne, Omid, Rayna, Riley, Silvia, Suzanne and Taya. You kept me sane, handed me tissues, provided shoulders (and wine!), argued about coding and generally ensured that I survived this ordeal. You will never know how grateful I am.

Thank you to Jackie Gabriel, Adam Hering, Terry Piche, Adam Pollock, Keith Klim, Taryn Waugh, Riley Glew, Felicity Wills, Bev Fairful, Glenna McGregor, Michelle Lange, Jocelyn Bartsch, and Allison Foster for the countless times that you took care of ‘my’ fur babies so that I could run off and help those belonging to others. Knowing that Bevin, Echo and Mirage were in good and loving hands meant I could focus on the needs and wellbeing of countless others in need.

Thank you to Peter Aikman, Agathe Bédard, Tyra Dickson, Emma Gardner, Teresa Kwong, Ken MacLeod, Amanda Malboeuf, Cam Nichol, Cam Nicolle, Rhonda Owen, Vu Pham, and Rick Sawatzky – all for very different reasons. I hope you all know why you are amazing. Thank you.

And last but definitely *not* least... Thank you to my parents, my sister and brother-in-law, and all of the rest of my family, friends and loved ones, for your staunch belief that I was doing something ‘important’; which made my lengthy absences, abrupt disappearances, missing of ‘key’ events, distracted forgetfulness, and oftentimes utter confusion, somehow forgivable. I love and cherish you all, and couldn’t have survived any of this without your help and support.

Cat: *Where are you going?*

Alice: *Which way should I go?*

Cat: *That depends on where you are going.*

Alice: *I don’t know.*

Cat: *Then it doesn’t matter which way you go.*

— Lewis Carroll, *Alice in Wonderland*

## *Dedication*

For the light of my life, Arya. You brought childish smiles and baby giggles to me when the weight of the world felt crushing and all I wanted to do was put my head down and cry.

And for all of the other children... hopefully this is a small step in keeping you safer.

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## *List of Key Abbreviations*

### ***Methods***

CBPR	Community-Based Participatory Research
DPM	Dog Population Management
KD	Knowledge Dissemination
KE	Knowledge Exchange
KM	Knowledge Mobilisation
KTr	Knowledge Transfer
KT	Knowledge Translation
KTME	Knowledge Translation, Mobilisation and Exchange
MMR	Mixed Methods Research
PAR	Participatory Action Research
PE	Participatory Epidemiology
R(C)CT	Randomised (Clinical) Control Trial
TE	Traditional Epidemiology (epidemiological)

### ***Groups, Communities and Organisations***

ASNTF	Alberta Spay and Neuter Task Force
BPT	Blue Paw Trust
CAP	Canine Action Project
CFIA	Canadian Food Inspection Agency
FAO	Food and Agriculture Organization
FN	First Nations
FSIN	Federation of Saskatchewan Indian Nations
ICAM	International Companion Animal Management (Coalition)
IFAW	International Federation of Animal Welfare
OIE	World Organisation for Animal Health
PHAC	Public Health Agency of Canada
STAG	Senior Technical Advisory Group
UN	United Nations
WHO	World Health Organisation
WSPA	World Society for the Protection of Animals

### ***Other***

ACO	Animal control officer
BSL	Breed-specific legislation
DDA	Dangerous Dog Act
FRD	Free-roaming dog

## ***Key Definitions***

*The following definitions are provided for explanatory purposes and ease of those reading the following research. They are not intended as a commentary regarding appropriate terminology.*

**Aboriginal/indigenous** - *The original caretakers of any location. E.g. Canada's First Nations, Métis or Inuit peoples; Australia's Aboriginal and Torres Strait Islander peoples; East Africa's Maasai; Central America's Maya; etc.*

*First Nations/First Peoples – member(s) of a recognised reserve*

*Métis – people of mixed ancestry who define themselves as such, are able to show ancestral connections, and are accepted as being Métis by the Métis Nation*

### **Dog ownership:**

*Individually owned – one individual claims ownership or cares for the needs of an animal*

*Community owned – more than one individual claims ownership or cares for the needs of an animal*

*Feral – an animal born and living in the wild but descended from domesticated animals, without contact or socialisation with humans*

*Semi-feral – an animal born and living in the wild without socialisation, with random interaction with humans for management or care purposes OR an animal previously cared for by an individual but now surviving without contact or interaction with humans*

*Stray – a previously owned and at least minimally socialised animal, now lost, abandoned, or who has run away, and now must meet its needs on its own*

*Dog population – estimated number of dogs within a community*

### **Dog movement:**

*Restrained – animal whose mobility, movement and freedom is completely limited*

*Restricted – animal who has controlled movement within the community*

*Roaming – animal not currently under direct control or is not currently restricted by a physical barrier*

*Free-roaming dogs - dogs in public areas and not currently under direct control of any person*

**Engagement:**

Balance (Netukulimk) – *the concept of interdependence and interconnectedness with the natural world*

Elder – *an individual sought out for spiritual and cultural leadership, with knowledge of cultural tradition and wisdom*

Ethical space – *the bridge creating a culturally safe framework to engage dialogue between indigenous communities and Western groups*

Time – *every decision should be considered with the sustainability of relationships seven generations in the future in mind*

Traditional knowledge – *knowledge, skills, and practices based on theories, beliefs, and experiences passed from generation to generation*

Tribal consciousness – *within group awareness and loyalty based on collective identity, attitudes, beliefs, and wisdom*

Two-Eyed Seeing (Etuaptmumk) – *using the strengths of Indigenous knowledge and ways of knowing, combined with those of Western culture and science (term coined by Elder Albert Marshall)*

## *The Indigenous Relationship to Dogs*

Within Aboriginal Canadian communities, stories were often the means of teaching the community how to respect and care for each other and their surroundings. In the stories that they tell, northern Saskatchewan Indigenous communities consider dogs to have been loyal and true friends to the people; and so those who are kind and respectful to their dogs always have plenty, while those who are abusive or neglectful have many problems and may be punished. This is likely because before horses arrived, dogs were critical to the survival and wellbeing of communities: used for packing and carrying heavy loads, pulling sleds, hunting game and guarding camps. In many communities it is believed that Spirit Dog and his mate wait for the People when they are near death. Without their help and guidance, the spirit forms of the People are not able to find their way to cross over to the Spirit World and are instead destined to roam. Therefore it is important to treat all dogs well to ensure an escort.

The following is a wintertime story, as told to me by an Elder during a discussion regarding the importance of dogs for their community and cultural survival in northern Saskatchewan.

*“Once long ago during the Long Dark, a hunter and his family were starving. Deep snow lay on the land, and the bison and the deer were nowhere to be found. The hunter grew weary as he walked long days searching for something to feed his family. Then one day, the hunter found a bison trail many hours away from camp. He followed the tracks all day, but did not find any animals. He turned to return home, but remembered the tears of his young children from the day before crying from the pain of their empty bellies. So instead, he called on the Creator and asked for a sign.*

*As he continued to walk the hunter found new tracks, and as he resumed his hunt, Wolf came up beside him. “Why do you look so sad and afraid?” asked Wolf.*

*The hunter replied, “My family and my village are hungry. We have had little food for many moons. But I have had no luck in hunting.”*

*Wolf looked thoughtful, and continued to run beside the hunter for a ways. Finally he said, “Stop here. See these bushes? You must hide behind them. I will make the bison run to you. But here – you must use my bow and only my arrows, for yours will not kill them and our time will be wasted.” And Wolf ran quickly into the trees.*

*The hunter looked at the small bow and arrows that Wolf had left. They seemed much simpler, and less well made than the ones that he had spent all summer perfecting by the fire. But he was sure this must be the sign that he had asked for. Suddenly he heard the stampeding of hooves, and so he took up Wolf’s bow, and quickly shot several animals, all straight through the heart.*

*As the last bison ran past, the hunter could not help but try to use his own bow and arrow. Though the animal passed right beside him, he missed his shot and Bison escaped. At the same time, Wolf came running up to the hunter. “How did we do?” Wolf asked.*

*“I killed many bison with your bow and arrows,” replied the hunter. “But for the last I tried to use my own, and he ran on.”*

*Wolf shook his head. “I told you that your bow and arrows would not work,” he said. “Yet there is plenty here for all of us.”*

*Working together they prepared the animals before they froze. Wolf asked that some of the meat be kept for his family, and so the hunter kept the butchered meat and bones from some of the bison for Wolf to take to his pack. The hunter then packed a travois with as much as he could pull back to his village, and left Wolf to guard the rest until he could return.*

*Once the people of the village had rejoiced and eaten what they could, they packed up their tipis and moved their camp to where Wolf had stayed keeping watch. Wolf had called his mate, who brought their young to eat and help protect the meat. With full bellies, the children of the village and the wolf pups played and wrestled happily together, finally falling asleep one by one curled together by the fire.*

*“We work well together,” the hunter said.*

*“Indeed we do,” Wolf replied. “Perhaps we shall stay and travel with you awhile.”*

*From that point on, Wolf and his family remained with the hunter and his village, helping hunt, and chasing away other animals. Eventually, they agreed to help carry heavy packs, and to pull those who became ill on sleds. After that, they never left the People again, and proudly bore the name that the hunter had given them as a sign of friendship: ‘Dog’.*

This story was originally told to explain and emphasise the meaning and importance that dogs have had for Aboriginal peoples. Without them, the People would not have survived through the long, harsh winters that are common on the prairies. It was important to keep pack dogs healthy and well treated, because their existence made life much easier. However, the story also served to emphasise another point; First Nations and Métis communities have a tradition of oral history and knowledge exchange. To truly share important information, the story must be told the right way.

*“And while I stood there I saw more than I can tell and I understood more than I saw;  
for I was seeing in a sacred manner the shapes of all things in the Spirit, and the shape of all  
shapes as they must live together like one being.”*

*Black Elk, Wichasha Wakan Oglala Lakota*

## Chapter 1 Introduction

*“The natural world is the larger sacred community to which we belong. To be alienated from this community is to become destitute in all that makes us human. To damage this community is to diminish our own existence.”*

*Thomas Berry - eco-theologian, 1990 (The Dream of the Earth, p82)*

The relationship between humans and dogs has existed longer than any other domesticated animal (Serpell, 2004). Dogs were first used as hunting companions and for defence against wild animals (Schwartz, 1997). Now, attitudes and beliefs surrounding the nature of the dog:human bond vary among different human communities, changing individual perceptions surrounding costs and benefits of the relationship to both humans and dogs (Phelan, 2007; Serpell, 1986). Though some communities favour ‘ownership’ by one or few individual owners, other cultures believe the dogs which reside within it are an important, traditional part of the community, and are not necessarily ‘owned’ by particular individuals (Cummins, 2002).

Most First Nations (FN) communities have a combination of free-roaming, semi-feral or kept dogs. This situation creates multiple problems, including aggressive interactions between humans and dogs, canine over-population, and two-way transmission of zoonoses (Brook *et al.*, 2010). Extreme methods for population control are disturbing and unsustainable, without maintaining healthier populations of dogs or humans. Health education models have the potential to be effective; engaging communities by incorporating values and global understanding of their role in the environment (Denzin & Lincoln, 2008, 2011).

Free-roaming dogs (FRDs) and semi-feral dogs are a source of many health-related problems in Northern communities, including parasites, rabies and other zoonotic diseases (Brook *et al.*, 2010; Salb *et al.*, 2008; Schurer *et al.*, 2014). Physical attacks by dogs are often on children, and may lead to death or disfigurement (Wright, 1985); in 2006 alone dog attacks killed three Canadian Aboriginal children (Raghavan, 2008). In general, owned dogs are healthier, safer (in terms of public health) and more manageable than un-owned, stray, or abandoned dogs (Fielding *et al.*, 2012; Salb *et al.*, 2008). Unfortunately, in northern Canadian communities there is reduced access to regular veterinary services, medications, information or education due to remote locations or limited financial resources (Brook *et al.*, 2010). In addition, financial constraints and competition for public resources has meant that dog control programs may not be emphasized, as other health needs such as such as inadequate housing, water supply and sanitation may be deemed more immediate (Brook *et al.*, 2010; Schelling *et al.*, 2005).

Without other options, many Aboriginal communities have implemented extreme population control methods such as “Dog Days” where a significant proportion of the semi-feral dogs are shot on an annual basis (Brook *et al.*, 2010). Unfortunately multiple studies, as well as anecdotal and historical evidence have shown that simply pursuing the symptoms (increased dog

populations) instead of the source of the problem has little effect on reducing either the magnitude of the dog population or the number of dog bites (Barnard *et al.*, 2015). For this reason control programs which involve shooting dogs do not substantially decrease nor create sustainable dog populations; therefore, they do not address ongoing problems. Therefore, Aboriginal communities in Saskatchewan have begun seeking out veterinary professionals who can provide expertise and assistance in defining and dealing with the dog issues in their communities.

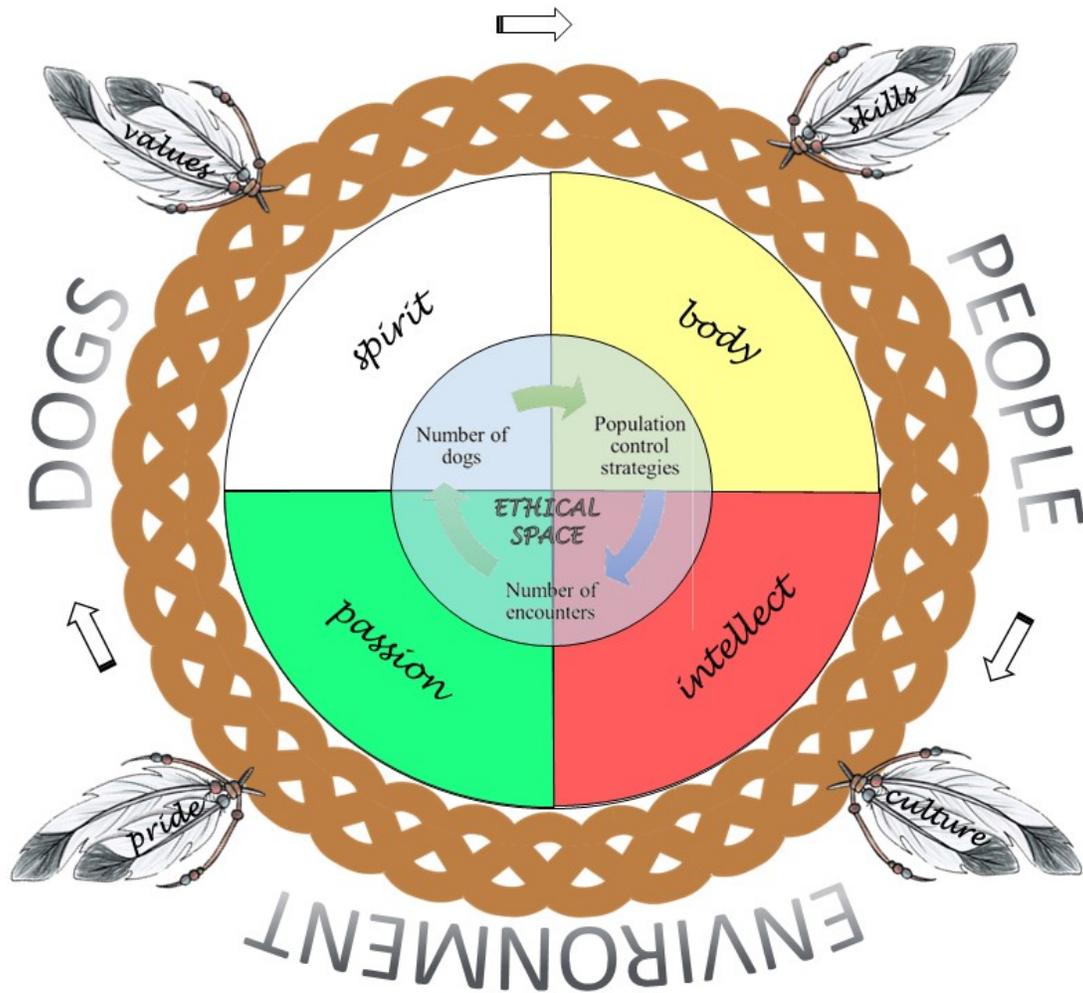


Figure 1.1 – Layers leading to the formation of ethical space within this research project  
*(For plains Cree, the three strands of the braid represent self, family and community. One without the others is weak and prone to break, however put together they are strong and resilient).*

The Western health education model previously used by researchers and administrators in Indigenous communities resulted in program development by ‘experts’ unfamiliar with community culture or history, and subsequent insensitive community delivery (Schelling *et al.*, 2005). This approach has been described as dysfunctional regarding both human health and education (Clifford *et al.*, 2009; Hunter, 2004; Jacobs, 2011). Instructors providing domestic animal education have also found this format to be restrictive and unsuccessful (Stewart, 2009). The values and reciprocal understanding of the people must be incorporated for promising community participation and engagement to occur in health and education (MacLennan & Khavarpour, 2004). Ermine *et al.*

(2004) describe this as the creation of an ethical space (see Figure 1.1). For Indigenous Peoples in Canada, the integration of scientific knowledge and traditional wisdom is called Two-Eyed Seeing (as described by Elder Albert Marshall (2004)). It is key to realise that for most Indigenous groups, health is ‘not just the absence of disease, but optimal functioning of mind, body and spirit, and interlinks with the social, emotional and cultural well-being of the whole community, the environment and its animals’ (Vass *et al.*, 2011).

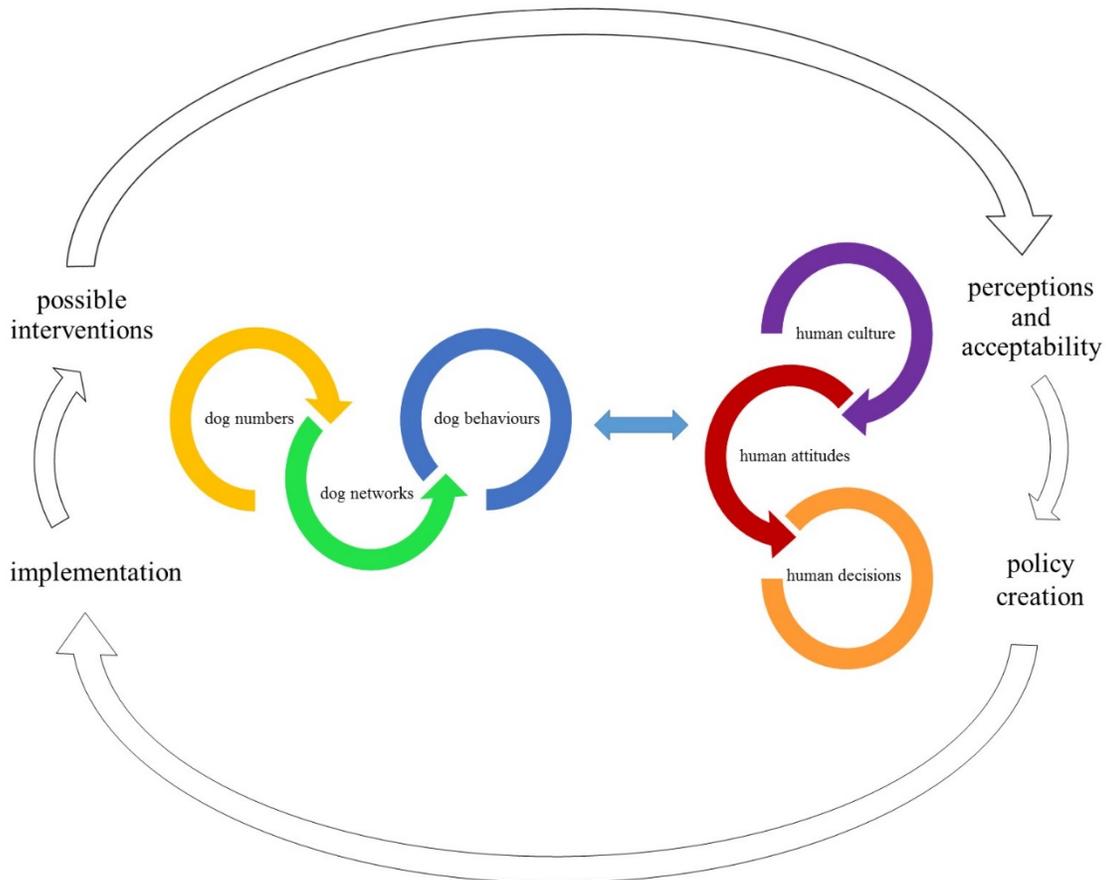


Figure 1.2 – Multiple intricate cycles influence community decision-making

As with the issues around human health, dogs in remote or rural areas are usually less healthy than their urban counter-parts (Salb *et al.*, 2008). Though important from a humane, dog welfare perspective, it also affects community health and wellbeing psychologically, physiologically and spiritually (Constable, 2012; Salb *et al.*, 2008; Serpell, 2009). Therefore, limiting any program in northern Aboriginal communities to a western colonialist medical view will be unlikely to functionally fulfill the community needs. An all-encompassing community approach will incorporate the broader outlook required (Ball, 2004). Veterinary education programs must create and integrate culturally-specific knowledge bases, along with pertinent community learning modalities for successful program development and involvement (Hawe *et al.*, 1997).

The current project incorporates the knowledge gained from an extensive and comprehensive structured global scoping review on dog population management and dog bites, into a multiphase, convergent mixed methods study in four separate communities. These data

informed the creation and development of risk models for assessing dog population growth and dynamics, and aggressive dog:human interactions. The community-based work assessed community-driven interventions by considering the public and individual perceptions of dog-related issues, methods of dog policy creation and implementation, true within-community dog demographic characteristics and rates of aggressive encounters by using community-based participatory research (see Figure 1.2). Table 1.1 details the research questions which shaped the overall study.

Table 1.1 – Questions shaping research development

<b>Method</b>	<b>Research questions</b>
<i>What are the factors behind dog bites and what is the prevalence of dog bites in northern Canadian communities?</i>	
Qualitative	<i>How do members from community XX feel about dogs? Why?</i>
Quantitative	<i>How many dogs are in community XX? How many individuals from community XX have had aggressive encounters/bites from dogs? Are risk factors common across all communities?</i>
<i>Which dog population management strategies, and dog bite (and disease) prevention methods would be most appropriate and successful in northern indigenous communities?</i>	
Qualitative	<i>Which population control methods and dog bite prevention strategies are communities choosing to use, and why? Do these strategies differ from those seen on a more global scale, and if so, why? What is the difference between how communities feel about dogs, and the population management strategies that they choose to employ?</i>
Quantitative	<i>What is the difference in number of dogs versus number of aggressive human-dog encounters between communities? Is it possible to identify specific risk factors that could potentially have a significant impact on the reduction of aggressive encounters should targeted interventions be applied?</i>
Mixed	<i>How are the dog population control methods and dog bite prevention strategies that communities are using developed, and have they been successful in stabilising dog populations and reducing dog bites within their communities? Are these methods similar to others seen in similar situations? What recommendations can be made to improve the success and sustainability of the interventions?</i>

Using multiple qualitative and quantitative methods, dog populations and the attitudes towards dogs (as a species and dogs as individuals) are explored within a subset of northern remote and rural Aboriginal communities in Saskatchewan in order to describe the aims and strategies of viable, acceptable and maintainable community-led dog population control programs (see Figure 1.3). A more complete and wholistic insight of community health and welfare of human and dog populations, as well as the critical issues, priorities, and availability of resources, is possible using mixed methods research.

By slowly uncovering the roots of public perception and opinions highlighting specific decision processes and policy development, it is hoped common underlying judgements and behaviours leading to either positive, sustainable interventions or susceptible, ineffectual methods may be identified. This knowledge can then be passed on and interchanged with other communities to inform or guide the implementation of new strategies in dealing with many of the same issues

and concerns. The sharing and exchange of newfound wisdom has the potential to wholistically improve the health not only of dogs and humans within indigenous communities, but society and the environment as an interconnected whole.

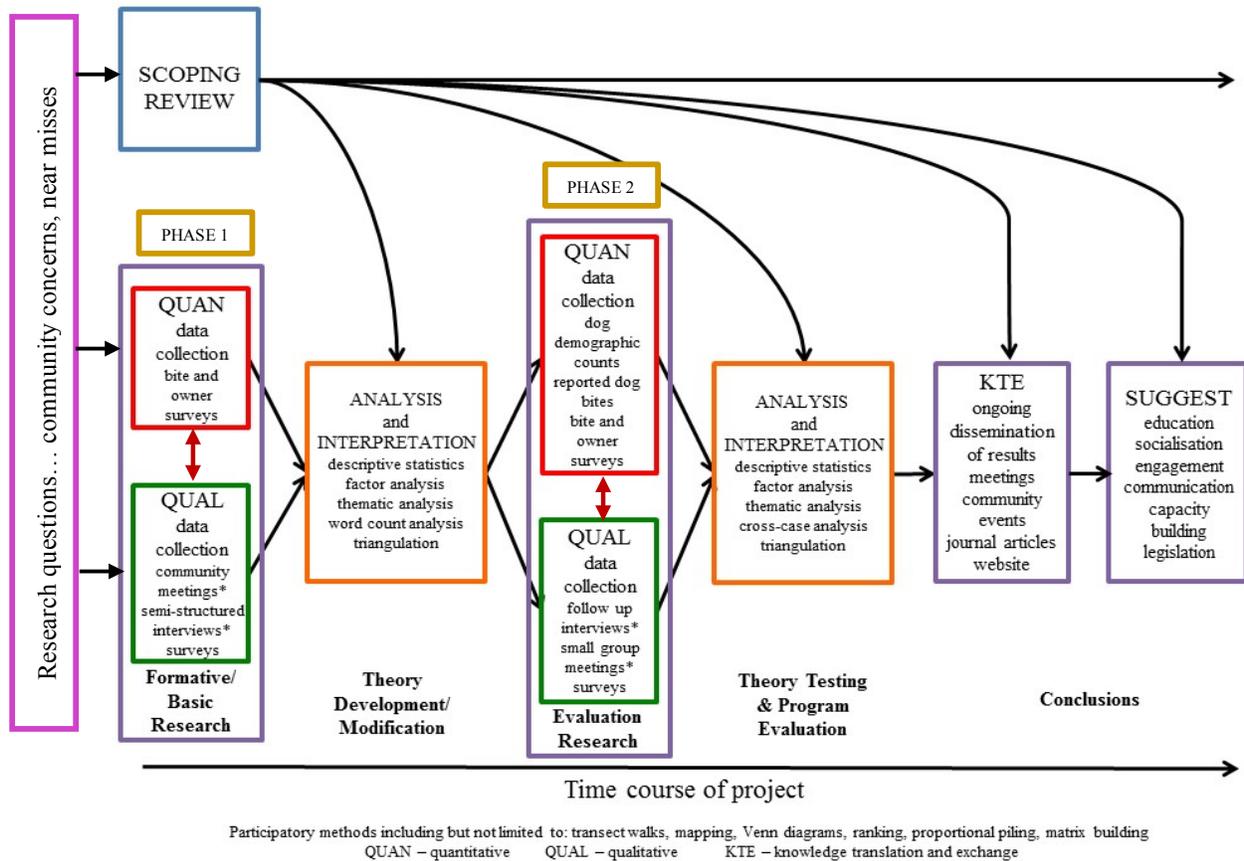


Figure 1.3 – Project design  
 (for the multiphase convergent mixed methods study on dog population management and dog bite prevention in remote indigenous Canadian communities)

## Chapter 2 Literature Review

*“A good decision is based on knowledge and not on numbers.”*

*Plato, The Dialogues of Plato, Laches 184e*

Controlling dog populations (and therefore dog-related issues and diseases) by means of culling has been largely unsuccessful. Separate strategies must be developed for each community in order to achieve comprehensive community participation and support, culturally appropriate and sensitive to local beliefs regarding dogs and their role in community life. In order to create these formalised, structured guidelines, multiple questions must first be answered:

*What are the factors behind dog bites and what is the prevalence of dog bites in northern Canadian communities?*

*Which dog population management strategies, and which dog bite and transmissible disease prevention methods would therefore be most appropriate and successful in northern indigenous communities?*

Understanding what is currently known, recognising uncertainties in knowledge and identifying socio-culturally constructive research methods are all critical to answer these questions.

### 2.1 Research Methodologies

The Western health perspective and methods have to date been completely inappropriate and ineffective in creating sustainable change or development for indigenous communities (Clifford *et al.*, 2009; Hopkins, 1994; Hunter, 2004; Jacobs, 2011; Schelling *et al.*, 2011; Stewart, 2008). Incorporating cultural sensitivity and history are necessary for complete community engagement (MacLennan & Khavarpour, 2004).

Mirroring human health outcomes, dogs in remote or rural areas are less healthy than their urban counter-parts (Salb *et al.*, 2008). Though important from a humane, dog welfare perspective, it also affects community health and wellbeing psychologically, physiologically and spiritually (Constable, 2012; Salb *et al.*, 2008; Serpell, 2009). Therefore, limiting any program in northern Aboriginal communities to a western colonialist medical view will be unlikely to adequately fulfill the community needs. An all-encompassing community approach will incorporate the broader outlook required (Ball, 2004). Veterinary education programs must create and integrate culturally-specific knowledge bases, along with pertinent community learning modalities for successful program development and involvement (Hawe *et al.*, 1997).

### 2.1.1 Scoping Reviews

During the last decade and a half, “evidence-informed decision-making in public health” has integrated best available evidence to inform public health policy and practice (Kohatsu *et al.*, 2004; NCCMT, 2012). Evidence-based medicine is considered to be the integration of the best available research evidence with scientific or clinical expertise and patient values or physical data. The expertise of the decision-maker (be they clinician, scientist or policy-maker) assists in determining whether external evidence applies to a particular case or situation, and the most effective method of inclusion.

However, evidence is not just limited to scientific literature, but encompasses community knowledge, perceptions, concerns and needs as well as public health resource capacity (NCCMT, 2012). In the human health field, scoping reviews (also called scoping studies) have become a popular method to investigate broad and complex problems (Anderson *et al.*, 2008). Scoping studies are similar to systematic reviews in their rigorous and transparent methodology but differ in that they are guided by the requirement to identify and collate all relevant literature regardless of study design or scientific peer-review process (Arksey & O'Malley, 2005; Davis *et al.*, 2009; Levac *et al.*, 2010). The end result is a method to identify gaps, as well as summarize and disseminate findings for broad topic areas where limited possibility exists for meta-analysis. They are therefore useful in investigating the magnitude, array and character of available research as it correlates to the specific requirements of partner communities.

As there were considerable discrepancies regarding terminology, rigour, validity, and the breadth and complexity of the scoping studies of grey literature being produced, Arksey and O'Malley initially developed a defined methodology in 2005 for the structure of scoping reviews/studies. In order to provide consistency in format and depth, their five main steps included “identifying the question, identifying relevant studies, study selection, charting the data, and collating, summarising and reporting the results” (Arksey & O'Malley, 2005). In addition, a sixth step involving stakeholder consultation was suggested but not considered to be required (Arksey & O'Malley, 2005).

Daudt *et al.* (2013) and Levac *et al.* (2010) each expanded the expectations and refined these steps to provide additional guidance and add a measure of quality control and assessment. This revised framework has improved researcher diligence in providing a rationale and purpose for a study, clarifying and defining concepts within the research question(s), outlining the scope, justifying the inclusion/exclusion criteria, and delivering evidence of basic analyses regarding the study findings and a basis for future policies, practice and research.

With the evolution of scoping review framework, the characterising description has also shifted. Arksey and O'Malley's (2005, p5, *emphasis added*) original proposal explained it as

*“scoping studies aim to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available, and can be undertaken as standalone projects in their own right, especially where an area is complex or has not been reviewed comprehensively before”.*

Numerous groups (Anderson *et al.*, 2008; Armstrong *et al.*, 2011; Davis *et al.*, 2009; Grant & Booth, 2009; Levac *et al.*, 2010; Rumrill *et al.*, 2010; Wilson *et al.*, 2012) have since attempted to provide comprehensive yet succinct definitions that would be widely accepted and utilised. Most recently Colquhoun *et al.* (2014, p1292, *emphasis added*) defined this type of study as

*“... a form of **knowledge synthesis** that addresses an **exploratory research question** aimed at **mapping key concepts, types of evidence, and gaps in research** related to a defined area or field by **systematically searching, selecting, and synthesizing existing knowledge.**”*

Notably absent from recent descriptions is the concept of time. This is likely due to the exponentially increasing quantity of research and data to be considered and categorised; as explained by Daudt *et al.* (2013) *it is better to be thorough and thoughtful, rather than rapid.* Currently the focus is on ensuring all relevant research is accumulated by exhaustive retrieval methods.

Four key motivations have been identified for conducting scoping reviews. First of all, studies are used to consider the amount and array of data available on the research topic. Secondly, scoping studies are used as the starting point to explore the validity of conducting a full systematic review and meta-analysis. Third, in areas comprising large volumes of information, they are used to distil and distribute research data to interested parties. Lastly, scoping reviews are central in identifying and outlining existing gaps within the currently available and accessible literature.

The rationale and breadth of reach for a scoping study often differs depending on the composition of the collaborators involved. Often within indigenous communities, policy makers and locally elected representatives do not have significant experience reading peer-reviewed scientific literature, relying instead on recommendations from available ‘experts’, experience from similar nearby communities, or knowledgeable websites. Generally the scientific community has not adequately communicated relevant or critical findings to the broader population in such a way that the average individual can leave with an improved understanding of the situation, risks or results. Special interest groups, bloggers, wikis, podcasts, newspaper or magazine articles, or laypeople frequently fill this communication gap with a special interest within the topic area. Therefore identifying the pertinent, influential and accessible resources for the ‘average individual’ assists in providing an understanding regarding the influential material that may change how communities create policies and make health legislation choices.

## 2.1.2 Community-Based Participatory Research

### 2.1.2.1 Background

Community-based participatory research (CBPR) has its origins in the development of concerns regarding who owns knowledge, the roles of researcher and “researched”, and how involved parties benefit (Minkler & Wallerstein, 2008). It was felt that too often in traditional research the researcher swooped into a community or project, recorded what they felt was important or novel, and then disappeared (Benoit *et al.*, 2005; Buchwald *et al.*, 2006). The researcher would then publish their findings (to the advancement of their careers and personal prestige), while the community or project participants were left solely with feelings of frustration and exploitation, as they observed no change in their environment(s) or long-term solutions to problems (Christopher *et al.*, 2008; Christopher, 2005). A rebalancing of the power relationship was considered critical.

The 20th century was a period of great social change. Philosophies on social structure and movement were not only being conceptualised but acted upon, as communities began to question the inequities of their social, political, religious and financial environments (Ritas, 2003). In the late 1930’s and early 1940’s, social psychologist Kurt Lewin began discussing the idea that both

nature and nurture influence behaviour (Minkler & Wallerstein, 2008). Lewin felt that because behaviour is decided by the entirety of an individual's condition, it cannot be separated from the historical context in which it derived (Hacker, 2013). Social interconnectedness, then affects all future interactions: so while individuals control their own reality, it is within the structure of what they have come to know and understand.

Meanwhile in the 1960's and 1970's, philosopher and educational reformist Paulo Freire advocated the need for individuals and communities to become empowered to change their own social existence before they are capable of addressing externally-driven goals (Minkler & Wallerstein, 2008). Once immediate issues such as hunger and shelter are controlled, Freire felt the key to social and community change was education because with knowledge comes power (Freudenberg & Tsui, 2014). True community growth could therefore only exist when each member has an equal opportunity to participate in the identification of common problems, the discussion of potential solutions, and the process of rebuilding.

As a result, amidst researchers, two separate schools of thought for empowering communities began to emerge. Within CBPR these are generally referred to as the Northern tradition (strongly influenced by the ideas of Kurt Lewin), and the Southern tradition (which pulls themes from José Ortega y Gasset and Paulo Freire) (Minkler & Wallerstein, 2008). The Northern tradition focuses on action research by means of creating collaborative relationships to build improvements within systems in order to overcome social inequality (Hacker, 2013) (see Figure 2.1). For those who conceptualise the Northern movement, there is value in the community reflecting on their own needs, and the path to achieve them.

The Southern tradition emphasizes participatory research by concentrating on emancipation of the community from under the traditional Marxist knowledge-power differential that occurs between the elite/educated and the rest of society (Minkler & Wallerstein, 2008). The Southern school of thought believes that there is intrinsic understanding through experience, which is as important as learning by any other means (Freudenberg & Tsui, 2014) (see Figure 2.1).

In an environment where communities were increasingly reluctant to participate in research due to a lack of trust and respect (in addition to suspicions that researchers had no real regard for the complexity of social, economic, political and cultural problems being faced) use of community participation by either methodological construct was seen as a tool where stakeholders could provide input, but also come away with tools with which to help themselves (Israel *et al.*, 2005a).

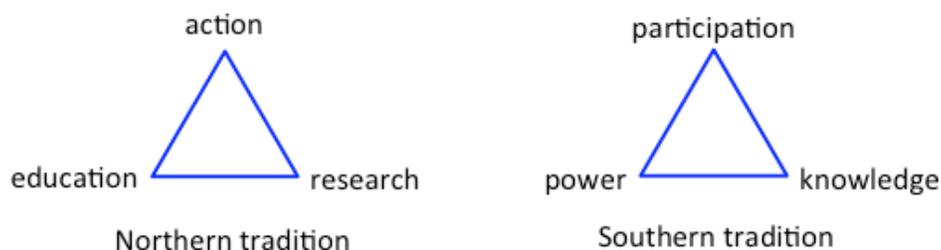


Figure 2.1 – Triads of power for Northern and Southern traditions of community-based participatory research

In the early 1980's, Habermas suggested that one of the major problems was not only the way the researchers regarded the community members, but how the community members saw themselves and their relationship(s) with the outside researcher (Ingram, 2010). This role was intrinsically linked to their place in what Habermas identified as the systems world (legal, economic, political) compared to their life world (families, cultural traditions) (Ingram, 2010).

With a perceived power imbalance the systems world dominates the life world, and the individual self-identifies with that lower standing, resulting in feelings of objectification. With a movement towards all community members having roles as decision-makers, individuals were free to fully explore both issues, and solutions.

These shifts in philosophy led to the community (not the individual) being seen as the research unit. Thus a key foundation in CBPR is that the focus is on the problems of the community as a group or an organisation. The goal of any interaction is to provide all members with the capacity and resources to completely understand all aspects of the situation, as well as any potential solutions that may assist in problem resolution (Stringer, 2013). In CBPR, community members are therefore collaborators and facilitators or partners, instead of solely being viewed as research participants (Sullivan *et al.*, 2001). Meanwhile researchers are active learners within the process, with co-learning occurring during mutual transfer of ideas, insights and proficiencies (Sullivan *et al.*, 2001). As collaborators, communities have access to and ownership of all aspects of a research project, creating an environment of complete transparency with respect to expectations, procedures and outcomes (Plowfield *et al.*, 2005).

In participatory action research (PAR), the community controls the research agenda, and assists with each phase of the research project; including needs assessment, research design, data collection, project implementation, and intervention evaluation (Banister *et al.*, 2011; Ferreira & Gendron, 2011; Fisher & Ball, 2003). As the community is involved from the project outset and inception, sustainability is therefore considered and discussed as a priority at each phase.

Though CBPR has the potential to be applied to any number of research areas, it is increasingly used with populations having a history of social inequity (Chino & DeBruyn, 2006; Menzies, 2001; Minkler & Wallerstein, 2008; Viswanathan *et al.*, 2004). As Indigenous populations have frequently been the subjects of “helicopter” research (which led to significant distrust towards researchers and science), projects on health and environmental research are progressively moving towards a more participatory approach (Buchwald *et al.*, 2006; Christopher, 2005; Cochran *et al.*, 2008; Jacklin & Kinoshameg, 2008; Minkler & Wallerstein, 2008). Partnerships between academic institutions, government ministries of health, health service providers, community based organisations and Indigenous communities, now allow researchers to identify risk factors shaping determinants of health, while enabling communities to identify individual priorities, and develop capacity to provide resources to community members (Syme, 2004).

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#### 2.1.2.2 Current Methods

Successfully creating and maintaining community-based collaborations and partnerships, that build relevant trusting relationships and respectful research endeavours takes time and patience. Barbara Israel *et al.* (1998) identified key principles that are the basis for much of the CBPR work presently being completed.

They can be described as:

- Identifying the community as the unit of identity
- Solidifying strengths, skills and assets in the community
- Creating cooperative partnerships through all stages of projects
- Promoting creation of competencies and skills building for all partners
- Incorporating and balancing learning and action for all collaborators

- Planning for long-term sustainability and committing to process
- Engaging a continually shifting, repeating and flexible approach to working
- Utilising a positive One Health outlook
- Sharing discoveries and attained evidence and materials with all partners

In 2008 and Wallerstein added two more:

- Encouraging a scholarship and empowering culture that notes inequities
- Focusing on research rigour and validity without losing community relevancy

By following these principles, researchers and community partners are able to work together to build and develop strategies to enhance communication, trust and cooperation. This leads to the ability to integrate and develop skills, knowledge and action towards social change, improved community health and member wellbeing. The aim is for full community participation, direction, creation and inclusion within the research process, the overall project, and the dissemination and maintenance of knowledge and results (Banister *et al.*, 2011; Christopher *et al.*, 2008; Wong *et al.*, 2013).

With insufficient dialogue mutual respect and interest are not developed. At best, researchers may only hear what the community chooses to share (what is considered public knowledge), or at worst complete mistrusts (Christopher *et al.*, 2008) (see Figure 2.2). This can result in research and interventions that completely lack a community voice. This may occur when researchers are under time constraints to get projects started, and unthinkingly limit the initial period of storytelling and introductory interactions (Ritas, 2003). Unfortunately by stopping these stories, frequently the entire community becomes silenced, preventing complete and open communication and participation. Although there are multiple levels of participation for community members in participatory projects, in true CBPR community members are partners who don't simply provide input but are involved in all areas of the design, development and research phases (see Figure 2.3). The development of this collaboration is critical, as it has the ability to make a significant impact on the power dynamics and trust (Plowfield *et al.*, 2005).

Community-based projects may be initiated either by a community identifying a potential area of concern, or by researchers identifying an issue, risk factor or discrepancy in incidences of disease or behaviour in a particular group, environment, or community (Minkler & Wallerstein, 2008). Once the connection is established, partnerships are created with representative members of the community, and other key stakeholders (Stewart, 2009). Discussions with collaborators must then identify either reason (or cause) for the research, as well as outline the research question (i.e., what?).

Developing the research problem requires answering the where (*which areas of the community will be focused on?*), who (*what roles and responsibilities does everyone have?*), when (*what is the timeline of the project?*), and how (*what research design will be used?*) of problem solving. This is the first and best opportunity for all partners to put their interests, needs, resources and limitations forward so that they may be discussed, as well as adapted into not only research development, but also program planning, evaluation, and intervention sustainability forecasting (Viswanathan *et al.*, 2004). Spending the time and energy to develop trust through listening to community viewpoints and ideas, and to pinpoint community skills, strengths, resources, and

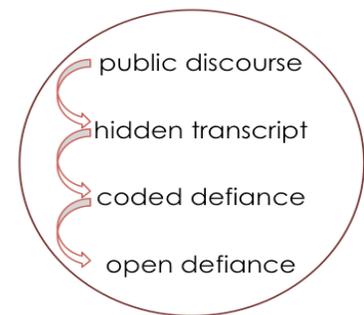


Figure 2.2 – True levels of community voice in public discourse

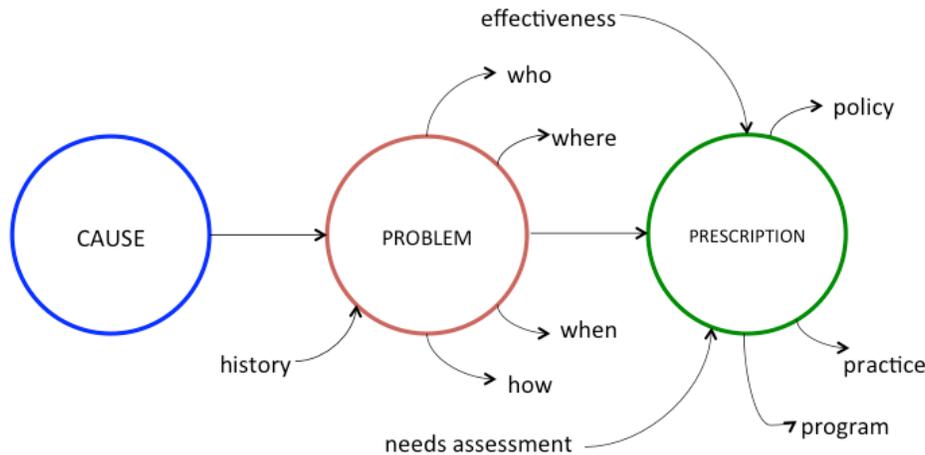


Figure 2.3 – Development of Community-Based Research project

assets, empowers the community as well as initiates the beginning of a relationship built on mutual respect and trust (Sullivan *et al.*, 2001). This in turn creates sustainable partnerships that survive after the research study is completed. Open discussion also delivers insights into potential areas for policy changes, additional stakeholders who should be invited, and possible challenges that may arise (Benoit *et al.*, 2005; Ritas, 2003).

In community partnerships academics relinquish much of the leadership role that they would hold within a traditional research study (Israel *et al.*, 2005a). For projects to be completed and maintain momentum, assigning tasks and responsibilities becomes a critical endeavour. One method of accomplishing this follows the features of community-partnered participatory research (CPPR) outlined by Jones *et al.* (2008).

By developing a leadership council with representatives from all stakeholder groups, communication remains open and ongoing with all collaborators (Chino & DeBruyn, 2006). The council is then able to assign various individuals to different work groups based on skill sets, resources and availability. Each work group is responsible for their section of the project, and participates in the planning, implementation and evaluation of their action plans with ongoing communication and review by the leadership council and representatives of the community (Banister *et al.*, 2011). Each work groups' products and results are integrated as a whole to create the overall intervention or project, and data are analysed for areas of success and improvement (Israel *et al.*, 2005b). Final assessments, details and findings are then shared with all members of the community, stakeholder groups and researchers' organisations (Wong *et al.*, 2013). To be successful, project councils move through three coalescing phases: the vision phase (where project is framed and objectives outlined), the valley phase (where strategies are established, executed and assessed), and the victory phase (where project is completed, circulated and celebrated) (Jones *et al.*, 2008). By following this structure, all partners are aware of their responsibilities towards the successful completion of the project, which improves accountability on all sides.

### 2.1.2.3 Strengths and Weaknesses

The majority of the advantages of CBPR are directly related to the benefits for the community, and the results of improved discourse between researchers and community members (see Table 2.1). CBPR can create opportunities for community members to feel empowered and

engaged in the decisions and work being done in the environment around them, so they have a voice in the community and what happens within it (Benoit *et al.*, 2005; Sullivan *et al.*, 2001). Interventions should have improved relevancy and desirability, leading to personal ownership, participation and pride. As a result, improved communication occurs with researchers, leading to more accurate and pertinent data and results (Teufel-Shone *et al.*, 2006). This in turn can lead to improved intervention evaluations, and result in the development of further partnerships or projects.

Table 2.1 – Advantages to using Community-Based Participatory Research methods

Advantages to using CBPR	• Diverse expertise possible, range of skillsets available and potential for learning
	• Community member participation improved, decreased loss to follow-up
	• Design of projects and interventions more relevant for community
	• Community driven means community priority of needs are met
	• Implementation of projects and interventions facilitated, more sustainability
	• Quality, reliability and external validity of research enriched
	• Data and results more pertinent and applicable, as collected in proper context
	• Increased trust and understanding between collaborators, bridge cultural barriers
	• Knowledge benefits and resources provided for both communities and researchers
	• Partnership may lead to development of further work, interventions and policies
	• Capable of reaching larger groups of community members
	• Provides vehicle for increased empowerment, capacity, knowledge and infrastructure
• Improved cultural interactions for present and future projects	

Many of the weaknesses that can be found in CBPR, stem from the expectations surrounding scientific research, academic performance and the history of research with marginalised social groups (Benoit *et al.*, 2005) (see Table 2.2). Scientific grants are often given a very limited timeframe in which to implement a study and provide rigorous, reliable, and valid statistical results. Unfortunately with CBPR, significant time is generally necessary to build partnering, trusting relationships, and to design and implement appropriately relevant community projects and interventions (Plowfield *et al.*, 2005). This is especially true in communities that have had negative prior interactions with academic or government researchers, in which little care was given to community priorities or project sustainability (Ermine, 2007).

Academic researchers are often also under significant pressure to show results and provide a successful publication record if they wish to stay in good standing with their institutions and granting agencies. This is difficult to do when using CBPR, due to the length of time each project requires from onset to evaluation (Minkler & Wallerstein, 2008). In addition, since projects are partnerships, communities also have at minimum (if not entirely) partial ownership of data and results, and may not wish to have results published (whether or not the intervention was successful or not).

Working, communicating and coordinating with large and diverse groups of individuals and stakeholders can be challenging. This can be especially difficult when study sites are remote, rural or inconveniently located (e.g. in another hemisphere, fly-in locations, etc.) (Wong *et al.*,

2013). Researchers must also develop extensive skill sets and expertise in order to implement CBPR well, and end up with valid, accurate results that are truly representative of the community with which they are working (Hacker, 2013).

Table 2.2 – Disadvantages to using Community-Based Participatory Research methods

Disadvantages to using CBPR	• Long timeframe required to be successful; sometimes considered inefficient
	• Communities begin with element of distrust
	• Cultural and social inequities must be handled with care
	• Communities may not feel they have the resources or finances to be partners
	• Maintaining positive partnerships requires time, energy, communication and effort
	• Academic and other institutions must also be on board and constructive
	• Difficult to know most effective stakeholders when ‘outside’ community
	• Community partners do not have same time available as researchers
	• Community may lose interest or support due to timing, politics, finances
	• Academics and communities may have different priorities and goals
	• Difficult to maintain scientific rigour when using ‘novice’ community members
	• Communities may be more interested in end results than process, different agendas
	• May be difficult to evaluate intervention success, risks to internal validity
	• Difficult to know potential outcome prior to intervention being implemented
	• Research may not be considered credible by granting agencies
	• Maintaining communication with large and diverse groups of stakeholders challenging
• Few researchers have extensive skillset required to perform CBPR research effectively	
• Travel time to and from communities may be inconvenient or challenging	

#### 2.1.2.4 Use in Dog Population Management and Dog Bite Prevention

While there are many cases of organisations and groups beginning to create dog population management protocols, and dog bite and rabies prevention projects over the last 15 years (e.g. World Society for the Protection of Animals (WSPA), International Federation of Animal Welfare (IFAW), Alberta Spay and Neuter Task Force, the Blue Paw Trust (BPT)), the unfortunate reality is that few of these projects are published. This makes it difficult to assess whether their methodology is truly community-based partnered strategies, or simply community-focused interventions. Many of those that do share findings, are only able to do so in internal documents or non-peer reviewed publications, or a lack of means or time to find suitable journals willing to publish the data and findings. These projects are then difficult to retrieve unless one is privy to their occurrence, resulting in limited successful public examples to share with communities and organisations that are hesitant in participating or funding such work.

One example of this is the 2007 Columbo dog population survey completed by WSPA, the BPT, and the Columbo Municipal Council (CMC), which was published as an internal document for WSPA (WSPA, 2007). The document meticulously details the methods used to survey the community and complete dog demographic characteristics, the plans for population management, community education, and dog bite prevention. It does not however, give any indication of the level of involvement that the CMC or the community members had in program design or implementation, which makes it impossible to know if this project was truly community-based, rather than being a project approved by the CMC as a necessity for improving community health.

Even the few projects published in peer-reviewed literature that appear to have utilised some level of community engagement are difficult to assess. For example though Lunney *et al.* (2011) completed a community survey in Guatemala assessing the prevalence of dog bites and human-dog conflict risk factors in a number of communities in Todos Santos using community member interpreters, they gave no indication whether community members were also instrumental in developing the project design and/or prevention strategies. This does not decrease the value of the study, as important information regarding dog ownership, attitudes towards dogs within the community, and dog bite issues, was collected, however feelings of community ownership may not be guaranteed. Other examples of studies that follow this trend are Kongkaew *et al.* (2004) (evaluation of rabies and dog population control in Thailand), Lunney *et al.* (2012) (evaluation of rabies and dog bite prevention in Cambodia), and Yoak *et al.* (2014) (dog population management and disease control in India).

Rather than being truly inclusionary, in many population management strategies and bite/rabies prevention endeavours, the involved organisation or institution has either been invited by a level of government (federal, state or municipal) overwhelmed by the magnitude of their dog issues, or has offered to assist as the locality has been identified as being at risk. Examples of this are seen in Hergert and Nel (2013) (dog bite and canine rabies report in South Africa), and Gsell *et al.* (2012) (dog demographic characteristics and dynamics for rabies vaccination planning in Tanzania).

However with the changes of researchers' viewpoints researchers (from community members being subjects, to being active and invaluable colleagues within their districts capable of collecting data and mobilising their compatriots to assist in improving the health and wellness of their communities), more researchers are attempting to collaborate. An early example of this in the dog population literature is Kitale *et al.*'s work in community-based rabies surveillance in Kenya (2000) (Kitale *et al.*, 2000). After years of insufficient passive surveillance, the Ministry of Health and the Department of Veterinary Services elected to request input and assistance from village chiefs and local leaders in developing the initial program design, as well as choosing local people to act as rabies caseworkers. The rabies workers were responsible for all case follow-up, sample submissions and data collection, as well as discussions with bite victims regarding post-exposure treatment. Researchers found a significant difference in the number of rabid animals tested positive compared to passive surveillance, and an improvement in the number of community members properly treating animal bites. This study led to permanent changes in surveillance systems for rabies in Kenya over the next few years.

More recently, Dr. Sophie Constable completed her doctoral work using community engagement to assist in developing health strategies and educational programs regarding dogs and dog population issues within Aboriginal communities in Australia. Her results have shown that building on community knowledge and learning modalities leads to improved human and dog health outcomes (in her case study communities), as well as increased community knowledge and understanding of the relevant health issues in the area (Constable, 2012).

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#### 2.1.2.5 Use in Veterinary Medicine

The use of community-based participatory research has been slow to take hold within the veterinary community. However use amongst pastoralists (nomadic herders) and small-scale farmers in developing countries in Africa and Asia has been spearheaded by researchers such as Catley and Mariner (2002; and *separately* Catley, 2004, 2006, 2012; Mariner 2012). Researchers who advocate for CBPR inclusion in veterinary work suggest that it be used as part of a series of tools, alongside traditional clinical methods, as a means of ensuring best practice while having the potential to add local knowledge and community priorities. This has led to some impressive results in recognising, treating and reducing disease illnesses in livestock. According to Toribio and Rushton (2012), one of the main difficulties with the inclusion of CBPR within veterinary research is the consistent belief that the veterinarian must have the role of ‘teacher’ in all contexts of animal health. Without the ability to recognise that community members have valuable ideas and knowledge to share, veterinarians miss critical opportunities to connect and develop deeper understandings of the complex interworking within which they can enhance human and animal health.

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#### 2.1.2.6 Research Gaps

Currently the vast majority of the literature available pertaining to dog management or dog bites is related either to controlling, preventing or treating rabies within dog (and human) populations, or surgical and medical treatments of dog bite victims (Dhillon, current scoping review). There are large numbers of articles quantifying bites, and retrospectively looking at demographic characteristics and medical notes to search for potential risk factors and human demographics, yet few published research studies actively investigate the interactions between humans and dogs to document the trigger behaviours (human or canine) that lead to attacks (Dhillon, current scoping review). This information is far more easily found on websites developed by dog trainers and veterinarians (e.g. website).

While rabies, dog bite prevention, dog behaviour and dog population demographic characteristics generate thousands of Google hits, few research articles discuss more than one concept at a time, though they may mention the potential to reduce rabies levels or bite occurrence by focusing on population management (Dhillon, current scoping review). In addition, there is little information available for the lay public on how to deal with dog bites, possible rabies exposure, or what to do in the midst of a possible attack (i.e., stopping the current attack).

In addition, though dog demographic methodology is becoming more common, there are few comprehensive studies that have been published on successful dog population management strategies, and none that have done so using a CBPR approach. Rather these policies can be found in non-governmental organisational publications, most of which use a ‘one-size fits all’ approach to project design and implementation, suggesting that regardless of circumstances the same methods and regulations will be successful (Dhillon, current scoping review).

Community-based participatory research has the potential to radically change the future of project development, and human and animal health care within marginalised communities. Discovering which priorities are most pressing and currently relevant for populations can lead to significant transformation of policy, planning and intervention design that consequently has lasting impacts and sustainability. Unfortunately, CBPR has not yet become routinely used, nor its value widely recognised within veterinary medicine. This creates limitations in the overall support of its

value, despite the increased time and effort involved in developing project relationships and disease surveillance.

### 2.1.3 Mixed Methods

#### 2.1.3.1 Research Paradigms

There are multiple research paradigms that underlie mixed methods research (MMR). For these purposes a paradigm is defined as a perspective based on a set of assumptions, concepts, and values held by either a community or researcher (Denscombe, 2008). The paradigm of thought that a researcher holds can potentially significantly influence both the type of information and the method with which it is collected, as well as the way they see and understand the data they gather (Guba & Lincoln, 1994). This is partly because it is assumed that epistemology and methodology are intertwined, so an individual's epistemological position guides what they believe to be of value, and the approach they use to interpret their data (Harrits, 2011).

For a considerable period of time debate has raged regarding the compatibility of diverse paradigms and MMR models. Howe (1988) believed the debate is based on the criterion and assumptions behind 'what works'. Namely that "*Positivist and interpretivist paradigms underlie quantitative and qualitative methods respectively; the two kinds of paradigms are incompatible; therefore, the two kinds of methods are incompatible*" (Howe, 1988, p10). That is, since quantitative and qualitative methods are governed by different approaches to research and different epistemologies, it was argued that mixing the two violated basic principles of theory (Greene & Caracelli, 2003). Conversely, Fan *et al.* (2012) and Hall (2012) advocated that although the two research methods are complementary, only the transformative and pragmatic worldviews are appropriate to be used with MMR. Several other researchers have supported this view (Harrits, 2011; Mertens, 2007; Symonds & Gorard, 2008).

Yet several other schools of thought have suggested that a researcher's individual paradigm(s) and a research method's potential paradigm are not only unimportant in the larger picture, but may provide for new ways of constructing knowledge. In Patton's aparadigmatic view he proposed that methods and paradigms are unconnected and independent of each other, and therefore irrelevant to research (Patton, 1990). Meanwhile the substantive theory proposes that paradigms are simply another tool that researchers use to assist them in understanding what they see, therefore paradigms do not restrict methodology, but rather open up different avenues of reflection (Greene & Caracelli, 2003). In comparison, the dialectic stance (which encourages various perspectives and processes) claims that researchers may use any number of paradigms within their study, as all paradigms contribute important functions towards a greater depth and breadth of understanding (Cameron, 2011). Lastly, the pragmatic philosophical outlook underscores the research question as being the core component in structuring and driving the methods used and the approach taken for study, data collection and interpretation, making a researcher's paradigm irrelevant (Morgan, 2007; Tashakkori & Creswell, 2007).

These last outlooks can therefore not only accommodate combining qualitative and quantitative methods, but potentially permit a research project to be built on more than one paradigmatic foundation. This is key, as the project outlined here is based in both pragmatism (i.e., '*solving practical problems in the real world*' (Feizler, 2010)) and constructivism (i.e., '*generating or inductively developing a theory or pattern of meanings based on the participants' views of the situation being studied*' (Creswell *et al.*, 2003)). This is because not only are we trying to learn and

determine what works, but we are hopefully learning how and why it works for each participating community.

### 2.1.3.2 Mixed Method Design

The expression ‘mixed methods’ is generally used to refer to projects in which two or more methods are employed to yield both qualitative and quantitative data (Cresswell & Plano-Clark, 2007; Greene, 2007; Teddlie & Tashakkori, 2009; Teddlie & Yu, 2007). The choice of which design to use is generally based on a number of factors, including the research questions being asked, the purpose of the research, and the environment in which the research is conducted (Johnson *et al.*, 2007).

MMR is often suggested when a researcher needs to pull together the breadth and generalised knowledge offered by a quantitative study, but also offer the enriched depth of comprehension that is supplied by qualitative research. Often this is because one datum source is deemed to be insufficient for a full understanding of the concepts being studied. While quantitative research tells us the story of “*If... then...*”, qualitative research tells us the story of “*how?*” and “*why?*”. Creswell *et al.* (2003, p8) said there are many justifications for using mixed methods, however the most common are that

*“... results need to be explained, exploratory results need to be further examined, a study needs to be enhanced through adding a second method, a theoretical stance needs to be advanced through the use of both types of methods, or a problem needs to be studied through multiple phases of research that include multiple types of methods.”*

Many researchers also argue that by combining techniques, qualitative and quantitative research designs can offset the problems and issues associated with methodological weaknesses by drawing on the strengths of the other (Cresswell & Plano-Clark, 2007; Greene, 2008; Johnson & Onwuegbuzie, 2004; Mertens & Hesse-Biber, 2013).

While utilising a mixed methods approach to research may improve credibility (by increasing reliability and validity as a result of triangulation), as well as give data a greater sense of completeness and context (providing both process and the reasons behind the mechanism), it also comes with immense challenges. Not only does MMR require a complete understanding of both qualitative and quantitative strategies to be done well, but it requires significant expertise, effort and time to appropriately examine the trends being investigated, and to recognise inconsistencies or complications when they occur (Mertens & Hesse-Biber, 2013). MMR researchers must have an active knowledge and comprehension of the procedures, tools, and assumptions that guide the different forms of research, and their data analysis. Decisions must be made during design planning regarding adequate sample sizes, as qualitative research accepts smaller sampling groups as significant compared to quantitative research designs (Cresswell & Plano-Clark, 2007). In addition, in order for data strands to be fully integrated, many researchers suggest that they must be transformed when analysed together, which can be difficult when working with different data types (Bazeley, 2004; Tashakkori & Teddlie, 2003) (however Caracelli and Greene (1993) argue that triangulation is less useful and thorough if performed after integration). Once analysed, researchers must also be capable of understanding and interpreting both forms of data separately, as well as in combination, and establishing strategies for dealing with conflicting results from different phases (Teddlie & Tashakkori, 2003). Without all of these skills, research can be open to criticism for lack of rigour. Finally, as more than one study must be

completed (both a qualitative and a quantitative element must be used for it to be MMR), additional resources and time must be available to properly conduct the research.

#### 2.1.3.2.1 Mixed Methods Research vs Traditional Epidemiology

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Traditional epidemiological (TE) approaches generally attempt to identify the link between risk factors or exposures to (disease) outcomes in order to determine the probabilities or likelihood of an event occurring by using a cross-sectional, case-control, or cohort study (case reports, case series and ecological correlation studies are sometimes used but are considered weaker). Simple descriptive studies begin by categorizing a case, from which researchers create a case definition that includes person, place and time. From the case details, they then attempt to discern possible risk factors, in order to develop a hypothesis on disease causation. Analytic studies then look for cause and effects by measuring and testing the level of association between the potential risk factor, and the outcome being studied. Since the overall purpose of the TE study is to determine relationships between risk factors and outcomes of interest, the key is to have a minimum of two groups, so comparative analysis can occur.

TE studies can also be categorised as either experimental (clinical or community trials) or observational (cohort or case-control). In experimental studies, the researcher determines what the exposure status is, and then follows the individual (or community) over time to assess the impacts of exposure. The gold standard of traditional epidemiological research is usually considered to be the randomised control trial (RCT), as when properly done the experimental results are fairly certain and straight-forward (though not necessarily generalizable), and the control (or comparison) group is capable of providing some general baseline data. By comparison, observational studies either 1) record the exposure status of the participants, and after a specific time interval measure the disease rate (outcome) in the exposed group compared to that of the unexposed group (a cohort study), or 2) they select a group of people with the outcome (cases) and compare their patterns of risk factor exposure to a second group without the disease (controls) (a case-control study). Thus for traditional studies, quantitative results are heavily prioritised compared to qualitative details.

Once completed TE research uses various methods to analyse data. Study design has a conclusive influence on the analytical methods used, and they should be planned and determined prior to the study beginning in order to reduce bias. Descriptive statistics on the study population are provided in all studies. The most common results to be reported are frequency measures (such as incidence and prevalence) and effect measures (such as odds-ratios and relative risks). Which numbers are calculable depends on the type of study run and the data collected (types of variables). As regression models (which consider confounding and interacting factors) can calculate relative risk, it is considered to be a stronger effect measure than an odds-ratio. However relative risks cannot technically be calculated for case-control or cross-sectional studies.

Compared to TE modern MMR designs place considerable value on both qualitative and quantitative measures and results. In addition, multiple research frameworks are expected to inform the study design, and then be combined in MMR in order to provide a fuller understanding of the data. Qualitative research is used to provide context for processes, while quantitative research is used to gather measurable evidence. More than a dozen different MMR designs are possible, which vary timing of research types, priority of research types, and points of interface (Bazeley, 2004; Cresswell & Plano-Clark, 2007). However, the designs of quantitative research studies within the MMR project are expected to be just as rigorous as if a traditional quantitative project was occurring on its own. The qualitative piece is simply used to enhance the understanding of the

results obtained by the more traditional study. In other words, TE research approaches such as RCTs, cohort, case-control, cross-sectional or correlational can easily be incorporated within the design planning of an MMR.

An important difference however, is in the data analysis. Unlike traditional studies where though there may be multiple data sets that must be correlated most data can be easily converted to a numerical form, MMR inherently contains qualitative results. Decisions must be made regarding whether data will be compared by changing the data in some way, or by comparing and relating data sets in their original forms. Working with two completely different types of data sets can become complicated very quickly.

Onwuegbuzie and Teddlie (2003) identified seven different methods used to handle MMR data. Data reduction (minimising the detail of qualitative data), data display (creating representative pictures of qualitative data), data transformation (quantitative data is turned into narrative, or qualitative data is changed into numerical codes), and data correlation (quantitative research results are compared to qualitised data, or qualitative research results are compared to quantitised data) all involve altering one data set type to more closely resemble the other for easier comparisons. Alternatively, data consolidation requires creating wholly new variables or data sets by combining the two types. Data comparison simply looks at the data sets in their original forms and compares the results for interpretation and understanding (this is frequently done by means of tables and matrices). Lastly, data integration mixes the data sets into one or two (separate) coherent package(s).

However, Cresswell and Plano-Clark (2007) suggested simplicity, and provided only two options based on MMR design. Concurrent data analyses involves analysing the two data types separately, after which merging is completed either through data transformation or by using a matrix for original data comparison. In sequential data analysis there is no need to combine data, as the results and analysis from the first stage of the project then informs the second stage of the project, after which the final results can be analysed as is appropriate for that data type. For the sequential design it is only during the final interpretation that the data is discussed together. No matter which authors a researcher is adhering to, it is obvious that data analysis within an MMR project has the capacity to be immensely complicated.

*“Mixed methods are inherently neither more nor less valid than specific approaches to research. As with any research, validity stems more from the appropriateness, thoroughness and effectiveness with which those methods are applied and the care given to thoughtful weighing of the evidence than from the application of a particular set of rules or adherence to an established tradition.”* (Bazeley, 2004, p9)

### 2.1.3.3 Mixed Methods and Causality

Cause (in an epidemiological sense) can be defined as an event or factor that affects (usually increases) the occurrence of an outcome or disease. Classically, identifying and corroborating a strong association between an explicit cause and a specific outcome/effect through rigorous (preferably RCT) experimentation determines causality. This is done by following a set of causal requirements (as determined by the researcher): Hill’s Criteria, Koch’s Postulates, Susser’s Criteria, Mill’s Theory of Agreement (by recording the postulated cause and effect regularly in various diverse situations) or Mill’s Theory of Difference (observing multiple indistinguishable cases in which only the considered cause and effect differ) (see Table 2.3). Generally, causes are

then found to be either necessary, and/or sufficient to produce the effect depending on the results found by testing causal hypotheses (when ethically sound).

Table 2.3 – Causal theory requirements

Hill's Criteria for Causal Inference	Koch's Postulates	Susser's Criteria
Consistency of findings	Agent is present in every case of disease by pure culture isolation	Time order (X must precede Y)
Strength of association		Direction (X always leads to Y)
Biological gradient (dose response)	Agent must not be found in cases of other diseases	Rejection only by: wrong time order, inconsistency, or factual incoherence
Temporal sequence	Isolated, the agent must be capable of reproducing disease in others	
Biological plausibility		Agent must be recovered from the experimental disease produced
Coherence with established facts		
Specificity of association		

Working within MMR, establishing causality is not always as straight forward, as historically established quantitative experimental methods used to establish causation are not always applicable, nor possible. Therefore both the credibility of the causal hypothesis and the elimination of plausible alternatives may need to be established using qualitative measures, or quantitative measures other than RCTs. In addition, MMR studies do not tend to be based on simple, uncomplicated questions, which can add levels of complexity when trying to decipher findings. Maxwell (2004, p246) suggested that we consider “causation as fundamentally a matter of processes and mechanisms rather than observed regularities”, and work towards “... *the development of a distinction between variable-oriented and process-oriented approaches to explanation*”.

Mertens and Hesse-Biber (2013) referred to the establishment of causality using “mixed methods causal chain analysis”, which involves gathering sufficient data, followed by the corroboration of links and associations to create a burden of proof by using both inductive (qualitative) and deductive (quantitative) methods. From a pragmatic perspective, causal systems are intrinsically linked to their context and therefore very difficult to establish (Teddlie, 2005). However, many researchers believe that certain processes within the causal chain may be directly observed, but that these mechanisms and effects will be interpreted through the investigator’s own philosophical frameworks and values (Cartwright, 2000; Putnam, 1999; Salmon, 1998).

Teddlie (2005) also differentiated between causal effects (strength of the relationship) and causal mechanisms (process by which the factor controls the outcome), and proposed that quantitative research can potentially measure the approximate effect but only qualitative measures can completely identify mechanisms. Results are then integrated by triangulation to create an overall view (Mathison, 1988; Morgan, 2007). These mechanisms are especially important when it comes to studies on social phenomena, or community decision making, for as Sayer (1992, p30) wrote “*Social phenomena are concept-dependent... what the practices, institutions, rules, roles, or relations are depends on what they mean in society to its members*”. Or from Borg and Gall (1989, p537):

*“Causal comparative studies are ‘aimed at the discovery of possible causes and effects of a behavior pattern or personal characteristic by comparing’ units of analysis in which ‘this pattern or characteristic is present’ with units of analysis in which ‘it is absent or present to a lesser degree’.”*

As such, despite the difficulties, MMR studies are perfectly positioned to study causality. Inherently including both quantitative and qualitative measures and relating and comparing them by triangulation, MMR has the ability to not only assess the level of the impact, but also the means by which certain actions influence others. That is MMR is capable of ascertaining not only that X causes Y (using quantitative experimentation), but also *how and why* X causes Y (using qualitative observation). In addition, the use of multiple measurements and methods in verifying and supporting results, reduces the risks of potential bias obtained by relying on a single datum source, thereby increasing the likelihood that described causality is actually occurring.

*“What causes something to happen has nothing to do with the number of times we observe it happening. Explanation depends instead on identifying causal mechanism and how they work, and discovering if they have been activated and under what conditions” (Sayer, 2000, p14)*

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#### 2.1.3.4 Research Gaps

Although qualitative pieces of MMR have been frequently used in health research (e.g. interviews and surveys), true MMR studies that have included rigorous triangulation and validation have been rare. Rather studies have focused on using qualitative assessments to establish general trends in knowledge or belief patterns to design more structured quantitative studies. Generally even studies that have completed both qualitative and quantitative sections synchronously have limited their analyses to the quantitative data, using qualitative material as support. This limits the potential for effective research follow-up or replication, and prevents valid generalisation to other populations.

In addition, the requirement for researchers involved in MMR to have multiple skillsets has frequently meant that portions or segments of the study may have had less scrutiny for accuracy and precision, depending on the strengths of the team and their understanding of the techniques involved. As a result, information and data that could be gleaned from a study and that may benefit other researchers or policy-makers, may not be obtained or disseminated.

## 2.2 Dog Issues in First Nations Communities

Improving the ability of communities to provide accessible, secure and culturally appropriate environments for their members is a part of the overall priority planning for most indigenous societies. Engaging in comprehensive means to provide traditional culture-based solutions to community and environmental problems and issues, strengthens community identity and capacity. In turn this generates and builds positive social networks and capacity, providing legitimacy of tribal consciousness. These goals extend to the outlook individuals have towards dogs: although with the myriad of difficulties indigenous communities currently face, dogs are often forgotten. However, dogs are inherently recognized as having intrinsic cultural, historical and emotional value (pers. comm. Tasha Epp, Dog Days, 2012).

## 2.2.1 Dog Population Control

### 2.2.1.1 Programs

Certain indigenous communities in Saskatchewan have begun implementing dog control options; such as microchip programs to establish demographic characteristics within the community, as well as dog control officer programs to provide lethal population management (pers. comm. Tasha Epp, Dog Days, 2012). Two distinct areas of thought exist. For some communities it is felt issues are daunting but some minimal start is needed to approach a solution with all possible and available means. Alternatively, other groups find the number of dogs and issues overwhelming, and see no clear direction on where to begin. Regardless of which options are pursued, communities need treaty rights, community rights and spiritual/cultural beliefs to be respected and included during program development.

First Nations communities agree that multiple barriers exist which prevent or encumber the development of control programs. These include lack of funding, inadequate leadership and lack of priority, resistance against social change, poor communication and difficulties in merging science while respecting First Nations culture. To be successful it has been critical to find an engaged community-driven champion and adequate funding sources. Collaborations between researchers, government and communities are possible with appropriate consideration of Two-Eyed Seeing and program development. It is also believed that flexible, unique, autonomous guidelines are essential for significant social conformity to occur. Education of all community members regarding ownership, behavior and safety is believed to have a substantial impact on the tolerance and approval of dog population programs (pers. comm. Tasha Epp, Dog Days, 2014).

### 2.2.1.2 Sterilisation

Generally techniques such as ovariohysterectomy (spay) or orchiectomy (neuter) are the backbone of any community's population control. Unfortunately, these techniques can only be performed by licensed veterinarians, so although effective, the required time, space, equipment, supplies and necessary personnel often make surgical sterilisation impractical and expensive. In remote or impoverished areas, this is especially true. Non-surgical methods have therefore been an active area of study.

Non-surgical methods offer an appealing, alternative form of population management in cats and dogs with the potential of being more feasible for large-scale population control, less invasive and less time consuming. Current options fall into two formats: permanent sterilization and temporary contraception. Unfortunately, non-surgical methods are still restricted by price, the need to be repeated and the welfare issues related to certain chemicals. In addition according to the Michelson Grant, an ideal procedure would produce infertility in both males and females, and in both dogs and cats (<http://www.michelsonprizeandgrants.org>). Although this is a dynamic area of investigation, most current products still require complete clinical reproductive examinations by veterinarians prior to use. Currently available non-surgical methods of fertility control can be broadly classified as either sterilants or contraceptives.

Chemical approaches to control reproduction use the immune system to cause permanent infertility by damaging the reproductive organs. Current methods of chemical sterilization have largely been limited to intratesticular injections of chemicals into the testes, epididymis or vas deferens that destroy both the somatic and germ cells causing testicular sclerosis and azoospermia

(ACC&D, 2013). As circulating testosterone levels are not always significantly affected by these treatments, sexual behaviour and secondary male behavioural characteristics may not be influenced (which is either beneficial or problematic depending on the purpose of sterilization). Several injectable sclerosing agents, including formaldehyde, chlorhexidine, minerals and oils, have been evaluated for use as chemosterilants (Cathey & Memon, 2010; Massei & Miller, 2013). For the most part, the potential use of these agents in companion animals has been limited by the tendency for variable individual results, and the potential for painful side effects. Currently the only fully tested and approved product, intratesticular administration of zinc gluconate neutralized by arginine, has shown promise as a chemosterilant in male dogs. The ideal product would target the reproductive system with minimal effect on other systems. For practical purposes it would utilize non-gender specific routes to optimize potential usage, while combining natural defenses and reducing objectionable sexual behaviours.

Under the trade name Zeuterin®, zinc gluconate neutralized by arginine created by Ark Sciences received US FDA approval in February 2014. For use in male dogs 3-10 months of age, it results in infertility by causing testicular atrophy and scarring within the seminiferous tubules after being injected into the testes (as per Ark Sciences, 2014). Reported to have a 99.6% efficacy with few reported side effects its use is limited to individuals who have received comprehensive training and certification through the company. The company currently has no immediate plans to pursue licensing within Canada (as per Ark Sciences, 2014). In the interim a few other agents are being explored that could have some feasibility. Calcium chloride is another intratesticular sterilant currently being trialled in various communities in Asia, however permanent success has not yet been witnessed without substantial complications or side effects (Massei & Miller, 2013). KU-AS-272 is an antispermatogenic/antioocytogenic agent, which has had remarkable effects in rats, but has not yet been fully studied in dogs or cats (Massei & Miller, 2013).

Options for contraception are based on hormonal treatments that briefly prevent conception, without affecting long term fertility. Available measures include the gonadotropin releasing hormone (GnRH) agonists and antagonists, immunocontraceptives, and the delivery of exogenous steroids (progestins and androgens) (ACC&D, 2013). Unfortunately, contraceptive agents for companion animals are not currently commercially available in Canada. In order to acquire them, an emergency drug release (EDR) must be completed, which requires providing a comprehensive explanation for their necessity (which is unfeasible for private clinics).

GnRH agonists and antagonists repress fertility by controlling release of the gonadotropin hormones follicle-stimulating hormone (FSH) and lutenizing hormone (LH) (Cathey & Memon, 2010). GnRH agonists, such as Deslorelin® (Europe and Australia) and Superlorelin® (USA), are frequently used contraceptives in companion animal medicine and downregulate GnRH receptors in the pituitary gland with persistent exposure, thus suppressing the release of LH and FSH (ACC&D, 2013). Yet, a phenomenon identified as the “flare-up” effect has been documented with these drugs, as they begin by stimulating the production of LH and FSH from the pituitary gland, prompting oestrus and ovulation (Trigg *et al.*, 2001). Moreover, due to low oral bioavailability parenteral administration is needed. Gonazon®, an injectable USDA wildlife vaccine is also being evaluated for use companion animals (Rubion *et al.*, 2006).

Meanwhile GnRH antagonists, such as Acyline, briefly stifle fertility by attaching to and blocking pituitary GNRH receptors, leading to downregulation (ACC&D, 2013). Unlike GnRH agonists, “flare-up” is not detected, however the cost and brevity of the contraceptive effects does not currently make these agents viable alternatives for population control programs.

The concept behind immunocontraceptives is similar to that of routine vaccination, using the body’s own immune system to induce the production of antibodies against specific targets in

the reproductive system, thereby suppressing fertility. Current targets of study include GnRH, the zona pellucida (ZP) cellular matrix and lutenizing hormone (LH) (Massei & Miller, 2013). To date, existing research in this area has been limited by variable responses and the need for repeated immunizations to maintain suppression of fertility.

Synthetic sex hormones progestins (such as Megestrol acetate, Proligestrone, Medroxyprogesterone acetate and Delmadinone acetate) and androgens (Mibolerone) are generally used to treat conditions and behavioural problems related to steroid sex hormones (Cathey & Memon, 2010). From the perspective of population management, exogenous administration of synthetic sex steroids (progestins and androgens) causes suppression of FSH and LH through negative feedback in response to elevated levels of the sex hormones in the bloodstream. The subsequent regulation in circulating levels of LH and FSH results in inhibition of reproductive function and suppression of fertility.

Unfortunately many of the contraceptive agents being considered for use in companion animals must either be compounded through human pharmacies or are only available on emergency drug release in Canada, requiring consistent access to knowledgeable and approachable veterinarians. This has notable challenges for implementation within indigenous communities. As well, the propensity for significant side effects such as mammary neoplasia, pyometra and diabetes after prolonged administration or high dosage rates, have limited their practical use in population management to date.

There are a few other areas of research that might yet yield results. These include gene-silencing techniques such as genomics and proteomics (which turn off genes by using small interfering RNA molecules), GnRH-regulators Kisspeptin and GnIH, and the use of essential oils (cloves produce approximately 72–90% eugenol which causes degenerative changes in reproductive tissue after injection) (Cathey & Memon, 2010; Massei & Miller, 2013). Unfortunately, the use of non-surgical methods in Canada is still restricted by price, the need to be repeated and the welfare issues related to certain chemicals. Though this area of research is constantly changing and under investigation, the greatest drawback to widespread use and implementation in remote communities is the ongoing requirement for clinical reproductive examinations by veterinarians prior to use.

### 2.2.2 Dog Bites and Disease Transmission

While the epidemiology of and risk factors surrounding dog bites has been intensively studied and discussed since Parrish *et al.*'s 1959 Pittsburgh, PA study, very little has been definitively established. Specific risk factors have been presented repeatedly as fact over the last several decades (e.g. non-Caucasian, male children under the age of 10 were more likely to be bitten; victims under the age of 10 were more likely to be bitten on the head and neck compared to adults who were more likely to be bitten on the extremities; victims were more likely to be bitten at home or by a known dog; intact dogs were more likely to attack compared to sterilised dogs). Yet each of these risk factors has been found to be insignificant or at odds with the results of at least one recent study (Feldman *et al.*, 2004 (victim race); Lunney *et al.*, 2011 (victim sex); Vargo *et al.*, 2012 (victim age); Patronek *et al.*, 2013 (victim relationship to dog); Alabi *et al.*, 2014 (anatomical location of bite); Casey *et al.*, 2014 (intact dogs have same risk as neutered males)). This is likely due in part to the low rates of reporting for minor bite wounds. However educational, behavioural and environmental factors may also carry significant weight. These elements include knowledge of appropriate dog:human interactions and dog warning signs, the percentage of

roaming dogs within a community, and whether the community is urban or rural/remote (Clarke & Fraser, 2013; Dixon *et al.*, 2013; Dupperex *et al.*, 2009; Gilchrist *et al.*, 2008; Raghavan, 2008).

If little is understood regarding the epidemiological features of dog bites, even less is known about the rate of reporting for dog bites amongst indigenous populations, nor within First Nations communities. While it is known that dog bites are notoriously underreported in all environments, the exact number of hidden events is undetermined. However, it is suspected that aggressive encounters are higher per capita within Indigenous communities compared to urban environments. High numbers of aggressive encounters can lead to (at minimum) significant long term emotional and physical distress due to the psychological repercussions of post-traumatic stress.

Another potential issue for lack of reporting, is the subsequent scarcity of knowledge regarding bite-transmitted infections. Rabies causes a fatal viral encephalitis in a comprehensive range of mammals, including man. Once clinical or syndromic signs develop, it is consistently fatal with no reliable cure. In the developed world, the infection is now controllable and wildlife vaccines have eliminated the disease in some areas, resulting in a rabies-free classification for some countries. While Canada is considered to be free of the canine variant strain of rabies, it is endemic in wildlife, with the skunk, fox, bat and raccoon strains being most commonly identified. Unfortunately little is known regarding the potential viral loads in the northern half of Saskatchewan due to lack of surveillance and low human population density.

Multiple infectious agents have also been isolated from dog bite wounds; generally *Staphylococcus* spp, *Clostridium* spp or *Pasteurella* spp. However, a complete list of potential bite contaminants has never been completed, nor is there adequate information regarding the prevalence of dog bite infections subsequent to dog bites. Therefore there is a complete lack of knowledge with regards to the rate and specificity of infections compared to aggressive encounters in general, and explicitly within Indigenous communities.

## 2.3 Knowledge Translation and Exchange

CBPR and successful knowledge translation and exchange (KTE) (also referred to by some experts as simply knowledge translation (KT)) are closely linked in methodology. Engaging and empowering KTE maintains the partnerships and dialogues researchers and communities have created throughout their work together, as it involves all of the stages between project creation through data collection, to information dissemination, and finally knowledge dissemination (Macaulay, 1999; Macaulay & Nutting, 2006). The Canadian Institutes for Health Research (2012) identifies multiple strategies that are consistent with a community-based approach: communication, education, exchange, and improvement initiatives. The CIHR (2012) definition of KT closely resembles the framework previously used for CBPR:

*"Knowledge translation (KT) is defined as a dynamic and iterative process that includes synthesis, dissemination, exchange and ethically-sound application of knowledge to improve the health of Canadians, provide more effective health services and products and strengthen the health care system - knowledge transfer, knowledge mobilization, knowledge exchange, implementation, and translational research."*

Meanwhile, the World Health Organisation (2005) considers KTE a bridge to use between “*knowing*” and “*doing*”. By creating a route that decision-makers can follow through the research results, data analyses, and final interpretations, findings can be used to inform health change and policy creation. For this reason, as data and results have become available, they are immediately

shared with the project collaborators in each community through conversations, written reports and diagrams. Their assistance in interpreting meaning is invaluable, and frequently guides the progression of research.

It must be emphasised that for indigenous communities, positive KTE is often determined by a thorough and open awareness of the cultural ways of knowing and sharing within the community (Estey *et al.*, 2008; Smylie & Anderson, 2006; Smylie *et al.*, 2006). The routes to learning may be many, and for indigenous groups they are intrinsically linked with knowledge of health, environment, culture and survival (Kaplan-Myrth & Smylie, 2006; Smylie *et al.*, 2009).

Therefore, for knowledge translation strategies to be successful in indigenous communities, they must incorporate past learning and wisdom within the context to which new information will be applied. Methodology must also be inclusive of all members of the community and respectful of traditional learning styles (Hanson & Smylie, 2006; Smylie *et al.*, 2004). Each individual within the community holds different knowledge: women to men, adults to children, family to family. These ideas are diverse and develop from different life experiences and ‘ways of seeing’. For this reason, the knowledge circles of First Nations peoples are often depicted as ecologic, universal, interconnected, multicultural, wholistic, eternal, boundless, collective, spoken and narrative-based (Castellano, 2000; Shiva, 2000; Stamler, 2010). All of this information is valuable to the continuous wellbeing of the community. Knowledge is considered to be shared generously and honestly, and must be respected by each individual who hears it.

To this end, Canadian researchers and Aboriginal communities have begun incorporating a model of information collection known as “Two-Eyed Seeing”. A term coined by Mi’kmaw Elder Albert Marshall (2004), Two-Eyed Seeing (TES) allows for tribal consciousness to integrate physical knowledge and spiritual wisdom with new methods of scientific research and data collection (see Figure 2.4). By combining these two aspects of evidence together, indigenous communities are able to reconnect with their culture and study health issues in a manner that allows for greater ownership and participation in all levels of systems identification, study designs and problem management. TES therefore creates a more equitable, collaborative and sustainable means of involvement for all partners. For maximum respect within research, this project has made every attempt to incorporate this accepted wisdom. For as Elder Marshall says:

*“...Two-Eyed Seeing is hard to convey to academics as it does not fit into any particular subject area or discipline. Rather, it is about life: what you do, what kind of responsibilities you have, how you should live while on Earth ... i.e., a guiding principle that covers all aspects of our lives: social, economic, environmental, etc. The advantage of Two-Eyed Seeing is that you are always fine tuning your mind into different places at once, you are always looking for another perspective and better way of doing things...*

*... When you force people to abandon their ways of knowing, their ways of seeing the world, you literally destroy their spirit and once that spirit is destroyed it is very, very difficult to embrace anything – academically or through sports or through arts or through anything – because that person is never complete. But to create a complete picture of a person, their spirit, their physical being, their emotions, and their intellectual being ... all have to be intact and work in a very harmonious way.”*  
(Marshall, n.d.)

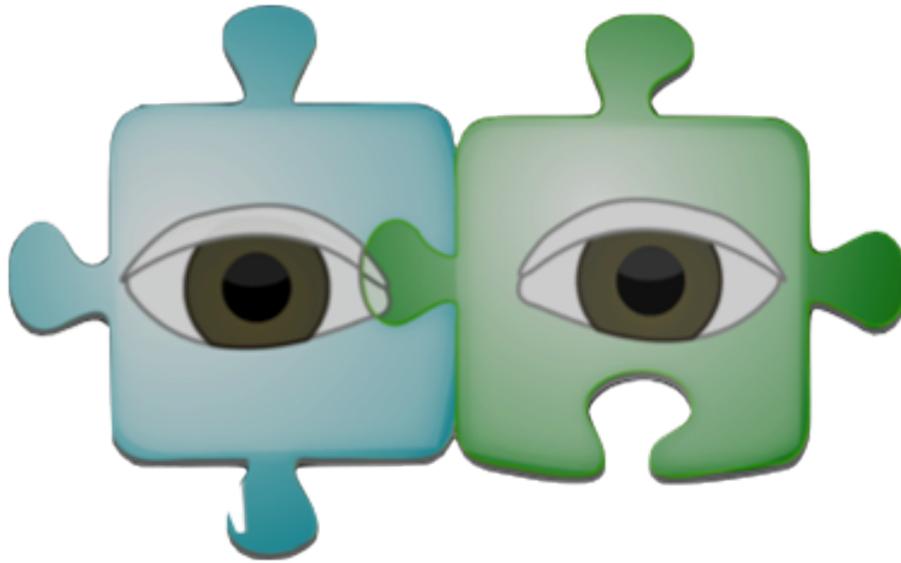


Figure 2.4 – Institute for Integrative Science & Health's depiction of Two-Eyed Seeing based on Elder Marshall's comment that “two jig-saw puzzle pieces help remind us that, with respect to Aboriginal Traditional Knowledges [Indigenous knowledges], no one person ever has more than one small piece of the knowledge”

## 2.4 Conclusions

Currently very little is known about the prevalence of dog bites or the demographic characteristics of the dog populations within indigenous Canadian communities. Nor have most communities undertaken significant means to control or prevent dog issues. However there is a certainty and an acceptance that health is about more than numbers, charts or medical results. The interweaving of the connection to the community's history, culture and wellbeing of all living things within the environment directly shapes an individual's strength and wellness. Unfortunately, traditional research rarely aptly portrays or encompasses these wider standards of health. For this reason, collaborative efforts using scientifically based “traditional” research, and community-based dissemination of wisdom must be melded and incorporated for realistic, sustainable community-driven programs to be successful. Without the positive use of Two-Eyed Seeing, appropriate and respectful knowledge translation of relevant, helpful information can often be lost and without context.

### ***Relevance to thesis***

*The scoping review which follows was completed in order to inform not only the study design used within the communities, but also to gauge the level of knowledge and understanding of the epidemiology surrounding the risk factors leading to dog bites and possible prevention interventions. An additional question was the feasibility and success of diverse dog population management practices that might be utilised within remote communities.*

*This paper is being submitted as four separate journal articles 1. Epidemiology of dog bites, 2. Dog population management strategies, 3. Dog bite sequelae, and 4. Dog bite interventions.*

## **Chapter 3 Scoping Review**

*“Everybody gets so much information all day long that they lose their common sense. They listen so much that they forget to be natural.”*

*Gertrude Stein, Reflection on the Atomic Bomb, 1946*

### **3.1 Background**

Dogs and dog:human interactions are not new to communities in Canada or around the world. Dogs have held an ongoing important role in Aboriginal culture for centuries. Unfortunately in many Canadian communities, as the roles of dogs changed from working animals to general companions, so too have the knowledge and traditions surrounding care, welfare and management. In some situations this has led to large populations of unrestrained, poorly socialised roaming dogs. Multiple studies have hypothesised that communities where groups or packs of free-roaming dogs (FRDs) are largely uncontrolled and unrestrained suffer higher numbers of dog:human aggressive encounters, bites and human fatalities (Kongkaew *et al.*, 2004; Lunney *et al.*, 2011; Raghavan, 2008; Wright, 1990). Though there have been few studies considering dog bite risk levels in North American Aboriginal communities, it is documented that First Nations peoples are at increased threat of aggressive encounters (Castrodale, 2007; Raghavan, 2008; Russell *et al.*, 2001).

Given social, economic, physical and psychological consequences of dog bites are often devastating for both individuals and the community fabric, a comprehensive understanding of the epidemiology of dog bites within the ecology of semi-feral and free-roaming dog populations is critical for Aboriginal policy makers in remote or rural locations. Unlike urban environments where the majority of dog bites generally occur by “known” dogs, communities with large free-roaming dog populations have a tendency towards greater percentages of bites by unknown animals (Lone *et al.*, 2014). Therefore recognition of potential population management and disease control interventions provides means to address the concerns and viewpoints of various collaborators thereby improving the success and efficacy of anticipated approaches (Lembo *et al.*, 2011). Creating a background of knowledge regarding the behaviour of FRDs, and positively received

community programs will ultimately also increase public acceptance of proposed strategies and interventions (Ratsitorahina *et al.*, 2009).

The literature and increasingly the World Wide Web can be significant sources of information regarding dog bites, dog population management and dog-bite related zoonoses. Evidence is frequently explored not only by academics, but also by policy makers, medical and public health officers, as well as members of the general public, in an effort to understand, contain and prevent canine behaviours and problems. Given the potentially immense amount of relevant and extraneous data, a scoping review is required to chart the research and non-research related material that is available on these topic areas, and to identify knowledge gaps in critical problem areas. Veterinarians, health officials, policy makers and the public must be on the same page in order to ensure that interventions are sustainable and agreeable to everyone influenced. Without a full understanding of exactly what individuals are seeing and reading, there is little chance that common ground can be forged when potentially emotionally charged issues occur and decisions must be made. With the wealth of information that is available, specific reference to the effectiveness of these methods will be sought with a focus on semi-feral and free roaming dogs.

During the last decade, “evidence-informed decision-making in public health” has integrated best available evidence to inform public health policy and practice (Kohatsu *et al.*, 2004; NCCMT, 2012). Evidence is not just limited to scientific literature, but encompasses community perceptions, concerns and needs as well as public health resource capacity (NCCMT, 2012). In the human health field, scoping reviews have been described and used to investigate broad and complex problems (Anderson *et al.*, 2008). Colquhoun *et al.* (2014) defined this type of study as

*“... a form of knowledge synthesis that addresses an exploratory research question aimed at mapping key concepts, types of evidence, and gaps in research related to a defined area or field by systematically searching, selecting, and synthesizing existing knowledge.” (p 1291)*

Scoping studies are similar to systematic reviews in their rigorous and transparent methodology but differ in that scoping reviews are guided by the requirement to identify and collate all relevant literature and information regardless of study design or scientific peer-review process (Arksey & O'Malley, 2005; Davis *et al.*, 2009; Levac *et al.*, 2010). The end result is a method to identify gaps, as well as summarize and disseminate findings for broad topic areas where limited possibility exists for meta-analysis. Most policy makers and locally elected representatives do not have significant experience reading peer-reviewed scientific literature, relying instead on recommendations from available ‘experts’, experience from similar nearby communities, or knowledgeable websites. Identifying the pertinent, influential and accessible resources provides an outline and understanding regarding how communities create policies and make health legislation choices.

There are two broad objectives in conducting this scoping review. First, it is important to chart the research and non-research related information that is available on dog bites and attacks, dog population management, dog bite prevention and zoonotic pathogen transmission and elimination (see Figure 3.1). Having a grasp of the successful methods being used in different jurisdictions can potentially inform recommended policy, without the need for extensive local trial and error. Secondly identifying any evidence of these methods in maintaining or reducing dog populations in rural and remote communities in other areas will provide a backbone on which to build a sustainable population management plan. In addition, there was interest in identifying any evidence that unequivocally showed these methods have a notable, supportable impact on the incidence of dog bites within these communities. Overall it is crucial to compile information

allowing for dissemination of the best available evidence to concerned partners, enabling the creation of sustainable and informed public health decision making.

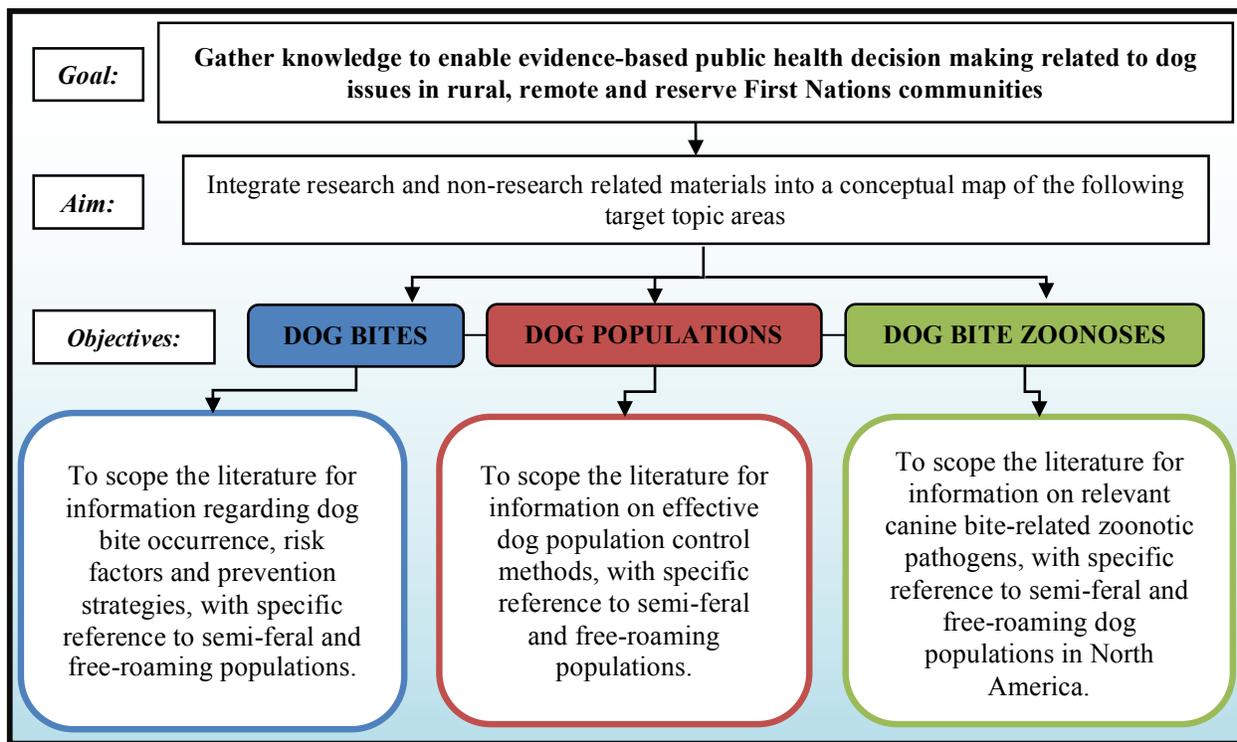


Figure 3.1 – Goals, aims and objectives of a scoping review on the epidemiology and potential interventions of dog bites and dog population management

## 3.2 Methods

Using adaptations of the basic steps presented by Arksey and O'Malley (2005), and Landa *et al.* (2011), this study conducted a scoping review using a critical realist stance within the following framework to identify relevant available information regarding the epidemiology of dog bites, interventions to prevent dog:human aggressive behaviour, and dog population management:

- a) Identification of the region of evidence to be mapped
- b) Definition of the boundaries of relevant material
- c) Search of the literature databases and the internet
- d) Charting of the literature found in a narrative framework
- e) Collation, summarization, and dissemination of a comprehensive mapping of the information to various stakeholders (including consultations and evidence-informed decision support at the local community and broader government levels)

To be comprehensive, a scoping review is required to search several literature sources. After consultations with librarians at the University of Saskatchewan, the Canadian Health Libraries Association and the Indigenous Peoples' Health Research Centre, an initial searching design was established, including databases, searching features (such as selection of keyword requirements, appropriate MESH terms, wildcard functions, etc.); and user-friendly platforms (see

Appendix B). Multiple search methods were employed by the researcher to collect citations, including exhaustive electronic database searches, exploring the bibliographies and reference lists of key articles, relevant reviews, trials, existing networks/websites, relevant organizations, and conferences, and incorporation of the recommendations of experts on dog population management, dog bite prevention, and dog population planning with indigenous communities. Resources were approached in numerous steps, first considering electronic literature databases. After pertinent material was selected appropriate websites, URLs, and references from key sources were examined to increase capture of key material. In order to ensure consistency, the researcher designed and executed precise search approaches, which required considerable time due to the magnitude of references.

### 3.2.1 Peer-Reviewed Printed Literature

#### 3.2.1.1 Search Strategy

Given the potential breadth of terminology that might have been used to describe the relevant articles, two research questions were initially chosen to focus the peer-reviewed literature search based on an initial scan of preeminent articles: a) “*What is the epidemiology surrounding dog bites?*” and b) “*What interventions could best be used to prevent dog bites?*”. As the objective was to perform a sensitive exploration of the literature rather than a specific one, broad lists of keywords were created using five thesauri (Encarta, Roget’s, Collins, Wordsmyth and MacMillan).

Initial exploratory searches including First Nations, indigenous or Aboriginal populations as a variable yielded fewer than 50 articles for input into Level 1. As a result, the scoping questions were simplified and omitted that defining categorization. Search strings were established and run through the nine selected databases (PubMed, MedLine, Web of Science, Biosis, Embase, OIE Database, CAB Abstracts, Agricola, and Animal Behaviour – see Appendix B) to obtain references containing elements of the search strings within the title, abstract or keyword fields.

A minimum of two search runs were performed at least one day apart per database, and requiring a search ‘hit’ of total retrieved articles to be within 0.1% to ensure statistical reliability and reproducibility. Once a stable number of references was obtained from a database, references (including abstracts when available) were saved into EndNote X6 (EndNote X6, Thomson Reuters, New York, NY, USA) prior to being uploaded into DistillerSR (DistillerSR, Evidence Partners, Ottawa, Canada).

The total number of articles initially collected prior to deduplication was N=23,716. Deduplicating was completed by the researcher twice in Endnote, once in DistillerSR, and twice by hand in Microsoft Excel 2010, resulting in a total of N=11,768 articles to be used in Level 1 in November 2012. This management software was of considerable value; the sheer volume of references would have been nearly impossible to work with, share and manage without it.

#### 3.2.1.2 Inclusion Criteria

Inclusion and exclusion criteria were developed by the researcher and the researcher’s primary supervisor, and applied to each level of analysis. The original sensitivity of the search strings resulted in a large number of irrelevant articles being rejected at the title level (Level 1). Using DistillerSR as a review database for article selection, the researcher was responsible for

screening articles at the title level using basic inclusion criteria determining relevance to the study (see Appendix B).

Once title screening was completed, abstract screening and article screening levels required both the researcher and the researcher's supervisor to assess inclusion criteria (see Appendix B). Articles required the agreement of both observers to be excluded. If disagreement occurred, articles were reassessed independently. There were no cases in which secondary assessment did not result in consensus. For articles to pass through the abstract screening level (Level 2) they required the following: that the article was written in 1985 or more recently, and a) that the article applied to any of the key questions, OR b) that the article contained information regarding EITHER of the key topics (see Appendix B).

For references to be included in the scoping review at the article screening level (Level 3), they had to be written in English, French, Spanish, Portuguese, Hebrew or German (languages read by the reviewers), and discuss dog bites, dog population management or dog behaviour (see Appendix B).

At this stage articles were kept for reference but not included in the scoping review unless they were original research, a case report, or a topically relevant systematic review. Articles were excluded from the review if they were incomplete conference proceedings, commentaries, editorials, letters to the editor, or non-systematic reviews. Studies were not excluded due to study design, methodological rigour, or methods of data analysis.

At this time it was noted that a significant number of the articles were directed towards rabies elimination. While these studies were of interest, and often contained relevant information, not all of the concerns would be similar to those in Canada, due to differences in rabies risk factors. Therefore a quick inspection was completed to determine the number of articles which focused specifically on rabies (Level 4).

### 3.2.1.3 Timing and Data Extraction

Initial searches were completed November 4<sup>th</sup>, 2012. Due to the length of time required for the peer-reviewed component of the scoping review to be completed, additional searches were completed on January 15<sup>th</sup>, 2013 and April 30<sup>th</sup>, 2014. In August 2014 it was also found that a number of relevant articles (N=18) had been lost during data transfer or deduplicating in DistillerSR. These updates and corrections added an additional 78 journal articles, bringing the total number of articles to be used in the scoping review (after article and type screening) to N=920.

All articles were briefly reviewed, and key topics and findings were summarised by a minimum of two reviewers. These articles and their corresponding data were separated into study types and charted in Microsoft Excel 2010. Articles were then thoroughly assessed for subject matter, themes, novel information and evidence using a standardised data extraction form (see Appendix B). Key information and details were summarised and enumerated independently before being compared between observers. Reviewers met regularly between February 1<sup>st</sup>, 2013 and October 31<sup>st</sup>, 2014 to discuss progress and discrepancies in observations. In situations of disagreement, articles were discussed in order to reach consensus.

From this group of 920 articles, a subset of 500 articles was randomly chosen to be uploaded into NVivo 10 for Windows (QSR International) to undergo rigorous, detailed thematic analysis and data queries (themes examined listed in Table 3.1). These articles were of necessity in English due to the limitations of the program, which resulted in a subset of N=445.

The articles found to include the major themes were then streamed through cluster analysis (using a Pearson correlation coefficient) to identify common subtopics and recurring concepts. The top 200 words of three letters in length or longer were kept after insignificant hits were discarded (i.e., numbers, articles such as ‘the’, pronouns such as ‘she’, conjunctions such as ‘and’, etc.). The results of the thematic analysis were then compared to those identified previously by the researchers to confirm the validity and reliability of the data recorded. Subsequently, articles were grouped into thematic categories (Level 5) for ongoing purposes.

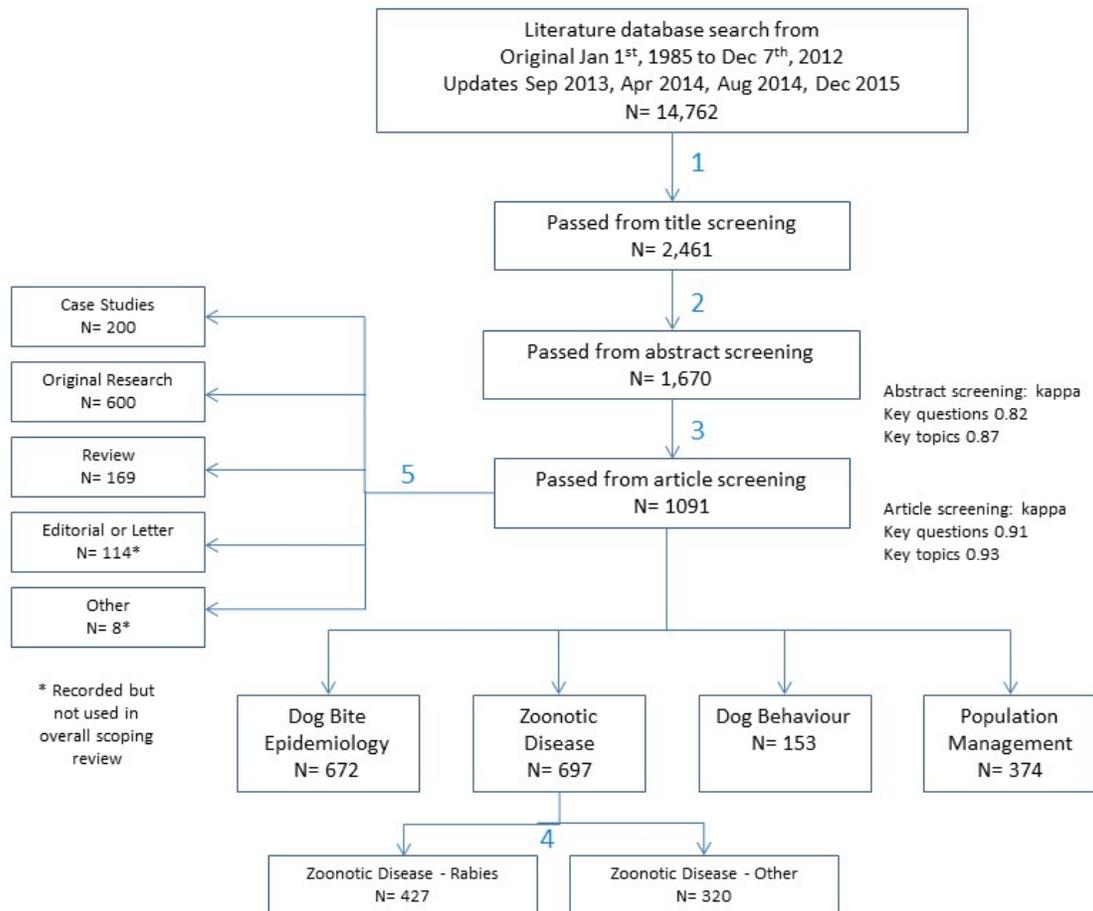


Figure 3.2 – Final flow of peer-reviewed material ending December 2015  
(numbers in blue indicate inclusion level)  
(numbers within topic categories do not equal N=1092 as most articles discussed more than one relevant topic, and were included in both categories)

### 3.2.1.3.1 Final Update

In November 2015, during attendance at the 14<sup>th</sup> International Society for Veterinary Epidemiology and Economics conference held in Mérida, Mexico, it was discovered that several potentially critical dog-bite risk factor defining research articles had been published the month prior. Although the scoping review was in its final stages of completion, it was decided one last update was required. During the first search run of the original nine databases (PubMed, MedLine,

Web of Science, Biosis, Embase, OIE Database, CAB Abstracts, Agricola, and Animal Behaviour), it was discovered that an additional 10 journal articles had been missed during the original searches.

To ensure a complete and exhaustive compilation, the database search was widened to include 22 more databases (Academic Search Complete, African Healthline, Allied Health Evidence, Centrewatch, CINAHL, The Cochrane Injuries Group's Specialised Register, Controlledtrials.com, ERIC, Free Public Health Databases, GIDEON (Global Infectious Disease Epidemiology Online Network), National Research Register, LISA (Library and Information Science Abstracts), Library Literature and Information Science, LILACs, PsycInfo, Science Citation Index, SIGLE, Social Science Citation Index, SPECTR, Vetgate, the WHO database, and Zetoc) to reduce the possibility of additional missed articles. In addition, three search runs were performed at least one day apart per database, requiring a search 'hit' of total retrieved articles to be within 0.1% to ensure statistical reliability and reproducibility. These additional searches were completed December 15<sup>th</sup>, 2015.

This update resulted in an additional 172 journal articles passing to Level 5 of the screening process, bringing the total number of articles to be used in the scoping review (after article and type screening) to N=1091 (see Figure 3.2). As per the original methodology, articles were overviewed, and key details were synthesised by two reviewers and entered into Microsoft Excel 2010. The newest articles were then compared to the subset of 445 that had previously been analysed with NVivo 10 for Windows (QSR International) to ensure that common subtopics and recurring concepts had remained consistent.

## 3.2.2 Web-Based Information and Grey Literature

### 3.2.2.1 Search Strategy

Grey literature has previously been described as “information produced on all levels of government, academics, business and industry in electronic and print formats not controlled by commercial publishing i.e., where publishing is not the primary activity of the producing body.” (ICGL Luxembourg definition, 1997. Expanded in New York, 2004). However, because of the speed with which internet communication is changing communications such as emails, blogs, and podcasts produced by reputable “specialists” such as researchers, scientific non-profits/charities (e.g. World Wildlife Fund, Heart and Stroke Foundation), universities, government departments, ‘experts’ (e.g. Dr. Oz) and special interest groups (e.g. Mothers Against Drunk Driving) are often included as grey literature (HLWIKI, 2016). Therefore for this review, grey literature was considered to be any alternative, non-peer-reviewed or non-mainstream inquiries, or material widely available to the general public via the internet.

Grey literature was searched, considering both online information and non-peer-reviewed publications. Consultation with community liaisons, non-government organisations and non-academic collaborators created an understanding of what interested parties would be likely to search, retain, and read. From these discussions lists of search terms, databases and material designs were established for use and evaluation of relevancy, usability and attainability.

A preliminary search was first conducted by using Google ([www.google.ca](http://www.google.ca)), Yahoo ([www.ca.yahoo.com](http://www.ca.yahoo.com)), and Bing ([www.bing.com](http://www.bing.com)) in order to compile a list of appropriate websites using the search term “dog”. A minimum of two search runs were performed at least one day apart

per database, recording the top 100 retrieved “hits”, and requiring a search ‘hit’ of total retrieved articles to be within 0.1% to ensure statistical reliability and reproducibility.

After recording these sites, a more thorough search was conducted, using the keywords “dog bite”. The first non-duplicated 100 links were downloaded between Aug 6<sup>th</sup> and Aug 22<sup>nd</sup> 2013 using Google ([www.google.ca](http://www.google.ca)) (Aug 6<sup>th</sup>, 8<sup>th</sup> and 15<sup>th</sup>), Google Scholar ([www.scholar.google.ca](http://www.scholar.google.ca)) (Aug 15<sup>th</sup>, 16<sup>th</sup> and 17<sup>th</sup>), Yahoo ([www.ca.yahoo.com](http://www.ca.yahoo.com)) (Aug 18<sup>th</sup>, 19<sup>th</sup> and 22<sup>nd</sup>) and Bing ([www.bing.com](http://www.bing.com)) (Aug 18<sup>th</sup>, 19<sup>th</sup> and 22<sup>nd</sup>). The search term “dog population” was also run the same days. The terms “dog management”, “dog aggression”, and “dog behaviour” were run Aug 27<sup>th</sup>, 30<sup>th</sup> and Sept 2<sup>nd</sup> 2013. The top 100 links for each search term were examined and relevant new ones included, while duplicates were discarded.

Between Sept 12<sup>th</sup>, 15<sup>th</sup>, and 21<sup>st</sup> 2013, all of the above terms were run through Scopus (<http://www.scopus.com/>), the Canadian Government Depository services catalogue (<http://publications.gc.ca/site/eng/ourCatalogue.html>), the National Library of Canada Electronic Collections (<http://www.collectionscanada.gc.ca/electroniccollection/>) and the Government of Canada Web Archive (<http://www.bac-lac.gc.ca/eng/discover/archives-web-government/Pages/web-archives.aspx>). Only 2 additional linking articles were found. Nor were additional articles found during multiple searches of Open Grey ([www.opengrey.eu](http://www.opengrey.eu)), the Grey Literature Report (<http://www.nyam.org/library/greyreport.shtml>), PapersFirst (<https://www.oclc.org/support/services/firstsearch/documentation/dbdetails/details/PapersFirst.en.html>), ProQuest Dissertations and Theses (<http://proquest.libguides.com/pqdt>), University of York Health Technology Assessment (HTA) (<http://www.crd.york.ac.uk/crdweb/>), University of Laval KUUC Knowledge Utilization Database (<http://kuuc.chair.ulaval.ca/english/index.php>), and WorldCat (<https://www.worldcat.org/>) from Sept 12<sup>th</sup>, 14<sup>th</sup> or 22<sup>nd</sup> 2013.

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### 3.2.2.2 Inclusion and Timing

Combining all searches resulted in a full list of 601 links to articles, websites, videos or blogs. It should be noted that some of the articles (N=31) were peer-reviewed journal articles that had been missed during the comprehensive database searches; for reliability, these were kept as grey literature search results but also thoroughly analysed as per peer-reviewed literature.

After deduplication 584 links remained. The next step removed websites for law or insurance companies, leaving 570 links. These were investigated systematically for information, including organisation reports, research papers, publications, and ‘expert’ recommendations and opinions. Investigations started by assessing the site map and search tools when possible. For websites without these tools, a more in-depth scrutiny and analysis of all site pages was undertaken.

As with the peer-reviewed literature, a screening process was used to determine inclusion. The initial screening question run between October 12 to 15<sup>th</sup>, 2013 first asked “*Does this site have anything to do with dogs?*” which removed 21 links. The second question asked “*Is this site relevant to the present study?*” which removed an additional 243 links. In addition, 14 sites were unavailable and 4 were found to be duplicated information. Websites, videos and blogs were kept if they seemed likely to be read or used as references by members of the public searching for information on one of the five search topics. After initial screening 288 links remained for topic screening.

Due to the length of time required for the scoping review to be completed, additional searches were completed in July, 2014. The second set of searches began on July 14<sup>th</sup>, 2014. The term “dog bites” was run July 14<sup>th</sup>, 15<sup>th</sup> and 17<sup>th</sup>, 2014. The first 100 links on Google

(www.google.ca), Google Scholar (www.scholar.google.ca), Yahoo (www.ca.yahoo.com) and Bing (www.bing.com) were compared to the previously compiled list from 2013. Similarly, the terms “dog population”, “dog management”, “dog aggression”, and “dog behaviour” were put through the same process on July 18<sup>th</sup>, 19<sup>th</sup> and 20<sup>th</sup>, 2014.

The new links were kept (204), while duplicates to 2013 (322), identical pages for 2014 (1099) or completely irrelevant links (e.g. music or movie websites, sites regarding prairie dogs, cancer or wild African dogs) (375) were noted but did not move through to initial screening. Links to law or insurance companies (18 included in the 375 irrelevant links) were also removed prior to initial screening unless there was a dedicated page that appeared helpful in dispensing important information on one of the five search topics. Once the preliminary sorting process was completed, an additional 177 links were included in the initial screening process developed for grey literature. Of the 177 links included in the initial screening for 2014, 112 passed into topic screening.

All of the previous terms were also run several times through Scopus (<http://www.scopus.com/>), the Canadian Government Depository services catalogue (<http://publications.gc.ca/site/eng/ourCatalogue.html>), the National Library of Canada Electronic Collections (<http://www.collectionscanada.gc.ca/electroniccollection/>), the Government of Canada Web Archive (<http://www.bac-lac.gc.ca/eng/discover/archives-web-government/Pages/web-archives.aspx>) and Open Grey ([www.opengrey.eu](http://www.opengrey.eu)) on July 21<sup>st</sup>, 22<sup>nd</sup> and 23<sup>rd</sup>, 2014. No additional links were found during these searches. Initial consideration of the links during the topic screening process further eliminated another 118 sites due to broken links, minimal relevance to the study questions or restricted public access. Therefore, all updates and comprehensive screenings resulted

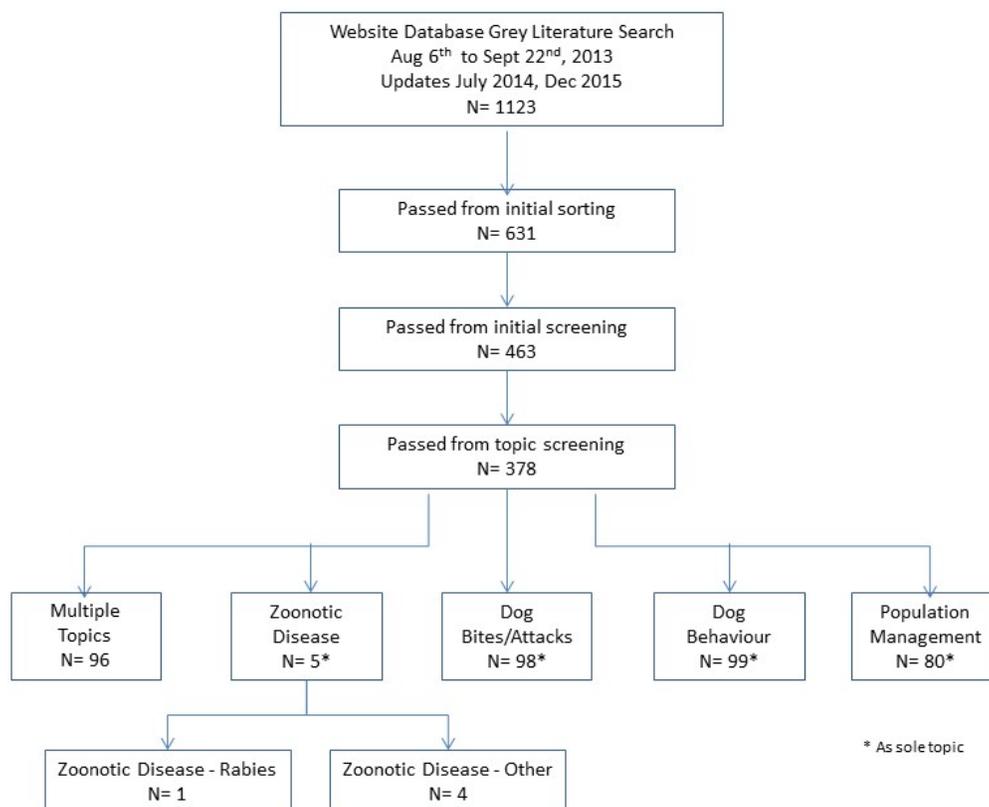


Figure 3.3 – Final flow of grey literature through the scoping review into categories as of December 2015

in the total number of sites to be used in the grey literature section of the scoping review to be N= 282 in July 2014. All relevant websites were then comprehensively examined for subject matter, themes, novel information and evidence by at least two reviewers. Key topics and findings were then summarised and charted in Microsoft Excel 2010.

As with the peer-reviewed literature, an additional update was required of the grey literature. This update was also completed on December 15<sup>th</sup>, 2015 and resulted in an additional 96 sites to be included within the topic screening (see Figure 3.3).

### 3.2.3 Synthesis and Summation

As the initial research questions were appropriately extensive in design, breadth and scope, a large volume of literature and information was amassed, producing more than 1000 peer-reviewed journal articles, and almost 400 pieces of grey literature for Level 5 classification and examination. Findings were categorised into specified sections and topic areas based on themes likely to be relevant for policy makers and community advisors, and the results were more closely scrutinised. Following these categories identified details not previously considered during the screening process, and allowed for a flexible framework in which to describe the literature. Mindful however of the original purpose of this review and research (to identify methods which could potentially be successful in northern remote and rural indigenous communities in Canada), further reflection was needed.

Deliberating on Daudt *et al.* (2013) recommendations on rigorous examination of outcomes, the following questions were asked:

*What results do the scoping articles provide? In particular, do they inform indigenous Canadian populations on successful methodologies for preventing dog bites and controlling dog populations?*

*Would these methods be implementable within indigenous communities?*

*What can be truly said regarding the data?*

*Did the scoping search provide all of the information that was needed?*

*Have all needs and rationales been appropriately captured during discussions with partners?*

After close inspection, it became apparent that although much of the data were valuable, not all of it would be applicable or pertinent to Aboriginal communities with different environmental or cultural issues (e.g. specificities of dog control economics in major urban centres). In addition the information or recommendations found in many of the articles, literature and websites could potentially run counter to the perspectives and belief systems of the very communities being engaged.

This realisation led to the addition of another level (6) to the scoping review in which the following additional questions were used for inclusionary/exclusionary categorisation for both peer-reviewed and grey literature (Figures 3.4 and 3.5):

*Is the information contained in this communication (article, publication, website, etc) relevant for indigenous communities in Canada? OR Is this material likely to be available and of interest (or usage attempted) by the general public within indigenous communities in Canada?*

As the initial community engagement sessions were occurring simultaneously to the scoping review, consistent consultation was possible throughout the project on necessary and desired information. It was also possible to determine how available literature and communications resonated with community members and policy makers. It was consequently believed that the review process was as extensive, meticulous and accurate as could be viable.

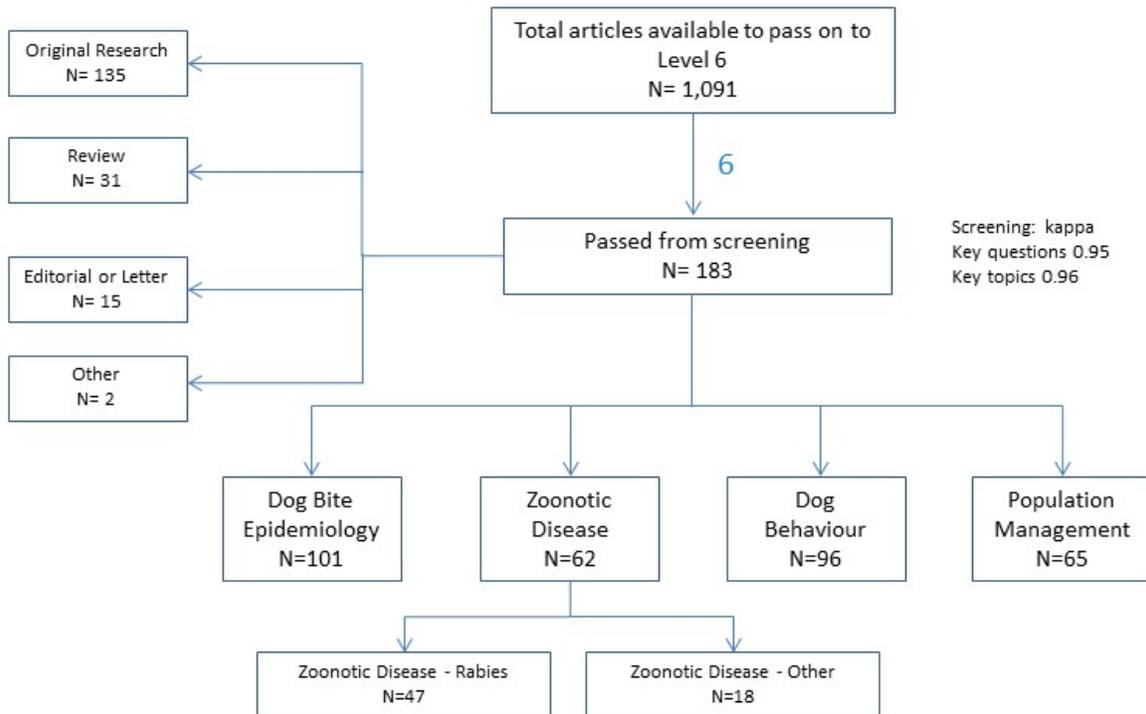


Figure 3.4 – Flow diagram of peer-reviewed articles showing relevance to indigenous Canadian communities

*(numbers within topic categories do not equal N=184 as most articles discussed more than one relevant topic, and were included in both categories)*

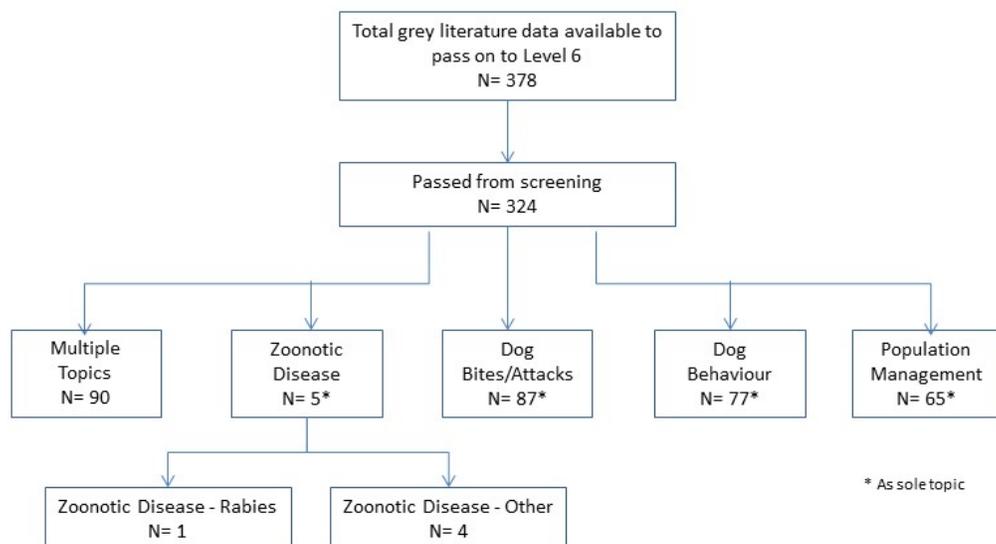


Figure 3.5 – Flow diagram of grey literature data showing relevance to indigenous Canadian communities

### 3.3 Results and Discussion

#### 3.3.1 Level 5

Of the original 1091 peer-reviewed journal articles, N=200 were case studies, N=600 were original research, and N=169 were relevant systematic reviews. The other 122 were editorials, commentaries, conference proceedings and letters. The majority of the original research included some discussion of bite epidemiology (N=524/600) regardless of what the focus topic was. All included journal articles from the peer-reviewed literature review may be found in Appendix B.

Table 3.1 – Major themes examined during thematic analysis of partial subset of screened journals

Theme	Major topic in article (N/445)	Topic percentage of articles	Search type	Search term
Aggression	291	65.4%	synonyms	aggress*
Bacteria	73	16.4%	stemmed words	bact*
Behaviour	131	29.4%	stemmed words	behav*
Bite	425	95.5%	synonyms	bite
Control	363	81.6%	synonyms and stemmed words	control*
Disease	370	83.1%	synonyms	disease
Epidemiology	286	64.3%	synonyms and stemmed words	epidemiology/epi*
Intervention	381	85.6%	synonyms	intervention
Population	321	72.1%	stemmed words	pop*
Prevention	396	90%	synonyms and stemmed words	prevent*
Rabies	286	64.3%	exact term	rabies
Risk (factor)	417	93.7%	stemmed words	risk*



Of the 378 grey literature hits, N=98 focused on dog bites or attacks, N=99 focused on dog behaviour and N=80 focused on population management, while N=96 focused on two or more topics. One website was strictly on rabies prevention, and four were lists of potential zoonotic diseases transmitted by dogs. All included journal articles and website links retained during the grey literature review may be found in Appendix C.

### 3.3.2 Level 6

Focusing the accumulated research eliminated 908 peer-reviewed journal articles and 54 pieces of grey literature (see Figures 3.6 and 3.7). That the original 1091 peer-reviewed papers, and 378 grey communications were narrowed to a specific set of 183 journal articles and 324 grey data, indicates the limited amount of literature that addresses the issues of dogs within indigenous communities or can potentially provide valuable information. Unsurprisingly fewer pieces of grey literature were able to be discarded due to their greater accessibility. Had these more stringent and restrictive inclusion criteria been preserved from the outset, it is unlikely that the daunting numbers of articles obtained would have been collected for analysis, however it is questionable that the full extent of the data acquired would have been achievable.

Of the 183 peer-reviewed journal articles that passed Level 6, N=135 were original research, and N=31 were relevant systematic or other reviews. It was decided that the 200 potential case studies were too specific to provide relevant information to communities, and that the information was available elsewhere, therefore they were eliminated. Fifteen commentaries and editorials, and 2 other non-categorised pieces were also included at this point, as it was likely that community members and policy makers could use these as a basis for further research and investigation. The list of included journal articles for Level 6 from the peer-reviewed literature review may be found in Appendix B.

Of the 324 grey literature hits that successfully passed to Level 6, N=87 focused on dog bites or attacks, N=77 focused on dog behaviour and N=65 focused on population management, while N=90 focused on two or more topics. All grey literature included in Level 6 may be found in Appendix B.

### 3.3.3 Part A – *Epidemiology surrounding dog bites*

Goal: To scope the literature for information regarding dog bite occurrence, risk factors and prevention strategies, with specific reference to semi-feral and free-roaming populations.

#### 3.3.3.1 Reporting and Incidence

##### 3.3.3.1.1 General

It is well documented that the factors that govern aggressive dog:human interactions are multifaceted and include canine, victim, owner and environmental features (see Table 2.1). Messam *et al.* (2008) emphasise that consideration needs to be given not only to the source(s) of research data, but also to all study-relevant canine and human environmental risk factors as both elements may significantly influence the results. Notably, studies conducted in hospitals compared to other environments appear to have some significant differences in results, as do studies

considering urban controlled situations versus those studying FRDs (de Keuster & Butcher, 2008). Regardless, globally the majority of authors agree that the true incidence of dog bites is unknown, as the vast majority remain unreported (Beck & Jones, 1985a; Gilchrist *et al.*, 2008; Sacks *et al.*, 1996a; Wright, 1990). Bites requiring medical care or young children, as well as fatalities are more often reported (Borud & Friedman, 2000; Klaassen *et al.*, 1996; Ndon *et al.*, 1996).

Meanwhile it appears that minor wounds or bites sustained due to poor judgement by adults are rarely acknowledged, possibly due to feelings of guilt or concern that reporting could cause harm or problems for either the offending dog or dog owner, or a lack of understanding regarding the notification system. In addition, bites from the family dog appear to be reported less frequently than those sustained from outside of the home (CHIRPP, 1996; Guy *et al.*, 2001a). According to the Canadian Communicable Disease Report (2002), fewer than 40% of respondents indicated they would seek medical attention if bitten by a pet, compared to more than 90% who would report a bite by wildlife.

Estimates of aggressive encounters within the United States have varied depending on the study and the parameters of inclusion. Sosin *et al.* (1992) estimated that approximately 585,500 injuries/year require medical interventions. Those numbers appear to have dropped significantly by 2001, when the CDC estimated that 370,000 bites/year required emergency care (MMWR, 2003), yet Gilchrist *et al.* (2008) suggest almost 885,000 bites/year required medical attention between 2001 and 2003. In a 1997 review of the literature, Garcia noted that while it appeared that 1-2% of bites require hospitalisation, an additional 10% of bites need medical care. These findings were also supported by Schalamon *et al.* (2006). In addition, Russell *et al.* (2001) estimated that there were approximately 20 deaths/year due to dog bites, which is similar to Gilchrist *et al.*'s (2008) estimate of 16 fatalities/year. However, there appears to have been little change in overall estimated bite incidence in the United States between 1994 (4.7 million bites/year (Sacks *et al.*, 1996b)) and 2003 (~4.5 million bites/year (Gilchrist *et al.*, 2008)).

In a Belgian study, Kahn *et al.* (2003) found that just under 50% of dog bites were reported to doctors or police, leading to an estimate of 1/1000 children sustaining dog bites per year. Other global studies have also produced results not following extreme underreporting trends, such as the study by Tenzin *et al.* (2011) in Bhutan, and that of Agarwal and Reddajah (2004). The improved reporting in some developing nations may be due to the fear of potential rabies exposure compared to perceived sociocultural drawbacks.

Various reasons have been hypothesized for individuals not reporting dog:human encounters. Amongst these are: time and effort/difficulty in reaching a medical centre, expense of transportation or medical services, belief that injuries are minor, physician's lack of knowledge (of protocols/procedures), fear of repercussions (either to own dog or by neighbours). Garcia (1997) estimated that of the two million mammalian bites per year that occur in the United States, at least 80% are relatively minor wounds, and Schalamon *et al.* (2006) suggested that 80 to 90% of animal bites are from dogs. Meanwhile, the desire for evidence for litigation or concern regarding disease transmission may prompt individuals to report aggressive encounters with dogs other than those personally owned.

#### 3.3.3.1.2 Key to Indigenous Canadian Communities

There are few studies considering dog:human aggression in Canada. Frequently a look at the data from the United States is required to get a more wholistic picture of the issue. Unfortunately, these comparisons may not always be completely accurate. When Raghavan (2008)

examined a 17 year span in Canada of media reported dog attacks resulting in mortality, several key differences were identified: more fatalities occurred in remote or rural areas on Aboriginal lands (usually by free-roaming dog packs), more attacks involved multiple animals, and more mixed and sled-dog breed animals were responsible.

Other risk factors were more closely aligned between the two countries (unsupervised children were more often victims than adults, males were involved more commonly than females, attacks were generally by unrestrained, intact, known dogs, and attacks were generally at home) (Raghavan, 2008). When Guy *et al.* (2001a) examined the number of injuries receiving medical attention from a case series of dog-bite incidents in the Atlantic provinces, fewer than 10% of injuries were reported to authorities. If Canadian bite statistics are similar to those estimated in American studies, approximately 1% of bites are actually reported (Clarke & Fraser, 2013).

Several studies have identified increased aggressive interactions between dogs and humans amongst Aboriginal peoples. Russell *et al.* (2001) found 431 bites/100,000 people on the Rosebud reserve (South Dakota). Bjork *et al.* (2013) indicate that dog bites delineate a key health issue for Aboriginal children in the United States, with indigenous children in Alaska having twice the national childhood average of dog-bite related hospitalisations and those in the Southwest having 1.7 times the average. In addition, Castrodale (2007) estimates that First Nations individuals demonstrate an incidence of dog:human aggressive encounters of more than three times that of non-Aboriginal populations, with a heavier burden occurring in more rural areas.

Clarke and Fraser (2013) found that dog bite reporting was higher in Canadian municipalities in which there was an active animal enforcement protocol and control program, likely due to visibility, knowledge and understanding of regulations. It also may be due to the feeling that it was more likely that reports would be followed up, and violations would be appropriately handled.

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### 3.3.3.2 Risk Factors – Human

#### 3.3.3.2.1 General

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Children more commonly behave in ways that provoke dogs (such as running, shouting and pulling ears or tails), and are less able to protect themselves during aggressive encounters. These confrontations may lead to multiple wounds. The CDC (2003) lists dog attacks as being the most common childhood injury (the incidence being greater than measles, mumps and whooping cough combined). The majority of studies have identified children under 10 years old (Bernardo *et al.*, 2002b; Hon *et al.*, 2007; MMWR, 2003; Russell *et al.*, 2001; Sacks *et al.*, 2000; Schalamon *et al.*, 2006; Thompson, 1997) as having higher incidences of aggressive dog:human interactions. However unsurprisingly, in a behavioural study by Davis *et al.* (2012), risk-taking by children encountering an unfamiliar dog was significantly correlated with shyness (hesitancy during new or ambiguous settings). Children who were described by their parents as generally being “shy” were less likely to approach strange animals or engage in potentially risky behaviours (e.g. approaching, petting, hugging) (Davis *et al.*, 2012). This supports the theory that in situations involving unknown animals, exuberant and uninhibited children are at greater risk of aggressive encounters regardless of age or sex.

Table 3.2 – Comparison of key dog bite risk factors from recent representative continental studies

North America - Oregon		Asia - Kashmir		Latin America - Guatemala	
Schuler et al, 2008		Lone et al, 2014		Lurnney et al, 2011	
Victim age	5-9 years old more likely to be bitten	Victim age	Mean age = 27.4 Most <10 22%	Victim age	<18 50.6%
Victim gender	No statistical difference	Victim gender	68% male	Victim gender	No statistical difference
Known dog	Most known 50.3% For <3yr own dog 46%	Known dog	96% strays	Known dog	84.7% known (48.2% neighbour's dog)
Anatomical site	Unknown	Anatomical site	Most lower limb (46.5%) For <10yr head and neck	Anatomical site	Most lower limb (85.9%)
Location of bite	Dog's territory 52.1%	Location of bite	public	Location of bite	unknown
Severity	50.5% sought treatment	Severity	74% severe	Severity	64.7% required treatment
Provocation	Unknown	Provocation	Unknown but generally none suspected	Provocation	Unknown but defensiveness suspected
Season	Summer 33.8%	Season	Most summer	Season	unknown
Europe - Netherlands		Africa - Nigeria		First Nations - Alaska	
Cornelissen and Hopster, 2010		Abubakar and Bakari, 2012		Castrodale, 2007	
Victim age	Most 16< 79%	Victim age	Mean age = 21.1 +/- 14.3 Most common 1-10	Victim age	Mean = 12.2 Most <9 71%
Victim gender	52% male	Victim gender	Males 4.8:1	Victim gender	63.2% male
Known dog	68.2% known (28% own dog)	Known dog	51.9% strays	Known dog	Majority known dogs
Anatomical site	Upper limbs 58% Lower limbs 29%	Anatomical site	Children lower 51.1% Adult upper limb 72.2%	Anatomical site	Head and neck 40% Upper limbs 40%
Location of bite	Dog's territory 51.6%	Location of bite	Unknown	Location of bite	"home" 60%
Severity	20% severe	Severity	Adults 44.4% severe; children 53.3% minor	Severity	Hospital stays ~2 days longer than non-Native
Provocation	60% believed provoked	Provocation	Unknown	Provocation	Majority suspected provocation
Season	Unknown	Season	Hot (April-June) 50.6%	Season	No statistical difference

Problematically the smaller stature of young children escalates the danger in receiving a bite, as their size puts their face and head more on level even with smaller dogs. This results in more bites to the face and head in young children (Bernardo *et al.*, 2002b; Horisberger *et al.*, 2004). Dog bites in general are more often to the head and neck in children, resulting in a significant proportion of incidents causing fatalities or requiring medical care (Thompson, 1997).

Rarely, researchers found adults to be either at equal or higher risk (Guy *et al.*, 2001a; Massari & Masini, 2006), or human age not to be a factor (Bennett & Rohlf, 2007; Hsu & Sun, 2010) in predicting the risk of aggression. This may in part be due to the type of surveillance and location of data collection as suggested by de Keuster and Butcher (2008). They proposed that given a greater percentage of severe injuries requiring a hospital visit occur in children (Thompson, 1997), hospital-based surveillance may provide an erroneous representation of risk (de Keuster & Butcher, 2008). This is supported by a veterinary-based study in which results found that 73% of bites occurred to adults (Guy *et al.*, 2001b). Meanwhile in an Australian study, Thompson (1997) found that the elderly were five times more likely to be admitted to hospital than adults between the ages of 21 to 59.

Males are also generally reported as being at a higher risk (e.g. Alabi *et al.*, 2014; Bernardo *et al.*, 2002; CDC, 2001; Hon *et al.*, 2007; Russell, 2001; Thompson, 1997), although both an Austrian study (Schalamon *et al.*, 2006) and a Dutch study (Cornelissen & Hopster, 2010) found there to be equal risk for boys and girls.

A 2008 knowledge survey conducted in an American pediatric emergency room concluded that young children and children of non-white parents have decreased understanding of safe behaviour around dogs and appropriate prevention strategies, which were not statistically improved by having a dog in the home or previous dog bite prevention education (Dixon *et al.*, 2012). Lower bite prevention knowledge scores thus appear to put them at greater risk of being involved in aggressive encounters (Dixon *et al.*, 2012). This correlates with the recurring findings from studies such as Bernardo *et al.* (2002b) which have provided data that in urban environments, young children are most likely to be bitten in their own home by their own dog.

#### 3.3.3.2.2 Key to Indigenous Canadian Communities

Although Daniels (1986) found that there was no risk difference between males and females for dog-bite related injuries in indigenous communities, other studies have found that incidences follow the trend of males being at greater risk (Bjork *et al.*, 2013; Castrodale, 2007). To date all studies conducted within indigenous populations found children younger than 10 to be at greatest risk for dog-bites, and children younger than 5 to be at highest risk for severe or fatal mauling (Bjork *et al.*, 2013; Castrodale, 2007; Daniels, 1986).

Horisberger *et al.* (2004) found that in contrast to adults, children were at increased risk of aggression by dogs known to them but non-family members. In addition, the study by Davis *et al.* (2012) also found that interactions with unfamiliar dogs appear to be controlled most strongly by a child's innate sense of caution or fear, rather than potential pleasure or enjoyment. This suggests that in situations where children are faced with unpredictable, stray or feral animals, shy children may have a level of protection from aggressive encounters. Unfortunately this protective factor is unlikely to exist in controlled situations with family pets, as the inhibition in interacting is not due to knowledge or education of potentially dangerous conditions. Therefore caution must be taken when considering personality traits as a risk factor during dog:human encounters.

### 3.3.3.3 Risk Factors – Dogs

#### 3.3.3.3.1 General

A key factor observed in most studies is the increased likelihood of aggression from male compared to female dogs, and intact versus neutered animals (Gershman *et al.*, 1994; Horisberger *et al.*, 2004; Messam *et al.*, 2012; Wright, 1990). The AVMA Task Force on Canine Aggression and Human-Canine Interactions (2001) also found that young, intact females attract free-roaming males when they are in heat, which may increase levels of overall aggression within the community due to fighting between males, and females protecting pups (this was also evident for Pal *et al.* (1999)). Horisberger *et al.* (2004) and Alabi *et al.* (2014) also noted a significantly greater number of young dogs (less than 5 years old) were responsible for bites leading to medical attention.

However, in looking at the characteristics of negative dog:human encounters, dominance or possessive aggression appears to occur more commonly by older, fearful, lower body weight dogs (Casey *et al.*, 2014; Guy *et al.*, 2001a). Severe dominance aggression encounters occurred more frequently with male and/or purebred dogs in this same study (Guy *et al.*, 2001a). In addition, specific behavioural traits such as high reactivity or impulsivity appear to increase the likelihood of a severely aggressive encounter (Guy *et al.*, 2001a; Kaneko *et al.*, 2013; Reisner, 2003). Of note it is likely that owner-directed aggression (ODA) may stem from triggers or factors separate from those generally instigating stranger-directed aggression (SDA), and that those dogs exhibiting one type may not exhibit all types of aggression (Casey *et al.*, 2014; Hsu & Sun, 2010). When these categories of aggression are separated and considered against confounding variables, multiple studies show that although ODA may occur more frequently with males, there are no significant sexual differences when considering SDA (Casey *et al.*, 2014; Goodloe & Borchelt, 1998; Hsu & Sun, 2010; Kaneko *et al.*, 2013; Takeuchi *et al.*, 2001).

Size and breed of dog have been included as part or all of the investigation by a number of urban studies. Possibly because bites from large breed dogs are more likely to result in wounds requiring medical attention, most of these studies found that bites were more often by large dogs (Aslam & Dickinson, 1999; AVMA, 2015; Avner & Baker, 1991; Bernardo *et al.*, 2000; Gershman *et al.*, 1994; Horisberger *et al.*, 2004; Schalamon *et al.*, 2006). It may also be that the injuries caused by medium to large size dogs are more likely to be considered severe enough from a fear or cautionary stance to warrant further consideration, reporting or behaviour modification, when compared to those inflicted and tolerated by smaller animals.

A few breeds (such as German shepherds, Dobermans, Rottweilers, bull breeds, and Akitas) were considered to be higher risk in multiple studies (Avner & Baker, 1991; Bernardo *et al.*, 2002a; Bini *et al.*, 2011; Horisberger *et al.*, 2004; Sacks *et al.*, 2000; Schalamon *et al.*, 2006; Thompson, 1997). Nonetheless, bites by small dogs to children under 5 were either reported or occurred more often than to individuals over 5 (Horisberger *et al.*, 2004; Schalamon *et al.*, 2006). This may be due to the improved success of dominance-related aggression by smaller dogs towards young children. As well, not all studies consistently report the same breeds as being low or high risk. For example, Messam *et al.* (2008) found Shih Tzus to have the same likelihood of biting as German Shepherds, and at greater likelihood than Rottweilers or Labradors.

It is also important to note that studies finding breed differences generally rely on owner or observer breed labelling (e.g. Gershman *et al.* (1994); Horisberger *et al.* (2004)), which similarly to eyewitness testimony and reports for crimes (Russ, 2015; Wells & Olson, 2003), are inherently flawed due to human nature (Patronek *et al.*, 2010; Sacks *et al.*, 2000; Simpson *et al.*, 2012; Voith *et al.*, 2009). This is especially the case for mixed or non-purebred animals. Schalamon *et al.* (2006)

note that dogs bred for fighting and violence have received more negative media attention in recent years. This has frequently led to public outcry regarding “violent breeds” and potentially dangerous environments created by having fighting breeds within the community (such as Victoria, Australia<sup>1</sup>; New Westminster, BC<sup>2</sup>; London, England<sup>3</sup>; Kansas City, Kansas<sup>4</sup>). However neither Klaassen *et al.* (1996), nor Schalamon *et al.* (2006), found a statistically significant increase in attack numbers or aggressive encounters by fighting breeds in comprehensive studies looking at factors influencing dog bites.

Of significance, Casey *et al.* (2013; 2014) indicate that there were no significant associations between breed and either ODA or SDA within their own territory/environments, nor were there distinct statistical differences between purebred or crossbreed dogs. In fact, the results of the multiple studies on breed aggression demonstrating clear differences other than what would generally be anticipated by common societal expectations, were upheld by a comprehensive study by Duffy *et al.* (2008) looking at N=1521 registered purebred dogs and N=3791 unregistered dogs. Using owner responses to the previously validated Canine Behavioral Assessment and Research Questionnaire (C-BARQ survey - see <http://www.vet.upenn.edu/cbarq> for more information), significant aggression differences were found between breeds regardless of their purebred status (Duffy *et al.*, 2008). Notably, Dachshunds, Chihuahuas and Jack Russell Terriers were found to exhibit more aggression in most situations (ODA, SDA, and DDA), while other breeds such as Akitas, Siberian Huskies and Pit Bull Terriers were more specifically aggressive towards other dogs (Duffy *et al.*, 2008). The differentiation between types of aggression should therefore be a detail included in any conversation regarding ‘breed’ aggression. Moreover, the potential for aggression having some genetic basis within dogs, especially those of purebred lines, merits further investigation following the studies by Duffy *et al.* (2008), Reisner *et al.* (2005) and Svartberg (2006).

In considering 256 dog-bite related fatalities in the United States between 2000 and 2009, Patronek *et al.* (2013) found that a lack of positive socialisation and human interaction appeared to be a factor in 76.2% of cases. In addition, owner mismanagement (37.5%) and/or neglect (21.1%) had a significant impact on the outcome of dog:human aggressive incidents (Patronek *et al.*, 2013). Again another notable point, is that while their study found that reproductive status was a key factor (in 84.4% of cases animals were intact), breed was not found to be a significant factor (Patronek *et al.*, 2013; Patronek *et al.*, 2010). This supports Messam *et al.*’s (2008) findings that sterilised animals show decreased aggressiveness in most situations when controlling for age.

### 3.3.3.3.2 Key to Indigenous Canadian Communities

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Contrary to the majority of available literature, Russell *et al.* (2001)’s study on the Rosebud Reserve found that there was no statistical difference in the frequency of biting between male and female dogs. However a significantly greater number of aggressive encounters are initiated by stray or owned FRDs compared to restrained animals in communities with high numbers of FRDs (Alabi *et al.*, 2014; Vucinic *et al.*, 2008).

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<sup>1</sup> Victoria, Australia: [http://www.parliament.vic.gov.au/images/stories/committees/SCEI/Dogs\\_Inquiry/Subs/Submission\\_212a\\_-\\_Linda\\_Watson.pdf](http://www.parliament.vic.gov.au/images/stories/committees/SCEI/Dogs_Inquiry/Subs/Submission_212a_-_Linda_Watson.pdf)

<sup>2</sup> <http://theyee.ca/Opinion/2015/08/04/Bring-Back-New-West-Pit-Bull-Law/>

<sup>3</sup> <http://www.animals24-7.org/2015/05/29/dog-attacks-surge-76-in-england-in-10-years-coinciding-with-exemption-of-staffordshire-pit-bulls-from-the-dangerous-dogs-act/>

<sup>4</sup> <http://wncn.com/2015/10/13/child-taken-to-hospital-after-johnston-co-dog-bite/>

Although both Duffy *et al.* (2008) and Hsu and Sun (2010) found Siberian Huskies to have low aggression scores despite the considerable differences in cultural attitudes towards dog:human interactions and dog-keeping behaviours, Raghavan (2008) found sled dogs to be involved in a greater proportion of fatalities than would be expected. This suggests that personal and environmental factors, and context outside of the individual's biological characteristics significantly bias each dog's potential to engage in aggressive behaviour. Svartberg in particular discusses "personality" playing a large role in behavioural reactions to different stimuli; at times causing almost as much 'within' breed contrast as is apparent 'between' breeds (Svartberg, 2002, 2005, 2006, 2007). The importance of the impact of an animal's genetic profile and environmental rearing determining forming aggressive tendencies, is also supported in several other studies (Casey *et al.*, 2014; Ledger *et al.*, 2005; Overall & Love, 2001; Reisner, 1997).

Another key point is that although much of the evidence points towards smaller dogs exhibiting more human-directed aggression and biting more frequently, any dog is capable of biting. Larger animals are capable of inflicting greater damage and causing serious injury even with a single bite. In addition given the extensive within-breed variation in aggressive behaviour and appearance, blanket labels are unlikely to be effective. In remote communities with little access to emergency services, ample animal socialisation, and public recognition of breed-specific signalling (i.e., the specific warning signals that particular breeds exhibit as warning signs such as the ruff and mane hackling of huskies) mitigates the likelihood of dangerous encounters. High-risk variables such as punishing training methods (both positive and negative), environmental care, and animal welfare, should be communicated broadly within communities. Correspondingly, given methods such as increased exercise and socialisation, positive training methods, and situation prevention are all shown to decrease the likelihood of aggression, therefore these factors should be encouraged within the community (Casey *et al.*, 2014; Jagoe & Serpell, 1996).

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### 3.3.3.4 Risk Factors – Environment and Situation

#### 3.3.3.4.1 General

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Hsu and Sun (2010) suggest that changes in environmental influences and amelioration of provoking risk factors external to either the people's or the dogs' personal characteristics, such as methods of reprimand or amount of exercise, might reduce the potential for aggression without alterations in any other set of variables. Russell *et al.* (2001) defined unprovoked attacks as

*“attacks by a dog when the victim is behaving in a non-confrontational way (e.g. individual is standing, walking, or involved in any other activity such as riding a bike or playing in a neutral territory)”* p34,

while a provoked attack was any other attack. Most authors use similar definitions.

Multiple studies indicated that human behaviours, especially by children, may have unintentionally provoked the dog who perceived the actions as being threatening within its own territory or space (e.g. running or quickly moving past the dog, disturbing it while eating or sleeping, etc.) (Alabi *et al.*, 2014; Avner & Baker, 1991; Dupperex *et al.*, 2009; Lunney *et al.*, 2011; Thompson, 1997). In the same vein, young children may not recognise that their attempts to play or show affection can be interpreted as showing aggression (Lakestani, 2007; Lakestani *et al.*, 2014). It is hypothesised that in some situations dogs may feel the need to defend their territory

and pack position against subordinates, and see newborns and toddlers as competition (Alabi *et al.*, 2014; Thompson, 1997).

Nevertheless, the majority of studies included in this review found that fewer than half of all bites appeared to have been provoked (6% (Alabi *et al.*, 2014), 46% (Avner & Baker, 1991), 40% (Hon *et al.*, 2007), 24% (Russell *et al.*, 2001)). In addition, Avner and Baker (1991) found that 55% of dogs were considered to be restrained (by a leash, fence or house) prior to attacking. However it is important to note that there were contrasting studies. For example, Schalamon *et al.* (2006) found that in approximately 75% of witnessed aggressive situations, children had disturbed the dog within its comfort zone in some manner. Similarly, Horisberger *et al.* (2004) found that in 82% of cases, children younger than 4 were interacting with the dog at home or within a familiar environment prior to an injury occurring (dog:human interaction had occurred in 56% of all cases).

Most studies are conducted within city environments and find that the lion's share of encounters are with 'known' animals (Avner and Baker (1991) 77% known; Garcia (1997) 6% by stray dogs; Hon *et al.* (2007) rarely unknown; Schalamon *et al.* (2006) 15% stranger/12% unknown; Thompson (1997) approximately 50% known). Given that in urban studies most attacks are by known dogs, it follows that Ndon *et al.* (1996) found that the majority of dogs involved in aggressive encounters reside near their victims. Lunney *et al.* (2011) suggest consistent interaction could result in canine territoriality or defensiveness.

Seasonality and time of day have been found to be somewhat ambiguous risk factors when considering dog-bites, showing significance in some studies (Agarwal & Reddajah, 2004; Dwyer *et al.*, 2007; Horisberger *et al.*, 2004; Kaye *et al.*, 2009; Lone *et al.*, 2014; MacBean *et al.*, 2007; Reece *et al.*, 2013; Rosado *et al.*, 2009; Sriaroon *et al.*, 2006; Tenzin *et al.*, 2011), but less weight in others (Raghavan, 2008; Shen *et al.*, 2014; Shuler *et al.*, 2008). Data from Raghavan (2008) suggest that patterns are more likely due to the exposure opportunity of free time. This may be due to dogs (especially FRDs) developing the same rhythms as the people within their community, due to access (e.g. FRDs are less likely to cause severe injury to random strangers outside with a single bite during winter months in northern Canada due to the layers of clothing worn), due to increased human movement at specific times of the day or seasons of the year, or due to more highly defined and delineated breeding and whelping seasons in more temperate climates.

Multiple other factors such as being freely able to move inside and outside, sleeping in the owner's bedroom, frequently being restrained (i.e., being chained), and inability to regularly demonstrate normal canine social behaviours have also been listed as possible triggers for aggression (Gershman *et al.*, 1994; Lockwood, 1995; Messam *et al.*, 2008). However, although numerous and seemingly intuitive, most hypothesised environmental associations have not been examined in enough detail to provide complete confidence in global causality. It is likely that in aggressive situations, multiple stressors have combined to result in tragic results, and that context is critical in determining an animal's aggression threshold.

#### 3.3.3.4.2 Key to Indigenous Canadian Communities

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However as previously indicated, a number of studies found that communities with large numbers of unrestricted roaming dogs (whether "owned" or community FRDs) had greater percentages of aggressive dog:human encounters initiated by dogs unknown to the human victim (Alfieri *et al.*, 2014; Alfieri *et al.*, 2010; Jackman & Rowan, 2007; Mengistu *et al.*, 2011b). This is in direct contrast to most controlled population studies in urban environments. The key difference in these encounters is that a greater percentage of the aggression shown by "known" dogs appears

to have been provoked (whether intentionally or not) compared to “stray” dogs who were more often reported to have attacked without cause (Alfieri *et al.*, 2014; Mengistu *et al.*, 2011a).

Critically, it appears most dogs that are reported to have bitten or attacked someone have not previously been involved in a recorded encounter (Guy *et al.*, 2001a). Unfortunately it is likely that the majority of these dogs had been exhibiting low levels of aggression for extended periods of time, which had remained unrecognised or tolerated by the owners or community, leading to the development of a preferred reaction (canine behaviour). Only once the behaviour escalates to a severe level, resulting in confrontations requiring medical attention or significant behaviour modification, are the issues addressed. This is especially problematic in environments in which there are significant numbers of FRDs, as repeated behaviours may not always be seen by the same individuals, nor by those with the ability to instigate appropriate interventions.

The key finding from the research by Hsu and Sun (2010) is that training and environmental factors may play pivotal roles in the overall types of behaviours shown by dogs. Predictably, dogs facing increased levels of physical punishment (especially random or unpredictable interactions - including both negative behaviour modification as well as abuse), and dogs working in guarding situations (where territoriality is rewarded), are more prone to respond to uncertain situations or unknown individuals with hostility (Casey *et al.*, 2014; Haug, 2008; Hsu & Sun, 2010). Likewise, dogs receiving significant amounts of attention and training from their owners, or praise and positive reinforcement for “sociability”, are less liable to become involved in violent encounters (Casey *et al.*, 2014; Haug, 2008; Hsu & Sun, 2010).

It was also found that higher rates of dog-bite related hospitalisations occurred in rural and remote areas of Canada (Raghavan *et al.*, 2014; Raghavan *et al.*, 2013). Given the majority of dogs acquired in more rural and remote areas spend significantly more time outdoors, and are used at least in part as guard dogs (or in the case of smaller animals “warning sentinels”), it is expected most of these owners show more tolerance for SDA. Protective behaviours are more likely to be seen as a positive trait until they become dangerous, or are turned on individuals that owners consider to be inappropriate. Unfortunately the development of those territorial responses cannot be expected to be context driven (i.e., it’s permissible to bark, growl and chase the strange mailman but not the unknown pizza delivery boy), leading to behaviour that manifests against all strangers (or less often, specific ‘types’ of strangers such as those in uniforms or baseball caps). Raghavan *et al.* (2013) also found that dogs were more likely to bite if they were from lower income neighbourhoods. Whether this is due to less time available for owners to spend socialising their pets, or whether it is due to encouragement of SDA for protective purposes is unknown.

While many commonalities exist between studies, it must also be emphasised that not all alleged causal links (see Figure 3.8) will necessarily occur in differing cultural or environmental conditions (Messam *et al.*, 2008).

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### 3.3.3.5 Interventions to Prevent Dog-Related Aggression

#### 3.3.3.5.1 General

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Understanding what knowledge, attitudes and perceptions people have towards dogs and dog welfare can significantly improve the success of intervention implementation, approval and overall execution. Early on, Beck and Jones (1985) suggested that the perception of severity influences the decisions made and the consistency with which owners and communities engage in appropriate prevention methods.

As an example, simple canine training practices have been observed to dramatically influence the display of aggressive conduct (Jagoe & Serpell, 1996; Netto & Planta, 1997; Podberscek & Serpell, 1997). Moreover, a number of studies mention correlating trends wherein increasing the length of time spent in positive interactions between owners and their dogs decreased overall dog aggression (Jagoe & Serpell, 1996; O'Sullivan *et al.*, 2008). Involvement in early socialisation and training from a young age also appears to have a residual shielding effect on preventing learned aggression (and therefore the reduction of aggressive behaviours in adult dogs) (Appleby *et al.*, 2002; Casey *et al.*, 2014; Seksel, 2008). However, negative training techniques result in a greater likelihood of ODA (Casey *et al.*, 2014).

Multiple authors have suggested that childhood educational programs have the potential to dramatically influence the number of dog:human aggressive encounters that occur between dogs and individuals under the age of 18 (Bernardo *et al.*, 2001; Borud & Friedman, 2000; Butcher, 2006; Butcher *et al.*, 2007a, 2007b; de Keuster, 2005; Lakestani *et al.*, 2014; Love & Overall, 2001; Meints & de Keuster, 2009). By increasing children's knowledge bases of dog behaviour, risky interactions, and avoidance techniques, it is suggested that children will recognise potentially dangerous situations, engage in more appropriate safe encounters, and extricate themselves from aggressive animals prior to bites occurring. Chapman *et al.* (2000), Coleman *et al.* (2008) and Schwebel *et al.* (2012) found in three separate studies that the short-term impact of educational programs is significant, and that older children (5 to 8 years of age in these studies) especially seem able to carry knowledge into future situations involving unknown animals. Positive results such as these has led to the development of a number of educational programs (see Table 3.3). Unfortunately there does not appear to be long-term retention of behavioural learning in the absence of consistent reinforcement, nor does there appear to be knowledge extension (students understood the specific details conveyed within educational sessions, but were unable to identify other risky behaviours that had not been included) (Chapman *et al.*, 2000; Coleman *et al.*, 2008; Lakestani & Donaldson, 2015; Schwebel *et al.*, 2012).

Initiating consistent administration and review of these programs in high risk areas, and amongst high risk populations to develop dog:human behavioural modification could significantly improve the overall incidence levels of aggressive interactions by providing building blocks that are otherwise missing. Schalamon *et al.* (2006) found that enhanced training and socialisation for both people and dogs would likely prevent a number of violent encounters. This was found to be especially true regarding parent education on recognition of appropriate safety choices (e.g. leaving children unsupervised with the family dog) (Kahn *et al.*, 2003; Schalamon *et al.*, 2006).

Interestingly, Morrongiello *et al.* (2013) observed that a significant issue for children is their parents, and the behaviours and interactions they encourage their children to engage in. Parents believed not only that children knew more than they do, but also actively urged their children to participate in dangerous actions (such as petting unknown dogs, hugging or kissing dogs, and sleeping with the family dog) (Morrongiello *et al.*, 2013). This supports Schalamon *et al.*'s 2006 data showing that appropriate behavioural and educational training are needed for all owners and dogs, as well as the suggestion by both Thompson (1997) and the AVMA (2010), that families postpone incorporating a dog into the family unit until all children are attending school.

Despite the increasing number of recommendations for prevention education and the development of educational programs, Dixon *et al.* (2012) warn that currently there are no comprehensive studies demonstrating definitive causation between prevention education and dog bite numbers. Given Schwebel *et al.* (2012) observed that improved knowledge and understanding of safe and appropriate interactions with dogs did not translate into behavioural implementation, child development and cognition of cause and effect must be considered. Therefore interventions

focusing on education must ethically be accompanied by additional preventative practices such as enforced legislation and repetitive educational module practices.

Minimising the potential for the formation of dog packs could have a significant impact in areas where the majority of aggressive encounters occur between multiple dogs and their human victims. This is due to the pack instinct to join and escalate an attack similar to the concept of human ‘mob mentality’, regardless of whether the initiating incident was meant as benign play or subtle threat (Avis, 1999; Kneafsey & Condon, 1995; Sacks *et al.*, 1989). This is undoubtedly part of the basis for active enforcement noticeably reducing dog-bite related injuries in areas with substantial numbers of FRDs (Clarke, 2009).

Though multiple studies mention legislation and communication as being key aspects to reducing dog bites (AVMA, 2001; Avner & Baker, 1991; Bjork *et al.*, 2013; Borud & Friedman, 2000; Chapman *et al.*, 2000; Cornelissen & Hopster, 2010; Daniels *et al.*, 2009; Dixon *et al.*, 2013; Farnworth *et al.*, 2012; Heath, 1998; Love & Overall, 2001; Meints *et al.*, 2010a; Mello *et al.*, 2007; Newman, 2012; Ozanne-Smith *et al.*, 2001; Presutti, 2001; Rezac *et al.*, 2015; Sacks *et al.*, 1996a; Schalamon *et al.*, 2006; Shields *et al.*, 2013; Villalbi *et al.*, 2010; Wilson *et al.*, 2003), only Klaassen *et al.* (1996), Clarke and Fraser (2013) and Raghavan *et al.* (2013) have published studies looking specifically at the influence of these particular interventions on the resulting incidence of reported dog bites (other than regulations surrounding dog breed ownership).

Despite the promotion of breed specific legislation (BSL) as being a necessary component of bite and mauling reduction strategies (Bini *et al.*, 2011), the only two comprehensive studies comparing a specific region’s pre- and post-BSL legislation did not find BSL to have a significant impact on the incidence of dog-bite related hospitalisations in either Manitoba or the UK (Klaassen *et al.*, 1996; Raghavan *et al.*, 2013). In fact, often the effectiveness of BSL is almost impossible to investigate due to the confounding of multiple other co-interventions (education, bylaw enforcement, public awareness) or lack of true community breed demographic characteristics (resulting in a lack of denominators when attempting to evaluate percentages of aggressive encounters as compared to overall percentages of a breed within a community).

In addition, Clarke and Fraser (2013) found that BSL did not significantly change rates of bite reporting in Canadian municipalities, in comparison to the noted reduction observed by active bylaw enforcement. Results from a study in British Columbia looking at human directed aggression by adopted pit bull breeds found no difference in the levels of misbehaviour when compared to other breeds (MacNeil-Allcock *et al.*, 2011). This was also found to be the case when looking at “so-called” dangerous breeds in Germany (Ott *et al.*, 2008), Spain (Martínez *et al.*, 2011) and the United States (Duffy *et al.*, 2008). As reported by the Australian Veterinary Association (2012), globally the majority of municipalities with BSL in place are repealing their bylaws as they find that BSL does not significantly reduce dog:human aggressive incidents for the following reasons:

- “1. breed on its own is not an effective indicator or predictor of aggression in dogs*
- 2. it is not possible to precisely determine the breed of the types of dogs targeted by breed-specific legislation by appearance or by DNA analysis.*
- 3. the number of animals that would need to be removed from a community to have a meaningful impact on hospital admissions is so high that the removal of any one breed would have negligible impact.*



In addition, BSL does not necessarily target the aggressive dogs within a community, simply the breeds believed to be most responsible for violence (AVMA, 2015; Patronek *et al.*, 2010). As mentioned previously, this is problematic when these breeds are generally not reliably identified, whether by the public or by animal control officers (ACOs) (Ledger *et al.*, 2005; Patronek *et al.*, 2010; Simpson *et al.*, 2012; Voith *et al.*, 2009). Of note is that aggressive dog behaviour may also be a result of patterns of owner training for assistance in criminal activity in some locations or neighbourhoods.

#### 3.3.3.5.2 Key to Indigenous Canadian Communities

Any dog, regardless of breed, gender, age, size and training, is capable of launching a violent attack if circumstances and the constellation of events is right. Although stricter regulations may decrease aggressive encounters between dogs and children, regulations looking at a specific animal's behaviour will have a greater effect on reducing dog bites compared to BSL (Raghavan *et al.*, 2011; Raghavan *et al.*, 2013). In addition, the implementation of culturally sensitive educational programming for children, students and community members will create greater awareness and understanding of risky human behaviours, potential problematic environmental issues, and animal warning signs prior to violent incidents and dog bites.

Periods of supervised socialisation and play between dogs is encouraged in order to develop “normal” dog manners and learned behaviours. Most dogs are more likely to display DDA than any other type of aggression (Casey *et al.*, 2014). However, every effort should be made to minimise the possibility of FRDs congregating and packing up within the community, especially around areas frequented by children and elders, in order to reduce the prospect of a dangerous encounter for vulnerable community members. In uncertain situations, there is the potential for DDA to spill over into an aggressive incident with a person. As well, understanding that dogs are generally territorial and defensive of “their pack” explains the increased hostility that may be shown towards strangers, especially those entering a dog's territory (i.e., yard, house, vehicle, etc.).

Frequent training around appropriately reacting to novel stimuli, situations and people, using positive reinforcement, should be given to all dogs in order to set them up for success rather than failure, and as a preventative measure against aggression. While owners of dogs that have shown aggressive tendencies are capable of minimising the potential for those encounters in public, they are harder to prevent at home. Proper training of both people and dogs, as well as recognition of warning signs and triggering stimuli go a long way in avoiding setting up these situations.

Table 3.3 – Educational Programs on Dog Bite Prevention Currently Being Used

Program	Type of program	Synopsis of main message	Key educational points
<p>BARK – Be Aware, Responsible and Kind                      Developed by: San Diego Animal Services  <a href="http://www.sddac.com/dogbiteinfo.asp">http://www.sddac.com/dogbiteinfo.asp</a></p>	<p>Classroom presentations                      Activity workbook                      Video</p>	<p>communication is different between people and animals</p>	<ul style="list-style-type: none"> <li>• Don't play aggressive games or at all with strange dogs</li> <li>• Don't approach unfamiliar dogs</li> <li>• Don't run from a dog and scream, instead remain motionless when approached by an unfamiliar dog</li> <li>• When knocked over roll into a ball and lie still</li> <li>• Don't stare directly at a dog</li> <li>• Don't disturb dogs when sleeping, eating, or caring for puppies</li> <li>• Let dogs meet you before petting them</li> </ul>
<p>Be a Tree                      Developed by: Joan Orr and Teresa Lewin  <a href="http://www.doggonessafe.com">http://www.doggonessafe.com</a></p>	<p>Seminar program</p>	<p>activities teach children to read dog body language and to act safely around dogs</p>	<ul style="list-style-type: none"> <li>• Dogs have feelings just like people – it's important to respect them</li> <li>• Dogs give hints about how they are feeling – watch their body language</li> <li>• Play safe games – fetch, teach tricks, hide and seek – no tug or chase</li> <li>• Respect the dog's resting place, toys, food and bones</li> <li>• Stand like a tree around strange, mean dogs or if nervous, and wait for help</li> </ul>
<p>Be Dog Smart                      Developed by: Regina Humane Society and the Regina Qu'Appelle Health Region  <a href="http://reginahumanesociety.ca/programs-services/education-programs/dog-bite-prevention/">http://reginahumanesociety.ca/programs-services/education-programs/dog-bite-prevention/</a></p>	<p>At home or classroom lessons</p>	<p>safe behaviour during encounters with dogs prevents dog bites</p>	<ul style="list-style-type: none"> <li>• Dogs do not communicate in the same way as people</li> <li>• Dogs might feel they have to protect things from you</li> <li>• Only pet a dog who is with his owners – always ask permission</li> <li>• Do not hug a dog</li> <li>• If a strange dog comes up or you are scared, stand still and wait for help</li> <li>• If you are on the ground, lie still and keep your head and neck covered</li> <li>• Do not hit or kick a dog</li> </ul>
<p>Bite Free                      Developed by: BC SPCA  <a href="http://www.sPCA.bc.ca/kids-teens/teacher/lesson-plans/bite-free-dog-bite-safety.html">http://www.sPCA.bc.ca/kids-teens/teacher/lesson-plans/bite-free-dog-bite-safety.html</a></p>	<p>Classroom curriculum</p>	<p>unknown</p>	<ul style="list-style-type: none"> <li>• Unknown - Available only for purchase (i.e., not freely available to public)</li> </ul>
<p>Blue Dog                      Developed by: Tiny DeKeuster, her team and The Blue Dog Trust  <a href="http://www.thebluedog.org/en/">http://www.thebluedog.org/en/</a></p>	<p>Interactive computer program</p>	<p>recognise and avoid potential risk situations especially at home</p>	<ul style="list-style-type: none"> <li>• Learn friendly and angry/fearful facial expressions and body language</li> <li>• Learn how to play safely with the family dog</li> <li>• Don't play with him without a parent</li> <li>• Pay attention to what he is telling you</li> <li>• Don't try to outrun him</li> </ul>

Program	Type of program	Synopsis of main message	Key educational points
<p>Delta Dog Safe program Developed by: Delta Society Australia Ltd <a href="http://www.deltadogsafetas.org.au">http://www.deltadogsafetas.org.au</a></p>	<p>Classroom curriculum Photographs Puppet show</p>	<p>education about appropriate behaviour around dogs for parents and children will reduce dog bites</p>	<ul style="list-style-type: none"> <li>• Ask permission to touch a dog</li> <li>• Carefully make sure that the dog wants you around and let it meet you</li> <li>• Don't stare at a dog and leave angry dogs alone</li> <li>• Stay still if a strange dog comes near you</li> </ul> <p>Most dogs are friendly but you need to treat them well</p> <ul style="list-style-type: none"> <li>• Stay calm around dogs</li> <li>• If a dog approaches, stay still</li> <li>• Ask before touching a dog and let the dog meet you properly</li> <li>• Watch a dog's behaviour carefully</li> <li>• Don't let the dog too close to your face</li> <li>• Treat dogs with respect</li> <li>• Stay away from dogs that are fighting or hurt</li> </ul>
<p>Doggie Do's and Don'ts: Dog Safety and You Developed by: AVMA <a href="https://ebusiness.avma.org/files/productdownloads/dog_bite_prevention_coloring_book.pdf">https://ebusiness.avma.org/files/productdownloads/dog_bite_prevention_coloring_book.pdf</a></p>	<p>Colouring book</p>	<p>proper training of pets and people can prevent dog bites</p>	<ul style="list-style-type: none"> <li>• How you interpret 'dog language' determines your interactions</li> <li>• Only pet dogs when you have permission</li> <li>• Introduce yourself to the dog properly</li> <li>• Pet the dog under the chin or chest</li> <li>• How can you tell what the dog is feeling?</li> </ul>
<p>Doggy Speak Developed by: World Society for the Protection Animals <a href="http://www.animalmosaic.org/Images/resources_FCAW_false_WSPA-Doggy-Speak-English_tcm34-18570_tcm46-29372.pdf">http://www.animalmosaic.org/Images/resources_FCAW_false_WSPA-Doggy-Speak-English_tcm34-18570_tcm46-29372.pdf</a></p>	<p>Colouring book</p>	<p>a dog's body language expresses what they are thinking and feeling</p>	<ul style="list-style-type: none"> <li>• Be careful and respectful of dogs</li> <li>• Ask permission before meeting or touching dogs</li> <li>• Stay calm and still if a strange or mean dog approaches</li> <li>• Use your bag or a book to protect yourself and distract an attacking dog</li> <li>• Protect your head, face and neck</li> <li>• Get an adult to help you</li> </ul>
<p>Fido! Friend or Foe? Developed by: Joanna Burnette and Etta Agan, Auburn University Distributed by: State Farm Insurance <a href="https://aacc.files.wordpress.com/2010/03/fridobook.pdf">https://aacc.files.wordpress.com/2010/03/fridobook.pdf</a></p>	<p>Children's book</p>	<p>dog bite injuries are avoidable by teaching responsible behaviour</p>	<ul style="list-style-type: none"> <li>• Unknown - Available only for purchase (i.e., not freely available to public)</li> </ul>
<p>Paws-itive Education Developed by: The Bow Wow Buddies Foundation <a href="http://scoutsangels.org/paws-itive-education/about">http://scoutsangels.org/paws-itive-education/about</a></p>	<p>Book series Interactive community education events</p>	<p>unknown</p>	

Program	Type of program	Synopsis of main message	Key educational points
<p>Pediatric Animal Awareness and Safety            Developed by: Bernardo et al., 2001            Bernardo, LM, Gardner, MJ, O'Dair, J, &amp; Cohen, B. (2001). The PAWS program: Pediatric animal awareness and safety. <i>J Emerg Nurs</i>, 27(4), 387-390.</p>	<p>Dog safety information packets mailed to families of injured children</p>	<p>age appropriate dog safety education is needed for public</p>	<ul style="list-style-type: none"> <li>• If you think a dog is going to bite, climb somewhere high</li> <li>• If you have nowhere to climb, fall face down and cover your head and neck with your arms</li> <li>• Don't try to outrun him</li> <li>• If a dog looks like it's going to bite you, give it something else</li> <li>• Use a low, firm voice with a dog that looks like it might hurt you</li> <li>• Use commands like "Go", "Go home", "Sit", "Down", or "No".</li> </ul>
<p>Prevent-a-Bite            Developed by: Chapman et al., 2000            Chapman, S, Cornwall, J, Righetti, J, &amp; Sung, L. (2000). Preventing dog bites in children: randomized controlled trial of an educational intervention. <i>West J Med</i> 173(4), 233-234.</p>	<p>Classroom lesson by dog trainer             Hands on interaction</p>	<p>precautionary behaviour can prevent dog attacks</p>	<ul style="list-style-type: none"> <li>• Don't try to outrun him</li> <li>• Approach dogs gently and respectfully</li> <li>• Ask permission before touching a dog</li> <li>• Don't disturb sleeping, eating, nursing dogs</li> <li>• Don't approach dogs behind fences, in cars, tied up, etc</li> <li>• Pay attention to the dog's signals</li> <li>• Stay still and protect your head and face if attacked or approached by a strange dog</li> </ul>
<p>Protecting our Tomorrows            Developed by: Humane Society International  <a href="http://www.hsi.org/about/how_we_work/local_empowerment/training/public_education.html">http://www.hsi.org/about/how_we_work/local_empowerment/training/public_education.html</a></p>	<p>Classroom curriculum</p>	<p>be polite and pay attention to dog communication</p>	<ul style="list-style-type: none"> <li>• Ways dogs communicate, reading dog posture and predicting their behaviour</li> <li>• Ask permission to touch strange dogs</li> <li>• Stay still when under attack – be a tree/be a rock</li> <li>• Clean wounds immediately</li> <li>• Do not run past or disturb dogs that are sleeping, eating, or nursing puppies</li> <li>• Do not act aggressively towards dogs</li> </ul>
<p>Safety Around Dogs            Developed by: For Kids' Sake  <a href="http://www.safetyarounddogs.org/index.html">http://www.safetyarounddogs.org/index.html</a></p>	<p>Classroom workshop</p>	<p>education is the key to dog-bite reduction</p>	<ul style="list-style-type: none"> <li>• All dogs can bite</li> <li>• Be respectful around dogs – walk quietly, don't scream or tease</li> <li>• Always ask permission first</li> <li>• Don't disturb a dog who is sleeping, eating, caring for puppies, in a vehicle, behind a fence, tied or chained up</li> <li>• Stay still when approached by an unfamiliar dog - Be a tree/be a rock</li> <li>• Use a calm and firm voice say "No!"</li> </ul>

### 3.3.4 Part B – Dog Population Management

Goal: To scope the literature for information on effective dog population control methods, with specific reference to semi-feral and free-roaming populations.

#### 3.3.4.1 General

Animal control is decentralised in Canada, requiring that each jurisdiction and municipality develop their own legislation, enforcement and population control practices. While this allows local governments to actively take action on issues as they arise, it creates a wide disparity in management practices. Most authors agree that prior to developing a population management program, an assessment of both population numbers and ecology is vital (Acharya & Dhakal, 2015; Baquero *et al.*, 2015; Cleaveland *et al.*, 2014; Dalla Villa *et al.*, 2010; Dalla Villa *et al.*, 2013; Gsell *et al.*, 2012; Hiby *et al.*, 2011; Otolorin *et al.*, 2014; Ratsitorahina *et al.*, 2009; Rupprecht *et al.*, 2006; Sudarshan *et al.*, 2001; WHO, 1990, 2004, 2013). Various methods have been employed to determine an estimate of dog population (see Table 3.4) with differing levels of success and confidence. As expected, studies using some form of triangulation had the most precise numbers, and were most confident in their overall population estimates (Morters *et al.*, 2014).

Limitations to methodology generally were most significantly influenced by cost factors, resource availability, or time and geographical constraints. Though Serafini *et al.* (2008) suggest that it benefits public health agencies to have accurate dog (animal) population assessments in order to monitor and control potential zoonotic disease transmission, they emphasise that if population numbers change due to migration or weather patterns, these estimates can be difficult. In addition after running and comparing several statistical methods and simulations, Fei *et al.* (2012) suggest that the use of Beck’s method (a basic sight-re-sight comparison over two sampling periods) can generally be safely employed in estimating roaming dog populations, provided basic statistical assumptions are not violated (closed populations and equal probability of being counted).

Unfortunately there are no published longitudinal studies considering FRD populations before and after interventions have been implemented, making it impossible to precisely identify the methods having the most significant long-term impact on overall population size (and subsequently on incidences of aggressive interaction). Nor are there published studies looking at the short-term efficacy of population control methods in rural, remote, underserved, or sparsely populated areas.

Table 3.4 – Demonstrated and established methods estimating dog demographic characteristics

Population estimation method	Demographic characteristics provided	Example study
Basic count	Estimate of total dog population	Hossain et al, 2013
Basic counts and door-to-door household surveys	Longitudinal population estimates; population ecology specifics; density estimates	Morters et al, 2014
Door-to-door survey	Population ecology specifics; dog:human density estimates	Pulczer et al, 2013
Mark-capture	Estimate of population total of roaming dogs (using ear notching); annual survival	Hiby et al, 2011
Sight-re-sight (variation of mark-recapture)	Estimate of population total, density estimate	Punjabi et al, 2012
Telephone survey and community registry (variation of mark-recapture)	Estimate of owned dog total	Caminiti et al, 2014

However, the WHO (1990) proposes that 70% or more of freely moving dogs are sterilised for communities to sustain population stability. Most remote, underserved areas and developing nations/communities do not have the resources to effectively maintain these levels through traditional methods (Epp, 2012, 2014; Jackman & Rowan, 2007; Massei & Miller, 2013; OIE, 2009; WHO, 1990, 2012; WSPA, 2007). For this reason, multiple organisations are searching for the perfect long-term, permanent, easily administered sterilant (see Table 3.5). To date none of these methods have been approved for general use in Canada, although deslorelin has been acquired through Emergency Drug Requests for short-term, temporary use by several non-governmental organisations working in Aboriginal community or on First Nations reservations (Dhillon & Hoopes, 2015).

Of note, the impacts of sterilisation on aggression and reactivity are conflicting. This was concisely described in a review by McKenzie (2010). While certain researchers have indicated neutering and spaying result in considerable reduction in aggressive behaviours (e.g. Messam *et al.* (2008), Gershman *et al.* (1994) and Hsu and Sun (2010)), others have shown no significant difference in aggression levels, or an increase in aggression and excitability by surgically sterilised animals (e.g. Bennett and Rohlf (2007), Farhooody and Zink (2010) and Podberscek and Serpell (1997)). Meanwhile, when stratified by sex, Perez-Guisado and Munoz-Serrano (2009) found that neutered males showed decreased dominance aggression and spayed females showed higher levels.

Even more inconsistent are the effects of chemical sterilisation, as there have been no longitudinal studies longer than 4 months post-administration looking at behavioural changes. In a study comparing the effects of surgical versus chemical sterilisation on a community of FRDs in Chile, not only did researchers find that surgical castration had little effect on sexual or aggressive behaviours, but that chemical castration had actually caused an increase in aggressive behaviour in approximately 80% of dogs observed 4 months post-castration (Garde *et al.*, 2015; Vanderstichel, 2015).

In addition, castration did not reduce roaming in most males (Garde *et al.*, 2015; Vanderstichel, 2015). This may be explained by Durr and Ward's study (2014), in which they determined that roaming behaviours had more to do with specific dog characteristics (i.e., personality) and season, than with canine sex or reproductive status (Ward, pers com 2015). In other words, some individuals just like to roam, while others prefer to stay closer to home.

Table 3.5 – Promising chemical sterilisation techniques currently under investigation

Chemical sterilisation method	Name	Duration	Gender	Study
Azagly nafarelin (GnRH agonist)	Gonazon	long term contraceptive (18 months+)	both	Rubion <i>et al.</i> (2006)
Bovine luteinizing-hormone receptor	LH-R	midterm contraceptive (~12 months)	female	Saxena <i>et al.</i> (2002)
Deslorelin (GnRH agonist)	Suprelorin	long term contraceptive (27 months+)	both	Trigg <i>et al.</i> (2006)
GnRH antagonist	Acyline	short term contraceptive	both	Romero <i>et al.</i> (2009); Valiente <i>et al.</i> (2009); Valiente <i>et al.</i> (2007)
4-vinylcyclohexene diepoxide	ChemSpay	permanent	female	Mayer (2006)
Zinc gluconate (chemical castration)	Zeuterin	permanent	male	Levy <i>et al.</i> (2008)
Zona pellucida vaccine	ZP3	short term contraceptive	female	Srivastava <i>et al.</i> (2002)

### 3.3.4.2 Key to Indigenous Canadian Communities

Many authors discuss dog density numbers when considering dog bites (Gsell *et al.*, 2012), however no published studies definitively establish a causal link. Given that urban environments generally have far higher dog densities (Gsell *et al.*, 2012), it would be expected that bite rates would be highest in urban environments. As previously noted, this has not been evidenced in previous Canadian research. Density numbers are required for effective planning of rabies vaccination and disease reduction strategies in areas with significant canine transmitted rabies cases. It does not appear to be relevant with regards to zoonotic disease or dog bite management due to semi-feral or free-roaming dog populations in rural or remote First Nations communities. It may be of concern however due to community tolerance levels and concerns regarding other potential public health issues such as community parasite loads, reduced quality of life (due to fear of roaming dog packs), or garbage and refuse dispersion (by dogs tearing open garbage bags, etc.).

Instead, the ratio of controlled owned to free-roaming and semi-feral dogs seems to have a greater role due to unrestricted and/or poorly socialised animals displaying no reticence in approaching community members. The assumption by community outsiders is that community members care little for their dogs or their welfare, due to the increased tolerance for roaming and reduced levels of vaccination and sterilisation. The attitude and tolerance of the community towards these dogs greatly changes the number of roaming dogs at any given time, as canine cultural importance and the perception of community safety often drives population management methods, especially those instigated by non-Indigenous policy makers and authorities (Gsell *et al.*, 2012; Hiby *et al.*, 2011; Morters *et al.*, 2014; Punjabi *et al.*, 2012). Importantly, culling to reduce numbers has not been found to be sustainable given dog populations are able to recover quickly (Matter & Daniels, 2000), and community members often replace lost or exterminated dogs within months. In addition the changing dog population creates instability in hierarchy, frequently resulting in aggressive encounters that may spill over to human community members.

## 3.3.5 Part C – Potential Diseases or Injuries Associated with Dog Bites

Goal: To scope the literature for information on relevant canine bite-related zoonotic pathogens, with specific reference to semi-feral and free-roaming populations.

### 3.3.5.1 General

Most attacks result in a single bite wound, but severe maulings can result in three or more (Lone *et al.*, 2014; Schalamon *et al.*, 2006). In the majority of reported cases, injuries were created by a single dog rather than a pack (Bernardo *et al.*, 2000; Russell *et al.*, 2001). However, cases involving multiple dogs packing up were more likely to result in serious injuries or fatalities in rural or remote areas of Canada (Raghavan, 2008). Accordingly, Reuhl *et al.* (1998) and Brogan *et al.* (1995) found that fatal cases were most likely to involve multiple bites, or injuries to the neck and head.

Daniels *et al.* (2009) and Thompson (1997) found that attacks on young children are more often to the head and neck, which also led more often to medical interventions or fatalities. This is potentially not only a product of body size and facial accessibility, but also due to childish tendencies to lean into animals, creating facial intrusion into the animal's personal space, possibly creating territorial or fear aggression (Meints *et al.*, 2010b). Therefore bites to children are more likely to result in death, as attacks to the head and neck are more likely to have fatal damage to

vital vessels and their fragile skull structure (Daniels *et al.*, 2009). In addition, likely due to children's smaller size in comparison to the jaws of an adult dog, the majority of them sustain deep wounds compared to superficial scratches or lacerations (Daniels *et al.*, 2009; Schalamon *et al.*, 2006). Older children and adults are found more commonly to be bitten on the extremities; either the hands (Alabi *et al.*, 2014; Maragliano *et al.*, 2007) or lower limbs (Knobel *et al.*, 2005; Sacks *et al.*, 2000).

Factors driving anatomical location of bites in adults is less conclusive. In general, more injuries occur to the extremities (upper slightly more frequently than lower), compared to the head and neck, or the trunk (least frequent) (Garcia, 1997; Hon *et al.*, 2007). Lunney *et al.* (2011)'s study contrasted with the 2009 study by Wake *et al.* who found a correlation between the potential instigating factors preceding a dog bite and the anatomical site bitten. Wake *et al.* (2009) concluded that in a significant number of adult cases, bites to the lower extremities were likely due to defensive territoriality. In comparison, there was no significant association found regarding dog bites to the lower body and territory protection against human incursion (Lunney *et al.*, 2011).

In most industrialised countries, the primary zoonotic diseases associated with dog-bites stem from bacterial wound infections, as vaccinations have dramatically reduced the prevalence of canine rabies (Hanlon *et al.*, 1999). Instead, canine and human interactions with wildlife rabies reservoirs such as other canids (foxes, coyotes, wolves, etc.), raccoons, skunks and bats, interaction with canine companions infected by wildlife, or travel abroad is more likely to result in rabies exposure (Hampson *et al.*, 2009; Lembo *et al.*, 2010; WHO, 2012) (see Table 3.6). This is in sharp contrast to developing nations who generally have lower levels of canine rabies vaccination coverage and higher numbers of roaming dogs (Cleaveland, 2003; Cleaveland *et al.*, 2007; Cleaveland *et al.*, 2006; Sudarshan & Narayana, 2010; Zinsstag, 2013; Zinsstag *et al.*, 2009; Zinsstag *et al.*, 2007) (see Table 3.6). In these areas, public apprehension regarding rabies is generally focused on roaming dogs as the disease vector (Suzuki *et al.*, 2008). Given that the majority of human rabies-related deaths occur in Africa and Asia (Adedeji & Okonko, 2010; Gsell *et al.*, 2012), a population management system that incorporated vaccination and deworming protocols would appear to dramatically transform the global level of canine associated rabies (Franka *et al.*, 2013; Lembo *et al.*, 2011; Mustiana *et al.*, 2015; OIE, 2010, 2011; Rupprecht & Kuzmin, 2015; Tenzin *et al.*, 2015a; WHO, 2013).

Although canine rabies has a fairly low basic reproductive rate (Hampson *et al.*, 2009), elevated levels of rabies within the environment, higher dog densities and increased frequency of dog:human interaction elevate the risk of transmission (Kitala *et al.*, 2002; Knobel *et al.*, 2005). In addition, several authors indicate that rabies appears to disproportionately target children less than 15 years of age (Abubakar & Bakari, 2012; Davlin & Vonville, 2012), though whether this is due to the disease epidemiology or to dog bite epidemiology itself remains questionable.

Unfortunately the symptomatic progression of rabies may potentially occur in children due to their reluctance to admit to interacting with unknown animals after strict instructions against it by parents and guardians (Bhanganada *et al.*, 1993; Cleaveland, 2003). Russell *et al.* (2001) found that the investigation lag time had a considerably wide range of 0 to 85 days, which has the potential to significantly influence timely prophylactic treatment and appropriate animal quarantine (as the incubation period for symptomatic disease manifestation is 20 to 90 days). In all cases, bites occurring in unprovoked situations should be treated with caution and at greater risk for rabies exposure (Presutti, 2001). This is still a critical consideration, as rabies continues to have the highest case fatality rate of all known infectious zoonotic diseases (Adedeji & Okonko, 2010), with only rare cases of survival once symptoms have manifested. In addition, training and methods in

quickly and properly diagnosing paralytic rabies (rather than malaria or Guillain-Barre syndrome) would assist in earlier interventions (Hemachudha *et al.*, 2002; Mallewa *et al.*, 2007).

Dogs from indigenous communities sustain higher rates of zoonotic infection than those in urban areas, similar to those of stray dogs in highly populated urban Westernised environments (Brown, 2006; Constable *et al.*, 2008; Palmer & Presson, 1990; Wilks & Williamson, 1998). Multiple studies have also shown that FRDs have increased rates of all zoonotic diseases and parasites, not just rabies (Budke *et al.*, 2005; Himswoth *et al.*, 2010; Kayali *et al.*, 2003; Schurer *et al.*, 2014; Ziadinov *et al.*, 2008). In addition people living in indigenous communities often share numerous pathogens with the dogs (Bentham *et al.*, 2007; Brown, 2006; Burleigh *et al.*, 2015; Constable *et al.*, 2013; Gaskin *et al.*, 2007; Senior *et al.*, 2006; Speare, 2006).

More than one hundred different bacteria have been isolated from bacterial infections of dog bites (see Table 3.7), suggesting that most oral flora have the potential to be pathogenic. In many instances, initial mistreatment (either due to patient reluctance to seek care, lack of resources or physician inexperience) results in severe disfigurement or mortality (Abrahamian & Goldstein, 2011; Chhabra & Ichhpujani, 2003; Chhabra *et al.*, 2015; Jaindl *et al.*, 2012; Jaindl *et al.*, 2015; Morgan *et al.*, 1995; Oehler *et al.*, 2009). Approximately 15-20% of cases result in severe infections (Cummings, 1994; Lewis & Stiles, 1995; Talan *et al.*, 1999). With the wide range of potential bacteria causing infection, lengthy incubation (minimum of 7-10 days) of aerobic and anaerobic cultures is recommended, with penicillins or doxycycline currently recommended as initial treatment (Chhabra & Ichhpujani, 2003; Goldstein *et al.*, 1997; Goldstein *et al.*, 2002; Presutti, 1997, 2001, 2013; Stevens *et al.*, 2005; Talan *et al.*, 1998).

While dramatic long-term impacts of dog bites such as permanent scarring and disfigurement, infection and pain are clearly visible, other sequelae such as post-traumatic stress, emotional distress and anxiety (due to embarrassment, increased fear of dogs or unknown situations, etc.), nightmares and economic costs (time lost from work or school, medications, medical equipment, etc.) are often overlooked (Chomel & Trotignon, 1992; Dixon *et al.*, 2012; Ji *et al.*, 2010). According to Peters *et al.* (2004) more than 50% of children show evidence of post-traumatic stress disorder one month after sustaining injuries during an aggressive dog:human encounter. Boat *et al.* (2012) also found that more than 70% of children developed new behaviours such as fearing and avoiding dogs, and separation anxiety as described by concerned parents. In addition the majority of parents develop feelings of guilt, anger or anxiety due to the incident (Boat *et al.*, 2012).

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### 3.3.5.2 Key to Indigenous Canadian Communities

Given the large number of possible sequelae and repercussions resulting from a dog bite, it is critical that community members are encouraged to report and seek medical attention for any injury sustained that breaks the skin. Although remote locations may not have the means of treating complicated injuries, initial treatment can begin and should the circumstances merit it, the victim can be moved to a larger medical centre. In addition, timely medical examination ensures that post-exposure prophylaxis is instigated when patients may be at risk.

Table 3.6 – Principal human rabies vectors by country and region  
(as per the most current and key rabies studies on public record as of December 15th, 2015)

Country	Study year	Principal vector	Most recent key study on public record
Angola	2007-2009	dogs	Fontes-Pereira <i>et al.</i> (2012)
Argentina	case report	dogs	Gury-Dohmen <i>et al.</i> (2009)
Austria	2004	travel abroad*	Strauss <i>et al.</i> (2005)
Australia	simulation	dogs	Durr and Ward (2015)
Bali*	2008-2010	dogs	Clifton (2011)
Bangladesh	2010	dogs	Tenzin <i>et al.</i> (2015a)
Bhutan	2012	dogs	Tenzin <i>et al.</i> (2015b)
Bolivia	2006	dogs	Suzuki <i>et al.</i> (2008)
Bosnia	1995-1996	dogs	Croft and Archer (1997)
Brazil	2009-2010	bats, cats, dogs	De Lucca <i>et al.</i> (2013)
Cambodia	2009	dogs	Lunney <i>et al.</i> (2012)
Cameroon	2010-2013	dogs	Sadeuh-Mba <i>et al.</i> (2014)
Canada	1996-2012	wildlife - bats, canids, skunks	Aenishaenslin <i>et al.</i> (2014); Bottoms <i>et al.</i> (2014)
Central African Republic	2006-2008	dogs	Nakoune <i>et al.</i> (2012)
Chad	2001-2002	dogs	Kayali <i>et al.</i> (2006)
Chile	2013	bats, dogs	Astorga <i>et al.</i> (2015)
China	1963-2012	dogs	Yin <i>et al.</i> (2013); Song <i>et al.</i> (2014)
Egypt	2001	dogs	Kishk <i>et al.</i> (2002)
Ethiopia	2011-2013	dogs	Yibrah and Damtie (2015); Digafe <i>et al.</i> (2015)
France	review	bats	Stahl <i>et al.</i> (2014)
French Guinea	1998-2001	dogs	Mimeau and Chesneau (2006)
Germany	review	foxes; travel abroad*	Johnson <i>et al.</i> (2005); Müller <i>et al.</i> (2012)
Grenada	2010-2011	dogs	Thomas <i>et al.</i> (2013)
Guinea	2002-2012	dogs	Youla <i>et al.</i> (2013)
Haiti	2010	dogs	Fielding <i>et al.</i> (2012)
India	2013	dogs	Valekar <i>et al.</i> (2014)
Indonesia	2012; 2013	dogs	Mustiana <i>et al.</i> (2015); Wera <i>et al.</i> (2015)
Iran	2011-2012	dogs	Hatam <i>et al.</i> (2013)
Israel	1999-2002	dogs	Dubnov <i>et al.</i> (2007)
Italy	1980-1986	dogs	Gelosa (1989)
Ivory Coast	2001-2009	dogs	Tiembre <i>et al.</i> (2010)
Japan	2001	dogs	Kato <i>et al.</i> (2003)
Kashmir	2010-2013	dogs	Lone <i>et al.</i> (2014)
Kenya	2013	dogs	Mucheru <i>et al.</i> (2014)
Lebanon	1991-1999	dogs	Bizri <i>et al.</i> (2000)
Lithuania	2006-2010	dogs	Jaceviciene <i>et al.</i> (2011)
Luxembourg	1979-1985	dogs	Huberty-Krau and Wigand (1988)
Madagascar	1984	dogs	Rakotonirina-Randriambeloma <i>et al.</i> (1985)
Malawi	2013	dogs	Jonasson (2014)
Mali	2013	dogs	Muthiani <i>et al.</i> (2015)
Mexico	1980-1990	canids – dogs, foxes, coyotes	Orihuela and Solano (1995)
Morocco	2013-2014	dogs	Ducrotoy <i>et al.</i> (2015)
Mozambique	1978-1982	dogs	Dias <i>et al.</i> (1987)
Nepal	1997	dogs	Kato <i>et al.</i> (2003)
New Zealand	1998-2006	travel abroad*	Shaw <i>et al.</i> (2009)
Nigeria	2004-2013	dogs	Eke <i>et al.</i> (2015)
Pakistan	1994-1995	dogs	Parviz <i>et al.</i> (2004)
Philippines	2009	dogs	Davlin <i>et al.</i> (2013)

Poland	2004-2005	dogs	Tomasiewicz <i>et al.</i> (2006)
Portugal	case report	travel abroad*	Santos <i>et al.</i> (2012)
Puerto Rico	1996-1998	dogs	Quiles <i>et al.</i> (2000)
Romania	1999-2003	cats, dogs	Cazacu <i>et al.</i> (2006)
Senegal	1986-2005	canids	Diop <i>et al.</i> (2007)
Sierra Leone	1995-2001	dogs	Hatch <i>et al.</i> (2004)
Slovenia	1992-2001	canids – dogs, foxes, wolves	Stantic-Pavlinic and Hostnik (2002)
South Africa	2008-2011	dogs	Morters <i>et al.</i> (2015)
Spain	1995-1996	cats, dogs	Knobel Freud <i>et al.</i> (1997)
Sri Lanka	2007-2011	dogs	Hasler <i>et al.</i> (2014)
Tanzania	2009-2010	dogs	Sambo <i>et al.</i> (2014)
Thailand	2002	dogs	Kongkaew <i>et al.</i> (2004)
Timor Leste	2013	dogs	Amaral <i>et al.</i> (2014)
Tunisia	1942-1976	dogs	Chadli (1988)
Turkey	2006-2010	dogs	Karbeyaz and Ayranci (2014)
Uganda	2002-2003	dogs	Fèvre <i>et al.</i> (2005)
United Kingdom	review	bats; travel abroad*	Johnson <i>et al.</i> (2005); Wijaya <i>et al.</i> (2011)
United States	2001-2011	wildlife - bats, canids, raccoons	Blanton <i>et al.</i> (2011)
Vietnam	2009	dogs	Phuong <i>et al.</i> (2010)
Zimbabwe	1992-2003	dogs	Pfukenyi <i>et al.</i> (2007)

Region	Principal vector discussed	Most recent key studies on public record
Africa	dogs	Cleveland <i>et al.</i> (2013); Jibat <i>et al.</i> (2015)
Africa and Asia	dogs	Morters <i>et al.</i> (2015)
Asia	dogs	Dodet <i>et al.</i> (2008)
Europe	terrestrial mammals, esp canids	Cliquet <i>et al.</i> (2014)
Latin America	dogs	Vigilato <i>et al.</i> (2013)
Middle East	dogs	Aikimbayev <i>et al.</i> (2014)
Overall	dogs	Meslin and Briggs (2013); Zinsstag (2013); Lankester <i>et al.</i> (2014); Gundamaraju <i>et al.</i> (2015); Rupprecht and Kuzmin (2015)

Table 3.7 – Comprehensive List of Bacteria Isolated from Dog Bite Wounds (as reported in published case studies, reports and reviews)

Bacteria	Previously known as (~ also valid nomenclature)
<i>Acinetobacter spp</i> <i>baumanii</i> ( <i>wolffi</i> )	<i>A. baumannii</i> = <i>Acinetobacter calcoaceticus</i> var <i>anitratus</i>
<i>Actinobacillus actinomycetemcomitans</i>	~ <i>Aggregatibacter actinomycetemcomitans</i>
<i>Actinomyces spp</i> ( <i>neuii</i> ( <i>subsp anitratus</i> ), <i>viscosus</i> )	
<i>Bacillus spp</i> ( <i>circulans</i> , <i>firmus</i> , <i>subtilis</i> )	
<i>Bacteriodes spp</i> ( <i>ovatus</i> , <i>pyogenes</i> , <i>tectus</i> , <i>uniformis</i> )	<i>Bacteroides ovatus</i> ~ <i>B. fragilis</i> subsp <i>ovatus</i>
<i>Bergeyella zoohelcum</i>	<i>Weeksella zoohelcum</i> , CDC group II-j
<i>Brevibacterium spp</i>	
<i>Brevundimonas diminuta</i>	<i>Pseudomonas diminuta</i>
<i>Campylobacter spp</i> ( <i>gracilis</i> , <i>ureolyticus</i> ) ( <i>curvus</i> )	<i>Bacteroides spp</i> ( <i>gracilis</i> , <i>ureolyticus</i> ) <i>Wolinella curvus</i>
<i>Capnocytophaga spp</i> ( <i>canimorsus</i> , <i>cynodegmi</i> , <i>ochracea</i> ) CDC group Non-oxidiser 1 (NO-1)	<i>C. canimorsus</i> = CDC group <i>Dysgonic Fermenter</i> (DF-2)
<i>Chromobacterium spp</i>	

<i>Citrobacter spp</i> ( <i>amalonaticus, freundii, koseri</i> )	
<i>Clostridium spp</i> ( <i>perfringens, tetani</i> )	
<i>Corynebacterium spp</i> ( <i>afermentans, aquaticum, freiburgense jeikeium, minutissimum, pseudodiphtheriticum</i> )	<i>C. aquaticum</i> = <i>Leifsonia aquaticum</i>
<i>Dermabacter hominis</i>	
<i>Diphtheroids</i> ( <i>Erysipelothrix, Listeria</i> )	
<i>Eikenella corrodens</i>	
<i>Empedobacter brevis</i>	<i>Flavobacterium brevis</i>
<i>Enterobacteriaceae</i> ( <i>cloacae</i> )	
<i>Enterococcus spp</i> ( <i>Non-group D, avium, durans, faecalis, malodoratus</i> )	
<i>Escherichia coli</i>	
<i>Eubacterium spp</i>	
<i>Filifactor alocis</i>	<i>Fusobacterium alocis</i>
<i>Flavobacterium spp</i> <i>meningosepticum</i> ( <i>brevis</i> )	<i>Flavobacterium CDC Group IIa</i>
<i>Flavimonas oryzihabitans</i>	
<i>Frederiksenia canicola</i>	
<i>Fusobacterium spp</i> ( <i>canifelium, gonidiaformans, necrophorum, nucleatum, russii</i> )	
<i>Gemella morbillorum</i>	<i>Streptococcus morbillorum</i>
<i>Haemophilus aphrophilus</i>	<i>CDC group HB-2</i>
<i>Kingella kingae</i>	
<i>Klebsiella spp</i> ( <i>oxytoca, pneumoniae</i> )	
<i>Lactobacillus spp</i> ( <i>jensenii, lactis</i> )	
<i>Leptotrichia buccalis</i>	
<i>Micrococcus spp</i> ( <i>lylae</i> )	
<i>Moraxella spp</i> ( <i>CDC group M-5 –catarrhalis, osloensis, phenylpyruvica</i> )	<i>M. osloensis</i> = <i>M. duplex</i> , <i>Mima polymorpha</i> var <i>oxidans</i>
<i>Neisseria spp</i> ( <i>animaloris, meningitidis, subflavia, weaverii, zoodegmatis</i> )	<i>N. animaloris</i> = <i>CDC group Eugonic Fermenter (EF) -4a</i> <i>N. weaverii</i> = <i>CDC group M-5</i> <i>N. zoodegmatis</i> = <i>CDC group (EF) -4b</i>
<i>Odoribacter denticanis</i>	<i>Porphyromonas denticanis; Bacteroides denticanum</i>
<i>Oerskovia spp</i>	
<i>Pasturella spp</i> ( <i>canis, dagmatis, multocida (subsp gallicida, subsp multocida, subsp septica), stomatis</i> )	<i>P. gallicida, P. septica</i>
<i>Pediococcus damnosus</i>	
<i>Peptostreptococcus spp</i> ( <i>anaerobius, asaccharolyticus, canis, magnus, prevotti</i> )	<i>Peptococcus spp (asaccharolyticus, magnus, prevotti)</i> <i>P. magnus</i> = <i>Diplococcus magnus</i> <i>P. prevotti</i> = <i>Micrococcus prevotti</i>
<i>Porphyromonas spp</i> ( <i>cangingivalis, canoris, cansulci, circumdentaria, gulae</i> ) ( <i>asaccharolytica, endodontalis, gingivalis, levii-like, macacae, salivosa</i> )	<i>P. gulae</i> ~ <i>P. gingivalis</i> <i>P. salivosa</i> ~ <i>P. macacae</i> <i>Bacteroides spp (asaccharolyticus, endodontalis, gingivalis, levii, macacae, salivosus)</i>
<i>Prevotella spp</i> ( <i>bivia, buccae, denticola, heparinolytica, intermedia, melaninogenica, zoogloformans</i> ) <i>P. stercoris</i>	<i>Bacteroides spp</i> ( <i>bivia, buccae, denticola, heparinolyticus, intermedius, melaninogenicus, zoogloformans</i> ) <i>B. fragilis</i>
<i>Propionibacterium spp</i> ( <i>acidi-propionicus, acnes, freudenreichii, granulosum</i> )	
<i>Proteus mirabilis</i>	
<i>Pseudomonas spp</i> ( <i>aeruginosa, fluorescens, vesicularis</i> )	<i>P. aeruginosa</i> = <i>Bacterium aeruginosa</i>
<i>Rikenella microfusis</i>	

<i>Spirillum spp</i>	
<i>Staphylococcus spp</i> ( <i>aureus</i> (& <i>MRSA</i> ), <i>auricularis</i> , <i>cohnii</i> , <i>delphini</i> , <i>epidermidis</i> , <i>intermedius</i> , <i>pseudintermedius</i> , <i>saprophyticus</i> , <i>warneri</i> , <i>xylosum</i> )	<i>Aurococcus spp</i> , <i>Micrococcus spp</i>  <i>Staph warneri</i> = <i>Staph hominis</i>
<i>Stenotrophomonas maltophilia</i>	
<i>Stomatococcus mucilaginosus</i>	
<i>Streptobacillus moniliformis</i>	<i>Haverhillia multififormis</i>
<i>Streptococcus spp</i> <i>α,β</i> and <i>γ</i> -hemolytic ( <i>agalactiae</i> , <i>anginosus</i> , <i>constellatus</i> , <i>dysgalactiae</i> , <i>equinus</i> , <i>gordonii</i> , <i>intermedius</i> , <i>mitis</i> , <i>mutans</i> , <i>pyogenes</i> )	<i>Strep gordonii</i> = <i>Strep sanguis</i>
<i>Tannerella forsythia</i>	<i>Bacteroides forsythia</i>
<i>Veillonella spp</i> ( <i>parvula</i> )	
<i>Yersinia pestis</i>	<i>Bacillus pestis</i> , <i>Pasteurella pestis</i>

(While potentially not exhaustive, the above list was compiled by a thorough listing of microbes as described by key Level 5 journal articles. Some bacteria were not capable of being identified past the genus level. (Abrahamian & Goldstein, 2011; Alexander *et al.*, 1997; Andersen *et al.*, 1993; Aravena-Román *et al.*, 2014; Börjesson *et al.*, 2015; Brook, 1987, 1989, 2003, 2009; Chomel & Arzt, 2000; Chomel & Boulouis, 2005; Chomel & Trotignon, 1992; Citron *et al.*, 1996; Dendle & Looke, 2008; Funke *et al.*, 2010; Funke *et al.*, 2009; Goldstein, 1989, 1991, 1992, 1999; Graham *et al.*, 1990; Hovenga *et al.*, 1997; Ichhpujani *et al.*, 2006; Ichhpujani *et al.*, 2008; Jacob & Lorber, 2015; Jandl *et al.*, 2012; Jandl *et al.*, 2015; Korczak *et al.*, 2014; Lane & Taylor, 2014; Montejo *et al.*, 2001; Ndon, 1991; Newman, 2012; Oehler *et al.*, 2009; Ordog, 1986; Peel, 1993; Reina & Borrell, 1992; Rodriguez *et al.*, 2000; Rothe *et al.*, 2015; Stull, 2013; Talan *et al.*, 1999; Talan *et al.*, 1989; Thomas & Buntine, 1987; Yi *et al.*, 2015; Zinn & O'Donnell, 2008))

### 3.4 Conclusions

If Canadian bite statistics are similar to those estimated in American studies<sup>5</sup>, only approximately 1% of bites are actually reported (Clarke & Fraser, 2013). Low reporting may create bias, but it is unknown whether that leads to greater differences or similarities between the two countries.

Currently the vast majority of the literature available pertaining to dog management or dog bites is related either to controlling, preventing or treating rabies within dog (and human) populations, or surgical and medical treatments of dog bite victims. There are large numbers of articles quantifying bites, and retrospectively looking at demographic characteristics and medical notes to search for potential risk factors and human demographics, yet few published research studies actively investigate the interactions between humans and dogs to document the trigger behaviours (human or canine) that lead to attacks. This information is far more easily found on websites developed by dog trainers and veterinarians.

While rabies, dog bite prevention, dog behaviour and dog population demographic characteristics generate thousands of google hits, few research articles discuss more than one concept at a time, though they may mention the potential to reduce rabies levels or bite occurrence by focusing on population management. In addition, there is little information available for the lay public on how to deal with dog bites, possible rabies exposure, or what to do in the midst of a possible attack (i.e., stopping the current attack).

<sup>5</sup> In a telephone survey Sacks *et al.* (1996a) found that although the dog bite incidence rate was 18 bites/1000 people/year, only 2/1000 adults and 6.4/1000 children received medical attention

### 3.4.1 Dog Bite Epidemiology

As the vast majority of dog bites are never reported or treated (Beck & Jones, 1985; Morgan & Palmer, 2007), it is difficult to provide a level of certainty regarding the risk factors and epidemiology surrounding aggressive encounters. Given the bites that are reported are often those most severe in nature it is likely we have a wide gradient in knowledge, where there is considerable information surrounding the epidemiology of fatal attacks, and less known regarding the initial trigger for minor injuries. Another problem is that much of the published data generally focuses on recounting details of injuries, treatments and disease patterns, rather than complete investigation in bite epidemiology. In addition, many review articles (such as the often quoted Overall and Love, 2001 study) consider only the most complete studies, which generally are those based in urban environments, and are often hospital retrospectives.

However, as the majority of studies show specific recurrent themes and trends, some risk factors are less controversial (i.e., gender of victim, socioeconomic status, education levels, knowledge of animal behaviour, severity and location of bite, animal provocation). Others are location or environment specific (i.e., age of victim, ownership of attacking dog, roaming, initiating incident, or quality of care). Still others continue to be highly provocative as they differ from study to study (i.e., dog breed, genetic predisposition, prior socialisation/treatment). Patronek *et al.*'s (2013) study provides significant support to recommendations by numerous researchers (e.g. (de Keuster, 2005; Ledger *et al.*, 2005; Overall, 2010; Shuler *et al.*, 2008)) that the majority of incidences are multifactorial, and therefore for preventative approaches to be successful, they must focus on multilayered interventions.

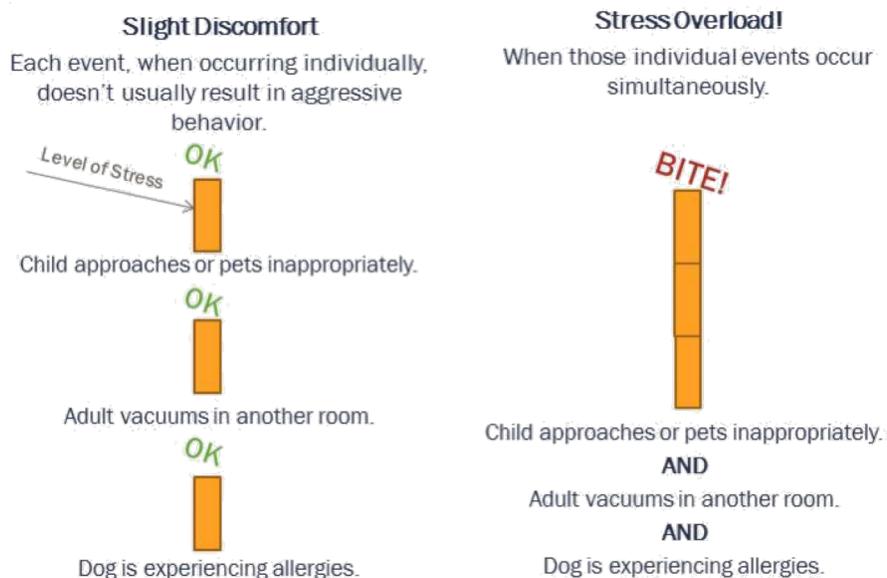


Figure 3.9 – Example of stressors causing trigger stacking and leading to potential dog-bite  
From [www.thecrossovertrainer.com](http://www.thecrossovertrainer.com)

It must be emphasised that aggressive dog encounters are very rarely uncontrollable or unpredictably ‘out of the blue’. Generally multiple factors have combined to develop a dangerous or volatile situation, leading to the perfect chain of events that culminates in an incident. These issues resemble building blocks, continuously getting bigger, which in behavioural terms is referred to as ‘*trigger stacking*’. Casey Lomonaco (2010) likens trigger stacking stressors leading to dog bites to a game of Tetris, in which each puzzle piece can be anxiety provoking but remain fairly benign. Unfortunately when multiple pieces land at once without the ability to clear previous ones, the added impact results in reaching threshold, and the game is over (see Figure 3.9). In a situation with potential aggression being the end result of an overload of negative stimuli, there is more than one loser. While triggers are specific to each individual (everyone has them), identifying

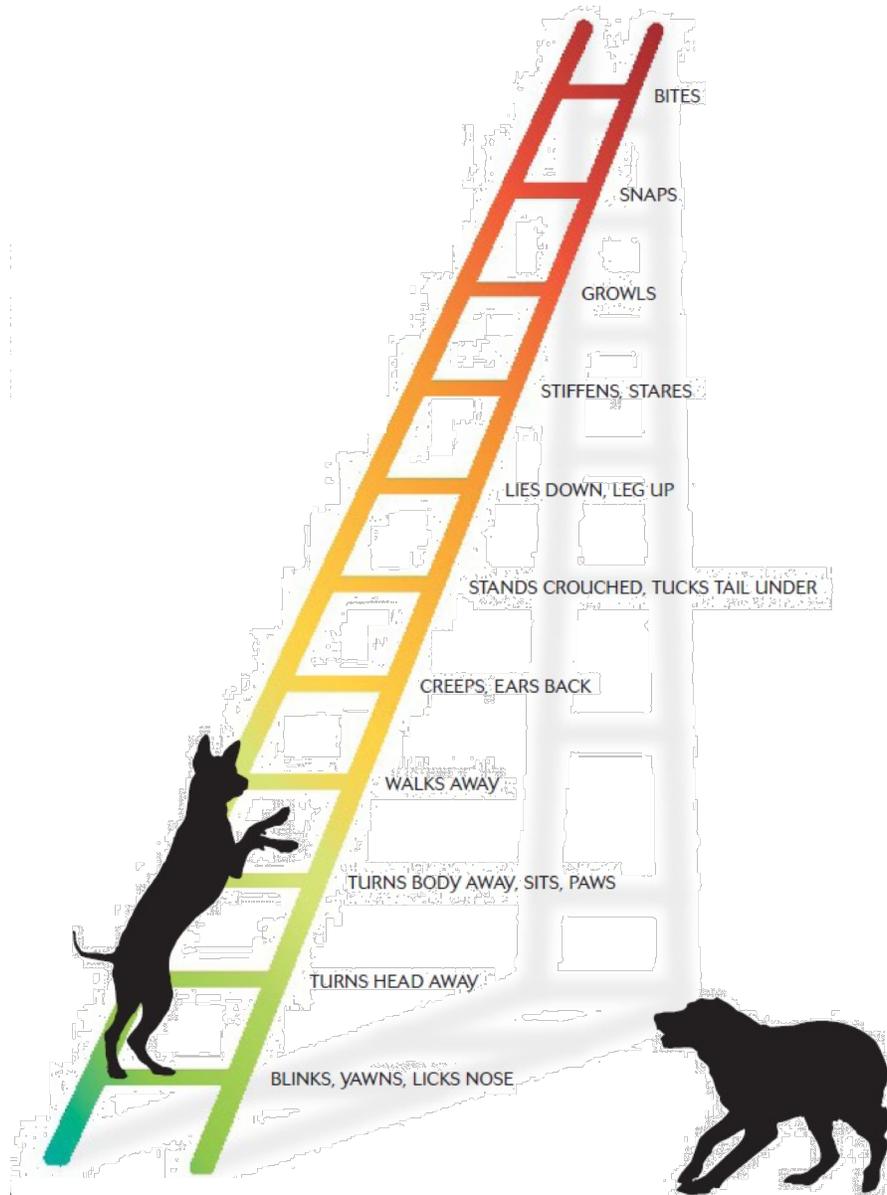


Figure 3.10 – Ladder of aggression  
 (Shepherd K. Ladder of aggression. In: Horwitz D, Mills DS. *BSAVA Manual of Canine and Feline Behavioural Medicine*, 2<sup>nd</sup> Ed. 2009.)

them early enough can prevent stacking from occurring. Reducing issues resulting in the stress hormones that are pushing the animal into a reactive state can avoid the dangerous situations that may be developing.

What is readily apparent is that although most appropriately socialised dogs will not be involved in an aggressive encounter with a person, environmental and behavioural circumstances can create potentially dangerous situations. In addition, with the right provocation any dog may attack, resulting in significant injury, especially to a child or individual incapable of protecting themselves. With a majority of reported cases involving a known dog, recognition of provoking behaviour, levels of aggression, or warning signs for both dogs and people would provide a safety buffer prior to an attack. Interestingly but unsurprisingly, higher impulsivity in either the dog or the interacting individual significantly increases the potential for a bite to occur. This would suggest that situations in which both actors have that trait (such as a young, exuberant child interacting with a less socialised puppy, or a fearful or painful adult dog) are more likely to result in a negative or dangerous encounter. It is highly recommended that these conditions are avoided, and when this impossible to prevent, that in these situations both parties are closely supervised and the environment is as controlled as possible. Furthermore, as the majority of biting dogs have demonstrated some level of discomfort or aversion to particular stressors, perceived threats or negative behaviours prior to resorting to aggression and biting (see Figure 3.10), more communication needs to be relayed to people regarding the dangers of ignoring those initial signs. This is particularly important in situations involving highly reactive animals with little means of avoidance, as the response or strategy for dealing with the threat can escalate rapidly.

Recognition that particular factors must be carefully controlled (such as startling a dog with poor vision and/or hearing) would also provide improved safety. All animals subjected to an environment in which they feel defensive or out of control are more likely to lash out, therefore consideration of an individual animal's limitations and temperament should factor into the interactions they are encouraged or permitted to engage in.

Differences in dog care, training and socialisation affect dog behaviour, and social and cultural norms dictate human acceptance and interaction with dogs. Both dog and human factors dramatically influence the nature of dog:human encounters and the potential for threatening situations. Given that child behaviour may change in the face of familiarity with the animals encountered (e.g. they may lose caution and reduce space with known dogs), added attention to the education of parents and children regarding appropriate personal space, and respect of dog communications could have a major role in dog bite prevention programs. Community-specific identification of pertinent risk factors, and serious consideration of the best means to provide culturally sensitive and relevant preventative education could decrease bite numbers.

Improved surveillance and reporting would greatly assist in identifying cultural, environmental and geographically specific risk factors and locations, in addition to ensuring appropriate medical attention was received by all victims.

### 3.4.2 Dog Bite Injuries and Diseases

Most literature on dog bites to date is restricted to descriptive records of injury incidence, patterns, and management. In addition, while many studies advocate safety education is an essential aspect in the prevention of childhood injury, dog bite prevention training is often not promoted by health care providers or researchers (Dixon *et al.*, 2012; Kahn *et al.*, 2003; Schalamon *et al.*, 2006).



For communities facing significant dog issues, and few available resources with which to create alternatives, access to a broader array of systems and procedures along with their requirements, advantages, disadvantages and efficacy would be beneficial (see Figure 3.11). Mass culls are ineffective and unpopular with the majority of community members (Kahn *et al.*, 2007), yet often remain the means turned to in times of crisis. If all levels of government became actively involved in preventative educational programs, and development and completion or enforcement of suitable community initiatives, it is likely that it would result in greater feelings of support, cohesion and collegiality. Instead communities on a global level are often left to flounder on their own, with limited access to resources feeling the pressure of the prevailing federal or state expectation that they can and should get their “dog issues” under control.

Currently there are few resources available for the lay person on methods of proactively dealing with aggressive dogs, and avoiding injurious situations. Providing knowledge on reading dog communication and behaviour could avert those difficult situations and enable the public and community to feel capable of handling most canine encounters. Prior to her death, Dr. Sophia Yin had recently begun providing some of this information via low stress handling and behaviour recognition through posters and videos on her website and blog ([www.drSophiaYin.com](http://www.drSophiaYin.com)).

Multiple behavioural dog trainers such as Victoria Stillwell (<https://positively.com>), Brad Pattison (<https://www.facebook.com/pages/Brad-Pattison/20535051408>) and Cesar Millan (<https://www.cesarsway.com>) use both blogs and television shows to provide training tips, however those methods rarely work in situations with unknown roaming dogs, or large packs of unknown dogs. In addition, training methods are always controversial, with some trainers (e.g. Victoria Stillwell) advocating positive reinforcement and learning, and others recommending aversive training (e.g. Brad Pattison). Others lie somewhat in the centre (e.g. Cesar Millan). Generally speaking proper training and dog behaviour signal recognition requires practice and experience with dogs, and for inexperienced individuals, more guidance than they can get from the videos, books or blogs available.

One example is the basic concept of canine behavioural (or emotional) threshold zones as seen in Figure 3.12 (see Appendix A for specific zone definitions). Although most owners understand the idea of ‘comfort zones’ as humans also have individual space requirements, recognising the signals exhibited at each level is far more complex. Communication displays depend not only on individual dogs’ breeds, environmental comfort and personalities, but also learned and trained behaviour.

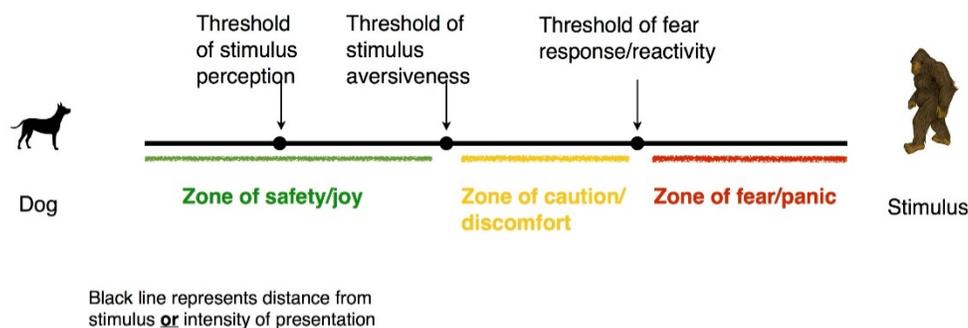


Figure 3.12 – Canine behavioural threshold zones (from [www.eileenanddogs.com](http://www.eileenanddogs.com) – first displayed in BARKS from the Guild, October 2014)

### 3.4.4 Dog Population Management Methods

Although dog demographic methodology is becoming more common, there are few comprehensive studies that have been published on successful dog population management strategies. Rather these policies can be found in non-governmental organisational publications, which use a ‘one-size fits all’ approach to project design and implementation. As a result, many researchers and policy makers simply rely on the basic guidelines outlined by the World Society for the Protection of Animals (WSPA) in 2007 which describe population estimation based on direct observation of roaming dog numbers in public areas.

While the methods described work well to provide simple estimates of population size and density, and therefore the impacts of interventions, basic counts assume regularity in roaming patterns, distribution and timing. Researchers must understand the community and cultural attitudes towards dogs and allowing roaming, and become skilled at recognising temporal, spatial and seasonal changes in behaviours. In addition, northern Canadian surveillance methods must account for seasonal modifiers such as extended cold spells, heavy snowfalls, and prolonged winters, in addition to summer drought conditions or forest fires.

### 3.4.5 Dog Management Impacts on Dog Bites

A number of studies considered dog density levels to be a factor in bite occurrences. However dog density does not take into account the number of people living within the area, nor the likelihood of contact occurring between humans and dogs. More accurate information can be procured by knowing the dog:human ratio, and the ecology of dog behaviour and culture of dog ownership within the community. Contrasting numbers between jurisdictions is then difficult without knowing the precise methodology used to obtain population counts. In addition if bite risk was calculated based on estimated populations and hypothesised interaction levels, extrapolations cannot realistically be made to other communities unless population and risk parameters of the target community are comparable.

## 3.5 Overall

There are concerns that Arksey and O’Malley’s scoping review framework lacks the ability to fully evaluate the quality of the retrieved data, and that quality measurement is a critical component of any review (Daudt *et al.*, 2013). While it is agreed that assessment is a necessary factor, articles were not discarded based on quality criteria. This is due to the attempt to identify all information that would potentially be available to the average community or individual attempting to find evidence regarding dog population management, dog bite prevention or the epidemiology of dog bites. Therefore caution must be taken when evaluating the trends identified, as not all ‘expert’ recommendations, case studies and research will have met equivalent levels of rigorous protocols or validation.

However, gaps were identified and recommendations were made here based on the highest quality of research collected. Quality appraisal when performed should be completed using proven and substantiated means. Given very different research methodologies, potential for bias (nonresponse, selection and recall biases), variability in environment, surveillance and case definitions, disparities in data collected and general propensity of missing data (due to

unasked/uncharted details or participant's refusal to answer questions) in many studies, it is difficult to confidently attach causality, commonalities and conclusions to most risk factors. Moreover, the ability to accurately generalise to every case, situation, or individual is not considered possible other than at a very basic level. These findings contributed a significant number of questions and data for the creation and design of several more comprehensive research projects. This scoping study therefore acted as a key stage in developing the subsequent phases of the research.

### ***Relevance to thesis***

*The community based participation developed for this project provides new information not only on the potential cultural issues that surround large numbers of free-roaming dogs within indigenous communities, but also on the use of successful interventions that might be utilised within remote communities to reduce the number of aggressive dog:human encounters seen each year.*

## **Chapter 4 Community Engagement**

*“Average people and the average community can change the world. You can do it just based on common sense, determination, persistence and patience.”*

*Lois Gibbs – environmental activist, 2003*

Dog bites, and diseases transmissible via dog bites, are an ongoing public health issue among indigenous communities in Saskatchewan. Currently, dog populations are often reduced by culling, but this approach is known to be largely unsuccessful due to public resistance, or lack of effect on dog population stability, dog bite incidence rates and dog-related disease transmission. New control programs are being explored in order to reduce the public health risk dogs pose in these communities.

In Aboriginal communities, free-roaming dog packs cause the majority of the serious or fatal dog-related injuries. In Canada over the last decade, there have been on average 1-2 fatal dog attacks per year, with many more non-fatal injuries occurring. As with the fatal dog mauling from Mosquito First Nation in 2011, considerable media attention has focused on attacks occurring in rural, remote and First Nations communities. Physical attacks by dogs are often on children, and may lead to death or disfigurement. In 2006 alone, dog attacks killed three Canadian Aboriginal children.

Unfortunately, in northern First Nations communities there is reduced access to regular veterinary care, animal health education, veterinary information or medications due to remote locations or limited financial resources. In addition, financial constraints and competition for public resources has de-emphasized dog control programs, as other health needs such as inadequate housing, water supply and sanitation are of necessity and considered more pressing.

### **4.1 Background**

In conjunction with the Federation of Saskatchewan Indian Nations (FSIN) Environmental Health Working group, the initial proposal for this community-based dog assessment project was developed and approved. Through a motion brought forth to Senior Technical Advisory Group

(STAG) members in May 2011, a short list of interested communities were chosen to participate on a voluntary basis. The FSIN was informed of project status on a regular basis, and each set of questions and each phase of data collection was submitted for ethics approval from the University of Saskatchewan prior to initiation, as well as being approved by each individual community.

While Aboriginal peoples in Canada are frequently grouped together for economic, political and health discussion purposes, it is critical to recognise that communities and populations have separate and unique concerns and stories. Often these issues have developed from individual histories, therefore respectful recognition and knowledge of details and timelines are required in order for the true community voice to be heard (see Figure 2.2, p11). For this reason, consent and endorsement of each aspect of the study was sought at various levels of each community, and not simply by a single member or group within the community.

Communities agreeing to participate conducted advertisements of the primary public forums through Council offices, and determined appropriate attendance for each subset of meetings. These forums provided individuals within the community the opportunity to participate by voicing concerns regarding dog issues in their community and participating in the decision making process of community programs to address the issues raised. To maintain anonymity, the researcher was not provided with the names of the individual community members in attendance at meetings, nor were there audio recordings of meetings. Instead summaries without identifying information or direct quotations were developed and shared with Council offices prior to any use for research purposes.

The purpose of this research project was to provide baseline information regarding dog bites and their impact among selected Saskatchewan First Nation communities, while exploring how communities pursue developing novel dog population control programs. Specific considerations for this study included: documenting dog related concerns prioritized by the communities, measuring dog population demographic characteristics and bite prevalence, and identifying resources and functional capacity for dog control program sustainability within the communities.

As the first objective of this project was to open lines of communication between communities and animal health care workers, including veterinarians, a Community-Based Participatory Research (CBPR) structure was chosen for community engagement and data collection. In addition, documentation of the dog population structure and health has been recorded using community members to help gather these data. Community concerns, needs, resources and ideas for sustainable programmes have been detailed so each community has a record of what is desired by their members. Communities were followed as they implemented the changes that they felt best suited their circumstances. As there is a significant knowledge gap regarding the prevalence of dog bites within First Nations communities, the last objective of this study addressed this by measuring and assessing the prevalence of bites in those communities wishing to participate. Using CBPR, the project detailed unique, locally driven solutions being developed, which are both culturally appropriate and sensitive to local beliefs regarding dogs and their roles in community life: these included multiple combinations of interventions, and strategies.

## 4.2 Methods

Developing partnerships within communities permits community members, researchers, and policy members to engage in a transparent wholistic process in which all participants feel valued and as though their input is critical to successful outcomes. This requires flexibility

throughout project development, initiation and completion, as the fluidity of decision making and data collection is not always straight forward, but often involves directional changes and increased consultation. Resiliency is critical to project prioritisation and survival. These methods are summarised below.

#### 4.2.1 Community Sites

Community A is a multi-community Nation of approximately 1200 members, with 70 to 75% living on-reserve. Most other members live within urban centres within Saskatchewan. Community A is approximately 125km from the closest major urban centre. This Cree reserve owns approximately 27,500 acres in one complete section, all of which has reserve status. There have been 6 to 10 recorded dog bites or maulings to both people and livestock in recent years in this community, and an overwhelming number of near misses. Anecdotal evidence suggests that interactions between FRDs, and other animals and humans are increasingly aggressive. In April of 2012, a number of FRDs packed up, attacked a foal and ate it alive.

Community B has approximately 5300 members, with approximately 75 to 80% living on-reserve. Most off-reserve members live in urban centres across Canada. Community B is roughly 50km from the closest major urban centre. This Nation owns approximately 52,500 acres divided into two reserves. It is a community of mainly Cree people. It is unknown how many dog bites occur per year in this community.

A mixed community of Cree and Saukteaux people, community C has approximately 4000 members, with around 25 to 30% living on-reserve. Most members live in urban centres across Canada. Community C is approximately 150km from the closest major urban centre. The reserve owns approximately 40,000 acres in various places in the province, of which 5,000 have reserve status. There has been one recorded dog bite per year over the last three years in this community. Anecdotal evidence suggests that prior to 2009, 75% of the recorded interactions between dogs and humans were aggressive, with more than 10 recorded bites per year.

Community D is a multi-community Cree nation of approximately 10,000 members, with around 50% living on-reserve. Most other members live in urban centres in Canada. Community D is approximately 250km from the closest major urban centre. The band owns approximately 100,000 acres. There have been twenty or more recorded dog bites per year over the last five years in this community. Anecdotal evidence indicates that interactions between FRDs and humans are becoming increasingly aggressive.

Community E is a Métis community of approximately 1300 members, with 85 to 95% being of indigenous descent. Site E is approximately 220km from the closest major urban centre. This mixed community covers approximately 6200 acres. In the last five years there has been a severe mauling to a young child, and an overwhelming number of near misses. Anecdotal evidence suggests that interfaces between FRDs, and other animals and humans are increasingly aggressive.

Although communities A and C were involved throughout phase 1 of the study (see Figure 1.3, page 5), during the transition to phase 2 separate within-community circumstances arose which necessitated more limited participation for the duration. In addition, community specific issues for site B early in study development required withdrawal from the project. While significant obstacles also occurred for both communities D and E during the study period, community opinion favoured maximum continued participation. This understandably resulted in cyclical periods of unreserved contribution alternating with more restricted involvement.

## 4.2.2 Qualitative Methods

Gathering affected community member attitudes, experiences and beliefs surrounding multifocal phenomena, is a key step in probing and processing potential causality of complex problems and concepts. The scarcity of documented information and data available pertaining to the challenges faced by indigenous Canadian communities relating to dogs provides an opportunity to explore current viewpoints and understanding, as well as community-based ideas for future approaches and preventative measures.

In three locations (Communities B, D and E), large-scale community-wide meetings, council meetings, multiple school group discussions, and elders' teas occurred. In Communities D and E in-depth community engagement was possible, allowing for multiple whole community gatherings, small group meetings and individual interviews. During these sessions and public meetings, multiple qualitatively based activities promoted open communication regarding the importance of dogs and acceptable dog population management and bite prevention strategies.

Depending on the group and situation, qualitative CBPR techniques included direct observation such as semi-structured interviews, visualisation such as mapping and Venn diagrams, and scoring techniques such as ranking, proportional piling and matrix building (see Appendix A). A semi-structured interview, Venn diagram and ranking activity were produced with each small group, and time permitting other approaches were integrated. In general, single-person meetings with individuals other than community liaisons incorporated two methods. All sessions began with the semi-structured interview as data initiation, and subsequent techniques generated data confirmation in order to maintain credibility, reliability and validity of the documented research. The diverse variety of methods used allowed for a comprehensive and thorough collection of data with rich depth and context. It also permitted within community methodological triangulation to ensure complete understanding of environmental context, and appropriate knowledge translation and exchange.

All discussions and sessions were transcribed by hand, with summaries regularly provided to community liaisons and members of council. Formal biannual reports and meetings followed to ensure appropriate capture and respectful portrayal of session contexts and understanding, and to renew permissions for interacting with the community.

In addition, in Communities D and E, community volunteers and high school students conducted household surveys (door-to-door and booths at local events) with community members on attitudes and methods of dog ownership, and experience with dog aggression within the community. Survey questions were based on those created, pretested and established for dog population management surveillance by the WHO (WHO, 1990), and refined by WSPA (WSPA, 2007), and included both open and close-ended questions (see Appendix C).

The survey questionnaire was then pretested on 60 participant households in Community D during the summer of 2013. Consistency within responses suggested that questions were clear and appropriate, therefore surveys were conducted in Community D between May 1<sup>st</sup> to June 15<sup>th</sup> (2014), September 1<sup>st</sup> to November 15<sup>th</sup> (2014), and May 1<sup>st</sup> to June 1<sup>st</sup> (2015), and in Community E between May 1<sup>st</sup> to June 15<sup>th</sup> (2014 and 2015). Simple random sampling was utilised as effectively as possible. In Community D surveys were given randomly (every third person at community events – at which community liaisons estimated community attendance at 95%) and every second home by door-to-door in 3 of 7 randomly selected community areas. In Community E an effort was made to approach every second house at least once during the survey periods.

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#### 4.2.2.1 Community Liaisons

A variety of qualitative participatory methods were used with each community liaison to maintain rigour and to be capable of methodological triangulation. Community liaisons were chosen based on interest, Council selection, and their role within the community dog management portfolio (health care provider, Council member and/or ACO). During discussions with community liaisons, semi-structured interviews, transect walks, mapping, and ranking of issues were completed at least twice over the course of the study. Sessions began using open-ended questions to establish a narrative regarding dogs within their community. This was then followed by community mapping and a transect walk to get a fuller sense of the area, as well as dog locations and activity throughout the area (in order to plan dog demographic counts). Ranking exercises outlining issues with dogs were either included during this session, or else completed during the following visit. Ongoing engagement consisting of (at minimum) monthly phone calls, emails or messages, and quarterly meetings, to discuss new developments within programmes, receive or provide community input results, and perform as a sounding board and resource for problem-solving and support, created an integrated relationship with the each community liaison by encouraging ongoing communication and interaction.

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#### 4.2.2.2 Elders' Teas

When possible out of respect for tradition and culture, an elders' tea was one of the first group sessions to be completed. A discussion with the elders on the importance and tradition of dogs within their community pinpointed the main themes to be explored during ongoing dialogues with the community. Context regarding the purpose and value placed on dogs was established, and in depth discussions concerning how and why these roles may have evolved provided basic insights on community viewpoints and philosophies concerning the present circumstances. A community timeline was developed during the session, and then corroborated during continuing discussion. During a following session, ranking exercises on community beliefs and attitudes towards dogs were completed and compared to the timeline, using the question '*How have the issues changed over time?*'.

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#### 4.2.2.3 Council Meetings

Developing themes arising from sessions with community members (including elders and community liaisons), discussions with the elected officials used key concepts and issues as topics for exploration, mind mapping and brainstorming. As they moved from identified difficulties and ideas, towards a picture of their ideal community dog situation, participants often debated potential policy options or community activities that they would like to implement, and the possible shortcomings and conceivable consequences of each of them. Session members were encouraged to share the steps or phases that they envisioned using for their community to move from their current dog issues. To confirm legitimacy, community acceptability and validity in ownership, the original concerns and resolutions were revisited during a second session using either a ranking or a matrix exercise.

#### 4.2.2.4 Community Meetings

To elicit feedback and potential support for council discussions, at the biannual community public forums and small group sessions the researcher used prompts and questions such as “*Tell me about dogs in this community.*” and “*What does the perfect community with people and dogs living here look like?*” These prompts and questions frequently led to diagramming present and futuristic timelines or mind maps, or ranking and scoring activities. These sessions also provided an opportunity to discuss the quantitative measures (surveys and dog demographic characteristics) that were being undertaken within the community, and to receive feedback on community impressions regarding the measures that had been implemented, or were being discussed.

#### 4.2.2.5 Other Groups

A number of sessions were held with other provincial stakeholders and health officials. These sessions were generally initiated at the request of community or health advisory groups, and involved large group discussions regarding the potential issues dogs bring to communities, as well as the provision of educational sessions on the current state of knowledge on dog population management, and disease and bite prevention. Key ideas, issues and solutions were explored using individual (followed by) and group ranking and Venn diagram exercises. As most of these sessions were multi-jurisdictional, the results of the previous exercises were then mind-mapped (see Appendix A) to investigate potential linkages between concepts to reduce resource requirements, while maximising impacts.

#### 4.2.2.6 Thematic Data Analysis

Thematic analysis is used to recognise, investigate and describe patterns within research. The researcher considers and evaluates assorted complex data, to find linkages between diverse concepts. Braun and Clarke (2006) outline five phases for implementing comprehensive thematic analyses, followed by dissemination of results:

1. Familiarisation with data
2. Generation of initial codes
3. Development and creation of themes
4. Review and refinement of themes
5. Definition of themes

While all phases were revisited multiple times throughout the research process, it is important to note that communities built and expanded on ideas and concepts, creating a constantly evolving, nonlinear depiction of the community environment and outlook. Due to the volatility and sensitivity of the topic being studied in vulnerable communities<sup>6</sup>, complete anonymity was required. Therefore conversations and sessions were transcribed by hand, and then typed into Microsoft Office Word 2010 prior to being uploaded into NVivo 10 for Windows (QSR International). This not only ensured complete confidentiality for individuals, but also retained the

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<sup>6</sup> Vulnerable communities are identified as disadvantaged sections of a community requiring careful consideration and increased protection during research. (*WMA Declaration of Helsinki-Ethical Principles for Medical Research Involving Human Subjects-59th WMA General Assembly, Seoul, Korea, October 2008*)

depth of replies received by the contributors. Interpersonal interactions between group participants, and specific nonverbal dynamics were also noted in order to ensure all community members had a full opportunity to express their concerns, beliefs and opinions, because as noted by McLellan *et al.* (2003) “*what is not said is just as important as what is said*” (p66). Due to the limited interviews and sessions held with Communities A, B and C, their results were combined, as were all sessions with external stakeholders, in order to maintain participant anonymity and confidentiality.

Once uploaded into the NVivo database, codes and themes were established to link and assess data in meaningful ways. Coding was done manually within the programme rather than using auto-coding in order to develop maximum familiarity with the information. Coding followed established suggestions such as identifying all promising themes, including context within each extract, and allowing extracts to be coded into all relevant themes and sub-themes (Braun & Clarke, 2006; Bryman, 2015). Overarching ideas that were consistently referred and added to were labeled as themes (e.g. community concerns, council/organisation struggles, community solutions). Themes were chosen for their ability to converge multiple topics into broad main concepts. These main themes were then broken down into sub-themes which differed slightly based on site or group involved (see Tables 4.2-4.10) but provided a means to organise the data in a logical and intuitive manner. Thematic mapping (Braun & Clarke, 2006; Bryman, 2015) was then used to develop visual representations of data areas (see Figures 4.6-4.14).

Key excerpts from each datum set were recorded as representative of group sentiment. Following the recommendations by Patton (1990, 2002, 2014), once themes were established and familiarity was gained from the data, they were examined for homogeneity (internal) and heterogeneity (external), ensuring similarity exists within themes and disparity exists between themes. Patterns were noted and recorded, and when necessary themes were polished, changed or amalgamated to ensure all significant concepts were covered. The essence of each theme was then distilled so that each main idea of the data had a descriptive label to be used as a term for presentation of results (see Table 4.1).

Table 4.1 – Overarching themes found in community discussions

Communities A, B and C, and external stakeholders	Community D	Community E
<ol style="list-style-type: none"> <li>1. Potential problems</li> <li>2. Solutions</li> </ol>	<ol style="list-style-type: none"> <li>1. Community concerns</li> <li>2. Council issues</li> <li>3. Solutions</li> </ol>	<ol style="list-style-type: none"> <li>1. Community concerns</li> <li>2. Council issues</li> <li>3. Solutions</li> <li>4. Community restrictions</li> </ol>

### 4.2.3 Quantitative Methods

In the two partial-project communities (A and C), bite statistics, dog counts and demographic data were collected by nongovernment animal organisations or community liaisons, and shared with the researcher. In these communities establishment of licensing is in progress, and where possible assessed numbers was compared to formal reported numbers (e.g. numbers of dogs counted to number of dogs licensed, and number of dog bites enumerated by the community compared to health region statistics). Meanwhile, in the two comprehensive-project communities (D and E), a number of dog and human community surveillance projects were undertaken.

#### 4.2.3.1 Community Surveys

A first set (by convenience sampling) of dog ownership and dog bite surveys (see surveys in Appendix C) was completed by researchers and students in each community (either in summer 2013 or spring 2014) on a subset of the population to test the appropriateness of the surveillance tools used. This was completed in spring 2014.

In an effort to completely engage and partner with the communities, door-to-door community-based surveys were completed by specific classes of high school students (under supervision of their teachers) in these two communities. Effort was made to interview at least 80% of households within the identified regions. Participating students were given volunteerism credit, and allowed to use this experience towards completion of specific class requirements. Included in the survey were questions relating to dog demographic characteristics, history of ownership (including morbidity or mortality events), and dog-bites/aggressive encounters. Provided classes wish to continue to participate in the future, annual assessments of the dog population parameters will be initiated by respective community Councils to continue to evaluate the impact, practicality and efficacy of community implemented dog population control measures.

Survey bite statistics were then compared to reported data from health regions to establish a more accurate understanding regarding dog bite reporting within First Nations communities.

Quantitative analysis was completed on dog demographic characteristics to evaluate baseline and annual population parameters (structure, distribution, dynamics, and health). As control programs currently vary considerably between the different communities, individual assessments were developed for each community, and a comparative descriptive analysis of proposed critical factors (as identified by the previous scoping review) for the effectiveness of dog population control and bite prevention programs within this subset of First Nations communities was completed. Additional quantitative statistical analyses regarding intervention success rates should be undertaken once there are sufficient data.

#### 4.2.3.2 Canine Sight Re-Sight Counts

As recommended by the WHO (WHO, 1984), community dog population numbers were physically estimated by sight re-sight sampling. This method is similar to traditional mark-recapture methods, however natural markings and identifying features were used in lieu of artificial ones in order to distinguish the dogs (Beck, 1973; Beck, 2000; Beck, 2011; Punjabi *et al.*, 2012).

Most current sight-re-sight models are an adaptation of the Cormack-Jolly-Seber (CJS) ecological population survival estimation model (see Figure 20). The CJS relies on live recaptures, which allows it to work well within a sight re-sight framework. Marked animals are counted by visual re-sight. When animals are “released” into the population after sampling 1, each subsequent “sighting” is an encounter occasion. The model suggests that a percentage of the marked population survives from the initial sighting to the second encounter occasion ( $S_1$ ), from the second encounter to the third ( $S_2$ ), and so on. Meanwhile, the probability of re-sighting at the second encounter is  $p_2$ , at the third encounter  $p_3$ , etc. In the CJS model, a minimum of two sightings are required to estimate the survival (i.e.,  $S_1$ ) between the first sighting and the next. By adapting this model, and using short time intervals to minimise population size changes, the theory is that an accurate population estimate can be calculated based on the percentage of animals that are “recaptured”.

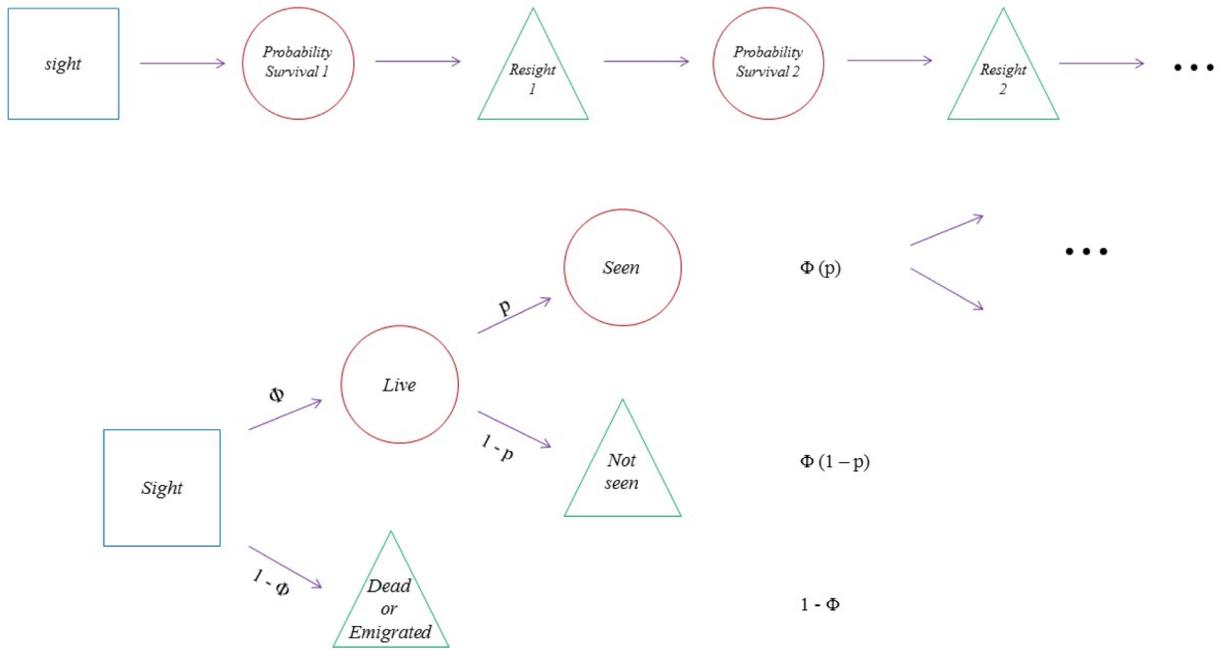


Figure 4.1 – Cormack-Jolly-Seber model a) simple model; b) realistic model

The use of sight re-sight demographic analysis provides specific benefits over mark re-sight methods in situations which are not conducive to repeated animal handling, but population sizes are unknown but needed for management methods (Beck, 1973; Otolorin *et al.*, 2014). For this technique to be effective, specific assumptions of identical definition of roaming, equal search effort, independence of capture, reliability of identification, and closed populations must be met (see Appendix C).



Figure 4.2 – Example of re-sighting over multiple primary sampling sessions

In addition, a closure test was used to assess the assumption of a closed population, and an open population model was calculated to compare population estimates. For these sampling counts, an adapted ICAM (2007) protocol was used. Primary sampling surveys were conducted over three to five days, with each day being demarcated as a secondary sampling unit. As mentioned previously, primary sampling intervals were short in order to maximise adherence to the assumption of a closed geographic and demographic population (therefore reducing immigration, emigration, mortality and natality).

To assess whether time of day actually influenced the numbers of dogs sighted (and re-sighted) as community members had suggested, counts were done mornings (at the time individuals would be getting ready and leaving for work and school), and late afternoons (at the time families would be getting home from school and work). These counts were then assessed separately and compared, as well as combined together. Although there were a minimum of 3 counts completed per time of day, the canine population may have been underestimated due to the short duration of primary sampling sessions.

Due to large survey areas and as per ICAM protocols, secondary sampling intervals were completed driving at 15km/h, in order to avoid the double counting of roaming dogs. Survey teams comprised at minimum a driver and a navigator/observer, with all members of the team responsible



Figure 4.3 – Example of secondary sampling repeated photographs for sight-re-sight demographics

for noting dogs. High quality photographs were taken using a Canon EOS Rebel T5 18 MP Digital SLR Camera with an 18-200mm lens. Each “marked” animal optimally had 2-3 photographs taken during preliminary scouting (full body +/- head and/or close-up of identifying markings) to improve re-sightability, and minimise misidentification (see Figures 4.2 and 4.3).

On secondary sampling days, each animal viewed had one full body photograph taken (and if necessary a second photograph for identifying characteristics of similar looking animals). In addition, each community area had secondary sampling tally sheets, where each dog observed was recorded in order to ensure total daily dog counts matched the combined totals of marked versus unmarked dogs each day. Predetermined sampling routes were travelled in such a way as to ensure sampling without replacement (i.e., double counting did not occur) (see Figure 4.4). Roads that were travelled more than once during a sampling interval were only counted the first time.



Figure 4.4 – Example of demographic surveillance route plan

After primary sampling intervals were completed, the number of dogs counted during secondary sampling (scouting day ( $n_1$ ), sampling days (day 2 =  $n_2$ , day 3 =  $n_3$ , ... day  $t$  =  $n_t$ ), the number of dogs photographed and considered “marked” on the scouting day ( $M$  \*only dogs with clearly identifiable markings or characteristics were delineated marked although all roaming dogs observed were counted), and the number of previously marked dogs re-sighted on sampling days (day 2 =  $m_2$ , day 3 =  $m_3$ , ... day  $t$  =  $m_t$ ) were used to calculate the total roaming dog population.

As multiple sampling days improve reliability and minimise the potential behavioural bias of some dogs roaming more widely and frequently, population estimation equations must also statistically account for the increased sampling sessions. This was first done using both a basic Lincoln-Petersen estimator model ( $N = \Sigma(Mn_i)/\Sigma m_i$ ) and a multicount version of Beck’s method (Beck, 2011), and compared to a modified Schnabel (Schumacher-Eschmeyer) model. In the

Schnabel model, each sample is handled as a Lincoln-Peterson (L-P) sample (Capello *et al.*, 2015), and then averaged to obtain an approximate population estimate (Belsare & Gompper, 2013). The total roaming dog population estimation in each area was therefore calculated using Equations 4.1 and 4.2.

$$\text{Beck's estimate of total dog population} = N = \frac{(n_1+1)*(n_2+1)*...*(n_t+1)}{(m_1+1)*...*(m_t+1)} - 1$$

Where

$n_t$  = the total number of dogs observed each day ( $t$ )

$m_t$  = the total number of dogs re-sighted each day ( $t$ )

$N$  = total roaming dog population estimate

Equation 4.1 – Beck's multicount population estimation

$$\text{Schnabel's estimate of total dog population} = N^{\wedge} = \frac{\sum (Mn_t)}{\sum m_t + 1}$$

Where

$M$  = the total number of marked dogs

$n_t$  = the total number of dogs observed each day ( $t$ )

$m_t$  = the total number of dogs re-sighted each day ( $t$ )

$\sum m$  = the summation of  $m$

$Mn_t$  = the product of each day's  $M$  and  $n_t$ ,

therefore  $\sum (Mn_t)$  = the summation of  $Mn$  to time ( $t$ )

$N$  = total roaming dog population estimate

Equation 4.2 – Schnabel's modified Lincoln-Peterson population estimation

As previously mentioned, two potential recapture biases may exist, heterogeneity and capture response. Heterogeneity infers that there may be differences in capture probabilities due to individual animal properties (e.g. unique personalities or behaviour patterns, sex, age, social hierarchy, etc.). Capture response is the likelihood of previous "capture" encounters causing a difference in the probability of being "recaptured" due to positive or negative stimuli (e.g. inducing interaction with treats = "trap happy", snaring in metal cages = "trap shy", etc.).

As a considerable number of individuals within the FRD populations found in Communities D and E were observed to be semi-restricted (i.e., on any given day owners may have chosen to restrain their dog, or allow it to roam – as noted by identifying 'marked' freely roaming individuals at times restrained within their yards) exact heterogeneity and capture response is unmeasurable in these communities. Instead what is calculated is a rough estimate of the FRD population at any given time. To double-check this, the results of previous population estimates were followed by

assessment of the recapture probabilities with the Bayesian model proposed by Matter *et al.* (Matter & Daniels, 2000; Matter *et al.*, 2000). Precision was also improved by increasing the total number of possible re-sightings (i.e., having a minimum of 3 secondary sampling days in contrast to the standard 1 day of re-sighting).

Establishing a reliable total roaming dog estimate for the entire community that can be regularly used without significant effort, requires calculating a detectability estimate (DE) (see Equation 4.3). The detectability estimate is the likelihood a roaming dog will be observed and recorded during sampling intervals. This DE is then used to correct other rapidly calculated population estimates. The DE is calculated by comparing the intensive sight re-sight calculations (i.e., intensive survey efforts, comprehensive community owner questionnaires could also be used)

$$\text{detectability estimate} = \frac{\text{rapid street survey estimate}}{\text{intensive survey estimate}}$$

Equation 4.3 – Detectability estimate

with other less intensive methods (such as rapid street surveys). Having a DE allows the community to conduct regular estimates to assess whether interventions are providing measurable results without requiring extensive community-wide sampling sessions.

These demographic numbers were compared to the ownership numbers obtained by the community surveys, in addition to the numbers of dogs registered and licensed in each community in order to provide a more accurate overall dog population number.

Finally, a test to assess the assumption of a closed population was run, and the results of all models were compared to an open population model to assess the potential impact of the violation of the closed population assumption.

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#### 4.2.3.3 Community Dog Health

Community surveys collected data on the animal health care choices made by owners (see survey in Appendix C). Raw number and percentages are reported.

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#### 4.2.3.4 Community Licensing Statistics and Incident Complaints

In Communities D and E, an attempt was made to keep track of the number of licensed animals and community complaints regarding aggressive dog:human encounters over the study period. It was hypothesised that with increased awareness and community trust, more people would license and register their dogs with their community office, and be willing to discuss potential problems and solutions with regards to dangerous encounters.

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#### 4.2.3.5 Clinically Seen Dog Bites

Permission was granted by Communities D and E to access records for reported dog bites to medical authorities. De-identified records and statistics were provided by Health Canada (for on-reserve dog bites), and the Northern Inter-Tribal Health Authority (for off-reserve dog bites).

These numbers were compared to the self-identified number of aggressive encounters and dog bites reported within the community surveys within the same time frame (January 1<sup>st</sup>, 2013 to December 31<sup>st</sup>, 2014). The combined databases were then scrutinised where possible for trends and associations (human – age, sex, anatomical location of bite, geographical location of incident; dog – age, sex, reproductive status, size, relationship to victim; incident – trigger, number of animals, number of bites) using Pearson  $\chi^2$ , likelihood ratios and simple logistic regression. The structure of these reports differed somewhat due to the need to protect patient confidentiality, therefore full case and community comparisons were generally not possible.

#### 4.2.4 Mixing Methods

The present project's design grew and evolved over the first year as it became apparent what was needed. This resulted in a more dynamic and cyclical structure, in which methods developed over the course of the research. Though it was understood that both qualitative and quantitative strands would be needed, the progression in which they occurred was very dependent on interaction with the communities themselves, and what they found to be of value.

For example, the communities' narratives were considered critical to understanding which control methods were in place and what would be preferred, but it was equally important to have a realistic view of exactly how many dogs were present in each community. As the project was a partnership with each community, each section built and informed both the preceding and the subsequent pieces in different ways, frequently leading to additional requirements more often than eliminating them. As well, the research and results of the previously described scoping review created ongoing discussion and diverging conversation points for the

Prior to the start of the project, the proposed design would have more closely resembled an embedded qualitative design (with the quantitative dog counts and survey results supporting the developing qualitative data), rather than the multiphase, convergent parallel design that it became. The original perspective was of a qualitative priority, as the narratives of the communities' members would give the depth of information necessary to understand the attitudes and beliefs around dogs (leading to implemented policy), while the quantitative statistics on dog populations and dog bites would serve to support the qualitative findings.

However as the study developed, it became apparent that the attitudes towards the dog populations, and the true numbers of dogs and their dispersal within communities did not always coincide. In addition, community policy makers were as interested in the numbers (of total dogs, ownership behaviour, bites, and aggressive encounters), as they were in community attitudes and perspectives. It may be that as members of the community(ies) themselves, policy makers feel they already have a basic sense of community needs and beliefs, whereas they potentially lack the more complex statistical data to provide key information with which to make knowledgeable, long term decisions. The quantitative strand consequently grew in importance and spectrum, to be considered of equal priority. Accordingly, both qualitative and quantitative strands from the initial phase combined to inform the data strands simultaneously being collected in the second phase (see Figure 4.5).

While attempts were consistently made to use the same quantitative and qualitative research techniques in the same order within each community, due to community events and activities, this was not always possible. However, within both the qualitative and the quantitative streams of the research project, data were obtained by multiple methods, allowing for methodological

triangulation and assessment of the validity and reliability within results. In addition, integration during several stages (data collection (open and closed-ended questions on surveys, encouragement of personal narratives during medical examinations), data analysis (via triangulation and correlation), and data interpretation) created a more comprehensive appraisal.

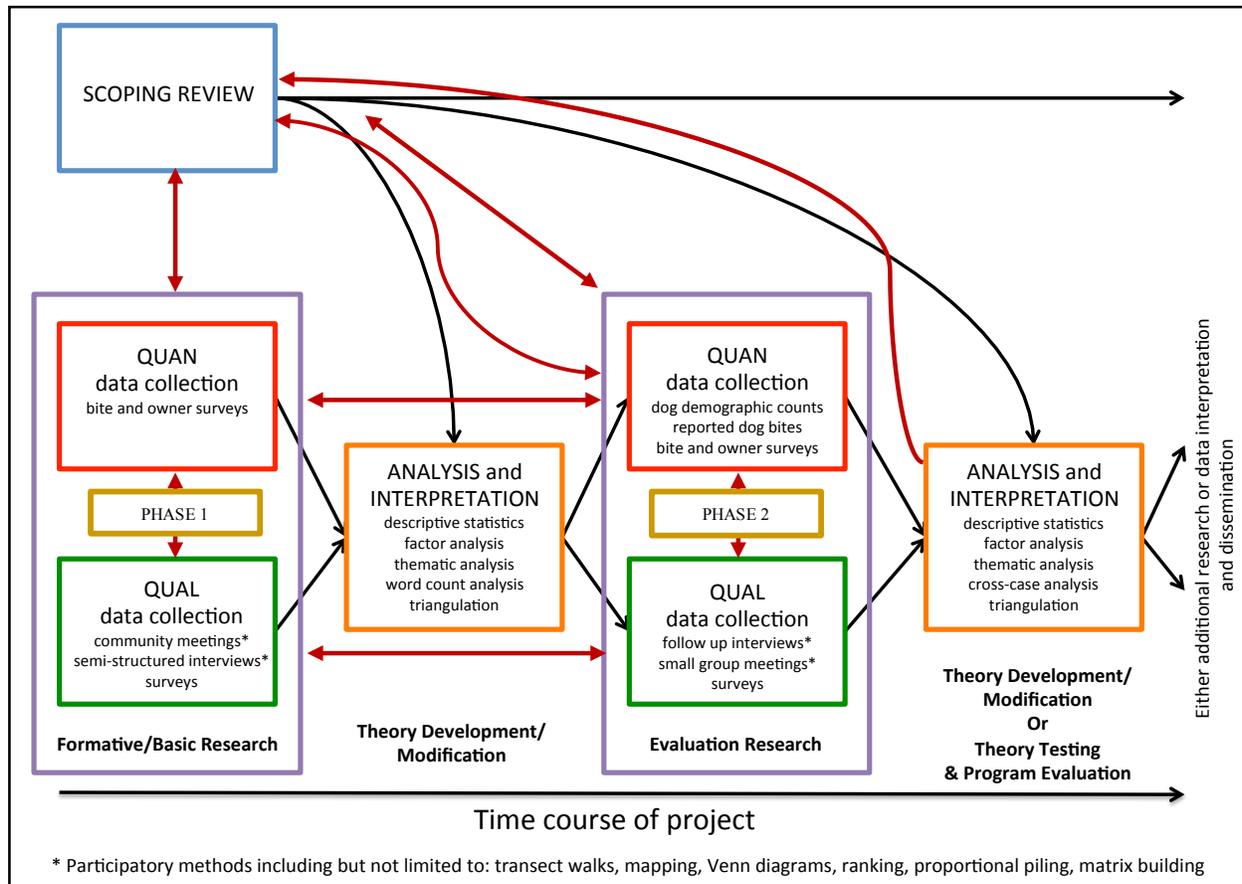


Figure 4.5 – Modified data collection phase for a multiphase, convergent parallel mixed methods study on dog population management and dog bite prevention in remote indigenous Canadian communities

Within the first phase of the qualitative component of the project, thematic analysis was used to analyse all of the community sessions by accumulating them and subsequently grouping them into related topics or ideas. The transcriptions also underwent a word-count analysis within NVivo to identify patterns of thought and develop a priority list within the identified themes. Meanwhile, the analysis for the quantitative component included a basic factor analysis, in addition to descriptive statistics, where the results were compiled as frequencies and percentages.

After preliminary community discussions, community mapping and the transect walk from the qualitative stream, qualitative results were compared, contrasted and correlated with primary results from the quantitative questions from the community surveys, and themes from the literature scoping review. This comparative analysis by triangulation showed that specific areas within communities and subsets of the population were more likely to have negative feelings towards dogs, be involved in more aggressive encounters with dogs, sustain more dog bites, be less willing to report bites, and be less willing to become engaged in community discourse regarding policy changes and solutions to dog issues within the community.

Subsequent discussions with site contacts and councils establishing respondent validation towards these initial impressions led to both communities a) requesting more in-depth analysis and b) increasing community communication efforts with respect to their dog population management program planning. First phase results subsequently informed several of the questions asked in second phase interviews and sessions (e.g. ‘*Are there areas of the community where you find more dogs? Is this a problem?*’; ‘*Are there situations in which you would be uncomfortable reporting an aggressive encounter with a dog? Can you tell me about them?*’). Initial results also reinforced the need for expanded community partnership for the second phase of the project.

Convergence and divergence of results were closely observed, assessed and compared to the literature. Divergence has the potential to produce new theories and levels of comprehension by creating additional ways of viewing and reasoning (Cresswell & Plano-Clark, 2007). Originally it was anticipated that the second phase of the project would qualitatively identify potential causal mechanisms and triggers behind the greater incidence of aggressive encounters between dogs and humans within these communities, as well as categorise cultural or social constructs reducing the willingness to report incidents and encounters. Having these data could then inform decision makers regarding the driving factors within their community for policy change or stagnation. While this did occur, the complexity of the current and historical sociocultural, political and economic environments, and the lasting impacts of previous policies are not easily compartmentalised, nor are there “simple” statements to be made.

Similarly, the quantitative data were expected to outline trends and patterns with regards to distinguishing features of higher risk individuals and population groups. In addition, indication of intervention effects and preliminary policy changes were hoped to be noticeable with regards to FRD numbers and reported dog bites and aggressive encounters. These results were then compared to the results from the scoping review to assess ‘*what is known*’ in a more comprehensive analysis.

#### 4.2.5 Statistical Model Building

All data handling and statistical analysis was performed using Microsoft Office Excel 2013 and STATA software version 14 (StataCorp, College Station, Texas). Analyses were completed to explore whether differences in dog care and management existed between Communities D and E. That is whether communities differed with respect to certain factors considered more likely to increase the risk of a dog bite (as identified through the previously described scoping review), as well as whether the communities were similar in their dog management characteristics, and therefore successful interventions could be generalizable across both communities.

Initially complete descriptive statistics including raw ratios and Chi-square ( $\chi^2$ ) for univariate analyses of categorical variables, and Mann-Whitney rank sum tests for continuous variables were calculated for each community. Pearson correlations and Fisher’s exact tests were run for all variables for communities separately.

Next, independent variables were built into unconditional logistic regression models using “community” as outcome. Variables with p-values smaller than 0.05 were immediately preserved, while variables with p-values greater than +/- 0.3 were discarded (see Appendix C).

Tests for confounding (showing significant influence on effect estimates by a greater than 20% difference between the adjusted odds ratios and the crude model) were also completed. As a final verification for variable retention, maximum likelihood estimates, proper likelihood ratios and Wald’s tests were completed for all factors. Finally, additional tests for linearity, normality,

homoscedasticity, independence and collinearity using scatterplot matrices, predicted residuals and partial-regression plots were implemented.

## 4.3 Results

### 4.3.1 Thematic Analysis

Although there were commonalities among all communities and groups during discussions and engagement sessions, on some topics the range was very broad and diverse. Prompts and questions such as “*Tell me about the dogs in your community.*” and “*What would the community look like if there were no dog issues?*” created much debate, and were not easily distilled down into categories. In contrast, topics such as “*Do dogs create problems within your community?*”, “*How are dogs seen in your community?*” and “*How can we build this (ideal) community?*” lent themselves well to theme development that could then be explored further in following sessions. The excerpts presented here illustrate the specific ideas frequently revisited within sessions. Unfortunately, thematic analysis itself does not show the frequency with which topics and terms arose, nor the similarities between them. To further examine sessions, word clouds were built to identify the importance and emphasis of specific concepts.

#### 4.3.1.1 Communities A, B and C

Within these three communities discussions surrounding the problems with dogs focused on three things: owners, lack of resources and public safety (see Figure 4.6). Participants broadly discussed the differences between a lack of knowledge and a lack of responsibility or “interest”, as well as the problems that a lack of resources created. Conversations generally culminated in elaboration on the extent to which community members felt dogs affected their safety. These sub-themes are shown in Table 4.2 and further explained in the discussion.

Table 4.2 – Community A, B and C Thematic Analysis of Community Dog “Problems” Sub-themes

Sub-themes	Example of Data Extracts	Coded as
<b>Owners</b>		
- lack of education	“there needs to be awareness that all dogs are capable of biting”	education; communication
- lack of responsibility	“irresponsible owners do not socialise or train their dogs”	attitude; behaviour; communication
<b>Resources</b>		
- lack of funding	“people need to know that having a dog is a commitment – just like having a baby – and they cost a lot of money”	cost
- lack of support	“everyone in the community needs to participate in reducing the problem of dangerous dogs”	communication; education; attitude
<b>Safety</b>		
- too many dogs	“there should be no intact dogs in the community”	attitude; safety; communication
- too much roaming	“dogs pack up and then idiots go out and shoot all of the dogs putting everyone’s safety at risk”	attitude; behaviour; safety

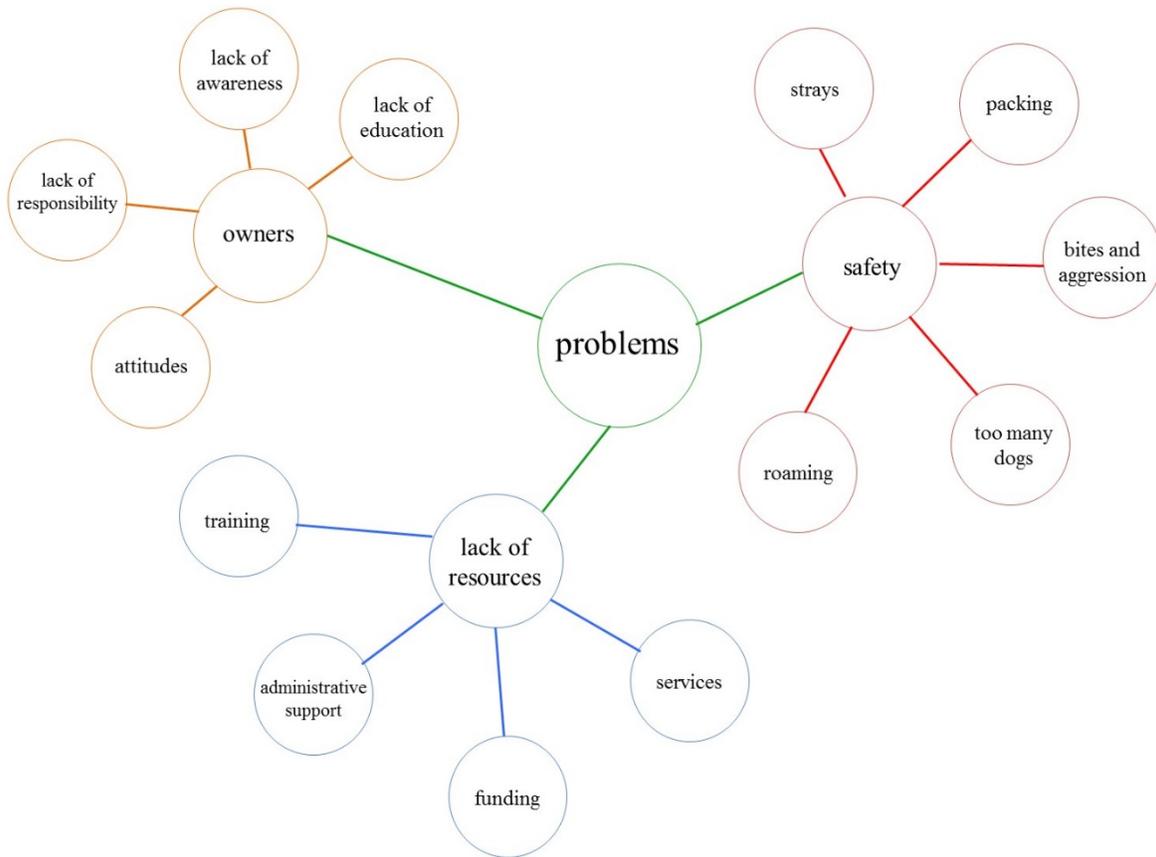


Figure 4.6 – Communities A, B, and C thematic map of community dog issues: 'Problems' theme

Table 4.3 – Community A, B and C Thematic Analysis of Community Dog “Solutions” Sub-themes

Sub-themes	Example of Data Extracts	Coded as
<b>Resources</b>		
- training	“educational programs for pet owners and behaviour dog training should be available for everyone”	education; resources; communication
- animal care	“ensure dogs in the community are well cared for by promoting access to veterinarians”	resources
<b>Funding</b>		
- holding facilities	“a shelter would permit enforcement to occur regularly; without a place to hold the dogs there is no point in picking them up – they just cost so much to set up and maintain”	resources; cost
- clinics	“sterilisation of community animals would really help with population control if we could pay for it”	resources; cost
- enforcement	“hire and train (and pay) officers properly - officers must be able to step forward and deal with animals everywhere”	resources; cost
<b>Communication and Support</b>		
- animal value	“we’ve always loved our and respected our dogs – people need to be reminded of our history”	attitude; education; communication
- public health	“community needs to be educated on the diseases dogs carry – maybe that will help with changing attitudes”	education; communication
- community safety	“dogs staying on own property would allow everyone to live safely and harmoniously”	education; safety; communication

In comparison, although the dialogue regarding solutions followed trends, often specific solutions were community oriented and specific. Certain commonalities did exist regarding broad areas on which to focus, including resource acquisition, funding procurement, and improved communication (see Figure 4.7 – Communities A, B and C thematic map of community dog issues: 'Solutions' themeFigure 4.7). The major ideas for community-based solutions are summarised in Table 4.3.

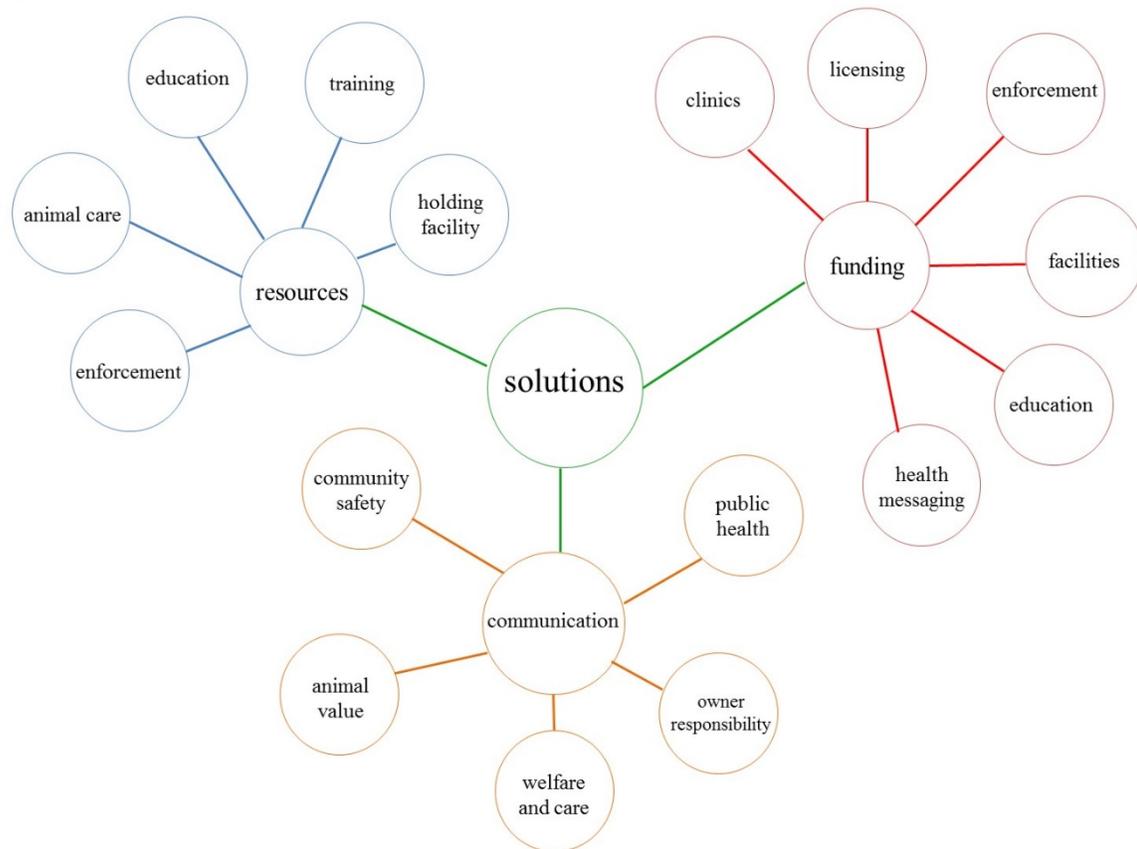


Figure 4.7 – Communities A, B and C thematic map of community dog issues: 'Solutions' theme

#### 4.3.1.2 Community D

In Community D there were some notable differences in the identified concerns depending on the group involved in the discussions. Community members recognised four key areas to be improved: dog ownership, availability of resources, communication and community safety (see Figure 4.8). In comparison, community Council members specified six issues of concern: owners, funding, community dissatisfaction, boundaries, strategies and communication (see Figure 4.10).

Although these conversations separated the specific issues associated with people, dogs and the environment, participants understood most problems were complex and multifaceted, having a number of root causes. Examples of sub-theme topics can be found in Tables 4.4 and 4.5, and are further discussed later.

Despite the differences in pinpointing areas of concern, all of the discussions with external stakeholders generated similar topics where the community could focus solutions: education, communication, legislation, socialisation, clinics and attitude (see Figure 4.9). These topic areas created broad, comprehensive lists of suggested changes that could be implemented in both the short and the long term. These have been summarised in Table 4.6, to be expanded on further in the discussion.

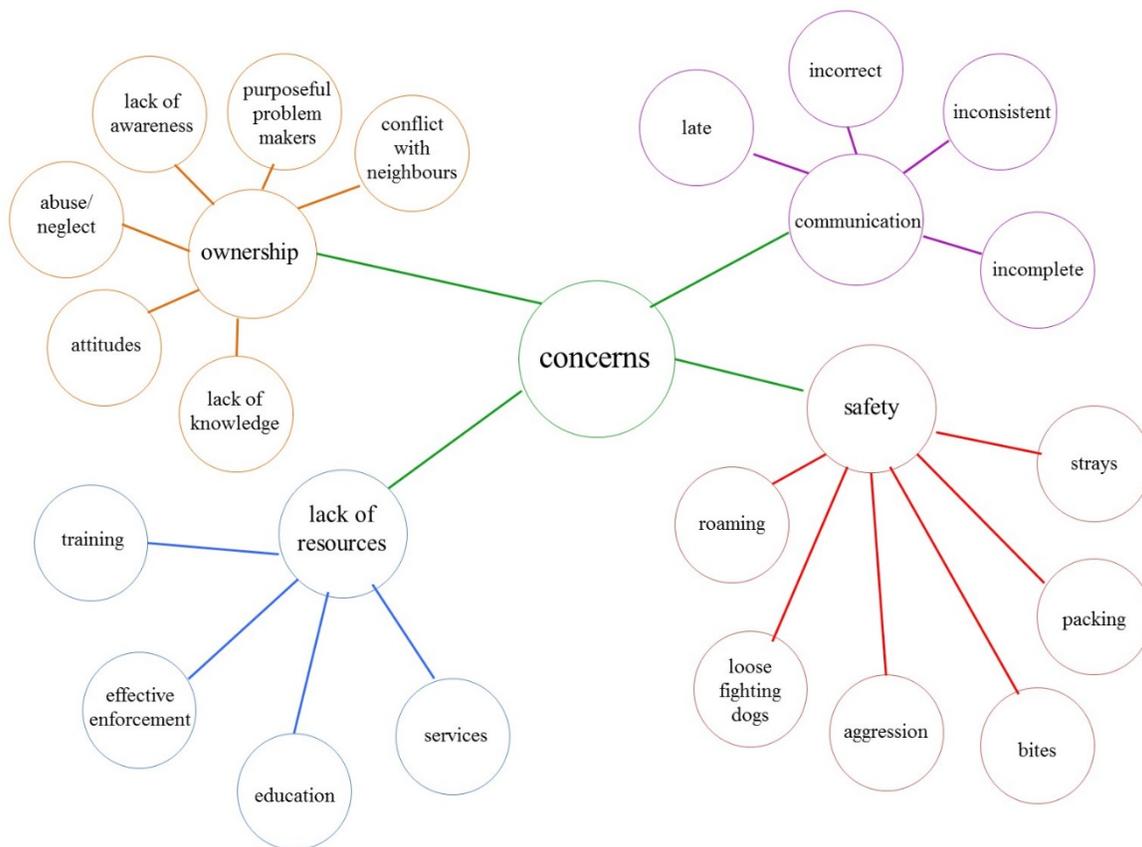


Figure 4.8 – Community D thematic map of community dog issues: 'Community Concerns' theme

Table 4.4 – Community D Thematic Analysis of Community Dog “Community Concerns” Sub-themes

Sub-themes	Example of Data Extracts	Coded as
<b><i>Ownership</i></b>		
- lack of understanding	“education is a key component that has not been built”	education
- purposeful abuse/negative aggression training	“some problem dogs are not able to be turned around due to the situation and the owner”	attitude
- learned behaviour/ attitudes	“provocation isn’t really understood”	communication; education
- neighbour conflicts	“there are conflicts with neighbours when there are behaviour issues”	communication; attitude
<b><i>Lack of resources</i></b>		
- training and education	“dog catcher is not equipped to deal with vicious dogs”	education; resources
- services	“too much reactionary behaviour... not enough planning and prevention”	resources
- enforcement	“culls breed mistrust and make animals disposable... this encourages animal abuse”	resources
<b><i>Communication</i></b>		
- poor communication	“definition of dangerous dogs not uniformly understood”	communication
<b><i>Fear of safety</i></b>		
- unowned dogs	“dogs without owners wander now – people have lost the knowledge of how to care for them”	education; behaviour; safety
- unrestrained owned dogs	“dogs pack up and chase people – afraid to walk”	behaviour; safety
- dog behaviour (roaming, packing, bites, aggression)	“there’s a difference between the few trained to be aggressive, and the many aggressive in a few situations”	behaviour; safety

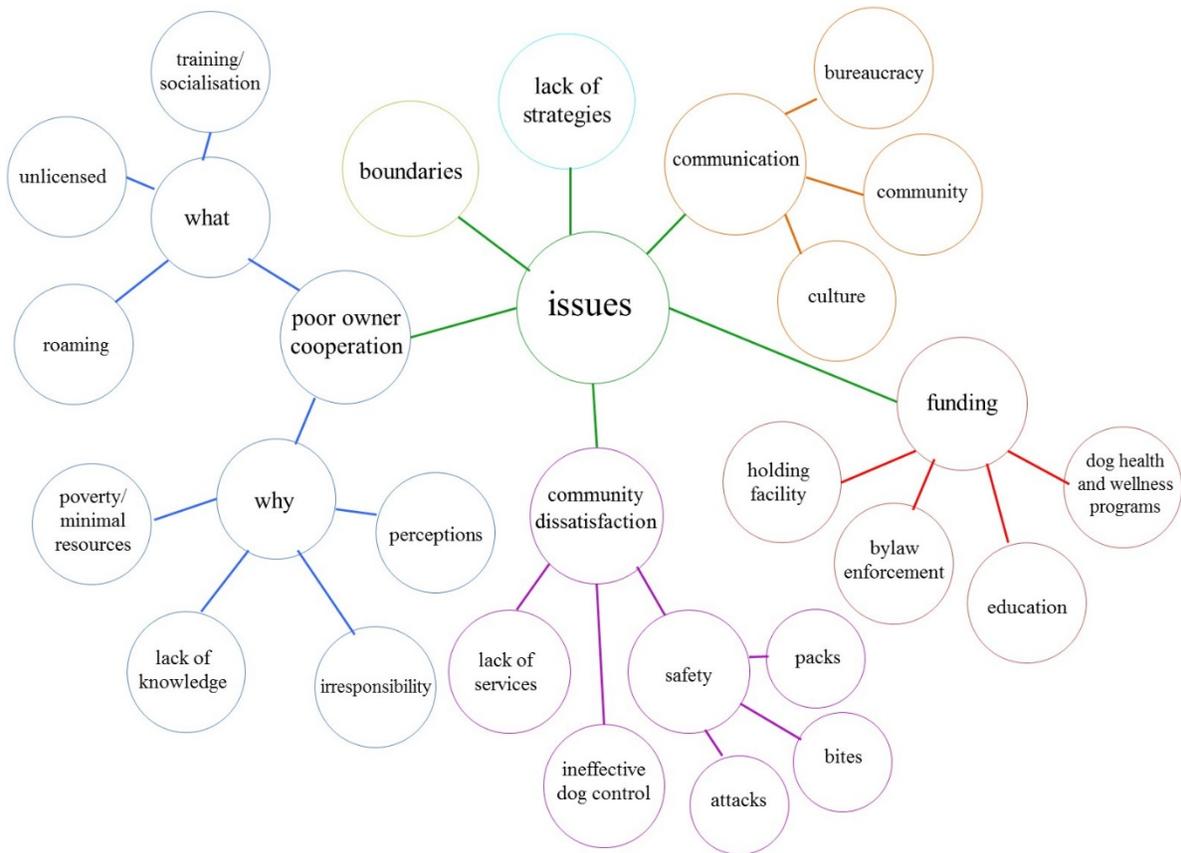


Figure 4.10 – Community D thematic map of community dog issues - 'Council Issues' theme

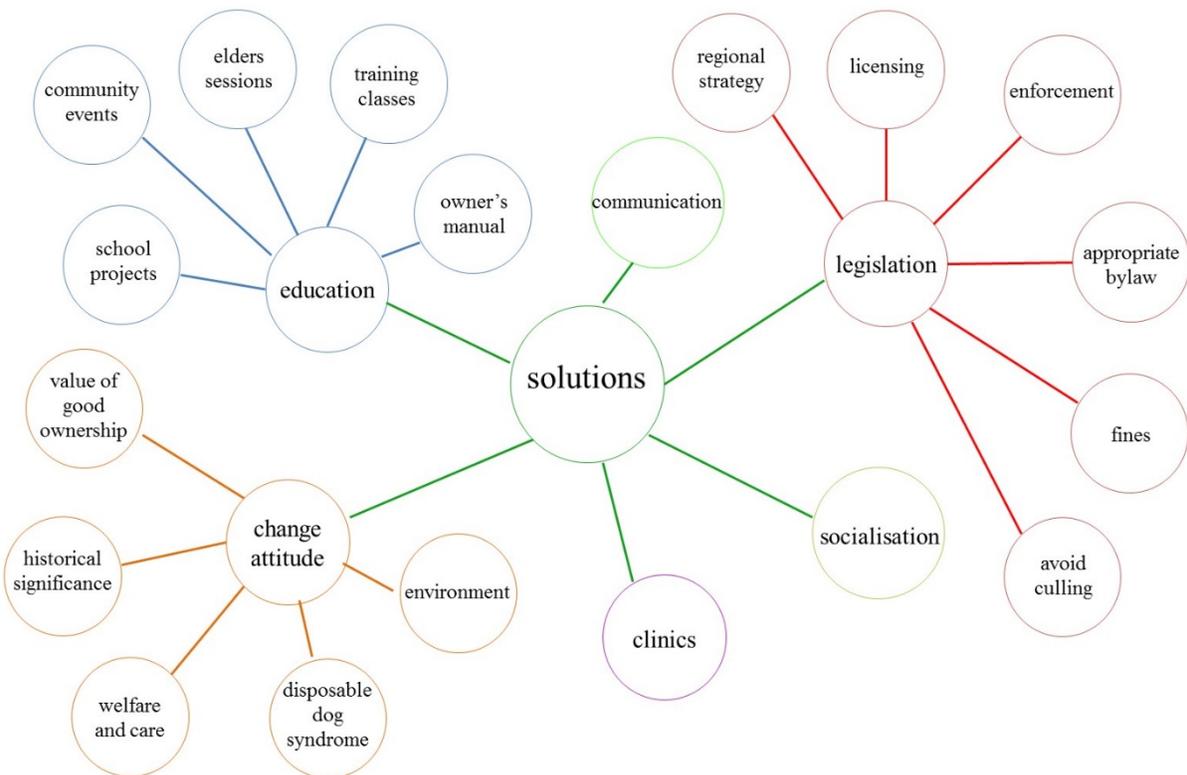


Figure 4.9 – Community D thematic map of community dog issues - 'Solutions' theme

Table 4.5 – Community D Thematic Analysis of Community Dog “Council Issues” Sub-themes

<b>Sub-themes</b>	<b>Example of Data Extracts</b>	<b>Coded as</b>
<b><i>Owners</i></b>		
- lack of owner cooperation	“there needs to be inventory of animals and owners”	attitude
<b><i>Community dissatisfaction</i></b>		
- services	“RCMP are being relied on to do many things outside of their mandate – additional resources and education would be helpful”	communication; resources
- safety	“this environment is ripe for dog abuse and neglect – there are too many dogs, doing too much packing up”	behaviour; education; communication; safety
- staff (dog catchers, public health, administration)	“people think staff aren’t doing their jobs... but they can’t be everywhere and doing everything”	resources
<b><i>Funding</i></b>		
- education	“this could have a significant impact on the dog population – reducing subsequent management costs”	communication; costs education
- services	“cost recovery would go a long way to paying for everything we need”	resources; costs
- facilities	“there needs to be something more permanent established”	facility; resources
<b><i>Boundaries</i></b>		
- responsibilities	“groups need to work as a single cohesive unit”	legislation
<b><i>Strategies</i></b>		
- lack of strategies	“there needs to be a two tiered system – immediate concern = protect safety; but long term = educational pieces that create behaviour change”	attitude; education; communication; safety
<b><i>Complex communication</i></b>		
- community	“phrasing is critical – the wrong words cause constant mistrust. e.g. <i>we are not here to kill your dog</i> ”	communication
- culture	“need to move from the idea of property to valued companions”	attitude
- bureaucracy	“management efforts get caught up in red tape at all levels and between different groups”	legislation

Table 4.6 – Community D Thematic Analysis of Community Dog “Solutions” Sub-themes

<b>Sub-themes</b>	<b>Example of Data Extracts</b>	<b>Coded as</b>
<b><i>Communication</i></b>		
- improved communication	“teach the community to treat dogs properly – control and train them”	communication; education
<b><i>Socialisation</i></b>		
- improved socialisation	“dogs need care and teaching, so they are helpers”	behaviour; education
<b><i>Improve resource access</i></b>		
- availability of clinics	“having regular veterinary care would go a long way in reducing the dog numbers”	resources
<b><i>Comprehensive legislation</i></b>		
- appropriate	“if we are looking to impact population size perhaps a spay-neuter section should be included”	legislation
- enforced	“consistent enforcement and funding is needed”	legislation; resources
- community supported	“the best programs are loved by everyone”	legislation
- multi-community	“sharing of licensing, resources and bylaws would promote and enhance management and enforcement”	legislation; resources
<b><i>Inclusive and widespread education</i></b>		
- schools	“educational programs that emphasize empathy can improve the care of dogs”	education
- community	“engaging the elders to provide information on history can help create sense of importance”	education
- owners	“ensure everyone knows and understands the bylaws and their personal responsibilities, and remind them to develop cultural value”	attitude; communication; education
<b><i>Modify attitudes</i></b>		
- value of animals and history	“perceptions of animals need to change”	attitude
- environment and welfare	“people just need to protect and care for at least their own dog... not every dog”	attitude

#### 4.3.1.3 Community E

In Community E, the community concerns were able to be clustered into two main themes: safety, and lack of resources (or access to) (see Figure 4.11). Significant emphasis was placed on everything missing by being remote and removed from a more urban environment, and the issues presented by dogs which affect safety. These are further expanded in Table 4.7 and discussed in detail presently.

Meanwhile, the issues that were most concerning to Council focused mainly on community noncompliance and financial costs (see Figure 4.12). It was felt that if the community was onboard with following regulations there would be few problems, and those that did exist or develop could be surmounted given sufficient financial assistance. These sub-themes are expanded in Table 4.8, and further described in the discussion.

Discussions with both community members and the Council moved from the problems that dogs create within the community to potential solutions for the issues (see Figure 4.13). Unlike other communities however, this brainstorming also identified and listed all of the specific restrictions that would need to be addressed to improve the situation within the community (see Figure 4.14).

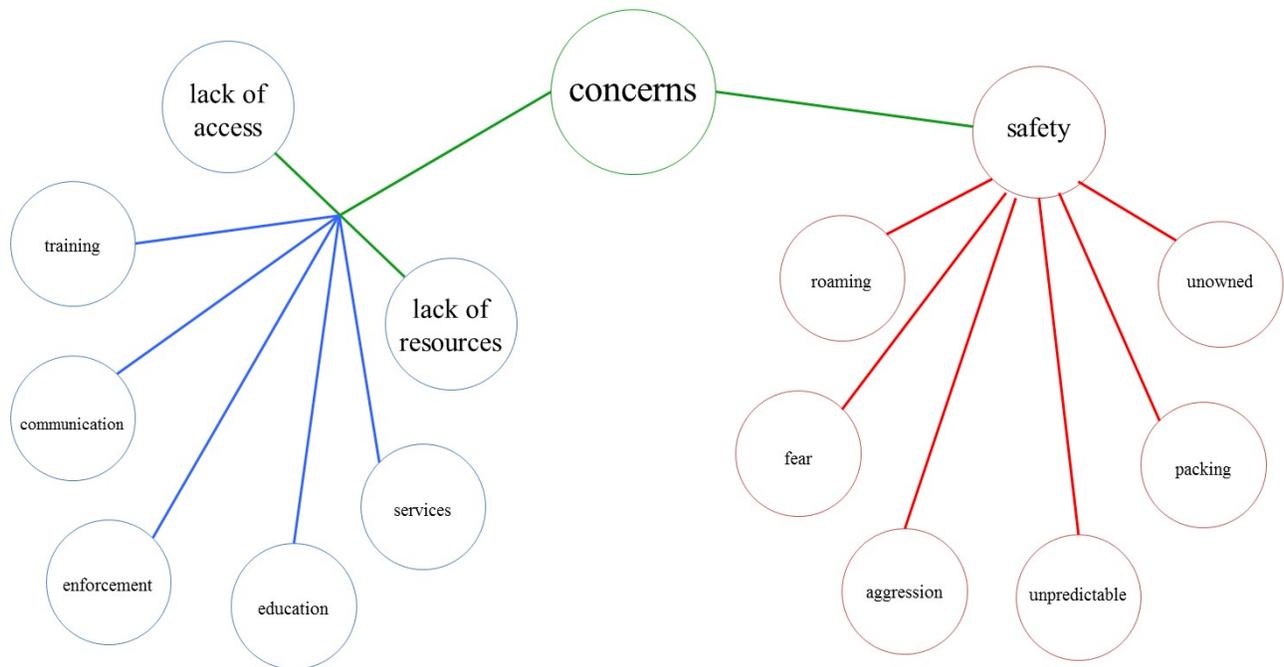


Figure 4.11 – Community E thematic map of community dog issues - 'Community Concerns' theme

Table 4.7 – Community E Thematic Analysis of Community Dog “Community Concerns” Sub-themes

Sub-themes	Example of Data Extracts	Coded as
<b><i>Missing resources and access</i></b>		
- lack of enforcement	“we need a proper bylaw officer”	legislation; resources
- lack of appropriate services	“most dogs aren’t getting proper veterinary care”	resources
- lack of training	“there is a complete lack of training and control”	resources
- lack of education/ communication	“there’s a recurring theme – I’m not responsible for that”	resources
<b><i>Safety</i></b>		
- roaming dogs	“dogs are not tied up or kept in a fenced yard”	roaming
- packing dogs	“there are so many loose dogs... all running together!”	behaviour, safety
- unowned dogs	“do the wandering dogs always belong to someone? Because they are dangerous and a nuisance”	behaviour
- aggressive animals	“aggressive dogs threaten everyone’s safety”	behaviour, safety
- fear for children/elders	“dogs hang around school becoming dangerous for kids”	behaviour, safety

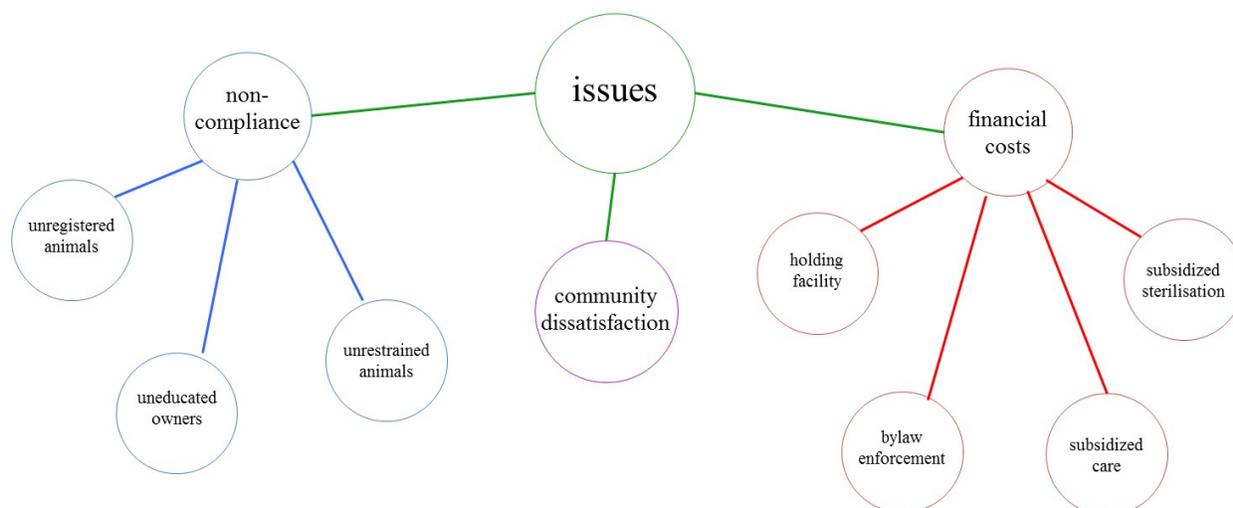


Figure 4.12 – Community E thematic map of community dog issues - 'Council Issues' theme

Table 4.8 – Community E Thematic Analysis of Community Dog “Council Issues” Sub-themes

Sub-themes	Example of Data Extracts	Coded as
<b><i>Financial costs</i></b>		
- holding facility	“there is nowhere to keep dogs that we pick up”	facility; costs
- bylaw enforcement	“owners won’t let their dogs go when the dog catcher goes to pick it up when it is roaming”	legislation; costs
- subsidizing care/neutering	“the increasing population is a whole community issue – we need to help”	resources; costs
<b><i>Community dissatisfaction</i></b>		
- attitudes	“owners are so upset with Council right now”	attitude
<b><i>Non-compliance</i></b>		
- unregistered/unlicensed animals	“very few people register their dogs”	registration
- unrestrained animals	“so many dogs on the loose”	roaming
- uneducated owners	“owners call the office angry about aggressive animals, but swear at staff and complain when we try to address the problem”	communication; education

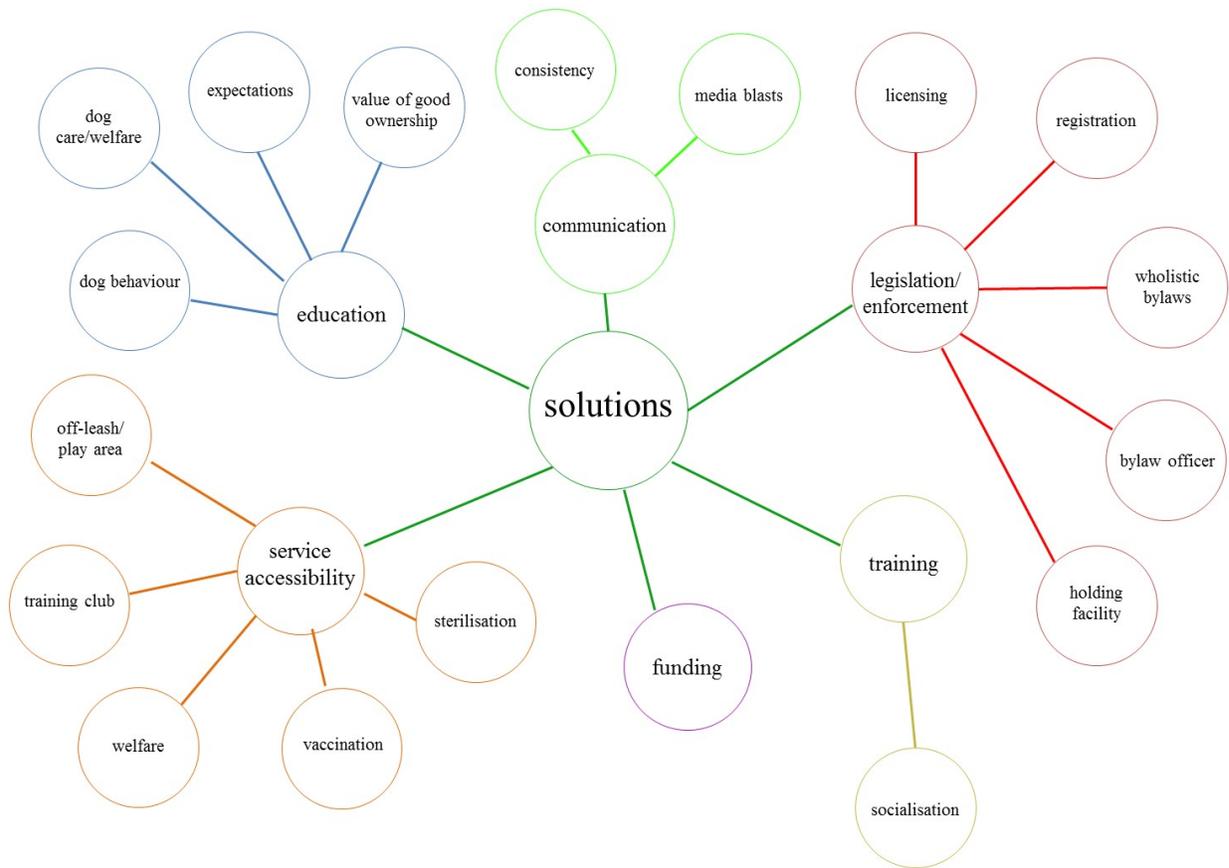


Figure 4.13 – Community E thematic map of community dog issues - 'Solutions' theme

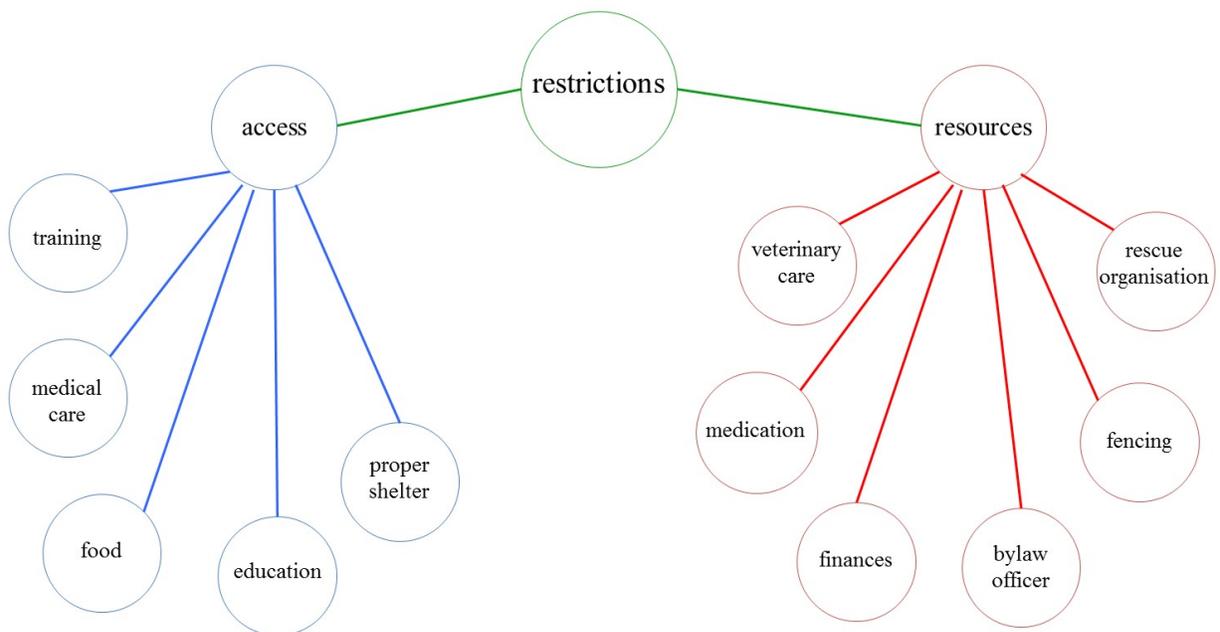


Figure 4.14 – Community E thematic map of community dog issues - 'Community Restrictions' theme

Table 4.9 – Community E Thematic Analysis of Community Dog “Solutions” Sub-themes

<b>Sub-themes</b>	<b>Example of Data Extracts</b>	<b>Coded as</b>
<b>Communication</b>		
- media blasts – FB, Twitter, radio, TV	“put the bylaws up on the website – and how it will be enforced”	communication
- consistent message	“keep repeating the same story... eventually everyone remembers”	communication
<b>Legislation and enforcement</b>		
- bylaw officer	“hire someone to talk and educate – not just be a dog killer”	legislation
- comprehensive bylaws	“the laws have to apply to everyone”	legislation
- holding facility	“build a place to keep the dogs”	resources
- registration and licensing	“write letters to remind pet owners”	legislation
<b>Education</b>		
- community expectations	“go to the schools and have public hearings so everyone hears and knows”	communication; education
- dog behaviour	“Be proactive – trained dogs are safer dogs”	education
- dog welfare/care	“have semi-annual clinic that includes learning”	education; resources
- value good ownership	“we need to increase the good feelings of pet ownership”	education
<b>Dog training</b>		
- improved socialisation	“I think animals that are handled and loved a lot understand humans better”	education; behaviour
<b>Funding</b>		
- monetary support	“are there some grants or something?”	costs
<b>Service accessibility</b>		
- sterilisation	“create an accessible spay/neuter program”	resources
- vaccination and basic care	“annual clinics would help”	resources
- training club	“experts could help a lot with training”	resources
- off-leash walking/play area	“dogs need space to run and play”	resources

Table 4.10 – Community E Thematic Analysis of Community Dog “Restrictions” Sub-themes

<b>Sub-themes</b>	<b>Example of Data Extracts</b>	<b>Coded as</b>
<b>Access</b>		
- care – medical, food, shelter	“I’d like to provide more – I just can’t afford to”	resources; costs
- training and education	“how do I know what’s ok? Everyone on TV says different stuff”	education; resources; costs
<b>Resources</b>		
- personnel – veterinary, bylaw officer, rescue organisation	“there’s no one here to help us”	resources; costs
- medication and vaccines	“keeping dogs healthy is more than just hoping”	resources; costs
- finances and supplies (e.g. fencing, hay, etc)	“some people can’t put food on the table but you want them to fix their fence?”	resources; costs

Both groups fully explored the feasible solutions that they felt had the potential to be successful within the community (as can be seen in Table 4.9). These interventions included improved communication, legislation and enforcement, increased comprehensive education, training, sustainable funding, and accessible services. Uniquely, during the identification of

solutions, the participants also acknowledged significant restrictions that have the potential to create difficulties for the implementation of the chosen improvements. These generally focused on accessibility and resource sustainability (see Table 4.10). In general, these restrictions had previously been identified as concerns, however they were expanded upon further in this context to more fully detail the limitations surrounding each issue. The expansion of these sub-themes is developed in the discussion.

### 4.3.2 Community Surveys

During the initial preliminary survey testing, when asked whether they or anyone in their household had ever been subject to an aggressive encounter (defined to be anything from a ‘near-miss’ to a fatal mauling), 100% of respondents responded “yes”. Therefore, the question was adjusted to limit timing to within the previous year.

In Community D, 38 out of 116 (~33%) households surveyed had at least one family member who had been a victim of an aggressive dog:human encounter within the previous 12 months, compared to Community E, where 52 out of 126 (~41%) households surveyed had at least one family member who had been attacked (see Table 4.11).

Table 4.11 – Community D and E households subject to aggressive encounters in the previous year

<b>Location</b>	<b>No</b>	<b>Yes</b>	<b>total</b>
<b>D</b>	78 Pearson $\chi^2 = 0.4$ Likelihood-ratio $\chi^2 = 10.6$	38 Pearson $\chi^2 = 0.6$ Likelihood-ratio $\chi^2 = -9.6$	116 Pearson $\chi^2 = 1.0$ Likelihood-ratio $\chi^2 = 1.0$
<b>E</b>	74 Pearson $\chi^2 = 0.3$ Likelihood-ratio $\chi^2 = -9.9$	52 Pearson $\chi^2 = 0.6$ Likelihood-ratio $\chi^2 = 10.8$	126 Pearson $\chi^2 = 0.9$ Likelihood-ratio $\chi^2 = 0.9$
<b>total</b>	152 Pearson $\chi^2 = 0.7$ Likelihood-ratio $\chi^2 = 0.7$	90 Pearson $\chi^2 = 1.2$ Likelihood-ratio $\chi^2 = 1.2$	242 Pearson $\chi^2 = 1.9$ Likelihood-ratio $\chi^2 = 1.9$
Pearson $\chi^2 = 1.87$ Pr = 0.17      Likelihood-ratio $\chi^2 = 1.88$ Pr = 0.17			Fisher's exact = 0.185
<i>Cells contain <math>\chi^2</math> of expected results under the null hypothesis</i>			

In Community D, 10 out of 38 (~26%) households subjected to an aggressive encounter had more than one family member who had been attacked within the last year (resulting in 49 unique encounters recorded) (see Table 4.12). In Community E, 14 out of 52 (27%) households had more than one family member involved in an aggressive encounter (resulting in 66 unique encounters recorded) (see Table 4.12).

Table 4.12 – Aggressive encounters within previous 12 months in Communities D and E

Location	Number of encounters per household over 12 months				Total households
	0	1	2	3+	
<b>D</b>	78	28	9	1	116
<b>E</b>	74	40	10	2	126
<b>Total households</b>	152	68	19	3	242

A key unknown is how many aggressive encounters are reported to authorities in indigenous communities. Table 4.13 shows the total number of aggressive encounters and bites which survey respondents claim to have reported to authorities (whether to a medical clinic or to RCMP/Council offices). As can be seen, approximately 43% (50/115) of all encounters were reported to authorities, while 42% (28/67) of all bites from both communities were reported.

Table 4.13 – Number of aggressive encounters reported by Community D and E survey respondents

		Encounter reported			Total encounters
		Yes	No	Unknown	
<b>Aggressive encounter</b>		50	44	22	115
<b>Bitten</b>	<b>Yes</b>	28	20	19	67 Pearson $\chi^2 = 6.5$ Likelihood-ratio $\chi^2 = 6.3$
	<b>No</b>	16	29	3	48 Pearson $\chi^2 = 9.2$ Likelihood-ratio $\chi^2 = 11.1$
	<b>Total</b>	44	49	22	115
		Pearson $\chi^2 = 15.7$ Pr = 0.0      Likelihood-ratio $\chi^2 = 17.4$ Pr = 0.0      Fisher's exact = 0.0			
		<i>Cells contain <math>\chi^2</math> of expected results under the null hypothesis</i>			

Using simple logistic regression, no statistical differences in the likelihood to report aggressive encounters, or bites, were found between these indigenous communities (aggressive encounters OR=0.58 with p = 0.733; bites OR=0.21 with p = 0.115). For individuals answering “unknown” it was assumed the household had not reported the incident, however were unsure whether it had been reported by other parties. Given the question was whether individuals (or families) within indigenous communities report encounters differently or at different rates than those within urban environments, unknowns were treated as “non-reporters” for the sake of statistical purposes.

The full results from the door-to-door surveys with victims of aggressive encounters can be found in Table 4.14. As can be seen, more adults were reported than children under 18 years old, and more females were victims of encounters than males. Given the large number of unknowns for the variables regarding dog's age, gender and reproductive status, it is not possible to identify any trends with respect to animal characteristics. This is also the case regarding whether the dog was housed inside or outside.

However where information was recorded, dogs were more commonly healthy, and were loose rather than being restrained. Encounters occurred more commonly away from home than at the victim's own residence. In addition, more dogs were considered by the victim or by the incident investigators to have been provoked, even if unintentionally. More animals involved in aggressive encounters were known than unknown, and more encounters involved only one dog rather than 2 or more. As can be seen, there were victims with all levels of knowledge, and dogs of all sizes involved in aggressive encounters. In both Community D and E more than half of the reported encounters resulted in a bite rather than just a show of aggression (Community D = 65%, Community E = 55%).

Table 4.14 – Aggressive encounter variables in door-to-door surveys in Communities D and E

<b>Risk factor</b>	<b>Community D (N= 49)</b>	<b>Community E (N=66)</b>
Victim age (age #)	child <10 = 9 child 10-18 = 7 adult (19-65) = 30 elder (65<) = 2 (adult no age given = 18)	child <10 = 11 child 10-18 = 7 adult (19-65) = 44 elder (65<) = 4 (adult no age given = 32)
Victim gender Male (M) Female (F)	male = 17 female = 27 unknown = 5	male = 18 female = 36 unknown = 12
Victim knowledge Little (L) Moderate (M) Considerable (C)	little = 21 moderate = 19 considerable = 9	little = 13 moderate = 40 considerable = 13
Dog age (age #)	puppy = 3 adult = 15 multiple = 4 unsure = 27	puppy = 5 adult = 5 multiple = 5 unsure = 51
Dog gender Male (M) Female (F)	male = 19 female = 11 unknown = 19	male = 12 female = 1 unknown = 48 multiple = 5
Dog reproductive status Intact (I) Fixed (F)	intact = 10 fixed = 11 unknown = 28	intact = 8 fixed = 3 unknown = 55
Dog health status Healthy (H) Sick (S)	healthy = 43 sick = 6	healthy = 57 sick = 9
Dog size Small (S) Medium (M) Large (L)	small = 10 medium = 17 large = 3 multiple = 12 unknown = 7	small = 12 medium = 26 large = 8 multiple = 18 unknown = 2

Dog restrained Restrained (R)    Loose (L)	restrained = 12 loose = 37	restrained = 8 loose = 58
Dog habitat Indoor (I)    Outdoor (O)    Both (B) Multiple with different habits (M)	indoor = 10 outdoor = 21 both = 2 unknown = 16	indoor = 6 outdoor = 11 both = 2 multiple = 5 unknown = 42
Dog provoked Provoked (P)    Unprovoked (U)	provoked = 35 unprovoked = 14	provoked = 56 unprovoked = 10
Dog ownership status Own (O)    Family/friend's (F) Community dog (C) Strange/stray (S) Multiple known (M) Multiple unknown (U)	own = 17 family = 18 community = 4 stranger = 3 multiple = 2 unknown = 5	own = 3 family = 28 community = 12 stranger = 10 multiple = 3 unknown = 10
Bitten Yes (Y)    No (N) (# bites)	yes = 31 no = 18  none = 17 one = 24 two to four = 6 more than four = 1	yes = 36 no = 30  none = 30 one = 24 two to four = 10 more than four = 2
Geographical location of bite Home (H)    Neighbour (N) Public (P)	home = 10 neighbour = 15 public = 24	home = 2 neighbour = 21 public = 43
Packing up (# dogs)	range = 0-3 mean = 1.2  single = 30 two = 11 three = 1 unknown = 7	range = 0-5 mean = 1  single = 38 two = 7 three = 3 four = 1 five = 1 unknown = 16

### 4.3.3 Canine Demographic Characteristics

Free roaming dogs were counted during 3-5 morning and 3-4 afternoon sessions in three randomly selected neighbourhoods ( $\alpha$ ,  $\beta$ , and  $\gamma$ ) in Community D in May 2014, September 2014, and May 2015. These counts were then compared to the estimates originally provided by the community rescue group in September 2013 (see Table 4.15).

In Community E, FRDs were counted in September 2014 and April 2015 during 3 morning and afternoon sessions. These counts were compared to estimates done in June 2014 by student volunteers, and those completed in February 2016 by the newly hired and trained bylaw officer (see Table 4.16).

Counts were not completed in either community in the fall of 2015, as wildfires requiring evacuation had raged throughout northern Saskatchewan for most of the summer. It was believed that fall 2015 counts would likely be an inaccurate estimation of the true level of FRD activity at that time.

Table 4.15 – Roaming dog population estimates based on sight-resight roaming dog counts for 2014-2015 in three neighbourhoods of Community D

	Count date	Petersen estimator	Beck model	Schnabel model	DE	Number of dogs/ household
Neighbourhood $\alpha$	09-2013	125				1.1
	05-2014	91	165	90	0.3	0.83
	09-2014	49	47	51	0.6	0.45
	05-2015	30	34	33	0.76	0.28
Neighbourhood $\beta$	09-2013	370				4.1
	05-2014	300	387	133	0.12	3.33
	09-2014	40	47	44	0.49	0.44
	05-2015	35	37	30	0.7	0.39
Neighbourhood $\gamma$	09-2013	120				1.2
	05-2014	93	95	74	0.29	0.93
	09-2014	42	39	45	0.75	0.42
	05-2015	33	35	30	0.82	0.33

\*DE = detectability estimate

Table 4.16 – Roaming dog population estimates based on sight-resight roaming dog counts for 2014-2016 in Community E

Count date	Petersen estimator	Beck model	Schnabel model	DE	Number of dogs/ household
06-2014	130				0.29
09-2014	115	402	114	0.66	0.26
05-2015	89	221	89	0.74	0.2
02-2016	25				0.06

#### 4.3.4 Community Canine Health

The results of the dog population management survey can be found in Table 4.17. Unfortunately although 206 household surveys were administered in Community D, 153 of them were destroyed in the summer of 2015 forest fires, leaving 53 for analysis. There were a total of 126 completed surveys in Community E.

Community D had more people owning or caring for a dog than Community E: a significantly greater likelihood of owning a dog (OR = 12.7, CI:5.1-32,  $p < 0.0001$ ) or caring for a

dog (OR = 25.5, CI:5.9-49.8,  $p < 0.0001$ ) was found for Community D. Other variables were not statistically different between communities (data not shown - see Appendix C). The majority of dogs were kept as companions in both Communities D (89%) and E (77%). In addition, although most dogs did not receive regular veterinary care (sterilisation, vaccinations, deworming, parasite control or wellness checks), most owners expressed interest and willingness to use facilities and resources if they were available.

Table 4.17 – Summary of descriptive analyses of dataset variables from door-to-door surveys considering dog population demographic characteristics and dog ownership in Communities D and E

<b>Dog ownership factor variables</b>	<b>Community D (N=53)</b>	<b>Community E (N=126)</b>
Household owns a dog	yes = 47 no = 6	yes = 48 no = 78
Household takes care of a dog	yes = 47 no = 2 unknown = 4	yes = 58 no = 63 unknown = 5
Household can handle the dogs	yes = 12 no = 1 unknown = 39 inapplicable = 1	yes = 62 no = 28 unknown = 32 inapplicable = 4
Head of household age (age #)	N = 41 range = 20-86 mean = 38.6 (S.D. 14.2) unknown = 12	N = 106 range = 19-89 mean = 44.3 (S.D. 16.1) unknown = 20
Head of household gender	male = 37 female = 10 unknown = 6	male = 81 female = 32 unknown = 13
Number of people in household (# people)	N = 53 range = 1-9 mean = 3.4 (S.D. 1.97)	N = 126 range = 1-9 mean = 3.7 (S.D. 1.63)
Number of dogs in household (# dogs)	N = 53 range = 0-5 mean = 1.5 (S.D. 1.2)	N = 126 range = 0-4 mean = 0.5 (S.D. 0.74)
Age of dogs in household	N = 81 adult = 52 puppy = 25 unknown = 4	N = 95 adult = 49 puppy = 14 unknown = 32
Dog gender	N = 81 male = 32 female = 47 unknown = 2	N = 95 male = 40 female = 25 unknown = 30
Loss of dogs in household in the last year (# dogs)	N = 40 range = 0-6 mean = 1.5 (S.D. 1.3)	N = 96 range = 0-5 mean = 0.85 (S.D. 0.94)

Dog was lost in the last year due to...	N = 17 given away = 3 killed by owner = 2 killed by other = 1 died in accident = 1 died due to disease = 2 died old age = 4 disappeared = 4	N = 29 sold = 2 given away = 10 killed by owner = 1 killed by authorities = 5 killed by other = 2 died in accident = 1 died due to disease = 5 died old age = 2 disappeared = 1
Household does not have a dog because... *respondents able to choose more than one	N = 6 dislike = 1 time = 2 not allowed = 3 still grieving = 2 other = 3	N = 78 looking = 4 dislike = 11 cost = 3 time = 39 space = 17 need = 2 not allowed = 4 still grieving = 1 other = 13
Dog breed	N = 81 pure = 17 cross = 5 mongrel = 56 unknown = 3	N = 95 pure = 24 cross = 8 mongrel = 29 unknown = 34
Where did household get their dog?	N = 81 own = 4 bought community = 4 bought outside = 25 gift community = 7 gift outside = 3 rescue = 13 other = 14 unknown = 11	N = 95 own = 5 bought community = 3 bought outside = 15 gift community = 16 gift outside = 10 rescue = 5 other = 4 unknown = 37
Dog purpose	N = 81 guarding = 2 protecting = 1 companion = 66 other = 1 multiple = 11	N = 95 guarding = 4 companion = 55 hunting = 1 breeding = 1 multiple = 34
Dog caregiver age* (age #) *in multi-dog homes each dog generally had a different caregiver	N = 81 range = 18-74 mean = 36.1 (S.D.2.1) unknown = 7	N = 95 range = 5-87 mean = 43.6 (S.D.2.7) unknown = 10
Dog caregiver gender* *in multi-dog homes each dog generally had a different caregiver	N = 81 male = 8 female = 52 no one specific = 20	N = 95 male = 27 female = 31 no one specific = 37
Dog sterilised	N = 81 yes = 28 no = 47 unknown = 6	N = 95 yes = 25 no = 27 unknown = 43

Reasons unsterilised	N = 53 too young = 3 used for breeding = 1 risk = 3 difficulty = 4 other = 34 unsure = 8	N = 70 too young = 12 used for breeding = 7 cost = 3 difficulty = 1 effects = 1 other = 4 unsure = 42
Dog sterilised age (age #)	N = 28 range = 3 months to 15 years mean = 3.2 (S.D. 2.5)	N = 25 range = 6 weeks to 16 years mean = 2.5 (S.D. 1.5)
Sterilisation method	N = 28 surgical = 28	N = 25 surgical = 20 physical = 5
Sterilised by	N = 28 private vet = 19 NGO = 3 unknown = 6	N = 25 private vet = 14 local clinic = 1 NGO = 3 special clinic = 2 other = 1 unknown = 4
If not sterilised is willing to sterilise	N = 47 yes = 34 no = 3 unknown = 10	N = 27 yes = 15 no = 3 unknown = 9
Dog vaccination	N = 81 full vaccines = 39 rabies only = 9 other only = 16 never vaccinated = 5 unknown = 12	N = 95 full vaccines = 25 rabies only = 3 other only = 7 never vaccinated = 12 unknown = 48
Dog vaccination timing	N = 81 this year = 35 within 3 years = 4 older than 3 years = 3 never vaccinated = 5 unknown = 18 unanswered = 16	N = 95 this year = 13 within 3 years = 8 older than 3 years = 5 never vaccinated = 4 unknown = 13 unanswered = 52
Dog vaccination where	N = 81 private vet = 16 local clinic = 13 NGO = 6 special clinic = 10 unknown = 13 inapplicable = 23	N = 95 private vet = 8 local clinic = 13 special clinic = 1 self = 1 other = 1 unknown = 57 inapplicable = 14
Dog deworming frequency	N = 81 regularly = 29 infrequently = 16 never = 13 unknown = 5 unanswered = 18	N = 95 regularly = 21 infrequently = 5 never = 6 unknown = 10 unanswered = 53

Dog deworming where	N = 81 private vet = 8 local clinic = 7 NGO = 8 special clinic = 9 self = 11 other = 1 unknown = 18 inapplicable = 19	N = 95 private vet = 9 local clinic = 14 special clinic = 1 self = 4 other = 1 unknown = 56 inapplicable = 10
Dog parasite control frequency	N = 81 regularly = 21 infrequently = 9 never = 21 unknown = 11 inapplicable = 19	N = 95 regularly = 14 infrequently = 5 never = 10 unknown = 12 inapplicable = 54
Dog parasite control where	N = 81 private vet = 4 local clinic = 3 NGO = 5 special clinic = 4 self = 13 unknown = 22 inapplicable = 30	N = 95 private vet = 5 local clinic = 11 self = 3 other = 1 unknown = 59 inapplicable = 16
Dog health	N = 81 private vet = 7 local clinic = 12 NGO = 10 special clinic = 4 self = 5 other = 5 unknown = 38	N = 95 private vet = 10 local clinic = 13 special clinic = 1 self = 3 unknown = 68

### 4.3.5 Community Licensing Statistics and Incident Complaints

When the research first began in spring 2013, Community D had 47 animals registered with the Council. This number had tripled to more than 160 by spring 2016. In Community E, there were fewer than 25 animals licensed in spring 2013, while in February 2016 (a month after the animal control bylaws came into effect) there were almost 100 (97).

Both communities credit the increase in licensing to improved community awareness and education, and consistent bylaw enforcement. Although community complaints to both Council offices regarding roaming dogs and aggressive encounters (not resulting in bites) are inconsistently tracked, both offices anecdotally report a consistent decrease in the amount of time spent dealing with dog concerns over the last several years (from a minimum of 2 to 3 per day, to 2 to 3 per week).

### 4.3.6 Reported Dog Bites

A comparison of the dog bites reported to health authorities from January 1<sup>st</sup>, 2013 to December 31<sup>st</sup>, 2014 for both Communities D and E can be found in Tables 4.18-4.20, and visually displayed in Figure 4.15. On-reserve more bites were reported in individuals younger than 10 years old (45%), or older than 19 years old (42%), while off-reserve the number of reported bites were more evenly spread between age categories. However, when taking into account the estimated population age structure using the median age, there were slightly more bites per age population in children 19 years or less compared to adults greater than 19 years for on- and off-reserve populations in community D, and considerably more for off-reserve in community E. There were considerably more bites to areas other than the head and neck in both communities (~80%), and only one reported case (on-reserve in Community D) involved multiple wounds.

Table 4.18 – Ages of victims of reported dog bites from Communities D and E

Age of client* (years)	Community D		Community E
	On reserve (%) 2013-2014	Off-reserve (%) 2004-2014	Off-reserve (%) 2004-2014
< 10	14 (45)	21 (27)	12 (41)
10 - 19	4 (13)	22 (28)	7 (24)
19 <	13 (42)	33 (42)	9 (31)
Unknown	0 (0)	3 (4)	1 (3)
Grand Total	31	79	29

\* in Community D the median age of individuals on-reserve for 2013-2014 was 18.6, while the median age for off-reserve individuals varied between 2004-2014 from 28.2 to 31.7 years of age (average age off-reserve = 29.9)

In Community E the median age of individuals off-reserve ranged between 21 to 27.2 years of age, however 21-30% of individuals were 10 years or younger; 35 to 40% under the age of 19 between 2004-2014

Table 4.19 – Anatomical location of reported dog bites from Communities D and E

Bite location	Community D		Community E
	On reserve (%) 2013-2014	Off-reserve (%) 2004-2014	Off-reserve (%) 2004-2014
Head & Neck	4 (13)	15 (19)	6 (21)
Rest of Body	25 (81)	64 (81)	23 (79)
Unknown	1 (3)	0 (0)	0 (0)
Multiple bites	1 (3)	0 (0)	0 (0)
Grand Total	31	79	29

Looking more closely at the age distribution of cases, for off-reserve incidents in Community D, there were approximately the same number of reports regarding bites to the head and neck in individuals over 10 years of age, as under 10. In contrast, there were slightly more cases of bites reported to the head and neck in individuals under 10 years of age on-reserve in Community D, and from Community E.

Table 4.20 – Comparison of ages of victims and anatomical locations of reported bites from on and off-reserve sites within Communities D and E

Bite Location	Community D							Community E			
	On-reserve (%) 2013-2014			Off-reserve (%) 2004-2014				Off-reserve (%) 2004-2014			
	< 10	10 & above	Total	< 10	10 & above	Unk	Total	< 10	10 & above	Unk	Total
Head & Neck	3 (10)	1 (3)	4 (13)	8 (10)	7 (9)	0 (0)	15 (19)	5 (17)	1 (3)	0 (0)	6 (21)
Rest of Body	11 (35)	15 (48)	26 (84)	13 (16)	48 (61)	3 (4)	64 (81)	7 (24)	15 (52)	1 (3)	23 (79)
Unknown	0 (0)	1 (3)	1 (3)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Grand total	14 (45)	17 (55)	31 (100)	21 (26)	55 (70)	3 (4)	79 (100)	12 (41)	16 (55)	1 (3)	29 (100)

\*unk = unknown

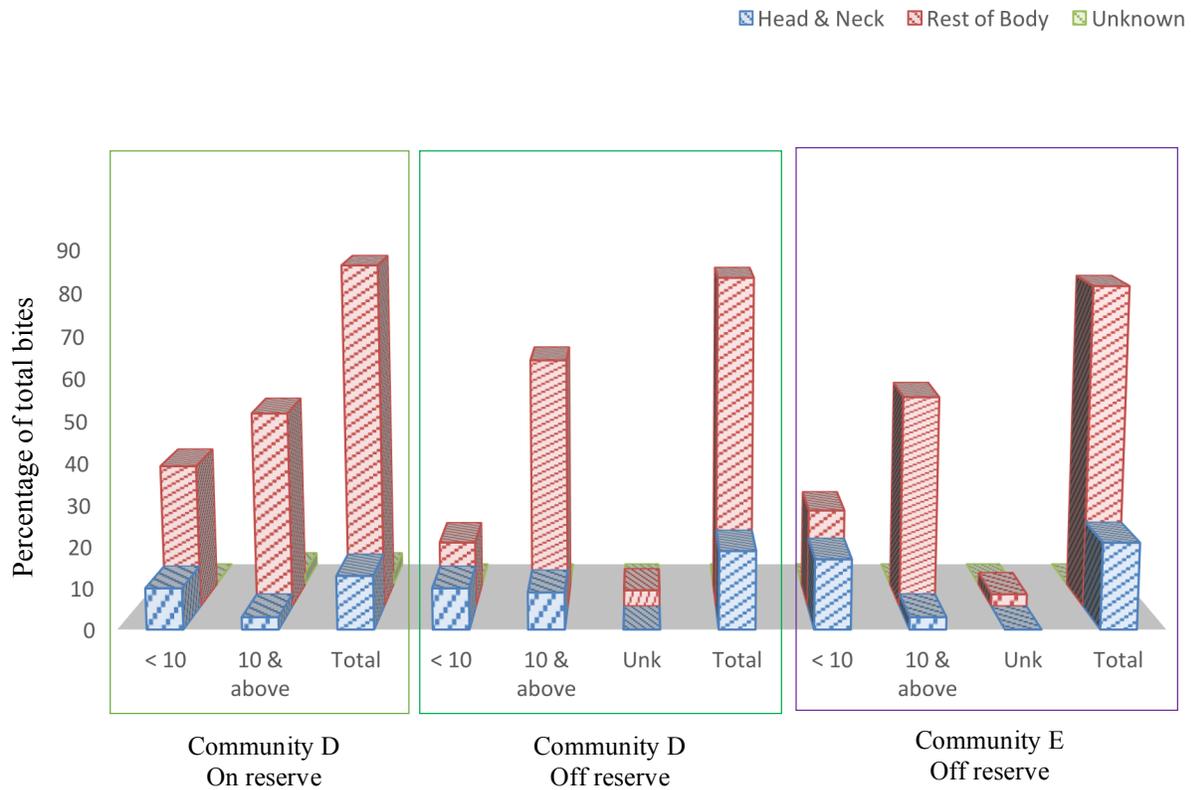


Figure 4.15 – Comparison of bite anatomy and age of victims of reported bites from Communities D and E

In order to preserve patient confidentiality, bite victim sex and seasonality of attack was not included within the off-reserve data from NITHA. Assessing the expected trends of increased male versus female victims, and increased bite occurrence during summer months could therefore only be done with the on-reserve Health Canada data. The results of these two variables, as well as their relationships to the variables of age and anatomical wound location can be found in Tables 4.21 and 4.22, and Figure 4.16.

Table 4.21 – Comparison of anatomical location of reported provoked and unprovoked attacks (by age and gender)

		<b>Provoked and Unprovoked Attacks By Anatomical Location</b>									
		<b>Unprovoked (N=13)</b>					<b>Provoked (N=18)</b>				
		head/ neck	uppe r	lowe r	unk	multi	head/ neck	uppe r	lowe r	unk	multi
<b>Male (N=17)</b>	less than 10	1	1	1				3			
	10 to 18			2							
	over 18		1	2			1	2	3		
<b>Female (N=14)</b>	less than 10	2	1	1				2	2		
	10 to 18							1	1		
	over 18				1			1	1		1
<b>total</b>		<b>3</b>	<b>3</b>	<b>6</b>	<b>1</b>		<b>1</b>	<b>9</b>	<b>7</b>		<b>1</b>

\*unk = unknown; multi = multiple locations

Table 4.22 – Seasonality of reported provoked and unprovoked attacks by age and gender

		<b>Provoked and Unprovoked Attacks During Different Seasons</b>							
		<b>Unprovoked (N=13)</b>				<b>Provoked (N=18)</b>			
		winter	spring	summer	fall	winter	spring	summer	fall
<b>Male (N=17)</b>	less than 10		1	2				3	
	10 to 18	1		1					
	over 18		1	2		1	2	2	1
<b>Female (N=14)</b>	less than 10		2	1	1	1	1	2	
	10 to 18					1	1		
	over 18	1				1	1		1
<b>total</b>		<b>2</b>	<b>4</b>	<b>6</b>	<b>1</b>	<b>4</b>	<b>5</b>	<b>7</b>	<b>2</b>

Regarding seasonality of bites, although there were a greater number of bites recorded in the spring and summer, this was not found to be statistically significant using simple logistic regression and Fisher's Exact tests, even once stratified by type of attack (i.e., provoked versus unprovoked) (see Table 4.23). Sex was also not found to be statistically significant when looking at seasonality, type of attack or age category; nor was anatomical location of bite wounds found to be statistically significant with regards to sex or age, whether it was stratified by type of attack or not (see Table 4.23).

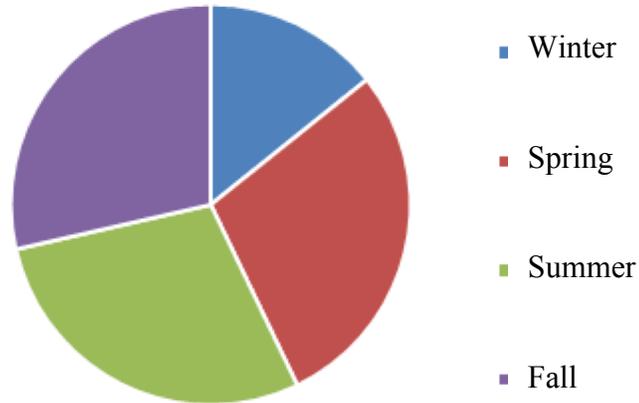


Figure 4.16 – Seasonality of on-reserve reported bites from Community D in 2013 and 2014

Table 4.23 – Specific risk factors for dog bite reporting from on-reserve bites (evidence dog:human interactions have complex dynamics)

Variable	Stratified by	Statistical results
seasonality	type of attack	spring: OR= 1.26 CI: 0.14-11.7 $\chi^2$ : 0.5 p > 0.85
		summer: OR= 0.87 CI: 0.09-8.87 $\chi^2$ : 1.2 p > 0.91
sex	seasonality	OR= 0.34 CI: -3.1-3.7 p > 0.88
	type of attack	OR= -1.14 CI: -3.17-0.9 p > 0.27
	age	OR= -2.13 CI: -5.65-1.39 p > 0.24
anatomical location	sex	OR= -2.64 CI: -6.77-1.5 p > 0.21
	age	OR= 1.19 CI: -2.57-4.96 p > 0.54

#### 4.3.7 Combined Intervention Assessment

Community supported interventions have the capacity to make significant impacts on both roaming dog numbers and overall aggressive encounters.

Figure 4.17 shows the example of Community D, with the trending reduction in dog bites in addition to that of roaming dogs, with the introduction of various interventions. Due to the implementation of a number of strategies over a short time frame, it is difficult to separate out the level of impact each had on the overall totals. It is however believed that the entirety of the community plan was significant in creating a safer environment for community members.

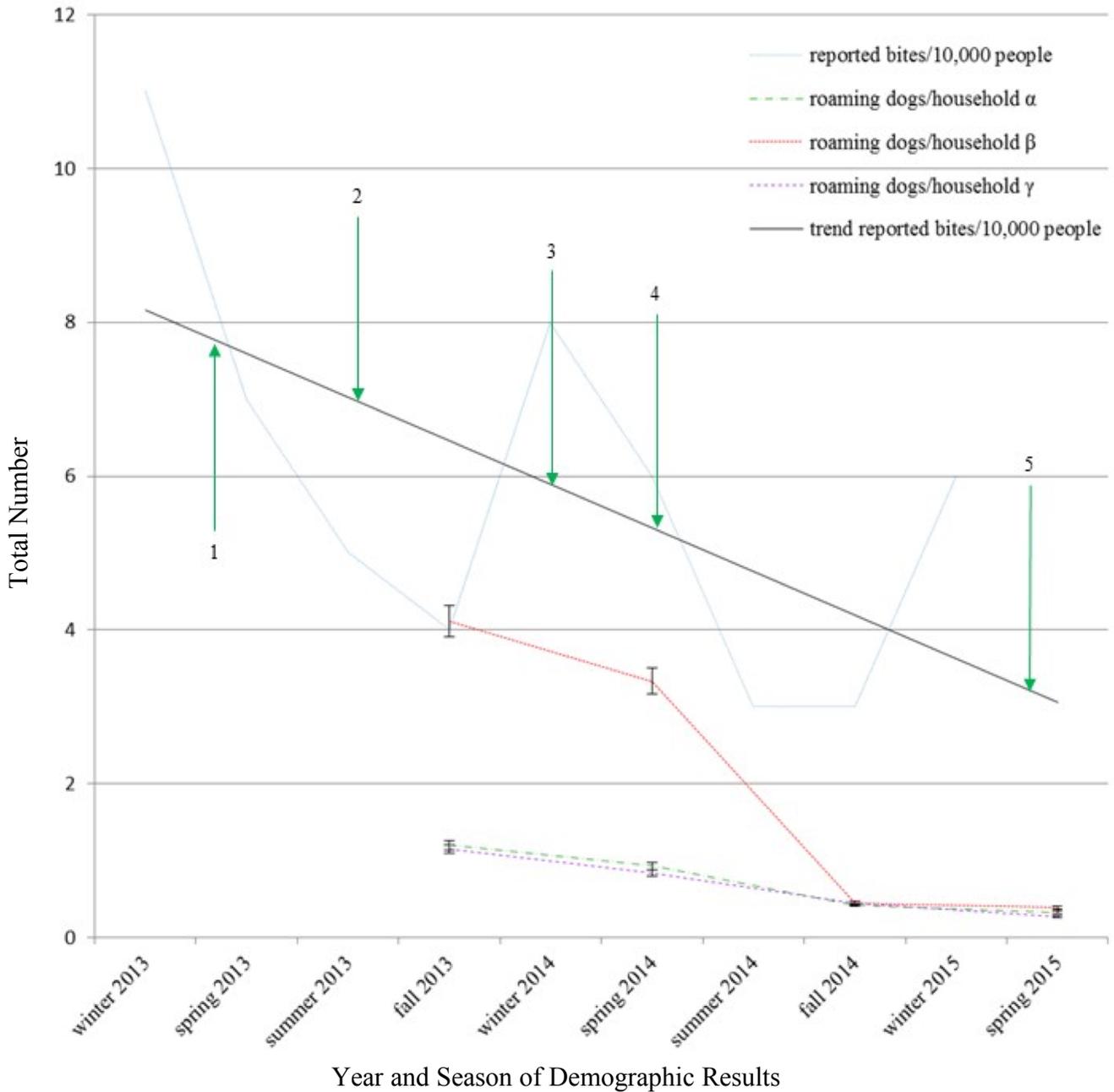


Figure 4.17 – Number of reported bites and roaming dogs in Community D from January 2013 to June 2015 with intervention measure initiation

1. initiation of community engagement on dog concerns, and communication regarding new dog bylaws
2. initiation of biannual full community dog education sessions
3. initiation of monthly school group education sessions
4. first biannual sterilisation clinic
5. new legislation legally in place

## 4.4 Discussion

Harrington and McNellis (2006) said *“If you can’t measure something, you can’t understand it. If you can’t understand it, you can’t control it. If you can’t control it, you can’t improve it.”*<sup>7</sup>

Given the complexities of dog population management and dog bite prevention, a full comprehension regarding not only the epidemiology of aggressive dog:human encounters in indigenous communities, but also the method and implementation of policy and decision-making processes leading to successful interventions and strategies is needed. With this project we provide support that while there are certain commonalities between indigenous communities, there are also differences that must be recognised for any community dog strategy to remain consistently efficacious.

### 4.4.1 Community Opinions

Dog overpopulation costs including animal complaints, impounding, sheltering, euthanising, public health risks, and loss of animal life have the potential to create considerable complications within indigenous communities. It is critical that Councils and policy-makers take into account not only community concerns, but cultural beliefs for interventions to remain successful. Community members must feel as though their needs and anxieties are being heard and met for any approach to have the chance of success.

Community members separated both concerns and solutions into those involving people, dogs and the environment, believing that all three are interwoven as a braid, and so are inseparable (see Figure 1.1, p2). Resource acquisition, funding procurement, and increased communication are the three areas that all external stakeholders and community collaborators agreed were most vital for future management efficacy and goal completion. Without improving these areas, prevention and control strategies are doomed to fail. In addition each community had separate areas of concern which need addressing, such as a lack of holding facilities or ineffective ACOs or inadequate bylaws.

Most groups believed a combination of factors were necessary for these issues to be transformed, requiring comprehensive and accessible education and communication, thorough legislation and companion animal socialisation and training, and finally available medical clinics and changed cultural beliefs and attitudes. Generally there were wide assortments of possible methods with which to achieve these solutions, all of which were community-specific and would require public engagement to be effective.

Communities credited increases in licensing and reductions in dog bites to improved community awareness, education and consistent bylaw enforcement. In that way, it becomes evident that community-based research affects those being studied in ways that are impossible to separate from the interventions being applied.

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<sup>7</sup> Harrington, H. J., & McNellis, T. (2006). Mobilizing the right lean metrics for success. *Quality Digest*, 26(5), 3, Retrieved April 14, 2015. [http://www.qualitydigest.com/may06/articles/02\\_article.shtml](http://www.qualitydigest.com/may06/articles/02_article.shtml) .

#### 4.4.2 Dog Population Management Methods

Estimated FRD numbers completed over the duration of the project indicate that with the implementation of community supported interventions, population management improves and dog roaming numbers decrease. This occurred regardless of what form interventions might take (such as enforced animal control bylaws, voluntary dog restraint (i.e. keeping animals at home via fences, leashing, in home, etc.) or human education and animal socialisation). It is possible that counts were underestimated due to loss of animals between counts (resulting in fewer animals being re-sighted and therefore an overestimate of the overall number of dogs), or else overestimated due to trap-happy animals being attracted to counters (resulting in more animals being re-sighted and therefore an underestimate of the overall number of dogs). However, the large number of repeated counts, and the fairly stable overall populations minimise these concerns.

In addition, as precise numbers were not required, but rather the objective was to obtain general estimates and indications of the basic size/direction in which the dog populations were moving, the impact of the potential issues created by animals being semi-restricted randomly restricted – i.e. being restrained when the owner “felt like it”), being potentially open populations, having significant heterogeneity of response, or some being trap-happy, are thought to be negligible.

Communities have different priorities, and therefore have instituted population management and bite prevention interventions in unique combinations, at various rates and assorted degrees. When several are consistently adhered to, their impacts are difficult to split apart (as can be seen in

Figure 4.17). However it is consistently apparent from both the scoping review and the community engagement from this project that comprehensive community-wide communication, participation and education are integral factors in any successful strategy.

This consultation and instruction has the ability to shape new beliefs and attitudes. While legislation provides support for the management systems that are implemented, without an understanding of the importance of the bylaw or full community member backing, it is rare that policies are entirely or willingly adhered to. This is especially valid when historical tradition or sociocultural norms guide different practices.

Some attention must be paid to the health, training and restriction of the dogs within each community. While simply restraining community dogs can reduce roaming, sick animals can spread disease, and unsocialised animals may be unpredictable or more destructive. As well, without significant connection, people and animals often fail to understand each other’s behavioural signals which can lead to increasingly aggressive encounters. The effect knowledge and education had on limiting aggressive encounters cannot be overlooked, and supports work done by researchers such as Chapman and Morrell (2000), Coleman *et al.* (2008) and (Schwebel *et al.*, 2012).

#### 4.4.3 Bites and Aggressive Encounters

It was anticipated that the project would be completed in accordance with Messam *et al.* (2008), in that play bites would be excluded from counts of aggressive encounters (as the circumstances behind play bites and violent interactions are generally very different). However, it

was found that those types of contacts were not actually discussed or reported within these communities, negating the need for episode removal.

As can be seen, the expected human, canine and environmental risk factor trends reported in previous studies (as previously identified and discussed in the scoping review) are not apparent here. Generally it has been suggested that dog bites occur more often to males than females (Cornelissen & Hopster, 2010; Schalamon *et al.*, 2006), to children under the age of 10 years old rather than adults (Bernardo *et al.*, 2002a; Schalamon *et al.*, 2006), and by intact male dogs (Horisberger *et al.*, 2004; Messam *et al.*, 2012). As well, it has been reported that in general 40-80% of recorded bites in children are to the head and face (Bernardo *et al.*, 2002b; Daniels *et al.*, 2009; Horisberger *et al.*, 2004; Thompson, 1997). ***The research here does not always follow these trends, providing evidence that dog bites are context-driven; that is any dog may bite anyone at any time.*** As well, it suggests that the methods of determining dog bite epidemiology and risk factors involve inherent bias, as generally study results are dependent on bites reported to health authorities, which tend to be those of most concern or severity.

On another note, Raghavan (2008) found that 68% of severe encounters resulting in fatalities in Canada between 1990 and 2007 involved multiple dogs. Although no fatalities were recorded in either Community D or E during the research period, 60% of encounters reported on surveys were with one animal and none of the reports to authorities involved multiple dogs. In addition, the severe encounters resulting in multiple bites were almost all single animal attacks (as reported on surveys – 17/19 = 90%, and health authority reports – 1/1 = 100%). The majority of encounters were also provoked, which supports findings by Schalamon *et al.* (2006) and Horisberger *et al.* (2004), amongst others.

Seasonality has been a somewhat controversial factor (Agarwal & Reddajah, 2004; Dwyer *et al.*, 2007; Horisberger *et al.*, 2004; Kaye *et al.*, 2009; Lone *et al.*, 2014; MacBean *et al.*, 2007; Raghavan, 2008; Reece *et al.*, 2013; Rosado *et al.*, 2009; Shen *et al.*, 2014; Sriaroon *et al.*, 2006; Tenzin *et al.*, 2011), and this ambiguity has also occurred here. Although looking at raw numbers there were more bites during spring and summer months, this was not found to be statistically significant.

It is noteworthy that the factors of dog restraint and relationship to the victim support most research studies (Alabi *et al.*, 2014; Avner & Baker, 1991; Hon *et al.*, 2007; Schalamon *et al.*, 2006; Thompson, 1997; Vucinic *et al.*, 2008). Although 75 to 88% of incidents discussed by survey respondents involved FRDs, 65 to 80% of encounters were with known animals. This is counter to the communities' initial assumptions that aggressive attacks were most often by unknown stray animals.

Interestingly, there were also a few differences between the demographic characteristics of the individuals who sustained dog bites reported to authorities, and those recounted by survey respondents. Although more individuals over 10 years of age were reported to have been bitten and enumerated in both the community survey and the reported bites, there was a significant percentage of encounters reported to authorities in children under age 10 (27-45% of bites) than were discussed in the survey (17-19% of bites). The older age demographic is similar to that found by Guy *et al.* (2001a, 2001b), and Massari and Masini (2006).

In addition, the survey showed a greater percentage of females involved in aggressive encounters, whereas the reported interactions were approximately evenly distributed between males and females. Both of these reporting trends are consistent with the published results from Daniels (1986) on the Navajo Reservation, and lend support to the hypotheses that a) circumstances surrounding the attack often determine whether bites are likely to be reported, b) bites involving

children are more likely to be reported to authorities or to be administered medical care than those involving adults, and c) bites are still underreported.

However, although it was believed violent encounters in indigenous communities were less likely to be reported than in other locations, the surveys indicated that 40 to 50% of aggressive interactions were reported in these communities. As observed in the scoping review, this is a significantly higher level of reporting than is estimated in urban environments (Gilchrist *et al.*, 2008; Sacks *et al.*, 1996a), however, it is consistent with reports from various authors reporting on the situation in areas with high numbers of FRDs (Agarwal & Reddajah, 2004; Tenzin *et al.*, 2011). This could potentially be due to the increased number of provoked encounters occurring with loose animals (whether known or unknown) away from home, unlike the fear of rabies that is believed to drive bite reporting in developing countries.

## 4.5 Conclusions

To our knowledge this is the first comprehensive study on dog bite prevention and dog population management decision making in indigenous communities, making the reported information an instrumental stepping stone towards a full understanding of dog:human interactions. The central inference from the combination of these studies confirms that big steps are not required to achieve success. A positive and accepting culture and environment enables engagement and transformation at every level, regardless of the community partner creating the atmosphere. This is in complete opposition to an impression of judgement, which prevents paradigm shifts regardless of the parties involved.

When aiming for change, beginning with the end in sight provides focus, as if desires are not clarified, any methods and results are considered acceptable. In addition it is critical to remember that methods have the potential to considerably affect the process of data collection and measurement, which may affect the results. However, when examining complex research questions, triangulation and cross-case comparison can help address these issues and assist in robust case analysis. Understanding the overarching goals and purpose of both the research and the ensuing interventions ensures not only appropriate study development, but also constructive feedback and recommendations.

## ***Relevance to thesis***

*The dog bite risk modelling undertaken provides additional confirmation that despite considerable previous research, there are no absolutes when it comes to assessing dog bite risk factors. It is critical for policy makers to understand that given the perfect constellation of circumstances, any dog may bite, any person may be a victim, and any environment may be a trigger. For this reason communication and education are more likely to prevent incidents than any other strategy.*

## **Chapter 5 Dog Bite Risk Modelling**

*“In the strict formulation of the causality law – ‘When we know the present precisely, we can calculate the future’ – it is not the final clause, but rather the premise, that is false. We cannot know the present in all its determining details.*

*Therefore, all perception is a selection from an abundance of possibilities and a limitation of future possibilities...”*

*Werner Heisenberg, Ueber den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik, 1927*

### **5.1 Background**

Epidemiology considers the relationship between demographic variables and/or other factors of subjects (e.g. environmental exposures, behaviour, genetic susceptibility) compared to the risk of disease or health phenomena in order to explain population level differences. This understanding of disease ecology can then help clarify and advise policy makers regarding preventative measures for public health (Wilsmore & Watson, 2006).

When studying subject matter (such as the occurrence of dog bites) and judging the ensuing effect particular variables (risk factors) have on the end result (outcome), consideration is given to a number of elements. Each key risk factor will have its own main effect on the final outcome; that is each independent variable will increase or decrease the likelihood of the final result. For the purposes of this discussion, the risk of “being bitten by a dog” will be treated in the same manner as the risk of disease exposure or incidence for other infectious diseases (e.g. Ebola, rabies, West Nile virus).

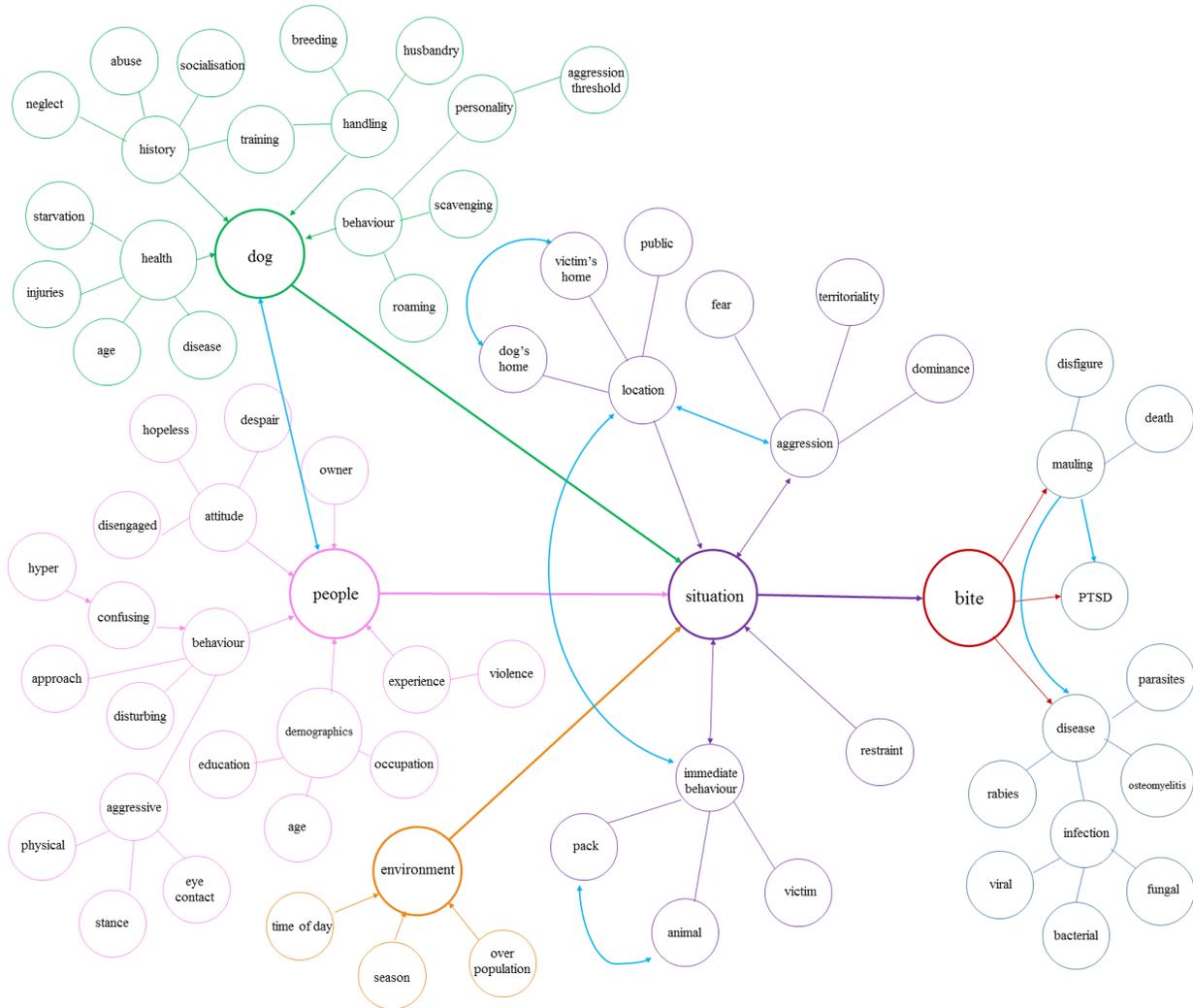


Figure 5.1 – Dog bite causal diagram

However, when looking at a disease issue such as dog bites, there are not only basic, straightforward physical or environmental risk factors (such as occupation or dog ownership), but also more complex sociocultural, psychological, economic, political or regional aspects (such as education, cultural beliefs (regarding dogs), or training (of dogs)) (see Figure 5.1). Given the vast number of potential causal factors, it is important to begin with a more simplified version (see Figure 5.2), and identify consistently reported significant risk variables (based on published literature such as that described in Chapter 3). Additional factors may then be added as supporting data become available.

In order to fully assess potential causal risk factors it is therefore important to verify that an association between the cause and effect under examination exists. In addition, any potential for the association to be due to an additional confounding variable must be ruled out, and the chance of an interaction influencing the association must be gauged. Then an assessment of the types and strengths of true potential factors can be completed and possible risk models may be developed.

Since two or more risk factors may act together, they potentially change the effect that either factor would have if present individually, so the final outcome (usually incidence of disease) differs from what is expected. This changed result is considered to be due to an ‘interaction’. Dohoo *et al.* (2010) stated that an “*interaction is said to occur when the combined effect of 2 variables differs from the sum of the individual effects.*”(p292). To complicate things, from a biological standpoint outcomes may have multiple pathways or frameworks in which risk factors (causes) occur. Therefore if a cause may lead to a disease on its own, it is considered to be a sufficient cause.

Conversely, if a cause requires other factors to be present in order for disease to occur it is considered to be a component cause. However, a disease may have any number of sufficient and component causes which work together in a myriad of different ways. This has led to interaction also being defined as “*co-participation of two component causes within one sufficient cause, so that both factors are necessary for the sufficient cause to occur*” (Hernandez *et al.*, 2006, p164). Overall, with either definition it is clear that two or more variables must be present, and together they affect the outcome differently than they each would on their own.

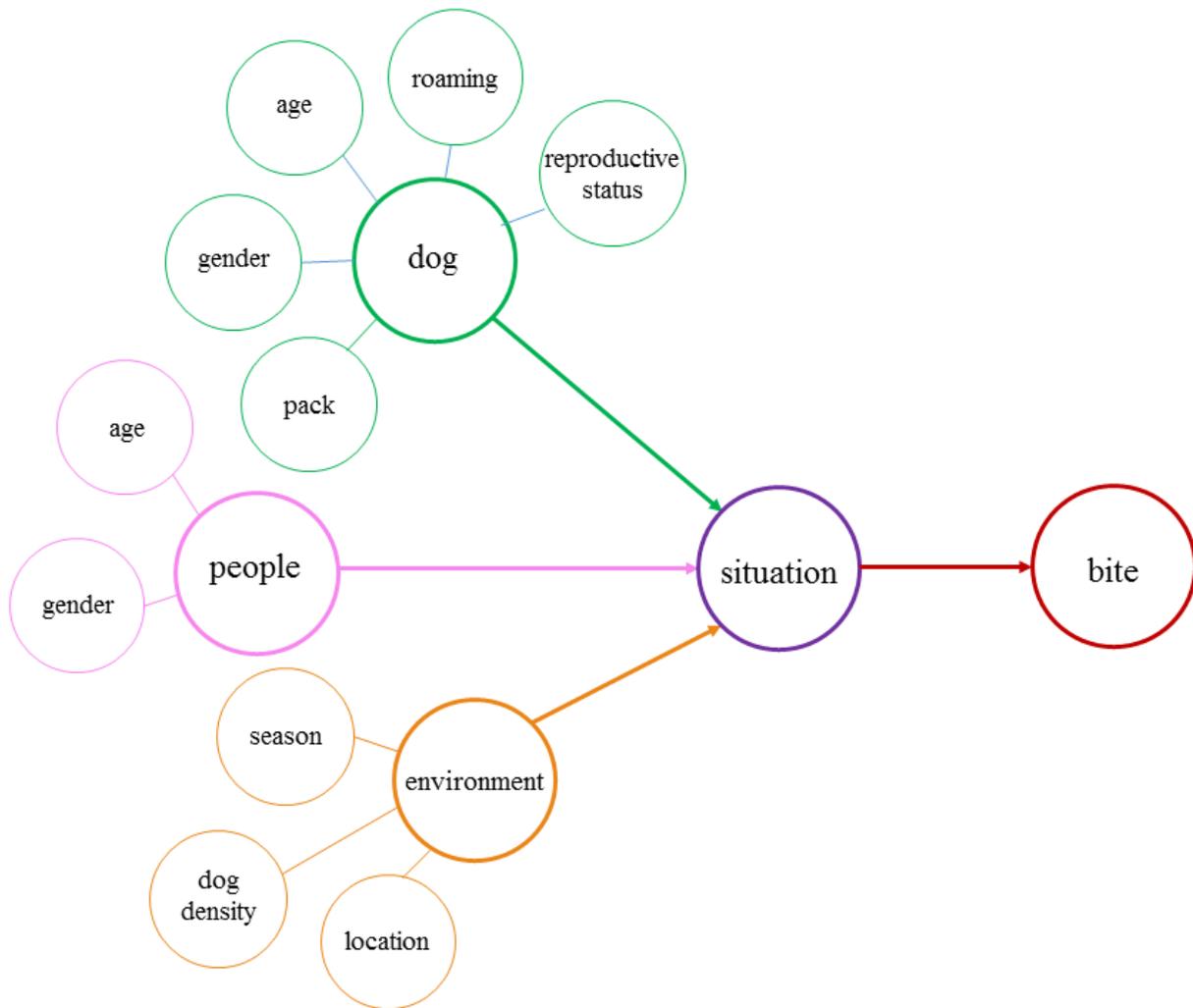
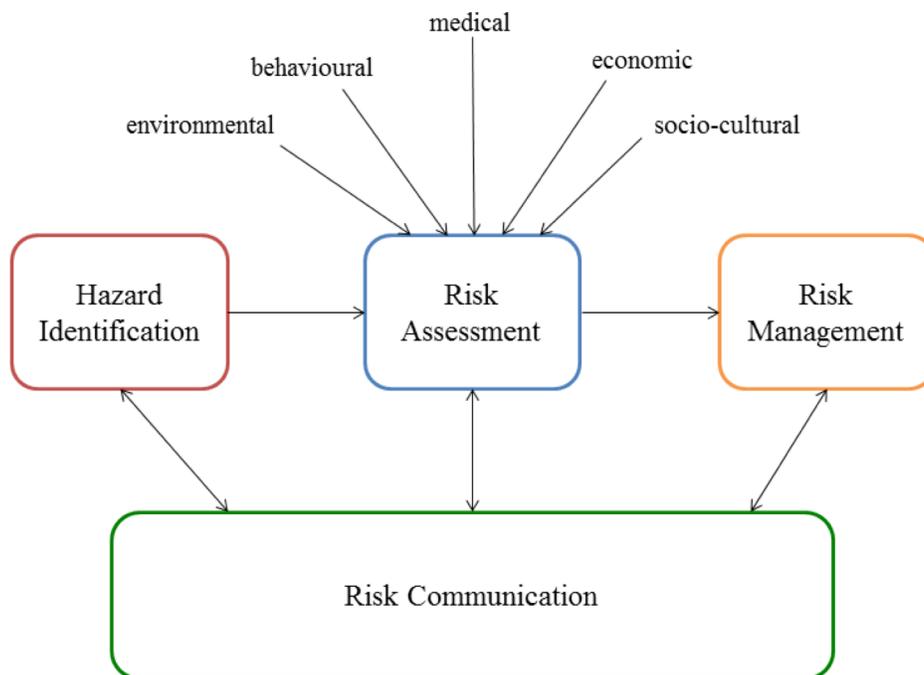


Figure 5.2 – Simplified dog bite causal diagram  
*(included risk factors are those “globally” assumed to impact likelihood of being bitten)*

Testing for interaction has historically depended on which measurement scale was used. The most commonly used scales are additive or multiplicative. Since the interpretation and conclusions that are drawn differ between scales, and data may fit more than one model, understanding the analysis that was used is critical to the understanding of research results. Recent discussions have suggested that alternatives from using statistical model frameworks are needed in order to truly understand biologically complex systems (Rothman & Greenland, 2005; Schwartz & Kanehisa, 2006). However, most of the commonly used models in epidemiology use a multiplicative scale (e.g. logistic or Cox regressions which are exponential), even though it appears that additive models better explain biological conditions (Ahlbom & Alfredsson, 2005; Rothman & Greenland, 2005; Schwartz & Kanehisa, 2006).

An additional part of the difficulty in assessment lies in the fact that statistical interactions may be amplifying (intensifying the produced effect), or diminishing (reducing the produced effect). Amplifying, or positive interactions of two risk factors, are considered to be synergistic, creating a greater than expected disease risk or incidence rate. Diminishing, or negative interactions, are seen as being antagonistic, resulting in less than expected disease risks or incidence rates. Though antagonistic interactions are not as common as synergistic interactions, they must be ruled out in order to fully comprehend certain disease frameworks.

While relative risk (RR) or odds-ratios (OR) compare the extent to which disease risk is multiplied in individuals with the variable in question compared to those without (using a multiplicative model), risk differences (RD) compare how the disease risk is added between the two groups (using the additive scale) (Hernandez *et al.*, 2006). Results are frequently quite different



Adapted from OIE Code 2011

Figure 5.3 – Risk assessment and management process

OIE - Terrestrial Animal Health Code, Twentieth edition, 2011, Chapter 2.1, p67

using an additive model compared to a multiplicative model. These variances could potentially lead to drastically different recommendations regarding policy changes or deployment of resources. When the fact that multiple pathways may be occurring for any particular disease at any particular time is considered, it becomes obvious that consistent methods to identify component factors and their overall impact on disease risk are important.

Bias describes the manner with which parameters are over or underestimated. These errors in calculation result in a misrepresentation of the population or variable of interest. Bias is usually due specifically to the sampling method, as often systematic errors occur when attempting to approximate the likelihood of uncertain events. Correcting for bias is sometimes possible using equation adjustments, when researchers understand where the error estimates exist. These numbers are easier to calculate when accepted reference values or true values are known.

The initial step of any epidemiological risk assessment is identification of the hazard (see Figure 5.3). In this situation the hazard has been outlined already as the risk of a dog bite or aggressive encounter. The second step of the process involves evaluating the dose-response relationship, conducting an exposure assessment and completing a risk characterization (which includes both an estimation of risk, and a statement of uncertainty) (see Figure 5.3).

Assessing the exposure risk of a dog bite within the indigenous northern populations requires an understanding not only of bite epidemiology and community behaviours, but also dog and human demographic characteristics and community structure, spatial distribution, and potential disease levels (see Figures 5.1 and 5.3). Without adequate recognition of risk factors, a complete and realistic assessment of the situation is impractical, and problem management and control is difficult, if not impossible.

## 5.2 Methods

Risk is defined as the probability of an occurrence happening in the target population during a specific period of time (see Equation 5.1):

$$\lambda = \frac{\text{new cases}}{\text{persons at risk}}$$

Equation 5.1 – Risk calculation

However, with population-based investigations if the actual number of people at risk is unknown, it is possible to use the overall population number as the risk denominator (see Equation 5.2):

$$\lambda_{pop} = \frac{\text{new cases}}{\text{population size}}$$

Equation 5.2 – Modified population based risk calculation

which assumes that all members of the population are at equal risk of exposure (and acknowledging that this includes an inherent margin of error). While the population is obviously not homogeneous when considering the potential for contact with aggressive animals in northern communities (e.g. ACOs are more likely to come into contact with aggressive dogs than the average community

member), using the population size gives a baseline number with which to work when more precise data are unavailable. In this case it is very important to recognize that the population-based estimate carries an unknown level of error. Therefore using reported dog bite data for 2014 received from NITHA and Health Canada for the analyses from Chapter 4 (p94), and the available 2011 Statistics Canada National Household Survey census data<sup>8</sup> (numbers were verified by both community Council offices):

The baseline dog bite risk for community D would be

$$\lambda pop_D = \frac{24}{10,000} = 2.4 \text{ per } 1000 \text{ people.}$$

The baseline dog bite risk for community E would be

$$\lambda pop_E = \frac{4}{1300} = 3.1 \text{ per } 1000 \text{ people.}$$

In spite of this, if the questions “*What is the probability that an individual from an indigenous northern community in Saskatchewan would be bitten by a dog, and is this likelihood greater than for individuals in urban environments?*” are considered, it is obvious that there are a

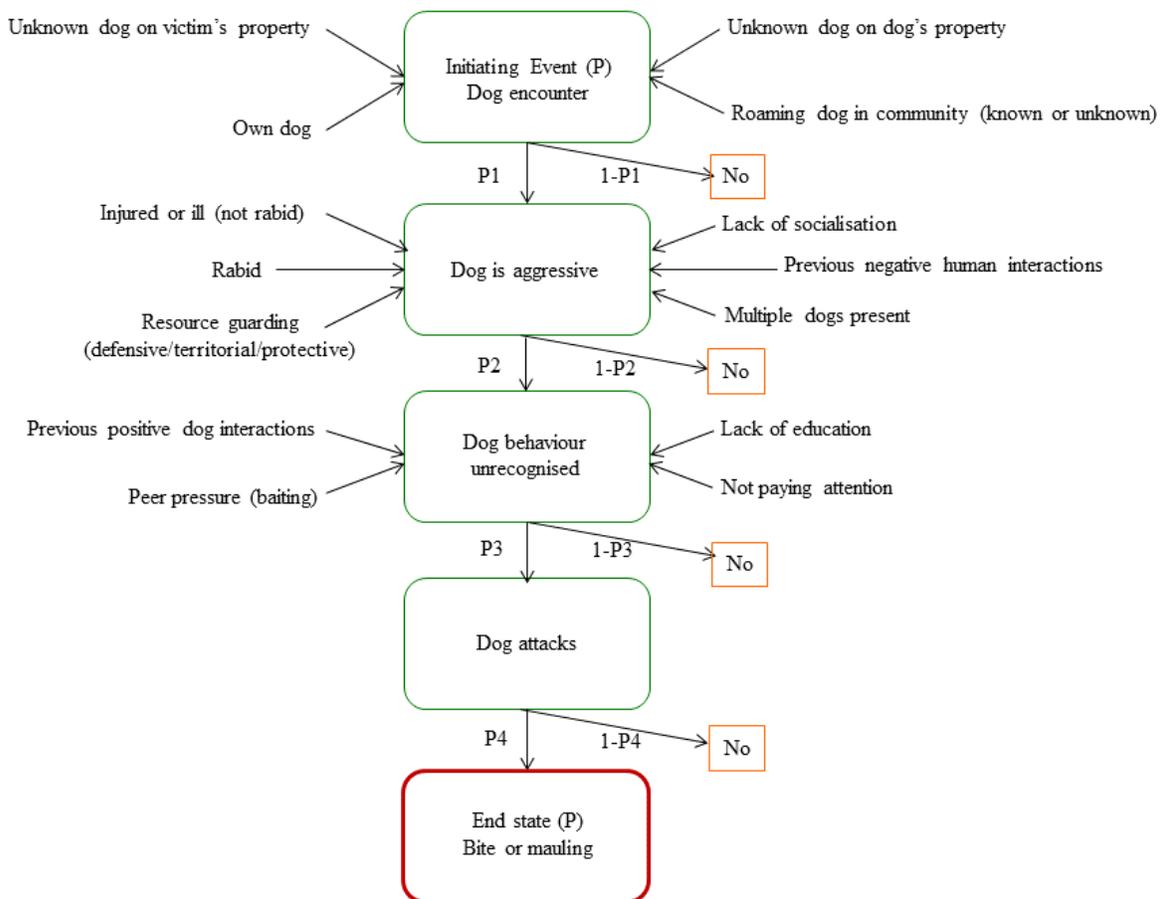


Figure 5.4 – Dog bite scenario pathway

<sup>8</sup> Statistics Canada, 2012

number of other factors that need to be examined apart from the present incidence rate. These include:

*What is the likelihood of contact between dogs and people?*

*What is the likelihood that the interaction results in an aggressive encounter?*

*What is the likelihood the encounter results in a bite?*

Although complete dog bite surveillance in northern Saskatchewan is limited, basic likelihood estimates of critical factors (negligible, low, moderate and high) can be assigned based on the current level of knowledge (see Figure 5.4). These can then be compared to published data from regions with similar sociocultural attitudes towards dogs, and population spatial distribution.

Spatial disease distribution (in this case distribution of aggressive and/or stray or FR unsocialised dogs) should be considered when attempting to evaluate the disease level in specific geographical areas (Ostfeld *et al.*, 2005). Given that individuals of concern (dogs = aggressors, and people = susceptibles) are more often clumped within communities, but that these zones may not completely overlap, an understanding of the true landscape ecology is important in a complete risk assessment (Ostfeld *et al.*, 2005). Knowing both the distribution and population of potential attackers, facilitates risk mapping (see Figure 5.5). When creating disease risk maps, the probability of dog bite occurrence decreases exponentially with increasing distance from a potential aggressor. As a result, spatial locations of communities, reservoirs and aggressive animals, as well as the potential for encounters are key pieces of information for dog bite dynamics.

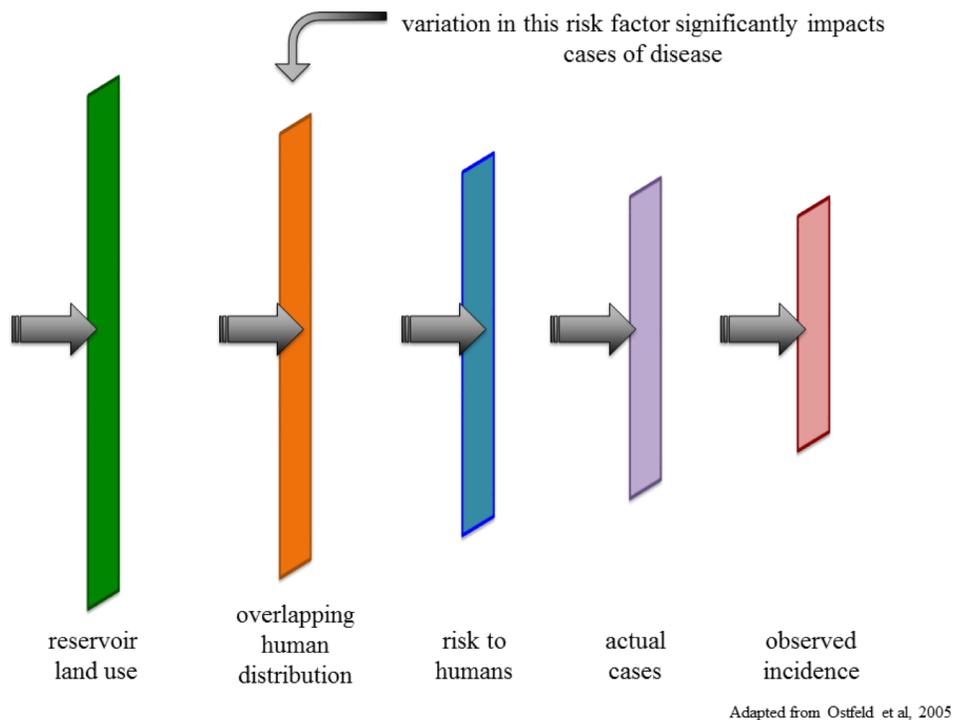


Figure 5.5 – Impact each level of spatial dynamics has on disease occurrence

A case-case study was developed to explore the potential differences and importance of dog bite risk factors between urban and rural reserve environments. The benefit of the case-case study format is the restriction of selection and information biases, due to similar identification and

recording systems for all cases within the province. As requirements for rabies records are the same across the province basic data collection tools were identical for all dog bite cases, therefore missing information can be considered completely at random (based on the memory, attention and time of the attending physician or nurse practitioner assigned to the case).

### 5.2.1 Participants

The de-identified records and statistics from 31 on-reserve dog bites from a remote rural community (provided by Health Canada) were compared to 714 reported dog bites from an urban centre (both sets from January 1<sup>st</sup>, 2013 to December 31<sup>st</sup>, 2014). The median age for the base population of individuals on-reserve in 2014 was 18.6 (male 18.2 and female 18.8), while for the urban centre was 35.4 (male 34.4 and female 36.6).

The 714 urban bites were retained from the original 1,136 cases obtained from the Health Region's Rabies Database (encounters reported by medical authorities after patient visits) based on geographic location of the incident (only encounters occurring within the specific urban centre were kept), on species (only episodes with dogs were kept), and wound (only bite incidents were kept). At minimum, information on victim sex, season, victim age, dog size, dog health, anatomical wound location and geographical bite location were retained when available.

The study protocol was approved by the ethics review boards at the University of Saskatchewan, the Northern Saskatchewan Population Health Unit, Health Canada, the Saskatoon Health Region Public Health Observatory, and the Federation of Saskatchewan Indian Nations.

### 5.2.2 Data Analysis

All data handling and statistical analysis was performed using Microsoft Office Excel 2013 and STATA software version 14 (StataCorp, College Station, Texas). Data analyses to ascertain if differences existed between the reporting of bite occurrences on-reserve or within urban communities were undertaken in four steps.

Initially 7 predictor variables were identified as available from both sets of data (victim sex, season, victim age, dog size, dog health, anatomical wound location, and geographical bite location – see Appendix C, Table 46 for definitions). “Age” was initially considered both as a continuous and a categorical variable; once linearity was established it was maintained during modeling solely as a continuous variable. All other variables were categorical. Complete descriptive statistics including raw ratios and Chi-square ( $\chi^2$ ) for univariable analyses of categorical variables (community, season, sex, age category, wound location, dog size, dog health, and bite (geographic) location), and a Mann-Whitney rank sum test for “age” as a continuous variable, were completed.

Unfortunately, it was determined that “dog health” was coded differently between health authorities (one was based on physical health, the other on behavioural abnormalities), and so this variable was discarded. In addition, the variables “sex” and “dog size” were screened more carefully due to high volumes of missing data. While “sex” was found to dramatically affect the number of observations used, “dog size” was not. Due to the effect the missing data had on attempted analyses, the variable “sex” was omitted from all further analysis (N=513 urban observations were missing gender details).

The outcome variable “community” (i.e. reported bite within on reserve community versus reported dog bite in urban community) was immediately explored using simple logistic regression.

During univariable analysis, variables with unconditional logistic p-values greater than +/- 0.25 for all categories were discarded (season, and initially wound location). Pearson correlations and Fisher's exact tests were run for the remaining 4 predictor variables: "season", "age", "dog size", and "bite (geographic) location". After considering the unexpected results from the community study, "wound location" was also explored as it is globally considered to be a significant risk factor for dog bites (and had 2 categories close to the  $p < 0.25$  cutoff).

Interestingly, although "dog size" also had a large amount of missing data (N=583 urban observations were missing data), comparative statistics using the full dataset with missing data categorised as "unknown" versus the smaller complete sub-dataset found no significant differences in associations or regression models using a generous value of  $p < 0.25$ . As a final verification for variable retention, maximum likelihood estimates, proper likelihood ratios and Wald's tests were completed for all factors, which resulted in "wound location" being preserved with a  $\chi^2$  probability of 0.23.

Predictor risk factor variables showing significance were built into univariable logistic regression models using "community" as outcome. Several predictor variables with p-values smaller than 0.001 were immediately preserved (age, dog size and bite location). Tests for confounding for "wound location" showed evidence of significance on effect estimates for "bite location" and "dog size". A greater than 20% difference between the adjusted odds ratios and the crude model was found, therefore "wound location" was retained within the model. This was followed by building a multivariable logistic regression model using backwards manual stepwise regression. Important interaction modifications were also assessed at this point.

Tests for linearity, normality, homoscedasticity, independence and collinearity were performed for all predictor variables using scatterplot matrices, predicted residuals and partial-regression plots (data not shown).

As verification, factor, cluster and discriminant analyses were completed, and the impact of outliers established. Due to lack of independence once all variables were included, a random effects logistic model and a generalised estimating equation were attempted to account for the clustering associated within the structure of the data. Unfortunately, convergence was not achieved with either of these analysis methods.

### 5.2.3 Scenario Pathway Analysis

Development of potential dog bite scenario pathways for Communities D and E was completed using data from the community studies and modelling whenever possible, and applying data obtained from the scoping review when no other information was available.

For pathway analysis, causal factors are identified as constant, predetermined or uncertain. Constant factors are those considered to remain stable, while for predetermined factors change is thought to be predictable. Predetermined factors are then either gradually varying phenomena, outcomes of limited conditions or inescapable involvements. However, generally scenario analyses focus on uncertain factors. Uncertain factors are those for which the consequences are potentially known, but when they will occur remains unknown.

In scenario process analyses, uncertain factors are a critical step as the uncertainties govern the main differences between scenarios, compared to constant and predetermined components which are consistent for each scenario. To simplify calculations and reduce the number of variables into a more manageable set, factors are clustered when possible. Usually predetermined factors assume alternative development of consequences and likelihoods are a priori known. By contrast,

the probabilities of uncertain factors are not known, and because they cannot always be predicted, may create a significant problem when policy makers are looking for best practice options.

In addition, there are three specific types of information that are considered:

1. *Things we know we know*
2. *Things we know we do not know*
3. *Things we do not know we do not know*

With building scenario and decision pathway models, the key is to transform the third type of knowledge into Type 2 whenever possible. Unfortunately providing data without knowing what it is or where to obtain it can often prove problematic.

Following the probabilistic scenario analysis pathway methodology outlined by Miller *et al.* (1993) a dog bite risk assessment was developed. Only effects conclusively supported by research to affect whether or not a dog bite is likely to occur have been incorporated into the scenario tree. Each included event was given a probability that it would arise. Whenever possible these numbers were generated from the results of the community survey data previously described (Chapter 4) or by the dog bite risk model developed here. When data were not available from either of these sources, they were estimated from literature used within the formerly outlined scoping review. These probabilities were considered conditional based on the likelihood of occurring once other events happened (given for example a dog bite cannot occur if the victim does not encounter a dog).

$$ES = 1 - (P_a \times P_b \times \dots \times P_n)$$

Equation 5.3 – Exogenous scenario pathway probability summation

In the first step, the probability that a single pathway-unit would cause a dog bite in the target community was calculated. The second step determined the probability that a dog bite occurs by a particular pathway was estimated. Steps 1 and 2 for all exogenous pathways in the model were analysed. In the last step the probability of a dog bite occurring was calculated by adding together the probabilities of all endogenous pathways within each level (see Equation 5.3), and multiplying these pathway sums. This total was then subtracted from the overall possible likelihood of 1 (see Equation 5.4).

$$P_x = \text{factor } a + \text{factor } b + \dots + \text{factor } n$$

Equation 5.4 – Endogenous pathway probability summation

## 5.3 Results

### 5.3.1 Case-Case Study

Descriptive data including raw numbers, can be found in Table 5.1. Chi square tests of independence were used with categorical variables to test for differences in distributions between communities, and a p-value of <0.05 was considered statistically significant. Although information

on “dog size” was limited, it was retained during analysis as both it and “wound location” were found to be confounders for “age”.

Associations were examined between the variables of interest, and community of incident (i.e. outcome variable being a reported bite being on reserve versus in an urban community). As can be seen in Table 5.1 only the variable “age” was initially found to be statistically significant (with a  $p < 0.05$ ) with regards to community of incident, with higher odds of a reported bite case in the urban centre versus on-reserve (rural) for all age comparisons.

Table 5.1 – Descriptive and univariable statistics for reported dog bites\* in two separate communities

Variable		Rural N=31	Urban N=714	Differences between communities**
$\chi^2 = 1.15$	Sex Male	17/31	97/201	Reference category
	Female	14/31	104/201	OR = 1.52, p=0.29, CI 0.71-3.27
$\chi^2 = 30.5$	Age (categorical) Under 10	14/31	82/714	Reference category
	10 to 18	4/31	99/714	OR = 4.23, p=0.014, CI 1.34-13.33
	Over 18	13/31	533/714	OR = 6.99, p<0.001, CI 3.18-15.42
$\chi^2 = 1.35$	Season Winter	6/31	134/714	Reference category
	Spring	9/31	233/714	OR = 1.16, p=0.78, CI 0.4-3.33
	Summer	13/31	239/714	OR = 0.82, p=0.72, CI 0.31-2.21
	Fall	3/31	108/714	OR = 1.64, p=0.51, CI 0.39-6.6
$\chi^2 = 5.1$	Wound location Head/neck	4/30	69/654	Reference category
	Upper body	12/30	344/654	OR = 1.66, p=0.39, CI 0.52-5.31
	Lower body	13/30	191/654	OR = 0.85, p=0.79, CI 0.27-2.7
	Multiple bites	1/30	50/654	OR = 2.91, p=0.35, CI 0.31-26.7
$\chi^2 = 45.2$	Dog size Small	2/19	27/131	Reference category
	Medium	10/19	42/131	OR = 0.31, p=0.15, CI 0.06-1.53
	Large+	7/19	62/131	OR = 0.58, p=0.52, CI 0.11-2.99
$\chi^2 = 55.5$	Bite location Home	9/25	362/683	Reference category
	Friend/neighbour	6/25	12/683	OR = 0.05, p<0.001, CI 0.015-0.16
	Public	10/25	309/683	OR = 0.77, p=0.571, CI 0.31-1.91
$\chi^2 = 3.03$	Animal health*** Healthy/normal Sick/abnormal	19/19 0/19	468/511 43/511	<i>Not used</i>

\*unknowns not included in totals

\*\* Urban centre versus rural reserve

\*\*\*variable not included in analyses due to differences in coding between health authorities

Table 5.2 – Pearson Correlations and Fisher's Exact results of reported dog bite risk factor variables

	Age	Season	Wound location	Dog size	Bite location
Sex	P $\chi^2$ = 0.943 FE = 0.603	P $\chi^2$ = 3.15 FE = 0.376	P $\chi^2$ = 3.33 FE = 0.52	P $\chi^2$ = 8.46 FE = 0.075	P $\chi^2$ = 4.22 FE = 0.278
Age		P $\chi^2$ = 9.3 FE = 0.147	P $\chi^2$ = 123.04 FE = <0.001**	P $\chi^2$ = 5.93 FE = 0.528	P $\chi^2$ = 23.32 FE = <0.001**
Season			P $\chi^2$ = 12.6 FE = 0.399	P $\chi^2$ = 12.7 FE = 0.389	P $\chi^2$ = 7.04 FE = 0.589
Wound location				P $\chi^2$ = 23.48 FE = 0.046*	P $\chi^2$ = 53.14 FE = <0.001**
Dog size					P $\chi^2$ = 8.84 FE = 0.757
P $\chi^2$ = Pearson's $\chi^2$		FE = Fisher's exact		*p<0.05; **p<0.01	

All variables of interest were then also checked for correlations for preliminary assessment of inclusion in the model, prior to developing potential regression models. As can be seen in Table 5.2, the variables “wound location” and “bite location” tended to be collinear together, as well as with the variable “age”. In addition, “wound location” also correlated with “dog size”. As the focus was identifying potential factor differences between communities, despite their initial lack of significance with “community”, the three variables “wound location”, “bite location” and “dog size” were retained along with the covariate “age” during the first step of the logistic regression model construction. Due to collinearity a more liberal p value was required, as adding collinear variables affects the precision of the model.

Multiple steps were taken when establishing the best-fit model of the logit of the probability of community as an outcome for the risk factors of “age”, “wound location”, “dog size” and “bite location” with respect to the reporting of dog bites (see Appendix D). These four variables were initially screened to be included, using univariate logistic regression models. Likelihood ratio tests were used to analyse all four predictor factors. The final step during multivariate logistic regression identified the strongest model as that including “age”, “wound location”, “dog size”, and “bite (geographic) location” ( $\chi^2=44.7$ ,  $p<0.001$ ) (see Table 5.4).

Factor analysis used a regression specification-error test, which indicated the model was specified correctly. In addition, extracted eigenvalues specified that the final model factors were able to explain 80-85% of the total variance (see Table 5.3). Cluster analysis using weighted-average linkage also found that the chosen model was constructed appropriately. Discriminant analysis was applied to measure goodness of fit and check statistical significance of each factor, showing the overall rate of correct classification at 95.8%. Of the urban reported bites, 99.6% were correctly classified (sensitivity), but only 42.9% of the rural reported bites were correctly classified (specificity). Given classification is dependent on comparative sizes of each group, favouring classification into the larger group, this is understandable. The area under the ROC curve was found to be 0.91, demonstrating excellent accuracy.

Important interaction modifications were also assessed, although none were found to be significant. Data were evaluated to assure the assumptions of independence and multicollinearity were met, and that the absence of outliers, leverage points and influential points was maintained. Eleven observations were discovered to have residuals (outliers) larger than +/-3, however dropping these observations did not significantly alter the fit, sensitivity or specificity of the model. Six of these outliers were from the rural reserve community, likely due to the smaller sample size.

Table 5.4 – Logistic regression results for final model of reported dog bite risk factors by community

Predictor Variable	$\beta$ estimate	SE $\beta$	95% CI	Odds Ratio	SE OR	z	P value	95% CI
<b>age continuous*</b>	0.05	0.01	0.02-0.07	1.05	0.01	3.50	0.00	1.02-1.08
<b>wound location</b>								
upper	-0.03	0.69	-1.40-1.33	0.97	0.67	-0.05	0.56	0.25-3.77
lower	-1.09	0.71	-2.49-0.31	0.34	0.24	-1.53	0.13	0.08-1.36
multiple	-0.39	1.21	-2.76-1.99	0.68	0.82	-0.32	0.45	0.06-7.28
<b>dog size</b>								
medium	-1.11	0.92	-2.92-0.69	0.33	0.30	-1.21	0.02	0.05-2.00
large	-0.38	0.93	-2.21-1.45	0.68	0.64	-0.41	0.04	0.11-4.25
<b>bite location</b>								
friend/neighbour	-3.69	0.75	-5.17- -2.22	0.02	0.02	-4.90	0.00	0.01-0.11
public	-0.31	0.51	-1.31-0.69	0.74	0.37	-0.60	0.05	0.27-2.00
<b>_cons</b>	2.20	1.03	0.17-4.22	8.98	9.28	2.12	0.03	1.19-68.10

\*age was run as a continuous variable

Table 5.3 – Factor analysis eigenvalues and variable variance weight

Variable	Initial Eigenvalues				After Rotation		
	Total	% of variance	Cumulative %	Uniqueness	Total	% of variance	Cumulative %
Age	1.91	31.85%	31.85%	0.3456	1.79	25.7%	25.7%
Bite location	1.44	22.92%	54.77%	0.2656	1.37	19.6%	45.3%
Dog size	1.23	18.37%	73.14%	0.2290	1.25	17.9%	63.2%
Wound location	1.03	12.11%	85.25%	0.2555	1.18	16.9%	80.1%
Season	0.62	8.55%	93.8%	0.2228			
Sex	0.37	6.2%	100%	0.2932			

### 5.3.2 Scenario Pathway Analysis

Initially all of the potential scenario pathway-units were calculated, and when possible the differences between Communities D and E were ascertained. These probabilities and the resulting endogenous pathway totals can be found in Appendix D, and the splitting of pathways can be found in Figure 5.6. The assumption for the primary probability step (i.e., encountering a dog) is assumed

to be 1 (or 100%) in these communities due to the large number of FRDs, and that between 40 to 65% of households own a dog.

The End State probability for a single dog:human encounter resulting in a dog bite in Community D is between 0.2% and 0.7% (depending on level of knowledge), and in Community E is 0.1% to 0.5% (again depending on personal dog knowledge). However, this percentage is simply the potential risk for each individual encounter. In communities where there are high numbers of FRDs, the result is multiple dog:human encounters per day, and hundreds per year. A conservative estimate would be 3 dog:human encounters within a community per day, which would result in approximately 1,100 encounters per year. Therefore even with a low probability of any encounter ending in a dog bite, the repeated encounters significantly increase the potential for a dangerous or aggressive situation.

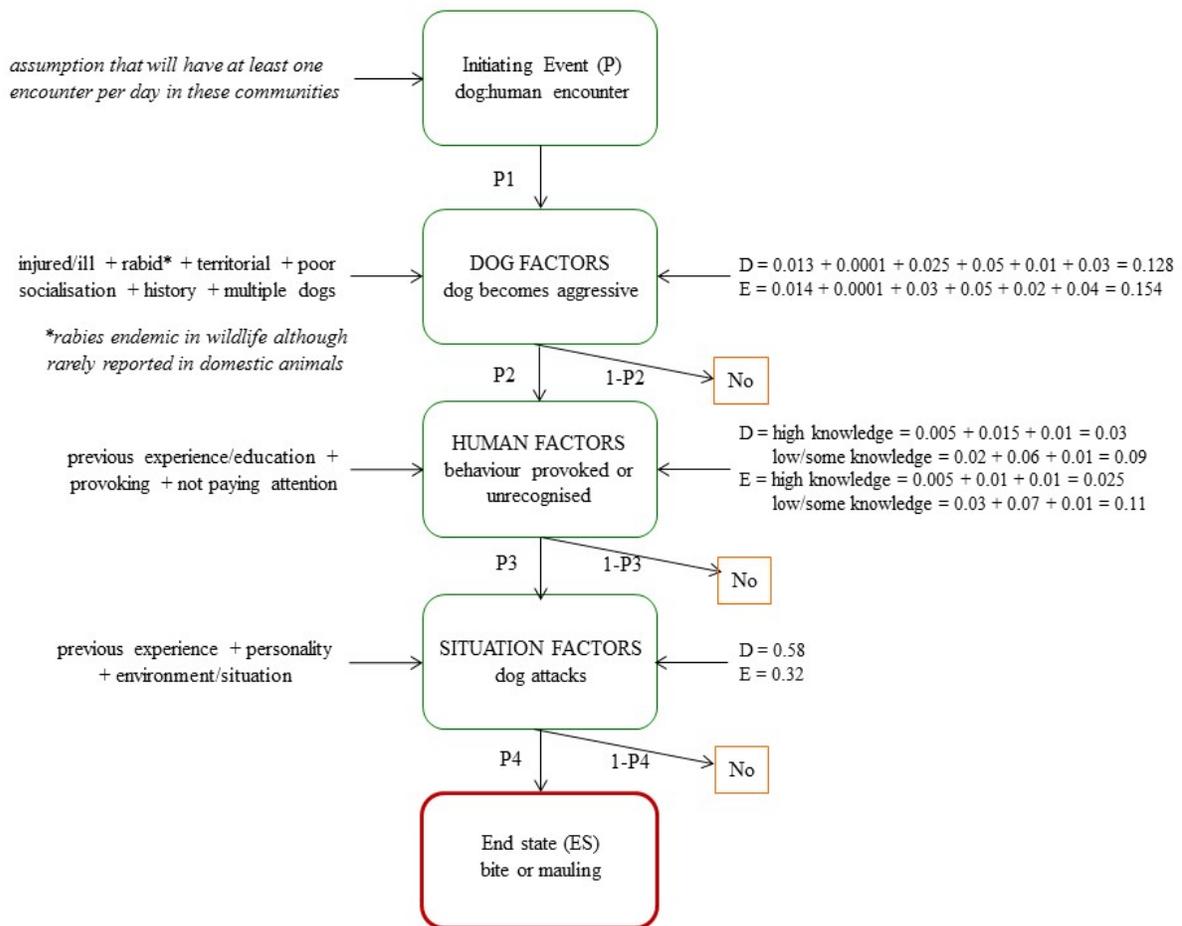


Figure 5.6 – Dog bite scenario pathways and calculations

## 5.4 Discussion

At the beginning of this study it was believed that differences existed between both the likelihood of reporting and the actual incidence of dog bites between urban and rural reserve communities; that higher number of bites occur but fewer are reported within indigenous communities (Castrodale, 2007). In addition, common rhetoric has generally suggested that children are more likely to be bitten than adults (Beck *et al.*, 1975; Daniels, 1986; De Keuster *et al.*, 2006; Gershman *et al.*, 1994; Gilchrist *et al.*, 2008; Harris *et al.*, 1974; Kizer, 1979; Ozanne-Smith *et al.*, 2001; Parrish *et al.*, 1959; Sacks *et al.*, 1996a; Wright, 1996; Wright, 1990), that males are more likely to be bitten than females (Beck *et al.*, 1975; Bjork *et al.*, 2013; Daniels, 1986; Gershman, 1993; Gershman *et al.*, 1994; Overall & Love, 2001; Parrish *et al.*, 1959; Shuler *et al.*, 2008; Weiss *et al.*, 1998; Wright, 1990), that incidents are more likely to occur in familiar locations and by known dogs (Bernardo *et al.*, 2002b; De Keuster *et al.*, 2006; Moss & Wright, 1987; Overall, 2001), and that more encounters occur in the summer than any other season (Frangakis & Petridou, 2003).

However, the results of this study support the previously presented descriptive analysis of community surveys and the analysis of the comprehensive scoping review, in that any individual may be bitten by any dog given the right circumstances and environment. In this study there are greater odds of an adult or an individual over the age of 10 becoming a reported bite case on reserve compared to an urban centre, rather than a child under 10. Given that the median age of individuals on-reserve was half that of those in the urban centre during the years studied, with children under the age of 10 comprising 36% of the total population (as per reserve census data), this data is considered to be a fair estimate of the true situation.

Although, “dog size” and “geographic location” were both considered significant in developing the final complete model, the actual impact of these factors on reporting dog bites in either community environment was negligible. As well, given “seasonality” was not found to be significant, it is difficult to ascertain the role that it may have on individuals reporting dog bites, and since the variables “victim sex” and “dog health” were excluded prior to model development, there is little that can be said regarding either of them. There is also a possibility that there were additional unknown factors having a significant influence on reporting practices that were not measured or included within the data set.

The scenario pathway analysis reinforces the community-based participatory research conclusions, that although there may be significant numbers of FRDs within the study communities, aggressive encounters leading to bites or mauling are less frequent than initially believed. Furthermore since almost half of dangerous incidents were reported to authorities within these communities, there is a strong likelihood that the recognition of potentially dangerous situations could have a significant impact on the outcome of any interaction. As self-described high levels of dog behaviour knowledge and understanding virtually eliminated the probability of a bite, improved behaviour communication and education could be successful in dramatic reductions in overall aggressive encounters.

It is important to note that the original hypotheses of rural remote communities and indigenous communities having significant differences in dog bite risk factors compared to urban environments were not supported in this study. Neither were the general trends found in previous dog bite research conclusively demonstrated or refuted. However, remote community assumptions of having a dangerously increased level of dog bite risk were also not upheld, especially when appropriate bite prevention education and dog socialisation occurs.

## 5.5 Conclusions

While there is no such thing as zero risk of dog bites within a community (because there is no way to completely eliminate the potential, short of eradicating the canine population), the prevailing question is “*what risk level is acceptable?*”. Generally when outlining, planning and recommending disease reduction and elimination strategies, a number of factors are considered. These include intervention efficacy, cost-benefit and effectiveness criteria, quality of life concerns, and time effects. A good understanding of all of these agents greatly assists policy makers in their decision analysis. Unfortunately, with respect to dog bite prevention, many of these measures are still unknown.

Despite this, two issues (or pitfalls for the unwary politician) stand out in the indigenous communities involved within this study. First of all, quality of life is considered to be in question. Despite the low calculated risk for a dog:human encounter to result in a bite or a more tragic ending, community members believe their FRD populations to be a danger and a nuisance to themselves and their loved ones. When parents are afraid to allow their children to walk 3 blocks to school for fear of being attacked by a pack of dogs, or when elders become reclusive shut-ins because of the belief they will be mobbed by dogs on their journey to visit relatives or friends, the entire community suffers from lack of freedom, contact and cohesiveness.

Secondly, there is no “quick fix” or short term initiative. Any interventions undertaken require time, effort and long term planning. This reality results in significant costs with respect to monetary, physical and human resources, as well as training, education and commitment. The entire community must support and participate in the initiatives being considered, developed and established for there to be prolonged comprehensive and continued success. This may initially mean restrictions in other areas of community development or expansion while dog population management and bite prevention programs are first introduced, which is why full community acceptance is critical.

One way to encourage and endorse the development of these programs, is the snowballing effect that they may have on the overall health of the community. In the two intensively studied communities, a number of “side effects” of the established interventions were noted both by Council members, and by general community members once the strategies allowed individuals to feel “safer”:

- a large percentage of citizens began regularly walking to school, work, events, or as evening recreation, which had demonstrable effects on their physical and mental health (several individuals mentioned significant impacts on blood pressure, blood sugars, body weight and state of mind);
- the process of the community participating in policy creation and decision making increased the feeling of community ownership, and the willingness to discuss other issues of concern;
- the increased feeling of freedom of movement led to increased attendance at community events, the Elders and Friendship Centres, and various impromptu social gatherings, which had an impact on overall community spirit and sense of connection;
- many community members believed that their dogs were also healthier, happier and better socialised than previously observed, and individuals had developed a closer bond to their pets;
- the inclusion of the Elders in education sessions, increased the understanding and respect of traditional knowledge and values, which was believed to impact the overall sense of connection to community, and pride of heritage.

When considering these overall community-wide improvements, it becomes apparent that even basic interventions such as education and communication can create significant improvements in both community-wide dog bite risk, but also reporting of aggressive encounters. Given the serious threat dog bites pose to public health, increasing awareness and acceptance of policies and alternatives has the potential to dramatically affect a community's sense of security and wellbeing. The public health burden and effect of dog bites and large FRD populations on community wellbeing and condition can be significant, and although preventative strategies may be costly, the overall benefits cannot be minimised.

### ***Relevance to thesis***

*Knowledge translation and exchange is a critical component of any research project, and especially those within indigenous communities. The consequences of the acrimonious history between Western researchers and traditional societies underscore the necessity of constant communication, feedback and participation for successful realisation.*

## **Chapter 6 Knowledge Translation and Exchange**

*“If you cannot – in the long run – tell everyone what you have been doing, your doing has been worthless.”*

*Erwin Schrödinger, The Spiritual Bearing of Science on Life, 1951*

### **6.1 Background**

*Kiskisamatotan Ma Miyo Pimatisiwin = translated from Woodlands Cree “Sharing what we know about living a good life” (Kaplan-Myrth & Smylie, 2006)*

It is important to remember that culture has a significant influence on the decision-making process (Shiva, 2000). Within many indigenous communities, there is the understanding that decision-makers have a responsibility to consider the impact that choices and actions will have on future generations (the 7 Generations Rule). This obligation requires considerable scrutiny of any proposed changes, and discussions of ‘what is known’. In this way it is obvious that good science may not always lead to good policy, just as no science (or bad science) does not always lead to bad policy.

In Western culture, it is often felt that science is needed in order to create policy. To build a bridge or framework between Western and indigenous beliefs, what is actually needed is understanding and rationality that all forms of information are valid sources of data. For First Nations and Métis peoples, evidence and knowledge comes in many ways. In addition to the previously described Western norms (section 2.3, Chapter 3), intuition, dreams, visions, ancestors, experience, stories, science, others, and more are held in high-esteem (Cochran *et al.*, 2008; Ellison, 2014). What changes is the context in which the audience finds different forms of evidence reliable. Therefore, if research and science are presented and proposed for use in decision-making, they should be used not only to help guide and develop policies, but also to evaluate them within culturally appropriate frameworks (Asselin & Basile, 2012).

A policy is simply a plan of action the community (and affiliated organisations) will take in order to shape decision-making (Banister *et al.*, 2011). The process of informing and developing

guidelines for both policy and future legislation is often as important as the policy itself (CIHR, 2012). In order to ensure community acceptance and compliance, it is critical for them to be engaged and involved in providing input, and hearing suggestions and results (Estey *et al.*, 2010). This way they can see the framework as it is constructed, and assist in the development of future assessments and regulations. Knowledge translation and exchange (KTE) becomes an essential component of this progression. Suitable and effective KTE is a constant transparent process, a wholistic and ethical exchange based on efficient communication involving two or more groups of people (Estey *et al.*, 2008).

As discussed previously, different groups have varied opinions regarding what constitutes evidence, and indigenous communities frequently have a lack of faith in researchers providing meaningful results (Asselin & Basile, 2012; Hanson & Smylie, 2006). Therefore much of what was included or excluded during discussions with each community was driven by questions of interest and requests for details. General information was initially provided, and followed up by key findings on the following topics:

- Dog population numbers and demographic characteristics
- Dog wellness data, including disease levels when available
- Community opinions and attitudes towards dogs, dog populations, and dog bites
- Current community perceptions regarding dog issues and disease risks
- Community suggestions for controlling dogs and preventing dog bites
- Examples of current successful population reduction/bite prevention strategies
- Examples of current comprehensive dog bylaws
- Updates on the provincial rabies prevention strategy

Communities working to change their current bylaws (usually to make them more comprehensive) have often moved conversations towards creating effective legislation and enforcement. Community councils, satisfied with current regulations, also generated questions on community member perceptions and suggestions, dog bite prevention strategies, dog population management guidelines, current dog demographic characteristics and animal behaviour analysis. Best practices regarding educating the public about dog behaviour and dog bite prevention, in conjunction with dog training, were also often focused on. One of the aims of this project was to follow communities focusing on decision-making and policy creation regarding dogs. To better understand evidence and attitudes determining dog population management strategies and bite prevention tactics, an attempt was made to provide answers (or contact information of those capable of providing answers) whenever possible.

Many community questions were able to be answered by the presented research. An example comes from one community meeting where one council member asked what percentage of community members had been involved in an aggressive encounter with a dog. Many attendees suggested everyone in the community had been bitten at least once. However another community member spoke up indicating that no one in his family had ever been attacked, and then asked why people were choosing to keep dogs if they had such negative dog:human history and experience. Not only did this generate discussion regarding choosing to have pets and community attitudes towards dogs, but it reinforced the council's desire for data on the number of households with dogs within that community, and the number of unreported aggressive encounters.

## 6.2 Community Partner Analysis

A full analysis of community collaborators requires an intensive examination of all programming and planning information to assess whose welfare and considerations are taken into account when shaping the final design and execution of the project. As stakeholders can be considered to be any individual or organisation for whom an intended policy may have an impact, when considering dog population management policies or dog bite prevention programs in remote locations these details are different in each community and may include (but are not limited to):

- public funding requirements (health care (wound care, rabies PEP, education), animal bylaw officer(s) and required equipment, licensing, sheltering (building, staffing, equipment, maintenance), information and education dissemination (development, facilitation))
- private (owner) funding requirements (restraint (fencing, dog houses), training, licensing)
- veterinary services (sterilisation or vaccination clinics (staffing, equipment, site location, pharmaceuticals))
- cultural acceptability and respect

These parties fall into particular classifications: civil, provincial and federal political councils and ministries, public health agencies, non-profit organisations, community members, commercial agencies, and potential donors (of time, resources, funding, etc.). Collaborators can influence the policies in question due to cultural, political or social impact, knowledge of program planning and design, and interests or biases in outcome at any time (Hanson & Smylie, 2006). Therefore community consultation is about communicating with, and listening to interested and affected individuals over the entirety of the research design and data accumulation, information dissemination, and program and policy planning, implementation and evaluation. Generally, these constructive relationships can result in instrumental feedback and sustainable supports over the duration of the process, leading to mutual trust and respect amongst all parties.

For comprehensive community partner involvement, meetings to disseminate research findings from this project included community councils and participating community members (Badger, 2012). First Nations and Métis communities were partners in all research collection and dissemination, and researchers had the obligation to ensure they were consistently informed, and at each stage of data procurement and analysis (Smylie & Anderson, 2006). This empowered each community to use data in a timely and efficient manner in the means with which they chose. It also generated support and communication for ongoing dissemination within the community (e.g. initial data from discussions within one community convinced the municipal council to establish policies on roaming behaviours, which in turn led to the construction of a holding facility). Once communities were satisfied that messaging to collaborators was appropriate, the following groups were actively engaged and consulted:

- all community members – especially Elders’ councils, Womens’ Councils, schools
- the Federation of Saskatchewan Indian Nations (or similar regional group)
- government agencies such as the Northern Inter-Tribal Health Authority, public health, medical health officers
- local RCMP detachments
- local non-profit animal rescue/welfare organisations (such as Northern Animal Rescue)

In addition, the following groups were informed of research when it was being conducted, and also of any changes in policies which occurred:

- private sector companies working in communities (they may be willing to fund certain initiatives, policies may affect staff living in the area)
- third parties identified by snowball sampling (where discussions with stakeholders identify other groups who should be included and informed)

A comment must be made regarding the use of the term “stakeholders” when communicating with Aboriginal communities. Due to the long, painful, and oftentimes destructive history between indigenous peoples, government and researchers, the term “stakeholder” has derived a negative connotation for many community members. Cheryl Brooks, president of the Indigenuity Consulting Group, has this to say about the topic:

*“Somewhere in the shift to citizen engagement, the term stakeholder was created, roughly defined as “being parties who have an interest in the issue or matter and should therefore be talked with and listened to.” First Nations people could not accept being grouped into that body of people who were being provided an opportunity to comment or participate at the discretion of other governments. As our leaders had said from first contact, First Nations or aboriginal governments have rights, responsibilities and obligations they must exercise just as the provincial and federal governments do. Accordingly, the inclusion of our governments in engagement processes flows from our legal recognition as another level of government, and not from a mere policy decision.*

*To refer to First Nations as stakeholders ignores and disrespects our constitutionally protected status as governments. Grouping us into the general body implies we merely have interests and not lawful rights. It is essential that Canadians, including governments, the public, and industry, understand and respect that we are rights holders who must and will exercise our lawful rights to support the process of helping our Nations take their rightful place culturally, economically and socially.”*

Cheryl Brooks President, Indigenuity Consulting Group, Spring 2013

Therefore during interactions with indigenous communities the term “stakeholder” was used sparingly during discussions regarding research, and not in reference to community partners. Rather the terms “community partner”, “community collaborator”, or “community researchers” (depending on the individual) were used instead.

### 6.3 Methods

The means by which developed knowledge gains were passed on was carefully researched and considered (see Figure 6.1). The qualitative exploratory and participatory methodology highlighted the crucial requirement of timely information and appropriate dissemination. It is hoped that this project was the impetus for increased research into a topic (dog bite prevention) of immense value for indigenous communities.

Developing key messages with the support of cultural knowledge brokers (respected members of the community such as Elders, band council members, shaman) is the most successful means of delivering important research results within indigenous communities (Ellison, 2014). These partners then assist in determining appropriate timing for the dissemination of knowledge to target audiences. In addition, they help choose the best strategy to use for any specific topic to any particular audience.

For this reason, the use of sharing and teaching circles was consistently employed with small community groups to develop two-way exchange of knowledge between researchers and community members at various time-points within the project. Elders' teas and story circles functioned to request permission for research phases, to learn critical cultural lessons and to share new nuances of project knowledge. Following these discussions, Elders then used local radio shows to describe the research, and answer questions in both English and local dialects (Cree, Michif). Online databases and a website were created to facilitate access for decision-makers and council members at times of dog management and dog bite prevention policy change or creation, as well as provide access to new, relevant information and data.

Within indigenous communities the sharing of wisdom and knowledge through storytelling, drawings, ceremonies, dance and song is a critical part of learning and developing respect and reverence for history and culture (Hanson & Smylie, 2006). They believe it is integral to ensuring the community can continue to live 'a good life' (Kaplan-Myrth & Smylie, 2006). To share the wholistic view of this project and convey detailed information and accumulated knowledge, stories, pictures and ceremonies were shared (see Figure 6.2). In addition, community members communicated the history of dogs and their important cultural role via stories, songs and dance.

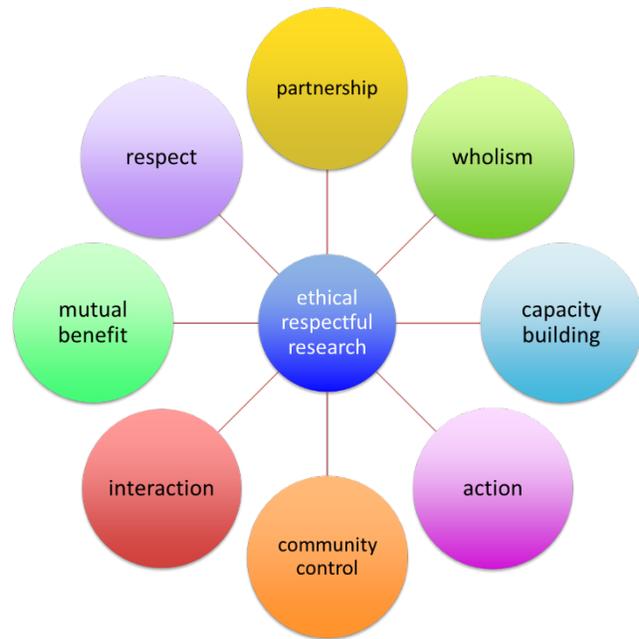


Figure 6.1 – Keys to successful knowledge translation in Aboriginal communities

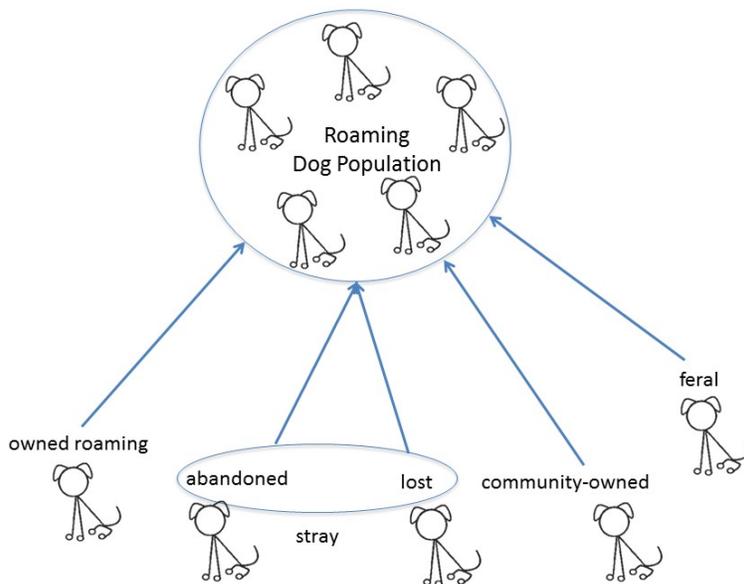


Figure 6.2 – Example of visual knowledge translation and exchange “Where the roaming dogs come from”

This mutual sharing and exchange developed the full story of dog health and wellbeing within each of the communities. Story creation and poster competitions were also one way to ensure the community youth were actively engaged (see Figure 6.3).

Communities regularly scheduled question and answer periods for researchers on local radio and television broadcasts, and school classes assisted in survey collection.

Results were regularly presented to the entire community in both written and oral presentation form. This



Figure 6.3 – Community dog management logo created by Stacy Caisse of Community E.  
*This logo became the logo used throughout the project for various levels of communications.*

ensured that all data remained relevant and useable, and that the project itself maintained significance for the communities. This gave each community the opportunity to provide feedback, additional insight and permission to share their paths, suggestions and successes towards dog population management and dog bite prevention.

Data were more widely disseminated by a variety of means: the FSIN were provided regular reports in order to inform participants of the results and to engage the rest of the network with the study; presentations were given at a number of national and international level conferences and community workshops; results have been submitted to academic and non-academic journals and newsletters; and discussions and meetings have occurred with various community collaborators. An effort was made to ensure that all relevant communities: indigenous communities, research communities, policy communities, and practice communities, could remain engaged and involved in discussions throughout the project.

## 6.4 Discussion

As Einstein said "*The significant problems we face cannot be solved at the same level of thinking we were at when we created them.*" (Albert Einstein 1879-1955). For change to occur, cultures and climates need active formation and guidance. It is important that community members and policy makers are strategic about sharing messages, and that they create a communication plan regarding what route will be taken when developing new plans. Methods of signposting must be undertaken to ensure all questions are answered and issues are faced.

Looking at the 'how' and 'why' of disease or condition causes and outcomes with fresh and constructive perspectives permits identification not only of all risk factors and problematic behaviour trends but also potential methods for improvement and transformation. The ability to anticipate these tendencies and shifts due to underlying human activities and high risk interfaces

also allows for risk assessment. Then by evaluating behaviours there is the ability to recognise potentially palatable changes to mitigate these risks.

For tangible improvement to evolve within the realms of indigenous health research, and significant progress to be made within indigenous social determinants of health, effective collaboration and consultation must occur with the recipient communities and parties. With ongoing community participation and dialogue, genuine partnerships can be developed. If these alliances are robustly built on respect, KTE can occur throughout any project and integrated within the research. Inclusionary KTE increases the appropriateness and applicability of policy, practice and research. In this study, the development of culturally acceptable communication, education and training/socialisation practices dramatically altered the health and management of community dogs.

## 6.5 Conclusions

The idea of KTE has been a part of indigenous culture and history for as long as anyone can remember. Elders have explained that it can occur in “*as many ways as there are stars in the sky*”, and as long as it is done in a humble manner, there are no wrong methods. The key is to find stability and balance between traditional ways of being and learning, and novel approaches to problem solving and management. It is critical to acknowledge the generations of knowledge and understanding that have been learned and retained within these communities, as this information is truly necessary for real impacts to be sustained. Without recognition of cultural and spiritual beliefs, communities often feel as though politicians and researchers are dictating and forcing unwanted strategies or policies on helpless individuals or groups. This belief then breeds resentment and an unwillingness to comply with legislations.

In addition, there is no point in research if the results are not utilised to make improvements or focus on change. Despite this, balance is integral to success; the community must believe that attempts are being made to create a union between the knowledge of the past and visions of the future. Change and capacity building at the community level should ultimately be the end goal for all collaborators, rather than temporary or stop-gap “helicopter research” meant to further only the researcher’s position. In short, in order to prevent the loss of project leadership once research is completed, and to maintain active interest in taking results to a logical conclusion, it is critical for community members to participate in all roles so there is personal investment in success.

## Chapter 7 What is Evidence?

*“Listen with the intent to understand, not the intent to reply.”*

*Stephen Covey, The 7 Habits of Highly Effective People:  
Powerful Lessons in Personal Change, 1990*

Since health and environmental policies are created in order to reduce disease and injury levels caused by biological, toxicological, physical, or psychological threats, and improve the wellbeing of people, animals and the ecosystem, it is important to have an accurate understanding of what those are (Stamler, 2010). Oftentimes, though certain hazards are dangerous to everyone at all times (e.g. a bullet to the heart is likely to kill you no matter who you are), identified risks change depending on community, culture, timing and perception. Therefore it is crucial to appreciate and recognize how communities determine “knowledge”. How do they identify evidence? What methods are used to communicate critical information? What value do they place on differing categories and sections of the story? Do these differ between community members and decision-makers, and if they do, how do you build a bridge? Researchers assume that if communities are presented with findings and scientific “evidence” that information will be appropriately considered, and will immediately be implemented into practice in order to improve social determinants of health (Colquhoun *et al.*, 2013). This expectation cannot be implicit if relevancy, comprehension, implementation or sustainability is at all questionable (Jack *et al.*, 2010). Nor can it be assumed that all evidence is considered equal.

When asked ‘what is evidence?’ the instinctual answer is to reply based on personal experience and discipline. What is perceived to be key or critical “evidence” is different for a medical practitioner versus a priest versus a farmer. In other words, evidence is completely contextual and personal. A simple response to the question would therefore be “*any information that assists individuals, groups or communities in making a decision or choice*” (see Figure 7.1). However there is often the belief that certain information is more valid, reliable or reasonable. This is especially true when considering scientific data; the understanding that clinical trials, and now meta-analyses are the “gold standard” to which all studies must be compared has been perpetuated for decades.

Unfortunately, this bias has in many ways conveyed the idea that all other forms of knowledge are worthless and without meaning. The belief that understanding may come only from rigorous testing and scientific protocol (i.e. following the Scientific Method), negates the learning

that may come from other sources such as storytelling, historical events, observation, and even the basic experience of daily survival. Often policy makers and scientists give little credence to concepts that remain untested. Likewise, the public may suspend belief until they have “seen it with their own eyes”. So the question becomes “*How do we respectfully and successfully merge oral history and traditional knowledge, with more modern methods?*”

When research is conducted with indigenous community partners, it requires understanding of cultural differences and protocols, in addition to historical interactions. Though indigenous groups have distinct customs and a wealth of knowledge to share, this information has not always been respected as key evidence in decision-making by traditional Western culture (Smylie *et al.*, 2004). As a result, indigenous communities frequently became marginalised and vulnerable while non-Aboriginal policy-makers made choices that led to loss of identity, culture and traditional practices. In contrast, simply recognising and valuing the basic differences between responsibilities, wisdom and influence of each of the Councils (Band/village, Elders, Grandmothers, etc.), and devoting time to gathering and incorporating this information while developing strategic planning, can solidify an overall comprehension of community and the research dynamic.

As the Elders’ describe it, in Aboriginal communities learning cycles through a multi-directional current of information (see Figure 7.2). Stories explain all of the mysteries of life, and flow into knowledge and wisdom. The knowledge circle holds all of the nuances of detail, which then course into a person’s full comprehension of everything that surrounds him, building wisdom and experience. In turn wisdom is passed on through new stories and deeper knowledge. The three are always linked and weaving a tapestry of understanding throughout the community. To share new ideas and information, a knowledge circle must be carefully and respectfully formed, so that new meaning may enter, without old insights and wisdom leaking away. Traditional wisdom and understanding is sacred and treasured. Knowledge is of the mind, and is therefore only about thinking and understanding. Wisdom is of the whole body: heart, spirit and mind. Wisdom therefore is about doing, seeing, being, and knowing. Words are powerful. Knowledge and Wisdom are gifts to be respected and may be shared by Stories, but only with those you trust.

In addition, a respectful understanding of the significant and ongoing impact that residential schools and the residential school syndrome<sup>9</sup> continues to have on Aboriginal

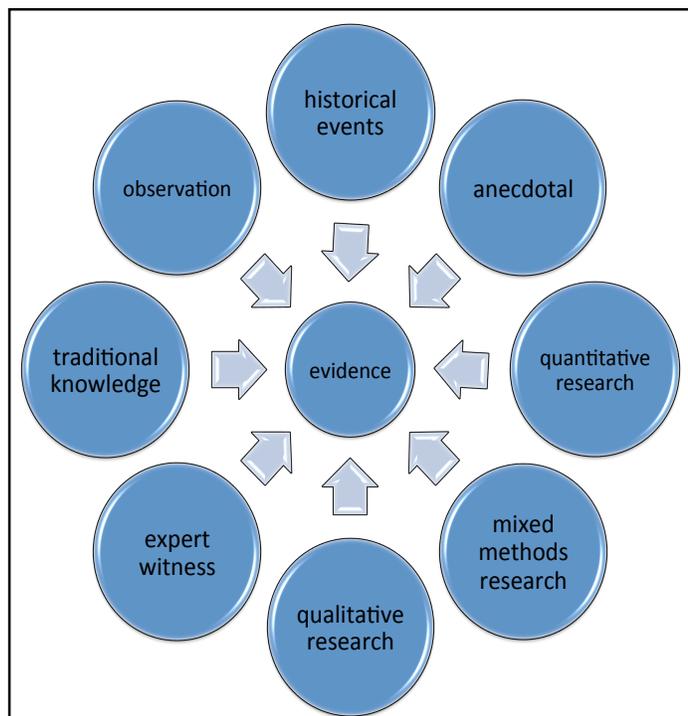


Figure 7.1 – Types of Knowledge that can be used as Evidence

<sup>9</sup> The term “residential school syndrome” was developed by Dr. Charles Brasfield to describe the ongoing emotional and psychological trauma symptoms residential school survivors and their families continue to experience. Brasfield, C. R. (2001). Residential school syndrome. *BC Medical Journal*, 43(2), 78-81.

communities in Canada is crucial. It is estimated that in Saskatchewan between the years 1883 and 1983<sup>10</sup> approximately 70-90% of indigenous children between the ages of 6 and 16 were sent to one of twenty residential schools in Saskatchewan. These estimates do not reflect the day schools, nor the privately run/non-federally funded church schools that also existed. The forcible removal of children from their parents and communities, and destruction of traditional heritage and wisdom, created glaring cultural knowledge gaps within most indigenous Canadian communities.

A relevant example, the resultant communal loss of traditional education, understanding, and recognition of canine cultural importance, dog behaviour, dog socialisation/training, and population management/restriction, can be directly attributed to the multigenerational social assimilation experienced within these schools. While some Elders remember and describe communities with well-trained and socialised working dogs, and the methods used to ensure there were few management issues and aggressive encounters, the average community member does not know what strategies may have been employed simply to control dog population numbers. These emotionally frustrating and contrasting levels of knowledge and faith in traditional wisdom must be met with compassion and diplomacy to balance what is often an internal struggle between following the multiple paths of adhering to culture, using ‘Western’ science/medicine, or forging a new system.

With First Nations communities reclaiming autonomy over their health care, environmental, political and educational policies and practices, early engagement and evidence sharing is also critical in the success of any potentially influential project (Schnarch, 2004). The relationship researchers have with Aboriginal groups is key when developing KTE strategies, and can in itself create insurmountable obstacles and tensions. This becomes especially complicated when science and oral tradition are at opposite spectra or seemingly develop cross purposes. It takes specific understanding and skills to balance the diversity of evidence that may exist and be available in any given situation.

It is important to note that issues with dogs are not just problematic within indigenous communities, but are a by-product of dogs and humans living within the same environment. Though some of the challenges may be similar in rural Aboriginal and urban communities, traditionally the strategic methods used as solutions may be vastly different due not only to culture, but also to historical evidence and knowledge. Knowing dog bites are epidemiologically multifactorial, specific variables may arise within different contexts while others may be present in all situations due to diverse stimuli. Given canine genetics, socialisation, experiences, living environment, training, and stressful external stimuli, not to mention owner and/or victim

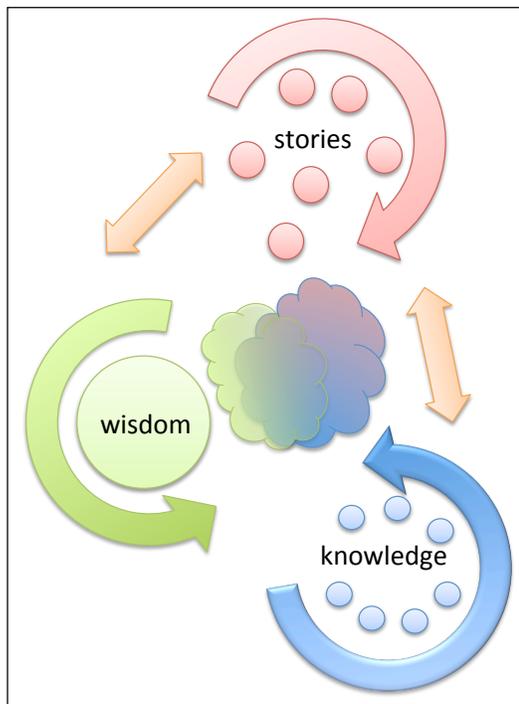


Figure 7.2 – The indigenous cycle of knowledge

<sup>10</sup> Although the last residential schools in Saskatchewan (and Canada) closed in 1996, federal operations ceased in 1983 and most closed in the mid-1970's (7 remained open into the 1980s and two did not close until 1996) (Truth and Reconciliation Commission of Canada)

behavioural characteristics, have the power to influence all dog:human encounters, the more prevention approaches an individual or community has within their toolbox, the safer and more successful they will be (regardless of intervention origin).

As noted, the ultimate concern should no longer be “*Who is most likely to be bitten?*” or “*Which dog is most likely to bite?*” as with research it becomes increasingly more obvious that any dog may bite, and any person may be a victim. Instead the focus now needs to be “*Why did this encounter occur?*” and “*How may we best prevent the next one?*” Finding suitable and sustainable culturally sensitive and feasible intervention alternatives is a goal, and often a challenge for any community. Complex interactions can arise at any time requiring immediate knowledge and quick thinking, making the simplest solution cultural and community specific education on dog behaviour and appropriate dog:human interactions. What is the easiest way to discover what is suitable for any community? Engage and Ask. Listen and Believe. Encourage and Support.

*“The traditional way of education was by example, experience, and storytelling. The first principle involved was total respect and acceptance of the one to be taught, and that learning was a continuous process from birth to death. It was total continuity without interruption. Its nature was like a fountain that gives many colours and flavours of water and that whoever chose could drink as much or as little as they wanted to whenever they wished. The teaching strictly adhered to the sacredness of life whether of humans, animals or plants.”*

*Art Solomon, Anishinaabe Elder*

## **Chapter 8 For the Future**

*“The only thing that we know is that we know nothing —  
and that is the highest flight of human wisdom.”*

*Leo Tolstoy, War and Peace, Chapter 1, 1869*

Employing a wide variety of qualitative and quantitative methods, this study explored the attitudes, knowledge and evidence behind decisions made regarding dog populations within a subset of northern remote and rural Aboriginal communities in Saskatchewan. To describe the aims and strategies of viable, acceptable and maintainable community-led dog population control and dog bite intervention programs, in depth community engagement was completed. A more wholistic insight of community health, and the welfare of human and dog populations, as well as critical issues, priorities, and availability of resources, was sought to provide tangible data for policy creation.

Slowly uncovering the history and origins of public perceptions and opinions highlighted specific decision processes and policy development methods founded on common underlying judgements and behaviours leading to either positive, sustainable interventions or susceptible, ineffectual approaches. This Knowledge has been passed on and exchanged with other groups by community leaders, and on a more global level via articles, presentations and a website, in order to inform or assist others in the implementation of new strategies in dealing with many of the same issues and concerns regarding dogs within their environment. The sharing and exchange of newfound Wisdom continues to improve the health not only of dogs and humans within indigenous communities, but society and the environment as an interconnected whole.

### **Challenges with Method Theory**

Community-based participatory research has the capacity to fundamentally transform project conception, and human and animal health care within marginalised communities. Determining which priorities are of most concern and pertinence for populations can lead to substantial change in procedure, preparation and strategy with enduring effects and sustainability. Unfortunately, CBPR is not consistently used, nor its importance extensively accepted or acknowledged within veterinary medicine. This creates restrictions in the overall support of its

usefulness, despite the increased energy, effort and time involved in developing project relationships and disease surveillance.

As has been described, part of the challenge of incorporating CBPR within the confines of a research project with vulnerable and marginalised communities stems from the suspicions developed by previous treatment or experiences with scholars with short time frames. As demonstrated, creating trust-filled relationships is more straightforward when indigenous communities are engaged as partners, seen as having the questions AND the answers, and all work is built as ongoing, sustainable collaborations between communities of actors (e.g. the university rather than the individual, the entire community rather than simply the liaison, etc.). However, it is important to remember that associations are tenuous, and any misstep may result in irreparable consequences. It is critical for “outsiders” to approach all interactions with as much historical knowledge and sensitivity as possible, and to remember that while delays may be an inconvenience to them, the impact of every decision made can be life-changing for community residents. The recognition that interventions affect people and individuals and not simply a bottom-line or statistical result, and that changing cultural strategies is a long-term community change and not a research publication, generally positively influences the conversations occurring between collaborators.

In this climate of disease prevention, improved skills in large-scale collaboration and communication are increasingly required. Working, collaborating and managing large and varied groups can be challenging. Unfortunately most human and veterinary medicine curricula do not incorporate significant training in community (or herd) level surveillance or intervention initiation. This often creates a potentially limiting environment where focus is placed solely on quantitative data and clinical experience, to the detriment of appropriate care and proactive medicine at a community level.

While qualitative portions of MMR have frequently been applied to health research, proper MMR studies encompassing rigorous triangulation and validation have been rare. Instead, studies generally applied qualitative assessments to follow trends in understanding or attitudes to construct increasingly controlled quantitative studies. Usually even those studies comprising both qualitative and quantitative sections limited their analyses to the quantitative data, with qualitative information providing support. In addition, the necessity for researchers implementing MMR to have manifold abilities has often meant segments of the study may have resulted in a decreased emphasis on accuracy and precision. This study has attempted to rectify those potential shortcomings.

Veterinary researchers interested in pursuing CBPR and MMR methodological approaches should be cognizant of the paucity of similar studies, and the length of time required to complete them successfully. Animal health care workers must be aware of the strong bias towards an unquestioned post-positivist ontology and quantitative epistemology (see Appendix A). As post-graduate veterinary courses fundamentally lack focus on the 'philosophy' aspect within a Doctor of Philosophy degree. This results in challenges for those interested in following or engaging in 'other ways of knowing', and designing programming other evidence that require a different ontological perspective. Although the recognition of traditional Knowledge and Wisdom infers a more Southern methodology when working with indigenous communities (see Chapter 2, p9 or Appendix A), the value achieved in supporting and empowering a community to reflect on their own basic requirements and the means to achieve them drove this research, resulting in a more Northern framework. This thesis demonstrates that this kind of worldview leads to a rich, contextual knowledge, incorporating both qualitative and quantitative data. This type of Knowledge is essential to affect real change in dog:community relationships: the ultimate goal of any companion animal veterinarian's interventions.

## Research Aims

Few studies have considered the overall complexities of dog:human aggression; and fewer still within Canada. Prior to this study, the majority of published studies on dog:human interactions related to controlling, preventing or treating rabies within dog (and human) populations, or surgical and medical treatments of wounds to dog bite victims. In addition few articles examined multiple issues at once. While the aim of this study was to evaluate the choice, integration, and success of various approaches to dog population management and dog bite prevention interventions within indigenous communities from as many angles possible, a subsequent result was the observation of dog:human interactions in multiple environments. Assessing the long-term sustainability of programs, and their effect on true within-community dog demographic characteristics and rate of aggressive encounters, was a secondary benefit. Addressing these goals, the major research questions (see Table 8.1)

1. *“What are the factors behind dog bites and what is the prevalence of dog bites in northern Canadian communities?”*
2. *“Which dog population management strategies, and dog bite (and disease) prevention methods would be most appropriate and successful in northern indigenous communities?”*

resulted in significantly more data, interest and information than anyone expected, and exponentially more than could be completed in a timely fashion for any doctoral dissertation. It is expected that engaged communities will continue to monitor and share their successes, and it is hoped that through their Knowledge Translation, Management and Exchange (KTME) that other interested communities may continue to learn and build on the successes these communities have developed.

Participatory community engagement and KTE allowed researchers to interact with communities as their issues were classified, and long-term interventions and solutions were identified. Involving community members in all areas of research collection gave them an opportunity to appreciate the scope and breadth of problems and community opinions. Ensuring communities were enabled, empowered and capable of achieving their goals for dog-human relationships within a culturally sensitive timeframe and with appropriate approaches, required comprehensive communication and education of all parties involved.

As has been noted, remote indigenous communities encounter numerous and substantial challenges influencing not only the ability to place importance on dog-related issues, but also on ameliorating them in community-approved ways once they have been prioritised. Policy development, health initiatives and population control measures for dog ownership and bite prevention vary significantly between regions, and are often dependent on the potential of perceived risk of an aggressive dog-human encounter. Therefore no single policy or prevention model will be effective in all situations. Sustainability of any intervention requires full community approval and support, and access to the required resources.

## Research Comparisons

When Guy *et al.* (2001a) examined number of reported dog-bite incidents in the Atlantic Canadian provinces, fewer than 10% were reported to authorities. Given that multiple studies also identified increased numbers of aggressive interactions between dogs and humans amongst Aboriginal peoples (Bjork *et al.*, 2013; Castrodale, 2007; Russell *et al.*, 2001), the outcomes of this

study were unexpected. Although it was initially thought dog:human aggressive encounters in remote indigenous communities would be less frequently reported than in urban locations, 40 to 50% of respondents claimed to have reported aggressive interactions. As previously observed in the scoping review, this is a considerably higher percentage of reporting than is projected in any urban environment (Gilchrist *et al.*, 2008; Sacks *et al.*, 1996a), but is consistent with reports from areas with high numbers of FRDs (Agarwal & Reddajah, 2004; Tenzin *et al.*, 2011). This could be a result of the compounding fear and frustration regarding the increased number of provoked encounters occurring with loose animals.

In addition, many of the originally hypothesised human, canine and environmental risk factors determined in preceding studies were not identified here, offering evidence that aggressive encounters are context-driven and that *any* dog may bite *anyone* at *any* time. Specific examples include:

- dog bites occur more often to males than females (Cornelissen & Hopster, 2010; Schalamon *et al.*, 2006)
  - in this study there were more females reported on surveys; interactions were approximately even between males and females on reports to authorities
- dog bites occur more often to children under the age of 10 years old (Bernardo *et al.*, 2002a; Schalamon *et al.*, 2006)
  - in this study a high percentage of bites to those over 10 were reported on surveys, and to authorities
  - although a higher number of reported encounters were in children under age 10 (27-45% of bites) than were discussed in the survey (17-19% of bites)
  - In the context of age distribution of the population using the median age, the bites reported still favoured children 19 years of age and under, although in community D both on- and off-reserve, this was not as strongly indicated as in other literature reported from the scoping review.
- dog bites occur more often by intact male dogs (Horisberger *et al.*, 2004; Messam *et al.*, 2012)
  - although difficult to assess due to incomplete data, there was no evidence supporting this hypothesis
- in children 40-80% of bites are to the head and face (Bernardo *et al.*, 2002b; Daniels *et al.*, 2009; Horisberger *et al.*, 2004; Thompson, 1997)
  - in this study 20-40% of reported bites in children under 10 were to the head and face
- severe encounters (including fatalities) more often include multiple dogs (Raghavan, 2008)
  - none of the reports to authorities involved multiple dogs, 60% of encounters reported on surveys were with one animal
  - severe encounters resulting in multiple bites were almost all single animal attacks
- dog bites occur more often in spring and summer (Agarwal & Reddajah, 2004; Dwyer *et al.*, 2007; Horisberger *et al.*, 2004; Kaye *et al.*, 2009; Lone *et al.*, 2014a; MacBean *et al.*, 2007; Reece *et al.*, 2013; Rosado *et al.*, 2009; Sriaroon *et al.*, 2006; Tenzin *et al.*, 2011)
  - seasonality was not found to be a statistically significant factor
- in areas with large numbers of FRDs, aggressive encounters are more frequently by unknown animals (Alfieri *et al.*, 2014; Alfieri *et al.*, 2010; Jackman & Rowan, 2007; Mengistu *et al.*, 2011b)
  - in this study although most incidents involved FRDs, 65 to 80% of encounters were with known animals
- higher rates of dog-bite related hospitalisations occur in rural and remote areas (Raghavan *et al.*, 2014; Raghavan *et al.*, 2013)

- less than 2% (~1.8%) of reported dog bites in this study required more than basic walk-in medical care compared to an estimate of 2.5% in the U.S. by the Agency for Healthcare Research and Quality (Rhea *et al.*, 2014)

The multiple research arms used here reinforced the idea that although there may be significant numbers of FRDs within the communities, encounters leading to bites or mauling occur less frequently than initially alleged. As almost half of dangerous incidents were immediately reported to authorities, there is a strong probability that the recognition of potentially dangerous situations, and training and knowledge regarding incident de-escalation could have a significant impact on the result of any altercation. Given self-identified increased levels of behavioural knowledge essentially eliminated the likelihood of a bite, augmented behaviour education could be effective in dramatic reductions in aggressive encounters. A caveat is that although knowledge was found to be a protective factor, it is unlikely to have a buffering effect within controlled situations with family pets due to the differences in incident instigation.

Therefore hypotheses of rural remote indigenous communities having significant differences in dog bite risk factors compared to urban environments were not supported in this study, nor were the more common trends found in previous dog bite research conclusively demonstrated or refuted. Although previously stated, it cannot be emphasised enough that the bulk of aggressive encounters are multifactorial, and for preventative methods to be effective, they must focus on multilayered interventions incorporating TES. Improved surveillance and reporting would also greatly assist in identifying cultural, environmental and geographically specific risk factors and locations, in addition to ensuring appropriate medical attention was received by all victims. Additional long term research into the level of connection between these factors would improve understanding of the malleable dynamics behind dog bites in indigenous communities.

## Dog Aggression

Any dog, regardless of its personal characteristics (genetics, breed, gender, age, size and training), is capable of becoming aggressive under the right conditions. Regulations aimed at a specific animal's behaviour and triggers will have a greater effect on reducing dog bites compared to broad reaching bans such as BSL. As well, the implementation of culturally sensitive behavioural education will create greater awareness and understanding of problematic human behaviours, prospective environmental concerns, and animal warnings prior to initiating incidents.

Most appropriately socialised dogs rarely become involved in aggressive dog:human encounters outside of identifiable environmental and behavioural circumstances. As the majority of biting dogs have demonstrated multiple signals indicating some level of discomfort or aversion to particular stressors prior to an incident, recognition of signals and communication regarding the repercussions of ignoring them must to be relayed. This is particularly important in situations involving highly reactive animals with little means of avoidance, as the response or strategy for dealing with the threat can escalate rapidly.

Comprehensive studies on successful dog bite prevention strategies are notably lacking. For communities attempting to design functional and efficacious strategies, vague and incomplete suggestions to focus on adequate legislation, appropriate population control and community education provide no concrete information on which to form a course of action. However these details are necessary in order to establish sustainable, cost-effective options. Communities handling multiple dog issues with few available resources need access to successful alternatives (including requirements, advantages, disadvantages and efficacy).

In remote areas without emergency services, emphasising animal socialisation, and public recognition of breed-specific signalling (e.g. the ruff and mane hackling of huskies) reduces the likelihood of dangerous encounters. Methods such as increased exercise, positive training strategies, and situation recognition have also been demonstrated to decrease the potential for aggression, therefore these approaches should be encouraged. Supervised socialisation between dogs may also help, however efforts must be made to prevent the congregation and packing up of FRDs within any community, to avoid aggressive encounters spilling over into human directed aggression.

Mass culls are ineffective and remain unpopular with community members, however they may appear to be the sole method available during times of crisis. It is recommended that all levels of governing bodies collaborate in supporting or developing accessibility to veterinary care, and become involved in developing preventative educational programs and suitable community initiatives in remote regions. This has the potential to create greater feelings of support, cohesion and collegiality. Given the economic, personal and emotional costs of dog bites and maulings, as well as the potential spread of zoonoses, there exists ample justification for involvement. In addition, emphasis should be placed on standardisation of data collection and recording to improve the surveillance and comparative data analysis required for appropriate feedback and integration for policy makers.

In view of the vast potential sequelae and ramifications of dog bites, it is essential that community members are encouraged to report and seek medical attention. While remote communities may be unable to care for complicated injuries, primary treatment can begin while transportation plans to other facilities are underway. In addition, appropriate medical care ensures that timely rabies post-exposure prophylaxis is provided when necessary.

## **Dog Overpopulation**

Few comprehensive studies have been published on successful dog population management strategies within remote environments. Any method being considered is reliant on an accurate estimate of the base number of animals being targeted. While many methods described (see Chapter 3.3.4) work to provide simple estimates of population size and density, few counting methods factor in differences in environmental (weather) variation or owner attitudes towards “semi-roaming” (e.g. “*my dog has been cooped up all week, he needs a break on the weekend*” or “*Fifi hates the rain, so she stayed home today*”). Nor do methods incorporate TES as a means of recognising community dog behaviour patterns or locations.

Without understanding community attitudes, the impacts of interventions assume regularity in roaming patterns, dog distribution and temporal behaviour. To truly be valuable, researchers must apply their understanding of the community and cultural attitudes towards dogs and roaming behaviour, as well as temporal, spatial and seasonal changes in animal behaviours, in developing community specific counting methods. In addition, northern Canadian surveillance methods must account for seasonal modifiers such as extended cold spells, heavy snowfalls, and prolonged winters, in addition to summer drought conditions or forest fires.

The FRD numbers estimated over the duration of this project demonstrate that with the initiation of community supported interventions, population control develops and roaming dog numbers decrease. Regardless of the applied interventions (enforced animal control bylaws, voluntary dog restraint (i.e., keeping animals at home via fences, leashing, in home, etc.) or human education and animal socialisation), both roaming and aggressive dog:human encounters were reduced. Although individual dog counts may have been underestimated due to loss of animals

between counts, or overestimated due to the attraction of trap-happy animals, the extensive repeated counts per session, and stable overall dog populations minimise these concerns.

The ratio of restricted animals to FRDs seems to have a greater role than overall dog density on aggressive encounters within remote indigenous communities. This is likely due to unrestricted and/or poorly socialised animals demonstrating little restraint in approaching community members. In addition the constantly changing dog populations (due to partial restriction or addition/loss of animals) creates instability and tensions between dogs, frequently resulting in aggressive encounters that may spill over to human community members.

Dog overpopulation costs including animal complaints, impounding, sheltering, euthanising, environmental pollution, public health risks, and loss of animal life, have the potential to create considerable complications within indigenous communities. Community members believe people, dogs and the environment are interwoven as a braid, and so are inseparable as a sacred community. To influence only one strand diminishes the existence of them all, affecting the balance within nature. While prevention and control strategies are vital, strategies focusing only on costs, without incorporating the sacred balance of the natural world are doomed to fail.

Most communities involved in the study believed a combination of factors are required to transform and improve problematic dog issues: comprehensive and accessible human education, extensive communication, in-depth legislation, companion animal socialisation and training, and inclusive animal health care. Focusing on the “whole” is felt to have the power to result in changed cultural beliefs and attitudes, leading to improved cooperation and compliance. Communities attributed the increases in animal licensing and registration, and the reductions in aggressive encounters and dog bites to improved community awareness, individual education and consistent bylaw enforcement. As communities instituted population management strategies and bite prevention interventions in various combinations, rates and degrees, the potential effect of any particular method is difficult to separate from the others. However it was overwhelmingly obvious that extensive community-wide communication, participation and education are integral factors in any successful strategy. Further research looking at individual interventions alone or in combination is required to more completely assess their effectiveness.

## **Recommendations and Conclusions**

The fundamental conclusion from the combination of this research substantiates the message that large measures are rarely required to achieve notable success. A constructive and supportive culture and environment empowers engagement and change at every level, regardless of the community collaborator assisting in developing the atmosphere. This is in complete contrast to an atmosphere of control or judgement, which prevents the necessary paradigm shifts needed for growth to occur, regardless of the parties involved.

When outlining and recommending disease prevention and eradication strategies at any level, multiple factors are considered. These consist of strategy efficacy, cost-benefit and cost-effectiveness criteria, quality of life concerns, and temporal requirements. Unfortunately, many of these measures remain unknown when considering dog bite prevention. However, quality of life is considered to be a major issue within many indigenous communities. When community members believe their FRD populations to be a major danger to their loved ones, the time required for stabilising interventions to be put into place may not be provided. Therefore strategies such as improved by law enforcement and education should be put into place well before more tragic endings (for either humans or dogs) occur.

As interventions require time, effort and collaboration, support should be sought from as many community partners as possible. This not only includes all levels of government, and community, but also local businesses, private companies, non-profit organisations, and medical associations (human and veterinary). The ability to reach out to a wide variety of groups allows for increased access to resources, as well as training and education.

It is important to recognise that with increased attention on the health, training and restriction of dogs within previously FRD-dense communities, there will be increased interaction between people and animals. Without appropriate owner understanding of socialisation and training methods, simply enforcing the restraint of community dogs may result in unpredictable or aggressive canine behaviour. As well, if strong dog:human bonds have not been developed, behavioural signals may be misunderstood, leading to increasingly aggressive encounters. The effect knowledge and education has on reducing violent dog:human interactions cannot be overemphasised.

For palpable advances to occur within indigenous health research and social determinants of health, culturally appropriate collaboration and sensitive TES dialogue must be developed. If alliances are formed on respect, KTE occurs throughout every interaction and is therefore cohesively incorporated within any project. Respectful KTE, which incorporates TES, improves the suitability and applicability any decision made. In this study, the foundation of culturally acceptable communication, education and training/socialisation systems significantly transformed the health and management of community dogs.

The purpose of any research is to search for answers, and when necessary, identify areas needing improvement or change. However, recognition that “improvement” is contextual and not necessarily universal is essential. Within CBPR, awareness that working within other communities necessitates balance, and a loss of “pride” or “ownership” (i.e. it is not “you” who succeeds or encounters difficulties, nor are decisions “yours” to make regarding best choices or alternatives) is critical to maintaining positive and effective relationships. Especially within indigenous groups, the community must believe that attempts are being made to create a union between the knowledge of the past and visions of the future, and that all collaborators respect the process.

For there to be an ending, there must have been a beginning, or so the Elders have told me. But how is the beginning identified? The development of the question? The establishment of need? The feeling of connection between an idea and its potential? Or simply the understanding that there exists something worth Knowing, and the braided paths to discovery may lead to many different places in the search for Wisdom?

Whichever it is, to answer Alice, there are multiple routes to improved dog population management and dog bite prevention in indigenous communities. However, the success lies in developing community:dog relationships in such a respectful way that the braided strands of the people, animals and environment, and those of the community, family and individual, remain tightly woven together balancing the needs and existence of the sacred natural whole.

Table 8.1 – Questions and answers shaping research development

Research questions	Research conclusions
<p><i>What are the factors behind dog bites and what is the prevalence of dog bites in northern Canadian communities?</i></p> <p><i>How do members from community XX feel about dogs? Why?</i></p> <p><i>How many dogs are in community XX?</i></p> <p><i>How many individuals from community XX have had aggressive encounters/bites from dogs?</i></p> <p><i>Are risk factors common across all communities?</i></p>	<p><i>Dog bites are multifactorial, and risk factors and attitudes vary not only between community but also within community</i></p>
<p><i>Which dog population management strategies, and dog bite (and disease) prevention methods would be most appropriate and successful in northern indigenous communities?</i></p>	<p><i>No one strategy will be successful in every situation, and the same method may not always be consistently successful within the same community. However education (knowledge of dogs and their behaviour) is the single biggest asset that any individual may have when attempting to avoid an aggressive encounter</i></p>
<p><i>Which population control methods and dog bite prevention strategies are communities choosing to use, and why?</i></p> <p><i>Do these strategies differ from those seen on a more global scale, and if so, why? What is the difference between how communities feel about dogs, and the population management strategies that they choose to employ?</i></p>	<p><i>No one strategy will be successful in every situation, and the same method may not always be consistently successful within the same community. However education (knowledge of dogs and their behaviour) is the single biggest asset that any individual may have when attempting to avoid an aggressive encounter</i></p>
<p><i>What is the difference in number of dogs versus number of aggressive human-dog encounters between communities?</i></p> <p><i>Is it possible to identify specific risk factors that could potentially have a significant impact on the reduction of aggressive encounters should targeted interventions be applied?</i></p>	<p><i>No one strategy will be successful in every situation, and the same method may not always be consistently successful within the same community. However education (knowledge of dogs and their behaviour) is the single biggest asset that any individual may have when attempting to avoid an aggressive encounter</i></p>
<p><i>How are the dog population control methods and dog bite prevention strategies that communities are using developed, and have they been successful in stabilising dog populations and reducing dog bites within their communities?</i></p> <p><i>What recommendations can be made to improve the success and sustainability of the interventions?</i></p> <p><i>Are these methods similar to others seen in similar situations?</i></p>	<p><i>No one strategy will be successful in every situation, and the same method may not always be consistently successful within the same community. However education (knowledge of dogs and their behaviour) is the single biggest asset that any individual may have when attempting to avoid an aggressive encounter</i></p>

## **Appendix A – Definitions**

*The following definitions are provided for explanatory purposes and ease of those reading the research. They are not intended as a commentary regarding appropriate terminology*

**Aboriginal/indigenous** - *The original caretakers of any location. E.g. Canada's First Nations, Metis or Inuit peoples; Australia's Aboriginal and Torres Strait Islander peoples; East Africa's Maasai; Central America's Maya; etc.*

**Natural world** – *“home” – intricate, interwoven links exist between everything in existence, requiring respect and gratitude, and the awareness and preservation of sacred connections and reverential stewardship*

**Vulnerable communities** - *disadvantaged sections of a community requiring careful consideration and increased protection during research.*

*(WMA Declaration of Helsinki-Ethical Principles for Medical Research Involving Human Subjects-59th WMA General Assembly, Seoul, Korea, October 2008)*

### **METHODOLOGICAL THEORY:**

#### ***Philosophical theory:***

*constructivism – knowledge is developed out of personal experience*

*determinism – world operates by laws of cause and effect*

*epistemology – “how” knowledge is discovered*

*interpretivism – knowledge requires an individual to “interpret” experience through social construct such as language. In opposition of positivism*

*ontology – endeavour to appreciate and identify ideas regarding ‘the world’ and not merely our opinions, involvements, or knowledge and understanding of ‘the world’ = the way the world “is”*

*positivism – knowledge is based on the natural world and its linkages, information is a result of tactile sensation, which is then understood through reasoning = knowledge describes what we experience*

*post-positivism – rejection of the theory of positivism = science and common sense are the same*

*critical realism – reality exists independent of thought, and science can identify patterns and errors, allowing for revision of theory*

*pragmatism – meaning or truth of theory is assessed by function and success of practical application and consequences*

*subjectivism – there is no external reality, only what one experiences*

*transformative – learning and knowledge have several layers – psychological (or self), convictional (or belief), and behavioural (or lifestyle)*

### ***Community-Based Research:***

Northern tradition – *action research encouraging the community to determine the research routes emphasising multiple levels of analysis (individual, interpersonal, group)*

Southern school – *participatory research attempting to challenge the status quo, and aiming for social change, transformation and justice*

### **METHODOLOGY:**

#### ***Participatory engagement:***

mapping – *tool combining cartography with the spatial knowledge of local communities. Based on idea community members possess expert understanding of local environments being expressed in a geographical framework. They show the elements communities feel are important such as boundaries, natural resources, sacred areas, etc.*

matrix building – *method used to prioritise alternatives by evaluating issues against a list of criteria; the sum of the ratings gives each alternative a relative value compared to the others*

mind mapping – *diagrams used to visually represent the relationships between various concepts and ideas*

ranking – *method of importance/significance analysis where participants order the issues or solutions along a continuum*

proportional piling - *technique used to assess the comparable importance of issues, events or items by creating relative shares*

semi-structured interviews - *inquiry combining a set of open questions with the opportunity to further explore themes and responses further*

Venn diagrams – *diagrams using circles or closed curves within an enclosing rectangle to represent ideas/issues/situations, where linkages or commonalities are identified by the areas of overlap*

#### ***KTE:***

Balance (Netukulimk) – *the concept of interdependence and interconnectedness with the natural world*

capacity building – *creation and development of resources*

Elder – *an individual sought out for spiritual and cultural leadership, with knowledge of cultural tradition and wisdom*

Ethical space – *the bridge creating a culturally safe framework to engage dialogue between indigenous communities and Western groups*

knowledge broker – *an individual linking researchers and community members or policy makers, who simplifies interactions so groups understand each other (goals, cultures, work, etc.)*

knowledge dissemination – *method of directing and adapting information and messages for a specific target audience*

knowledge exchange - *interactive practise requiring collaboration and active exchange of material and evidence between two groups*

knowledge management – *method of evidence and knowledge collection, maintenance, dissemination, synthesis and utilisation*

knowledge mobilisation – *activities developed to promote application of results by identifying and overcoming barriers*

knowledge transfer - *unidirectional flow of information from researchers to community members or policy makers, which does not take into account individual-specific needs, issues, solutions*

knowledge translation – *exchange and development of knowledge by development of respectful relationships between groups*

- *The CIHR (2005) explains KT as*

*“all of the steps between the creation of new knowledge and its application in order to yield beneficial outcomes for society. It includes: knowledge dissemination, communications, technology transfer, ethical context, knowledge management, knowledge utilization, two-way exchange between researchers and those who apply knowledge, implementation research, technology assessment, synthesis of results within a global context, development of consensus guidelines and more.”*

knowledge utilisation – *application of gained knowledge to inform policy and practice for the promotion of change in a health care system*

time – *every decision should be considered with the sustainability of relationships seven generations in the future in mind*

traditional knowledge – *knowledge, skills, and practices based on theories, beliefs, and experiences passed from generation to generation*

tribal consciousness – *within group awareness and loyalty based on collective identity, attitudes, beliefs, and wisdom*

Two-Eyed Seeing (Etuaptmumk) – *using the strengths of Indigenous knowledge and ways of knowing, combined with those of Western culture and science (term coined by Elder Albert Marshall)*

### **Coding:**

code – *process of transforming data into a form sorting concepts and ideas into groups and categories for further analysis*

extract – *a specific idea identified and recorded for further analysis*

theme – *a key concept capturing a trend in relation to the research question and representing some meaning within the data set*

## **DOGS:**

individually owned – *one individual claims ownership or cares for the needs of an animal*

community owned – *more than one individual claims ownership or cares for the needs of an animal*

feral – *an animal born and living in the wild but descended from domesticated animals, without contact or socialisation with humans*

semi-feral – *an animal born and living in the wild without socialisation, with random interaction with humans for management or care purposes OR an animal previously cared for by an individual but now surviving without contact or interaction with humans*

stray – *a previously owned and at least minimally socialised animal, now lost, abandoned, or who has run away, and now must meet its needs on its own*

dog population – *estimated number of dogs within a community*

### ***Dog movement:***

restrained – *animal whose mobility, movement and freedom is completely limited*

restricted – *animal who has controlled movement within the community*

roaming – *animal not currently under direct control or is not currently restricted by a physical barrier*

free-roaming dogs - *dogs in public areas and not currently under direct control of any person*

### ***Types of aggression:***

dog-directed aggression - *threatening or harmful behaviour directed towards another dog*

owner-directed aggression - *threatening or harmful behaviour directed toward the owner*

stranger-directed aggression - *threatening or harmful behaviour directed towards an unknown individual*

redirected aggression – *where animal switches targeted threatening or harmful behaviour from one object to another*

### ***Behavioural threshold zones:***

perception: *level at which an animal becomes aware of a stimulus*

reactivity: *point where the dog's sympathetic nervous system engages and a notable fear or anger response occurs (barking/lunging/growling)*

stimulus aversiveness: *threshold between perception and reactivity, where the stimulus is uncomfortable however the animal has not yet responded*

trigger-stacking - *when multiple aversive stimuli occur within a short period of time creating an additive effect that increases the stress that any one particular stimulus would have on its own*

## Appendix B – Scoping Review

### Search

#### 1. Define & refine research search terms and questions

##### *What is the epidemiology surrounding dog bites?*

a) epidemiology: dog bites, zoonotic disease, animal exposure, risk factor, incidence, prevalence

Table B.1 – Search terms used in scoping review for the topic "epidemiology"

	Search terms	Synonyms
Initial/ Root terms	dog	hound, pup, stray, canid, pet, canine
	bite	nip, wound, attack, maul, pierce, injure
	animal	mammal
	exposure (expose)	contact, risk, threat
	zoonosis (zoonotic)	<i>none found</i>
	disease	ailment, afflict*, attack, condition, disorder, ill*, infect*, epidemic, sick*, infirm*, disable*, contagion (contagious), infirm*
Iteration 1	wound	damage, harm, hurt, pierce, scratch, pain
	maul	mangle, abuse, lacerate*, molest*, ill-treat, tear, maim, savage, mutilate*
	attack	assault, molest, damage, assail
	injure* (injury)	hurt, harm, damage, disfigure*, maim, mutilate, pain, impair, disable
	risk	danger, peril, trouble, chance, hazard, jeopardy, imperil*, menace, possible*
	threat	confront*, danger, hazard, menace, provoke*, endanger, imperil, peril, jeopardize
	epidemic	outbreak, plague, rash, spate, outbreak, epizootic, pervasive, disorder
	ill* (illness)	disorder, mutilate*, syndrome, morbid*
infect* (infection)	affect, ill-treat, maltreat, mistreat*, disfigure, influence, provoke	
Iteration 2	assault	aggression, charge, encroach*, encounter, violent*
	danger* (dangerous)	<i>nothing new</i>
	harm	violence
	hurt	<i>nothing new</i>
	maim	cripple, incapacitate*
	provoke	aggravate*, goad, instigate*, trigger, invoke
	syndrome	problem*
	morbidity	<i>nothing new</i>
mistreat	mishandle	
Iteration 3	violence	brutal*, severe*, ferocity
	cripple	ravage
	problem	issue
	trigger	cause*
Iteration 4	brutal* (brutality)	vicious*
	severe* (severity)	<i>nothing new</i>
	fierce* (ferocity)	vicious
	issue	consequence
	ravage	<i>nothing new</i>
	cause* (causation)	precipitate
Iteration 5	vicious*	<i>nothing new</i>
	consequence	outcome
Iteration 6	outcome	impact
Iteration 7	impact	<i>nothing new</i>

\* all related words included in search – root word included in table

**What interventions could best be used to prevent dog bites?**

b) interventions: dog bite, bite prevention, bite avoidance, population management, immune contraception, education

Table B.2 – Search terms used in scoping review for the topic "interventions"

	Search terms	Synonyms
Initial/ Root terms	dog	hound, pup, stray, canid, pet, canine
	bite	nip, wound, attack, maul, cut, wound, pierce, injure*
	animal	mammal
	prevention (prevent)	deter*, halt, interrupt*, obstruct*, evade*, impede*, eliminate*, preclude*, inhibit*, suppress*
	avoidance (avoid)	circumvent*, evasion, avert*, elimination, deterrence
	population	community, public
	management (manage)	control, manipulate*
	immune	resist*
	contraception	<i>none found</i>
educate* (education)	learn*, teach*, know*, inform*, study, train*, develop*, instruct*	
Iteration 1	wound	damage, harm, hurt, pierce, scratch, pain
	maul	mangle, abuse, lacerate*, molest*, ill-treat, tear, maim, savage, mutilate*
	attack	assault, molest, damage, assail
	injure* (injury)	hurt, harm, damage, disfigure*, maim, mutilate, pain, impair, disable
	deter* (determent)	block, discourage*, divert*, restrain*, stop, hinder
	inhibit* (inhibition)	arrest, avert, constrain*, discourage*, impede, restrain, repress*, stop, hinder, stifle, disrupt*
	suppress* (suppression)	contain*, quash, quell, curb, repress, stifle, stop, subdue, squash, squelch, quench, restrain,
	evasion	<i>nothing new</i>
	circumvent* (circumvention)	bypass, elude, escape
	eliminate* (elimination)	eradicate, terminate, purge, end, stop, remove (removal)
	control	constrain, contain, quell, limit*, repress, restrain, regulate*, restrict*, curb, stop, curtail*
	learn* (learning)	<i>nothing new</i>
	teach* (teaching)	guide
	knowledge	theory
	inform* (information)	<i>nothing new</i>
	train* (training)	propose*, guide
develop* (development)	create*, plan	
instruct* (instruction)	guide, create	
Iteration 2	assault	aggression, charge, encroach*, encounter, violent*
	danger	<i>nothing new</i>
	harm	violence
	hurt	<i>nothing new</i>
	maim	cripple, incapacitate*
	restrain	<i>nothing new</i>
	stop	cease*, discontinue*, end
	eradicate	abolish*, eliminate
	terminate	cease, discontinue, end
	hinder	<i>nothing new</i>
	remove	eliminate, abolish
	create	<i>nothing new</i>
	guide	<i>nothing new</i>
plan	<i>nothing new</i>	
Iteration 3	violent* (violence)	brutal*, severe*, fierce*
	cripple	ravage
	end	<i>nothing new</i>
	eliminate	<i>nothing new</i>
Iteration 4	brutal* (brutality)	vicious*
	severe* (severity)	<i>nothing new</i>
	fierce* (ferocity)	vicious
	ravage	<i>nothing new</i>
Iteration 5	vicious* (viciousness)	<i>nothing new</i>

\* all related words included in search – root word included in table

**2. Identify databases and search engines and query using the search terms.**

**Databases (Peer-reviewed literature)**

MEDLINE Ovid MEDLINE; PubMed; Web of Science with Conference Proceedings; BIOSIS Previews; EMBASE: Excerpta Medica & EMBASE Classic; OIE Database; CAB abstracts; Agricola; Animal Behaviour abstracts; Academic Search Complete (ASC); Expanded Academic ASAP; JSTOR; Arctic & Antarctic Regions; African Healthline; Allied Health Evidence; Centreview; CINAHL; The Cochrane Injuries Group's Specialised Register; Controlledtrials.com; ERIC; Free Public Health Databases; GIDEON (Global Infectious Disease Epidemiology Online Network); National Research Register; LISA (Library and Information Science Abstracts); Library Literature and Information Science; LILACs; PsycInfo; Science Citation Index; SIGLE; Social Science Citation Index; SPECTR; Vetgate; WHO database; Zetoc

\*databases in blue are nine initially used

**Search engines (Websites and grey literature)**

[www.google.ca](http://www.google.ca); [www.ca.yahoo.com](http://www.ca.yahoo.com); [www.bing.com](http://www.bing.com)

**Search strings** (synonym strings not included for simplicity)

Table B.3 – Search strings used in scoping review

dog	AND bite
	AND bite AND (exposure OR zoonosis OR disease)
	AND bite AND (incidence OR prevalence OR demographic)
	AND bite AND prevention
	AND bite AND population AND management
	AND bite AND (immune contraception OR chemical sterilisation OR vaccination)
	AND bite AND education
	AND bite AND prevention AND education
	AND population AND management
	AND population AND management AND (immune contraception OR chemical sterilisation OR vaccination)
AND population AND management AND education	

## *Matrices*

### 3. Create and apply the inclusion & exclusion criteria filters

#### Title inclusion –

Table B.4 – Title screening matrix used in Distiller

<b>Question Header</b>	<b>Answer Text</b>	<b>Answer Header</b>
Does the TITLE suggest the article includes information on dog bites on humans?	yes	yes
	no	no
	I don't know	I don't know
Does the TITLE suggest the article includes information on dog population management?	yes	yes
	no	no
	I don't know	I don't know
Does the TITLE suggest the article includes information on dog bite transmissible zoonoses or complications from dog bites?	yes	yes
	no	no
	I don't know	I don't know
Does the TITLE suggest the article includes information on dog behaviour or dog education?	yes	yes
	no	no
	I don't know	I don't know

**Abstract inclusion –**

Table B.5 – Abstract screening matrix used in Distiller

Question Header	Answer Text
Was the ARTICLE written in 1985 or more recently?	yes
	no
	I don't know
Does this article POTENTIALLY apply to ANY of the key questions? Question 1 - What is the epidemiology surrounding dog bites? Question 2 - What interventions could best be used to prevent dog bites or dog-related aggression? Question 3 - What is known about dog population management on a global scale? Question 4 - What is known about the potential diseases or injuries associated with dog bites? Question 5 - Is there evidence these methods sustain or reduce dog populations in rural and remote communities, or that these methods have any impact on the incidence of dog bites in these communities? Question 6 - What is known about the attitudes and knowledge of people towards dogs?	yes
	no
	can't tell
Does this article contain information regarding EITHER of the key topics? Epidemiology – mention of case reports, risk factors, impacts, incidence/prevalence, behaviours, attitudes Interventions – mention of education programs, population management methods or protocols, community participation activities	yes
	no
	I don't know

**Article inclusion –**

Table B.6 – Article screening matrix used in Distiller

Question Header	Answer Text	Answer Header
The article is available for review	yes	yes
	no	no
Is the ARTICLE either in English, German, Spanish, Portuguese or French?	yes	yes
	no	no
Does the PAPER... a) discuss sequelae associated with dog bites to humans? b) discuss dog bites to humans? c) discuss dog population management or interventions? d) discuss dog behaviour or dog education or attitudes towards dogs?	yes	yes
	this paper contains none of the above	this paper contains none of the above
This ARTICLE is a...	review	review
	original research	original research
	case report	case report
	letter to the editor or an editorial	letter to the editor or an editorial
	none of the above	none of the above

**Topic screening –**

Table B.7 – Topic screening matrix used in Distiller

<b>Question Header</b>	<b>Answer Text</b>
This article is about...	Dog population management - Spay/neuter
	Dog population management (other)
	Dog bite epidemiology
	Dog bite prevalence
	Dog bite sequelae (other than rabies)
	Dog bite sequelae - Rabies
	Dog behaviour
	Human education on dogs
	Legislation
	Other
This article also mentions...	Dog population management - Spay/neuter
	Dog population management (other)
	Dog bite epidemiology
	Dog bite prevalence
	Dog bite sequelae (other than rabies)
	Dog bite sequelae - Rabies
	Dog behaviour
	Human education on dogs
	Legislation
	Other
	No other topics are mentioned

## **Journal articles**

### **List of Level 5 and 6 Articles used in Scoping Review**

(articles in bold included in both Level 5 and 6)

**Abbas *et al.*, 2011. Rabies control initiative in Tamil Nadu, India: A test case for the 'One Health' approach.**

Abrahamian *et al.*, 2011. Microbiology of animal bite wound infections.

Abuabara, 2006. A review of facial injuries due to dog bites.

Abubakar & Bakari, 2012. Incidence of dog bite injuries and clinical rabies in a tertiary health care institution: A 10-year retrospective study.

**Adeleke, 2010. Impact of dog bite in Kano city a retrospective study.**

Adeyanju *et al.*, 2002. Investigation of animal bites: Objective basis for the management.

Adeyanju *et al.*, 2002. Known sources of human exposure to rabies: A brief review.

Aenishaenslin *et al.*, 2014 characterizing rabies epidemiology in remote Inuit communities in Quebec, Canada: A one health approach.

Agaie & Daneji, 2002. Occupational health hazards associated with bites from laboratory animals: An overview.

Aghahowa & Ogbevoen, 2010. Incidence of dog bite and anti-rabies vaccine utilization in the, University of Benin Teaching Hospital, Benin City, Nigeria: A 12-year assessment.

**Ahmed *et al.*, 2000. Rabies and dog bite in children: A decade of experience in Sokoto, Nigeria.**

Aikimbayev *et al.*, 2014 Fighting rabies in Eastern Europe, the Middle East and central Asia.

Akahane *et al.*, 2011. A case of wound dual infection with *Pasteurella dagmatis* and *Pasteurella canis* resulting from a dog bite: Limitations of Vitek-2 system in exact identification of *Pasteurella* species.

Akhtar *et al.*, 2006. Surgical delay in the management of dog bite injuries in children, does it increase the risk of infection?

**Alabi *et al.*, 2014. Profile of dog bite victims in Jos Plateau State, Nigeria.**

Alavi & Alavi, 2008. Epidemiology of animal bites and stings in Khuzestan, Iran, 1997-2006.

Al-Himdani *et al.*, 2015. Antimicrobial prophylaxis for dog bites in UK plastic surgery units: A nationwide survey.

Ali *et al.*, 2015. Eyelid lacerations due to dog bite in children.

Ali, 2003. Guidelines for prophylaxis of rabies in Pakistan.

**Allen, 2001. Believes aggression is more common in some dog breeds.**

Altmann *et al.*, 2009. Knowledge, attitudes, and practices of French travelers from Marseille regarding rabies risk and prevention.

Alvarez *et al.*, 1994. Partial recovery from rabies in a nine-year-old boy.

**Anaku *et al.*, 2010. Dynamics and control of stray dog populations.**

**Amaral *et al.*, 2014. Estimation of roaming dog populations in Timor Leste.**

Anderson *et al.*, 1997. Compartment syndrome in victims of dog bites.

Anonymous, 1996. Rabies vaccine.

Anonymous, 1997. Fatal case of rabies.

Anonymous, 1997b. Human rabies - New Hampshire, 1996.

**Anonymous, 2001. Preventing dog bites.**

**Anonymous, 2004. Dog bites: Teaching your child to be safe.**

**Anonymous, 2005. Preventing dog bites with the help of "The Blue Dog".**

**Anonymous, 2007. Child education to prevent dog bite accidents.**

Anonymous, 2007. Rabies vaccine – update.

**Anonymous, 2011. Anaerobic infections (individual fields): Skin and soft tissue infections - bite infections.**

**Anonymous, 2012. Preventive solutions needed on dangerous dogs.**

**Anonymous - VR, 2013. DEFRA proposes increased maximum penalties for dog attacks.**

**Anonymous - VR, 2013b. DEFRA issues draft advice on enforcing antisocial behavior measures.**

**APGAW, 2008. Dangerous dogs: An AGPAW mini-report May 2008.**

Arguin *et al.*, 2000. Survey of rabies pre-exposure and post-exposure prophylaxis among missionary personnel stationed outside the United States.

Arif, 2006. Dog Bite: A rare cause of oesophageal Injury.

Arnaudova & Varlyakov, 2010. Shelter policies in the management of canine aggression.

Arya, 1989. Failures of post-exposure rabies and other immunotherapies in developing countries.

Aslam & Dickinson, 1999. Dogs bite bones too: A tale of fractures in adult hands.

Aslam, 1999. Life-threatening *Capnocytophaga canimorsus* infection after dog bite.

Astorga *et al.*, 2015. Dog ownership, abundance and potential for bat-borne rabies spillover in Chile.

**Atuman *et al.*, 2014. Dog ecology, dog bites and rabies vaccination rates in Bauchi State, Nigeria.**

Auer *et al.*, 2001. Myocardial infarction after dog bite.

- Avis, 1999. Dog pack attack: Hunting humans.
- AVMA, 2015. The role of breed in dog bite risk and prevention.**
- Avner & Baker, 1991. Dog bites in urban children.**
- Awoyomi et al., 2007. Socioeconomic factors associated with non-vaccination of dogs against rabies in Ibadan, Nigeria.**
- Ayres et al., 2010. Retrospective analysis of post-exposure to human anti-rabies treatment in Botucatu, Sao Paulo State, Brazil.
- Bailey & Leicester, 2014. The complex issue of dog bites.**
- Bandi, 2012. Dog bite: Please report.**
- Bandow, 1996. Will breed-specific legislation reduce dog bites?**
- Barbieri et al., 2007. Behavioural profile of the aggressive dog: A review.**
- Barnard et al., 2015. Free-roaming dogs control activities in one Italian province. Is the implemented action effective?**
- Barnard et al., 2015b. Smartphone and GPS technology for free-roaming dog population surveillance.**
- Barnham, 1991. Once bitten, twice shy: The microbiology of bites.**
- Barnham & Holmes, 1992. Isolation of CDC group M-5 and *Staphylococcus intermedius* from infected dog bites
- Barros et al., 2009. Zoonosis perception of people visiting the 66th Northeast Fair of Animal and Derivative Products.
- Barry, 2015. Dogs and children.**
- Basgoz & Frosch, 1998. A 32-year-old woman with pharyngeal spasms and paresthesias after a dog bite: Rabies involving the central and peripheral nervous systems, salivary glands, and heart (epicardium).
- Bata et al., 2011. Retrospective study of dog bite cases reported to ECWA Veterinary Clinic, Bukuru, Plateau State, Nigeria.**
- Beach, 2012. When Fido sees red: Aggressive behaviour in the domestic dog.**
- Beaumont et al., 2005. Aggressive dogs.
- Beck & Jones, 1985. Unreported dog bites in children.**
- Beck et al., 1987. An epizootic of rabies in Maryland, 1982-84.
- Beckman et al., 2014. Tourists' perception of the free-roaming dog population in Samoa.
- Bello et al., 2007. A fifteen-year retrospective study of the prevalence of rabies in Bauchi State, Nigeria.
- Belsare & Gompper, 2013. Assessing demographic and epidemiologic parameters of rural dog population in India during mass vaccination campaigns.**
- Benfield et al., 2010. The epidemiology of dog attacks in an urban environment and the risk of vascular injury.
- Bennett & Rohlf, 2007. Owner-companion dog interactions: Relationships between demographic variables, potentially problematic behaviours, training engagement and shared activities.
- Bennett et al., 2007. Immunizations, neonatal hyperbilirubinemia and animal-induced injuries.
- Benson et al., 2006. Dog and cat bites to the hand: Treatment and cost assessment.
- Bernardo et al., 1998. Dog bites in children admitted to Pennsylvania trauma centers.**
- Bernardo et al., 2000. Dog bites in children treated in a pediatric emergency department.**
- Bernardo et al., 2001. The PAWS program: Pediatric Animal Awareness and Safety.
- Bernardo et al., 2002. A comparison of dog bite injuries in younger and older children treated in a pediatric emergency department.**
- Bernardo et al., 2002. The DOG BITES program: Documentation Of Growls and Bites in the emergency setting.**
- Bewley, 1985. Medical hazards from dogs.**
- Beyer et al., 2011. Metapopulation dynamics of rabies and the efficacy of vaccination.
- Bhanganada et al., 1993. Dog-bite injuries at a Bangkok teaching hospital.**
- Bijari et al., 2011. Epidemiological survey of animal bites in east of Iran.
- Bingham et al., 2010. Knowledge and perceptions of dog-associated zoonoses: Brazos County, Texas, USA.**
- Bini et al., 2011. Mortality, mauling, and maiming by vicious dogs.**
- Bir et al., 2007. Acute transverse myelitis at the Conus medullaris level after rabies vaccination in a patient with Behcet's disease.
- Bischof et al., 2014. Delayed treatment of a dog bite resulting in devastating *Capnocytophaga* sepsis in an alcoholic patient with functional asplenia.
- Bischoff, 2012. Bite injuries frequently lead to wound infections: Better to use antibiotics once too often!
- Bizri et al., 2000. Human rabies in Lebanon: Lessons for control.
- Bjork et al., 2013. Dog bite injuries among American Indian and Alaskan Native children.**
- Black & Dinman, 1996. Dog bites in children.**
- Blackman, 1998. Man's best friend?**
- Blackshaw, 1991. Dog bites and bull terriers.**
- Blankenship et al., 2005. Human rabies - Florida, 2004.
- Blanton et al., 2005. Rabies postexposure prophylaxis, New York, 1995-2000.
- Blanton et al., 2011. Rabies surveillance in the United States during 2010.

Blouin, 2013. Are dogs children, companions, or just animals?

Blum, 2015. When horse serum meets dog bite.

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**Boat *et al.*, 2012. Pediatric dog bite victims: A need for a continuum of care.**

**Bocion, 2010. Dog bites in Switzerland.**

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Boglioli *et al.*, 2000. Unusual infant death: Dog attack or post-mortem mutilation after child abuse?

**Boland, 2001. Ill-advised proposal to ban certain dog breeds.**

**Bordas *et al.*, 2002. A descriptive study of dog bites to children: Analysis of cases recorded at the emergency room of the paediatric hospital Trousseau (Paris).**

**Borges *et al.*, 2015. Fertility in adult bitches previously treated with a 4.7mg subcutaneous Deslorelin implant.**

**Boruah *et al.*, 1993. A note on rabid dog bite with particular reference to human rabies in Guwahati.**

**Boruah *et al.*, 1994. A study on dog bite in relation to literacy, occupation and geographical distribution in and around Guwahati City.**

**Borud & Friedman, 2000. Dog bites in New York City.**

Botek & Goldberg, 1995. Management of eyelid dog bites.

**Bottoms *et al.*, 2014. An evaluation of rabies vaccination rates among canines and felines involved in biting incidents.**

**Bouis *et al.*, 2010. Control of injuries caused by dogs: A public health perspective.**

**Boulouis, 2004. Infections after dog or cat bites: Bacterial agents and therapeutic strategies.**

**Bower, 2014. The complex issue of dog bites.**

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**Bregman & Slavinski, 2012. Using emergency department data to conduct dog and animal bite surveillance in New York City, 2003-2006.**

**Brengelmann, 2008. Investigation into knowledge about dogs, dog ownership and the behavior of dog owners living in Germany.**

**Brogan *et al.*, 1995. Severe dog bites in children.**

**Brook, 1987. Microbiology of human and animal bite wounds in children.**

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Brooks *et al.*, 2010. Incidence and impact of dog attacks on guide dogs in the UK.

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**Brusoni *et al.*, 2010. Epidemiology and public opinion of the dog bites in San Martin de Los Andes (Neuquen).**

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**Burgos-Caceres, 2011. Canine rabies: A looming threat to public health.**

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Burroughs *et al.*, 2002. Periocular dog bite injuries and responsible care.

Buso *et al.*, 2009. Characteristics of biting animals submitted to rabies diagnosis, Sao Paulo State, Brazil, 1993-2007.

**Buso *et al.*, 2013. Epidemiological aspects of dog bites considering biter dogs and victims.**

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**Butcher, 2011. "The Blue Dog": Challenges in promoting a prevention message.**

Buyuk *et al.*, 2007. Rabies in Turkey: Three human cases illustrating the importance of suspecting exposure.

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Bygott *et al.*, 2008. First clinical case of *Corynebacterium auriscanis* isolated from localized dog bite infection.

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Calkins *et al.*, 2001. Life-threatening dog attacks: A devastating combination of penetrating and blunt injuries.

Callahan, 1994. Prophylactic antibiotics in dog bite wounds: nipping at the heels of progress.

**Caminiti *et al.*, 2014. Completeness of the dog registry and estimation of dog population size in a densely populated area of Rome.**

**Campbell, 1986. The prevalence of behavioral problems in American dogs.**

**Capello *et al.*, 2015. Estimate of the size and demographic structure of the owned dog and cat population living in Veneto region.**

Carlone *et al.*, 2015. Level of anxiety and perception of dog stress in human mothers and non-mothers.

Carr, 1998. Once bitten.

**Carroll *et al.*, 2010. The use of immunocontraception to improve rabies eradication in urban dog populations.**

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Castrodale, 2009. Use of rabies post-exposure prophylaxis supplied by the Alaska section of epidemiology, Alaska, 2002-2007.

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CDC, 1997. Dog-bite-related fatalities - United States, 1995-1996.

**CDC, 2003. Nonfatal dog bite-related injuries treated in hospital emergency departments: United States, 2001.**

CDC, 2005. Human rabies - Florida, 2004.

Chadli, 1986. Rabies in Tunisia. Analysis of the results of the last 34 years.

Chand-Meena *et al.*, 2015. Fatal dog bite injury.

**Chang *et al.*, 1997. Dog bite incidence in the city of Pittsburgh: a capture-recapture approach.**

Chapman & Morrell, 2000. Barking mad? Another lunatic hypothesis bites the dust.

**Chapman *et al.*, 2000. Preventing dog bites in children: Randomized controlled trial of an educational intervention.**

Charles *et al.*, 2009. Bites and stings.

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Chu *et al.*, 2006. Fatal dog maulings associated with infant swings.

Clark *et al.*, 1991. Fatal and near-fatal animal bite injuries.

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**Clarke, 2007. Education of dog owners is key to reducing attacks.**

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**Cleaveland *et al.*, 2003. A dog rabies vaccination campaign in rural Africa: Impact on the incidence of dog rabies and human dog-bite injuries.**

**Cleaveland *et al.*, 2006. Canine vaccination: Providing broader benefits for disease control.**

**Cleaveland *et al.*, 2013. Relevance of research for development of national rabies control strategies in Africa.**

**Clifton, 2000. Views on laws governing dog ownership by breed.**

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**Coleman *et al.*, 2008. An evaluation of a pet ownership education program for school children.**

**Conan *et al.*, 2015. Evaluation of methods for short-term marking of domestic dogs for rabies control.**

**Conan *et al.*, 2015b. Population dynamics of owned, free-roaming dogs: Implications for rabies control.**

**Constable *et al.*, 2010. For the love of dog.**

**Constable *et al.*, 2013. Approaches to dog health education programs in Australian rural and remote Indigenous communities: Four case studies.**

**Constable *et al.*, 2013b. Education resources in remote Australian Indigenous community dog health programs: A comparison of community and extra-community produced resources.**

**Cornelissen & Hopster. Dog bites in The Netherlands: A study of victims, injuries, circumstances and aggressors to support evaluation of Breed Specific Legislation.**

Cosme *et al.*, 2000. Descriptive study of animal attacks and bites in the municipality of San Juan, Puerto Rico, 1996-1998.

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Croft & Archer, 1997. Dog bites in Bosnia.

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**Dalla Villa *et al.*, 2011. OIE questionnaire on dog population control: results of a survey in 81 countries.**

Dalla Villa *et al.*, 2014. Drivers for animal welfare policies in Europe.

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**De Keuster, 2009. Epidemiology of dog bites.**

**De Keuster, 2011. Dog bite prevention in children: "The Blue Dog" project.**

**De Keuster & Butcher, 2008. Preventing dog bites: Risk factors in different cultural settings.**

**De Keuster & Butcher, 2011. Navigating the web and other resources for data-driven tools for preventing dog bites: An international approach.**

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**De Keuster *et al.*, 2005. Dog bite prevention: How a "Blue Dog" can help.**

**De Keuster *et al.*, 2006. Epidemiology of dog bites: A Belgian experience of canine behaviour and public health concerns.**

De Lucca *et al.*, 2013. Assessing the rabies control and surveillance systems in Brazil.

**De Meester *et al.*, 2008. A preliminary study on the use of the Socially Acceptable Behavior test as a test for shyness/confidence in the temperament of dogs.**

**De Meester *et al.*, 2011. ESVCE position statement on risk assessment.**

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Decoster *et al.*, 1992. *Capnocytophaga canimorsus* endocarditis.

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Delanaye *et al.*, 2002. Dog bite in a splenectomized patient.

**Delise, 2007. The Pit Bull Placebo: The media, myths and politics of canine aggression.**

Delise, 2012. Imprudent use of unreliable dog bite tabulations and unpublished sources.

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## *Grey literature*

### List of Level 5 and 6 Web-Based Information Used in Scoping Review

(websites in bold included in both Level 5 and 6)

#### ***Behaviourist, veterinary, medical and humane society websites***

4 Paws University - <http://www.4pawsu.com>

ACC&D - <http://www.acc-d.org/resource-library>

American Humane Association - <http://www.americanhumane.org/animals>

Animal Behaviour Associates - <http://www.animalbehaviorassociates.com/pdf/freart1.pdf>

Animal Humane Society - <http://www.animalhumanesociety.org/training/reasons-aggression-dogs>

Animal Law in Canada- <http://www.animallaw.ca>

Animal Welfare and Trade - <http://animalwelfareandtrade.com/animal-welfare-european-parliament-adopts-written-declaration-on-dog-population-management>

Animals Asia -

[https://www.animalsasia.org/cn/assets/pdf/8%20Animals%20Asia%20Recommendations%20on%20Dog%20Management%20Regulations\\_Mar10.pdf](https://www.animalsasia.org/cn/assets/pdf/8%20Animals%20Asia%20Recommendations%20on%20Dog%20Management%20Regulations_Mar10.pdf)

APBC - <http://www.apbc.org.uk/articles/dog-aggression-faqs>

ASPC - <http://www.aspc.org/pet-care/virtual-pet-behaviorist/dog-behavior/aggression-dogs>

Australian Humane Society - <http://www.ashumanesociety.org/paper.pdf>

AVMA - <https://www.avma.org/public/pages/Dog-Bite-Prevention.aspx>

Bathurst Animal Clinic - <http://petdoctor.ca/animal-wellness/canine-behaviour/aggression-in-dogs/>

BC-SPCA- <http://www.sPCA.bc.ca/pet-care/health-safety/why-do-dogs-bite.html>

Blue Cross - <http://www.bluecross.org.uk/2156/behaviour.html>

Bro & Tracy Animal Welfare- <http://www.joycefay.com/articles/dominantdogs.shtml>

Calgary Humane Society - <http://www.calgaryhumane.ca>

Canada Safety Council - <https://canadasafetycouncil.org/child-safety/protecting-children-dog-bites>

Canadian Federation of Humane Societies - <http://cfhs.ca/athome>

Canine Rabies - <http://caninerabiesblueprint.org>

Caro dog - <http://www.carodog.eu/about-us-2/>

CDC - <http://www.cdc.gov/HomeandRecreationalSafety/Dog-Bites>

Cesar Millan - <http://www.cesarsway.com>

Cullen's Archangel Rescues - <http://www.caretoadopt.org/info/display?PageID=2243>

Dog Aggression & Training - <http://www.dogaggressiontraining.com/dog-aggression/>

Dog listener - <http://www.doglistener.co.uk/aggression/types.shtml>

Dog Obedience Training - <http://www.dog-obedience-training-online.com/dog-bite-statistics-by-breed.html>

Dog Owner's Guide - <http://www.canismajor.com>

Dr. Sophia Yin - <http://drsophiayin.com/resources>

Drs. Foster and Smith - <http://www.peteducation.com/article.cfm?c=2+2109&aid=1507>

European Medicines Agency - [http://ec.europa.eu/food/animal/diseases/eradication/rb\\_rep2930112012\\_5\\_stray\\_dog\\_management\\_en.pdf](http://ec.europa.eu/food/animal/diseases/eradication/rb_rep2930112012_5_stray_dog_management_en.pdf)

FAO - [http://www.fao.org/ag/againfo/home/en/news\\_archive/AGA\\_in\\_action/2011\\_Dog-Population-Management.html](http://www.fao.org/ag/againfo/home/en/news_archive/AGA_in_action/2011_Dog-Population-Management.html)

FERA - <http://dogs2012.fera.defra.gov.uk>

Gentle Medical - <http://millbasindoctor.com/urgent-care/dog-bites-and-human-bites/>

Humane America Animal Foundation - [https://dq25e8j0im0tm.cloudfront.net/public/org-info/A\\_Survey\\_Analysis\\_of\\_LA\\_Pet\\_Population.pdf](https://dq25e8j0im0tm.cloudfront.net/public/org-info/A_Survey_Analysis_of_LA_Pet_Population.pdf)

Humane society international - [http://www.hsi.org/issues/street\\_dog/](http://www.hsi.org/issues/street_dog/)

Humane Society of the United States - <http://www.humanesociety.org/animals/dogs/tips/aggression.html>

International Companion Animal Management Coalition - [http://www.icam-coalition.org/downloads/Humane\\_Dog\\_Population\\_Management\\_Guidance\\_English.pdf](http://www.icam-coalition.org/downloads/Humane_Dog_Population_Management_Guidance_English.pdf)

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**Positively** - **Victoria Stilwell** - <https://positively.com/articles/fatal-dog-bites-share-common-factors/>  
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Unleashed Unlimited dog training - <http://unleashedunlimited.com/5-steps-to-ruining-a-dog/>  
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*Samples of excellent educational diagrams found in scoping review*  
(Used in dog bite prevention and behaviour awareness)

## Body Language of Fear in Dogs



**Slight Cowering**



**Major Cowering**

### More Subtle Signs of Fear & Anxiety



**Licking Lips**  
when no food nearby



**Panting**  
when not hot or thirsty



**Brows Furrowed, Ears to Side**



**Moving in Slow Motion**  
walking slow on floor



**Acting Sleepy or Yawning**  
when they shouldn't be tired



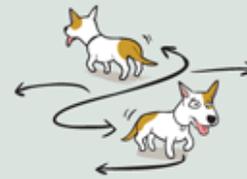
**Hypervigilant**  
looking in many directions



**Suddenly Won't Eat**  
but was hungry earlier



**Moving Away**



**Pacing**

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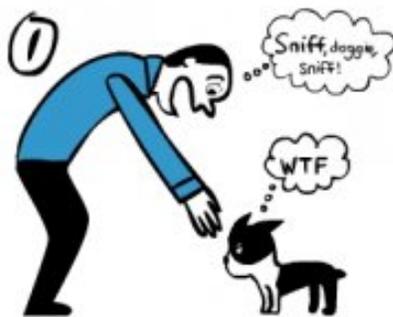
**Dr. Sophia Yin, DVM, MS**  
*The Art and Science of Animal Behavior*

For additional free dog bite prevention resources and more dog behavior books and products, visit [www.drsophiayin.com](http://www.drsophiayin.com).



# HOW NOT TO GREET A DOG

Most people do this stuff and it stresses some dogs out.  
I don't care how cute you (or your kid) think Boogie is. Please show him some respect.



**DON'T**  
Lean over the dog & stick your hand in his face



**DON'T**  
Lean over the dog & stick your hand on top of his head



**DON'T**  
Grab or Hug him



**DON'T**  
Stare him in the eye  
(This is an adversarial gesture)



**DON'T**  
Squeal or shout in his face

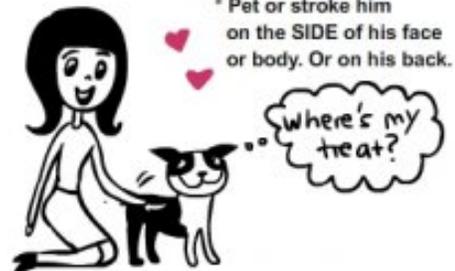


**DON'T**  
Grab his head and kiss it  
(This is an invasion of space)

## THE CORRECT WAY:



- \* No Eye contact
- \* Let the dog approach you in his own time
- \* Keep either your **SIDE** or **BACK** towards the dog (non-threatening posture)



- \* Pet or stroke him on the **SIDE** of his face or body. Or on his back.

# How Kids SHOULD Interact with Dogs

Use common sense.

Be polite and kind to pets



Learn to recognize when your dog is scared or anxious



Play appropriate games with pets, such as:

Fetch



ROLL OVER



Training tricks (like roll over, shake, beg, etc.)

Walking and running with a dog



SNIFF SNIFF



Playing hide-n-seek

Always remember:

Supervise all interactions. Accidents can happen in a split second.



Train your dog to associate the kids with positive experiences so he'll be more likely to tolerate your child in case she accidentally interacts inappropriately.



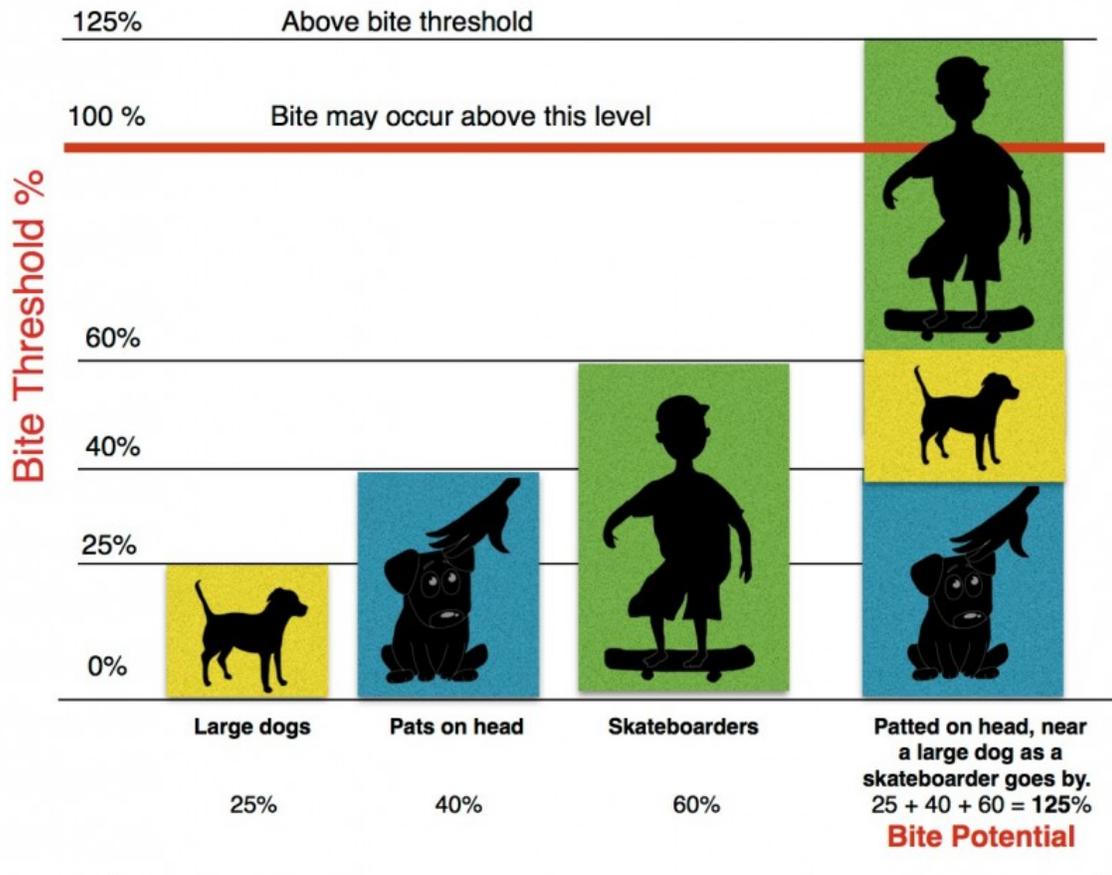
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## Trigger Stacking

Multiple stressors occurring at the same time.  
This can cause **any** dog to bite (all dogs have a bite threshold).



**Triggers (stressors) - things that a dog fears or dislikes.**

Eg. Dog is uncomfortable around large dogs, afraid of skateboards and hates to be patted on the head.  
One stressor at a time and he can hold it together. When all 3 happen at the same time it is too much.

[www.YaletownDogTraining.com](http://www.YaletownDogTraining.com)

# TALKING DOG

Dogs communicate using body language more than they do vocally. Here's a quick guide to get a good idea of what your dog is telling you. Look at the whole of the dog: head, face, body and tail to get a more accurate idea of what the dog is saying.

## FEARFUL / ANXIOUS / STRESSED

In all cases, respect the dogs need for space and offer signs of appeasement and peace: See the Doggy Dos and Don'ts poster



If not read correctly, stress, anxiety and fear often lead to behaviour commonly termed "aggressive", as the dog attempts to make it clearer that they are uncomfortable: raised hackles are a sign of fear:



### TAIL POSITIONS

tucked



in line with spine



high and rigid

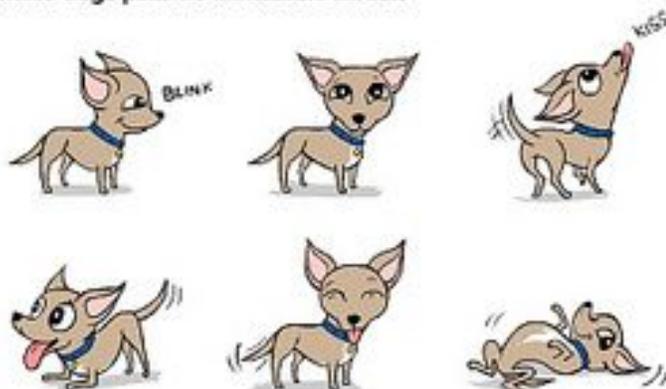


low and wagging slowly



## CONTENT / HAPPY / SOCIAL

These dogs pose no immediate threat.



### TAIL POSITIONS

relaxed

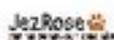


high and wagging quickly



casually at 45 degrees



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ANNUAL STATISTICS

CHILDREN & DOG BITES



Adults with 2 dogs in the household are 5 times more likely to be bitten



**THIRTY** 

Dog bite related deaths in 2013

**359,223**  
**CHILDREN**

ages 1 to 14 were bitten by dogs between 2010 and 2012



Educate yourself, your children and others about dog bite prevention.  
**AVMA.ORG/DOGBITEPREVENTION**



FAMILY PAWS  
PARENT EDUCATION

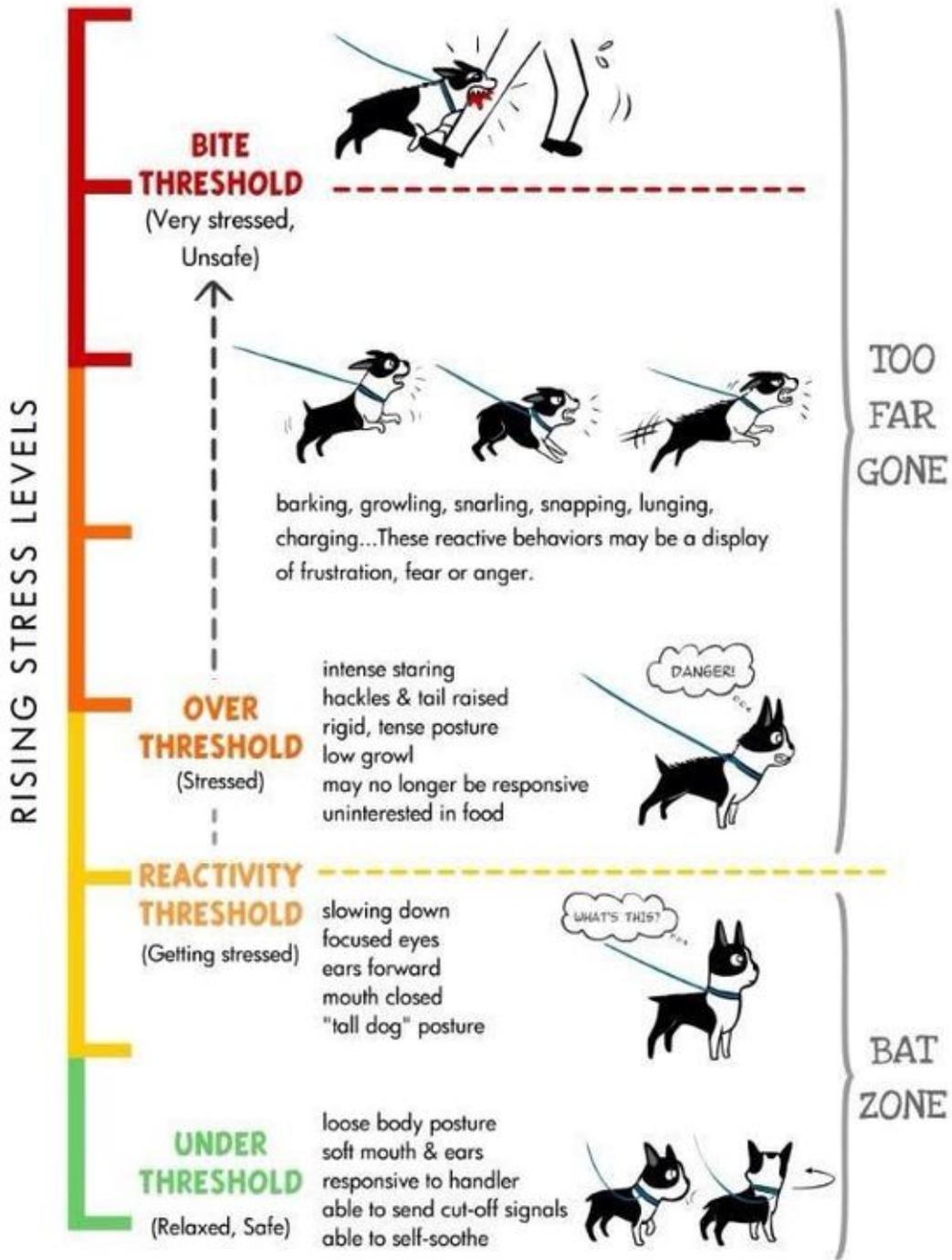
## The 5 Types of Supervision

<p><b>1</b></p>		<p><b>ABSENT</b></p> <p>Adult not in room with dog and baby/toddler</p> <p>☆☆☆☆</p>
<p><b>2</b></p>		<p><b>PASSIVE</b></p> <p>Adult in same location but distracted and not watching</p> <p>☆☆☆☆</p>
<p><b>3</b></p>		<p><b>REACTIVE</b></p> <p>Responding after dog or child is too close</p> <p>☆☆☆☆</p>
<p><b>4</b></p>		<p><b>PROACTIVE</b></p> <p>Planning and preparing safe separation.</p> <p>☆☆☆☆</p>
<p><b>5</b></p>		<p><b>ACTIVE</b></p> <p>Full awake adult supervision</p> <p>☆☆☆☆</p>

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# REACTIVITY CHART

## WHEN DOG ENCOUNTERS A TRIGGER



## Appendix C – Community Surveys and Demographics

### Surveys

#### Dog Bite Questionnaire

1. Has anyone in your household been involved in an aggressive encounter with a dog?

Yes No

If yes – May we ask who? *We do not need names*

*(take down gender of victim, and their age at time of attack for all casualties and continue to question 2)*

A: \_\_\_\_\_ B: \_\_\_\_\_ C: \_\_\_\_\_ D: \_\_\_\_\_ E: \_\_\_\_\_

(M= male/F= female)

2. May we ask about the incident(s)? *(If yes complete question, if no go on to question 3)*

2.1 How many dogs were involved in the incident? *(write down total number of dogs/incident)*

A: \_\_\_\_\_ B: \_\_\_\_\_ C: \_\_\_\_\_ D: \_\_\_\_\_ E: \_\_\_\_\_

2.2. Was the dog/Were the dogs *(put U for unknown)*

	A	B	C	D	E
From your household					
Neighbour's dog					
Unowned dog in the area					
Unidentified strange dog					

2.3. Do you know any details about the dog(s)? *(put U for unknown)*

	A	B	C	D	E
Male/female? Age?					
Size? small/medium/large					
Spayed/neutered?					
Indoor/outdoor dog?					
Roaming/loose?					
Healthy/sick?					

2.4. During the encounter was anyone bitten? How many times? *(Yes/No and number)*

A: \_\_\_\_\_ B: \_\_\_\_\_ C: \_\_\_\_\_ D: \_\_\_\_\_ E: \_\_\_\_\_

2.5. Was the incident reported to anyone? *(Yes/No- If yes continue to 2.6, if no go to question 3)*

A: \_\_\_\_\_ B: \_\_\_\_\_ C: \_\_\_\_\_ D: \_\_\_\_\_ E: \_\_\_\_\_

2.6 Did anyone follow up after it was reported? *(If yes, who? If no go to question 3)*

A: \_\_\_\_\_ B: \_\_\_\_\_ C: \_\_\_\_\_ D: \_\_\_\_\_ E: \_\_\_\_\_

3. Do you know anything about the situation(s)? *(If yes complete question, if no go on to question 4)*

3.1 How would you rate the victim's knowledge of dog behaviour? (*low/medium/high*)

A: \_\_\_\_\_ B: \_\_\_\_\_ C: \_\_\_\_\_ D: \_\_\_\_\_ E: \_\_\_\_\_

3.2 Do you feel the animal was provoked? (*yes/no*)

A: \_\_\_\_\_ B: \_\_\_\_\_ C: \_\_\_\_\_ D: \_\_\_\_\_ E: \_\_\_\_\_

Can you give details?

4. Is there anything else that you would like to tell us about dog aggression in the community?

(*continue on back if necessary*)

---

## Demographic Characteristics Questionnaire Survey

Town: \_\_\_\_\_ District: \_\_\_\_\_

Date: \_\_\_\_\_ Interviewer: \_\_\_\_\_ Interview no: \_\_\_\_\_ Interview type: \_\_\_\_\_

***The details above are collected for purposes of ensuring as many people as possible are assessed in each area.  
They will be removed prior to data entering.***

-----

*Every selected household at which there is an adult member present gets an interview number. If the household owns a dog, the interview type is "DOHH". If the household does not own a dog, the interview type is "NOHH".  
Writing in italics is for your information only.*

*When they arrive:*

*- Smile!*

- Hello, my name is \_\_\_\_\_ and I am working with the University of Saskatchewan, *so they know you are a professional.*

- Is there someone (*an adult*) who would be willing to answer a questionnaire?

- The band wants to work on a humane dog population management programme, so we need to understand dog ownership in the community. I would like to discuss dogs and your experiences and concerns with dogs with you.  
*Don't go into too much detail as this may bias their later answers.*

- Any information that you give us is completely confidential, and no one will be able to recognise you in anything we write. We are not here to check registration or report unvaccinated dogs. We simply want to know how you feel about dogs, what you provide for your dogs and why.

***Ask them the following questions:***

i) Does the household own a dog? NO YES

*If YES, ask the respondent if we can ask further questions. Tell him/her that the interview will take approximately 10 minutes.  
Permission received? YES/NO*

*If NO, please ask the reason why \_\_\_\_\_  
this is so we can adapt our questionnaire style to get greater acceptance in the future*

*If YES and permission has been received, go to Question 1.1*

ii) Does the household feed or look after any dogs? NO YES

*Ask this question if the household does not have dogs of their own (they may still take care of community dogs)*

iii) Would anyone in the household be able to handle any of these dogs safely, e.g. put on a collar/leash? NO YES

*Go to Question 1.1.*

1.1. Head of household: Gender: \_\_\_ Age \_\_\_\_\_

1.2. Respondent (if person being interviewed is not head of household): Gender: \_\_\_ Age \_\_\_\_\_

1.3. How many people live in the household? \_\_\_\_\_

1.4. 

TOTAL	M	<b>Adults</b>	F	Unk	M	<b>Puppies</b>	F	Unk
-------	---	---------------	---	-----	---	----------------	---	-----

How many dogs does the household own?

How many dogs would the household like to own?

How many dogs did the household own 12 months ago?

Over the past 12 months, did any dogs that the household owned die or leave the household? YES/NO

	Sex	Fate	Age at event
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	1. Male	1. Sold	8. Died through starvation
	2. Female	2. Given away	9. Died other
	3. Unk	3. Killed by owner	10. Disappeared
		4. Killed by authorities	11. Abandoned/Disowned
		5. Killed by someone else	12. Stolen
		6. Died in accident	13. Unknown
		7. Died of disease/parasites	

→ DOHH: Go to Question 2.1

→ NOHH: Go to Question 1.5

1.5. What are your reasons for not having a dog now? *Mark a maximum of three items:*

Currently looking for a new dog

Don't like dogs

Can't afford the cost of a dog

Don't have time to look after a dog

Don't have enough space to keep a dog

Discouraged by religion/culture

Don't feel the need for a dog

Other reason: \_\_\_\_\_

*Circle the reason given above that is the MOST important reason for not having a dog*

→ NOHH: Thank you for your time. Do you have any questions for us at this time? I now have a few questions to ask you related to dog bites. Do you have anything you would like to tell me before we begin?  
Go to Dog bite form

2.1. Household Dog Information:

Dog no.	Name	Sex	Age	Breed	Source	Age when acquired	Purpose	Who looks after the dog?
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
		1. Male	≤3 mos – days/weeks	1. Pure bred	1. Pup of own dog		1. Guard household	Age & sex of household member
		2. Female	4-18 mos weeks/mos	2. Pure bred cross	2. Bought inside area		2. Protect livestock	
		3. Pregnant	>18 mos mos/years	3. Mongrel	3. Bought outside area		3. Protect crops	
		4. Lactating			4. Gift from inside area		4. Pet	
		5. Unk			5. Gift from outside area		5. Hunting	
					6. Adopted off the street		6. Breeding	
					7. Other (specify)		7. Other (specify)	
					8. Unknown			

2.2. Household Dog Sterilization:

Dog no.	Sterilized ?	If 'NO':	If 'YES':			Comment	Willing?
		Why not?	What age?	How?	By whom?		
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							
	1. Yes	1. Still too young		1. Surgical	1. Private		1. Yes
	2. No	2. Want puppies from dog		2. Chemical	2. Government		2.No
	3. Unk	3. Too expensive		3. Physical	3. NGO		3.Unsure
		4. Too much trouble			4. Special clinic		
		5. Makes the dog fat/lazy			5. Self		
		6. Want dog to have a litter			6. Other (specify)		
		7. Risk to dog					

2.3. Household Dog Veterinary Care

Dog no.	Vaccinated previously?	When?	Who?	Deworming	Who?	Ectoparasite control	Who?	Action if sick?
1.								
2.								
3.								
4.								
5.								
6.								
7.								
8.								
9.								
10.								
	1. Rabies plus	1. Within last year	1. Private	1. Regularly	1. Private	1. Regularly	1. Private	1. Private
	2. Rabies only	2. Within last 3 year	2. local vet	2. Infrequently	2. local vet	2. Infrequently	2. local vet	2. local vet
	3. Never	3. >3 years ago	3. NGO	3. Never	3. NGO	3. Never	3. NGO	3. NGO
	4. Unknown	4. Never	4. special clinic	4. Unknown	4. special clinic	4. Unknown	4. special clinic	4. special clinic
		5. Unknown	5. Self		5. Self		5. Self	5. Self
			6. Other (specify)		6. Other (specify)		6. Other (specify)	6. Other (specify)

→ **DOHH:** Thank you for your time. Do you have any questions for us at this time? I have a few questions to ask you related to dog bites. Do you have anything you would like to tell me before we begin?  
Go to Dog bite form

*At the end of the complete survey:*

Thank you for taking the time to speak with us today. Is there anything further you would like to say or ask us?

Have a wonderful day!

## Survey variables

Table C.1 – Summary of dog bite survey dataset variables identified during community surveys

Summary of dog bite dataset variables		
Variable of interest	Type of variable	Definition
Community	Categorical	Community of residence was recorded based on location of survey
Victim age	Continuous	The concrete age of the bite victim This number ranges from <1 to 70< (some adults preferred not to give age)
Victim age category	Categorical	The age of the bite victim: child <10, child 10-18, adult, elder (adult but exact age unknown were placed in adult category)
Victim gender	Binary	The gender of the bite victim, recorded as male or female (as identified by victim or victim's family)
Victim knowledge	Categorical	Victims were self-classified according to amount of knowledge of dogs and dog behaviour: little, moderate, considerable
Dog age	Binary	When possible the true age of the dog was recorded. Often this was known only as adult or puppy (for statistical purposes when unsure, animals were considered to be adults)
Dog gender	Binary	The gender of the dog, recorded as male or female
Dog reproductive status	Binary	Reproductive status was recorded as intact or fixed. (for statistical purposes when unsure the dog was assumed to be intact)
Dog health status	Binary	The health of the dog was recorded as healthy or sick. (When the victim was unsure the dog was assumed to be basically healthy)
Dog size	Categorical	Size of dog was recorded based on subjective labelling by the victim or observers (small, medium, large). If breed was recorded size was allocated based on generally accepted sizes: Small dogs < 25 lbs (10kg) Medium dogs 25 to 60 lbs (10 to 27.5kg) Large dogs 60 lbs (27.5kg) <
Dog restrained	Binary	Dogs were classified as roaming or restrained
Dog habitat	Categorical	Dogs were classified as being indoor, outdoor or both. (Cases where this was unknown were classified as both)
Dog provoked	Binary	Dog aggression was generally subjectively classified as being provoked or unprovoked by the victim or observers. (Cases where no scenario was provided were classified as provoked)
Dog ownership status	Categorical	Dogs were classified as being the victim's own dog, owned by family/friend, community dog, strange stray or multiple
Anatomical location of bite	Categorical	Bite location was identified as being head or neck, upper body, or lower body
Geographical location of bite	Categorical	Attacks were categorised as being at home, at a neighbour's, or in public
Seasonality	Categorical	Time of year was identified when possible: spring, summer, fall, winter
Packing up	Continuous	The number of animals involved in the attack was recorded as the number. This number ranges from 1 to 5<

Table C.2 – Summary of dog population management variables identified during community surveys

<b>Summary of dog population management dataset variables</b>		
<b>Variable of interest</b>	<b>Type of variable</b>	<b>Definition</b>
Community	Categorical	Community of residence was recorded based on location of survey
Household ownership	Binary	Whether households own a dog was recorded as yes or no
Community ownership	Binary	Whether households helped care for community dogs was recorded as yes or no
Safe handling	Binary	Level of socialisation recorded as ability to safely handle the dog and recorded as yes or no
Head of household age	Continuous	The concrete age of the head of household. This number ranges from 18 to 65<
Head of household gender	Binary	The gender of the head of household, recorded as male or female
Number of people in household	Continuous	The concrete number of people in the household This number ranges from 1 to 8<
Number of dogs in household	Continuous	The concrete number of dogs in community households This number ranges from 0 to 5<
Age of dogs in household	Continuous & binary responses binary results	The concrete age of dogs in community households; when possible the true age of owned dogs were recorded. Often this was known only as adult or puppy. This number ranges from 1 to 19<
Dog gender	Binary	The gender of the owned dogs was recorded as male or female
Loss of dogs in household	Continuous	The concrete number of dogs lost from community households in the last 12 months This number ranges from 0 to 5
Method of dog loss	Categorical	The methods by which dogs were lost to the community were identified as sold, given away, killed (by owner, authorities, someone else), died (by accident, of disease, starvation, unknown), disappeared, abandoned, stolen, or unknown
No dog	Categorical	Reasons for not currently having a dog were identified as: currently looking, dislike, cost, time, space, religion/culture, need or other
Dog breed	Categorical	The breed of dog was recorded when possible as: pure-bred, pure-bred cross or mongrel. When the breed was unknown, it was recorded as a mongrel
Dog source	Categorical	The methods of obtaining household dogs were recorded as being: own pup, bought in community, bought outside community, gift from within community, gift from outside community, rescued from street, or other
Dog purpose	Categorical	The reasons for having a dog were identified as being: guarding, protecting livestock, protecting crops, companion, hunting, breeding, or other
Dog caregiver age	Continuous	The concrete age of the individual caring for the dog This number ranges from 5 to 84
Dog caregiver gender	Binary	The gender of the individual caring for the dog was recorded as male or female
Dog sterilisation	Binary	Whether the household dog was sterilised or not was recorded as yes or no
Reasons unsterilized	Categorical	Reasons for dogs being unsterilized were identified as: too young, want to breed, cost, difficulty, risk, effects or other
Dog fixed age	Continuous	The concrete age the dog was sterilised was recorded This number ranges from 3 months to 10 years
Dog fixed method	Categorical	The method used to sterilise the dog was recorded as being: surgical, chemical or physical
Dog fixed who	Categorical	The individual responsible for sterilising the dog was recorded as being: private clinic, local vet, NGO clinic, SPCA, self or other
Willing to sterilise	Binary	Households with unsterilized dogs asked if they were willing. This was recorded as yes or no
Dog vaccination	Categorical	Whether the household dog was vaccinated or not was recorded as: rabies and other, rabies only, vaccines other than rabies, never or unknown
Dog vaccine timing	Categorical	When the household dog was last vaccinated was recorded as being: within the last year, within the last 3 years, more than 3 years ago, never or unknown
Dog vaccine where	Categorical	Where the household dog was vaccinated was recorded as being: private clinic, local vet, NGO, special clinic, self or other
Dog deworming	Categorical	Whether the household dog was dewormed or not was recorded as: regularly, infrequently, never or unknown
Dog deworming where	Categorical	Where the household dog was dewormed was recorded as being: private clinic, local vet, NGO, special clinic, self or other
Dog parasite control	Categorical	Whether the household dog was given parasiticides or not was recorded as: regularly, infrequently, never or unknown
Dog parasite control where	Categorical	Where the household dog was given parasiticides was recorded as being: private clinic, local vet, NGO, special clinic, self or other
Dog health	Categorical	Where the household dog is taken when sick was recorded as being: private clinic, local vet, NGO, special clinic, self or other

### ***Sight-resight method assumptions***

1. Definition of ‘roaming’ (to be counted) is identical for all surveillance sessions.

*During counts, free-roaming animals were considered to be those that were uncontrolled or unrestricted by physical barriers at the time of counting.*

2. Search effort is equal during all counts (preferably the same individual or team surveys the same area at the same time each day).

*Search efforts were maximally equivalent and consistent by doing the following:*

*a. Survey teams consisted of 2-3 people for each counting session, which were led by the primary investigator. Whenever possible the same volunteers were used in the same community areas.*

*b. Team members were trained on counting methods, including both theory and practice.*

*c. Two counts were done daily in Sites D and E as close to 7:30-10am and 4-6:30pm as possible, conducted in the same area of each site in the same order each time.*

*d. A minimum of one scouting day, and 2 surveillance days were done per primary sampling/counting session.*

3. Assuming independence of the capture and recapture samples, all roaming animals have equal likelihood of being seen during any count, and the sighted population is representative of the unsighted group – that is the likelihood of being seen one day does not influence the potential to be seen during a separate sampling session.

*As most of the free-roaming animals within the communities surveyed are owned animals or previously socialised strays, they are generally highly visible. Unlike wildlife or feral animals, they do not tend to be extremely fearful or elusive. Animals with natural markings are also no more likely to be sighted than others, making them representative of a random subset of the overall community canine population.*

*However dogs are territorial animals, with personalities and histories that may influence behavioural patterns, leading to differences in capture probabilities. This may also have been influenced by giving “treats” in order to get individuals to remain stationary while taking their picture. If there are differences in likelihood of being seen due to activity patterns or owner behaviour, the overall population may be overestimated. Therefore the inclusion of heterogeneity of capture or detection within the calculation could permit estimates to be more robust.*

4. All counted animals have equal likelihood of reliably being identified during subsequent surveillance counts, and there is no loss or change of markings. That is, unique identifiers make recognition of subjects 100% sensitive and specific.

*A number of techniques were used to improve re-sight reliability:*

*a. As counting sessions were conducted in the spring and fall, and community members indicated anecdotally that their dogs appeared to be more active during the hours individuals would be commuting to/from work or school (likely because these would be times when increased contact might translate into feeding), counting times were set for hours with adequate light and visibility, and expected increased canine activity.*

*b. In each community area, teams included volunteers and students familiar with the district, improving the potential for local dogs to be spotted. Counters were trained in the surveillance methods being used, and were accompanied by the lead investigator.*

*c. The day prior to the initial sampling day, survey routes were followed on comprehensive scouting sessions to identify and photograph all FRDs with identifiable and observable marks or characteristics. These animals were then considered to be 'marked' for the duration of the sampling period. During subsequent sampling days, all FRDs observed were again photographed and recorded. These photographs were then compared to those from the scouting session in order to determine which dogs were "marked" and which were "unmarked" (or novel) individuals.*

*During the scouting sessions, dogs in yards with incomplete fences were also documented separately, to monitor whether they consistently remained within their yards or were ever permitted to roam freely.*

5. The population under study is both demographically and geographically closed.

*To increase the prospect of each area remaining a closed population, the following was done:*

*a. Scouting and sampling sessions were conducted within the same week (maximum 5 days) to minimise the potential for immigration into or emigration out of the sampling area.*

*b. All areas sampled were bordered by a minimum of 2km between them and the nearest inhabited community space; generally sampling areas were also separated by major highways or several acres of industrial buildings, making it less likely that most animals would roam outside of their particular community area for any length of time.*

*c. Sampling sessions were conducted at times unlikely to be altered by the seasonal appearance of large numbers of new dogs within the community.*

*d. Sampling sessions were also conducted during weeks with no scheduled population management enforcement occurring (e.g. culls, round ups, rescue group mass adoption events, etc.).*

## Appendix D – Dog Bite Risk Analysis

Table D.1 – Summary of logistic regression analysis for variables predicting dog bites  
(urban versus rural reserve reporting communities)

Predictor Variable	$\beta$ estimate	SE $\beta$	p-value	odds-ratio (95% CI)
<b>Step 1 – univariable</b>				
1. Age	0.97	0.21	<0.001	2.64 (1.76-3.97)
2. Wound location	0.099	0.19	0.599	1.10 (0.76-1.6)
3. Dog size	0.59	0.12	<0.001	1.8 (1.44-2.27)
4. Bite location	-0.363	0.18	0.040	0.7 (0.5-0.99)
<b>Step 2 – multivariable (4)</b>				
Age	1.24	0.24	<0.001	3.45 (2.14-5.55)
Wound location	-0.112	0.2	0.566	0.89 (0.61-1.31)
Dog size	0.66	0.13	<0.001	1.94 (1.51-2.5)
Bite location	-0.55	0.2	0.005	0.57 (0.39-0.84)
<b>Step 3 – test interaction terms</b> Age, Wound location, Dog size & Bite location				
<i>Nothing of significance found</i>				
<b>Step 4 – multivariable (3)</b>				
1. Age, Dog size & Bite location				
Age	1.21	0.24	<0.001	3.35 (2.11-5.32)
Dog size	0.66	0.13	<0.001	1.93 (1.5-2.48)
Bite location	-0.56	0.2	0.004	0.57 (0.39-0.85)
2. Age, Wound & Bite locations*				
Age	0.04	0.12	<0.001	1.05 (1.02-1.05)
Wound location	0.03	0.18	0.856	1.03 (0.72-1.49)
Bite location	-0.43	0.18	0.019	0.65 (0.46-0.93)
<b>Step 5 – test interaction terms</b> Age, Dog size & Bite location				
<i>Nothing of significance found</i>				
<b>Step 6 – multivariable (2)</b>				
1. Age & Dog size				
Age	1.04	0.22	<0.001	2.82 (1.84-4.34)
Dog size	0.64	0.13	<0.001	1.89 (1.48-2.42)
2. Age & Bite location				
Age	1.09	0.22	<0.001	2.98 (1.94-4.58)
Bite location	-0.5	0.18	0.006	0.61 (0.42-0.87)
3. Dog size & Bite location				
Dog size	0.59	0.12	<0.001	1.8 (1.43-2.26)
Bite location	-0.37	0.18	0.046	0.69 (0.48-0.99)

\*model without “dog size” run due to high number of missing observations

Table D.2 – Scenario pathway variables and values

<b>Factor</b>	<b>Pathway variable</b>	<b>Data origin</b>	<b>Pathway-unit total</b>	<b>Endogenous pathway total</b>	<b>Exogenous pathway total</b>
<b>Dog</b>	Injured/ill Community D Community E	community data	0.013 0.014	Community D 0.128  Community E 0.154	Probability of a dog:human encounter ending in a bite or mauling     Community D Low - 0.007 High – 0.002  Community E Low - 0.005 High – 0.001
	Rabid	Appendix H	0.0001		
	Territoriality Community D Community E	community data	0.025 0.03		
	Poor socialisation	scoping review	0.05		
	Negative history Community D Community E	community data	0.01 0.02		
	Multiple dogs/pack Community D Community E	community data	0.03 0.04		
<b>Human</b>	Previous education Community D  Community E	community data	<i>knowledge</i> Low 0.02 High 0.005 Low 0.03 High 0.005	Community D Low – 0.09 High – 0.03	
	Provocation Community D  Community E	community data	<i>knowledge</i> Low 0.06 High 0.015 Low 0.07 High 0.01	Community E Low – 0.11 High – 0.025	
	Inattention	scoping review	0.01		
<b>Situation</b>	Dog attacks Community D Community E	community data		0.58 0.32	

## **Appendix E – Knowledge Translation Articles**

### ***With community collaborators***

These articles have been submitted for publication with the Journal of Indigenous Wellbeing (Pimatisiwin)

### ***Building a better bylaw: The process of animal control legislation creation for First Nations communities in Canada***

#### **Abstract**

Dog overpopulation and freely roaming populations are significant problems in many remote indigenous communities. Developing enforceable and appealing legislation in Canadian First Nations communities can often be fraught with difficulties due to the multilevel approval process involved. In addition, finding common ground for all community members requires substantial diplomacy, engagement and knowledge of all impacted community partners over an extended period of time. We discuss the steps and stumbles taken in developing one such piece of legislation, and provide recommendations for communities looking to create their own ‘dog bylaw’.

**Keywords:** dogs, roaming, bylaws, legislation, First Nations, overpopulation, dog bite prevention, public health

#### **Article**

Dog overpopulation is a growing and increasingly dangerous problem in many Canadian First Nations communities. In uncontrolled and unsocialised populations, dogs are often less predictable, with a greater tendency to run in packs. This frequently leads to increased dog bites and aggressive encounters, with the potential for transmission of zoonotic diseases and severe maulings. Improving these environments is an ongoing public health struggle for First Nations and Métis councils. Multiple methods are often employed in order to develop manageable dog populations, however difficulties are regularly faced given the lack of access to resources in remote locations.

As a result First Nations communities are choosing to incorporate and enforce comprehensive bylaws, along with community education programs to develop new community philosophies and understanding. Most First Nations communities do not have bylaws whereas municipalities adopt the animal control bylaws which are created regionally. However, when a First Nation develops bylaws, they must be approved at a federal level due to the current legislation on First Nations reserves.

This is the case for one northern First Nations community, who began the process of bylaw creation in 2010. The community had no official bylaw in place, and relied on yearly dog round up days to reduce overpopulation and deal with overly aggressive animals. As a result not only were neighbourhood dogs terrified and consistently skittish, but community members were unhappy and dissatisfied, finding these methods distasteful and counter to cultural acceptability. The goal was therefore to develop some method that would allow better control over local animals, and promote a safe neighbourhood. In addition, education regarding animal welfare (e.g. care, immunizations, housing, etc.) and owner responsibilities was believed to be a critical key in shaping group mind-set.

The first step was to ensure that the community supported a new initiative, as without full community approval any proposal was doomed to fail. In 2011, after extensive discussions and surveillance (collected from door-to-door and Treaty table surveys in 2010/2011), 89% of the community favoured establishing a comprehensive bylaw covering all aspects of dog habitation within the community. This was to include building a holding facility, developing legislation with respect to permissible dog regulations, creating an educational school curriculum and community awareness program, and generating partnerships that would enable community members to access veterinary care.

In October of 2011 a fatal dog mauling of a 3-year old girl occurred on Saskatchewan's Mosquito First Nation, resulting in considerable media attention being focused on attacks occurring in rural and remote First Nations and Métis communities. The community was aware that an average of 1-2 fatal dog attacks occur per year on reserve lands and that most physical attacks by dogs are often on children. Realising that significant numbers of free-roaming dogs were regularly running in packs in the schoolyards, the larger community believed that a change was needed immediately. Unfortunately, as with most northern communities, this First Nations community has reduced access to regular veterinary care and information, animal health education and resources, due both to remote location and limited financial resources. Therefore it was decided that the first and easiest item on the agenda would be the creation of a new animal control bylaw.

The First Nation Band Council hoped that with a new animal control bylaw in place, the opportunity for better dog control and public education would have a major impact on dog population management and public safety. Legislation awareness could provide a discussion point regarding animal care (feeding, sheltering, immunising, etc.), in addition to owner responsibilities (restraining, socialising, neutering, training, etc.). Community education had the potential to establish a safer, more compassionate environment. Optimism soon hit a few snags however, as Indian and Northern Affairs Canada (INAC) almost immediately rejected the first draft submitted in the fall of 2012 (based on the old bylaw and the current nearby municipal bylaw). The feedback that this First Nation received was that the proposed bylaws were not 'official' enough and should be reviewed by a lawyer.

Rewriting the bylaw to INAC's requirements was a lengthy process, and during that time a change in the First Nation's leadership (due to an election) also occurred (2014). This meant that the document needed to be reapproved and passed at band council level prior to being federally proposed. The new Council amended a few details, which were examined by the lawyer, and reworded. Rewording of the document required new Band Council resolution. At this point, the regional public health authority requested some major changes. Submission to the federal government was subsequently delayed as the First Nation's lawyer worked through the health authority's concerns.

The INAC approved the amended bylaws during the summer of 2014, with a strict requirement that the returned be ratified and returned by Chief and Council within 30 days. Given the timing and the composition of this multi-community Band Council (with councillors coming from different regions), ratification could not be completed within the thirty day time frame. Since the ratification deadline had passed, the bylaw had to be resubmitted for a new ratification issuance. Unfortunately, each subsequent issuance arrived either during a holiday period or during a community crisis, understandably leaving the animal control bylaw a lesser priority.

In the meantime, the community has built a holding facility that is capable of sheltering 6 to 9 roaming dogs, and acquired the necessary equipment needed for safe and secure animal retrieval. Relationships concerning local dog issues have been developed and fostered with the surrounding municipalities. In addition, a partnership between the band and the local humane society and animal rescue is developing. An added bonus is the collaboration that has occurred between the First Nation, the municipalities, the animal rescue, and one of the Canadian veterinary colleges. As part of a novel northern outreach program created to provide fourth year students with an opportunity to develop surgical, clinical and educational skills in resource restricted areas, the university has run several spay-neuter clinics in the area to assist with population control. Each small piece of the puzzle assists in creating the safer environment that the community first began envisioning during discussions in 2010.

As a result of her own learning experiences, Councillor X has these recommendations for First Nations communities developing their own dog population control bylaws:

1. Ask for community input on all aspects of your program  
*(this ensures community members support and value your efforts)*
2. Look at several established bylaws from other communities, and develop yours based on what is appropriate for your area  
*(not all sections from other communities will be necessary in your community)*

3. Decide how detailed you want your bylaws to be early on  
*(more detail means there is a greater chance of rejection due to the potential for infringement of personal rights)*
4. Ask for help and input from experts when needed  
*(this can save a lot of time and unnecessary expense)*
5. Work from a place of knowledge  
*(truly know the issues in your community and what the potential solutions are)*
6. Understand the INAC's policies and regulations when it comes to bylaw amendment *(a good lawyer can help the process go more smoothly)*

Although the process for the First Nation community has been time consuming and full of complications, in the long run the process has been considered constructive. The resulting legislation is hoped to be robust and comprehensive enough to provide guidelines for any situation that might unfold. The progression has also been a means of connecting and engaging the community on issues that can otherwise be highly emotionally charged and divisive. By and large, appropriate animal bylaws are hoped to create a safer and more resilient community, and to date the preliminary demographic data has been suggestive of positive impact.

## ***Creating control – An animal control officer’s tale: Building a dog population management program from the ground up***

### **Abstract**

Roaming dog populations are known to increase the risks of dog bites and aggressive dog:human encounters. In many indigenous communities in Canada, especially those in remote locations, increasing dog numbers are considered to be a dangerous and emotionally charged issue. Unfortunately the resources, time and community engagement required to provide positive solutions are not always immediately or readily available prior to the occurrence of traumatic interactions. Here we describe the basic steps taken within a successful population management program in two indigenous Canadian communities, and highlight the impacts of the intervention.

**Keywords:** dogs, population management, roaming, animal control, First Nations, dog bite prevention

### **Article**

Imagine simply being asked to ‘deal with the dogs’ in your community. A rural community in which 75% of the dog-human interactions for the previous several years have been aggressive, most of which resulted in injuries. A community in which more than 90% of the dogs are uncontrolled, untrained and free-roaming, and most of which are sexually intact. Then imagine you are told you have no protocols in place, an obscure bylaw as legislation, and few resources on which to depend. How do you begin?

This is the situation that often presents itself to animal control officers in remote and rural Canadian indigenous communities. Meanwhile, dog bites and infectious diseases continue to be significant health care problems for Métis and First Nations communities. Since 2000, there have been an average of 1-2 fatal dog incidents per year in Canada, and thousands of reported bites. Unlike urban environments, in reserve communities these encounters are generally not in the family home. The historical tolerance for free-roaming dogs has often produced poor socialisation and dog packing behaviours. Lack of predictable interactions by these animals frequently results in numerous dog bites and increased aggression, with possible disease transmission or fatal mauling. Adding to the problem, dog overpopulation serves to intensify these issues.

Understandably, limited resources and increasing demand for public finances due to critical health needs such as lack of housing, poor water or improper sanitation, lead to an environment in which dog concerns take a secondary role. Add limited access to veterinary care, education, information or medications, and options become restricted in remote communities. For these reasons, culling after dangerous encounters is often used to control dog populations. However, communities are generally uncomfortable with this approach and research has shown that culling has little impact on dog population levels, bite reduction or disease transmission.

To start from scratch is a daunting task, however it is possible. Initially armed with only the World Wide Web, a notebook and a printer, animal control officer X developed and instituted such a dog management program in two First Nations communities between 2009 and 2013. Over a period of four years, the protocols that were developed and enforced, and the community education that was provided, successfully reduced the overall dog population by 50%, the roaming dog population by 90%, and the number of reported dog bites from 6-10/year to 1/year (for 3 years).

Initially, advertising began through community meetings and social media that an animal control officer had been hired, and would be speaking with all households, school classes, and community groups. During household visits, pictures and identifying information were taken of all family dogs for future reference, as well as education provided on the requirements for appropriate dog care and welfare. A basic holding facility for 7 dogs (including space for 2 large breed dogs) was built, and outside ties and huts for a further 10 dogs were put in place.

In the first two weeks of program development, owners were warned when their dogs were found wandering ‘at large’ via phone calls. Retrieved unknown dogs were advertised as having been found using social media posts (Facebook, town website) and posters. After this initial introductory period, all warnings

were logged and leveled for each dog caught freely roaming. For first time offences, owners were given a verbal warning. If a second infraction occurred, owners were issued a written warning. Finally, subsequent violations resulted in both a verbal and a written warning, and the dog was impounded at a cost of \$10/day for a maximum of 7 days. If the owner chose not to recover the dog or not to pay the fine, dogs were relinquished to one of five nearby rescue groups/humane societies. All dogs responsible for attacking or biting a person were immediately impounded and quarantined for 10 days to eliminate the possibility of rabies (and further exposures), and were then euthanized as per community regulations.

Community-wide patrols were conducted several times daily to identify and detain roaming animals (potentially dangerous wildlife such as bears and mountain lions, as well as dogs). In addition, community members were encouraged to call and anonymously report any problem animals within their area. When alerted to an issue, an animal control officer would respond anytime of the day or night, any day of the year. Within 18 months, community reports of roaming animals had decreased from 4 or 5/day (all new or different animals) to 2 or 3/week (generally repeat offenders). In this new environment, elders and children reported feeling safer while moving freely around the community. Community members largely attributed success of the program to consistent enforcement, thorough program communication, and resolute dedication and determination of involved personnel.

Unfortunately due to a change in band council members, the described animal control program was terminated in the summer of 2013. The new band council saw the successful results as an indication that the dog population was no longer problematic and the resources being allocated could be otherwise distributed, relying instead on volunteer enforcement. The effect of this dramatic change in consistent implementation of animal control was a doubling of the dog population in less than 12 months, and a notable increase in dog roaming, dog packing and aggressive encounters. Two years later, the dog population had increased to double the numbers it was at prior to the population control program initiation, due to both immigration (community members bringing new dogs into the community) and increased births as most animals remain intact). Many community members now express renewed concern, fear and nervousness when walking alone, or being approached by unknown dogs.

In the meantime animal control officer X has these recommendations for communities attempting to begin an animal control program:

1. Communicate all protocols and objectives to the entire community regularly  
*(this avoids any feelings of ill will or the idea that there is a hidden agenda)*
2. Ensure that all partners (council, community members, shelters, educators, government/law enforcement, corporations) are in agreement with the protocols in place  
*(this reduces the chance of sudden withdrawal once the program is in place)*
3. Provide education at the same time you are enforcing legislation  
*(this creates an atmosphere of knowledge transfer so community members completely understand why decisions are being made and why specific protocols are in place)*
4. Find funding for sustainable development, including sterilization and wellness clinics  
*(running a successful program requires financial support – equipment, personnel, education materials, etc. – without which little can be done)*

Although the dog population situation for these two First Nations communities regressed after the termination of the described established dog control program, several things are evident. First, with community support and engagement large changes can be made in a relatively short period of time. Secondly, a successful program requires consistency with respect to effort, time and enforcement. Lastly, for long-term improvements to be possible any program must be ongoing and adapted as new challenges arise. Safer communities, with fewer aggressive dog-human interactions, are possible with relevant and timely programming and cooperation.

## *Identifying promising interventions to diminish dog issues in remote communities*

### **Abstract**

In Canada, there is an average of 1-2 fatal dog attacks in indigenous communities per year. The majority of these deaths have involved free-roaming or semi-restricted dogs. Dealing with the extensive problems these animals continue to create (over population, aggressive encounters, environmental destruction, zoonotic disease transmission, etc.) having a population management plan and dog bite prevention program in place is a necessity. However, developing a community supported comprehensive intervention can be complicated. We discuss the steps taken in one community to create a successful solution.

**Keywords:** dogs, roaming, bylaws, legislation, First Nations, overpopulation, dog bite prevention, public health

### **Article**

Dog bites, and diseases transmissible via dog bites, are an ongoing public health issue among Métis and First Nations communities in Canada. In 2009, tragedy struck a northern indigenous community when a 6-year-old child was mauled by a free-roaming community dog. Although in this instance the offending dog was destroyed and the child eventually recovered physically, the situation served to highlight the ongoing dog issues that remote and northern Métis and First Nations communities have been facing. In these communities, free-roaming dog packs cause the majority of the serious or fatal dog-related injuries that occur each year in Canada. Over the last decade 1-2 fatal dog attacks have occurred per year in Canada, with an unknown number of non-fatal injuries happening. According to the National Canine Research Council, there were 47 dog-related fatalities between 1964 and 2010. In 2014 alone, dog attacks (in Manitoba) killed two children and one adult. Physical attacks by dogs are often on children, and can lead to death or disfigurement, and generally result in long lasting psychological trauma including post-traumatic stress disorder.

Financial constraints and competition for public assets de-emphasize dog control programs in resource limited communities, as other health needs such as inadequate housing, water supply and sanitation are more immediate. In addition, in northern communities there exists reduced access to regular veterinary care, animal health education, veterinary information or medications due to remote locations or limited financial resources.

As a result, when free-roaming dogs cause problems, or there are dog-related aggression issues, limited options are available. In serious situations, dog populations are often reduced by culling in an effort to fix the immediate, short-term concerns. This approach is known to be largely unsuccessful due to community resistance, as well as a lack of impact on dog population stability, dog bite incidence rates and dog-related disease transmission. For this reason, communities are working towards more sustainable, comprehensive programs that encompass all aspects of human-dog interactions to reduce the public health risk dogs pose.

After their close call, Community X began working on multiple ways to approach the community's dog population and aggressive free-roaming pack problems. These methods include updating and creating more wholistic bylaws and legislation, hiring a fulltime bylaw enforcement officer, building a holding facility for free-roaming dogs, school and community education sessions, and planning for a future high volume/low cost spay/neuter clinic.

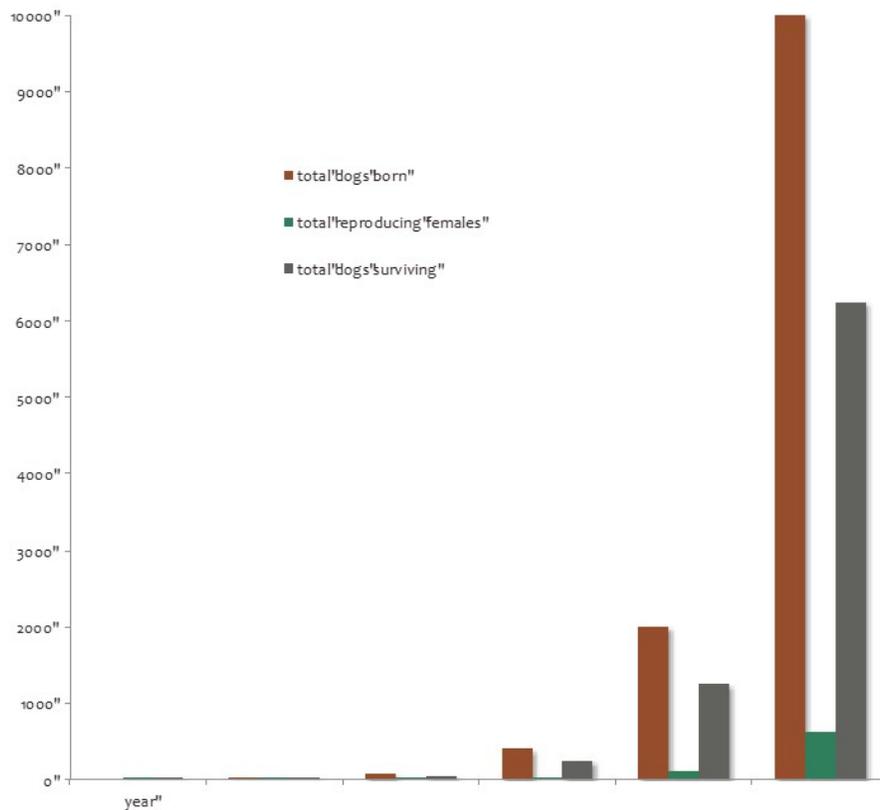
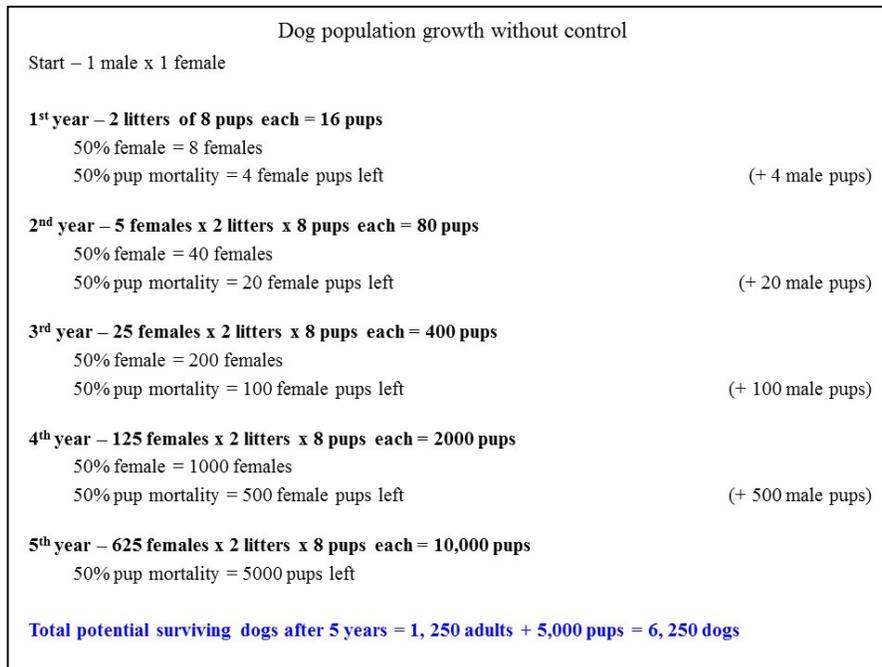
These alternatives were selected and prioritised based on community-wide discussions and engagement. Meetings were held with all school classes, community groups and agencies, village council and elders. Small groups and individuals who had additional concerns or suggestions were encouraged to speak to members of the village council personally.

Initial discussions identified that schoolyards were the community's principal area of concern, as dogs were following students, and then creating packs in the schoolyards. This resulted in dogs trailing young children and approaching school visitors. Additional misgivings included mounting numbers of



## Appendix F – Knowledge Translation Diagrams

### Dog Population Growth



## Appendix G – Rabies in Saskatchewan

In Saskatchewan, the known incidence rate of rabies amongst wildlife and domestic species has been slowly decreasing over the last few years. Most years, approximately 50 to 70% of positively diagnosed<sup>11</sup> rabies cases in the province are skunks, with an additional 5 to 15% from domestic species (dogs, cats, cattle, horses and sheep) carrying skunk-variant rabies virus (see Figure G.1) (CFIA, 2014). To date, most of the remaining reported positively diagnosed rabies cases in Saskatchewan have been bats or animals carrying bat-variant rabies (CFIA, 2014).

It is known that skunks behaviourally prefer habitats in low-lying areas, with crop-forest edges or hay agriculture (Rosatte and Lariviere, 2003). In a study from New York, it was found that there were higher number of rabies cases per census tracts associated with low-intensity residential areas, lower elevation, and with nearby major roads, rivers and lakes (Recuenco et al. 2008). Given the landscape of much of the province, and the wide geographical range of the striped skunk (see Figure G.2), this has potentially alarming repercussions for the possible transmission of this fatal zoonotic disease to the human population, as the disease may be simmering within wildlife populations.

In addition, there has been concern that changing weather patterns and prey availability in the Northwest Territories and Nunavut are influencing fox (Arctic and red foxes) geographical ranges, causing the two species to overlap more than they did historically (see Figure G.3), and potentially bringing the arctic fox-variant of rabies south into Saskatchewan (Audrey Simone, pers com). Red foxes successfully inhabit various environments, including subarctic areas, in addition to coastal, mountainous and urban habitats.

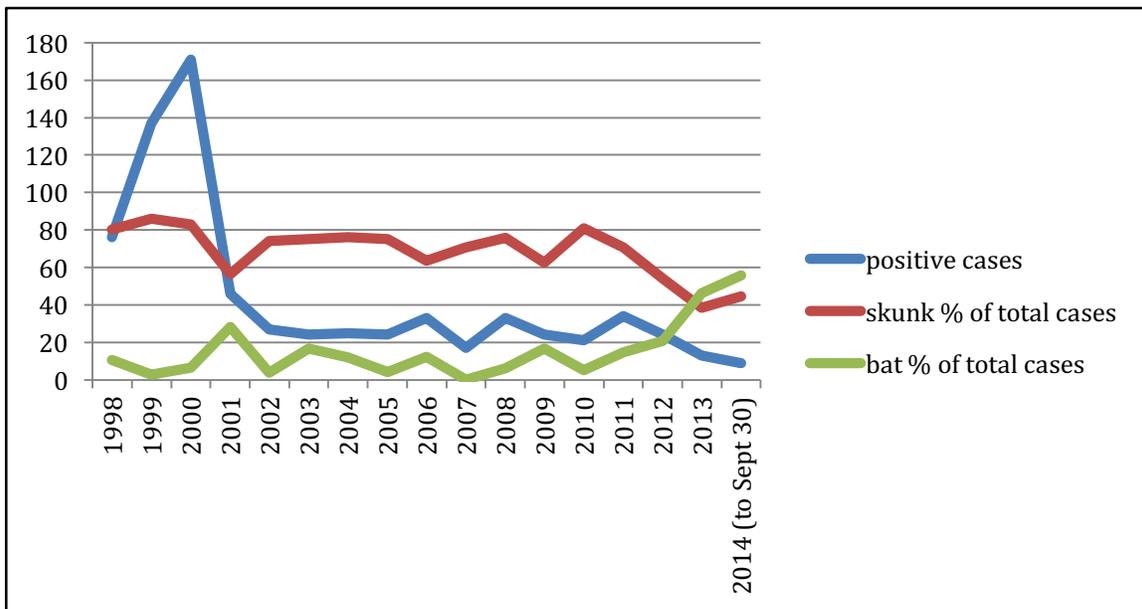


Figure G.1 – Positively diagnosed rabies cases in Saskatchewan from 1998 to September 30th, 2014 compared to overall skunk and bat percentages of cases

<sup>11</sup> using the direct fluorescent antibody (DFA) test, which looks for the presence of rabies virus antigens (Negri bodies) in brain tissue

Though there have been no reported cases of rabies further north than 50km north of Prince Albert in the last 15 years (1998 to 2014) (Wendy Wilkins, pers com), this may be due more to limited surveillance than absence of disease<sup>12</sup>. Human outbreaks can occur as a result of epidemics in the animal population or when a rabid animal bites multiple people; generally speaking, rural poor (such as those on reserves) and children, are most at risk. With fox rabies in the NWT and Nunavut undergoing cyclical outbreaks (see Figure G.4), surveillance is desperately needed in northern Saskatchewan to precisely identify the prevalence of fox-variant rabies within the province (cases in the NWT-Nunavut not attributed to foxes have all been wolves or dogs carrying fox-variant rabies over the last 15 years) (CFIA, 2014). Luckily, there currently appears to be a band of low rabies prevalence that stretches across the province, beginning approximately 100km north of Prince Albert to the northern border of Saskatchewan.



Figure G.2 – Current year round geographical range of the Striped skunk in Canada

<sup>12</sup> most cases are found in October and November - the most active trapping months



Figure G.3 – Current geographical range of the Arctic and Red fox in Canada

Amongst the general public, ambivalence, inadequate understanding of the risks of rabies, and the belief that rabies is non-existent, has led to many pet owners refusing rabies vaccination for their dogs and cats even where veterinary care is available. Farmers often feel that rabies vaccination is an unnecessary expense when considering a cost/benefit analysis for their cattle and horses. Unfortunately, further north where veterinary care is unavailable or erratic, even if owners wish to vaccinate their pets, accessing care is generally time consuming, costly and requires travel to the closest veterinary clinic (which can be more than 900km away – e.g. Stony Rapids to Prince Albert is 907km or a 12 hour trip by car), resulting in few people choosing to do so.

Given that most northern Saskatchewan First Nations communities have a considerable number of FRDs, if rabies is present in the environment the potential for wildlife to companion animal transmission is a strong possibility. Owners may not know their pets have had contact with potentially rabid animals, and a lack of concern regarding dog-bite sequelae contrasted with a fear

of potential reprisals frequently leads to avoidance in reporting of dog bites in these communities. The delay in seeking medical treatment may result in the development of clinical rabies, leading to death. Roaming dogs often also create multiple other problems, including non-rabies related aggressive interactions and over-population issues.

International studies have shown that there are barriers to rabies eradication and an increased likelihood of rabies outbreaks when there is a lack of awareness on all levels; about responsible pet ownership (vaccinating pets), about the need for post-exposure prophylaxis, and about primary wound care (AAPCID, 2009; Beyer et al, 2011; Chulasugandha et al, 2006; Cleaveland, et al, 2014; Pastoret et al, 2004).

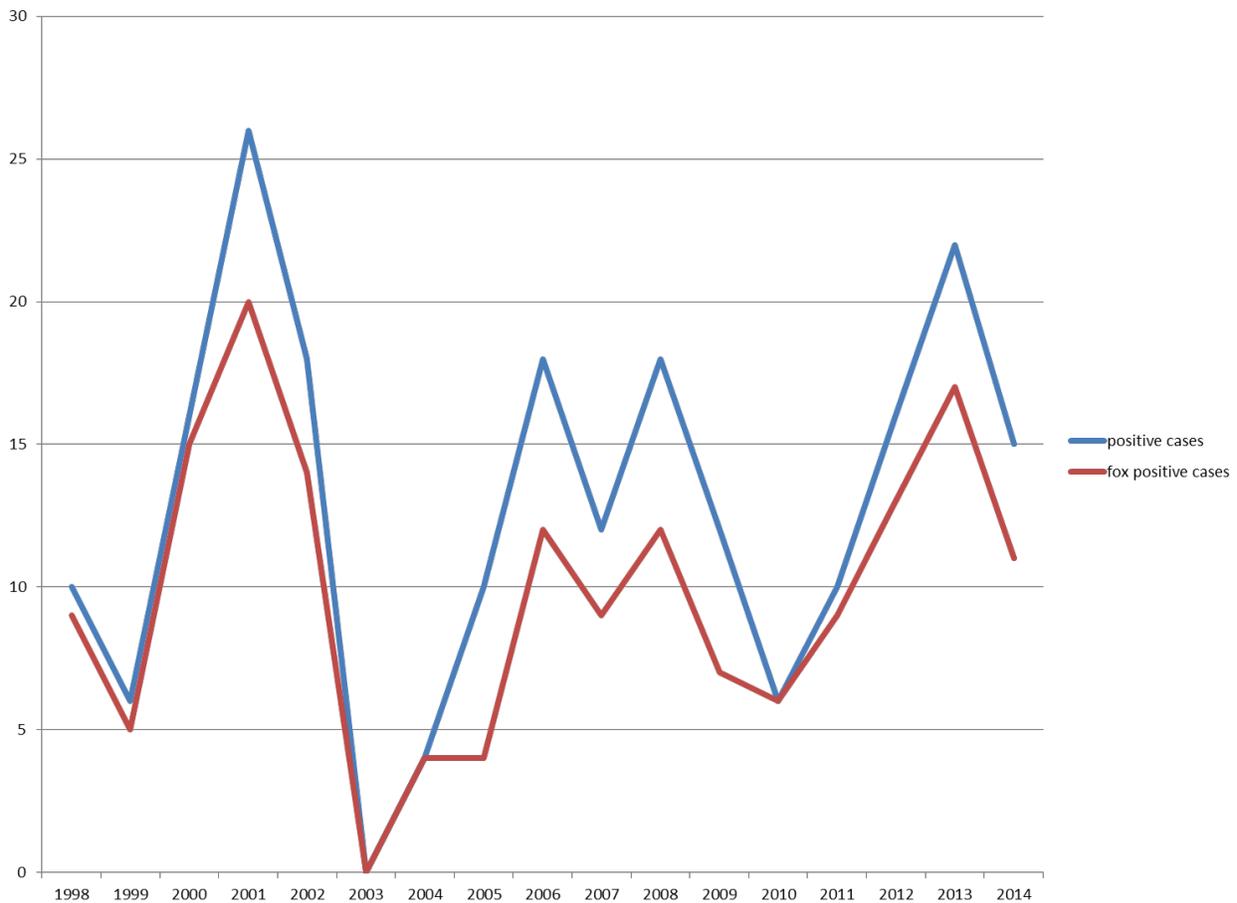


Figure G.4 – Positive rabies cases compared to the total fox positive rabies cases from 1998 to 2014 in the Northwest Territories and Nunavut

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