EPIDEMIOLOGY OF LYME DISEASE IN BC RESIDENTS
FROM 1997-2006

by

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ABSTRACT

Lyme disease (LD) is a bacterial infection transmitted through the bite of infected ticks. This research sought to clean and reconcile the data held within three databases at the BC Centre for Disease Control (BCCDC). The goal was to determine an accurate count of LD infections from 1997-2006. Through this process demographic characteristics would also be revealed. Capture-recapture (CR) methodology was applied to the data to in order to estimate the total, potential population and then finally the confirmed cases were overlaid against suspected ecological niches. This research indicated that 68 confirmed cases were reported in British Columbia. The majority of cases were male and <41 years of age. CR- methodology suggested that the total number of LD cases could be 137 (CI: 23 – 784) highlighting possible gaps in the existing surveillance and reporting structures. Finally, after overlaying confirmed cases against suspected ecological niches, there was 94% model accuracy.

Keywords: Lyme Disease; British Columbia; Capture-recapture; Ecological niche modelling

Subject Terms: Bacteriology; Communicable diseases; Epidemiology; Public Health
DEDICATION

In recognition of all the wonderful and strong people in my life who have encouraged me throughout this process. In particular, I would like to acknowledge my parents, Carole and Bob, who have encouraged me to follow my passions. I would also like to thank Allyn Thomas and Rob Monk who have stood by me throughout the difficult process of returning to school.
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## GLOSSARY

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<th>Description</th>
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<tr>
<td>BCCDC</td>
<td>British Columbia Centre for Disease Control</td>
</tr>
<tr>
<td>CR</td>
<td>Capture-Recapture Methodology</td>
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<tr>
<td>EIA</td>
<td>Enzyme immuno fluorescent assay</td>
</tr>
<tr>
<td>IgG</td>
<td>Immune globulin G</td>
</tr>
<tr>
<td>IgM</td>
<td>Immune globulin M</td>
</tr>
<tr>
<td>LD</td>
<td>Lyme disease</td>
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<td>WB</td>
<td>Western Blot</td>
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CHAPTER 1: INTRODUCTION

The British Columbia Centre for Disease Control (BCDCC) is the senior public health agency responsible for communicable disease surveillance and control within the Province. In addition, the BCCDC supports public health efforts through the operation of a wide-array of quality laboratory services in order to aid in the reliable diagnosis of multiple pathogenic organisms. In order to support ongoing surveillance activities, the BCCDC collects statistics on (provincially mandated) reportable infections, one of which is Lyme disease (LD). Information related to LD is collected in three separate databases including:

1. The Integrated Public Health Information System (IPHIS) – A central database in which all cases of reportable infections (diagnosed by clinicians or through a laboratory) are collated.

2. The laboratory database – A central database of all microbiological testing of LD conducted within BC.

3. The LD enhanced surveillance database – A database used to capture detailed epidemiological information (e.g. exposure location) from probable or confirmed cases.

While these three data sets contain an abundance of information related to the epidemiology of LD within BC, these databases do not communicate and there exists no formal or ongoing mechanisms to link them. According to Perry et al.
A successful infectious disease surveillance system will exhibit seven key features including:

i) The use of standard case definitions to identify priority diseases;

ii) Collecting and using surveillance data to alert higher levels and trigger local action;

iii) "Investigate and confirm suspected outbreaks or public health events using laboratory confirmation when indicated";

iv) Analyzing data collected from outbreaks and from routine monitoring;

v) Use information to implement appropriate responses;

vi) "Provide feedback within and across levels of the health system";

vii) "Evaluate and improve the performance of surveillance and response systems";

These are important fundamental principles to remember when evaluating the efficacy of a surveillance system.

In the summer of 2007 a research effort was undertaken to reconcile these three databases. The primary objective of this research was to more accurately determine the true number of cases of LD within the Province during the period of 1997 – 2006. Another objective of this database reconciliation was to offer a better illustration of the demographics of LD cases within the same ten-year period. Finally, a third outcome was to apply an epidemiologic technique known as capture-recapture (CR) methodology to the data. CR methodology
allows for a mathematical prediction of the number of missing cases (non-reported / diagnosed) within the Province. When combined with the number of cases obtained from the reconciliation, the end result would offer a more accurate depiction / estimation of the annual incidence of LD within the Province.

What follows is a summary of the findings and an epidemiologic picture of LD disease within BC during the 1997-2006 period.
CHAPTER 2: BACKGROUND

Lyme disease was first suspected to be caused by an infectious source in the 1970's when a cluster of patients from Old Lyme, Connecticut were presenting with arthritis-like symptoms (Feder, H.M., 2006) (Steere, A.C., 2004). Multiple epidemiological links were suggestive of an infectious organism, but it was not until 1983 that a bacterial spirochete offered a plausible explanation for the mysterious syndrome (Feder, H.M., 2006). Lyme disease is an arthropod-borne bacterial infection caused by Borrelia burgdorferi (Wormser, G.P., 2006).

LD typically presents with a characteristic rash known as erythema migrans (EM). EM typically presents 2 to 30 days following an inoculation by an infected tick (Feder, H.M., 2006). This rash often presents with central clearing, purpura or vesiculation (Feder, H.M., 2006) thus giving it the lay description of a “bulls-eye” rash. Beyond the characteristic EM presentation, LD can aptly be described as having multi-systemic effects. The systemic manifestations of LD can include: “multiple EM, fleeting arthritis, meningitis, neuritis, and carditis” (Feder, H.M., 2006. p. 510). In fact, within days to weeks of disease onset, the bacterial spirochete has been recovered in specimens taken from: the blood; cerebrospinal fluid (the fluid lining the brain and spinal cord); myocardium (heart tissue); retina; bone; spleen; liver; meninges (the envelope of the central nervous system); and brain (Steer, A.C., 2004).
LD is diagnosed according to a set of pre-determined criteria which can include both clinical and microbiological observations. A clinical diagnosis can be made if a patient presents with EM and has a history of outdoor exposure (wooded / grassy area) to a known endemic region (Feder, H.M., 2006). The clinical diagnosis of EM is considered sufficient and often further serologic testing will be negative at such an early stage of the disease (Feder, H.M., 2006). For later manifestations of LD, objective findings of symptoms previously mentioned, coupled with a likely exposure history would necessitate further laboratory investigation (Feder, H.M., 2006). Laboratory investigation for LD can be carried out using a variety of techniques. Tissues, including CSF, synovial fluid, skin and blood can all be sent for microbiological investigation. If serology is the principle means of investigation, the testing typically follows a two-step process (Depietropaolo, D.L., 2005). This process involves an initial antibody screen using an Enzyme Immuno Flourescent Assay (EIA) to detect the presence of IgM or IgG antibodies. If the serology is positive, it should be followed-up with a Western-blot test to confirm the presence of IgM and / or IgG antibodies to *borrelia burgdorferi* (Depietropaolo, D.L., 2005). It should be noted that the development of antibodies to *borrelia burgdorferi* is a slow process and that patients with an early stage of LD will only exhibit antibodies 50% of the time (Depietropaolo, D.L., 2005). It is for this reason that appropriate clinical diagnosis and / or alternate tissue sampling (e.g. skin biopsy) are considered for individuals at an early stage of infection (Wilske, B., 2005).
As the pathogen which causes LD is a bacterial spirochete, effective treatment can often be achieved with an appropriate course of antibiotic therapy. Depending on the stage of progression, antibiotic therapy can include either oral or parenteral (e.g. intravenous) dosing. Preferred oral antibiotics can include: amoxicillin, doxycycline, or cefuroxime (Wormser, G.P., 2006). For later stages of disease or for those who cannot tolerate the recommended oral dosing, effective parenteral regimens can include: ceftriaxone, cefotaxime, or penicillin G. (Wormser, G.P., 2006).

While effective antibiotic treatments do exist, it is important to note that these treatments should not be given for long-term (≥ 6 months) reported symptoms (Wormser, G.P., 2006, p. 1094). The existence of chronic LD (LD following treatment) has proven to be a controversial, if not contentious area. Most clinicians agree that late stages of LD can result in a sequelae of symptoms persisting for some time following successful treatment. However, there remains some thought that the *borreliosis* may in fact persist, chronically, and thus require long-term antibiotic treatment. While this latter school of thought may generate significant attention, scientifically, it is without sound basis (Wormser, G.P., 2006)(Feder, H.M., 2007). Aside from the lack of clinical evidence for the existence of chronic *borreliosis*, the proposed long-term treatments, consisting primarily of antibiotic therapy, can be harmful in addition to being ineffective (Feder, H.M., 2007). This ongoing debate between the scientific community and those who argue for the existence of a chronic, resistant infection, has given rise to advocacy groups and, in the most extreme, suggestion of conspiracy, cover-up
and collusion within the scientific community. The resulting friction has necessitated the need for concrete data related to the microbiology and epidemiology of this emerging infectious disease.

In North America, LD is principally transmitted though the bite of infected ticks including: i) *Ixodes scapularis*; and ii) *Ixodes pacificus* (Wormser, G.P., 2006) (Ogden, N.H., 2006). LD is highly endemic in the northeastern portion of the United States (Hanincova, K., 2006). In varying degrees, LD has also been observed across the US and in the south-eastern and western provinces of Canada. The principal vector for LD in the north-eastern segment of North America is tick known as *Ixodes scapularis*, whereas, in the western segment of North America, the most prevalent vector of transmission is the *Ixodes pacificus* (Hengge, U.L., 2003). 93% of all reported cases of locally acquired LD in the US were from ten reference states (Connecticut, Delaware, Maryland, Massachusetts, Minnesota, New Jersey, New York, Pennsylvania, Rhode Island, and Wisconsin) (US Centers for Disease Control and Prevention (CDC), 2007) the majority of which are located in the northern-eastern portions of the country. The average annual incidence of infection in these 10 states alone during the 2003 – 2005 period was 29.2 cases / 100,000 people (CDC, 2007). In this highly endemic region, the majority of cases were found in males (54%) and children / youth aged 5 – 14 (61%) (CDC, 2007).

In Canada, passive surveillance for Lyme borreliosis within *Ixodes scapularis* has taken place since 1990 (Ogden, N.H., 2006). From these surveillance activities, it is believed that the prevalence of infection has been
concentrated to the northern shores of Lake Ontario, Lake Erie and the southeastern coast of Nova Scotia (Ogden, N.H., 2006). While the concentration of infected *I. scapularis* ticks is believed to currently reside primarily within these regions, it is thought that the effects of global warming could in fact push the habitat of both host and vectors further north creating a new endemic distribution of Lyme borreliosis within northeastern Canada (Brownstein, J.S., 2005). Moreover, the expansion of the deer population and encroachment of human populations into previously wild habitats is likely contributing to a rising infection rate, particularly in the north-eastern and Midwestern U.S. (Steere, A.C., 2006).

LD is a reportable infection across Canada. While much attention has focused on the epidemiology of the infection and its principal vector (*Ixodes scapularis*) in eastern Canada, there has been little in the way of a comprehensive review of the epidemiology of this infection and vector (*Ixodes pacificus*) in the West. What follows is a ten year review of the epidemiology of LD in British Columbia conducted in conjunction with the BC Centre for Disease Control.
CHAPTER 3: METHODOLOGY

After obtaining approval from the Research Ethics Board at Simon Fraser University for the secondary use of human data, three separate databases [Laboratory, Integrated Public Health Information System (IPHIS), Enhanced Surveillance], created and housed by the BCCDC were the primary sources of information. Within the laboratory database all positive Enzyme Immuno-flourescent Assays (EIA) and/or confirmatory Western Blot (WB) tests for borrelia burgdorferi between 1997 and 2006 were initially included. Subsequently, all the multiple, individual tests were reconciled to specific individuals. All individuals who had at least one positive EIA and/or WB were initially included (n=817). All individuals reported in the IPHIS (n=48) and enhanced (n=31) databases, were also included. This yielded a total combined initial sample size of 896 individuals. A standard diagnostic criteria (Canadian Public Health Laboratory Network, 2007) was then applied to all three databases. This meant that either: a) an appropriate clinical diagnosis with confirmatory exposure history and/or b) two-step serological testing including a confirmatory positive WB IgG test were maintained in the sample. Those who do not meet the criteria were excluded. Cases for whom the diagnosis could be classified as being ambiguous (e.g. multiple positive WB IgG tests followed by a negative result) were referred to an expert physician team comprising one physician epidemiologist and a medical microbiologist for determination. After applying the
above criteria, 763 individuals were excluded from the laboratory database, 2 individuals were excluded from the IPHIS database and no individuals were excluded from the enhanced surveillance database.

Epidemiological factors were abstracted from the confirmed cases. These factors included age and sex distribution. In addition, incidence rates for the Province were obtained using data obtained from the Provincial Government (BC Stats, 2007). This information was compared against incidence rates reported by neighbouring Washington State.

In order to ascertain the true incidence of LD, an epidemiological technique known as Capture-Recapture (CR) methodology was applied to the results obtained. This technique, which was adapted from animal-ecology, involves the application of a mathematical formula to two or more sets of distinct data (Hook, E.B., 1995). Thus, the CR methodology was applied to the results achieved from each of the three cleaned databases to yield a final estimate of the missing cell. In using the CR-methodology, a "goodness-of-fit" calculation was performed on the data, which suggested a model using two degrees of freedom and treating the data as semi-dependant would be the most appropriate. In other words, a model which treated the data as "semi-dependent" would be the most appropriate in order to make an accurate estimate. This also partially addresses concerns raised by certain researchers as to the validity of CR methodology that treats all data as independent (Tilling, 2001). This calculation was performed with confidence intervals in order to demonstrate the potential range of values. In
order to complete this analysis, it was necessary to perform a Yates continuity correction of 0.5 for zero values in the data.

Finally, the BCCDC had previously performed ecological niche modelling for the *Ixodes pacificus* species. This computer modelling took into consideration elevation, humidity, temperature and ecology factors in order to predict the likely ecological niches for this tick species. The data obtained from this database reconciliation of confirmed cases was then overlaid against the likely ecological niches.
CHAPTER 4: RESULTS

Once the databases had been cleaned and then reconciled against one another, the end results yielded a total of 68 confirmed cases over the ten year period under study. Of this total, 87.6% of cases (n=46) were reported on the IPHIS database, 45.6% of cases (n=31) were reported in the enhanced surveillance database and 79.4% of cases (n=54) were reported in the laboratory database (see the Venn diagram in appendix ‘A’). What became evident through the reconciliation is that there existed considerable overlap between all three of the databases.

With regard to the demographics of the confirmed cases abstracted from these three databases, 44.1% (n=30) were males and 55.9% (n=38) were female. The age distribution is displayed in table 1 (below) with the vast majority of cases falling within the 41-70 year old groupings.

Table 1: Age distribution of confirmed LD cases

<table>
<thead>
<tr>
<th>Age distribution</th>
<th>Count</th>
<th>n (%)</th>
<th>Age distribution</th>
<th>Count</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>2</td>
<td>(2.9)</td>
<td>41-50</td>
<td>15</td>
<td>(22.1)</td>
</tr>
<tr>
<td>11-20</td>
<td>7</td>
<td>(10.3)</td>
<td>51-60</td>
<td>13</td>
<td>(19.1)</td>
</tr>
<tr>
<td>21-30</td>
<td>5</td>
<td>(7.4)</td>
<td>61-70</td>
<td>17</td>
<td>(25.0)</td>
</tr>
<tr>
<td>31-40</td>
<td>4</td>
<td>(5.9)</td>
<td>&gt;71</td>
<td>5</td>
<td>(7.4)</td>
</tr>
</tbody>
</table>
The mean age of the confirmed cases discovered through this study was 48.7 years and the median age was 52.5 years with a range of 84 years (min=4, max=88). Information regarding exposure risks (including travel) were systematically collected from confirmed cases though the enhanced surveillance database from 1999 onwards. While the data is not complete for the ten-year period of study, the enhanced data does provide some information related to potential location of exposure. Of the confirmed cases of LD (1999 – 2006), a total of 41.9% (n=13) were identified as being travel related. Of those cases for whom a travel-related exposure is known, 53.8% (n=7) were potentially exposed in Europe and 46.2% (n=6) were potentially exposed in the United States. Of those exposures occurring in Europe, the following countries were identified as potential sources of infection: France; Germany; Switzerland; Sweden; and Yugoslavia. Of those exposures possibly originating from within the USA, the following states were identified as likely exposure sites: Washington; New Jersey; New York; New Hampshire and Connecticut.

Using BC Provincial census data from the past ten years, this research reveals an annual incidence for LD which is compared with data from Washington State during the same time period (see Figure 1 below).

The residential and/or likely exposure locations of the confirmed endemic cases were then mapped against likely ecological niches for the *Ixodes pacificus*. When the two data sets were overlaid against one another (see figure 2, appendix '2') the result was a 94% model accuracy. In all, 33 of the confirmed cases had residential / exposure locations which fell within those areas considered "optimal"
for *Ixodes pacificus*, 3 cases within areas classified as being "potential" and 3 cases in regions considered "not suitable" for *Ixodes pacificus*.

![Figure 1: LD incidence rates per 100,000 in BC and Washington State](image)

1. Washington State data from the State Department of Health
2. BC incidence total (endemic and travel) incidence rates for LD by year

In analysing the likely completeness of data obtained through the three surveillance databases, the CR-methodology was applied to the results obtained using a 0.5 Yates correction *for* the zero values obtained in the 2x2 contingency table. This epidemiological analysis estimated that the potential true number of LD cases could in fact number 134 (CI: 23 – 784).
CHAPTER 5: DISCUSSION

From the data obtained, a much clearer picture is emerging as to the epidemiology of LD within British Columbia. Over the ten year period under study (1997-2006), 68 cases of confirmed LD, both clinical and serological, have emerged. When the incidence is distributed by year and compared against Washington State, it is apparent that the two sets of data suggest a relative level of congruence (e.g. both jurisdictions have a yearly incidence rate of <0.5/100,000). One potential factor that could account for yearly variations between the two jurisdictions is travel exposure, but this would require further investigation which is beyond the scope of this current research.

When comparing the yearly incidence rate of BC against the ten reference states in the U.S. which are considered to be highly endemic regions for LD, a revealing picture emerges. According to the CDC (2007), the ten highly endemic reference states had an combined annual incidence rate of 29.2/100,000 people. When contrasted against an incidence rate in British Columbia averaging <0.5/100,000 people, a strong argument could be made against BC being considered a highly endemic region.

A further comparison which is worthy of consideration is epidemiological picture between regions considered to be highly endemic and the situation in British Columbia. According to the CDC (2007), the majority of cases within the ten reference states are: a) male and b) younger (e.g. 5-14 years of age).
According to this research, a majority of cases within BC are: a) female and b) > 41 years of age. While demographics could partially account for the differences exhibited, it is nonetheless a notable finding.

While B.C. currently enjoys an incidence of LD which could not be considered highly endemic, one important future consideration is the role of climate change. It is a certain consideration that a changing / warming climate could alter the geographical niches for both vectors and hosts (Brownstein, J.S., 2005). This consideration further bolsters the need for continued, vigilant surveillance on the part of public health authorities. From the previous research conducted by the BCCDC on ecological niche modelling for *Ixodes pacificus*, coupled with the confirmatory overlay of confirmed cases, a predictive map now exists with those areas of the Province which might be considered to be at a higher risk for exposure. This finding will certainly assist health authorities in conducting ongoing and enhanced surveillance. In addition, prevention activities can more effectively be targeted towards those regions in which there currently exists a greater risk. This mapping activity should be repeated on a regular basis in order to monitor the ecology of the *Ixodes pacificus* and adapt public health strategies accordingly.

When the data was subjected to a CR analysis, it became evident that a important number of cases could potentially be missing from currently established surveillance activities. While the predicted missing data set (n=134) would not be significant enough to propel BC into the ranks of the highly endemic reference states, it is still a substantial number of missing cases. This predicted
number (more than twice the number of confirmed cases) could potentially impact the demographic picture of LD within BC. We should however be cautious of the predictive value of the CR results obtained. The confidence intervals are extremely wide which lessens the predictive strength of the data derived.

Developing strategies to increase awareness of the clinical presentation, testing requirements and reporting of LD by clinicians may be important strategies to address this problem. However, such a strategies should only be pursued after conducting a cost-benefit analysis as to the resources required and the added-value of such labour and financial intensive activities.

One further area of concern captured in the course of this research is the effectiveness / efficiency of current surveillance activities. In relation to the seven key principles identified by Perry et al. (2007), it is evident that the existing surveillance system as it relates to LD has some significant shortcomings. The existing Provincial system does use standard diagnostic criteria, investigates public health events using confirmatory lab data and analyzes data obtained. However, the surveillance system falls short when it comes to alerting higher levels and triggering local action, using the data to trigger an appropriate response and providing complete and timely information across the health system. With regard to the seventh point, which centres around addressing the ongoing improvement of the surveillance system, this was not thoroughly addressed until this research project was undertaken.

Currently data is captured in three separate databases, it is not linked and there does not exist a structure to regularly validate the data contained within. In
order to ensure that data is accurate and up to date, it is important for the BCCDC to develop mechanisms for linking the data. This could potentially be accomplished through a real-time, electronic link between the laboratory database and the iPHIS database. The data could then be immediately uploaded into a new enhanced surveillance database which would include all the data contained within both the iPHIS and the laboratory databases. Enhanced surveillance data could then be inputted directly into this new database to enrich the quality of the information therein. An alternative strategy would be for the BCCDC to ensure that regular (e.g. annual) reconciliations of the data was conducted. This would ensure that a quality-review structure was instituted and would allow for a regular review of provincial LD trends.

A third opportunity exists to improve the quality of data captured with the development of new computerized surveillance systems. Currently efforts are underway to upgrade the computerized surveillance systems right across Canada called Panorama. In creating a new, pan-Canadian system, the limitations related to LD identified within the course of this research should be considered and included in the systems architecture.

As was previously mentioned there exists a growing number of advocates who are suggesting that formal public health structures are not adequately studying / addressing this issue within the Province. This research should be used to address components of the concerns raised. More specifically, the research can provide some epidemiological insight into the documented / reported incidence of LD within the defined study period and suggest further
evidence related to potentially higher risk regions. A second benefit is derived in demonstrating epidemiologic relationships between similar jurisdictions (e.g. Washington State). This should allay some concerns about British Columbia being a highly endemic Province. While this research would clearly not address all of the concerns articulated by certain advocates, it is a starting point in concretely reporting the ongoing surveillance work of the Province and opening further, constructive dialogue.

In terms of limitations encountered in conducting this research, it is important to acknowledge the potential for some underlying bias. Referral bias is one potential obstacle in that certain practitioners may be more aware of the clinical presentation of LD than are others. Depending on the scope / number of missing cases, misdiagnosis or under-reporting could significantly impact statistical results and predictions which are reported in this research. This concern about the completeness of data-sets is further echoed when examining critiques of CR-methodology. Certainly CR methodology has limitations and one such limitation is the potential for producing biased estimates if “one source (or combination of sources) captures very few cases.” (Tilling, pg.13, 2001). Despite concerns raised about the transferability of CR methodology from wildlife ecology to epidemiology, it is potentially a useful tool, due in part to its ease of use, in making estimates of the completeness of a surveillance system (Hook, 1995). In addition to referral bias, recall bias is a key consideration as many patients do not always remember specific exposure risks. While this list of potential
limitations is not exhaustive, these two limitations are identified as having a potential impact on the accuracy of the data presented.

In conclusion, the data captured in the course of this research demonstrates that British Columbia does have a low level of endemic LD when compared with other jurisdictions of North America. This is further confirmed when comparing the incidence rates against those in neighbouring Washington state. There do exist several key differences in the epidemiology of LD in BC (e.g. age, sex) when compared against ten known highly endemic reference states in the US.

This research also mapped confirmed cases of LD against suspected ecological niches. The results revealed a high degree of predictive accuracy. Thus, public health officials now have a good sense as to the regions within the Province that are at a higher risk for exposure. Also emerging from this research are some key areas requiring further attention action. The CR methodology indicated that a number of cases may have been missed using current surveillance mechanisms. Additionally, surveillance data is captured in three separate databases that are not linked nor does there exist any fixed method for quality review / control. These are certainly areas worthy of further study. This is important to equip BC to understand the emergence of LD within the province.
CHAPTER 6: PERSONAL REFLECTIONS

This research experience was an excellent opportunity to participate in disease surveillance activities on a Provincial level. Throughout my experience at the BCCDC I was able to participate in epidemiology team meetings, to prepare educational materials and to interact with a large interdisciplinary team in achieving my research objectives. More specifically I had the opportunity to work very closely with raw surveillance data and to analyze/interpret this data for reporting purposes. It is hoped that this data will ultimately be used for a scientific publication and this will be my first time to contribute/author such a peer reviewed piece. While I have previously had significant public health experience at the local/regional level, having now worked on the Provincial level, I have a broader understanding of the intersections and the varied roles of specific governing bodies.

In terms of challenges encountered, I believe that there exist significant resource issues at all levels of government. This impacts the capacity for thorough and rigorous surveillance in all domains of disease monitoring. In my own experience conducting this research, there were substantial delays related to receiving the raw data and some further challenges in accessing necessary supports to guide the research. This resulted in a longer than expected practicum experience and some unnecessary mistakes throughout the process.
While there were certainly challenges, I believe that the independent nature of this research project allowed me to more thoroughly immerse myself into the data and to develop a level of expertise related to LD specifically, and research more generally, which I did not previously have. In all, this was an excellent opportunity and a valuable project which I hope will be a valuable contribution to the BCCDC and other public health bodies.
APPENDICES

Appendix A:

Figure 2: Venn diagram of current LD data sources within BC
Appendix B:

Initial sample
Includes all individuals who had a positive lab result (EIA and / or WB IgG/IgM) on the laboratory database. Also includes those individuals who had a clinical diagnosis or who were contained within the enhanced surveillance database.

n = 896

Laboratory database
(Meeting case definition)
YES = 54
NO = 763

Laboratory database
(Meeting case definition)
YES = 46
NO = 2

iPHIS database
(Meeting case definition)
YES = 31
NO = 0

iPHIS database
(Meeting case definition)
YES = 46
NO = 2

Enhanced database
(Meeting case definition)
YES = 31
NO = 0

Total cases meeting case definition = 131

Total cases following reconciliation of databases = 68
(Duplications eliminated from cases reported in multiple databases)

Figure 3: Inclusion / exclusion tree for LD cases
REFERENCE LIST


