

Canada Goose

Management Strategy

for Mount Arrowsmith Biosphere Region



This management strategy outlines scientifically-based management solutions to reduce and control locally overabundant Canada Goose populations.

While it applies to an area of land and sea corresponding to the lower elevations of Mount

Arrowsmith Biosphere Region on east-central Vancouver Island, British Columbia, Canada, the strategy may be a valuable resource for any jurisdiction struggling with 'too many', nuisance, or invasive Canada Geese.

Purpose

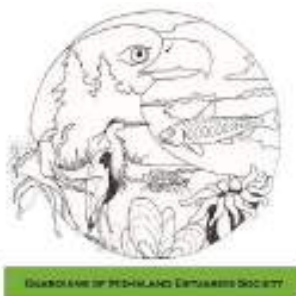
The primary focus of this strategy is to facilitate the restoration of high quality fish and wildlife habitat, and in particular, estuarine marsh habitats degraded by locally overabundant Canada Geese (*Branta canadensis*). Without goose management, restoration efforts will be short-term and limited to areas excluded from geese.

Importantly, this strategy is *not a management plan*. The strategy provides the science to inform regional Canada Goose management, and introduces and recommends options for management. We hope those who are tasked with creating and implementing management plans are well served by the information herein.



THE GUARDIANS

Since 2002, members of the Guardians of Mid-Island Estuaries Society have led efforts to reduce regional Canada Goose populations by addling eggs and promoting additional hunting. From 2008 to 2012, the Guardians and other volunteers banded and collared nearly 300 Canada Geese at the Englishman



River, Little Qualicum River, and Craig Creek estuaries. Marked and unmarked Canada Geese in the region were surveyed to learn more about their seasonal abundance and use of the estuaries and other habitats. Today, we have sufficient knowledge to guide this science-based management strategy.

MESSAGE FROM THE AUTHOR

I have written this document in the first-person, meaning that “I” is me (Holly), and “we” refers to all of the members of the Guardians of Mid-Island Estuaries Society (The Guardians). I am a member of the Society, a biologist, and a budding social scientist (DocSocSci Candidate, MA, BSc., Dipl. Renewable Resource Management). I became involved in this project because I like Canada Geese and I’m a huge fan of estuaries. I was eager to discover whether the two could peacefully coexist.

In 1987, I was hired by Alberta Fish and Wildlife to assess regional Buck for Wildlife projects, which included installing round hay bales to encourage Canada Geese to nest in prairie potholes. There, local biologists celebrated the discovery of every goose found nesting on a man-made structure. Twenty years later, I wandered mid-island estuaries to search for Canada Goose eggs, to prevent them from hatching. It was hardly cause for celebration.

‘Too many geese’ is a challenging problem. There are no magic formulas or quick and easy fixes. Recognizing that we still have much to learn about Canada Geese and their management, I welcome informed critiques and new ideas. I expect there are

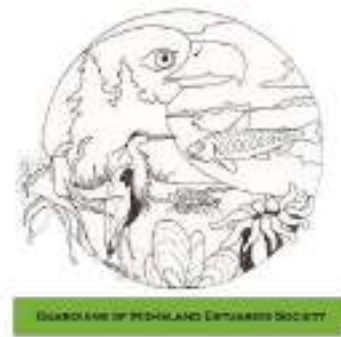
errors and omissions in this document, and certain statements and recommendations will be unpopular in some circles. When fingers are pointed, they are not meant to criticize, but to respectfully direct those with the power to fix this unsatisfactory situation. My wish is for users to select the types of management actions that will work best for their communities and for the health of estuaries and other sensitive and valuable ecosystems.

While this document is scientific, it is not without colloquialisms. This is purposeful, to appeal to a broad spectrum of readers. Canada Goose management requires many types of expertise.



DISCLAIMER

This report and the publications cited and discussed herein are intended solely for information purposes. We accept no liability for the consequences of any actions taken on the basis of the information provided in this document.



CITATION

Clermont, H. 2015. Canada Goose (*Branta canadensis*) Management Strategy for Mount Arrowsmith Biosphere Region: Towards the Restoration of Goose-Damaged Estuaries. Prepared for the Guardians of Mid-Island Estuaries Society. Available from guardiansmie.org.

or

Guardians of Mid-Island Estuaries Society. 2015. Canada Goose (*Branta canadensis*) Management Strategy for Mount Arrowsmith Biosphere Region: Towards the Restoration of Goose-Damaged Estuaries. Prepared by H. Clermont. Available from guardiansmie.org.

ACKNOWLEDGMENTS



Goose roundup crew at Little Qualicum River estuary, July 2010

There were many people involved in the production of this strategy and the years of work leading to it. Please accept my apologies if I have missed anyone.

The Guardians Board has led the way since its inception in 2010. The Board consists of John Cooper, Tim Clermont, Craig Wightman, Doug Herchmer, Karen Barry, and Doug Janz, an outstanding group with a wealth of knowledge of wildlife biology and ecology. They were the primary reviewers of the strategy.

The banding crews were a courageous and cheerful lot. In alphabetical order, they were Karen Barry, Kirsti Brennan, Trudy Chatwin, Dawson Clermont, Holly Clermont, Jory Clermont, Tim Clermont, Adrian Cooper, John Cooper, Eric Demers, Bruce Cousens, Doug Herchmer, Charlene Lee, Lori Lynch, Shane Johnson, Joel McNeil, Donna Monty, Guy Monty, Rich Mooney, Danielle Morrison, Gabe Pakozdy, Aaron Ritchie, Shawn Stenhouse, and Craig Wightman.

The adulling crews were fearless and had at least one strong arm. In alphabetical order, they were Terry Berkely, Bev Bravender,

Ian Bryce, Owen Catheral, Holly Clermont, Tim Clermont, John Cooper, Selam Cooper, Kokeb Cooper, Neil Dawe, Steve Godfrey, Doug Herchmer, Lori Lynch, Donna Monty, Guy Monty, Danielle Morrison, Phil Morrison, Aaron Ritchie, and Kevin Robinson.

Monitoring of Canada Geese was led by Danielle Morrison, Aaron Ritchie, Phil Morrison, and Tim Clermont. Regular surveys were augmented by observations from Holly Clermont, Rhys Harrison, Mike Murphy, Mike Inglewood, and Dawson Clermont.

Winter survey participants included, in alphabetical order, Karen Barry, Suzanne Beauchesne, Lynne Brookes, Heloise Chenelot, Tim Clermont, John Cooper, Kokeb Cooper, Selam Cooper, Bruce Cousens, Neil Dawe, Eric Demers, Nadene Ebell, Dan Gray, Sandra Gray, Kevin Green, Maggie Green, Derrick Grimmer, Rhys Harrison, David Helem, Pat Herzog, Bob Hunt, Mike Ingledew, Doug Janz, Janet Jefferey, Charlene Lee, Elaine Lefebvre, Maggie Little, Danielle Morrison, Karen Morrison, Gary Murdock, Ronda Murdock, Andy Pearson, Margaret Pim, Aaron Ritchie, Jeanne Schippers, Rob Schippers, Pat Sears, Peggy Sowden, Howard Stiff, Roger Taylor, Catherine Watson, and Craig Wightman.

Danielle Morrison and Aaron Ritchie were tasked with most data entry. Heloise Chenelot set up our Access database, no easy feat. Howard Stiff, Tim Clermont, Danielle Morrison, and Aaron Ritchie patiently assisted with data cleaning. Howard and Danielle graciously shared their software

skills and programming expertise. Howard performed most of the project's statistical analyses, and we are very grateful for his considerable skills in navigating challenging datasets. Mark Drever (CWS) conducted an early statistical analysis of current and historical data, and provided analytical assistance. Arco Van Strien provided the TRends and Indices for Monitoring (TRIM) software program and guidance for its use. Special thanks to Tim Clermont, Howard Stiff, and Danielle Morrison for many hours of mind-bending, brainstorming fun.

Thanks also to external reviewers David Bradbeer, Tom Reid, and Jack Evans.

The Guardians of Mid-Island Estuaries Society logo was created by the very talented Amy Hillaby. Many thanks to Guy Monty and Lyn Topinka who contributed amazing close-up photos. Thanks also to Doreen Bakstad, Trudy Chatwin, Tim Clermont, Charlene Lee, Neil Dawe, Mike Inglewood, and others who graciously shared photos. Most photos without credits were provided by Holly Clermont and Danielle Morrison.

Orthophotography was provided by Tom Sohier and Margaret Paridaen (Regional District of Nanaimo (RDN)). Mapping support was provided by Danielle Morrison and Dan Buffett (Ducks Unlimited Canada (DUC)).

The project received funding or in-kind support from DUC, Living Rivers/B.C. Conservation Foundation, City of Parksville, RDN, MoE, Fisheries and Oceans Canada and CWS.

Executive Summary

Beginning in the 1950s, enthusiastic wildlife managers across North America began relocating Canada Geese and enhancing potential goose habitats in a concentrated effort to grow their populations. This highly successful assisted migration led to many locally overabundant goose populations. Unwanted geese were transplanted to unfilled sites where their offspring would eventually become a problem for farmers or municipalities and the phenomenon would repeat.

Once a small population was established, site fidelity, a tendency to return again and again to the same places, ensured it would continue to grow. Young breeding females in particular precipitated exponential growth in local goose populations by returning to nest where they were hatched or reared. It is a myth that geese have become a problem because of a failure to migrate.

In fact, many geese in the area do migrate, if only for short distances (e.g., to the Saanich Peninsula or Washington State), debunking the notion that geese stay in the area because all of their needs are met right here. Fourteen different migrant types have been found among geese that were presumed resident, banded at the nest or during the moulting (or flightless) period. These ranged from local residents, present for all five seasons of the Canada Goose life cycle (i.e., spring migration, nesting, moulting, fall migration, and overwintering) to birds that flew long distances (e.g., to California, Alberta). Although local residents are the foundation of our year-round Canada Goose population, other migrant types are always present. Migrants are attracted to areas where local residents gather, and within a few days can have a major impact on those habitats.

Such findings are key to effective management decisions. Since 2000, members of the Guardians of Mid-Island Estuaries Society have helped manage Canada Geese to protect conservation lands damaged by burgeoning goose populations, and in 2008 began marking individual birds ahead of surveys to better understand their population dynamics and distributions. Birds were banded at the Little Qualicum River (LQRE), Englishman River (ERE), and Craig Creek (CCE) estuaries. More than 12,707 survey records, some dating back to 1989, as well as 1,663 nest records and 4,746 records of re-sighted marked birds were used to examine our regional Canada Goose population and develop this strategy.

Still, we were unable to determine whether the regional population is significantly increasing or decreasing. Comparable external datasets, such as those from Bird Studies Canada, showed weakly increasing or possibly cyclic trends. Notably, goose populations are unlikely to be limited by the ecological carrying capacity of the region. They were observed on only 232 of 342 sites identified as available goose habitat.

There were two times of year when large numbers of geese were observed. Overwintering and summer moult counts were higher than counts in other seasons, peaking at ~1,500 birds in 2014. These peaks, partly attributed to additional survey sites, may be of management concern. Only continued monitoring will determine whether these represent a new trend upwards, peaks in a recurring cycle, or standalone highs.

The least amount of mixing between local residents and other migrant types occurred during the nesting season. The maximum count during the nesting season was 443 in 2013, not including undetected nesting birds and geese that left the region to moult. If surveys of both breeding and non-breeding birds were conducted on and near the nesting grounds, a trend for local resident populations might emerge.

Across all seasons, goose counts were highest at the estuaries. During the moult, they concentrated on the estuaries and in marine and freshwater habitats, such as Hamilton Marsh. In fall and winter, estuaries were preferred roosting and loafing sites, and destinations when other areas were exposed to hunting pressure or were frozen. Our estuaries experienced a reprieve of sorts only after the moulting period prior to the first hunting season, when flocks tended to forage elsewhere.

Estuaries are critical and year-round habitats for Canada Geese, but they are also used by an estimated 80% of coastal fish and wildlife and provide many services to humankind (e.g., flood control, water filtration, carbon sequestration). Geese have overgrazed mid-island estuarine marshes, and grubbed the roots and rhizomes along channel edges, exposing the thick marsh platform to erosion. Built up over millennia, this platform has washed away in many areas, channels have become shallow, and productive habitats have been reduced to gravel. When a similar scenario occurred in northern salt marshes, primarily from overabundant snow geese, entire plant communities were eliminated and areas exclosed from geese remained denuded 20 years later.

Even without the additional burden of overgrazing geese, many mid-island marsh ecosystems are at-risk of extinction; at least four ecological communities are provincially imperiled, and another three are of special concern. Geese have also introduced invasive plants into imperiled Garry Oak ecosystems, and may be overgrazing eelgrass, a keystone species in estuarine and subtidal environments.

Urban and agricultural areas have also suffered. When the size of habitats were taken into account, goose densities were found to be highest in the Parksville Church Road and Parksville Bay/City areas, and on sites with access to freshwater in particular.

High concentrations of geese may lead to contamination of drinking water, and fouling of beaches, parks, school grounds, sports fields and other sites, all of which pose risks to human and animal health. Island Health inspectors have found no significant issues with water samples taken from Qualicum Beach, Parksville, or Rathtrevor Provincial Park's popular beaches. However, other areas remain unsampled. Young children playing in sand may have a greater exposure to goose-borne bacteria, as bacteria persist longer in sand than in water. Some dogs participating in hazing programs have become unwell. A 2010 health risk assessment, commissioned by the Canadian Wildlife Service (CWS), found there were insufficient data to conduct a meaningful assessment. It recommended fecal waste management, a working group to develop national standards for the management of peri-urban (or 'rurban') goose populations, and investments in monitoring and research.

Our survey of stakeholders identified many concerns. The Department of National Defense was concerned about bird strikes near its helicopter pad in Nanoose Bay. Local farmers had experienced crop damage. Some respondents suspected contamination of drinking water, shellfish beds, and areas used by farm animals. People complained about damage to landscaping, noise issues, and aggression towards people and pets. Many had incurred costs associated with goose control or damage. Importantly, the survey revealed Canada Geese had diminished the quality of life of area residents by keeping them from enjoying special places and activities. Some local businesses were affected by off-put tourists. Although it appears that our communities have exceeded our tolerance, or 'social carrying capacity' for geese, additional community members should be surveyed to augment our limited survey data.

In Canada, they may be an icon, but in many other countries Canada Geese are considered one of their worst invasive species and a serious threat to biodiversity. In some U.S. jurisdictions, they are classified as ‘overly abundant’, although areas without this designation appear to have considerable latitude in dealing with nuisance geese. The U.S. Fish and Wildlife Service provides management support, including, among other things, capture and euthanasia, egg addling, and hazing. It maintains an e-permits website whereby anyone in the conterminous U.S. (i.e., the lower 48 States) can register for federal authorization to destroy Canada Goose nests and eggs. The U.S. Department of Agriculture (USDA) provides management services on a cost-reimbursable basis. There are also State-funded control programs. Due in part to the direct involvement of senior governments, culled geese suitable for human consumption are typically donated to food banks or other charitable organizations. USDA economists found that for every dollar spent controlling Canada Geese, U.S. \$1.31 to \$5.56 could be saved in damage and maintenance costs.

In general, a combination of hunting, egg sterilization, culling, and hazing are used to control Canada Geese. Elsewhere in B.C., organized hunts, kill permits, and large-scale egg addling programs have been used with some success. The first cull of geese on Vancouver Island was held in the Capital Region in the summer of 2015.

Hunting has been promoted as the best way to address nuisance geese. Twenty-one percent of our marked geese were shot by hunters, and 68% of these were killed within our region. Seventy-two percent of marked geese shot outside of the region had never been observed on huntable sites here. More than half of marked geese shot by hunters were banded at the Little Qualicum River estuary. All LQRE-banded birds had been observed on huntable sites in the region, whereas only one third of ERE-banded birds and two thirds of CCE birds were huntable.

If Canada Geese were designated as ‘overabundant’, exceptional hunting methods and equipment could be used. Hunting pressure may also be increased by opening new areas to hunting, even for a limited period, and by creating incentives for hunters, encouraging landowners with geese to allow hunters, and further reducing hunting restrictions. However, many studies have shown that hunting alone will not control goose populations.

Egg sterilization is a common management tool. The mid-island egg addling program has focused on the Englishman River and Little Qualicum River estuaries, and to a lesser degree on the Nanoose Bay unit of the Qualicum National Wildlife Area. Nest densities were highest at the Little Qualicum River estuary, however nest and egg numbers there are now trending downward. By contrast, the number of nesting geese at the other estuaries has increased. Despite these conflicting trends, we can unequivocally say the addling program has made a significant impact. From 2002 through 2014, it prevented at least 5,345 eggs from hatching, or at least 2,088 new breeding birds, despite a lack of consistent funding and personnel. Given an average clutch size of 5.8 eggs per goose, and using a very rough calculation, the addling program has prevented more than 6,000 additional eggs *per year*.

There are other ways to control geese, used with varying levels of success. What works well for one site may be unsuitable for another, and there is a legitimate concern that birds kept out of one area will wreck havoc elsewhere. Even hunting and egg addling move birds and impacts to other areas. Some survey

respondents had used damage or danger permits, however these are probably underutilized due to a lack of awareness that such permits exist, onerous permitting processes, and a reluctance to perform the tasks. A provincial compensation program for farmers was also underutilized; while compensation is not a control measure, it is a form of management.

Culling - the selective, lethal removal of wild animals, is a sensitive topic and has been considered a measure of 'last resort'. Yet, it has some distinct advantages over other types of control methods. Like hunting and permits to kill adult birds, it decreases the breeding population. However, it typically targets a larger number of birds at one time, can be applied directly to a problem population, its effects are obvious and immediate, and there are fewer risks that surviving members will cause problems elsewhere. Still, repopulation is anticipated, as individuals that escaped the cull return, nearby populations continue to grow, and suitable habitats remain available.

Fewer people are opposed to culling of nuisance geese when they are utilized in some way. Other game animals have been culled, processed, donated, and even sold and exported, and our provincial agencies support the use of culled meat. There are revisions proposed to the *Migratory Birds Regulations* that would allow consumption of culled geese, requiring the development of standards with public health and food inspection agencies. A made-in-B.C. solution may also be possible, should the provincial inspection program take the lead and donated meat remain in the province.

Also anticipated are revisions to the *Migratory Birds Regulations* that allow First Nations to harvest migratory birds and their eggs throughout the year; to sell down and non-edible by-products; and to barter, exchange, trade, or sell birds and eggs with other Indigenous communities. However, collaboration and consultation with First Nations is important for reasons aside from their potential contributions to goose management. Canada Geese frequent reserve lands and traditional use areas, causing degradation there too.

We encourage local governments and regulatory agencies to work together with affected landowners and land managers to reduce and control the regional Canada Goose population. It is appropriate that CWS leads a regional working group that dedicates and pools resources to address the full breadth of problems caused by geese. It is important that CWS, B.C. Ministry of Environment (MoE) and Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) develop a communications protocol to bridge the mostly-siloed goose management initiatives in B.C. so that efforts are cohesive, and experiences and expertise are shared. Some frank discussions should ensue, such as how CWS might set population objectives for Canada Geese based on the ability of habitats to support them, and the merits of an overabundance designation for temperate-breeding geese. The group should also develop a monitoring program in advance of predictive population modeling.

This strategy has been designed to serve individuals and groups coping with nuisance geese and/or tasked with creating and implementing management plans. There were three mostly distinct, but sometimes overlapping subpopulations in the region, corresponding to geese banded at the LQRE, ERE, and CCE. These subpopulations merit individual management plans, as they are composed of unique blends of migrant types, experience different levels of hunting pressure, and pose challenges that may not be relevant across the entire region. Recommendations for each plan are provided in Chapter 14.

Table Of Contents

Front Matter Page 2

Message from the Author 2

Disclaimer 2

Citation 2

Acknowledgments 3

Executive Summary 4

Acronyms and Abbreviations 11

Chapter 1 - Background 12

1.1 Problem Origins 13

1.2 From Rare Migrant to Locally Overabundant 14

1.3 First Management Efforts 15

1.4 Guardians of Mid-Island Estuaries Society 16

1.5 Study Area 17

Chapter 2 - Strategy Purpose and Goals 18

2.1 Overview 19

2.2 Purpose and Goals 19

2.3 Towards an Estuarine Marsh Restoration Plan 20

Chapter 3 - Introduction to the Canada Goose 21

3.1 Taxonomy 22

3.11 Dusky Canada Goose 23

3.12 Vancouver Canada Goose 24

3.13 Moffitt's (Western) Canada Goose 24

3.14 Lesser Canada Goose 24

3.15 Cackling Cackling Goose 24

3.16 Taverner's Cackling Goose 25

3.17 Aleutian Cackling Goose 25

3.2 Food Preferences 25

3.3 Habitat Preferences 27

Chapter 4 - Current Regulatory and Policy Framework 29

4.1 Jurisdiction 32

4.2 Pacific Flyway Council 32

4.3 Migratory Birds Convention Act 32

4.4 Migratory Birds Regulations 33

4.41 Overabundance 33

4.42 Airport Permits 34

4.43 Damage and Danger Permits 35

4.44 Scare Permits 36

4.45 Management Plans 36

4.5 Wildlife Policy for Canada 37

4.6 Hunting Regulations 37

4.7 B.C. Wildlife Act Permits 39

4.8 Firearm Regulations 39

4.9 Processing Non-hunted Wild Game for Consumption 40

4.91 Consumption of Non-hunted Wild Game in Canada 40

4.92 Consumption of Non-hunted Canada Geese in the United States 41

4.93 B.C. Rules for Sharing of Game 42

4.10 Aboriginal Rights 43

4.101 Parksville Protocol 43

4.102 Proposed Changes to the Migratory Birds Regulations 43

4.103 Contemporary Treaty Agreements 43

Chapter 5 - The Need for Action 44

5.1 Few Benefits, Many Problems 47

5.2 Impacts to Estuaries 48

5.3 Other Ecological Impacts 50

5.4 Socio-economic Impacts 51

5.41 Transportation Safety 51

5.42 Crop Depredation 52

5.43 Contamination and Fouling 53

5.44 Fouling and Grass Turf Management 55

5.45 Distribution of GM Seeds 56

Chapter 6 - Population Structure 57

6.1 Banding 58

6.2 Goose Surveys 60

6.21 Survey Areas and Sites 60

6.22 Survey Types 61

6.23 Winter/Autumn Counts 61

Chapter 6 - Population Structure cont'd

- 6.24 Moulting Counts 61
- 6.25 Routine Population Counts 62
- 6.26 Addling Counts 63
- 6.27 Waterfront Counts 63
- 6.28 Dawn to Dusk Survey 63
- 6.3 Subpopulations 64
- 6.4 Migrant Types 65
 - 6.41 What is a "resident" Canada Goose? 65
 - 6.42 Assigned Migrant Types 66
 - 6.43 Migrant Types and Home Ranges 69
 - 6.44 Local Residents, Long-distance Migrants 70
- 6.5 Relative Abundance of Migrant Types and Subpopulations 71

Chapter 7 - Canada Goose Seasons 72**Chapter 8 - Seasonal Distribution 74**

- 8.1 Spring Migration and Pre-nesting 76
- 8.2 Nesting 80
- 8.3 Brood-rearing 86
- 8.4 Moulting 87
- 8.5 Transition - Moulting to Autumn Migration 93
- 8.6 Autumn Migration 94
 - 8.61 A Cold Day in November 97
- 8.7 Overwintering 98

Chapter 9 - Spatial Trends 104

- 9.1 Hotspots 105
- 9.2 Site Fidelity 108
- 9.3 Nest Density 110

Chapter 10 - Population Trends 113

- 10.1 Statistical Analysis 114
 - 10.11 Methods 114
 - 10.12 Results 115
- 10.2 External Data Sources 122
 - 10.21 B.C. Coastal Waterbird Survey 122
 - 10.22 Christmas Bird Count 123
 - 10.23 Study of Canada Geese in Parksville 125

- 10.24 Other Data Sources 125

10.3 Life History by the Numbers 126

- 10.31 Natality 126
- 10.32 Mortality 130
- 10.33 Immigration and Emigration 131

Chapter 11 - Management in Other Jurisdictions 132

- 11.1 International 136
 - 11.11 United States 136
 - 11.12 Europe 138
 - 11.13 New Zealand 139
- 11.2 National 140
- 11.3 Regional 140
 - 11.31 Capital Region 140
 - 11.32 North Island 142
 - 11.33 Lower Mainland 142
 - 11.34 Okanagan Valley 143

Chapter 12 - Management Options 145

- 12.1 Status Quo 149
 - 12.11 Egg Addling Program 149
 - 12.12 Hunting 151
 - 12.13 Use of Permits by Landowners 159
 - 12.14 Goose Unfriendly Habitats 159
 - 12.15 Hazing 162
- 12.2 No Action 163
- 12.3 Additional Non-lethal Controls 166
 - 12.31 Goose Unfriendly Habitats 166
 - 12.32 Hazing 168
 - 12.33 Adult Sterilization 170
- 12.4 Additional Lethal Controls 170
 - 12.41 Additional Hunting 170
 - 12.42 Additional or Expanded Kill Permits 171
 - 12.43 Culling 171
- 12.5 Renewable Resources 174
- 12.6 Compensation 175
- SWOT analysis of management options 177*

Chapter 13 - Carrying Capacity 182

- 13.1 Ecological Carrying Capacity 183
- 13.2 Social Carrying Capacity 185
- 13.3 Alternatives to Carrying Capacity 185

Chapter 14 - Strategic Direction 189

- 14.1 Responsibilities 190
- 14.2 Population Objectives 191
 - 14.21 Population Abundance 191
 - 14.22 Population Structure 191
- 14.3 Spatial Objectives 193
 - 14.31 Distribution 193
 - 14.32 Management Zones 194
- 14.4 Temporal Objectives 200
- 14.5 Social Objectives 201
- 14.6 Monitoring 203
- 14.7 Timelines 203
- 14.8 Actions 203

*Table of Management Objectives 204***Chapter 15 - Personal Communications and Literature Cited 209**

- 15.1 Personal Communications 209
- 15.2 Literature Cited 209

Appendices 224

- Appendix A. Survey Sites
- Appendix B. Calendars
- Appendix C. Limitations
- Appendix D. Encounter Histories

Acronyms and Abbreviations

CAGO	Canada Goose/Canada Geese
CBC	Christmas Bird Count
CCE	Craig Creek Estuary
CDC	B.C. Conservation Data Centre
CFIA	Canadian Food Inspection Agency
CFMETR	Canadian Forces Maritime Experimental and Test Ranges
CRD	Capital Regional District
CREC	Campbell River Environmental Committee
CWS	Canadian Wildlife Service
DDT	dichlorodiphenyltrichloroethane
DND	Department of National Defense
DNR	Department of Natural Resources (U.S.)
DUC	Ducks Unlimited Canada
ERE	Englishman River estuary
GM	genetically modified
LQRE	Little Qualicum River estuary
MABR	Mount Arrowsmith Biosphere Region
MoE	B.C. Ministry of Environment
MFLNRO	B.C. Ministry of Forests, Lands and Natural Resource Operations
MVIHES	Mid-Vancouver Island Habitat Enhancement Society
NBE	Nanoose Creek/Bonnell Creek estuary
PQBWMA	Parksville - Qualicum Beach Wildlife Management Area
PCB	polychlorinated biphenyl
PECP	Pacific Estuary Conservation Program
RDN	Regional District of Nanaimo
ToR	Terms of Reference
TNT	Nature Trust of British Columbia
UBCM	Union of B.C. Municipalities
UNESCO	United Nations Educational, Scientific and Cultural Organization
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

Chapter 1 - Background Highlights

The problem of local overabundance, or simply ‘too many Canada Geese’, stems largely from exuberant wildlife management. Beginning in the 1950s, Canada Goose transplant and habitat enhancement projects spread like a wave across North America, rolling out along the Atlantic, Mississippi, and Central Flyways, and later in the Pacific Flyway, in a concerted effort to grow goose populations.

B.C. Ministry of Environment’s 1979 *Preliminary Canada Goose Management Plan for British Columbia* sought to: increase B.C.’s breeding population from 25,000 to 40,000; develop major concentrations of migrating Canada Geese in several parts of the province to provide wildlife spectacles for public viewing; develop programs to reduce or prevent conflicts between geese and agriculture; and provide 45,000 sport-hunting days and an annual sustained harvest of 20,000 birds. Four types of conflict were identified, with agriculture, recreational areas, aircraft, and hunting near urban areas. At the time the plan was written, transplanted geese from Victoria had already made their way to Duncan, and ‘less migratory’ populations had established on the Lower Mainland.

Prior to the late 1960s, Canada Geese were considered migrants and temporary visitors throughout all of southern Canada. By the 1980s, geese were nesting in the region and trending upward. From 1989 to 1993, autumn surveys showed a 92% increase in Canada Goose populations.

Efforts to manage expanding Canada Goose populations began with the Nature Trust of British Columbia, on concerns for its holdings in the Cowichan Valley, Englishman River, and Nanoose Bay. A series of meetings over several years, with representatives from all levels of government and farmers, prompted an egg addling program on estuarine conservation lands. Addling, a form of egg sterilization, was initiated at the Cowichan River estuary in 1999, at the Englishman River estuary in 2002, at the Nanoose and Bonnell estuaries in 2003, and at the Little Qualicum River estuary in 2004.

From 2002, members of the Guardians of Mid-Island Estuaries Society led efforts to reduce regional Canada Goose populations through egg addling and by promoting additional hunting days and bag limits. Outreach by the Guardians and others included presentations to local governments, television appearances, production and dissemination of videos and brochures, news articles, seminars, meetings, and poster presentations. To better understand abundance and distribution, the Guardians banded and collared nearly 300 Canada Geese at the Little Qualicum River, Englishman River, and Craig Creek estuaries from 2008 to 2012, and conducted goose surveys from 2011 to 2014.

Citations, excluded here for brevity, can be found in the text of the document’s chapters. Please do not cite highlights without consulting the chapters.

I.1 Problem Origins



Collared Canada Goose at her nest in Maple Ridge, B.C., May 1979 (the same year the Preliminary Canada Goose Management Plan for B.C. was drafted). Photo by John Cooper.

A Canada Goose is sometimes referred to as a *Canadian Goose*. Canada Goose is the accepted common name for the species *Branta canadensis*. It is found in many countries outside of Canada. The term *Canadian goose* more appropriately refers to any goose in Canada, regardless of species.

The problem of ‘too many Canada Geese (CAGO)’ is wide-ranging, extending far beyond Parksville, Qualicum Beach, Oceanside, or the lowlands of Mount Arrowsmith Biosphere Region. The source of the problem is also widespread, stemming largely from exuberant wildlife management across North America.

Canada Geese are known to migrate along four ‘flyways’ in North America; westernmost is the Pacific Flyway that includes our region. During the 20-year period from 1955 to 1974, the combined population of all races (and/or subspecies, see Chapter 3.1, Taxonomy) of Canada Geese in the Pacific Flyway declined by more than 10%. Yet, during the same period, populations in the Atlantic, Mississippi and Central Flyways increased by 138%, 169% and 70%, respectively, in “one of the more

spectacular accomplishments of wildlife management” (Bellrose 1976, p. 142). Western wildlife managers and interest groups soon joined the quest to grow Canada Goose populations.

Despite their propensity to form highly localized populations, Canada Geese were successfully relocated from other areas, with high nest success and brood survival “even on areas subject to considerable human disturbance” (Bellrose 1976, p. 143). The relocations and introductions often occurred with enhancements to goose habitat and restrictive hunting regulations (cf. Ankney 1996; Smith 2000). This concerted effort to increase Canada Goose populations in North America carried on until at least 1987.

PRELIMINARY CANADA GOOSE MANAGEMENT PLAN FOR BRITISH COLUMBIA

A *Preliminary Canada Goose Management Plan for British Columbia* was drafted in 1979. It described the Canada Goose as “prized by sportsmen for its wariness, size and table quality”, as well as “highly adaptable”, and able to “reproduce prolifically in close proximity to man when habitat is available” (BC Ministry of Environment (MoE) 1979, p. iii). At that time, the Ministry aimed to:

- 1) increase B.C.’s breeding population from 25,000 to 40,000;
- 2) develop major concentrations of migrating Canada Geese in several parts of the province to provide wildlife spectacles for public viewing;
- 3) develop programs to reduce or prevent conflicts between geese and agriculture; and
- 4) provide 45,000 sport-hunting days and an annual sustained harvest of 20,000 birds.

It would achieve these objectives by protecting and enhancing breeding and staging habitats, establishing sanctuaries to attract concentrations of Canada Geese, and restricting hunting to allow transplants to thrive. “Advice will be provided to people who wish to attract geese to their property”, stated the author (MoE 1979, p. 10). Expecting some of the birds would be harvested south of the border, the Ministry sought to produce more birds than would be killed in the province (MoE 1979).

Notably, in this 1979 plan, four types of conflicts were identified: with agriculture, recreational areas, aircraft, and hunting near urban areas. “In urban areas with excessive numbers of birds, the solutions are often costly (provide alternate land for the birds) or are publicly unacceptable (destroy many of the birds). The best way is often to prevent populations that are likely to cause problems from becoming established” (MoE 1979, p.11).

By the time the plan was written, Western Canada Geese (*Branta canadensis moffitti*) transplanted years before to a site near Victoria had already expanded north to Duncan. Five hundred breeding pairs of Vancouver Canada Geese (*B. c. fulva*) on Vancouver Island and the south coast, acknowledged to be 'less migratory' than other subspecies, were spending their winters in Washington and Oregon. And approximately 2,000 breeding pairs of non-migratory, hybrid Canada Geese had successfully established on the Lower Mainland from deliberate introductions (MoE 1979). It would not be amiss to say the plan was well underway.

"Canada geese breeding in southern Canada are not northern geese that stopped migrating, they are the result of the natural increase of populations that were re-introduced or introduced for the first time" (CWS 2010).

1.2 From Rare Migrant To Locally Overabundant

Before people began moving Canada Geese, they are believed to have nested on Vancouver Island only north of Great Central Lake (Dawe & Stewart 2010). This breeding population was probably of pure race, i.e., the 'less migratory' Vancouver Canada Goose (*B. c. fulva*) (MoE 1979; Dawe & Stewart 2010).

Small populations were established from game farm releases in the Victoria area in the 1920s and '30s, and in the Parksville and Nanaimo areas, possibly as early as 1946 through the early 1970s. Most introductions occurred in the 1970s and '80s, first to enhance wildlife viewing and hunting opportunities, and later to relocate problem birds (CWS 2010; Dawe & Stewart 2010).

Prior to the late 1960s, Canada Geese were considered migrants and temporary visitors throughout all of southern Canada (CWS 2010). In our region, there were few Canada Geese until the early 1980s, evidenced by several bird surveys conducted by CWS. Weekly surveys at the Englishman River estuary conducted from 17 June, 1979 to 29 June, 1980 found Canada Geese on only three occasions; eight was the greatest number of birds recorded. By contrast, geese were recorded at each weekly survey from 3 November, 1988 to 24 May, 1989, with a high count of 233 birds (Dawe & Stewart 2010).

During weekly bird surveys from January, 1975 to May, 1979 at the Little Qualicum River estuary, Dawe and Buechert (1995) observed Canada Geese only 8 times. Most were seen on a single occasion during the autumn migration in 1976 (Figure 1-1).

At the Nanoose unit of the Qualicum National Wildlife Area (which includes the Nanoose and Bonnell Creek estuaries), there were two records of Canada Geese: 1 bird on 9 November, 1978 and 1 bird on 16 May, 1979. This area was surveyed monthly from December, 1974 to 31 August, 1976, and weekly from August, 1976 to September, 1977 (Dawe & Lang 1980).

By the 1980s, Canada Geese were nesting in the region. During a breeding waterbird survey of 31 wetlands in 1981, a single nesting pair was discovered at Enos Lake (Dawe & Stewart 2010). A nesting pair was documented on the Little Qualicum River estuary in 1984 (Dawe & Buechert 1995) and on the Englishman River estuary in 1989 (Dawe & Stewart 2010).

Generally, the number of bird surveys, as well as birdwatching and reporting, have increased over time. It is important to keep this in mind when using historical data to examine growth in bird populations, as the populations may appear to be growing faster, when in fact they are merely being seen and reported more often.

In 1988, a pair and 3 goslings were sighted at Hamilton Marsh (RBCM files in Dawe & Stewart 2010). During the spring of 1995, members of the Parksville Qualicum Fish and Game Club observed up to 10 nesting pairs, some only 100 feet apart.

While geese nested on the hummocks in the marsh, they did not stay to raise their young there (Cousens, Lee, & Blood 1996; C. Lee and B. Cousens, pers. comm. 2014). Cousens and Lee (pers. comm. 2014)

attributed this to a lack of food suitable for goslings and to the threat of predation by raptors in the marsh. They suspected the families moved to nearby wetlands and adjacent agricultural fields, or possibly to saltwater. Near this time, local naturalist K. Fortune documented 120 Canada Geese at Hamilton Marsh during the winter (B. Cousens and C. Lee, pers. comm. 2014).

As early as 1989, populations were trending upward. From 1989 through 1993, CWS and MoE conducted autumn surveys of Canada Geese from Victoria north to Courtenay-Comox on Vancouver Island. They discovered populations in the Parksville-Qualicum area expanded from 497 to 953 (a 92% increase) during that four-year period (Dawe & Morrison 1989, 1990, 1994).

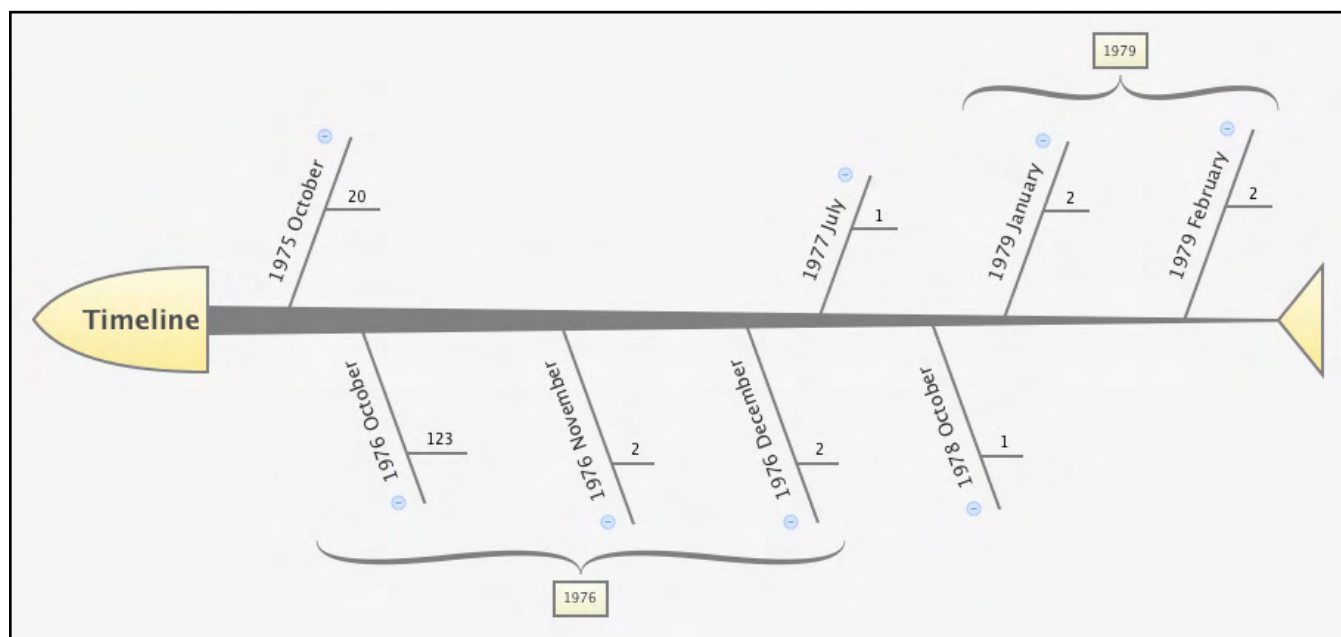


Figure 1-1. Canada Goose observations at the Little Qualicum River estuary, 1975-79. During weekly bird surveys, Dawe and Buechert (1995) found Canada Geese only 8 times.

1.3 First Management Efforts

In 1999, the Nature Trust of British Columbia (TNT) initiated discussions with stakeholders, concerned about the negative impacts of Canada Geese on its lands along Cowichan Bay, Nanoose Bay and the Englishman River. Meetings were held in 2000 and 2001 with provincial wildlife and agriculture ministries, farmers, and the District of North Cowichan, and with City of Parksville staff and councillors in 2003, in an effort to develop a coordinated goose management plan. City of Parksville staff admitted to being “inundated with political pressure to do something” about the geese in the community park (email, September, 2003).



The Pacific Black Brant is 'a friendly little sea goose', a blue-listed, migratory goose that is sometimes confused with the Canada Goose. Photos by Guy Monty.

Local government representatives and the public were confused about the difference between nuisance Canada Geese and Pacific Black Brant (*Branta bernicula nigricans*), a goose requiring protection from harassment while staging on the Parksville-Qualicum Beach Wildlife Management Area (PQBWMA).

Central to stakeholder discussions were concerns that localized harassment efforts (e.g., in city parks) using dogs or raptors would concentrate Canada Geese on vulnerable conservation lands (email, September, 2003).

TNT developed and gradually expanded an egg addling program

to reduce the number of Canada Geese recruited into local populations. The program first began in the Cowichan Valley, then included the Englishman River estuary in 2002, and the Nanoose and Bonnell estuaries in 2003 (Manning, Cooper and Associates 2003), and Little Qualicum River estuary by 2004. Also in 2003, Fairwinds Golf Course in Nanoose Bay was reported to have contributed funding for addling on small islands nearby (email, September, 2003). The responsibility for the egg addling program transitioned to the Guardians of Mid-Island Estuaries (The Guardians) when the society was formed in 2010.

1.4 Guardians Of Mid-island Estuaries Society

The Guardians of Mid-Island Estuaries Society (www.guardiansmie.org) was created to: 1) implement a pilot project that would increase the primary productivity of the Little Qualicum River and Englishman River estuarine marshes; 2) help agency partners effectively manage Canada Goose populations to enable the marshes to recover; and 3) support local communities in developing management plans and actions to reduce goose populations.

Since 2002, members of the Guardians have led efforts to reduce regional Canada Goose populations by addling (i.e., sterilizing) eggs and promoting additional hunting days and

increased bag limits. From 2008 to 2012, the Guardians and other volunteers banded and collared nearly 300 geese at the Englishman River, Little Qualicum River, and Craig Creek estuaries. We then surveyed both marked and unmarked Canada Geese in the region, to learn more about their seasonal abundance and use of the estuaries and other habitats.

The Guardians, on the heels of work completed by the Mid-Vancouver Island Habitat Enhancement Society (MVIHES) and retired CWS biologist Neil Dawe, have raised awareness of the adverse effects of Canada Geese on estuarine habitats.

As a result of presentations to local governments, television

appearances, videos, newspaper articles, seminars, meetings, poster presentations, and brochures, local communities are now much more informed of the impacts of Canada Geese. Chapter 5.1, Questionnaires and Interviews, describes the stakeholder consultation conducted in the preparation of this strategy. While this communication was not comprehensive, lacking both First Nations and public consultation, it demonstrated that numerous stakeholders, representing a variety of sectors, are aware of the need for a comprehensive Canada Goose management strategy.

1.5 Study Area



Part of the study area at French Creek, during the peak of the Pacific Herring spawn. Photo by Maggie Henigman and Rick Guthrie, March 6, 2009

This management strategy covers an area of land and sea corresponding to the lower elevations of Mount Arrowsmith Biosphere Region on east-central Vancouver Island, hereinafter referred to as the 'region' or our 'area'.

The boundaries of the study area roughly correspond to the lower elevations of Mount Arrowsmith Biosphere Region (MABR). This area is sometimes referred to as Oceanside, or the Parksville-Qualicum Beach area. MABR encompasses the islands of the Ballenas/Winchelsea Islands archipelago, a marine area to approximately 300 m below sea level, and several complete watersheds with headwaters on Mount Arrowsmith, Mount Moriarty, Mount Cokely, and the Nanoose peninsula (Clermont 2011) (Figure 1-2). The Little Qualicum River, Englishman River, and other streams meet the saltwater of the Strait of Georgia/Salish Sea in estuaries. The marshes of these estuaries are the focus of our study, although Canada Geese have been observed throughout much of the

marine area and terrestrial lowlands.

MABR is one of sixteen biosphere reserves/regions in Canada and one of 631 worldwide. Designated by the United Nations Educational, Scientific and Cultural Organization (UNESCO), biosphere reserves are mandated to test and demonstrate new and optimal practices to manage nature and human activities. Biodiversity and functioning ecosystems are considered fundamental to healthy communities and prosperous economies (Clermont 2011; UNESCO n.d.). In the spirit of biosphere scholarship, this document examines Canada Goose issues respecting the 'ecosystem approach' and its long-range, balanced view of management practices, policies, and legislation (cf. UNESCO, 2000).



Vancouver Island, British Columbia

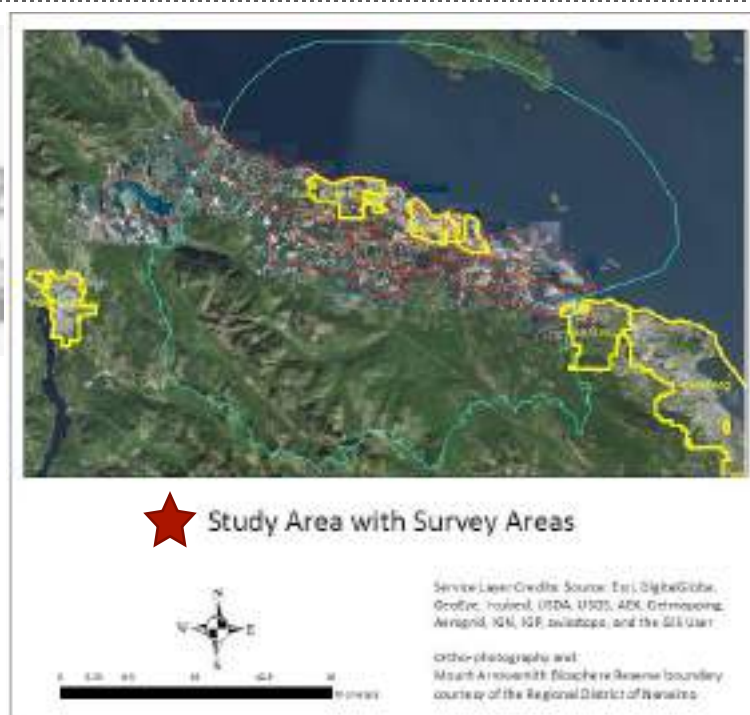


Figure 1-2. Study area. MABR boundary = turquoise, survey area polygons = red, and municipalities = yellow

Chapter 2 - Strategy Purpose and Goals Highlights

Purpose: To develop scientifically-based management solutions that reduce and control locally overabundant Canada Goose populations, thereby enabling the recovery of degraded estuarine marshes on mid-Vancouver Island.

Goal 1. Characterize Canada Goose populations and migrant types, and examine population trends to set population objectives.

Goal 2. Delimit Canada Goose 'seasons' and seasonal distributions to set temporal management objectives.

Goal 3. Define habitat types and identify Canada Goose hotspots to set spatial management objectives.

Goal 4. Examine management of Canada Geese in other jurisdictions and identify options appropriate for this region.

Goal 5. Integrate population, temporal, and spatial information and objectives into a strategic direction to inform management planning for the region.

2.1 Overview

While most other regional goose management strategies have been developed to reduce direct impacts to human habitats (e.g., damage to agricultural crops, clean-up of feces in urban green spaces, contamination of public swimming areas, hazards to aviation), the primary focus of this strategy is to facilitate the restoration of high quality fish and wildlife habitat. It aims to help estuarine marsh habitats degraded by the grazing and grubbing of locally overabundant geese.

Estuaries are naturally rare, comprising less than 3% of B.C.'s coastline (Pacific Estuary Conservation Program (PECP) 1999), and due to a variety of threats, several estuarine ecosystems are provincially ranked as

imperiled (S2) or of special concern (S3). There are at least 3 red-listed and 2 blue-listed ecosystems, or *ecological communities*, at the Little Qualicum River estuary, and at least 3 red-listed and 1 blue-listed communities at the Nanoose/Bonnell estuary (Dawe & White 1982; Kennedy 1982; Dawe & White 1986; B.C. CDC 2014, January; Clermont 2014). Red-listed Lyngbye's Sedge Herbaceous Vegetation (*Carex lyngbyei* Herbaceous Vegetation) ecosystems have been heavily impacted by Canada Geese (MVIHES 2009; Clermont 2011; Dawe et al. 2011).

Recovery of at-risk mid-island estuarine marsh communities is simply not possible without significantly reducing or controlling Canada Geese.

2.2 Purpose and Goals

The purpose of this strategy is to develop scientifically-based management solutions to reduce and control Canada Goose populations to halt degradation and support the recovery of mid-island estuarine marshes. There are five goals:

Goal 1. Characterize Canada Goose populations and migrant types, and examine population trends to set population objectives.

Goal 2. Delimit Canada Goose 'seasons' and seasonal distributions to set temporal management objectives.

Goal 3. Define habitat types and identify Canada Goose hotspots (i.e., areas where geese are frequently present or in high densities) to set spatial management objectives.

Goal 4. Examine management of Canada Geese in other jurisdictions and identify options appropriate for this region.

Goal 5. Integrate population, temporal, and spatial information and objectives into a strategic direction to inform management planning for the region.

A STRATEGY IS NOT A MANAGEMENT PLAN

It is important to note that this management strategy is not a management plan. A management plan is developed to gain approval by CWS prior to receiving permits to relocate or kill birds, or dispose of carcasses. A management plan should identify a specific site or sites, set a population target, outline an approach to achieve and maintain target numbers, and address public opinion. Although it has some attributes of a management plan, this management strategy provides the science for informed regional Canada Goose management, and introduces and recommends options for management.

We hope that the agencies, private landowners and others tasked with creating and implementing management plans are well served by the strategy.

Management plans are described in CWS' *Best Practices for Management Plans - Canada Goose and Cackling Goose Management*, at <https://www.ec.gc.ca/mbc-com/default.asp?lang=en&n=80E1F5DD-1>.

2.3 Towards an Estuarine Marsh Restoration Plan



Exclosures enable growth of Lyngbye's Sedge (*Carex lyngbyei*) and Seaside Arrowgrass (*Triglochin maritima*), species preferred by geese (upper). Sedges planted in denuded areas were protected from grazing with snow fencing (lower).

Implementation of this Canada Goose management strategy is necessary prior to the development of a comprehensive restoration plan for the area's estuaries. A draft plan was developed in May 2011 that outlined a framework of restoration principles and experimental design to rehabilitate the mid-island estuaries (Clermont 2011). Its goal was to increase the primary productivity of the Englishman River estuary (ERE) and Little Qualicum River estuary (LQRE), by re-vegetating denuded areas of the marshes with native species providing high quality habitat for rearing juvenile salmonids and wintering waterfowl. Later, the Craig Creek estuary (CCE) south of the ERE was found to be degrading as well. Restoration and data collection are well underway at the LQRE, and limited efforts have been made on the periphery of the ERE marsh. There have been no attempts to restore the CCE.

Eighteen 50 and 100 m² fenced exclosures were installed on the LQRE and ERE in 2010, to isolate areas from Canada Goose herbivory, and data were collected to quantify whether and how vegetation might recover if geese were excluded. At the LQRE, the exclosures appeared to screen the areas behind them, effectively protecting open areas from herbivory. In 2013 and 2015, sedge plugs were transplanted from healthy areas to denuded areas of the estuary and protected with snow fencing. During the Canada Goose moulting period, additional snow fencing was installed to screen and protect other parts of the estuary.

Early observations on the LQRE support the findings of MVIHES (2009) and Dawe et al. (2011) that areas outside of exclosures are subject to Canada Goose herbivory. Existing and future data will suggest the extent of recovery once Canada Geese are excluded, and the conditions (e.g., elevations, soil salinities) that are necessary to allow sedges and other vegetation to establish and spread in denuded areas. Additionally, an assessment of our restoration techniques may help evaluate the efficacy of various Canada Goose management alternatives (e.g., barriers to site lines and access to water, size of area needed to lift off).

A comprehensive restoration plan is needed, describing what has been learned and outlining next steps for estuarine marsh recovery at all three estuaries. Other local estuaries, including the French Creek estuary, and Nanoose Creek/Bonnell Creek estuaries (NBE) should be examined for damage and restoration potential.

Rehabilitation is the action of improving from a degraded state, while restoration is frequently defined as the act of restoring to an original state or an unimpaired condition. This strategy uses the definition of restoration provided by the Society for Ecological Restoration International (2004), i.e., the process of assisting the recovery of ecosystems that are damaged, degraded or destroyed.

Chapter 3 - Introduction to the Canada Goose Highlights

Prior to 2004, there were 11 recognized subspecies of Canada Goose in North America. They were subsequently split into 7 subspecies of large-bodied Canada Geese and 4 subspecies of small-bodied Cackling Geese. One of the large-bodied subspecies, the Dusky Canada Goose (*Branta canadensis occidentalis*), is provincially red-listed (ranked S2M). Cackling Geese (*Branta hutchinsii*) are a species of special concern (ranked S3M). The identification of distinct subspecies is difficult, complicated by numerous translocation programs and hybridization.

CWS and B.C. Ministry of Environment require assurance that efforts to control nuisance Canada Geese do not adversely affect vulnerable lookalike species. Migratory Dusky Canada Geese are believed at risk mainly due to earthquake-induced changes on their Alaskan nesting grounds, however not all Dusky Canada Geese are northern-breeding migrants. In the 1950s, Dusky Canada Geese were transplanted to Washington to establish a breeding population; some birds were moved to Oregon in 1971. There are now three types of Dusky Canada Geese recognized in Washington State: migrants, residents, and hybrids. In recent years, the populations and ranges for Cackling Geese have increased dramatically. No Dusky Canada Geese and few Cackling Geese were observed in our surveys from 2011 through 2014. Management of nuisance geese should have no significant impacts on these at-risk species.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

3.1 Taxonomy



Pair of Canada Geese on the Englishman River estuary. The goose is often smaller than the gander.

Members of different species or subspecies of Canada Geese may look the same. CWS and B.C. Ministry of Environment required assurance that management action for nuisance Canada Geese would not affect vulnerable lookalike subspecies.

Our study was partly motivated by concerns for the Dusky Canada Goose (*Branta canadensis occidentalis*), a subspecies of Canada Goose that is threatened with extinction. Kereki (2007) had identified our mid-island estuaries as important stopover sites for migratory Dusky Canada Geese that begin migration in poor condition, based on computer models that recognized the conservation designation of these estuaries.

The provincially red-listed Dusky Canada Goose is one of 7 taxonomically recognized subspecies of Canada Geese, which also includes Atlantic Canada Goose (*B. c. canadensis*), Hudson Bay Canada Goose (*B. c. interior*), Giant Canada Goose (*B. c. maxima*), Moffitt's (also called Western or Great Basin Canada Goose) (*B. c. moffitti*), Lesser Canada Goose (*B. c. parvipes*), and Vancouver Canada Goose (*B. c. fulva*) (Banks et al. 2004, Sibley et al. 2010). Of these, Dusky, Vancouver, the Pacific population of Moffitt's, and the occasional Lesser Canada Goose may be found in our region.

In 2004, 11 subspecies of North American Canada Goose were split into two species: the large-bodied group described above, and a small-bodied group now recognized as a separate species, the Cackling Goose (*B. hutchinsii*). Cackling

Geese are blue-listed in B.C. There are currently four subspecies of Cackling Goose, including one formerly known as the Cackling Goose, now the Cackling Cackling Goose, *B. h. minima*. Other Cackling Goose species include Richardson's Cackling Goose (*B. h. hutchinsii*), Taverner's Cackling Goose (*B. h. tavernii*), and Aleutian Cackling Goose (*B. h. leucopareia*) (Banks et al. 2004). Cackling, Taverner's, and Aleutian Cackling Geese may be found in our region.

Banded Dusky Canada Geese may have green or red collars, Moffitt's Canada Geese may have white or black collars, and Lesser Canada Geese may have blue or grey collars. Banded Cackling Geese may have yellow collars, and Aleutian Cackling Geese may have blue or grey collars (Warren 2006).

The Dusky Canada Goose is designated S2M, an imperiled migrant. Cackling Geese are designated S3M, a migrant of special concern (B.C. Conservation Data Centre 2014).



Cackling Geese are generally smaller than nuisance Canada Geese, which are typically descendants from large-bodied subspecies. Photo by Guy Monty.



Dusky Canada Geese can often be distinguished from nuisance Canada Geese by their dark breast.

Photos by Lyn Topinka, A Photographic Journal, Ridgefield National Wildlife Refuge, at http://ridgefieldbirds.com/TheRefuge/Birds/ridgefield_NWR_canada_goose.html.

The distinctions among these subspecies can be so subtle that few people can discern one from another (Howard Breen 1990). For example, Dusky Canada Geese share the dark colouration of Vancouver Canada Geese but are smaller. They are slightly larger than the Taverner's Cackling Goose, and have a broader wing. There is considerable variation within subspecies as well; for example, Dusky Canada Geese may be quite light to very dark (Warren 2006).

The Washington and Oregon Departments of Fish and Wildlife require hunters to take a goose identification course prior to permitting in certain areas, to ensure they can distinguish Dusky Canada Geese from other subspecies (see http://wdfw.wa.gov/hunting/canada_goose/). If they kill a Dusky Canada Goose, their permits will be confiscated (Washington and Oregon Departments of Fish and Wildlife n.d.; Warren 2006).

However, the recognition of distinct subspecies has been clouded by numerous translocation programs. It is well established that hybrid geese, derived from stocks of several different races, were introduced to Vancouver Island and the Lower Mainland (MoE 1979; Dawe & Stewart 2010). In B.C., relocations of Canada Geese were taking place as late as 1991 (Campbell et al. 1990; Dawe & Stewart 2010). Genetic mixing may have occurred to such an extent that only long-distant migrants (i.e., those that nest in northern B.C, the territories, or Alaska) may be considered pure subspecies.

Range and seasonal distribution are often used to tell one subspecies from another. Yet, for some subspecies, distribution has never been clearly defined (cf. Subcommittee on Pacific Population of Western Canada Geese 2000). The distributions of Canada Geese and Cackling Geese are dynamic, shifting frequently and rapidly in response to climate, food supplies, and alterations to habitat (Howard Breen 1990; Sibley et al. 2010). The winter range of Cackling Cackling Geese shifted northward in the 1990s from California to western Oregon, for example (Sibley et al. 2010).

The Pacific Flyway Council (2008) described the effort to protect Dusky Canada Geese while managing other, abundant subspecies on the wintering grounds as time-consuming, controversial, and expensive. Restrictive hunting seasons implemented in the U.S. since the 1980s are believed to have dramatically reduced the mortality rate of Dusky Canada Geese, but also increased survival rates for other geese (Washington and Oregon Departments of Fish and Wildlife n.d.).

3.11 Dusky Canada Goose (*B.c. occidentalis*)

Dusky Canada Geese breed and moult in Alaska, and migrate through southeastern coastal Alaska and coastal B.C., to and from wintering areas in Washington and Oregon. There, they mingle with up to seven subspecies of Canada Geese and Cackling Geese that look

similar (Bromley & Rothe 2003; Oregon and Washington Departments of Fish and Wildlife n.d.; B.C. Conservation Data Centre 2014). Dusky Canada Geese rely on estuarine and freshwater habitats during migration and agricultural crops in winter (Bromley & Rothe 2003). They readily use small fields, even those enclosed by trees.

Dusky Canada Geese are commonly less wary than other subspecies, adding to their vulnerability (Washington and Oregon Departments of Fish and Wildlife n.d.; Warren 2006).

Over the years, some Dusky Canada Geese collared in Alaska were discovered on Vancouver Island in autumn. Many wintered on the Saanich Peninsula (Macgregor 1993, Vanderpol 1997 in Bromley & Rothe 2003; Pacific Flyway Council 2008). In the late 1950s, Dusky Canada Geese were transplanted to Willapa Bay, Washington to establish a breeding population at the wildlife refuge there; some of these birds were moved to Oregon in 1971. Three types of Dusky Canada Geese are now recognized in Washington State: migrants, residents and hybrids (Bromley & Rothe 2003). Given this history, some Dusky Canada Geese likely pass through or linger in our area, although none were documented in our surveys.

The red-listed status of Dusky Canada Geese is primarily due to reductions in nesting habitat resulting from an earthquake in 1964. Subsequent predation had a major impact on Dusky production (Warren 2006). Increasing competition from other geese, and hunting mortality on the wintering grounds are also cited as

contributing factors (Bromley & Rothe 2003). The global (G5T3, T for intraspecific taxa) and provincial (S2M) ranks were assigned in 2008 and 2009, respectively (B.C. CDC 2014).

3.12 Vancouver Canada Goose (*B.c. fulva*)

Vancouver Canada Geese breed along the coast from southeastern Alaska to northern B.C. (Campbell et al. 1990). Some breed on northern Vancouver Island (G. Monty, pers. comm. 2008). They winter mainly in B.C. and Washington (Washington and Oregon Departments of Fish and Wildlife n.d.).

Many are non-migratory or migrate only short distances (Campbell et al. 1990; Howard Breen 1990; Washington and Oregon Departments of Fish and Wildlife n.d.).

3.13 Moffitt's (Western) Canada Goose (*B.c. moffitti*)

The Pacific population of Moffitt's Canada Geese nests and winters west of the Rocky Mountains from northern Alberta and B.C. through the Pacific Northwest to California (CWS Waterfowl Committee 2013). Non-breeding birds are known to moult-migrate as far as the Northwest Territories (Subcommittee on Pacific Population of Western Canada Geese 2000).

The Pacific population has dramatically expanded its breeding range, and its size continues to increase; it was estimated at 221,600 geese in 2012, 11% higher than the year before (Subcommittee on Pacific

Population of Western Canada Geese 2000; USFWS 2013).

Moffitt's Canada Geese are comprised of migratory and non-migratory elements. The non-migratory segment, now concentrated in Greater Victoria and the Lower Mainland, probably spread from more eastern habitats or were introduced (CWS Waterfowl Committee 2013; Warren 2006).

Moffitt's Canada Geese tend to occur in groups apart from other subspecies (Warren 2006). Aside from this, this subspecies is probably indistinguishable from the offspring of introduced Canada Goose hybrids, many of which have arisen from Moffitt's Canada Geese (G. Monty, pers. comm. 2008). (Canada Geese have also been known to hybridize with domestic geese (cf. Ray 2011).)

3.14 Lesser Canada Goose (*B.c. parvipes*)

Lesser Canada Geese nest in the Yukon and Alaska. They are common in winter in eastern Oregon and Washington, but less abundant along the coast (Washington and Oregon Departments of Fish and Wildlife n.d.). They are highly adaptable and can be found in urban areas (Warren 2006).

3.15 Cackling Cackling Goose (*B.h. hutchinsii*)

Cackling Cackling Geese breed in western Alaska (Campbell et al. 1990; Warren 2006). In recent years, there has been a pronounced northerly shift of wintering birds away from California into Oregon and

Washington (Washington and Oregon Departments of Fish and Wildlife n.d.). Although populations have been stable for a few years, they have fluctuated dramatically since the 1960s (Warren 2006).

Most spring migrants pass through B.C. between mid-April to mid-May. Most autumn migrants bypass the B.C. coast entirely (Campbell et al. 1990). A few winter locally (G. Monty, pers. comm. 2008). They have been recorded in B.C. from August 8 to June 5 (Campbell et al. 1990). Cackling Geese are wary, preferring open areas. They will, however, use urban park habitats (Warren 2006).

3.16 Taverner's Cackling Goose (*B.h. tavernii*)

Nesting Taverner's Cackling Geese are broadly distributed across western Alaska. They winter in northwest Oregon and southwest Washington. Occasionally, Taverner's Cackling Geese will winter in our area. One individual was reported in Parksville

Community Park in January 2008; it was very small and easily differentiated from other geese (G. Monty, pers. comm. 2008). In Washington and Oregon, the subspecies increased from fewer than 2,000 in the 1970s to more than 50,000 [no date provided]; Northwest Oregon and southwest Washington are now wintering more Canada and Cackling Geese than at any other time in recorded history (Washington and Oregon Departments of Fish and Wildlife n.d.).

3.17 Aleutian Cackling Goose (*B.h. leucopareia*)

Aleutian Cackling Geese nest on the Aleutian Islands in Alaska, and winter mainly in California. Small populations winter along the Washington and Oregon coasts; they are commonly found with Cackling and Taverner's Cackling Geese (Washington and Oregon Departments of Fish and Wildlife n.d.; Warren 2006). Aleutian Cackling Geese have been seen locally in the fall and winter, but only rarely (G. Monty, pers. comm. 2008).



Canada Goose and smaller Cackling Goose, Englishman River estuary. Photo by Tim Clermont.

3.2 Food Preferences

Canada Geese are selective herbivores. They alter their feeding behaviour to meet seasonal nutritional requirements through habitat selection, and more specifically, by discriminating among plant species, among individual plants of the same species, and among different parts of the same plant (Conover 1991; Winn 2001). There is considerable evidence that local foraging and migration patterns closely track plant growth and phenology (e.g., moving from a pasture to a salt marsh when availability of protein on the marsh equals or exceeds that of the pasture) (cf. Winn 2001).

Some authors believe Canada Geese select plants that supply high levels of protein, carbohydrates, or fats, depending on their needs at the time (USDA 1999; CWS 2010). In general, they seek protein in spring and summer, and carbohydrates and fats in autumn and winter (Winn 2001). However, several studies suggest that selection is not always correlated to nutritional characteristics, but to palatability. They prefer plants which can be pulled apart with little force, have a high water content, and a low ash content (Conover 1991). In other words, they like plants that taste good, and are easy to eat and digest.



Lyngbye's Sedge (*Carex lynbyei*)

The quantity and quality of dietary protein are often considered limiting, because the availability of protein-rich foods fluctuates during critical periods (such as during egg formation), and geese are unable to store protein in a concentrated and labile (i.e, easily altered) form. Geese obtain protein for reproduction primarily from the foliage of grasses, sedges, and forbs, but also from the roots and rhizomes of wetland plants (Krapu & Reinecke 1992).

Geese have an inefficient digestive system; vegetation passes through the gut in two to four hours, leaving large fragments intact (potentially spreading seeds). Time spent feeding is a function of both forage quality and foraging opportunity. Studies show geese spend, on average, 60-70% of their time feeding. Night feeding is particularly evident during periods

of disturbance (Winn 2001).

In the course of our study, Guardians personnel observed grazing Canada Geese in local estuaries during spring and summer and documented what they were eating. Geese chose young, tender Lyngbye's Sedge (*Carex lynbyei*) and Seaside Arrow-grass (*Triglochin maritima*) along the edges of the channels. If these were absent or too tall, they progressively selected less palatable species. On the Englishman River estuary, in areas where Lyngbye's Sedge and Seaside Arrow-grass have been absent for many years, geese grazed on Dunegrass (*Leymus mollis*) in late summer; this grass is coarse, offers comparatively little nutritional value, and often grows to 150 cm in height. Canada Geese also grubbed rhizomes, roots, and seeds along the channel edges.



Family of Canada Geese exiting a Lyngbye's Sedge channel edge community.

In nearshore marine habitats, eelgrass (*Zostera spp.*) was favoured whenever it was accessible, generally at lower tides or if found floating. Along the wrack line, geese chose eelgrass and Sea Lettuce (*Ulva lactuca*). They did, however, eat many other types of aquatic plants.

Away from the estuaries, geese flocked to fertilized, mowed, and watered grassy areas. Less often, they fed in less manicured

areas. In the spring, recently planted hayfields or pasture, cereal and legume crops, and some types of vegetable crops were also favoured. In the fall and winter, they fed on grains, forage crops, and corn (survey respondents; cf. CWS 2010).

While geese may favour certain plants, they also avoid others. After the City of Parksville replaced the grass on one of its sports fields with grass turf over a

sandy substrate, use by geese plummeted (A. Metcalf and W. Payne, pers. comm. 2014). In feeding trials with captive geese, Conover (1991) found that geese refused to eat Common Periwinkle (*Vinca minor*) and English Ivy (*Hedera helix*), invasive ground covers. He attributed this avoidance to the presence of secondary metabolites. (Note: we do not recommend planting invasive species to control geese.)

3.3 Habitat Preferences

Canada Geese occupy habitats on and near tidewater and freshwater, from temperate regions to tundra (Banks et al. 2004). Their large body mass allows them to reside in moderately cold climates, year-round (USDA 1999). They regularly use agricultural lands, pastures, and meadows (Granholt 1988). They make use of many man-made structures, including dykes, irrigation ditches, and sewage lagoons. Canada Geese are increasingly found on lawns, golf courses, parks, and sports fields in urban areas (Campbell et al. 1990; USDA 1999; Banks et al. 2004). Areas without hunting, near large fields for feeding, and fresh water for drinking are ideal (Howard Breen, 1990).

As a rule, Canada Geese are highly adaptable (MoE 1979). A nest found in the Nanoose Bay area, far from open water on a stump at the edge of a forestry

road, is testament to this versatility. However, geese will more typically choose to nest in secluded areas near water, preferably on sites with partial concealment for the incubating female, space for the gander to loaf, and good visibility (Granholt 1988). On the estuaries, geese consistently nest on stumps and other large woody debris just out of reach of tidal action. Islands often have high densities of ground nests, as they offer additional protection from predators and disturbance.

In *Birds of British Columbia*, 62% of 1,244 reported nests were found on islands, and 27% were on the edge of other waterbodies, most notably marshes, lakes, or slow-moving rivers. Almost all nests were within 60 m of water, but one nest was 1.6 km from water (Campbell et al. 1990).

Most nests (64%) were built on the ground. Others were in former raptor nests, on muskrat or beaver

lodges, on artificial nesting structures, or on other man-made structures such as pilings, bridges, and buildings (Campbell et al. 1990). Nests can be a metre in diameter, and usually consist of grasses with other vegetation (CWS 2010).

Whereas good visibility is a prerequisite for nesting birds, adults with goslings screen themselves from predators by vanishing into tall grasses and other vegetation.



Canada Geese prefer feeding and loafing areas with unobstructed views, adjacent to water.



Canada Goose nest on the Englishman River estuary. Nests were often partly concealed by logs, stumps, and other Large Woody Debris (LWD).

Outside of the nesting season, both land and water are used for loafing and sleeping; resting on the water protects geese from terrestrial predators.

During the moult, when Canada Geese are growing new flight feathers and cannot fly, geese gather in small and large flocks in estuaries, along the foreshore, and on larger freshwater bodies where they can more easily escape terrestrial predators and other threats. They rest on adjacent fields, tidal flats, gravel bars, or expanses of bedrock that are usually free of dogs and other perceived threats. When the birds

are able to fly, some will feed in upland areas during the day or early evening, returning to roost on or beside the water.

The perceived threat of disturbance is fundamental to their use of habitats. Disturbances, particularly new ones - such as the onset of a canine control program, cause geese to move from one site to another. They readily adjust to regular disturbances once they understand them to be of little threat, but will never completely lower their guard. For example, moulting geese may rest in busy resort areas, but only where there is a clear escape route.



Canada Goose nest adjacent to tidewater

Chapter 4 - Current Regulatory and Policy Framework

Highlights

The Pacific Flyway Council has prepared management plans for Pacific populations of most Canada Goose subspecies (i.e., Dusky, Vancouver, Aleutian, Lesser, Taverner's, Western) and Cackling Geese. Some plans are long outdated (e.g., 1979). The 2000 Western (Moffitt's) Canada Goose plan, which may best reflect the composition of our regional population, set 3-year population index objectives and advocated for stable funding for landowner assistance programs, and urban management plans with community input and population monitoring components. CWS does not use Pacific Flyway groupings for management purposes, and it remains unclear whether any of these plans are appropriate for managing hybrid Canada Geese, which probably make up most of our regional population.

In this strategy, Canada Geese are described as 'locally overabundant' because 'overabundance' is a legal term in the *Migratory Birds Regulations*. In Canada, Canada Geese have not been designated as overabundant or even formally evaluated. During the evaluation process, distribution and abundance are compared to CWS objectives for the species, and damage and risks posed by the species are assessed. Although population objectives refer to temperate-breeding Canada Geese, an overabundance designation would apply to the entire species, including Dusky Canada Geese.

Snow Geese and Ross's Geese were designated as overabundant when overgrazing and grubbing caused changes in salt marsh plant communities. The *Migratory Birds Regulations* were amended to enable the use of exceptional hunting methods and equipment. The growth of Greater Snow Goose populations were quickly halted, although the special measures did not reduce the size of populations. It is too soon to tell whether the designation has affected Ross's Goose population growth and abundance.

In the U.S., resident Canada Geese in the Atlantic and Mississippi Flyways are designated as 'overly abundant (OA)' and 'Birds of Management Concern'. Canada Geese along the Pacific Flyway are not designated overly abundant, but are still 'Birds of Management Concern' as 'high priority gamebirds'.

Since 2011, CWS is more apt to issue damage and danger permits to landowners and land managers experiencing problems with Canada Geese. This is a departure from earlier policies that required applicants to exhaust all other avenues of control.

Permittees or their designates generally cannot use decoys, calls, blinds, or bait, because the killing of birds under most damage and danger permits is to reinforce the scaring of birds, not to reduce the population. Decoys, calls, blinds and bait are hunting methods that entice birds, rather than scare them away.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 4 - Current Regulatory and Policy Framework

More Highlights

For CWS, relocation remains an acceptable option for goose management, despite its role in creating the current situation. Relocation permits may be allowed to move birds from non-hunttable to hunttable areas, after alternative methods of control have been attempted. Permit holders are required to find landowners who will accept the birds.

The Province has a somewhat ambiguous role with respect to Canada Goose management. Federal Migratory Game Bird Hunting Permits and Canadian Wildlife Habitat Conservation Stamps to hunt Canada Geese are dispensed by the Province and licensed vendors. Provincial wildlife staff are rarely involved in issuing other types of permits for Canada Geese, deferring to CWS. However, the Province may choose to become involved where staff are subject to public enquires or for other reasons, and the provincial wildlife veterinarian must be included in any plans to cull geese.

Using a firearm, aircraft, or bird of prey to scare Canada Geese requires a permit from CWS. However, other scare techniques do not need a permit, including the use of supervised dogs. To avoid injury to flightless birds, dogs should not be used from May 1 through July 31. Depending on the scare technique and the bylaws of the jurisdiction, municipal permits may be needed also.

CWS requires local governments and other organizations to complete Canada Goose management plans prior to the issuance of some permits. While management plans may be helpful for many reasons, they are a policy tool, rather than a legislated requirement.

The *Migratory Birds Convention Act, 1994* requires hunting for migratory game birds to be closed from March 10 to September 1, and further restricts hunting to a period not exceeding 3.5 months, or 107 days. To increase the harvest of Canada Geese, hunting seasons were adjusted from two to three seasons in 1998-99, and from three to four seasons in 2007-08. Larger bag and possession limits were implemented in 2012.

The migratory game bird hunting regulations are reviewed every second year. Individuals and groups interested in amending the regulations, (including designating Canada Geese as overabundant), may submit proposals or requests to CWS or the Province. Contributions submitted in 2015 will be considered for inclusion in the 2016-17 regulations.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 4 - Current Regulatory and Policy Framework

More Highlights

In general, provincial legislation closes all cities, municipalities, and regional district parks and trails to the discharge of firearms unless specifically exempted. CWS encourages regulators to enable hunting wherever geese are a problem and public safety is not an issue.

Fewer people are opposed to culling of nuisance geese when they are eaten by humans or other animals. Canada Geese culled in the U.S. are routinely provided to food banks. Although other game animals have been culled, processed, donated, and even sold and exported, and our provincial agencies support the use of culled meat - particularly by disadvantaged individuals, there have been several barriers preventing the consumption of non-hunted Canada Geese in Canada. CWS has claimed that by not allowing the birds to be eaten, birds are killed because they are causing damage and not for the purpose of providing hunting opportunities outside of the regular hunting season. Where appropriate, people are encouraged to leave carcasses in the open as a deterrent to other geese, although this is not a regulatory requirement. There are now revisions proposed to the *Migratory Birds Regulations* that would allow consumption of culled geese, requiring the development of standards with public health and food inspection agencies. A made-in-B.C. solution may also be possible, should the provincial inspection program take the lead and donated meat remain in the province.

The Parksville Protocol amended the *Migratory Birds Convention Act* to enable First Nations to harvest migratory birds and their eggs throughout the year; to sell down and non-edible by products; to barter, exchange, trade birds and eggs with other Aboriginal communities; and to sell birds and eggs to other Aboriginal communities. The *Migratory Birds Regulations* have not yet been changed to reflect the amendments to the *Act*, however proposed changes are currently in revision, and contemporary treaty agreements reflect this wording. Under an agreement between senior governments and the Maa'nulth First Nation on Vancouver Island, a person exercising the right to harvest must not waste the edible and usable parts of any migratory bird.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

4.1 Jurisdiction

As migratory birds, Canada Geese are under the jurisdiction of the Government of Canada and more specifically CWS, in accordance with the *Migratory Birds Convention Act, 1994* and other international agreements. Canada Geese are also managed within the purview of the

provincial *Wildlife Act, 1996*; i.e., its definition of wildlife includes game, and migratory birds generally. Provincial regulations for migratory birds may be more, but not less, restrictive than federal regulations. Generally, the Province does not alter federal regulations (S. Pendergast, pers.

comm. November 24, 2014). The Pacific Flyway Council works with federal bodies (i.e., CWS and USFWS) to review data and set regulations and policies for migratory birds in western North America.

4.2 Pacific Flyway Council

The Pacific Flyway Council contributes to annual hunting regulations and other management initiatives. The Council includes one representative from each state and province along the flyway, and an ex-officio federal representative for each country (i.e., U.S., Canada and Mexico). There are also two technical committees with a similar structure, for game and non-game birds. The public can contribute to Pacific Flyway Council activities through provincial or state representatives. Currently, the Ministry of Environment's Provincial Bird Specialist is B.C.'s representative, and CWS' Wetland Bird Biologist is Canada's representative.

The Council has prepared management plans for Pacific populations of most Canada Goose subspecies (i.e., Dusky, Vancouver, Aleutian, Lesser, Taverner's, Western) and Cackling Geese, as well as a *Northwest Oregon/Southwest Washington Canada Goose Agricultural Depredation Control Plan*. Many plans are outdated.

CWS treats most Vancouver Island birds as Moffitt's (or Western) Canada Geese or hybrids of these (M. Chutter, pers. comm. February 2, 2015). In the Western Canada Goose management plan, there were 3-year population index objectives specifying the level below which harvest restrictions should be considered,

and the level above which harvest rates should increase (Subcommittee on Pacific Population of Western Canada Geese 2000). The plan advocated for stable funding for landowner assistance programs, and urban management plans with community input and population monitoring components.

Management plans and other documents are available at <http://www.pacificflyway.gov/Management.asp>. However, CWS staff asserted that Canada does not recognize or use Pacific Flyway groupings for management purposes (A. Breault, pers. comm. February 2, 2015). It appears they are a U.S. construct.

4.3 Migratory Birds Convention Act

The *Migratory Birds Convention*, a 1916 treaty between Great Britain (for Canada) and the U.S., was the precursor to the present *Migratory Birds Convention Act, 1994*. The Act protects and conserves Canada Geese and other waterfowl, and authorizes Environment Canada's CWS to establish regulations in cooperation with provincial governments.

Article IV authorizes "such measures as may be necessary to control the introduction of live animals... which could disturb the ecological balance of unique island environments", in this case the estuarine marshes of Vancouver Island.

4.4 Migratory Birds Regulations

The *Migratory Birds Regulations* delimit specific requirements of, and exceptions to, the *Migratory Birds Convention Act, 1994*. Schedule I identifies seasons, bag and possession limits, and measures for overabundant species. Schedule II identifies the types of permits available and their costs. For some, the permitting processes are onerous (interviewees, pers. comm. 2014).

4.41 Overabundance

In this strategy, we use the term ‘locally overabundant’ (rather than ‘overabundant’) to describe our problem of ‘too many geese’. We do so because ‘overabundance’ is a legal term in the *Migratory Birds Regulations*.

CWS (2011, p. 11) noted that “In the United States, resident Canada Geese have been declared overabundant”, however this is only partly accurate. The U.S. Fish and Wildlife Service (USFWS) designates a subset of the species protected by the *Migratory Bird Treaty Act, 1918* as ‘Birds of Management Concern’. “To be of management concern, a bird must be a high priority gamebird, on the Birds of Conservation Concern 2008 list [for which Canada Geese are not eligible, as they are a hunted gamebird (USFWS 2008)], a federal threatened or endangered species listed in the U.S., or overly abundant (OA) leading to management conflicts” (USFWS 2011). Only Canada Geese in the Atlantic and Mississippi Flyways are designated as ‘overly abundant’, while the Pacific Flyway geese are not; Pacific Canada Geese are, however, a high priority gamebird (J. Sands, pers. comm. February 17, 2015).

In Canada, Canada Geese have not been designated as

overabundant or even formally evaluated. During the evaluation process to establish overabundance, distribution and abundance are examined and compared to CWS objectives for the species. Damage and risks posed by the species are assessed (CWS 2011). When a species is injurious to, or threatens, environmental, agricultural, or other similar interests, and is designated as overabundant, additional opportunities for harvest can be explored. For example, new hunting seasons and additional hunting methods or equipment may be allowed.

Presently, Canada Goose numbers exceed population objectives in several parts of Canada (CWS 2011). The ‘regional’ population objective for temperate-breeding Canada Geese in southern B.C. was 10,000 to 15,000 geese in 2011–2012, based on an estimated 17,000 geese (Lok 2011; Hughes 2012).

Regional population objectives for temperate-breeding geese must meet Environment Canada’s conservation goals, be consistent and integrated with existing Canada Goose management programs, be measurable, have clearly defined spatial boundaries, be completed at a provincial scale (i.e., not more than one objective per province), and consist of a range of acceptable values -

recognizing there is a level of scientific uncertainty inherent in population estimates. Population numbers are expected to fluctuate for reasons within and beyond the control of wildlife managers (E. Lok, pers. comm. December 1, 2014).

The *Migratory Birds Convention Act, 1994*, Article II, recommends the “management of migratory birds on a population basis”. Regional population objectives are determined for the Maritime provinces, southern Quebec, southern Ontario, southern prairie provinces and southern B.C. Yet, this begs the question, ‘what is a population?’ For all intents and purposes, Canada Geese in these regions do not comprise a single goose population; rather, many populations of various subspecies, hybrids, and area-based subpopulations are included. CWS asserts that broad population objectives are an advantage for managing large goose populations; if Environment Canada’s conservation objectives are met by having plenty of birds to sustainably hunt, then it is easier to argue for higher bag limits or to consider permit applications to remove or kill birds. If population objectives were developed on a finer scale, Canada Geese would be more difficult [and expensive] to monitor and evaluate.

CWS suggested developing more specific objectives in local management plans that work within the Environment Canada population objective and management framework (E. Lok, pers. comm. December 1, 2014).

Under the *Migratory Birds Convention Act*, all Canada Geese are considered the same species, with no regard for subspecies or subpopulations. The population objectives refer to 'temperate-breeding Canada Geese', but an overabundance designation would apply to all Canada Geese in Canada (E. Lok, pers. comm. December 1, 2014).

Notably, Snow Geese (*Chen caerulescens*) and Ross's Geese (*Chen rossii*) were designated as overabundant when overgrazing and 'over-grubbing' caused changes in salt marsh plant communities to such a degree that they could not be restored (Batt 1997; Calvert et al. 2007).

Canada amended the *Migratory Birds Regulations* in 1999 and created special conditions within which hunters could use exceptional methods and equipment such as electronic calls and bait to take more Snow Geese. Habitat management regimes on some refuges were changed to increase exposure to hunting. The special measures were first implemented in selected areas of Quebec and Manitoba, then expanded into Saskatchewan and Nunavut in 2001, and into southeastern Ontario in 2012 (CWS 2013, November, December).

The Greater Snow Goose

Working Group found the overabundance designation and subsequent liberalization of hunting rules quickly halted the growth of Greater Snow Goose populations (Calvert et al. 2007). However, the special measures did not reduce the size of the population (Anonymous 2013).

CWS proposed the federal government designate the Ross's Goose as overabundant in June, 2013, although the U.S. applied a similar designation to the species in 1999 (McConnell 2013). In 1999, the Animal Alliance of Canada, Animal Protection Institute, Canadian Environmental Defence Fund, Dene Nation, and Zoocheck Canada won a court decision to protect Ross's Geese from overabundance regulations, as it had not been sufficiently demonstrated that this species was contributing to habitat damage [Animal Alliance of Canada v. Canada, 1999]. This decision effectively delayed the implementation of controls and led to more habitat damage (CWS 2013, December).

To date, environmental damage has been the only rationale successfully used to apply the designation. "Although there is evidence that Canada Geese are causing ecological damage in B.C. (mid-island estuaries, Gulf Islands etc), this is not necessarily the case in all places where Canada Geese occur. Given these challenges, the process [of designating Canada Geese as overabundant] hasn't been initiated. There is also the consideration that there are other regulatory tools (damage and

danger permits for example) that might be more applicable on a regional/local scale" (E. Lok, pers. comm. December 1, 2014).

CWS biologists believe that the special measures enabled by an overabundance designation would do little to address Canada Goose impacts, as large scale patterns across BC. and more generally throughout North America show that the numbers of hunters and the areas where people are allowed to hunt are declining (K. Fort, E. Lok, pers. comm. November, December 2014).

Nonetheless, individuals and groups interested in amending the regulations for Canada Geese may submit proposals or requests to CWS and/or the Province through their regional biologists. Contributions submitted in 2015 will be considered by the B.C. Waterfowl Technical Committee for inclusion in the 2016-17 regulations. The process is described at <http://www.ec.gc.ca/rcom-mbhr/default.asp?lang=En&n=6DE5A330-1#ee>.

4.42 Airport Permits

Permits are readily available, on request by airport owners and managers, to reduce the risk of Canada Goose collisions with aircraft. Permittees may scare or kill geese, and destroy eggs to reduce numbers of nesting geese on airport property. CWS recommends airport authorities develop a Canada Goose management plan in cooperation with local government(s) (CWS 2011).

4.43 Damage or Danger Permits

Prior to 2011, CWS resisted aggressive management of temperate-breeding Canada Geese, to rigorously protect the Dusky subspecies. In 2011, a website, handbook, and best practices guidelines were developed. Although concerns for the vulnerable subspecies remain, better data for both temperate-breeding and Dusky Canada Geese now support decision-making processes, including the distribution of damage and danger permits (E. Lok, pers. comm. December 2, 2014). For example, in 2010, applicants wishing to obtain a kill permit were required to demonstrate the persistence of the problem after all other reasonable management options had been attempted (CWS 2010). Today, damage permits may be issued to landowners and land managers suffering serious property or crop damage from Canada Geese, if scaring has been unable to prevent such damage. Danger permits may be issued to minimize a danger to health or safety, e.g., to prevent contamination of drinking water sources.

There are 4 types of damage or danger permits: 1) scare using a firearm or aircraft; 2) kill to scare; 3) kill; and 4: relocation. Kill permits allow the destruction of eggs or killing of birds.

For damage permits, areas must be open to, or the permittee must have received an exemption for hunting and/or discharge of firearms.

CWS strongly recommends using a damage permit in conjunction with a hunting permit when feasible, and only use the damage permit when hunting is not available (E. Lok, pers. comm. February 2, 2015).

The landowner or manager may name other individuals or companies to carry out the activities specified in the permit. In general, permittees or their designates cannot use decoys, calls, blinds, or bait, nor can they discharge firearms within 50 m of any water area. The killing of birds under most damage or danger permits is to reinforce the scaring of birds, not to reduce the population, and blinds and calls are hunting methods that entice birds, rather than scare them away.

CWS permit applications are available at <http://www.ec.gc.ca/nature/default.asp?lang=En&n=677AEBD4-1>. Permittees are required to report their activities to Environment Canada (CWS 2010).

Prior to submitting any permit application, CWS urges people to consult the *Handbook - Canada and Cackling Geese: Management and Population Control in Southern Canada*. This is a how-to manual designed to help landowners and others manage conflicts with geese. Permit applicants are asked to review *Best Practices for Destroying Eggs or Preventing Hatching - Canada Goose Management*, and *Best Practices for Killing Birds and Disposing of*

Carcasses - Canada Goose Management. These documents may be accessed at <http://www.ec.gc.ca/mbc-com/default.asp?lang=En&n=6D2B893B-1>.

Given the origins of the Canada Geese problem in this region, it is inconceivable to us that relocation of birds may be entertained as a management option. However, relocation permits for birds causing damage or danger are still available. Importantly, the MFLRNO does not consider relocation a suitable option for goose management (S. Pendergast, pers. comm. December 2, 2014).

Relocations often lead to nuisance problems in new areas, and may introduce or spread disease. Birds may simply return (Subcommittee on Pacific Population of Western Canada Geese 2000; CWS 2010). Still, *Best Practices for Capturing, Transporting and Caring for Relocated Canada Geese - Canada Goose Management* is available to help potential applicants understand whether relocation is a viable alternative. According to CWS, relocation permits may be allowed to move birds from non-hunttable to hunttable areas. Prior to any relocation, alternative methods of control must be attempted. Permit holders are required to find someone who will accept the birds, which has been an increasingly difficult challenge (E. Lok, pers. comm. December 1, 2014).

Some time ago, provincial permits were also required for destroying, possessing, and transporting geese or goose eggs, however this is no longer the case. The MFLNRO now sends all permit requests for Canada Geese to CWS. Provincial staff become involved in cases where staff may be subject to public enquires or questioned as to their stance on a specific issue (e.g., participating in group discussions where culling of geese is being considered). The provincial wildlife veterinarian must be involved in such cases, to ensure appropriate handling and euthanasia protocols are used, and all standards of animal care are met (S. Pendergast, pers. comm. November 24, 2014).

4.44 Scare Permits

To use a firearm (even with cracker shells or screamers) or aircraft (including drones and remote-controlled hobby planes or helicopters) for the purpose of scaring Canada Geese, a CWS damage or danger permit is required.

If the intent is to kill, and not scare Canada Geese, then a kill permit is required. Kill permits are also required when using birds of prey to scare geese, as these birds have the instinct to kill. It is not permissible to kill or wound birds while scaring them (CWS 2010).

However, any person may, without a permit from CWS, scare migratory birds that are causing or are likely to cause damage to crops or other property, using equipment other than firearms or

an aircraft.

An applicant need not be a landowner or land manager to be issued a permit to scare Canada Geese. Applicants may name assistants to carry out hazing activities.

CWS does not issue permits to use dogs to scare geese. However, if a bird is injured or killed by a dog, it must be reported to Environment Canada. To avoid potential injury, dogs should not be used from May 1 through July 31, as birds may be flightless or a less mobile family group. To use dogs during this period, a provincial permit may be required; a regulation to enable this is under development (S. Pendergast, pers. comm. February 3, 2015). At other times of year (August 1 through April 30), provincial permits are unnecessary, but the dogs must be kept under constant supervision. There are also special restrictions in the Parksville - Qualicum Beach Wildlife Management Area.

Municipal permits may be required to disturb Canada Geese, depending on the bylaws of the jurisdiction and the type of disturbance.

4.45 Management Plans

Although CWS has stated it may require a management plan prior to issuing permits (CWS 2010), management plans are not legislated requirements of any permitting process, i.e., they are not specified in the Act or regulations as prerequisites for permits to control geese. However, CWS, as a policy measure, may

require a management plan, particularly if large numbers of geese are expected to be killed (CWS 2011). A plan may also streamline the permitting process for large landowners with Canada Goose conflicts on several sites. Recommended for local governments, golf courses, and large farms undertaking multiple goose control activities, management plans are noted to improve implementation efficiency, facilitate evaluation and adaptive management, and reduce administrative challenges (CWS 2011).

Best Practices for Management Plans - Canada Goose and Cackling Goose Management was published by CWS in 2011 (see <http://www.ec.gc.ca/Publications/default.asp?lang=En&xml=7C6E31D5-B9F7-4717-A0E5-FC64B0217154>). Best Practices is a six-page document with a template. Applicants are asked to set a population target, and outline approaches to maintain target numbers and address public opinion. "Killing is not to be the primary management approach" (p. 1).

4.5 Wildlife Policy for Canada

The Wildlife Policy for Canada, 1990, is a national policy and framework for federal, provincial, territorial, and non-governmental policies and programs affecting wildlife. A guiding principle was that “all Canadians share the costs of conserving wildlife [and] those whose actions result in additional costs should bear them” (p. 9). The policy asserted, “wild animals that cause unacceptable risk to people; damage to crops, aquaculture, or livestock; or pressure on habitats or other wildlife populations should be controlled only on the basis of long-term, scientifically sound, and economically justified programs. Such programs should be developed in close consultation with public and private interests; should employ only the most safe, efficient, economical and humane methods; and should be subject to regulation. Lethal methods should be used minimally and only when preventative measures fail. In certain cases of crop damage, compensation may be paid” (p. 22-23, Wildlife Ministers’ Council of Canada 1990). The policy is not widely cited or used (K. Brock, pers. comm. November 17, 2014).

4.6 Hunting Regulations

According to the *Migratory Birds Convention Act, 1994*, the closed season on migratory game birds is between March 10 and September 1 (with exceptions for subsistence purposes). The season for hunting any species within a given region is further restricted to a period not exceeding 3.5 months, or 107 days.

Until recently, CWS had reviewed migratory game bird hunting regulations every year, with input from the provinces and interested organizations and individuals. Three documents were developed in this process: 1) *Population Status of Migratory Game Birds in Canada*, 2) *Proposals to Amend the Canadian Migratory Birds Regulations (including Regulation Proposals for Overabundant Species)*, and 3) *Migratory Birds Regulations in Canada*. The proposals to amend are created in accordance with the *Objectives and Guidelines for the Establishment of National Regulations for Migratory Game Bird Hunting*. The final document summarizes the regulations for the

upcoming hunting season. The timing of the reports allowed Canadian representatives on the international Flyway Councils to report on already-legislated changes (CWS Waterfowl Committee 2011).

From the 2014-15 hunting season, the regulations will be established in two year intervals. To ensure new regulations can become law by early June, the timing of the reports has been adjusted. The status report is completed from September through November and posted in early January. The proposal to amend, including any designation of overabundant species, is posted by mid-January. These are completed in consultation with the Province and stakeholders. In early July, the *Migratory Birds Regulations in Canada* report is posted, containing the approved hunting regulations (CWS Waterfowl Committee 2013). (See Chapter 4.41, Overabundance, to learn how to request or propose changes to the regulations.)

The Province may accept or strengthen the annual federal regulations. The *Hunting and Trapping Regulations Synopsis*, available at <http://www.env.gov.bc.ca/fw/wildlife/hunting/regulations/>, summarizes B.C. hunting regulations made under the *Wildlife Act, 1996*. The Synopsis includes important hunting regulations and defines open seasons with maps indicating no hunting, no shooting, and other closed areas. Our region is included within Provincial Management Units 1-5 and 1-6, which are part of District 1, a federal management unit encompassing Vancouver Island.

To hunt Canada Geese, hunters must possess a valid federal Migratory Game Bird Hunting Permit with a Canadian Wildlife Habitat Conservation Stamp. Hunters under the age of majority are afforded the opportunity to hunt without permits during Waterfowler Heritage Days, while accompanied by a licensed mentor.

HUNTING SEASON BAG AND POSSESSION LIMITS 2014-2015

Waterfowler Heritage Days October 4 - 5, 2014

Open Season for Canada Geese - September 6 - 14, 2014 (b)(c)(d) (9 days); October 11 - November 23, 2014 (b)(c)(d); December 20, 2014 - January 11, 2015 (b)(c)(d); February 10 - March 10, 2015 (b)(c)(d). (b) includes 1-5 and 1-6. (c) provincial regulations. (d) Canada Geese and Cackling Geese only.

Daily bag limit = 10 (any combination of Canada Geese and Cackling Geese)

Possession = 30 (any combination of Canada Geese and Cackling Geese)

Hunting seasons were adjusted from two to three seasons in 1998-99, and from three to four seasons in 2007-08. The total number of hunting days stayed the same. Larger bag and possession limits were implemented in 2012 to increase harvests of Canada Geese (Table 4-1).

Table 4-1. Hunting Seasons and Bag Limits for Management Units 1-5 and 1-6, 2008-2015.

Year	Seasons	Bag Limit	Possession Limit
2014-15	Sep 6-14 (9 days), Oct 11-Nov 23 (44 days), Dec 20-Jan 11 (23 days), Feb 10-Mar 10 (29 days) = 105 days	10	30
2013-14	Sep 7-15 (9 days), Oct 12-Nov 24 (44 days), Dec 21-Jan 12 (23 days), Feb 10-Mar 10 (29 days) = 105 days	10	30
2012-13	Sep 1-9 (9 days), Oct 6-Nov 18 (44 days), Dec 15-Jan 6 (23 days), Feb 10-Mar 10 (29 days) = 105 days	10	30
2011-12	Sep 3-11 (9 days), Oct 8-Nov 20 (44 days), Dec 17-Jan 8 (23 days), Feb 11-Mar 10 (29 days) = 105 days	5	10
2010-11	Sep 4-12 (9 days), Oct 9-Nov 21 (44 days), Dec 18-Jan 9 (23 days), Feb 10-Mar 10 (29 days) = 105 days	5	10
2009-10	Sep 5-13 (9 days), Oct 10-Nov 22 (44 days), Dec 19-Jan 10 (23 days), Feb 10-Mar 10 (29 days) = 105 days	5	10
2008-09	Sep 6-14 (9 days), Oct 11-Nov 23 (44 days), Dec 20-Jan 11 (23 days), Feb 10-Mar 10 (29 days) = 105 days	5	10
2007-08	Sep 8-16 (9 days), Oct 6-Nov 23 (49 days), Dec 15-Jan 6 (23 days), Feb 16-Mar 10 (24 days) = 105 days	5	10
2006-07	Sep 15-Oct 22 (38 days), Dec 15-Jan 25 (42 days), Feb 14-Mar 10 (25 days) = 105 days	5	10
1997-98	Sep 15-Oct 25 (41 days), Nov 20-Jan 25 (67 days) = 108 days	5	10

Our bag and possession limits in the early September season were twice that of Washington State's Whatcom County, where some of our marked geese have been observed or shot (Table 4-2). Their early season was 3 days shorter, and there were only 74 total hunting days, compared to 105 days here. There were an average of 952 geese (all species) harvested in Whatcom County each season, from 2009 through 2013 (Washington Department of Fish and Wildlife 2014), compared to an average of 1,515 geese (all species) harvested in Vancouver Island management units 1-5 and 1-6 over the same period.

Table 4-2. Washington State Hunting Seasons and Bag Limits, Goose Management Area 3 (including Whatcom County)

Year	Seasons	Bag Limit	Possession Limit
2014-15	Sep 10-15 (6 days)	5	15
2014-15	Oct 11-23 (13 days), Nov 1-Jan 25 (55 days)	4	12

4.7 B.C. Wildlife Act Permits

Pursuant to the *Wildlife Act, 1996*, permits are required for possessing or transporting dead wildlife or wildlife parts; capturing and possessing live wildlife; killing wildlife for crop protection, population control, scientific research, public safety, ceremonial, educational or humane purposes; possessing or distributing game meat for sustenance (e.g., food bank); trafficking in wildlife or wild meat; and operating a commercial hunting club. However, most permits related to Canada Geese are issued by CWS, not the Province. This is not an exhaustive list; see http://www.env.gov.bc.ca/pasb/fw_permreg.html and the Act for regulated activities and permitting instructions.

4.8 Firearm Regulations

It is beyond the scope of this document to describe all of the rules which govern the use of firearms in the control of Canada Geese. This section is a general overview; it is the responsibility of each individual to understand the laws and regulations for gun ownership, transport, and use.

The federal *Firearms Act, 1995*; provincial *Firearm Act, 1996*; B.C. *Wildlife Act, 1996*, section 108 (2); various regulations associated with these Acts; and municipal bylaws collectively determine where and how firearms may be discharged. The *Migratory Birds Regulations* also require a permit when firearms are proposed for scaring or killing migratory birds causing damage or danger (CWS 2011).

In general, provincial legislation closes all cities, municipalities, and regional district parks and trails to the discharge of firearms unless specifically exempted. Discharge of shotguns may be permitted in certain areas, such as agricultural zones. Municipal bylaws affecting discharge of firearms are not included in the B.C. *Hunting and Trapping Regulations Synopsis*.

The City of Parksville's *Bylaw to Regulate and Prohibit the Discharge of Firearms and the Use of Bows (Bylaw No. 1458), 2010*, is available at <https://parksville.civicweb.net/document/1130/Bylaw%201458%20-%20Firearms%20Regulation%20Bylaw.pdf?handle=B334153A7907462B9640889AF9BA01D2>. The bylaw

prohibits firearm discharge within city limits with certain exceptions. Peace officers, conservation officers, Fisheries and Oceans Canada enforcement officers, CWS employees, and bylaw officers enforcing an animal control bylaw are allowed to discharge firearms within the city, in the lawful performance of their duties. On farmlands larger than 2 ha, a landowner or another with permission from the owner can discharge firearms to protect agricultural crops, livestock or domestic animals from wildlife.

The Town of Qualicum Beach Parks Bylaw No. 551 also prohibits the discharge of firearms (D. Marshall, pers. comm. November 12, 2014).

CWS encourages provincial and municipal regulators to enable hunting where geese are a problem, by allowing firearms to be discharged in areas that do not require prohibitions to protect public safety (CWS 2011).

4.9 Processing Non-hunted Wild Game for Consumption

In a June, 2014 meeting in Parksville, a CWS biologist suggested that attendees not spend time and effort trying to change firmly written legislation prohibiting the consumption of non-hunted Canada Geese (I. Whitehorne, pers. comm. June 18, 2014). A few months later, CWS reported there were revisions proposed for the *Migratory Birds Regulations* that would allow consumption of culled geese, requiring the development of standards with agencies responsible for public health and food inspection (E. Lok, pers. comm. December 1, 2014).

4.91 Consumption of Non-hunted Wild Game in Canada

Various literature (cf. Keefe 1996; Coluccy et al. 2001) and local comments suggest that fewer people are opposed to the culling of nuisance geese when they are used to feed the homeless and others. Per the *Migratory Birds Regulations*, birds killed under such permits cannot be traded, bartered, or sold. CWS reasoned, “by not allowing birds to be eaten we help to ensure that the birds are being killed because they are causing damage, and not for the purpose of providing hunting opportunity outside of the regular hunting season” (CWS 2011). The spread of disease was another issue of concern (I. Whitehorne, pers. comm. June 18, 2014).

Yet the *Migratory Birds*

Regulations state, “a person may give a migratory game bird to another person for... human consumption... if the bird was killed under the authority of a migratory game bird hunting permit”. It does not say this may occur under the authority of a damage or danger permit, but it doesn't say it cannot, either.

There is sometimes a misconception that geese killed to prevent further damage must be left where they are killed (S. Pendergast, pers. comm. November 2014). However, leaving the birds in the field is not a regulatory requirement; the recommendation that carcasses be left as visual deterrents and to attract scavengers are disposal best practices (CWS 2011b; E. Lok, pers. comm. December 19, 2014).

CWS' *Best Practices for Killing Birds and Disposing of Carcasses* include discarding, burning, burying, landfilling, and incineration as methods of Canada Goose disposal. These Best Practices are appended to CWS permits issued under Section 26.1 of the *Migratory Birds Regulations, 1994* (i.e., permits to reduce damage and danger-causing Canada Geese). A commercial poultry processor is recommended as one of five methods to kill Canada Geese prior to disposal (CWS 2011b), as opposed to a route to human consumption.

Nonetheless, Canadian wild game have in fact been culled, processed, donated, and even sold and exported. Canadian Food Inspection Agency (CFIA) food inspectors have monitored caribou harvesting in Nunavut,

for example (A. Messner, pers. comm. November 6, 2014). The Southampton Island harvest began in 1994 as a cull to protect habitat. An annual harvest is now operated by a company that ships the meat to Rankin Inlet for final processing, distribution and sale. The harvest employs Aboriginal Canadians and provides a regular boost to the local economy (Greer 2003).

However, CFIA perceives the Nunavut example as a very special case. A temporary federal inspection plant was established, and federal veterinarians and inspectors were flown in, at great expense. The carcasses were managed and inspected in the same manner as any other type of meat destined for export, in compliance with international standards for trade (K. Roblesky, pers. comm. February 12, 2015).

In a Quebec pilot project, wild deer, squirrel, muskrat, hare, and beaver were being served in some Quebec restaurants. Abundance and food safety were considerations for the choice of species (CBC News 2014).

In B.C., trappers can use their quarry as they please, and people who have nuisance issues with furbearers can hire trappers to get rid of them (S. Pendergast, pers. comm. November 2014).

CFIA regulates birds for which an inspection system has been established. Currently, there is no inspection system for wild geese (J. McClendon, pers. comm. February 11, 2015).

In general, wild game is not permitted in processing plants and some abattoirs/ slaughterhouses because they are not raised according to health standards or inspected prior to killing, and because there is a risk of cross-contamination and transmission of diseases, pathogens, and even chemical residues to humans (cf. Ontario Ministry of the Attorney General 2004).

Importantly, “if the [Province] took over the cull bird slaughter under [its inspection] program, the federal system would not require any change. The only stipulation would be that the meat could not move out of B.C.” (J. McClendon, pers. comm. February 11, 2015). Therefore, a made-in-B.C. solution is possible.

4.92 Consumption of Non-hunted Canada Geese in the United States

In the past, CWS asserted that Canada Geese, as migratory birds, cannot be managed in the same way as one might manage ungulates, for example, due to strict provisions in the *Migratory Birds Convention Act* (CWS, pers. comm. 2008). In other words, Canada’s treaty with the United States prevents certain management techniques, including culling Canada Geese for human consumption.

More recently, CWS acknowledged that culled geese are used for human consumption in the U.S., but this varies from state to state (E. Lok, pers. comm. December 1, 2014).

In 1996, Keefe published the *Feasibility Study on Processing Nuisance Canada Geese for Human Consumption* for the Minnesota Department of Natural Resources. Orchestrated trials demonstrated that capturing, holding, and processing Canada Geese from the Twin Cities region for human consumption was an economical (\$18-25/goose), operationally feasible, and socially acceptable method of controlling nuisance populations. Birds that were held and pastured or fed for a few months after capture appeared to yield a better product, when compared with birds processed immediately after capture during the moult.

A concurrent study by Cooper (1995) showed there was no evidence in the literature to suggest that geese captured on non-industrial sites, including golf courses, parks, and other turf grasses, were unfit for human consumption due to potential or realized exposure to herbicides, insecticides, or fungicides. A health assessment of nuisance geese in Lansing, Michigan revealed detectable levels of various contaminants, including PCBs and DDT, but none were at levels deemed to pose a risk to children or adults (U.S. Department of Health and Human Services 2008).

These studies laid the foundation for many jurisdictions to cull and donate captured geese to food banks (Keefe called them ‘food shelves’). In the St. Paul - Minneapolis area, 16,551 geese were trapped and processed in licensed facilities

from 1995 to 2005. A 1999 white paper explored the use of goslings for human and animal food; a third option to kill, landfill and incinerate them would only be considered if avian influenza became an issue. In 2006, the animal food option was approved by the USFWS and DNR. Geese were donated for human consumption and goslings were provided to a Wildlife Science Center to feed captive wolves and bears (City of Eden Prairie 2008).

In Wisconsin, Canada Geese that are captured and processed are sampled for contaminants known to be harmful to human health, prior to distribution to food pantries (Wisconsin DNR 2000 in USDA 2000).

In Missouri, distribution for human consumption through charitable organizations occurs when other techniques have been unsuccessful and where local communities formally support and pay for capture and processing (USDA 2002). Affected property owners typically pay a fee to offset the costs of trapping and transportation to the processor. Food banks pay for transportation from the processor to their facilities (Missouri Dept. of Conservation 2002).

4.93 B.C. Rules for the Sharing of Game

In effect, there are few provincial barriers to donating geese to food banks. The B.C. *Wildlife Act* prohibits the possession of wildlife except as

authorized under a license or permit or as provided by regulation. Communities may obtain a permit from MFLNRO to cull, i.e., hunt or humanely kill wild ungulates as a means of population management or control, and MFLNRO may also permit these jurisdictions to donate the meat; the permit details directions for transportation and transfer of ownership (B.C. Centre for Disease Control 2012).

While wild animals cannot be processed in a provincial plant (due to federal regulations), problem deer have been captured, humanely euthanized, field dressed under the supervision of an inspector or transported to a butcher. The processed meat was then donated to local food banks or to First Nations (K. Roblesky, H. Schwantje, pers. comm. February 12, 2015). In other words, there is precedence for salvage and donation of culled meat in the province.

In addition, road killed ungulates are routinely salvaged, dressed, processed, and provided to needy individuals (cf. B.C. Wildlife Federation 2012). Legally harvested wild game is often donated to non-profit groups for fundraising dinners.

In 2012, B.C. Centre for Disease Control, B.C. Ministry of Health, and the five regional Health Authorities published *Standards for the Donation of Culled Game Meat*. The meat must be from carcasses that are inspected in the field by

individuals that have completed the one-day MFLNRO training program and are deemed fit for human consumption. Donation of game must comply with B.C.'s *Food Safety Act, 2002* and *Public Health Act, 2008*, and corresponding sections of the *Meat Inspection Regulation* and the *Food Premises Regulation* pertaining to sanitation and food hygiene. Game must be processed by approved facilities and donated to food banks or to individuals and families for their personal consumption. As the *Food Premises Regulation* requires that foods come from an approved source, and be slaughtered in a federally or provincially inspected facility, game meat cannot be donated to soup kitchens, charitable organizations or any facility in which compliance with the Food Premises Regulation is required (B.C. Centre for Disease Control, Food Production 2012).

“Economically disadvantaged individuals and families may have challenges in obtaining high quality nutritious food. Donated food, particularly the high protein and low fat meat obtained from game animals, can greatly increase the diversity and nutritional quality of recipients’ diets.... The benefits of donating wild game meat to economically disadvantaged individuals and families can outweigh any disadvantages or costs such a program may entail”

(B.C. Centre for Disease Control, Food Protection 2012, p. 2).

In essence, if the provincial approach to wildlife handling could be applied to geese, permittees who destroy geese to prevent damage to their lands would be required to make all attempts to provide the meat to people in need, if they did not consume it themselves (S. Pendergast, pers. comm. June 14, 2014).

4.10 Aboriginal Rights

4.101 Parksville Protocol

The Parksville Protocol is an amendment to the *Migratory Birds Convention Act* that recognized and endorsed traditional Aboriginal harvesting rights, signed in 1995 between Canada and the U.S., and brought into force in 1999 as an addition to the Act schedule. Subject to existing Aboriginal and treaty rights under section 35 of the *Constitution Act, 1982*, relevant treaties, land claims agreements, self-government agreements, and co-management agreements, the Protocol enables First Nations to harvest migratory birds and their eggs throughout the year. Down and inedible by-products may be sold, and birds and eggs can be offered for barter, exchange, trade, or sale among Aboriginal communities.

4.102 Proposed Changes to the Migratory Birds Regulations

While the Act was changed to accommodate the Parksville Protocol, the regulations were not. CWS has proposed the following changes to the regulations, currently in revision, to bring them in line with the current legal environment:

An Aboriginal person of Canada with treaty or aboriginal harvesting rights may domestically harvest migratory birds for food, social or ceremonial purposes in

the area where those rights are derived: without a migratory game bird hunting permit, throughout the year, and with no bag or possession limit. The Aboriginal peoples of Canada may barter, exchange or trade, but not sell, migratory birds domestically harvested under aboriginal or treaty rights within or between Aboriginal communities. The Aboriginal peoples of Canada may sell inedible parts of migratory birds domestically harvested under aboriginal or treaty rights (Teillet 2013).

4.103 Contemporary Treaty Agreements

While none of the First Nations in our region currently have settled land claims or other agreements affecting Canada Goose management at this time, such agreements are expected in future. To date, agreements in other parts of the province have been mostly consistent with the wording and spirit of the Parksville Protocol and subsequent proposed changes to the regulations.

Some self-governing First Nations have jurisdiction over wildlife conservation and management on their lands. Notably, the Westbank First Nation's jurisdiction includes any individual harvesting migratory birds on Westbank Lands, not just its own citizens. Nisga'a Lisims

Government may make laws requiring that any wildlife or wildlife parts that are transported outside Nisga'a Lands for the purpose of trade or barter be identified as such (Wilson-Raybould 2011).

The final agreement signed by Canada, the Province, and the Maa'nulth First Nation on Vancouver Island in 2008 may provide some insight as to what a future agreement in this area might entail. The federal Minister retains authority for managing and conserving migratory birds and migratory bird habitat. Migratory birds can be harvested within a designated Migratory Bird Harvest Area. Maa'nulth Tribe and Nation members may barter and trade migratory birds and bird parts among themselves and with other Aboriginal people in Canada. The *Wildlife and Migratory Birds Regulation* was brought into force by one of the member nations/tribes, the Uchucklesaht Tribe, in 2011 (see [http://www.maanulth.ca/laws/uchucklesaht/ut_wildlife_migratory_birds_regulation_\(00307386\).pdf](http://www.maanulth.ca/laws/uchucklesaht/ut_wildlife_migratory_birds_regulation_(00307386).pdf)). A utilization of animals provision states, "A person who is exercising the right to harvest... must not waste the edible parts of any... migratory bird or any reasonably usable part of any... migratory bird".

Chapter 5 - The Need for Action

Highlights

We administered a questionnaire and conducted interviews to investigate the socio-economic impacts of geese on our communities. Problems identified included fouling of grassy areas (reported by 85% of respondents); damage to landscaping (54%); contamination of water in recreation areas (46%); damage to crops or hayfields (38.5%); degraded water quality (38.5%); invasive or weedy plants arising from feces (38.5%); contamination of shellfish beds (23%); noise issues (23%); aggression towards people or pets (23%); and contamination of drinking water sources (8%). Reports of contamination of water and shellfish had not been confirmed by testing. Respondents and interviewees also noted damage to fish and wildlife habitat, possible cross-contamination/spread of disease between geese and grazing livestock, loss of playing areas for children, unpleasant playing conditions for golfers, and threats to aircraft. On average, survey respondents rated the severity of their Canada Goose problems at 7.5/10. Ninety percent of respondents had incurred goose-related damages.

Estuaries are critical and year-round habitats for Canada Geese. They are also rare and sensitive ecosystems that provide many local services to humankind (e.g., flood protection, water treatment) and support an estimated 80% of all coastal fish and wildlife. In the region's estuaries, there are at least four different imperiled ecological communities (i.e., provincially red-listed, ranked S2), and at least three communities that are of special concern (i.e., provincially blue-listed, ranked S3); the red-listed Lyngbye's Sedge Herbaceous Vegetation community has been heavily impacted by Canada Geese. While this channel edge community is important for many reasons, it is arguably most valuable in providing shade for salmonids, as water temperatures in channels without overstream sedges have reached lethal levels as early as May in recent years.

Estuaries accumulate nutrients and sediments from the sea, streams, and uplands, which combine to form a 'platform' of rich substrates and organic materials that support prolific plant growth. When Canada Geese are locally overabundant, they overgraze emergent vegetation and grub roots and rhizomes along the channel edges, exposing the thick marsh platform to the tides. The platform, built up over thousands of years, washes away, leaving behind gravelly substrates that can no longer support lush emergent plant communities. The loose material infills the dendritic channels on the higher parts of the marsh with a deep layer of fine sediment, clogging waterways and feeding areas for fish and wildlife.

Although the mid-island estuarine marshes are the first in B.C. to succumb to overgrazing and grubbing by geese, this is not a new phenomenon. A similar situation has occurred in northern coastal marshes, where several species of geese (including Canada Geese, but predominantly Snow Geese) have altered and eliminated entire plant communities, and decreased and changed the composition of soil invertebrates, among many other things. Areas exclosed from geese remain denuded 20 years later. Marsh degradation eventually led to measurable declines in goose productivity and survival rates. Additional hunting opportunities facilitated by an overabundance designation suppressed the growth of Snow Goose populations, but have been mostly ineffective in decreasing them.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 5 - The Need for Action

More Highlights

Canada Geese have an inefficient digestive system whereby vegetation passes through the gut quickly, potentially leaving seeds and fragments of invasive plants intact for propagation. Several studies in imperiled Garry Oak ecosystems point to Canada Geese as the vector for invasive grasses outcompeting plant species at risk of extinction.

Canada Goose feces have contributed to phosphorus loading, eutrophication, and algae blooms in nearby jurisdictions. This type of impact has not been examined locally.

Canada Geese consume and may overgraze eelgrass, a keystone species in estuarine and coastal marine habitats. Such concerns have been raised in our area, and along the Gulf Islands. There is empirical evidence in other jurisdictions that seagrasses overgrazed by Canada Geese do not recover.

Canada Geese are contributing to climate change by decreasing the productivity of estuarine marshes and eelgrass beds. These ecosystems store and sequester vast amounts of 'blue carbon'.

Aircraft can be downed by bird strikes, and most airports have kill and hazing programs. Locally, staff at the Department of National Defense Canadian Forces Maritime Experimental and Test Ranges in NanOOSE Bay were concerned with growing populations of Canada Geese on the property, and geese nesting near the helicopter landing pad in particular. At the Qualicum Beach airport, the goose problem is "unremarkable", although there are plans to fill a depression to avoid ponding and attracting waterfowl.

Our surveys included responses from five local farmers, all experiencing annual crop damage. Some had lost nearly entire crops to geese. To mitigate losses, farmers had over-seeded, replanted, repaired/'re-pastured', drained wet areas, and altered their farming practices and crops. Aside from grazing, geese trampled and disturbed soils, deposited weed seeds, and pulled out young plants without eating them. For some farms, most depredation occurred during spring and autumn migration periods, while others experienced problems year-round. Nonetheless, two of the five cited the potential benefits of geese, and one was willing to attract Canada Geese if he could legally harvest and market them.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 5 - The Need for Action

More Highlights

Contamination of drinking water, and fouling of beaches, parks, sports fields and other areas by goose feces, feathers, etc. pose risks to human and animal health. In response to increasing complaints by parks departments and other agencies, and media attention to H5N1 and other pathogens, CWS commissioned a risk assessment. However, the Canadian Cooperative Wildlife Health Centre found insufficient data were available to conduct a meaningful assessment. Recommendations included improving traditional water quality indicators, mitigating risks through fecal waste management and other strategies, investing in monitoring and research to develop an evidence-based risk assessment, and forming a working group to develop national standards for the management of peri-urban goose populations.

Risks to health may be higher in aquatic areas, and in areas where geese are congregating in proximity to children or people who are immunocompromised. Young children playing in sand may have greater exposure to goose-borne bacteria, as bacteria persist longer in sand than in water. Notably, water tested at popular beaches has been unremarkable.

Our survey respondents suspected drinking water contamination; infections in dogs frequenting fouled lawns, paths, and roadways; contaminated water in recreation areas; and contaminated shellfish beds. Children were often exposed to large amounts of goose feces on school grounds and sports fields.

Fouling of grassy areas deterred youth from playing sports, discouraged golfers from playing preferred courses, and dissuaded tourists from return visits. For some, clean-up was time-consuming and expensive. The City of Parksville purchased a machine to sweep goose feces from parks, sports fields, other grassy areas, and hardscapes; however, the sweeper was ineffective when the fields were wet.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

5.1 Few Benefits, Many Problems

Who among us has not been reminded of the changing of the seasons with the chatter and honking of migrating geese in characteristic V formation? Or gazed fondly at soft, yellow goslings trotting along with their parents? Canada Geese are truly a Canadian icon. Their image adorns signage and advertising in nearly every jurisdiction. At the time of this writing, they were running 4th in a competition for national bird (Canadian Geographic 2015). Perhaps it is no surprise that wildlife enthusiasts once sought to increase wildlife viewing and hunting opportunities of Canada Geese, or that some local residents appreciate the geese and even feed them, despite the known problems.

The literature associated with the management of nuisance Canada Geese is voluminous and repetitive, peppered with studies and policy documents. There are many government and company web pages dedicated to reducing the impacts of Canada Geese.

Our questionnaire respondents provided a snapshot of the problems associated with geese in our area (Table 5-1). In addition to these, respondents noted damage to fish and wildlife habitat (estuaries, floodplains, eelgrass meadows), possible cross-contamination/spread of disease to and from grazing livestock, loss of playing areas for children, and unpleasant playing conditions for golfers.

On a scale of 0 to 10, where 0 is trivial/not concerned at all, and 10 is critical/very concerned, survey respondents reported that their Canada Goose problems were 7.5, on average (n=13). Responses ranged from 0 to 10, and 3/4 of respondents rated their problems 8 or higher. Respondents had different views as to whether goose problems were increasing, decreasing, or static (e.g., over the past 5 years). City of Parksville staff believed that some problem areas in the city had improved, others had worsened, and some had stayed the same. Most problems

Questionnaires and Interviews

To investigate socio-economic impacts of geese on our communities and explore management initiatives adopted by those having problems, a questionnaire was administered to 35 people, representing local governments, farmers, golf course operations, resorts, airports and airlines, residents groups, schools, and community groups. Dismal response rates led to follow-up calls and interviews. While far from comprehensive, the results provided a snapshot of the nature and extent of Canada Goose-related issues experienced by various sectors.

were seasonal. For owners and managers of mostly terrestrial landscapes, the moulting period offered a short reprieve from goose management.

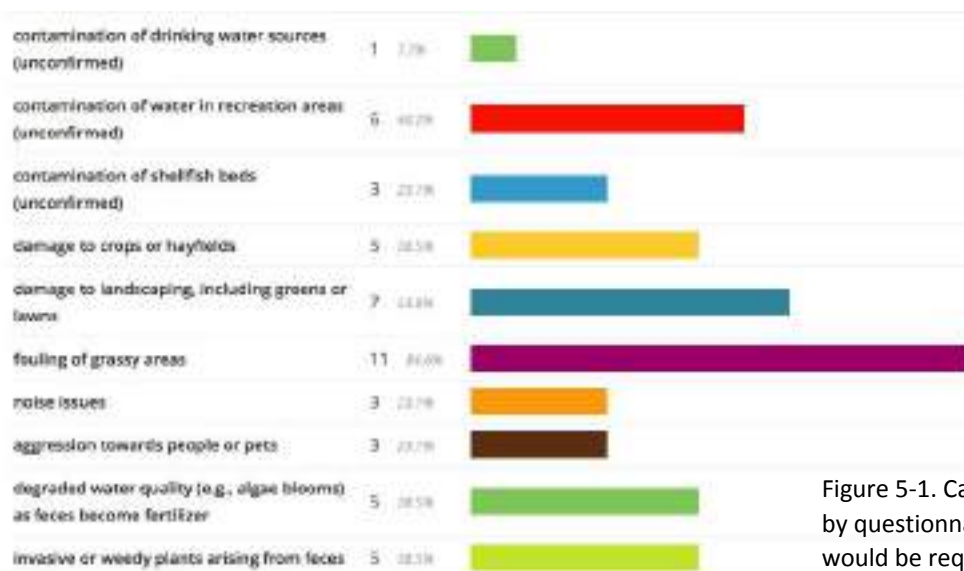


Figure 5-1. Canada Goose problems experienced by questionnaire respondents. Positive lab tests would be required to confirm contamination.

5.2 Impacts to Estuaries



Vegetative changes at the Little Qualicum River estuary. Upper photo August 1978, Lower photo August 2005. Photos by Neil K. Dawe.

In contrast to other jurisdictions, Canada Geese have caused significant and long-lasting damage to mid-island estuaries. They overgraze emergent vegetation and grub roots and rhizomes along channel edges, exposing the thick marsh platform to the tides. The platform, built up over thousands of years, washes away, leaving behind gravelly substrates that can no longer support lush emergent plant communities. On the higher parts of the marsh, the loose sediment infills the dendritic channels, clogging waterways and feeding areas for fish and wildlife with a deep layer of fine sediments. Seeds, concentrated along the channel edges by winds and currents, are consumed or lost to subsequent erosion (Krupu & Reinecke 1992).

In 2009, MVIHES published *Caring for the Englishman River Estuary* (available at <http://www.mvihes.bc.ca/newsroom/published-documents/119-publisheddocuments>), which mapped dramatic changes in estuarine vegetation and substrates between 1976 and 2008 (Kennedy 1976; MVIHES 2009). In the same year, the Guardians began planning

the restoration of the Little Qualicum and Englishman River estuarine marshes. Dawe et al. (2011) quantified changes in estuarine vegetation at the Little Qualicum River estuary, by comparing data collected in 1978 and 2005. MVIHES (2009) and Dawe et al. (2011) attributed most of these changes to Canada Goose herbivory. Similar changes have occurred in the Campbell River estuary, possibly due to moult migrants (Dawe et al. 2015).

Estuaries accumulate nutrients and sediments from the sea, streams and uplands, which combine to form rich substrates that support prolific plant growth. These highly productive habitats are used by an estimated 80% of all coastal wildlife (Pacific Estuary Conservation Program 1999). For many species, estuaries are critical habitat - without it, they could not survive. They may rely on estuaries for at least one stage in their life cycle, or use them when other habitats are unavailable. For example, waterbirds depend on estuaries for survival when other habitats are frozen (Dawe et al. 1998).

A healthy, productive Little Qualicum River estuary, 1996. Photo by Tim Clermont





Nesting Canada Goose on a remnant of marsh platform at the Englishman River estuary (upper)

Canada Goose tracks at the Little Qualicum River estuary. Heavily grazed sedges, a grubbed and eroding marsh platform, and channels infilled with silt are prevalent (lower)

Estuarine marshes are also valuable for the local services they contribute to humankind. They provide food, by supporting fin fisheries and shellfisheries. Many of the intertidal and marine species that we eat depend on estuaries for some part of their life history. Estuaries also protect the coastline from flooding and storm damage, by storing water and dampening wave action; maintain water quality, by naturally treating storm water and other types of runoff; and offer recreational, social and spiritual opportunities that contribute to health and well-being. Increasingly important is their role as indicators of cumulative environmental change; problems arising in estuaries may signal unnoticed or underestimated natural and anthropogenic impacts in linked freshwater, marine and terrestrial ecosystems (D'Alpaos 2011; Clermont 2014).

LGL and B.C. Conservation Foundation (2012) found the ERE was used for rearing by juvenile Coho and Chinook Salmon from April to at least late August, by Coho smolts in May and June, and by Chum fry from April to June. They also found salmon preferentially selected habitats with overstream edge vegetation and large woody debris. Aside from escape cover, such vegetation helps maintain the cool temperatures salmon need to survive. Wightman (pers. comm. 2013) found temperatures in channels lacking overstream vegetation at the LQRE reached 25 degrees Celsius by May in 2011 and 2012; this is the lethal threshold for migrating and holding adult Chinook and Coho Salmon, as

well as for juvenile growth and rearing. Sub-lethal temperatures, which are considerably lower, may block migration and lead to reduced growth, among other things (Carter 2005).

At the LQRE, which currently is in far better condition than the ERE, the estuarine detrital food web was shorted by at least 22 tonnes of above-ground biomass from 1978 to 2005, primarily a result of Canada Goose and swan grazing and grubbing of channel edge plant communities (cf. Dawe, Boyd, Buechert, & Stewart 2011). Detritus supports invertebrates, which salmonids depend upon for food. It is extremely likely that the lack of vegetation in the estuary due to Canada Goose grazing and grubbing significantly limits salmonid productivity.

In the subarctic, the degraded state of coastal marshes was probably initiated by foraging damage from an exceptional stopover of staging Snow Geese and Canada Geese, followed by foraging pressure of relatively small numbers of nesting and migrant geese (Kotanen & Abraham 2013). Snow Geese in particular overgrazed and grubbed salt marshes, precipitating a cascade of adverse changes in marsh substrates that led to alteration and elimination of entire plant communities and a persistent, alternative state (Jeffries, Rockwell, and Abraham 2003; CWS Waterfowl Committee 2013). These included, among other things, losses of organic matter and nutrients, depletion of the seed bank, the



Eroding marsh platform at the Englishman River estuary. Much of the central marsh is now bare gravel and mudflat.

development of a hardened thick algae crust, and hypersaline conditions, all of which inhibited vegetative regrowth. There were also declines in the abundance and composition of soil invertebrates, important sources of food for many species. Experimental plots, exclosed after being denuded, were devoid of vegetation more than 20 years later. The long-term decrease in available, high quality forage caused declines in goose clutch sizes, and in survival and body mass of goslings. In stark contrast, areas experiencing low-density goose grazing had increases in primary production, probably due to additional nitrogen from fecal matter (Jeffries, Rockwell, & Abraham 2003).

In Maryland, Canada Goose herbivory was deemed responsible for a major decline in natural wild rice (*Zizania aquatica*) in the Patuxent River tidal marshes (Haramis & Kearns 2006).

Other studies have shown that geese affect primary production, nutrient flows, and invertebrate production. The susceptibility of plants to grazing depends in part on their stage of growth (e.g., their nutritive value determining whether geese will choose to feed on them, their height controlling whether they are accessible), and how well they rebound from grazing pressure (Kadlec & Smith 1992).

5.3 Other Ecological Impacts

Concerns that Canada Geese were impacting critically imperiled Garry Oak and associated ecosystems on the Gulf Islands prompted several studies. Best and Arcese (2009) and Isaac-Renton et al. (2010) discovered that selective herbivory by geese on exotic grasses, common in urban feeding areas, likely precipitated an introduction of invasive grasses to sensitive small island habitats through defecation, fertilization, and grazing. The Winchelsea Islands, offshore from Nanoose Bay, were included in the study areas.

In large quantities, goose poop is known to contribute to phosphorous loading and eutrophication in waterbodies. For example, in Washington State's Puget Sound area, fecal matter

from geese created algae blooms, depleted dissolved oxygen, degraded water quality, and reduced habitat for fish and invertebrates in area lakes (USDA 1999). In Missouri, goose fecal deposits on lakes resulted in algal blooms, oxygen depletion, and fish kills (USFWS 2002). No studies have been undertaken to assess whether eutrophication is occurring locally as a result of goose excrement.

Eelgrass (*Zostera marina*) is a keystone species and a favoured food item; Canada Goose flocks consume large amounts of it during the moulting period. A seagrass ecosystem that grows in estuaries and along low wave shorelines, eelgrass meadows support complex food webs, serving as 'salmon highways' and nurseries

for invertebrates, shellfish and juvenile fishes (Wright et al. 2012). Although seagrasses may recover from annual grazing events, Rivers & Short (2007) found that Maine-New Hampshire eelgrass beds grazed by ~100 Canada Geese from January through July did not recover. Wright et al. (2012) identified overgrazing of eelgrass by Canada Geese as a growing concern along the Gulf Islands.

It may seem like a stretch to say that Canada Geese are contributing to climate change, but this is indeed the case. Estuarine marshes and seagrass meadows store and sequester vast amounts of 'blue carbon' in anaerobic sediments, where it can remain for millennia. Rates of carbon sequestration are comparable to those in tropical rainforests and



Canada Geese feeding in eelgrass beds in Craig Bay

peatlands (Sifleet, Pendleton, & Murray 2011; Blue Carbon Portal 2013; Crooks et al. 2014).

These coastal ecosystems can become carbon sources, as marsh vegetation and eelgrass beds are lost, and biomass and organic substrates are oxidized (Blue Carbon Portal 2013).

Rebuilding the marsh platform to support emergent vegetation, which will trap additional sediments, will help restore carbon stocks. Protecting existing marsh vegetation from grazing Canada Geese will help mitigate climate change and preserve valuable ecosystem services.

5.4 Socio-economic Impacts

“Although the amount of suitable habitat is a key factor governing the number of geese in a given area, the number of geese considered “problem birds” will be determined by how they are perceived by property owners and property users” (CWS 2010, p. 7). The social license to implement sensitive management solutions will depend upon the nature and severity of the problem as perceived by various stakeholder groups.

In the Puget Sound area, survey respondents to an environmental assessment for the management of conflicts associated with Canada Geese described a general decline in their quality of life. Most felt unable to use their properties and public areas (e.g., parks, piers, beaches, foot paths) due to contamination and fouling from feces (USDA 1999). We found similar results from our questionnaire. For example, an elementary school principal spoke of slippery, unsanitary school fields and

walkways, and fields rendered unusable for activities as children were not allowed near the geese.

5.41 Transportation Safety

Most airports pay for hazing programs to protect aircraft from Canada Geese and other birds (CWS 2011). The USDA (1999) reported an estimated 7 fatalities and \$245 million damage to civilian and military aircraft each year, with only 20-25% of all bird strikes reported. The most published collision event occurred in January 2009, when U.S. Airways Flight 1549, carrying 155 passengers, was forced to make an emergency landing in the Hudson River, after striking a flock of Canada Geese during take-off from LaGuardia Airport. The event prompted plans to gas 2,000 geese in New York City (Caruso 2009). At Vancouver’s YVR in 2013, there were 199 bird strikes involving 254 birds. YVR has an extensive wildlife management program that includes wildlife patrols, border collies, and trained raptors; in 2013, an estimated 544,561 birds were moved away

from aircraft operating areas, and 209 birds were killed (Vancouver Airport Authority 2013).

Locally, staff at the Department of National Defense (DND) Canadian Forces Maritime Experimental and Test Ranges (CFMETR) in NanOOSE Bay have significant concerns with a growing population on the property, and Canada Geese nesting in proximity to the helicopter landing pad in particular.

By contrast, the manager of the Qualicum Beach airport described the goose problem at the airport as “unremarkable” (B. Weir, pers. comm. November, 2014). The airport has a wildlife management plan. A Town of Qualicum Beach employee inspects the airstrip daily and drives the perimeter. A KD Air employee with one year experience reported no problems with Canada Geese; however, a plane recently collided with a gull (pers. comm. November, 2014).

Although Canada Geese do cross local roads, no complaints have been made.



Goose traffic in the City of Parksville, October 2014. Photo by Doreen Bakstad.

Although infrequent, Canada Geese have been known to act aggressively to cyclists and pedestrians. An Ontario cyclist was attacked by a goose with a brood. Despite wearing a helmet and sunglasses, she suffered a concussion, fractured cheekbone, face lacerations and loose teeth (Desjardins 2014).

5.42 Crop Depredation

During the spring and fall migrations, along migratory corridors that experience hundreds of thousands of northern-breeding waterfowl, crop depredation is a significant problem. Without crop depredation programs (e.g., scare cannons, bait pads to direct birds away from crops), some prairie farmers would have lost their entire harvest.

Here, five farmers rated their level of concern regarding goose depredation on a scale of one to ten. Their responses ranged from 7 to 10, with a mean of 8.2. Although CWS (2010) noted that crop depredation is accentuated on farms within communities where municipal bylaws prevent the discharge of firearms, hunting occurred on all of the farms that had experienced problems with geese. All experienced damage every year, to cereal, vegetable, or hay crops.

In addition to depredation in spring and fall, Canada Geese were found to trample and disturb soils, and deposit weed seeds which easily established in the disturbed soils. One corn farmer noted the geese pull out young plants, but do not always eat them. Some farms

reported most of their problems occurred during the spring and fall migration, while others had Canada Geese on their properties year-round. A local hunter that helps farmers rid themselves of geese suggested that species other than Canada Geese, such as smaller-bodied cackling geese and Greater White-fronted Geese (*Anser albifrons*), may be a significant part of the depredation problem during the fall migration.

In a Connecticut study, corn crops were most often depredated by geese, followed by grass/hay, and then rye and alfalfa cover crops. Most of the financial losses were on corn and rye fields; they ranged from \$100 to \$40,000, with an average loss of \$4,000. Losses increased linearly with the acreage of the farm (Huang 2010).

The Errington farm that reported the greatest level of concern grew corn. Most damage occurred when geese pulled out corn seedlings in spring. Up to 20 acres of corn required replanting annually, at a cost of \$500/acre.

Other local farms reported damage to hayfields and pasturelands, on newly seeded areas as well as established grasslands. "The geese eat germinating grass or the existing grass, right down to the soil, thus killing the grass. Large pockets of land are now unusable," reported one farmer. Farmers lamented exposed soils in winter, and weeds establishing in bare patches.

One French Creek farmer reseeded 7 acres, with seed prices at \$113/acre. She estimated spot damage over 100 acres, at costs of

A single flock of geese can destroy a newly planted pasture or cash crop in a short time, if allowed to graze without interference (CWS 2010).

more than \$16,000 to repair. As she cannot afford to take 100 acres out of production at one time, the worst fields are chosen each year, and restored 30-40 acres at a time.

Another contracted a neighbouring farmer to 're-pasture' damaged lands at a cost of \$4,000. She planted a fall wheat crop, only to have it "almost entirely eaten by geese", and has since struggled with weed control and germination of preferred species. In 2013 and 2014, more than 40 hours of work and \$1,000 of expenditures were directed towards drainage and over-seeding.

Agricultural lands may benefit from fertilization by goose feces, and increased sprouting as a result of grazing (MoE 1979); one local farmer did not mind geese grazing his winter cover crops, precisely for these reasons. Another farmer was willing to attract Canada Geese if he could legally harvest and market them.

5.43 Contamination and Fouling

Contamination of drinking water, and fouling of parks, beaches, sports fields, playgrounds, and other areas by goose feces pose risks to human and animal health. Estimates of daily fecal output from a single goose range from 0.39 to 0.9 kg, and fecal matter is often deposited within 100 m of a waterbody (Filion et al. 2006; USDA 2004). Smith, Craven, & Curtis (1999) reported that 60 geese were the

threshold for complaints about goose feces.

In Puget Sound, concentrations of geese and ducks precipitated coliform counts exceeding those found in raw sewage, making swimmers sick and closing beaches (USDA 1999).

New Zealand farmers lost sheep to Canada Geese carrying salmonella (Win 2001).

In Maryland, state officials were concerned when geese tested positive for duck virus enteritis, a disease highly contagious to other waterfowl (USFWS 2002).

Canada Geese in Georgia and North Carolina were identified as potential vectors of pathogens, including antimicrobial-resistant variants, affecting agricultural crops and water sources (Cole et al. 2005).

Kullas et al. (2002) found the prevalence of virulent strains of bacteria in goose feces in Fort Collins, Colorado was closely associated with increases in summer temperatures. Compared to migratory geese, resident geese were exposed to greater levels of environmental *Escherichia coli*, because of their use of easily fouled, small water impoundments and limited mobility in warmer months.

In Rochester, Minnesota, the idea of a large urban bird population in the midst of a possible avian influenza pandemic (H5N1) created sufficient alarm for some to suggest that the geese be immediately euthanized. At the same time, the U.S. Secretary of

Health acknowledged that humans could become infected with H5N1 through contact with fecal matter, and that some birds could be carriers without showing any symptoms of illness. The first few results from a Mayo Clinic study of the geese were negative, but a pandemic plan was outlined nonetheless (Eckberg 2010).

In Canada, in response to increasing complaints by Parks Departments and other agencies, and media attention to pathogens such as H5N1 and West Nile Virus, CWS commissioned the Canadian Cooperative Wildlife Health Centre to perform a risk assessment. Fraser and Fraser (2010), on behalf of the Centre, found insufficient data were available to conduct a meaningful assessment. There were very large gaps in evidence with respect to the prevalence of pathogens and parasites in geese, epidemiological information to link pathogens in geese to cases in people or livestock, goose fecal distribution patterns, and the nature and extent of contact between geese and humans, or geese and livestock. Notably, data on *E.coli*, *Cryptosporidium*, and *Giardia* were more readily available (Fraser & Fraser 2010). Fraser and Fraser (2010) suggested traditional water quality indicators be improved, and risks mitigated through fecal waste management and other strategies. They also recommended that CWS invest in monitoring and research to develop an evidence-based risk assessment, and form a working group to develop national standards for the management of peri-urban goose populations.

Transmission of pathogens could occur along many pathways, such as: directly through feathers, skin, droppings or external lesions; contaminating water with feces and respiratory secretions; and also via intermediate vectors such as arthropods and insects (Fraser & Fraser 2010). Geese can also act as intermediate hosts in the life cycle of schistosome parasites that cause swimmer's itch (USDA 1999).

While the probabilities of exposure to pathogens and parasites were unattainable based on existing data, Fraser & Fraser (2010) acknowledged that risks to human health may be higher in aquatic areas, and in areas where geese congregate near people that are immunocompromised, such as in proximity to health centres. Similarly, risks to those with undeveloped immune responses, such as young children and animals would be higher in spaces shared with geese. Young children playing in sand will have greater exposure to goose-borne bacteria, as bacteria persist longer in sand than in water (Fraser & Fraser 2010).

Half of our survey respondents suspected contaminated water in recreation areas. Parksville Bay

and Rathtrevor Beach are popular beaches frequented by geese; there are an estimated 11,500 visitors to Parksville in the peak summer period (B. Sepos, pers. comm. November 22, 2014), and there were 461,648 visitors to Rathtrevor Beach Provincial Park from January 1 - October 31, 2014 (D. Chapman, pers. comm. November 24, 2014).

Island Health/Vancouver Island Health Authority (VIHA) Health Inspectors test water at beaches that are formally recognized public recreational water bathing areas with lands and access controlled by a government agency; only beaches with high numbers of bathers are sampled (VIHA n.d.; G. Gibson, pers. comm. December 19, 2014). Sampling of indicator bacteria (i.e., *E.coli* for freshwater areas, and *Enterococci* for saltwater areas) typically occurs from May through Labour Day in September, at an intensity that is based on usage, previous sample results, and potential sources of contamination. A beach advisory may be posted by the Medical Health Officer if the average of several sample results exceeds 200 *E.coli* or 35 *Enterococci*, or a single

sample exceeds 400 *E.coli* or 70 *Enterococci* (VIHA n.d.).

According to the Central Island Health Inspector, there have been no significant issues with samples taken from Qualicum Beach, Parksville, or Rathtrevor beaches (G. Gibson, pers. comm. December 19, 2014). In 2014, a single sample taken May 27 found 135 *Enterococci* on Parksville's northwest beach; this was the only sample that exceeded bathing beaches standards (VIHA 2014). Sources of contamination are generally not examined (G. Gibson, pers. comm. December 19, 2014).

In the summer of 2014, two teens were observed swimming with kickboards in the upper reaches of the Craig Creek estuary, among concentrations of goose feces and feathers. Such beaches would not be sampled, due to the low numbers of bathers known to use the area. Swimming in these conditions could result in gastroenteritis, and swimming with open sores could lead to skin infections (G. Gibson, pers. comm. December 19, 2014). There can also be increased risks of ear, nose, and throat infections (VIHA n.d.).

Goose feathers and feces in the water and intertidal areas of the Craig Creek estuary, summer 2014



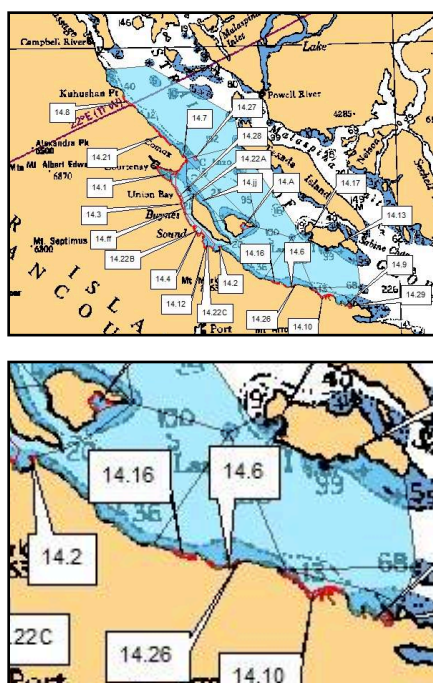


Figure 5-2. Sanitary shellfish closures. Regional context (upper) and specific beaches (lower) (Fisheries and Oceans Canada 2014)

Two survey respondents were concerned about the contamination of shellfish beds. Qualicum Beach, Wall Beach, Parksville Bay (Englishman River to French Creek), the mouth of the Little Qualicum River, and Northwest Bay are all closed for shellfish harvesting (Figure 5-2). Craig Bay is no longer closed (Fisheries and Oceans Canada 2014). Sanitary closures may be attributed to factors other than Canada Geese, such as failing septic systems.

Survey respondents and interviewees were concerned about contamination of other sites. One farmer suspected her drinking water was contaminated, although it was unclear whether this was drinking water for humans or livestock. Another respondent suspected infections in dogs due to fouling of lawns, roadways, and paths.

At Parksville Elementary School, geese often wandered on smaller grassy areas close to the school building and sandboxes. Staff occasionally raked the fields, and volunteers removed dried feces (survey respondent, 2014). Parents were very concerned about contamination and health risks; the soccer field was littered with goose feces while children played an inter-school soccer match, one day after

a feces removal effort (J. Cooper, pers. comm. 2015).

5.44 Fouling and Grass Turf Management

Fouling of grassy areas was a concern of local governments, golf course and resort managers, farmers, a school principal, and a DND Environment Officer (survey respondents, 2014).

Many young soccer players have been reluctant to play on 'Poopville's' (Parksville's) sports fields. City of Parksville staff were distressed to report "teams of youth sliding and slipping and rolling around in goose feces". Fortunately, players are more likely to be healthy and not immunocompromised, reducing health risks (Fraser & Fraser 2010).

The City purchased a machine to sweep goose feces from the parks, sports fields, other grassy areas, and hardscapes such as pavement. In smaller spaces, a blower is used. From 2007 through 2014, \$102,633 was spent on sweeping. However, the sweeper is ineffective when the fields are wet (A. Metcalf, W. Payne, pers. comm. September 23 and October 6, 2014), i.e., most of the winter, when soccer, field lacrosse, and other sports are played.

Fouling of play areas at Ballenas Secondary School (left) and at Winchelsea Elementary School (right), Parksville





A sweeper is used to clean goose feces from the sports fields in Parksville Community Park.

A golf course manager reported losing revenue with golfers staying away because the course was “too messy”. The course supports a resident Canada Goose population of 30-50 that is augmented by “transients... stopping by”, resulting in total numbers of 150-200 geese. The manager noted that full moons resulted in more poop. Aside from cleanup, which takes 5-10 hours per week, time is spent removing goose tracks from sand traps.

In the Puget Sound area, the costs of re-establishing overgrazed lawns and cleaning droppings from sidewalks have been estimated at more than \$60/bird (Allan et al. 1995). In Connecticut, Huang (2010) found the occurrence of goose problems on golf courses was highly, positively correlated with the presence and amount of water on the course. Costs for turf damage and cleanup of feces and feathers ranged from \$0 to \$15,000, with a mean of \$2,800 (Huang 2010). The USFWS (2002), in an impact study for the conterminous U.S., recorded golf course damages of \$20,000 per green, and individual municipal cleanup costs exceeding \$150,000.

Turf management is made more complex and costly when geese overgraze and grub grassy areas and other landscaping, and compress and erode soils (USDA 1999; CWS 2010). So far, no one has explicitly identified these types of impacts in our area.

5.45 Distribution of Genetically Modified Seeds

Many plants propagate with the help of birds. Yet when Canada Geese were believed to have spread viable seeds of genetically modified (GM) wheat from one of Agriculture Canada’s experimental farms, there were a flurry of responses from farmers and others concerned about mixing of ordinary crops with GM varieties, as GM products are more difficult to sell in certain markets (Spears 2013). This is probably a general bird issue, rather than a Canada Goose one, but still merits a note here. Farmers who have claimed their crops have inadvertently been cross-pollinated with nearby GM crops have been exposed to lawsuits from GM seed companies claiming they used the seed without paying necessary royalties (cf. Gillam 2013).



Canada Geese at Morningstar Golf Course

Chapter 6 - Population Structure Highlights

This chapter characterizes the regional Canada Goose population by subpopulations and migrant types. Together with Chapter 10, Population Trends, it lays the foundation for Goal 1 (setting population objectives).

There appear to be three mostly distinct, but sometimes overlapping subpopulations in the region, corresponding to geese banded at the Little Qualicum River, Englishman River, and Craig Creek estuaries (LQRE, ERE, and CCE, respectively).

Resident' and 'non-migratory' have multiple meanings. In the U.S., resident geese are often defined as those that nest and reside predominantly within the conterminous United States. Geese nesting in southern Canada are often called 'temperate-breeding geese'. 'Northern-breeding' geese nest in northern Canada and Alaska, and tend to migrate greater distances than migratory, temperate-breeding geese.

Resident geese are not birds that have lost their ability to migrate. Canada Geese have a strong fidelity to nesting areas. When geese, particularly female geese, reach breeding age, they return to their birthplaces to nest. This repeats year after year. It is likely that the earliest residents were transplants from other regions, or the progeny of birds held in captivity.

Some say that resident Canada Geese do not migrate because all of their needs are met at home. However, we identified 14 migrant types among birds that were supposedly 'resident', captured during the nesting and moulting periods: local residents, local residents plus, moult and winter residents, moult migrants, migrants, dispersed juveniles, emigrants, returned juveniles, Vancouver Island migrant, Vancouver Island moult migrants, B.C. migrants, Alberta migrants, U.S. migrants, and U.S. moult migrants. We defined local residents as geese that were locally present in all five seasons of the Canada Goose life cycle - spring migration, nesting, moult, fall migration, overwintering. Although local residents are the foundation of the year-round regional Canada Goose population, other migrant types are always present.

The three estuary-based subpopulations were comprised of different blends of migrant types. The LQRE subpopulation had the most emigrants and Vancouver Island migrants but no moult migrants and the fewest number of local residents. CCE-banded birds had the highest proportions of moult migrants, moult-winter residents, and local residents plus (present for at least 6 months but absent for at least one season, over multiple years). ERE-banded birds had the highest proportion of U.S. migrants and local residents. Because our birds were banded at the nest and during the moulting period, and Canada Geese are known to migrate north to moult, none of our marked birds would have been northern-breeding migrants.

Local resident populations now rival or exceed long-distance-migrant populations in all flyways, likely because these migrants face a wide range of threats and energetically demanding activities (e.g., long flights, snow and ice-covered food and water resources), while local residents spend more time loafing/ resting, roosting, and grazing within familiar landscapes.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

6.1 Banding



Two bands, a U.S. Fish and Wildlife Service (USFWS) metal leg band and a plastic black-on-yellow leg band, identified Canada Geese captured at their nests on the Englishman River estuary. Photo by Guy Monty.



Nesting Canada Geese on the Little Qualicum River estuary were banded with black-on-pink leg bands.

To characterize our regional Canada Goose population, we looked for marked (i.e., banded and collared) geese during regularly scheduled goose counts. It is assumed that the information gathered from re-sights of this marked sample can be extrapolated to the greater population.

The Canada Goose banding program began at the Englishman River and Little Qualicum River estuaries in 2008. Stealth and salmon nets were used to catch Canada Geese at their nests; plastic-coated nets did not get caught in the birds' feathers and were less stressful to use, for the geese and the banders. A total of 19 Canada Geese were banded at their nests at the ERE over 3 nesting seasons (i.e., 5 in 2008, 8 in 2009, and 6 in 2010) (Clermont 2010, June). At the LQRE, 3 Canada Geese were banded at their nests (1 in 2008, 2 in 2009). During the moult in July 2009, 9 flightless adults and juveniles were corralled and banded at the LQRE. These birds were marked with standard federal numbered aluminum alloy bands and plastic alphanumeric leg bands (e.g., A1F). ERE leg bands

were black-on-yellow, and LQRE bands were black-on-pink.

The Guardians later purchased plastic neck collars to mark additional birds, as observers were challenged to see the leg bands when the birds were on the water or standing in tall grass. In July 2010, 85 moulting Canada Geese were trapped at the LQRE and marked with numbered K-series, black-on-white collars (e.g., K001), bringing the total number of geese marked at the LQRE to 97 birds (Clermont 2010, September). Also in July 2010, 70 moulting Canada Geese were trapped at the ERE and marked with numbered M-series collars (e.g., M001). In May 2011, four more birds were collared at the ERE, bringing the total number of geese collared there to 93.

In July 2012, 106 moulting Canada Geese were trapped and marked at the CCE with numbered T-series collars (e.g., 001T) (Morrison 2013). These collars were glued with E-6000 adhesive to prevent the collar loss experienced with the K and M-birds. In all, 296 Canada Geese were banded from the three estuaries.

More than 12,707 survey records - some dating back to 1989, as well as 1,663 nest (addling) records, and 4,746 records of re-sighted marked Canada Geese over the last seven years (2008 - 2014) were used to examine the structure, abundance, and distribution of our regional Canada Goose population.



Canada Geese on the Englishman River estuary were marked with USFWS metal leg bands and M-series, black-on-white plastic collars.



Release of geese rounded up at the Craig Creek estuary in 2012. We ran out of bands before we ran out of birds to band.

All birds were marked under appropriate CWS scientific capture and band permits.

It is noteworthy that unusual preening behavior was observed among some collared birds. This issue merits further investigation.

Limitations

Marked Canada Geese were sexed or aged only when it was easy to do so (e.g., goose and gander could be differentiated at the nest, as only the goose incubated the eggs). Without this information, certain types of analyses were impossible.

Some birds banded at the LQRE and ERE removed their collars. Collars were glued to prevent loss, for geese banded at the CCE.

Once flocks had been collared, leg-banded geese may have been under-represented in surveys generally, as surveyors were often positioned at distances where collars could be read with a spotting scope.

Because all marked birds were captured during the nesting and moulting seasons, the sample is heavily biased to specific migrant types, notably birds that are locally resident during the spring and summer, and moult migrants. (See Chapter 6.4 for a description of migrant types.)



Englishman River estuary round-up. Canada Geese were herded into a trap, banded, and collared during the moulting period in July.

Compared to coloured leg bands, collars were much easier to read in tall vegetation, on the water, and at a distance.
Photo by Guy Monty



6.2 Goose Surveys

6.2.1 Survey Areas and Sites

CWS/MoE established routes and survey areas in the late 1980s, and in subsequent years, areas were added or merged. By the mid-2000s, the region was divided into 17 survey areas (Figures 6-1 and 6-2, Table 6-1). A group of volunteer surveyors were responsible for surveying one or more of these 17 survey areas.

Most areas included habitats that geese would be unlikely to use, such as forests. It is unclear whether Canada Goose populations were growing and expanding into new areas, whether the survey effort was increasing, or both.

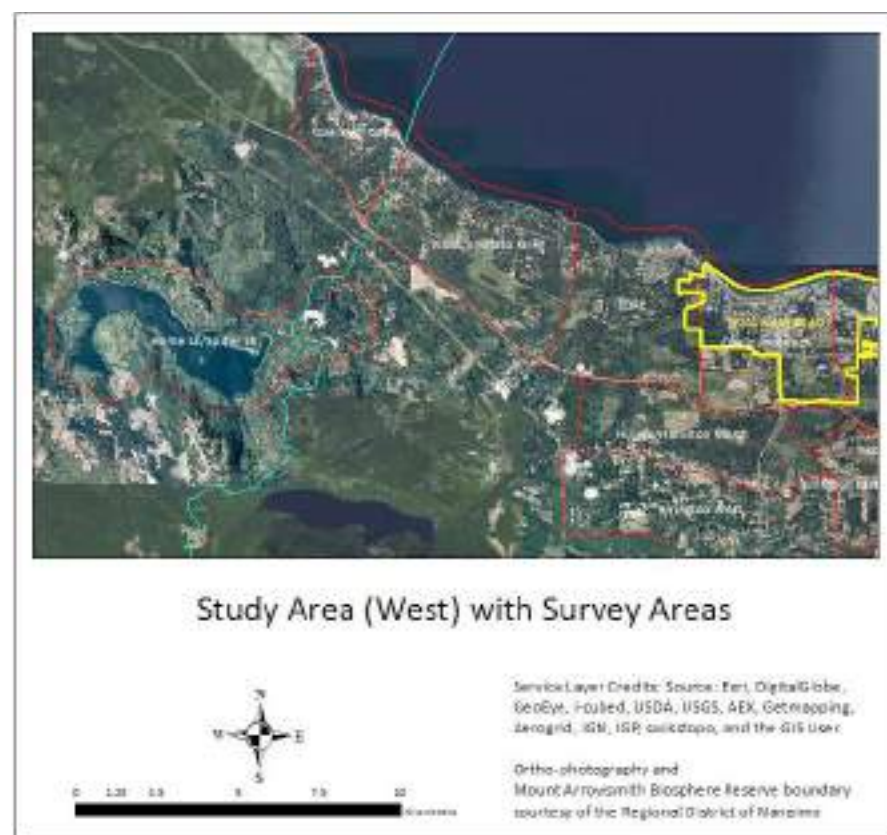
The Guardians used the 17 areas for later surveys (and many of the same volunteers), but also mapped 342 specific survey sites within the larger areas.

Each site that encompassed known or potential goose habitat was designated one of seven habitat types: crop, meadow, estuarine marsh, estuarine other, includes freshwater, greens/lawns, or marine (See Appendix A). Site mapping occurred over time, as geese were discovered on new sites and survey routes expanded. Some sites were lost to development. There are also potential goose habitats that were not mapped, because they were difficult to access or simply

because geese were never observed there.



See Appendix A for maps of survey sites.



Limitations

Progressively expanding survey areas made it difficult to discern changes in population size from changes in survey area and effort. We addressed the issue of survey effort by limiting specific components of our analysis to areas where geese had been observed, by eliminating peripheral areas that were added to later surveys, or by using densities, rather than total numbers.

Figure 6-1. Study area (west) with survey areas and sites. The MABR boundary is turquoise, the area polygons are red, and the boundaries of the municipalities are yellow.

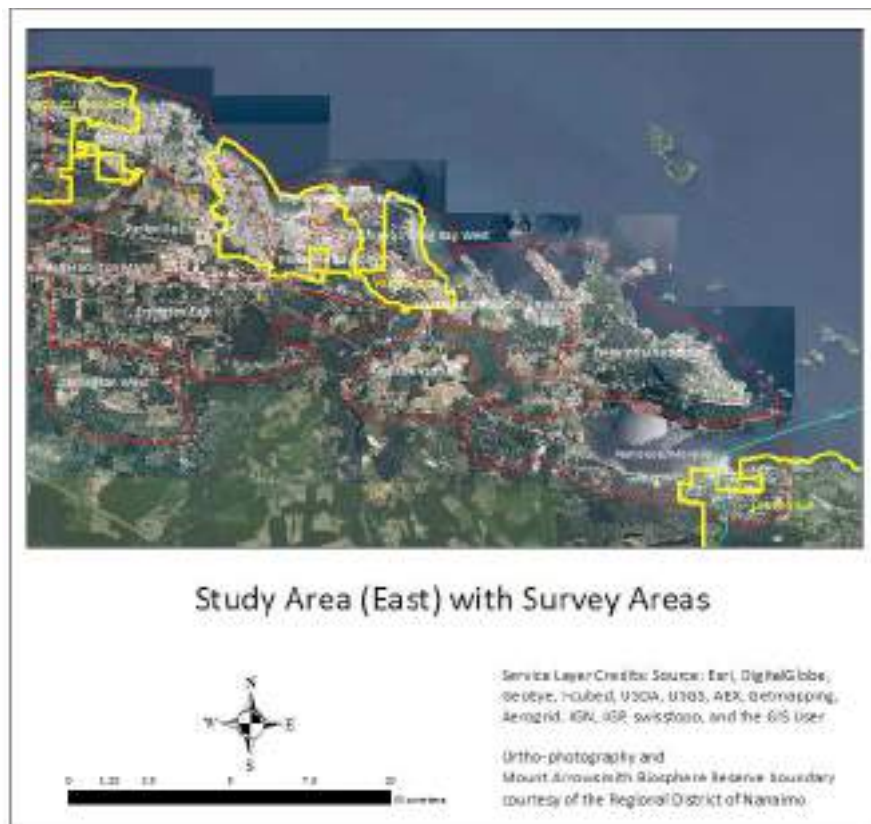


Figure 6-2. Study area (east) with survey areas and sites. The MABR boundary is turquoise, the area polygons are red, and the boundaries of the municipalities are yellow.

6.22 Survey Types

We conducted several types of regular surveys, including winter/autumn counts, moult counts, routine population counts, addling counts, and waterfront counts. A 'dawn to dusk survey' was carried out to augment the data from regular counts. Each of these are described below. Survey dates are shown in a series of calendars in Appendix B.

6.23 Winter/Autumn Counts

Autumn surveys conducted from 1989 through 1993 by CWS and MoE (Dawe & Morrison 1989, 1991; Dawe, Martin & Morrison 1994; Dawe, Monty &

Clermont 2006) provided a baseline for our surveys. Limited visibility (fog) in November 2005 caused surveyors to repeat the count in January 2006, whereupon they discovered greater numbers of birds were present in winter. The Guardians then replicated this survey in January 2012, 2013 and 2014, as an assessment of peak overwintering birds.

6.24 Moulting Counts

Summer moult counts were conducted in 2007, and 2011 through 2014. Surveys focused on the Parkville-Qualicum Beach Wildlife Management Area and larger freshwater bodies.

Limitations

Because the November and January counts were conducted in different seasons, they were not directly comparable.

The 2012 to 2014 winter counts were only partly useful for gathering mark-re-sight data. Some forms stated, “the purpose of this survey is to do a count so don't worry too much about getting band/collar numbers. If you can simply mark whether bands/collars were present, it will give us information as to where banded CAGO have been seen so that we can go back at a later date to get the numbers”.

Table 6-1. Survey areas

Area ID	Size (ha)	Area Description
EE	179.1	Errington East
ERE	311.3	Englishman River Estuary
EW	177.6	Errington West
FC	182.7	French Creek
FNB	172.1	Fairwinds/Nuttal Bay
HHM	150.2	Hilliers/Hamilton Marsh
HSL	17.5	Horne Lake/Spider Lake
KDR	119.0	Kaye Road/Dawson Road
LQRE	186.1	Little Qualicum River Estuary
NBCB	319.5	Northwest Bay/Craig Bay East
NM	329.8	Nanoose/Morello
PBC	154.2	Parkville Bay/City
PCR	132.8	Parkville Church Road
QBA	98.7	Qualicum Bay
QBE	271.1	Qualicum Beach
RCB	221.6	Rathtrevor/Craig Bay West
WPF	155.0	Walsh's Potato Farm
All Areas	3,178.3	Study Area



Surveyor Aaron Ritchie conducting routine population counts in Errington, June 2014

6.25 Routine Population Counts

Population surveys were conducted from June 2011 through June 2014. Our most frequent surveys, they were performed monthly from January through March, and twice each month from May through December, whenever staffing or volunteer support was available. April surveys were abandoned in favour of adding efforts. Winter and moult counts replaced the January and first July surveys, respectively (Morrison 2013; Guardians of Mid-Island Estuaries Society 2014). The population surveys typically occupied a smaller area than the area surveyed during the winter count; for example, Horne and Spider Lakes were not included in regular population surveys but were included in winter counts.

Two routes, one for Parkville-Nanoose Bay, and the other for Errington-Coombs-Qualicum Beach, were driven by one or two surveyors as quickly as possible while counting Canada Geese and reading bands. Two surveyors often surveyed the entire area in one day. A single surveyor might require up to three days (Morrison 2013; Guardians of Mid-Island Estuaries Society 2014; A. Ritchie, pers. comm., 2014).



Addling crew leader Danielle Morrison beside a goose nest at the Little Qualicum River estuary

6.26 Addling Counts

The addling counts were not true surveys, as personnel only counted nesting pairs and the occasional marked bird on the nesting grounds. Non-breeding, unmarked birds on the periphery were generally ignored. See Chapters 12.11 and 12.2 for more information on the egg addling program.

6.27 Waterfront Counts

Waterfront surveys were conducted during the moult along the shoreline, first in 2012 to find out how Canada Geese were moving leading up to the July 2012 roundup, and shortly thereafter to locate the newly marked geese (Morrison 2013). In 2013, waterfront surveys were done to look for geese returning for the moult. Waterfront counts were not comparable from year to year, or to other types of surveys. They were most useful for re-sighting marked birds (D. Morrison, pers. comm., 2014).

6.28 Dawn to Dusk Survey

Because our surveys were conducted in the daytime using repetitive routes, and estuaries were known to be important loafing/resting and roosting sites, we conducted a survey every two hours from 1 p.m. to dusk on November 13, 2014, and from dawn to 1 p.m. November 14, on the Craig Creek estuarine marsh and outer estuary to determine whether the timing of surveys had a profound impact on our knowledge of their movement and use of the estuaries in particular (see Chapter 8.61, Seasonal

Distribution, Autumn Migration - A Cold Day in November). The survey was initiated during the hunting season, and over a cold snap, which augmented our understanding of these factors on Canada Goose movement.

Limitations

Our surveys did not measure the sensitivity of birds to egg addling crews or surveyors, although there was some evidence during banding at the nest and addling that, in general, LQRE geese were more skittish than those at the ERE. They were easily flushed off their nests and quick to leave the area if one ventured too close. These propensities likely affected nest detectability, although many repeated visits to the estuaries for egg addling may have minimized any significant differences.

Notably, in an experiment designed to measure flushing and return time related to human disturbance, Miller, Abraham, and Nol (2013) found the frequency of visits did not affect either flushing distance or return time.

Limitations related to seasonal detection and survey effort are described in Appendix C.

6.3 Subpopulations

The marking of Canada Geese at three separate estuarine sites affords a window into potential management strategies that would not be present had the study used a single capture site. We can better examine the characteristics and mixing of the three groups to determine if we have a single population where individuals freely mix, two or more spatially disjunct metapopulations which interact through immigration/emigration,

or two or more loosely defined subpopulations.

If the marked birds freely mix, and use habitats in similar ways at similar times, then management techniques that successfully control some birds may be useful for the others. If the regional population is largely segregated, a one-size-fits-all approach could fail. Management activities would need to be employed at finer scales to be tenable (cf. Huang 2010).

On separating re-sights of the marked Canada Geese into groups based on where they were banded (i.e., CCE, ERE, LQRE groups), there appear to be three mostly distinct, but sometimes overlapping subpopulations (Figure 6-3). Assuming the marked birds are representative of the regional population, the LQRE, ERE, and CCE subpopulations merit different management approaches.



Figure 6-3. Re-sights of marked Canada Geese banded at the Craig Creek estuary (CCE), Englishman River estuary (ERE), and Little Qualicum River estuary (LQRE), 2008-2014.

6.4 Migrant Types

6.41 What is a “resident” Canada Goose?

There is a vast body of literature identifying and attempting to manage the ‘too many geese’ problem. A Google search on “Canada Goose” and “problem” on November 24, 2014 yielded 7,870,000 hits. “Canada Goose” and “resident” landed 413,000 results, only ~5% of the broader search, yet the perception of many is that resident geese cause most of the problems (e.g., Vancouver Sun 2008; Eckberg 2010). Are they, as some have proposed, birds that have lost their ability to migrate? Or as others have suggested, are they individuals that don’t need to go anywhere else because they have everything they need right here? (cf. CWS 2011).

The rootedness of non-migratory Canada Geese is likely a function of a strong fidelity to nesting areas, which is well documented in the literature (e.g., Balkcom 2010). Howard Breen (1990) suggested the earliest residents were injured females unable to return to their traditional nesting sites. When their progeny reached breeding age, they returned to their birthplaces to nest. With the return of subsequent generations, local numbers increased from year to year. In our area, the earliest residents were more likely to be transplants from other regions, or the progeny of transplanted birds held in captivity, than injured birds. Yet the end result

was the same. Breeding birds returning to the nesting areas to breed year after year, and their returning young, could generate exponential growth in local breeding populations if they were not constrained by natural limitations, such as the availability and quality of habitats, as well as human controls (e.g., egg addling).

The notion that geese stay home because their current landscape provides them with everything they need is more complex. Simply put, if local resources met the needs of all geese in the area, none would migrate.

Importantly, fourteen migrant types have been identified in this region, and all of these birds have been sufficiently ‘resident’ to enable capture and marking during the nesting and moulting periods.

The capture of birds on the nest and during the moult was expected to restrict the study to a mostly resident population. Birds that do not nest or moult in the estuarine capture areas may use the region but were mostly absent from our mark/re-sight data. In other words, migrants were under-represented and our understanding of them is restricted to those captured and marked. Northern-breeding migrants were probably unrepresented.

Terms such as, “resident” or “nonmigratory”, have multiple meanings, largely depending on the scale at which they are applied. In the U.S., resident geese are typically defined as ‘non-migratory geese that nest and reside predominantly within the conterminous United States’ (cf. USDA 1999). In other words, geese that rarely cross the Canadian border are U.S. residents. The Subcommittee on Pacific Population of Western Canada Geese (2000) described the Pacific populations of Western Canada Geese (*B.c. moffitti*) as “relatively nonmigratory, with many segments wintering on or in close proximity to breeding areas” (p. 1). Geese nesting or moulting in southern Canada are often called ‘temperate-breeding geese’ (cf. Fraser & Fraser 2010).

For the purpose of this regional strategy, ‘local residents’ refer to birds that are locally present in all periods, or seasons, of the Canada Goose annual life cycle (i.e., spring migration, nesting, moulting, fall migration, overwintering). In the following typology, local residents and migrants are further differentiated.

6.42 Assigned Migrant Types

Migrant types, shown in the box below, were delineated and assigned to each marked Canada Goose, based on their encounter history (i.e., site, date, and frequency of re-sights).

Of all 296 marked birds, more than a third (36.5%) were present in our area for 6 months or more (Figure 6-4). A few others (2.4%) were present only during the moult and winter.

Another 4.4% were characterized as moult migrants, birds that come back to the area to moult, and may be present before and after for a short time (see 8.4, Moulting).

More than 15% had dispersed, emigrated, or otherwise disappeared within two years of banding.

Less than 1% were identified as juveniles that had dispersed and returned to breed; however, most banded birds were not aged, so this number may be low.

Also, 13.5% were some form of migrant - they were present in the area only sporadically, or had been documented elsewhere on Vancouver Island, the Gulf Islands, in mainland B.C., Alberta, Washington, Oregon or California.

Nearly a third (27%) could not be assigned a migrant type based on existing information.

Four birds deemed to be migrants nested in our area, including one Vancouver Island migrant (observed in Bowser in September). This appears to contradict the notions that only

local residents nest locally, that our local area boundary encompasses an entire population, or both.

Estuary-based subpopulations were characterized by unique blends of migrant types (Figure 6-5). For example, there were fewer local residents and more emigrants among the LQRE-marked birds when compared to the ERE and CCE-marked birds



Local resident 065T preening at the Craig Creek estuary

A TYPOLOGY OF MIGRANT TYPES

Local Resident (LR): Locally present in all periods or *seasons* of the Canada Geese annual life cycle (spring migration, nesting, moult, fall migration, overwintering), consecutive or not. Generally more than 20 resights over several years.

Local Resident Plus (LR+): Locally present in at least 6 calendar months. Not seen for at least one season over multiple years.

Moult and Winter Resident (MWR): Present during the moult and in winter, over the bird's entire encounter history.

Moult Migrant (MM): Present during at least 2 consecutive moult periods. Not seen during nesting and winter.

Migrant (M): Present sporadically, over at least a 2 year encounter history. May have been observed just outside the study area.

Dispersed Juvenile (DJ): Juvenile dispersed (or dead). Confirmed 'hatch-year' (HY) when banded. Locally present until at least the end of the first calendar year, but less than 2 years, then absent.

Emigrant (E): Emigrated (or dead). Age likely 'after-hatch-year' (AHY) or unknown (U) when banded. Locally present until at least the end of the first calendar year, but less than 2 years, then absent.

Returned Juvenile (RJ): HY bird that has returned to nesting/moult area after a period of absence

Vancouver Island Migrant/Moult Migrant (VIM/VIMM): Resighted on Vancouver Island outside of the local study area

B.C. Migrant (BCM): Resighted on the Gulf Islands or mainland B.C.

Alberta Migrant (ABM): Resighted in Alberta.

U.S. Migrant /Moult Migrant (USM/USMM): Resighted in the U.S.A.

Not Enough Information (NEI): Not enough information to assign a migrant type, or not seen or died in the first calendar year.

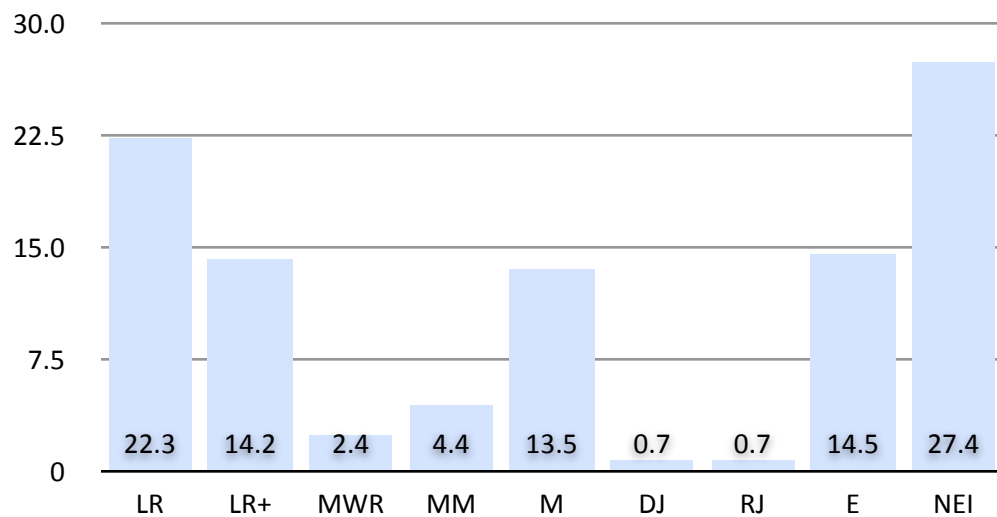


Figure 6-4. Migrant types of Canada Geese banded in the study area (%) (n=296). (See box for descriptions.)

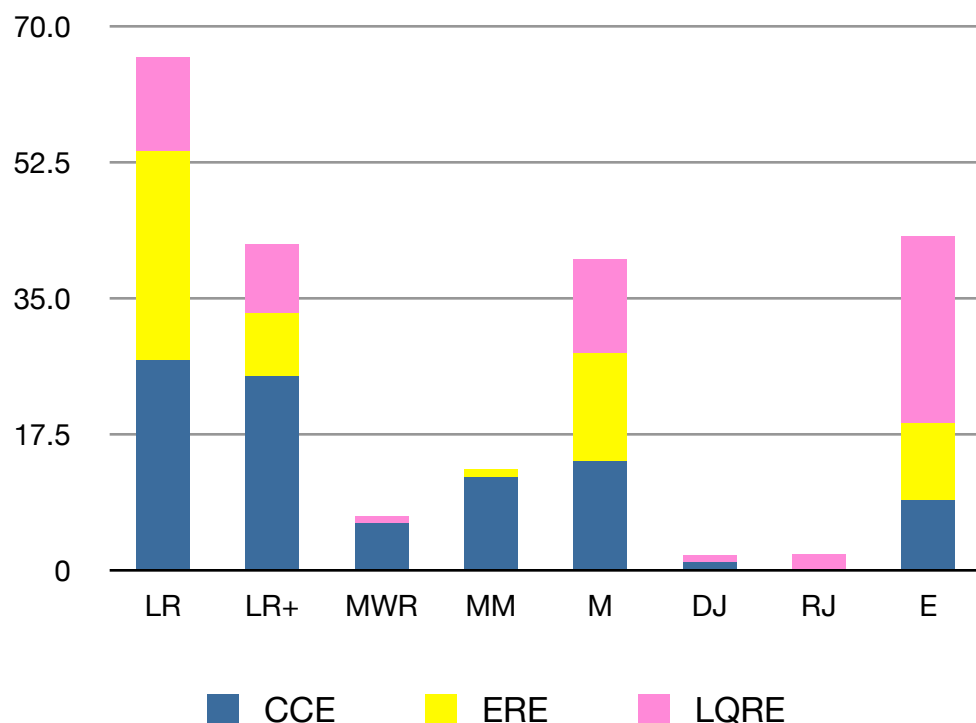
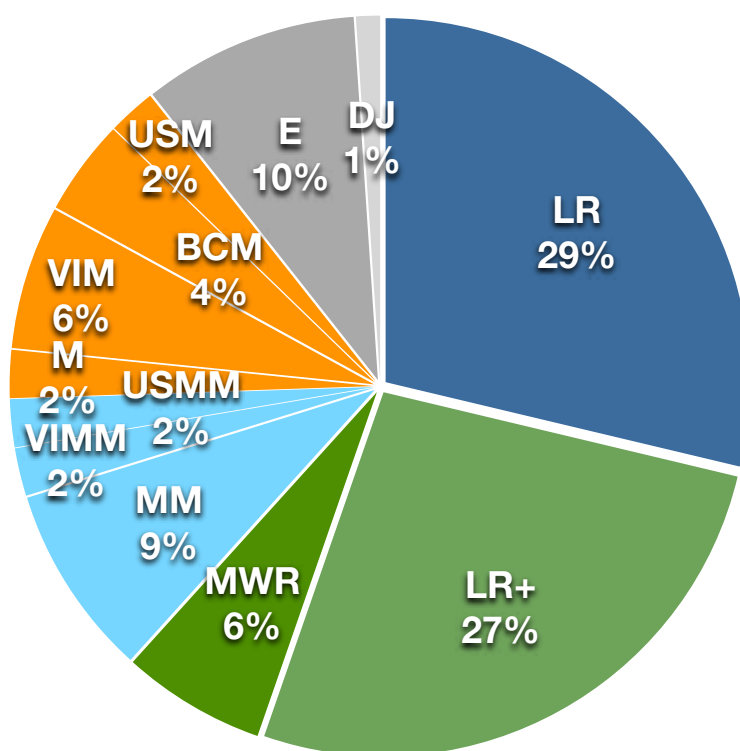


Figure 6-5. Migrant Types by Banding Location. Shown are the migrant types of Canada Geese banded at the Craig Creek estuary (CCE) (n=94), Englishman River estuary (ERE) (n=60) and Little Qualicum River estuary (LQRE) (n=62) (n assigned migrant types =216)

Craig Creek Estuary

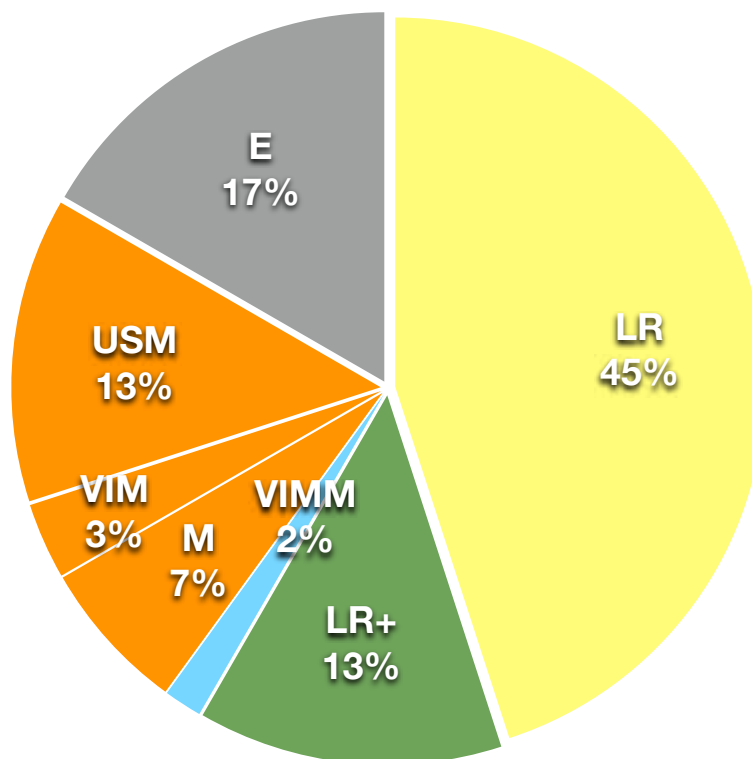
Compared to the other estuaries/banding sites, Canada Geese banded at the CCE had the highest proportions of moult migrants (MM) and moult and winter residents (MWR) (Figure 6-6). The CCE also supported the highest percentage of LR+ birds, which were present for at least 6 months of the year, but absent for at least one season over multiple years.

Figure 6-6. Migrant types of Canada Geese banded at the Craig Creek estuary (n=94). An additional 12 birds (11% of all Canada Geese captured at the CCE) were not assigned a migrant type.

***Englishman River Estuary***

Canada Geese banded at the ERE had the highest proportion of local residents (LR), and the highest percentage of U.S. migrants (USM) (Figure 6-7).

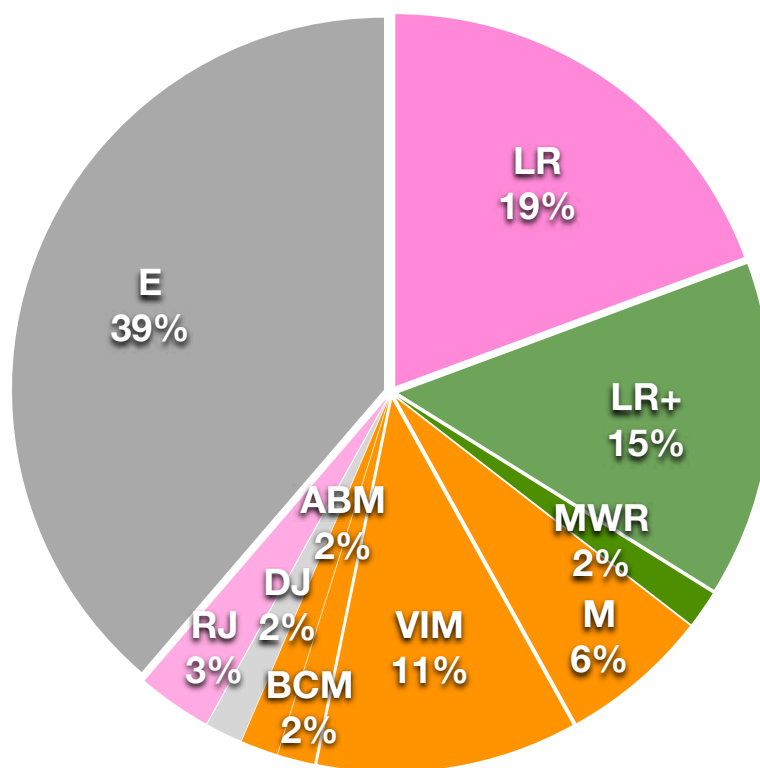
Figure 6-7. Migrant types of Canada Geese banded at the Englishman River estuary (n=60). An additional 33 birds (35% of all Canada Geese captured at the ERE) were not assigned a migrant type.



Little Qualicum Estuary

The LQRE supported the fewest number of local residents (LR), the highest proportion of emigrants (E), the only returned juveniles (RJ), and the highest percentage of Vancouver Island migrants (VIM), when compared to other banding locations (Figure 6-8). There were no moult migrants identified from the LQRE.

Figure 6-8. Migrant types of Canada Geese banded at the Little Qualicum River estuary (n=62). An additional 35 birds (36% of all Canada Geese captured at the LQRE) were not assigned a migrant type.



6.43 Migrant Types and Home Ranges

Canada Geese that are local residents or migrate for only short distances are known to have compact home ranges (cf. Giles 2010). Home range sizes for local residents were as small as 130.1 ha and as large as 18,585 ha, with a mean of 1,796.8 ha (or ~18 km²). ERE-banded birds had the smallest home ranges (130.1 to 2,814.6 ha, averaging 927.5 ha (or 9.3 km²); for context, the City of Parksville is ~1243 ha in size. By comparison, Groepper et al. (2008) reported mean home range sizes of 25.3 km² for

resident females near Lincoln, Nebraska.

Migrants and moult migrants were clearly distinguishable from other migrant types by an index derived from their home range parameters (Figure 6-9). Appendix D provides summaries of encounter histories and associated maps for each migrant type, for marked Canada Geese that exemplify typical home ranges and have been re-sighted more often than others. Table D-1 in the Appendix shows that most U.S. migrants and moult migrants were re-sighted during the spring and fall migrations.



M055 was a moult migrant banded at the ERE in July 2010. It was spotted in Washington during the spring migration, nesting, and autumn migration periods, and came back to the ERE and CCE to moult in 2011, 2012, and 2013.

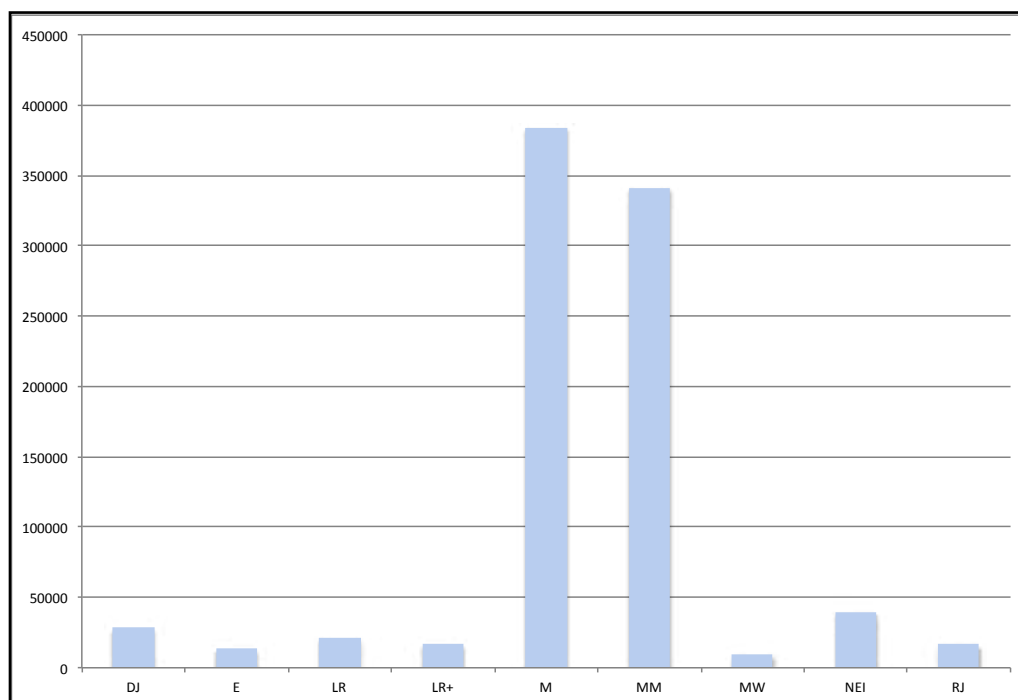


Figure 6-9. Mean Home Range Index. Minimum Convex Polygons (MCPs) were used to calculate the maximum distance between observations, the area of the home range, and its perimeter. These values were summed to create a home range index for each Canada Goose, and then averaged across migrant types. The “y” axis values are relative, not absolute.

6.44 Local Residents and Long-distance Migrants

Whereas geese that migrate long distances face a wide range of energetically demanding activities and threats (e.g., short growing seasons, long flights, cold weather, snow and ice-covered food and water resources, predators, cell phone towers and other structures to collide with, hunting seasons timed to their migration), local resident Canada Geese are more likely to spend their time loafing/ resting, roosting, and grazing (USFWS 2002). Although local residents are more likely to be exposed to toxins and pets

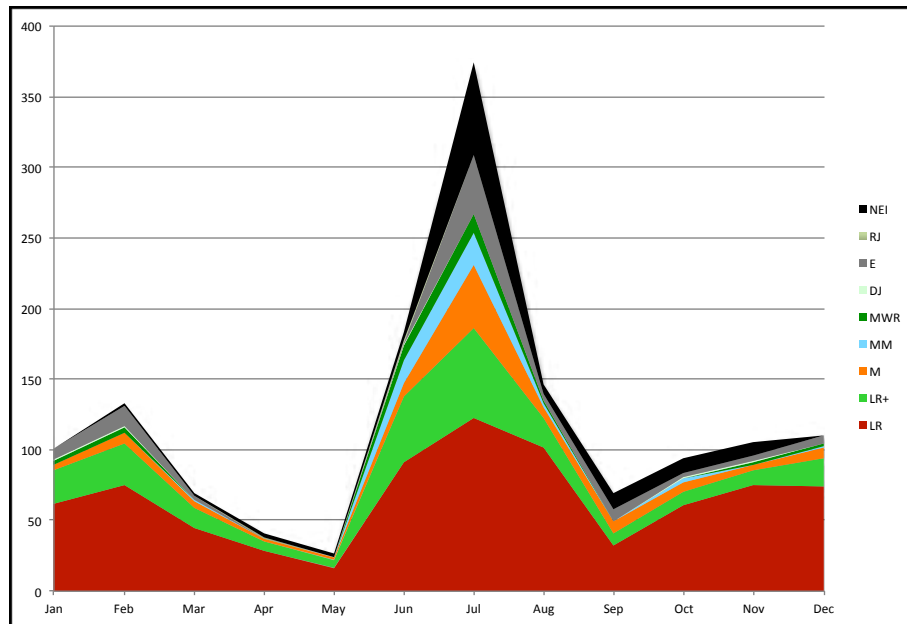
(USFWS 2002), their familiarity with the distribution of food resources, roost sites, cover, predators and hunters may offer significant reproductive and survival benefits (Hestbeck, Nichols, & Malecki 1999; USFWS 2002; Beaumont 2013).

With higher potential population growth rates, local residents, once a small fraction of total goose populations, may now rival or exceed migrant numbers in all flyways (USFWS 2002).

Notwithstanding, differentiating migratory Canada Geese from resident Canada Geese has been increasingly

difficult for agencies to do. Migrants were once surveyed on wintering areas, as they were concentrated and easier to count. Once it was realized migrants and residents were mixing on the wintering grounds, migrants were counted on their breeding areas. However, the timing of counts was an issue. Nesting birds were difficult to spot, and moult migrants were on migrant breeding areas later in the season. Thus the reliability of surveys to detect long-distance migrant Canada Geese has continued to decrease as resident populations have increased (cf. USFWS 2002).

6.5 Relative Abundance of Migrant Types and Subpopulations

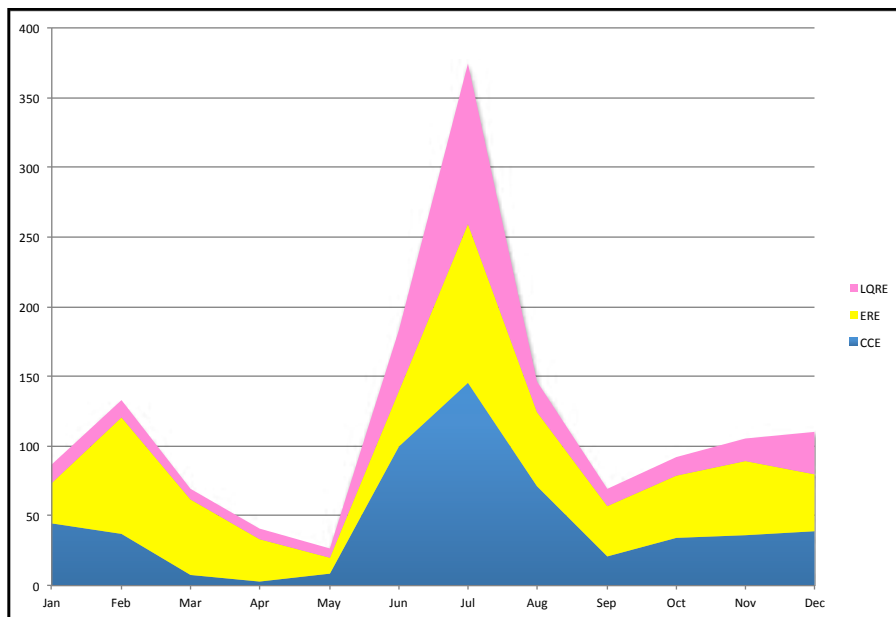


Local residents (LR) are the foundation of our year-round regional Canada Goose population, but other migrant types are always present (Figure 6-10).

Limitations

Limitations related to seasonal detection and sampling intensity/survey effort are described in Appendix C.

Figure 6-10. Marked Canada Geese re-sighted each month, by migrant type, 2008-2014, corrected for sampling intensity ($n = 4,731$). Numbers along the “y” axis are relative, not absolute.



Compared to the other estuary-based subpopulations, fewer birds returned to the LQRE after the winter and to nest (Figure 6-11). Canada Geese marked at the ERE included a local resident cohort present throughout the year. CCE-marked birds were most plentiful in our area during the moult period.

Figure 6-11. Temporal distribution of Canada Geese banded at the Craig Creek estuary (CCE) ($n=106$), Englishman River estuary (ERE) ($n=93$), and Little Qualicum River estuary ($n=97$) (n marked Canada Geese = 296), corrected for sampling intensity. Numbers along the “y” axis are relative, not absolute. Counts have been summed for all years (2008-2014).

Chapter 7 - Canada Goose Seasons

Highlights

This chapter describes five Canada Goose 'seasons' that delimit the temporal distribution of marked geese, underpinning Goal 2 (setting temporal management objectives).

Although there is considerable overlap among Canada Goose seasons, we have delimited them as follows: spring migration = February/March, nesting = April/May, moulting = June to middle of August, fall migration = middle of August to end of November, overwintering = December/January.

Canada Goose Seasons



Canada Geese overwintering in the Craig Creek estuary, January 8, 2005

The Canada Goose life cycle consists of a series of 'seasons', including spring migration, nesting, moulting, fall migration, and overwintering. Finer life cycle descriptions include pre-nesting and brood-rearing periods. Table 7-1 divides the year into life cycle seasons; the first row shows hard boundaries between each period. In reality, these seasons overlap, as some birds begin nesting earlier

than others, some linger at the moulting areas while others move on, and so forth. These 'true' seasons are also shown in the table.

Seasons were delimited mainly by examining the movements of marked birds. The nesting season was derived from observations made over 7 years of egg adding on the estuaries. Brood-rearing was determined based on a 25-28 day incubation period.

Table 7-1. Canada Goose seasons. The first row divides the year into an annual cycle encompassing overwintering, spring migration, nesting, moulting, and fall migration periods. In the rows below, entire, overlapping seasons have been delimited wherever possible.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Over-wintering	Spring Migration		Nesting		Moulting			Fall Migration			Over-wintering
	Spring Migration: ends Mar 22										
	Pre-nesting: begins Mar 8										
			Nesting: Mar 30 - May 30		Laying (B.C.): March 13 to July 6 (<i>Birds of British Columbia</i> , Campbell et al. 1990). Peak laying April 1-14 (Dawe & Davies 1975).						
			Brood-rearing (hatch): April 24 - Jun 27			Brood-rearing from hatch to fledging (B.C.) April 15 to August 24 (<i>Birds of British Columbia</i> , Campbell et al. 1990). Peak hatching May 6-19 (Dawe & Davies 1975).					
				Moulting: May 17 - Aug 22, most May 31- Aug 16							
Over-wintering: ends Feb 22									Overwintering: begins Oct 26, most after Dec 6		

Chapter 8 - Seasonal Distribution

Highlights

This chapter describes the seasonal distribution of marked geese. This information is instrumental for Goal 2 (setting temporal management objectives) and Goal 3 (setting spatial management objectives).

During the spring migration period, 11 of our marked birds were observed or shot outside of the region: in Victoria, the Saanich Inlet, Lower Mainland, Washington, Oregon, and California. During the nesting season, 5 marked birds were observed elsewhere: Campbell River, Bowser, Cowichan Valley, Maple Ridge, and Washington. During the moulting period, 4 marked birds were observed elsewhere: just outside of the biosphere region in Qualicum Bay, and in Campbell River, Washington, and Oregon. During the autumn migration period, 16 marked birds were observed elsewhere: Comox Valley, Gabriola Island, Chemainus, Saltspring Island, Lower Mainland, Alberta, Washington, and Oregon. In winter, 10 marked geese were found elsewhere: Courtenay, Denman Island, Bowser, Cowichan Valley, Washington, and Oregon.

The distribution of Canada Geese differs by season. During the spring migration, Canada Geese were widely dispersed over many different habitats, in mostly small flocks. There was very little overlap among subpopulations. During the nesting season, geese were paired or in small flocks on the estuaries, or on other sites with freshwater, such as Hamilton Marsh. Again, there was very little overlap among subpopulations. During the moult, geese were found almost exclusively in estuarine, marine, and freshwater habitats. While the other subpopulations were observed mainly in 'usual' areas (e.g., LQRE-banded birds at the LQRE, Qualicum Beach, Hamilton Marsh, and Sunnymere Farms; ERE-banded birds at the ERE and in Parksville), CCE-banded birds were widely distributed along coastlines from north Lantzville to Qualicum Beach. In autumn, Canada Geese were more scattered and the subpopulations more mixed than they had been earlier in the year. In autumn, the greatest daytime concentrations of geese were on agricultural fields. Many geese also fed in urban and peri-urban fertilized grassy habitats, particularly those associated with freshwater. Distributions in winter were similar, yet flocks were more frequently observed in the estuaries during the day. In both fall and winter, estuaries were preferred roosting and loafing/resting sites.

Birds arrive on the nesting grounds in family units and quickly disband. Older, more dominant females nest earlier than young ones, and pairs that nested the previous year typically reclaim the same nest site. If suitable sites are unavailable, other breeding geese may forego nesting rather than venture far from the place where they were hatched. Yearlings and juveniles gather at the edge of the nesting territories. One and two-year old females may attempt to pair-bond or mimic older birds by building and tending nests. Juvenile ganders often disperse.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 8 - Seasonal Distribution

More Highlights

If the first clutch is destroyed, pairs may re-nest. From 2008 through 2014, only 3 marked pairs were known to re-nest. Then in 2015, 3 re-nests were discovered. Rather than re-nest, failed nesters may linger near the nest site and then form flocks with non-breeding geese, and still others may leave the area before moulting.

Prior to the moulting period, some Canada Geese leave their nesting grounds and travel considerable distances north (40 to 2,500 km or more) to favoured moulting sites in what is known as a moult migration. Most moult migrants are believed to be non-breeding geese, unsuccessful nesters, and pairs that have lost their broods. Thirteen of our marked birds were moult migrants from other areas, (e.g., from the Cowichan Valley, Victoria, Washington, and California), and one marked bird migrated to Campbell River to moult. Management techniques that cause nest failure, such as addling, may induce moult migration, reducing pressure on local moulting habitat but potentially increasing nuisance populations in other areas.

Migratory geese are attracted to areas where local residents gather, and within a few days can have a major impact on those habitats.

Estuaries are critical habitat for Canada Geese and other waterfowl when other areas are frozen.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

8.1 Spring Migration and Pre-nesting

During the spring migration, northern-breeding migrants travel from overwintering areas, mainly in the continental U.S., to nesting grounds in arctic and sub-arctic regions (CWS 2010). They typically leave their wintering grounds in late February and early March, linger in southern Canada to feed, and arrive in northern Canada in mid-May and early June (Howard Breen 1990; CWS 2010). This potentially places them in our area from late March to the end of April

(Campbell et al. 1990; CWS 2010). Our understanding of these birds is limited, as they would not be nesting on the estuaries, nor present during the moult; none should have been banded during our study.

During the spring migration/pre-nesting season, 11 of our banded birds, marked during the nesting and moult periods, were observed or were shot by hunters

on other parts of Vancouver Island (052T in Victoria, 006T and 053T in the Saanich Inlet), on the Lower Mainland (120T in Pitt Meadows), and in Washington (M055, M063, M067), Oregon (070T, M059), and California (022T, 066T) (Figure 8-1). There were no re-sights north of the study area. The earliest arrival date for these birds was May 20, suggesting none of them were northern-breeding migrants (Table 8-1).

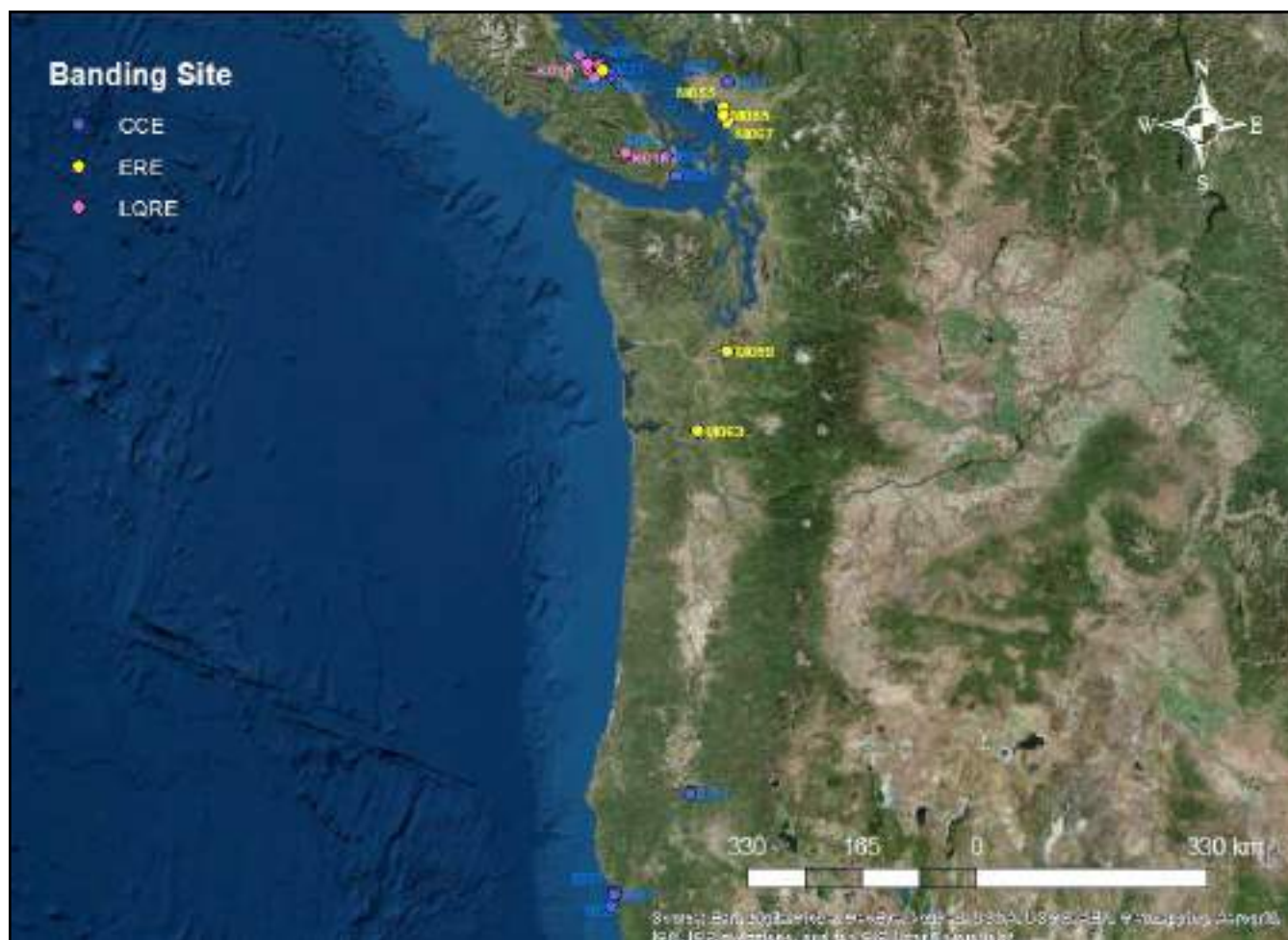


Figure 8-1. Spring migration (February/March) re-sights of marked Canada Geese, 2008-2014.

Table 8-1. Arrival dates of marked birds found outside of the region during the spring migration/pre-nesting period.

Canada Geese	Earliest Arrival Dates in the Region	Observed Elsewhere
006T	May 20, 2014	Saanich August 22, 2012 and March 16, 2013
022T	June 14, 2013 (was here until January 26, 2013 - local sightings in July, September, December 2012)	California March 2 and 22, 2013
052T	June 14, 2013	Victoria February 11, 2013 and West Saanich/Saanich Peninsula October 10 and 18, 2014
053T	no evidence of arrival/return since banding	Saanich August 22, 2012, Saanich Inlet March 2013, and October 10, 2014
066T	June 11, 2013	California March 2 and 22, 2013
070T	no arrival recorded after OR sighting	Oregon February 28, 2014
120T	N/A, shot in Pitt Meadows	Pitt Meadows February 26, 2013
M055	June 16, 2011; June 26, 2012; June 14, 2013	Washington October 23, 2010; May 6, 2011; November 12, 2012; February 5 and 6, 2014
M059	no arrival recorded after OR sighting	Oregon September 30, 2010; February 5, 2011;
M063	N/A, shot in Washington	Oregon September 30, 2010; Washington March 2 and December 21, 2011
M067	N/A, shot in Washington	Washington October 23, 2010; November 6, 2010; March 18, 2011

Although our migratory birds were too few to detect weather-related patterns, the timing of spring migration is known to closely follow weather variations. This has been shown to be most evident in migrants that travel only short distances (Lehikoinen, Sparks, & Zalakevicius 2004).

Increasingly, earlier arrival dates in the majority of migratory species are attributed to climate change (Lehikoinen, Sparks, & Zalakevicius 2004). Birds are known to react quickly to environmental changes, and to precipitate further changes in ecosystems by spreading seeds, diseases, etc. (Böhning-Gaese & Lemoine 2004). Our data do not cover a sufficient time period to detect shifts in arrival dates.

Within the study area, Canada Geese were found at all estuaries during the spring migration/pre-nesting period (Figure 8-2). LQRE and CCE birds were widely distributed, yet there was relatively little overlap among subpopulations. ERE birds were concentrated in the City of Parksville.

Spring migrants, in contrast to fall migrants, travel in smaller flocks over a longer period of time (Howard Breen 1990). The flocks are family units comprised of goose, gander, last year's goslings (i.e., yearlings), two or three year-old juveniles, and individuals that have lost their mates or had failed to pair-bond (Howard Breen 1990). They may migrate during the day or at night (Granholt 1988).



Figure 8-2. Spring migration/pre-nesting (February/March) re-sights of marked Canada Geese in the study area, 2008-2014

Local resident Canada Geese act as decoys, drawing long-distance migrants into the area (Smith, Craven, & Curtis 1999). Pairs, which typically mate for life, home to the female's natal area to breed (Bellrose 1976; Cooper 1978; Johnson et al. 1992, and many others). By the time the birds arrive on their nesting grounds, they have completed courtship, pairing, and copulation (Howard Breen 1990). Family units disband within a day or two of

arriving (Brakhage 1965).

During spring migration (and possibly during the overwintering period), migratory Canada Geese alter their diets to change their body composition and gain body weight (Krapu & Reinecke; Martin & Guignion 1983). The goose acquires most of the protein needed for reproduction at these times. Krapu and Reinecke (1992), synthesizing data from many different sources, reported that spring migrants spend about 80%

of their daylight hours feeding to build up fat reserves which will progressively deplete during the nesting season.

Early on, food availability may be restricted primarily to the underground portions of plants (USFWS 2002). Importantly, grubbing and subsequent damage to the estuarine marsh platform is more likely to occur when palatable, aboveground vegetation is unavailable.

In a study of migrating geese in Prince Edward Island, Martin and Guignion (1983) noticed a distinct feeding pattern in the spring. During the first two weeks of their stay, the birds were more confined to the estuary, lingering for 1-4 hours after sunrise before flying elsewhere. After the two weeks, they congregated near the centre of their estuarine roosting site just after dawn, and began leaving in small groups to feed in nearby

fields. Flocks moved from one field to another at least once each day, progressively inland as food resources were depleted. After many fields were cultivated, they returned to the estuary by midmorning to loaf and feed on the marshes (Martin & Guignion 1983).

In our region, there were many small flocks, with concentrations at the LQRE, ERE, Nanoose-Bonnell estuary, and Sunnymere fields -

suggesting many Canada Geese had arrived on their nesting grounds (Figure 8-3). Large flocks were observed in a variety of habitats, including meadow (Windhaven Farm adjacent to the LQRE, Sunnymere fields, Stanford Avenue field), estuarine marsh (French Creek), marine (Craig Bay east), and greens/lawns (Ballenas Secondary sports fields, lawn adjacent to the Nanoose estuary).

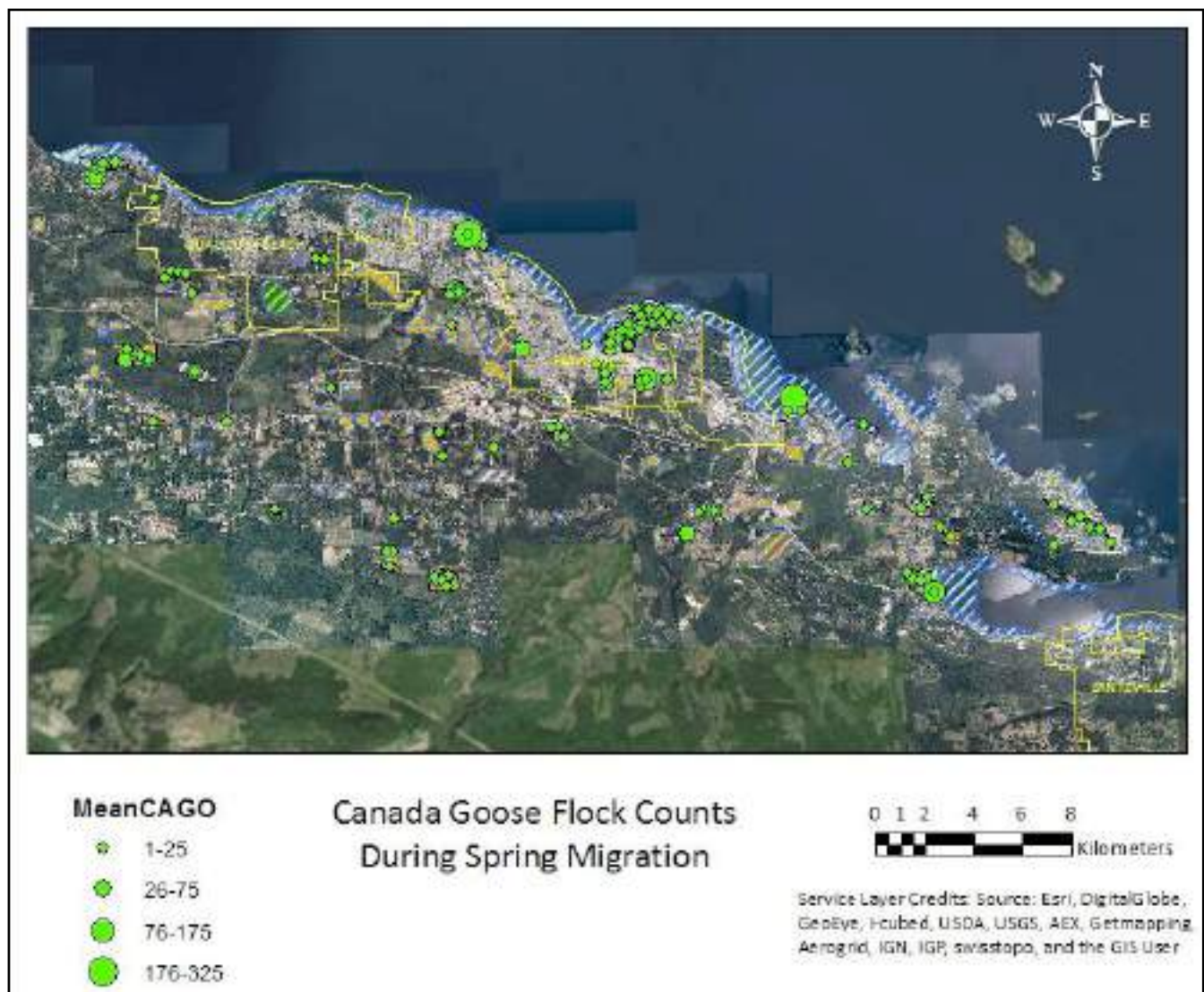


Figure 8-3. Canada Goose flock counts during spring migration, weighted for number of surveys (n=875).

8.2 Nesting

Canada Geese are the earliest of all waterfowl to breed (MoE, 1979). They may begin defending territories up to 6 weeks prior to egg laying (Brakhage 1965). Canada Geese that nested in southwestern B.C. typically established nesting territories by mid-March (CWS 2010).

Conflict over nest sites begins as soon as the flock arrives on the nesting grounds (Howard Breen 1990). The most aggressive birds hold the largest territories (Brakhage 1965). Brakhage (1965) found that territory size decreased

as incubation progressed; Cooper (1978) disputed this, albeit anecdotally.

Pairs that nested the previous year typically reclaim the same nest site. Other breeding females try to nest near the place where they were hatched (Granholm 1988). If suitable sites are unavailable, geese may forego nesting that season, rather than venture far from the original site (Howard Breen 1990).

Young or inexperienced geese begin nesting later than older females, perhaps because of the

time taken to establish territories, or because older birds are in better condition, as the condition of the female is known to influence the timing of nesting (Perrin & Birkhead 1983; Johnson et al. 1992). Brakhage (1965) found that females 5 years and older arrived on the nesting grounds earliest, and began laying first; laying followed an age-based hierarchy of dominance among females. The size of family groups is also linked to hierarchical position (which is probably correlated to the age of the dominant female) (Raveling

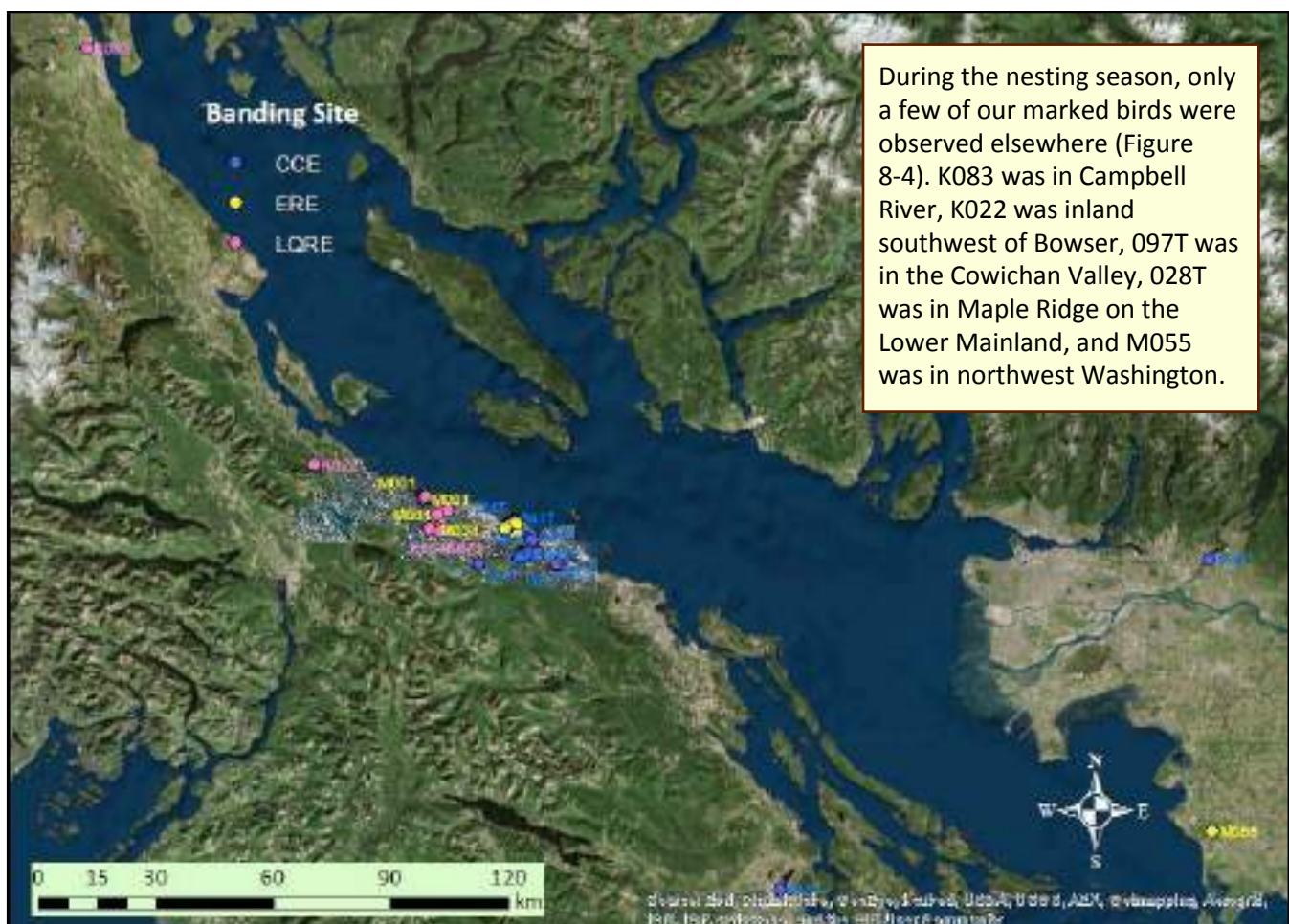


Figure 8-4. Nesting season (April/May) re-sights of marked Canada Geese, 2008-2014.

1970 in Anderson & Titman 1992). Weather (e.g., cold or hot temperatures, wind, rain) also affects the timing and occurrence of nesting (Johnson et al. 1992).

Yearlings and juveniles gather at the edge of the nesting territories (Granholm 1988). One and two-year old females stay near the natal area (Johnson et al. 1992). They may try to mimic older birds, attempting to pair-bond or build and tend nests. The next year, they may return to the same site to nest in earnest (Granholm 1988). Yearlings and unpaired males often disperse (MoE 1979; Johnson et al. 1992).

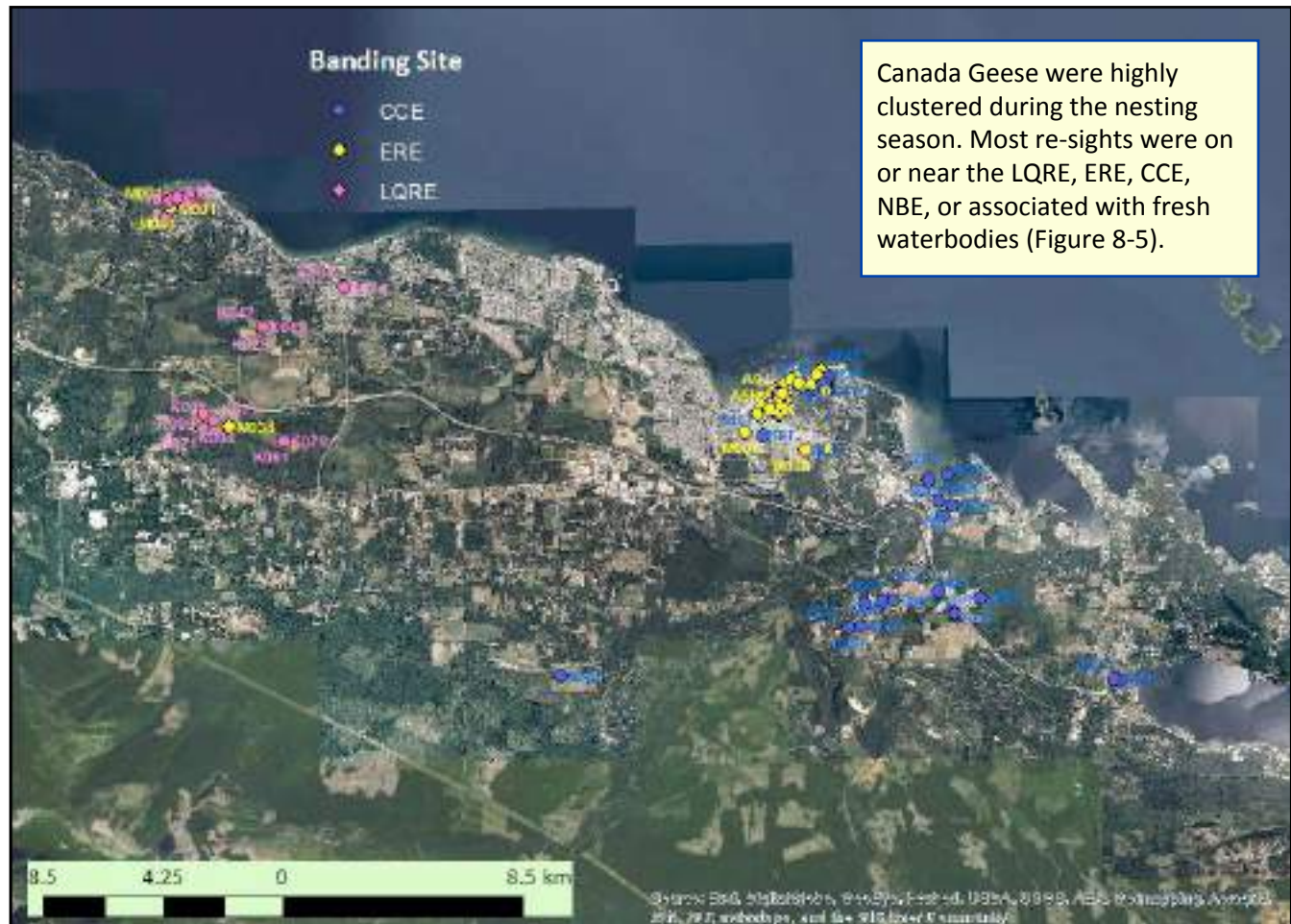


Figure 8-5. Nesting season (April/May) re-sights of marked Canada Geese in the study area, 2008-2014.



Nesting Canada Goose, April 21, 2011. Photo by Danielle Morrison.



Aside from M001, which was banded at the ERE, all marked birds observed at the LQRE had been banded there, i.e., they were marked with K-collars or pink leg bands (Figure 8-6).

Figure 8-6. Nesting season (April/May) re-sights of marked Canada Geese at the Little Qualicum River estuary, 2008-2014.



LQRE-banded Canada Geese were also found at Hamilton Marsh and Sunnymere pond during the nesting season, together with a single ERE-banded bird (Figure 8-7).

Figure 8-7. Nesting season (April/May) re-sights of marked Canada Geese in the vicinity of Hamilton Marsh, 2008-2014.



Figure 8-8. Nesting season (April/May) re-sights of marked Canada Geese at the Englishman River estuary, 2008-2014.

At the ERE, most observations were of M-collared or yellow leg-banded Canada Geese (Figure 8-8). Thirteen CCE-banded birds also nested at the ERE, including 6 paired with one another, and one paired with an ERE-banded bird. The lone LQRE-banded bird found on the ERE during the nesting season was a returned juvenile; it was observed April 17, 2013 at the ERE, then found at the LQRE on May 2, 2013. Outliers, e.g., Canada Geese found in downtown Parksville, were comprised of local resident, emigrant, migrant, U.S. moult migrant, and perhaps other migrant types.



Figure 8-9. Nesting season (April/May) re-sights, 2008-2014, of Canada Geese marked at the Craig Creek estuary.

CCE-banded Canada Geese were also found near the CCE, at the NBE, within Nanoose Bay's River's Edge community (Figure 8-9), and at the French Creek estuary.

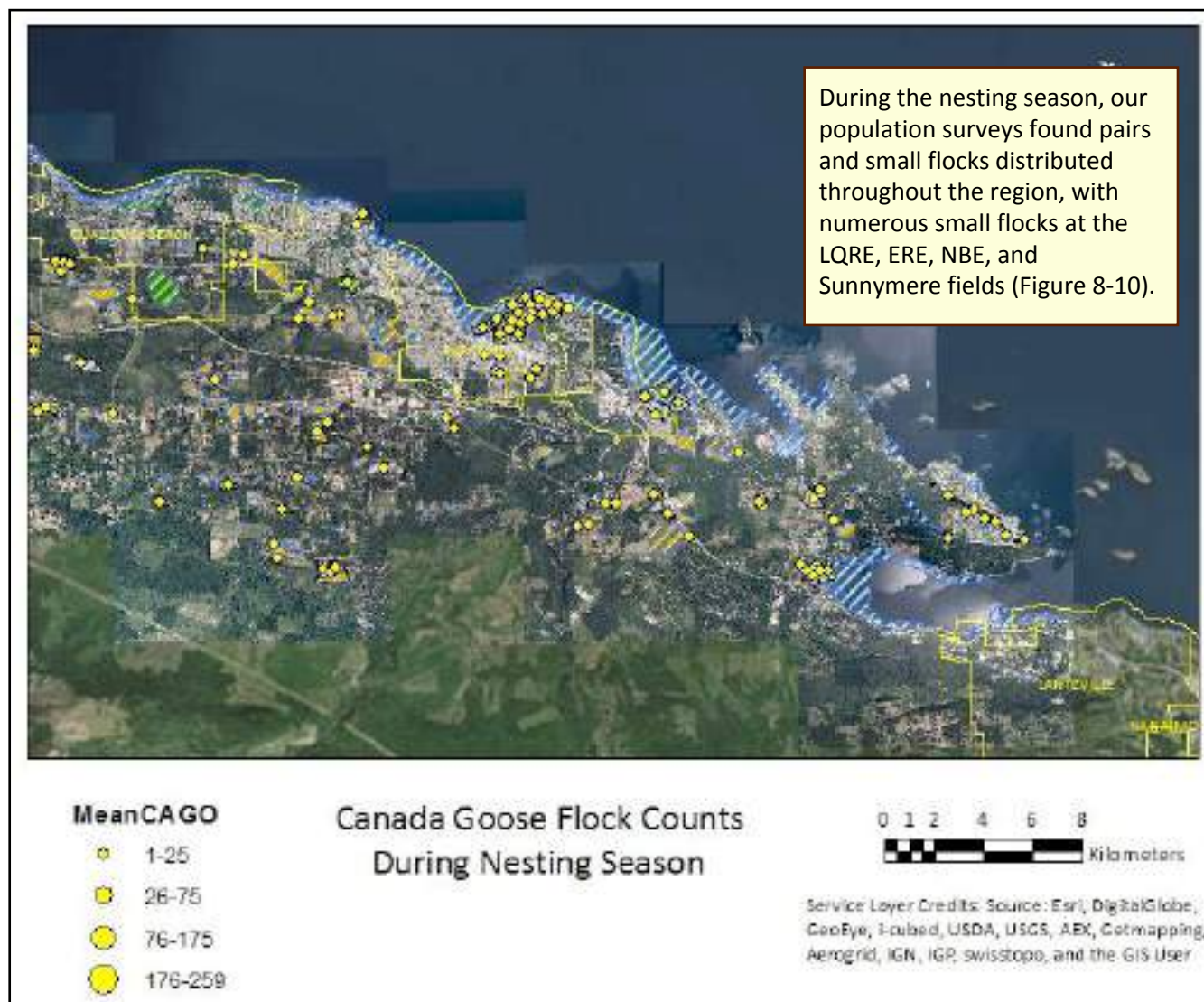


Figure 8-10. Canada Goose flock counts during the nesting season, weighted for the number of surveys (n=570).

Pair of Canada Geese defending their nest, Englishman River estuary, April 21, 2011





Goose nest in a stump at the Little Qualicum River estuary, 2013

Typically, egg-laying begins by the end of March and continues into late May (CWS 2010). In our area, new eggs were observed from March 30 to May 30. For 1,405 clutches in B.C., laying was found to occur from March 13 to July 6, with 52% recorded between April 18 and May 2 (Campbell et al. 1990); the June and July records were probably from northern B.C.

It takes about a week to lay a complete clutch (Howard Breen 1990; CWS 2010), or 1-2 days to lay each egg (Cooper 1978). Once laying is completed, the goose incubates the eggs for 25 to 28 days, while the gander stands guard nearby. He vigourously defends the nesting territory from intruders (MoE 1979; Howard Breen 1990; CWS 2010).

Once nesting, foraging usually occurs near the nest. However, geese tending a nest may take 'recesses' to forage and drink; these have been recorded as far as 8 km away (Cooper 1978; Granholm 1988). Brakhage (1965) observed that pairs left their nest together, usually during the first and last 2 hours of daylight; the goose fed ravenously and occasionally preened briefly while the gander rarely fed. Cooper (1978) found that females had a fixed routine, which included drinking, bathing,

preening, and feeding, always at a hurried pace. Feeding areas consistently supported an abundance of new plant growth and were absent of dense, decadent vegetation. Back at the nest, the goose preened water from her breast to moisten the down around the eggs, likely to increase humidity. Cooper also noted that pairs had days without recesses, and days that included up to 5 recesses. Time away from the nest varied from 1 to 68 minutes, with an average of 15 minutes (Brakhage 1965; Cooper 1978). With each additional egg, time spent away from the nest was reduced (Brakhage 1965).

The hatch peaks in early to mid-May (CWS 2010). On average, it takes approximately 24 hours for the clutch to hatch, but hatching time can range anywhere from 8 to 36 hours (Kossack 1950; Brakhage 1965; Cooper 1978). Depending on the timing of the final emergence, goslings may be off the nest by the next morning (Brakhage 1965; Cooper 1978). They are closely guarded by both parents. Initially, the new family stays near the nesting grounds (MoE 1979; Howard Breen 1990; CWS 2010), but the adults do not defend the nest site or territory (Brakhage 1965). If forage and water are

To avoid being seen, a nesting goose lowers her profile, while the gander stands guard a short distance away. Photo by Guy Monty.



limited, they may move several km to a more suitable rearing area (Kossack 1950; Granholm 1988).

If the first clutch is destroyed, pairs may re-nest. Over the period 2008-2014, three different pairs re-nested, in 2012, 2013, and 2014, all on the ERE. Eggs in two of the original nests had not been added, and one had been visibly predated. In 2015, there were two confirmed re-nests on the ERE and one on the LQRE.

Atwater (1959) found that unsuccessful nesting pairs in Montana moved away from the nest sites and were quite solitary, often wandering from one waterbody to another. Cooper (1978) found unsuccessful pairs in Manitoba remained within 500 m of the nest site for 2 days to 4 weeks, with an average of 2 weeks. In Quebec, females that had lost their nests or abandoned their young left the area before moulting and returned in November (Beaumont, Rodrigues, & Giroux 2013). Unsuccessful nesters in South Dakota formed flocks with non-breeding geese that had remained in the nesting area until mid to late May (Dieter & Anderson 2009).

8.3 Brood-rearing

The moulting season encompasses the latter part of the brood-rearing period, as the parents are replacing their flight feathers (i.e., moulting) while their goslings are growing, developing flight feathers, and learning to fly (CWS 2010). For 2,076 Canada Geese broods in B.C., brood-rearing (hatching to fledging) occurred between April 15 and August 24 (Campbell et al. 1990).

A pair with its brood may be solitary for 5-7 days, then loosely associates with other pairs with similar-aged young (Brakhage 1965). Broods may mix for several (e.g., 3 to 6) weeks before reorganizing into their original families (Bellrose 1976; Dieter & Anderson 2009). They may also form crèches (sometimes called gang broods). One might see 10-20 goslings under the care of a single

pair of adults, typically when young females give up their goslings to older birds (Bellrose 1976; Howard Breen 1990). Crèches may also be accompanied by 2-5 productive pairs and additional, non-breeding females (Brakhage 1965). Brakhage (1965) found that pairs which gave up their broods returned to the vicinity of their nesting territories.



Pair with large brood at the Little Qualicum River estuary, May 21, 2009

8.4 Moulting



Flightless Canada Geese make their way from the main trail in Rathtrevor Beach Provincial Park to the foreshore.

During the summer, adult Canada Geese replace their flight feathers and are unable to fly, or fly well, and are more vulnerable to predation (Howard Breen 1990; CWS 2010). Non-breeding juveniles and adults, and adults whose nests have been destroyed, are usually the first to moult (Smith, Craven, & Curtis 1999). Successful nesters begin to moult when the goslings are about two weeks old; both parents and young are able to fly at approximately the same time, 4-6 weeks later. Initially, they confine their movements to secluded areas near their nesting grounds. Later, they move to prime grazing areas where they can better address the high nutritional demands required for feather production, and to mudflats or riverbanks where they can find grit for digestion (Bellrose 1976; Howard Breen 1990; CWS 2010). As the young reach adult-size, the family may venture further and join other flocks. Near the end of the moulting season, the combination of warm temperatures, high quality food resources, and decreasing nutritional demands allow more time for loafing and preening (Winn

2001).

Although CWS (2010) delimited the moult period from mid-May to late July, and we defined a moulting season from June 1 to August 15, a few birds were flightless as late as August 22.

7.41 Moul Migration

Canada Geese that leave the nesting grounds and travel considerable distances to return to favoured moulting areas year after year are known as moult migrants. Both Arctic/sub-arctic and temperate-nesting Canada Geese populations may undertake moult migrations (cf. Sheaffer, Malecki, Swift, & Dunn 2004). Distances recorded have ranged from 40 km to more than 2,500 km (Dieter & Anderson 2009). Most moult migrants are believed to be juvenile, non-breeding Canada Geese (Salomonsen 1968; Sheaffer et al. 2004). However, some are unsuccessful nesters or pairs that have lost their broods to predation or gang broods (Sheaffer et al. 2007; Dieter & Anderson 2009). Moult migration tends to occur in June (Sheaffer et al. 2007).

Annette Lucas of Blonde Ambition Communications films Canada Geese loafing on the sandstone near Pearl's Rock in Craig Bay for the Guardians' video *Mitigating Impacts of [Locally] Overabundant Canada Geese*.



Management techniques that cause nest failure, such as egg addling, may induce moult migration (Sheaffer et al. 2007; Dieter & Anderson 2009), reducing pressure on local moulting habitat and perhaps exposing more birds to hunting, but potentially increasing nuisance populations in other areas. In a variety of studies of satellite-tracked Canada Geese

in the eastern U.S., up to 73% of females whose nests had been destroyed subsequently moult-migrated. However, nest-failed females from rural areas were more likely to moult migrate than their coastal counterparts; authors attributed this to an abundance of good quality moulting habitat in coastal near-urban landscapes (Sheaffer et al. 2007).



Moulting Canada Geese on Craig Bay near Rath Trevor Park, summer 2014

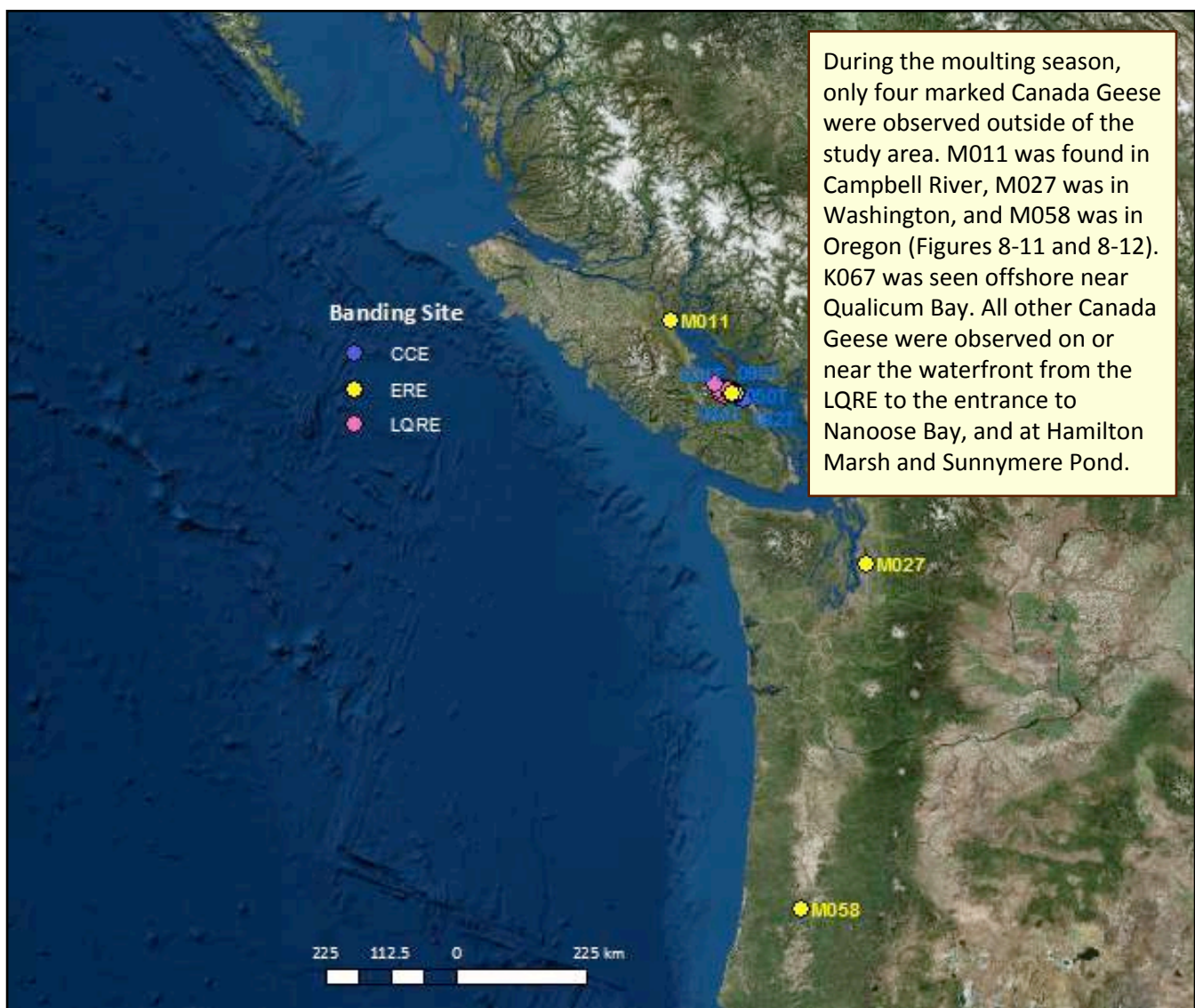
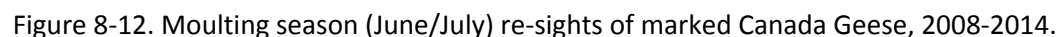


Figure 8-11. Moulting season (June/July) re-sights of marked Canada Geese, 2008-2014.



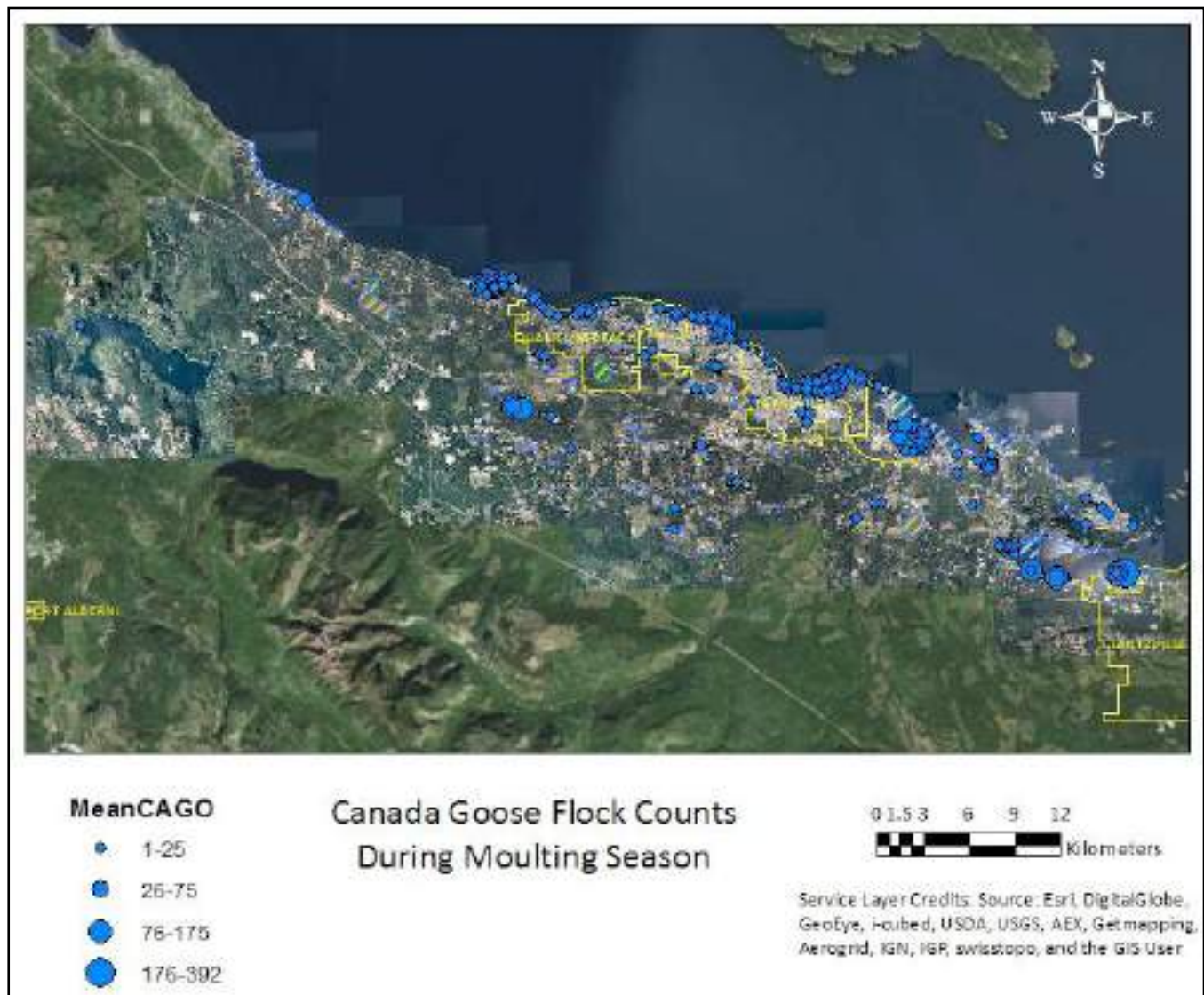


Figure 8-13. Canada Goose flock counts during the moulting season, weighted by the number of surveys (n=2,018).

In our study, 13 Canada Geese (4.4% of all marked Canada Geese, 6% of all Canada Geese assigned a migrant type) were assessed as moult in-migrants. (Moult in-migrants come to our region to moult, whereas moult-out migrants leave the region to moult.) Three were U.S. moult migrants; two of these were sighted in California in March, and the other was observed in Washington in

October, November, February, and May. Two were Vancouver Island moult migrants; one was seen in the Cowichan Valley in January, and the other was in Victoria in February. The others fit the definition of a moult migrant (i.e., present during at least 2 consecutive moult periods, not seen during nesting and in winter), but their whereabouts in other seasons were unknown. A 14th bird,

assigned a Vancouver Island migrant type, moulted in Campbell River in 2011. All are consistent with a body of literature that suggests **moult migrants typically migrate north to moult** (MoE 1979; Sheaffer et al. 2007).

Because most marked birds were captured during the moult, our data were heavily skewed to identifying in-migrants.

Annual moult counts found the greatest densities of Canada Geese were at the ERE, French Creek estuary, and LQRE (Figure 8-14). However, goose numbers (not considering the size of sites) were highest in the Craig Creek estuary/Craig Bay east area (Figure 8-15). A 2014 moult count that included Nanoose Bay east towards Lantzville boosted Canada Geese counts for Nanoose Bay sites.

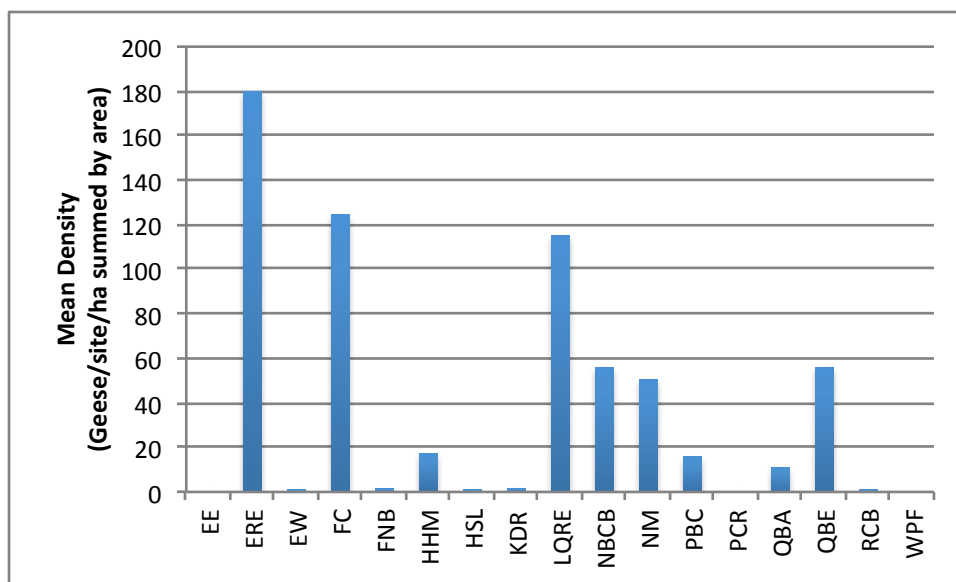


Figure 8-14. Canada Goose density (Canada Geese/site/ha summed by area) during the moulting period, 2011-2014 (n=581 sites). FC=French Creek, NBCB=Northwest Bay/Craig Bay East. See Table 6-1 for other area descriptions.

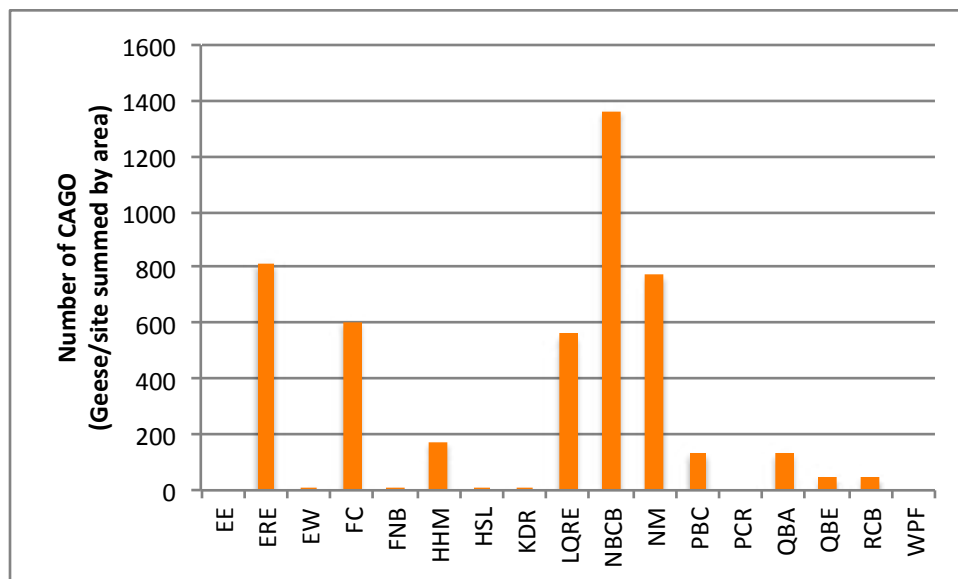


Figure 8-15. Mean Canada Geese counted during the moulting period, 2011-2014 (n=581 sites). NM=Nanoose/Morello. See Figure 8-14 and Table 6-1 for other area descriptions.

During the moult, Canada Geese were found almost exclusively in estuarine, freshwater, and marine habitats (Figure 8-16). In marine and outer estuarine habitats, geese were either clustered or spread out over large areas; when goose numbers were tallied without consideration for density, totals were highest in these areas (Figure 8-17).

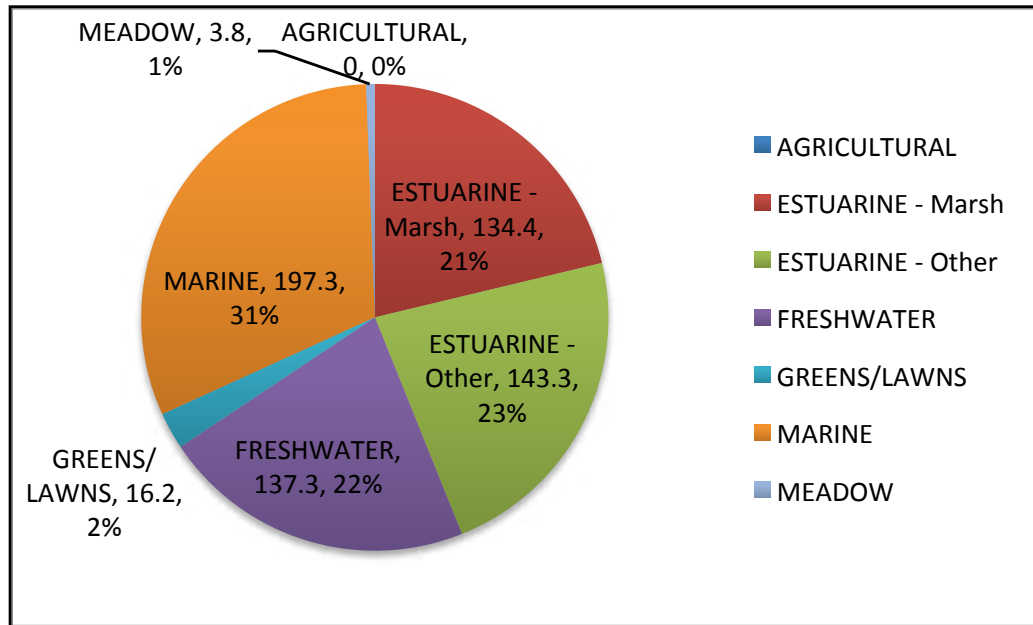


Figure 8-16. Canada Geese density during the moulting period, by habitat type, 2011-2014 (ha, %) (n=581). Area is in hectares (e.g., marine = 197.3 ha, 31% of total area used during the moult).

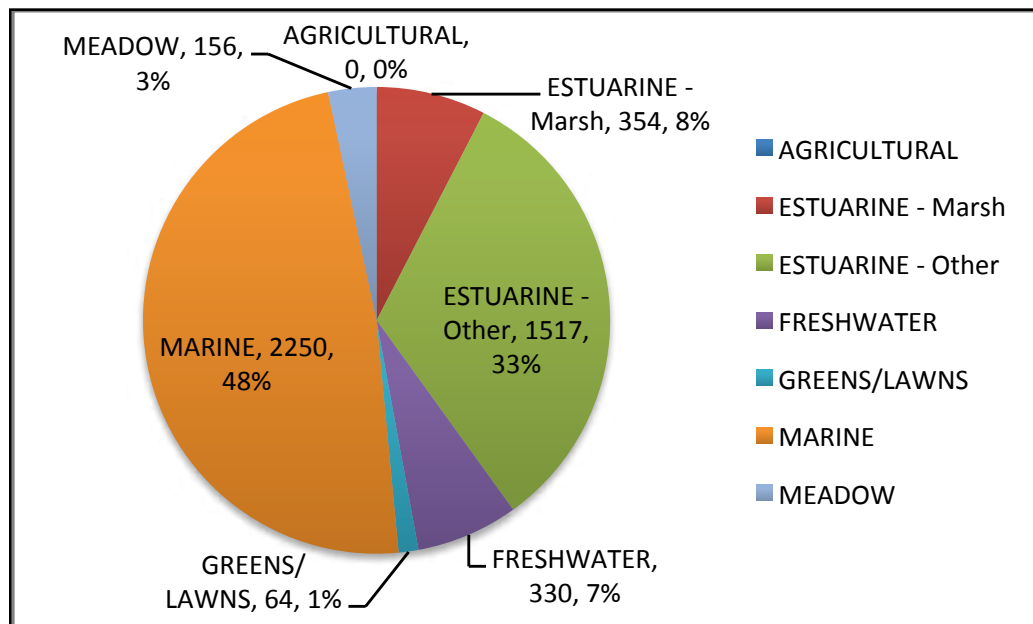


Figure 8-17. Canada Geese use of habitats during the moulting period, 2011-2014 (ha, %). (n=581).

8.5 Transition - Moulting to Autumn Migration

In August, many marked birds remained in their moulting areas (Figure 8-18). Although the second half of August is characterized as a migration period, only two marked birds were observed outside of the study area; 006T and 053T were spotted on the Saanich Peninsula. Most Canada Geese were mobile by this time, feeding beyond the moulting areas but returning to roost.



Canada Geese enjoying a leaking hose at a building site in Parksville, August 17, 2009



Figure 8-18. August re-sights of marked Canada Geese in the study area, 2008-2014

8.6 Autumn Migration

Autumn migration along coastal routes peaks in the first week of November and declines by the end of the month (Campbell et al. 1990). Most temperate-breeding geese do not migrate long distances, typically staying in the region or neighbouring regions (Smith, Craven, & Curtis 1999). If weather conditions are harsh or high quality food is unavailable, they will head south (CWS 2010).

Seven Canada Geese were found beyond Vancouver Island.

K021 was observed in *Alberta*; M027, M059 and M063 were seen in Oregon; M055 and M067 were found in Washington; and 028T was shot on the Lower Mainland (Figure 8-19).

On Vancouver Island, there were 9 Canada Geese observed or shot outside of the study area: K010 at Cowichan Bay; 048T and 071T near Saltspring Island; 001T and 088T at Chemainus; 067T at Gabriola Island; and K011, M007 and M045 in the Comox Valley.

Migratory geese are attracted to areas where local residents gather, and within a few days can have a startling impact on those habitats (Smith, Craven, & Curtis 1999). One survey respondent spoke of hosting 200 birds in the autumn, where there had been ~30 during the rest of the year.

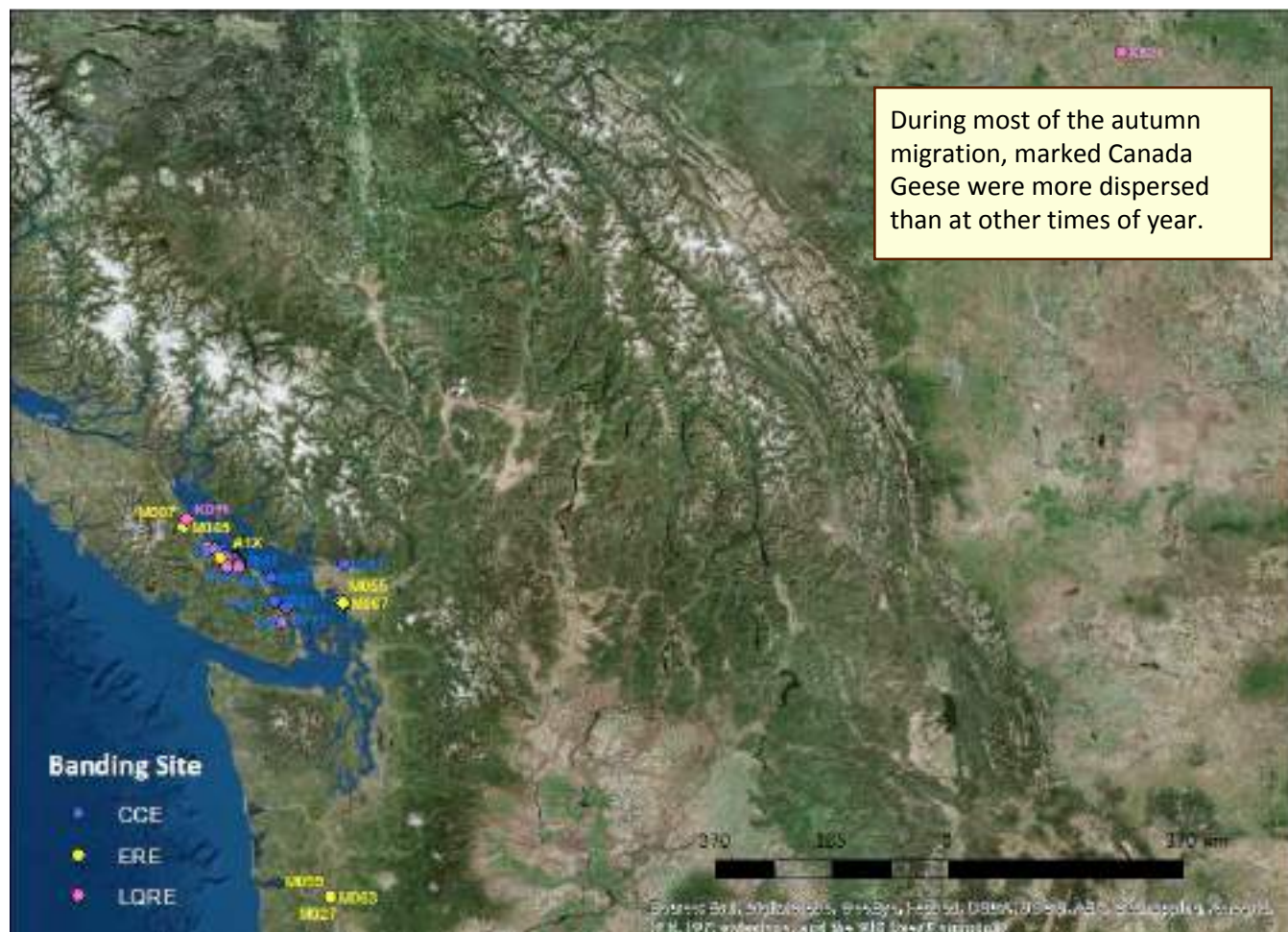


Figure 8-19. Autumn migration (September, October, November) re-sights of marked Canada Geese, 2008-2014.

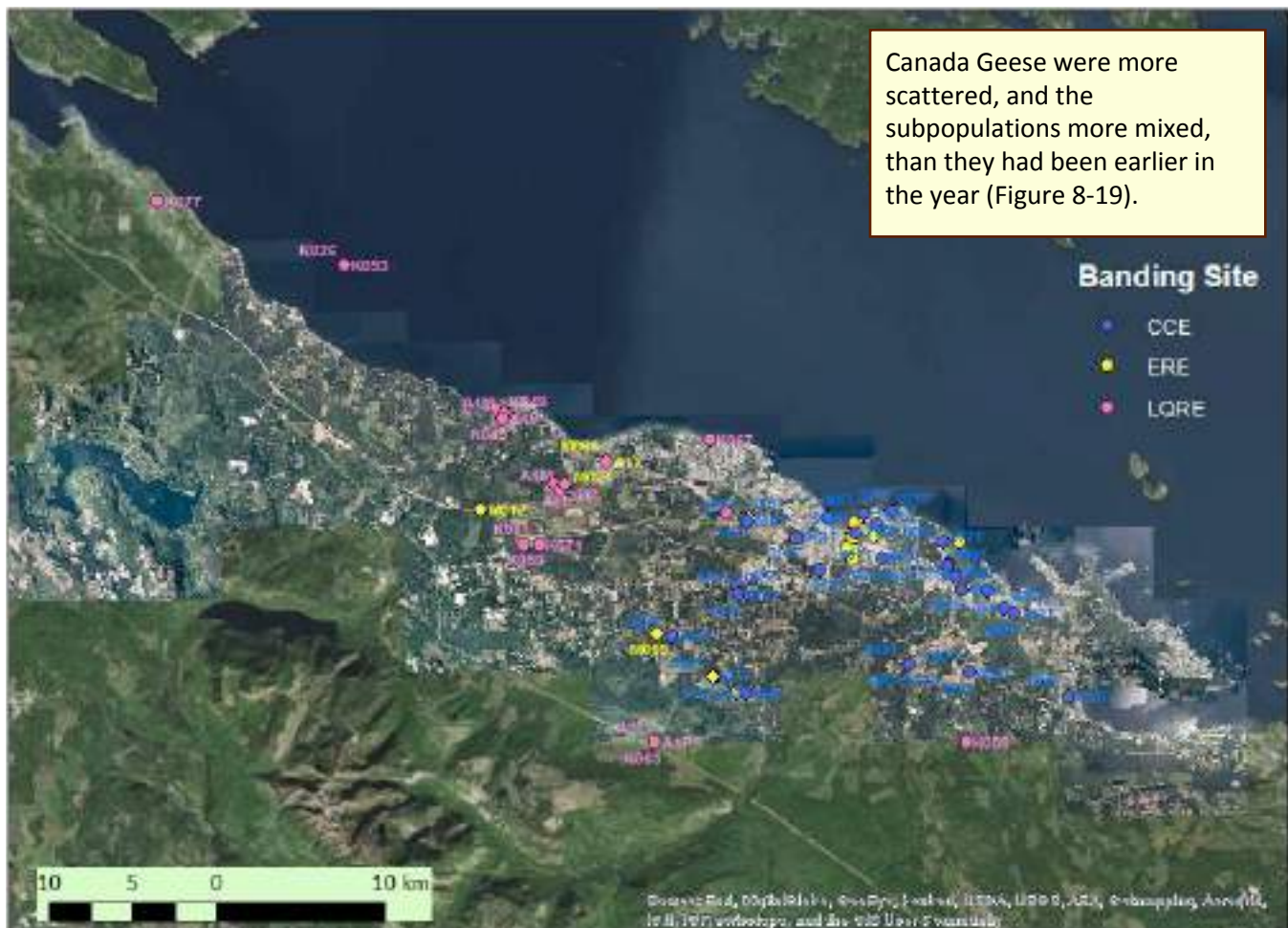


Figure 8-19. Autumn migration (September, October, November) re-sights of marked Canada Geese, 2008-2014.

Researchers in Prince Edward Island found no evidence of the regular daily movements observed during the spring. Instead, autumn movements were determined by hunting pressure, weather, and agricultural activities. Geese foraged primarily on tidal flats once fields were cultivated, and during the hunting season, many geese loafed and fed in areas inaccessible to hunting (Martin & Guignon 1983).

Quebec researchers found that the movements of radio-collared local resident geese

were restricted to smaller areas once northern migrants arrived (Beaumont et al. 2013).

Some geese, particularly those accompanying juveniles, moved into areas with little or no hunting pressure *several weeks before* hunting season began in September (Beaumont et al. 2013). The effect of hunting on Canada Goose movement is further discussed in Chapter 12.12, Hunting.

Migrants are generally more wary and easily startled, and so may be differentiated from more

resident birds at this time of year (cf. Smith, Craven, & Curtis 1999).

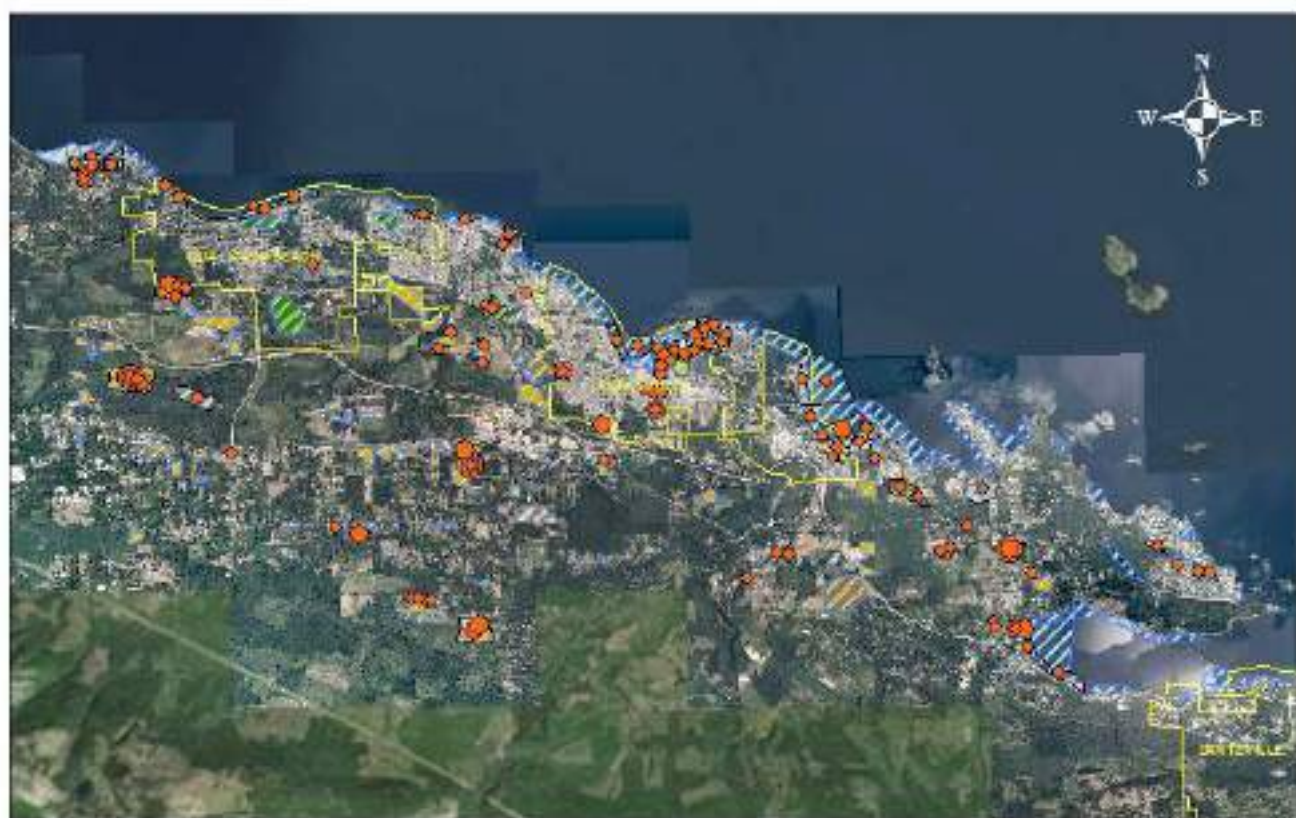


Canada Geese drinking from a puddle in
a Parksville parking lot, September 28,
2015

Canada Geese were as widely distributed in the autumn as they had been in spring (Figure 8-20). The large flocks observed at the French Creek and Craig Creek estuaries in spring were comparatively smaller in the fall. In autumn, the greatest concentrations of geese were on agricultural lands in Nanoose Bay, Errington, and Hilliers.



Canada Geese grazing in a Nanoose Bay farm field, September 28, 2015



MeanCAGO

- 1-25
- 26-75
- 76-139

Canada Goose Flock Counts
During Autumn Migration

0 1 2 4 6 8
Kilometers

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User

Figure 8-20. Canada Goose flock counts during autumn migration, weighted by the number of surveys (n=827).



Canada Geese were dispersed over the rarely flooded high marsh of the Craig Creek estuary, as well as the mid-marsh and low marsh at 1:43 p.m., November 13, 2014.

8.61 A Cold Day in November

In mid-November, 2014, more than 100 Canada Geese were loafing each afternoon at the Craig Creek Estuary. A cold snap lasting several days began on November 13th; the weather station at Springwood Middle School reported a low of -3.4 degrees Celsius that night. To assess how geese used the partly frozen estuary during a period when there was ice on freshwater sources and hunting was open (hunters had been on a nearby farm on November 14th), we surveyed the estuary every two hours from 1 p.m., November 16th to dusk, and from dawn, November 17th to 1 p.m.

November 16

1:00 p.m. Temperature 5 degrees C., mainly sunny, estuary partly frozen. Twenty-two geese were on Craig Bay, offshore from Pearl's Rock at Pacific Shores Nature Resort.

3:00 p.m. Temperature 4 degrees C., sunny and clear. No geese.

4:15 p.m. A resident of Craig Bay estates observed 141 geese, including 7 collared geese, on the south shore of the Three Bridges Pond. Two of the collared birds were moult-winter migrants, three were local residents plus, and two were local residents. He noted that the birds had been using the ponds and neighbouring grassy areas for the last four days. They generally left the ponds at ~4:30 p.m., returning ~8:30 a.m. each day.

4:35 p.m. Dusk

4:56 p.m. Temperature 1 degree C., nearly dark. From 4:56 to 5:15, geese flew into the estuary in

small flocks (7, 54, 27, 3, 23, 2, and 12 birds), a total of 138 in 7 groups.

November 17

7:00 a.m. Temperature -3 degrees C., sunny and clear, estuary partly frozen, upper marsh has thick frost. A total of 122 geese were mostly clustered at the entrance to Craig Bay (near Pearl's Rock).

7:30 a.m. dawn

7:15 to 8:17 a.m. Geese left in small flocks, 21, 3, 18, 10, 4, 1, 23, and 22 geese flew towards the direction of Craig Bay estates, 12 geese flew through the estuary towards Springford's farm, 3 more geese flew towards Craig Bay estates. Ten of the birds that had flown were collared. Five geese remained.

9:00 a.m. Temperature 0 degrees C., sunny and clear. No geese.

11:00 a.m. Temperature 5 degrees C., sunny and clear. No geese.

1:00 p.m. Temperature 5 degrees C., mainly sunny. No geese.

These observations provided several insights:

1) In autumn, fertilized, green lawns and fields were preferred feeding areas, as the quality of food in the estuary deteriorated. Yet, the estuary was favoured for loafing and especially roosting, regardless of icy conditions. (In past years, as cold snaps progressed and ice spread down the estuary, we found geese moved with the ice sheet, clustering just beyond the covered areas on open water.)

2) Hunting pushed the geese into non-huntable areas. It is

November 2014 was cold. The temperature at the Springwood Middle School weather station in Parksville was -6.3 degrees Celsius on November 30, 2014, the coldest November day since the station was installed in 2006. Minimum temperatures from November 12-18 ranged from -1.1 to -3.4 degrees, and from November 29-30 they ranged from -1.6 to -6.3. The mean monthly minimum was 2.5, and the daily average was only 5.8 degrees Celsius (Victoriaweather.ca 2015).



Fifty-five Canada Geese were counted at Craig Bay estates ponds, at 9:39 a.m., November 17, 2014. Photo by Mike Ingledew.

notable that moult-winter migrants were present, ahead of the overwintering period (December - January); if not for the cold weather, this might suggest that both the late November counts from 1989 to 2005, and the January winter counts thereafter, were indicative of overwintering populations.

3) Importantly, the exercise provided evidence that **the predominance of daytime surveys grossly underestimated the presence of Canada Geese in our estuaries.**

8.7 Overwintering

In winter, estuaries are preferred roosting sites. Geese will undergo daily excursions to feeding areas, such as farm fields and urban grassy areas (cf. Campbell et al. 1990). They generally make two foraging trips each day from their roosting sites, one shortly after sunrise and the other later in the afternoon, depending on temperature and light intensity (USFWS 2002). Flocks may forage up to 48 km

away from their roosting sites (Granholt 1988).

Ray (2011), who observed marked geese in Phoenix, Arizona, found she could differentiate migrants from local residents by their early morning behaviour; migrants left the overnight roosts at first light for daytime feeding sites, while residents began grazing after sunrise or continued to rest.

Warmer conditions may cause migrants to winter further north than usual (Hestbeck, Nichols, & Malecki 1991; Böhning-Gaese & Lemoine 2004). Despite known fidelity to overwintering sites, Canada Geese have been vacating southern wintering areas in favour of northern ones for decades (Reeves et al. 1968 in Hestbeck, Nichols, & Malecki 1999; USFWS 2002). With climate change, this trend is expected to continue.



Canada Geese roosting/resting with Mallards, scaup, and other waterfowl at the mouth of Craig Creek. Much of the estuary was frozen, early February, 2014



Figure 8-21. Overwintering (December, January) re-sights of marked Canada Geese, 2008-2014.

Canada Geese in the frozen Craig Creek estuary, January 8, 2005





Figure 8-22. Overwintering (December, January) re-sights of marked Canada Geese in the study area, 2008-2014.



Canada Geese in the Craig Creek estuary, January 8, 2005

Population surveys and annual winter counts found large flocks at the Big Qualicum River estuary, LQRE, CCE, and NBE; smaller flocks occurred at the French Creek estuary, and there were many small flocks at the ERE (Figure 8-23). At the same time, large flocks of Canada Geese were using agricultural fields in Qualicum Bay, Qualicum Beach, French Creek, Errington, Hilliers, and Nanoose Bay. Smaller flocks were distributed over other farm fields, sports fields, golf courses, and other sites.



Canada Geese roosting/resting with Mallards, scaup, and other waterfowl at the mouth of Craig Creek. Much of the estuary was frozen, early February, 2014

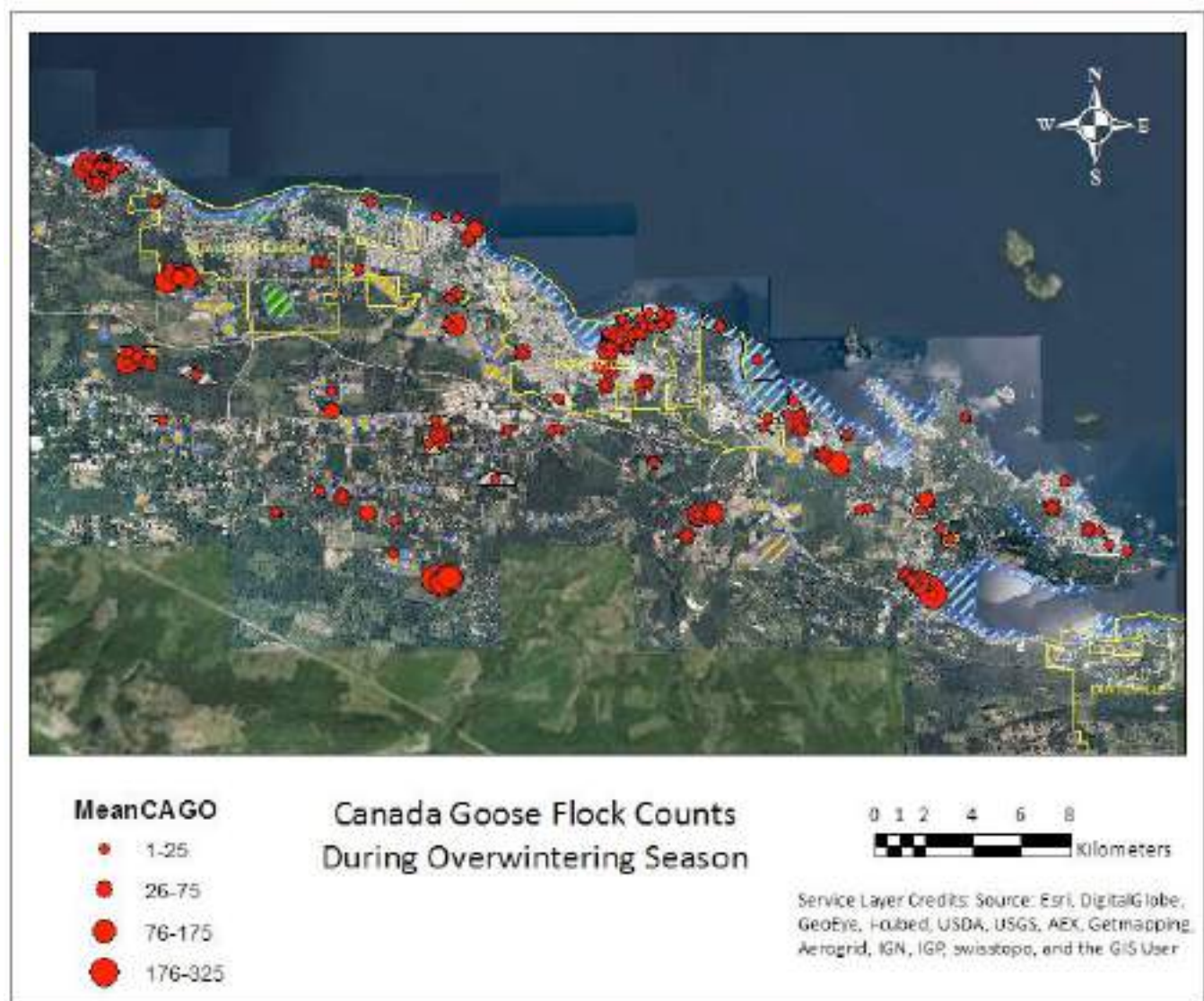


Figure 8-23. Canada Goose flock counts during the overwintering season, weighted by the number of surveys (n=1,757).

Winter counts revealed high densities of geese in Nanoose Bay (Figure 8-24), and high numbers of Canada Geese in agricultural areas throughout the region (Figure 8-25).

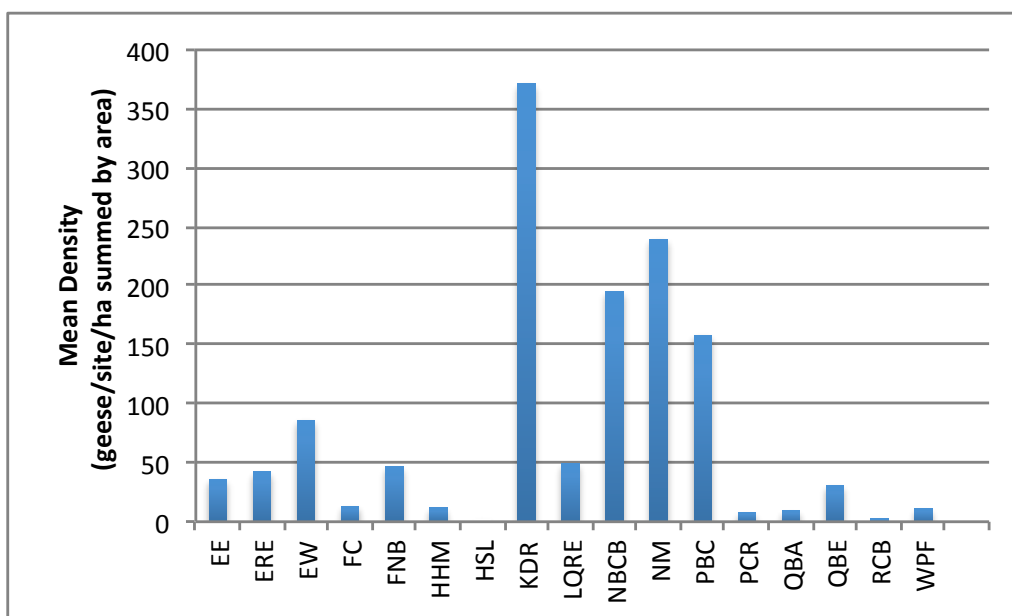


Figure 8-24. Canada Goose density during the overwintering season, 2012-2014 (Canada Geese/site/ha summed by area)(n=651 sites). KDR=Kaye Road/Dawson Road, NBCB=Northwest Bay/Craig Bay East, NM=Nanoose/Morello, PBC=Parksville Bay/City. See Table 5-1 for other area descriptions.

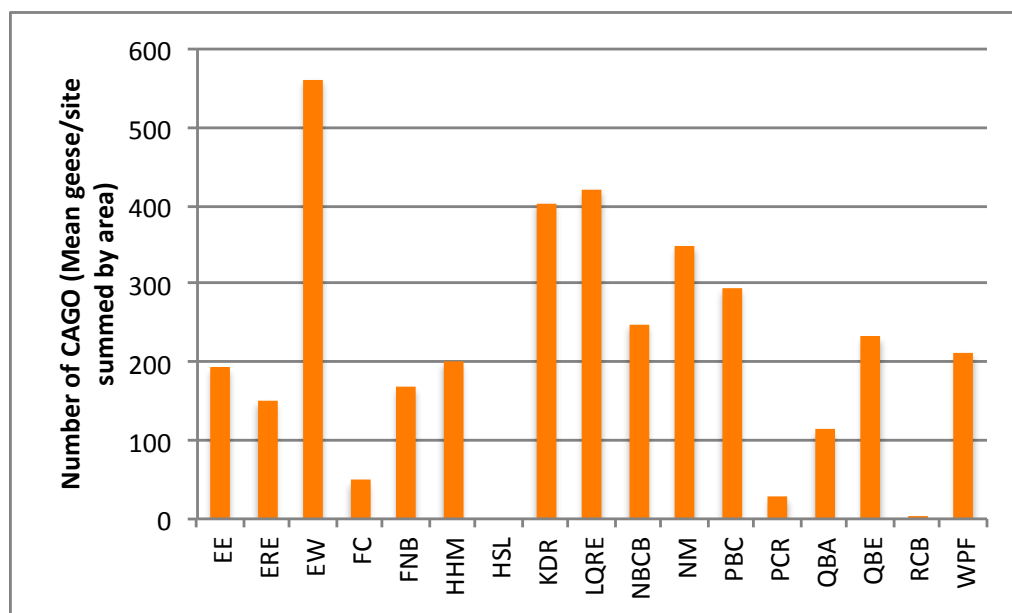


Figure 8-25. Canada Geese counted during the overwintering season, 2012-2014 (n=651 sites). EW=Errington West. See Figure 8-24 and Table 6-1 for other area descriptions.

Meadows and greens/lawns associated with freshwater were important overwintering sites (Figures 8-26 and 8-27). Marine sites were used far less in the winter than in other seasons.

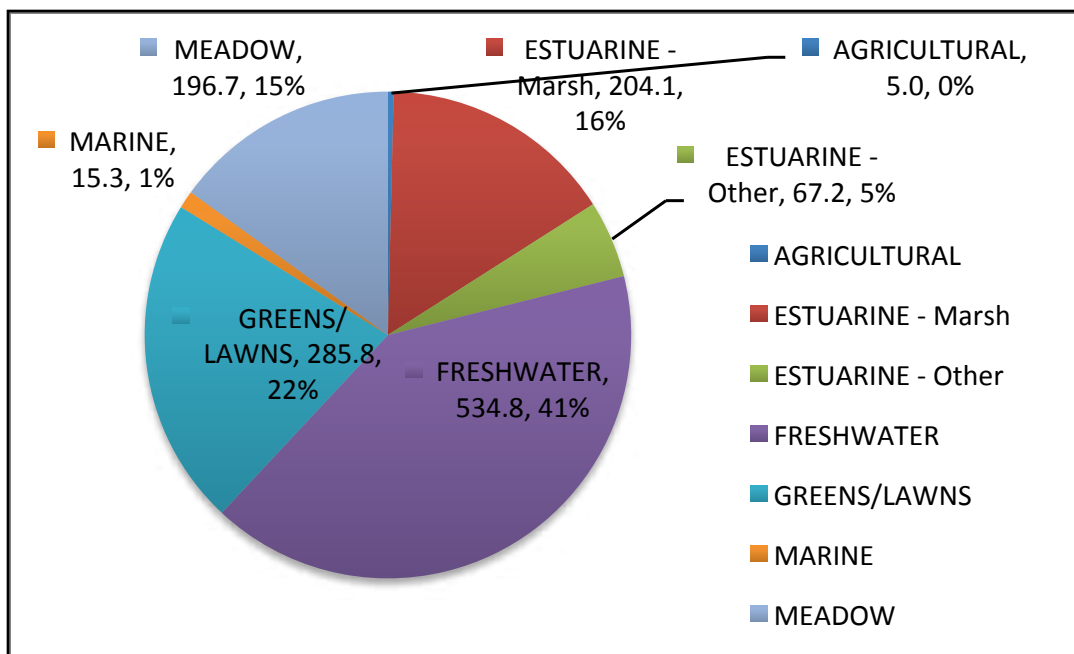


Figure 8-26. Canada Geese density during the overwintering season, by habitat type, 2012-2014 (ha, %)(n=651). Area is in hectares (e.g., marine = 15.3 ha, 1% of total area used during the overwintering period).

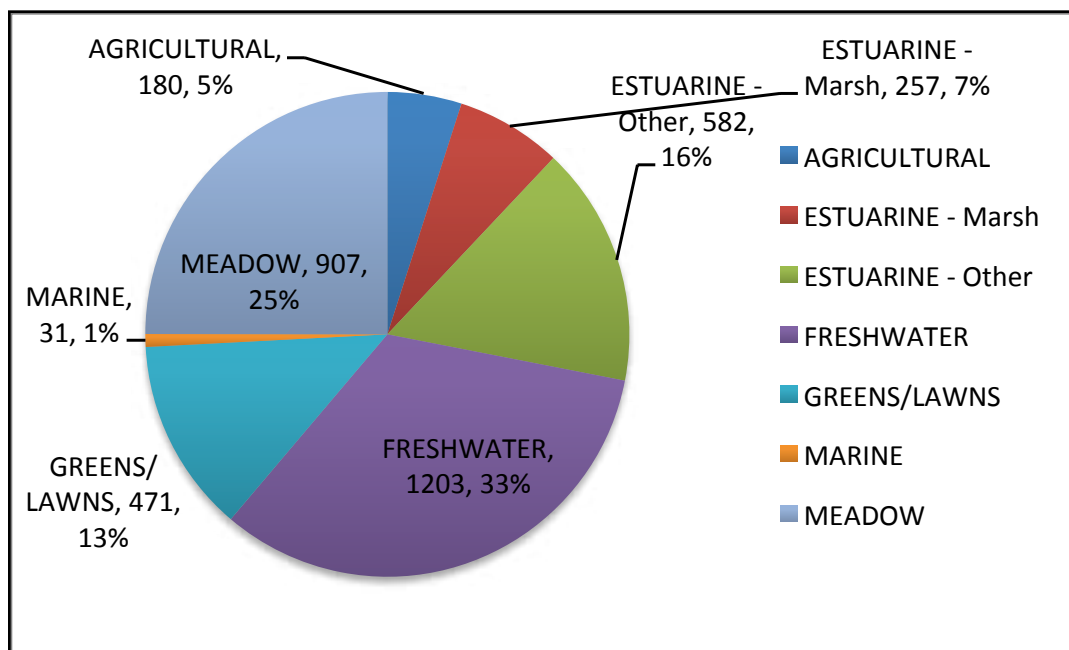


Figure 8-27. Canada Geese use of habitats during the overwintering season, 2012-2014 (n=651).

Chapter 9 - Spatial Trends

Highlights

This chapter discusses spatial trends, including hotspots (i.e., places where geese are frequently present or in high densities), site fidelity, and nest density. These contribute to Goal 3 (setting spatial management objectives).

The three main hotspots for Canada Geese were the LQRE, ERE, and CCE/Craig Bay. Across all seasons, goose counts were highest at the estuaries, particularly the 'hotspot' estuaries and the Nanoose/Bonnell Creek estuary.

Daytime goose densities were highest in the Parksville Church Road and Parksville Bay/City areas, and on sites with access to freshwater in particular.

Canada Geese return again and again to favoured sites. Seasonally, fidelity was strongest on nesting sites, and on sites used during the spring migration/pre-nesting period. With respect to habitats, geese had strong fidelity to croplands, sites with freshwater, and estuarine marsh sites.

Nest densities were highest at the LQRE, on the spit and the lower parts of the estuary that still support vegetation.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

9.1 Hotspots

Canada Geese can be found in many grassy and aquatic habitats in Mount Arrowsmith Biosphere Region's lowlands (Figure 9-1), they tend to concentrate in specific areas. The three hotspots for geese were on our estuaries: the LQRE, ERE, and CCE/Craig Bay.

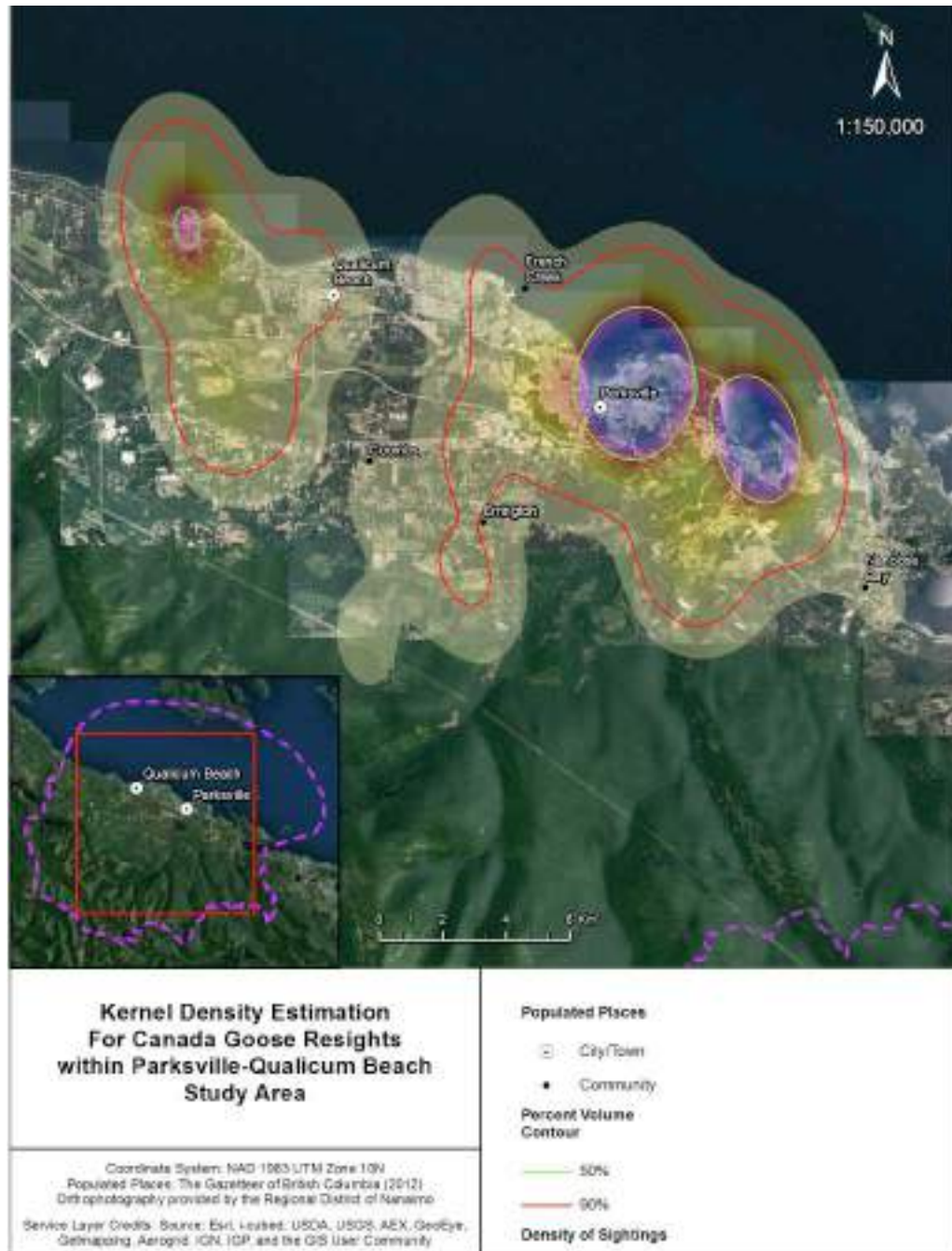


Figure 9-1. Canada Goose hotspots (n=4,692). All re-sight data were included (i.e., addling counts, routine population counts, moult counts, winter counts, waterfront counts), across all seasons.

Across all seasons, goose counts were highest at the estuaries. The greatest numbers were observed at the LQRE, ERE, in the Northwest Bay-Craig Bay east area encompassing the CCE, and in the Nanoose Morello area including the NBE (Figure 9-2).

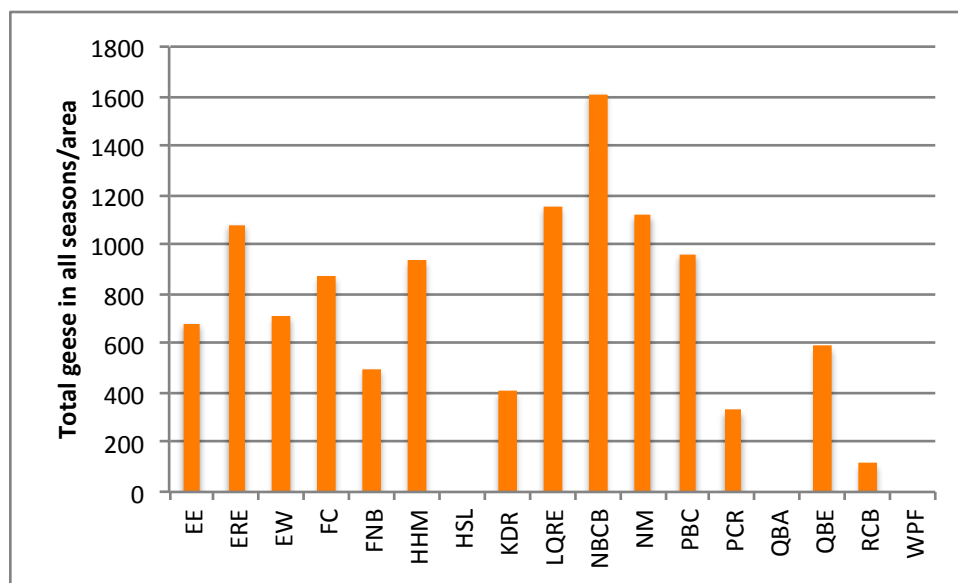


Figure 9-2. Total Canada Geese counted during routine population surveys, across all seasons, 2011-2014 (n=2,963). See Table 6-1 for site descriptions.

When the size of the sites were taken into account, Canada Goose densities were highest in the Parksville Church Road, and Parksville Bay/City areas (Figure 9-3).

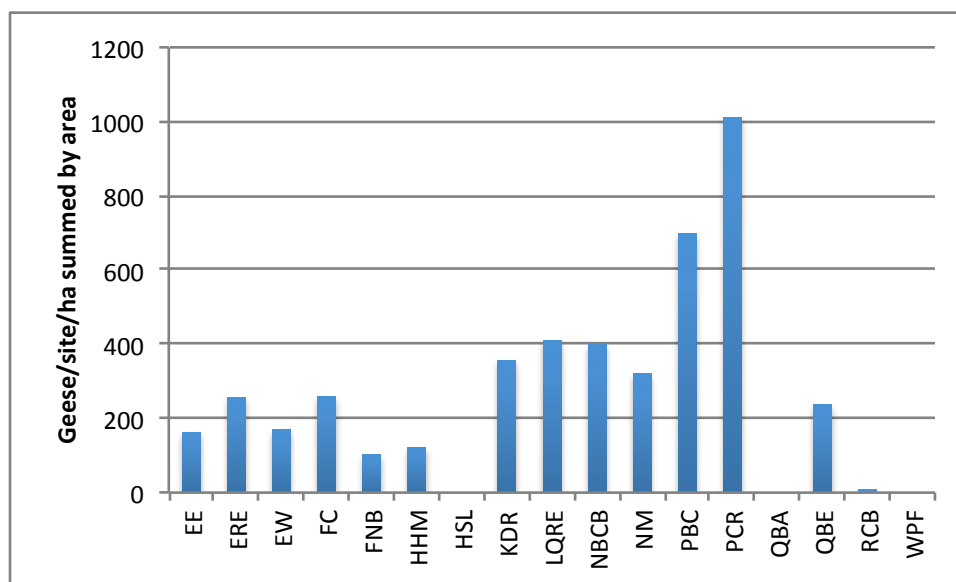


Figure 9-3. Canada Goose density (Canada Geese/site/ha summed by area) over all seasons. Based on population surveys, 2011-2014 (n=2,963).

During daytime population surveys over a four-year period, sites with access to freshwater supported the greatest densities of Canada Geese. In our area, these sites are few and most are small. They are generally associated with greens/lawns or meadow (Figure 9-4).

During the fall migration and overwintering seasons in particular, geese used estuaries primarily in the early morning, evening, and night, outside of most survey periods. Densities on estuarine marshes were higher than other estuarine and marine habitats, because of their relative sizes; marsh areas are smaller than most other estuarine sites (e.g., mudflats) and marine sites. Densities were also low on agricultural areas, which are typically large fields.

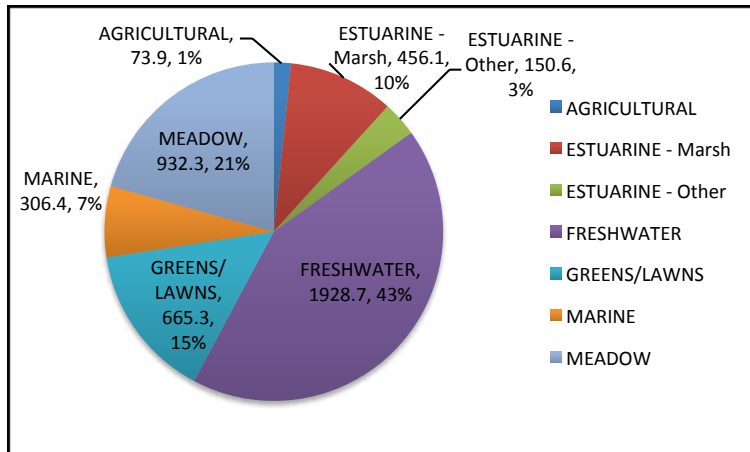


Figure 9-4 Sum of Canada Goose densities per site (Canada Geese/ha) by habitat type. Based on routine population counts, 2011-2014 (n=2,963).

When goose populations were considered irrespective of the size of survey sites, habitat use was more widely distributed (Figure 9-5). Estuaries and marine sites were used 43% of the time.

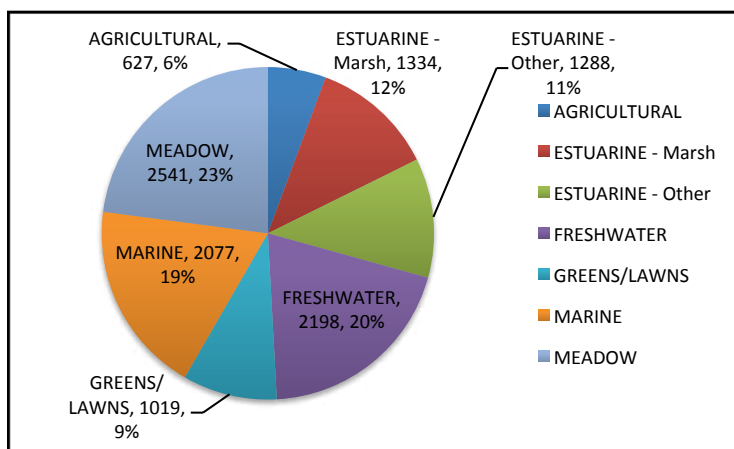


Figure 9-5. Mean Canada Goose numbers per site, for each habitat type. Based on routine population counts, 2011-2014 (n=2,963).

Preferred habitats in limited supply, such as estuarine and freshwater moulting areas, tend to support dense populations. Canada Geese were observed on 100% of the region's estuarine marsh sites, yet those sites represented less than 5% of all available sites. Sports fields and other greens/lawns in the City of Parksville represented only 1% of all available goose habitat.

9.2 Site Fidelity



This nest on the Englishman River was used every year until the log was removed in a storm event.

Measuring Site Fidelity

Fidelity is best determined by complex modeling, taking into account re-sight rates, sex, age, year, and various population, habitat, and management parameters (cf. Beston et al. 2014). Lacking appropriate data for some of these variables, we used Groepper et al.'s (2008) measure of site fidelity, which simply divided the number of times a marked goose was observed at a site by the total number of observations of that goose.

Hunting, weather, habitat modification, and management activities such as egg addling and hazing all affect site fidelity and have not been taken into account in these estimates. The data are also subject to the same limitations described for surveys.

Canada Geese are known to return, again and again, to nesting, moulting, staging, and overwintering sites (Bellrose 1976; Cooper 1978; Hestbeck et al. 1991; CWS 2010; Huang 2010 and many others). The fidelity of Canada Geese to nesting, feeding, loafing, and roosting areas is strong, even with heavy hunting pressure (Shultz et al. 1988). This fidelity, in concert with the propensity of young birds to return to their original nesting and rearing places (MoE 1979; CWS 2010), can have a profound effect on habitats. In fact, it is this trait that was used to successfully establish new breeding populations (MoE 1979).

The steady northerly shift of overwintering ranges, emigration (mainly by young males), and moult migration (mainly by sub-adults) create movement away from sites to which geese have fidelity (MoE 1979; Reeves et al. 1968 in Hestbeck, Nichols, & Malecki 1999; USFWS 2002; Sheaffer et al. 2007; Beston et al. 2014). Still, the site fidelity phenomenon must be considered when managing Canada Geese.

Sex and age affect fidelity (and directly affect vital rates), but fidelity also influences vital rates (Huang 2010). Hatch-year geese, which have lower site fidelity (67.9% for females and 48.1% for males) than after-hatch-year geese (90.4% for females and 86.9% for males)

(Beston et al. 2014), are typically more vulnerable to disturbances than older birds that home to familiar territories and preferred nesting sites.

Migrant type is also linked to fidelity. Groepper et al. (2008) found overall site fidelity for female resident geese in Nebraska was 75%.

Site fidelity will also factor into the speed at which sites may repopulate if vacated through management (e.g., culling).

In our area, total re-sights of marked geese were highest at Northwest Bay/Craig Bay sites (746 observations), Parksville Bay/City sites (706 observations), ERE sites (693 observations), and LQRE sites (350 observations).

In general, fidelity was strongest on nesting sites (75%) and spring migration sites (65%) (Figure 9-6).

Geese exhibited strong fidelity to some sites while showing less loyalty to others (Figure 9-7). They had strong fidelities to most nesting and some moulting sites, and to a smaller number of autumn migration and overwintering sites.

With regard to habitat types, fidelity was strongest to croplands (64%), sites with freshwater (62%), and estuarine marsh sites (59%) (Figure 9-8).



Figure 9-6. Seasonal mean site fidelity (%), 2008-2014 (n=2,387). Sites visited only once were excluded from the analysis.

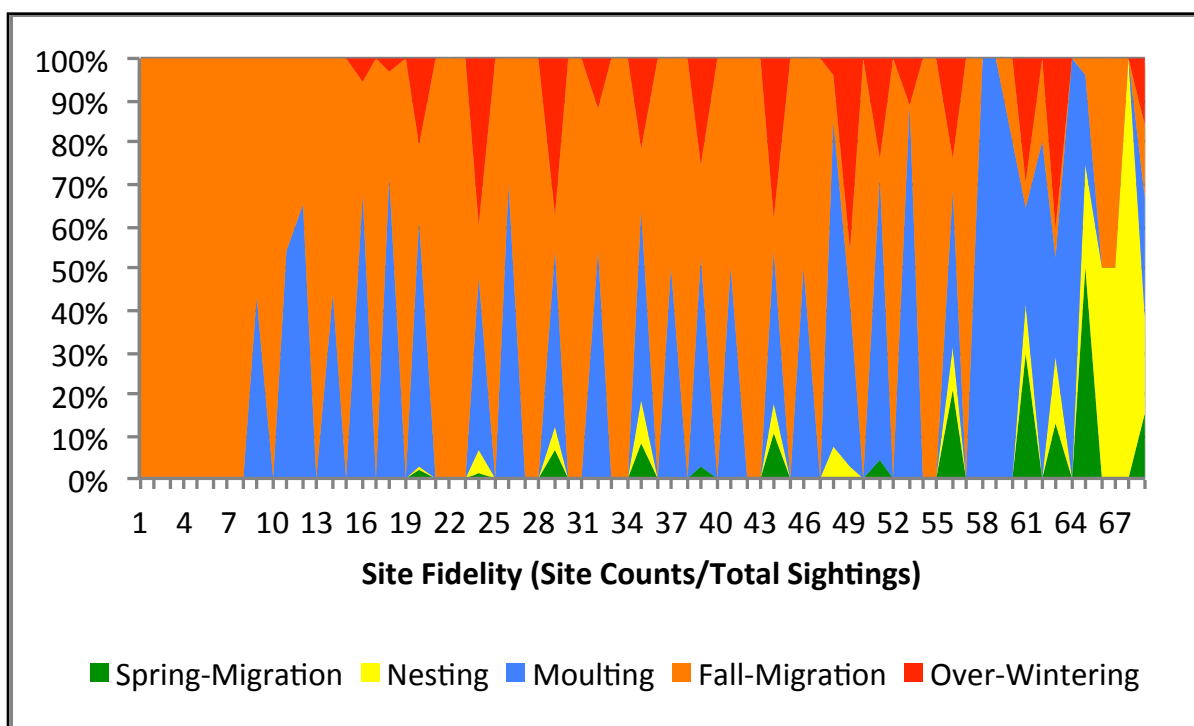


Figure 9-7. Seasonal site fidelity of Canada Geese, 2008-2014 (n=2,387). Sites visited only once were excluded from the analysis. This 100% stacked area graph shows the fidelity of geese to individual sites allocated to each type of seasonal habitat. For example, a thick yellow band on the right side of the graph shows there was strong fidelity to most nesting sites. Smaller yellow 'peaks' to the left of this band indicate there were nesting sites that were visited less frequently.

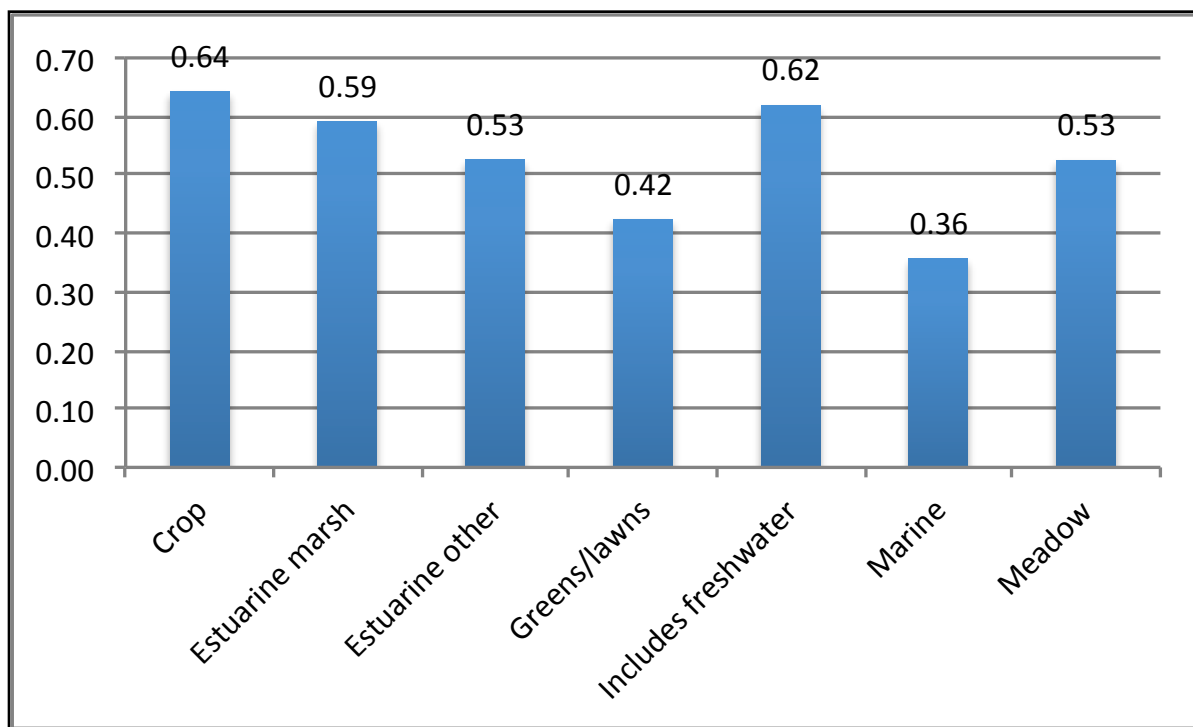


Figure 9-8. Mean site fidelity to habitat groups (%), 2008-2014 (n=2,387). Sites visited only once were excluded from the analysis.

9.3 Nest Density

Although Canada Geese are not colonial nesters, nest densities may be so high on favoured sites that they look like colonies (Granholt 1988; Anderson & Titman 1992). Authors have reported densities as high as 150 and 155 nests/ha (Campbell et al. 1990; Naylor 1953 in Granholt 1988, respectively). Allan et al. (1995) documented Canada Goose nests within 6 to 10 feet of each other, Dow 1943 in Granholt (1988) found nests spaced as little as 2.7 m or 9 feet apart, and Palmer 1976 in Howard Breen (1990) reported 4 geese nesting on an

12 x 30 foot island and 11 nests on a large haystack.

Nest densities in our area, calculated using the sum of nests for all years (2008 through 2014, rather than individual years), and divided by the area of survey sites, were nowhere near 150 nests per hectare. We calculated densities up to 31.5 nests per hectare (Figures 9-9 and 9-10); this number is probably low, as the sites included areas that could not support nesting, such as the water in the LQRE mill pond. The highest nest densities were observed on the LQRE

around the mill pond, on other areas of the spit, and on the parts of the lower estuary that still support vegetation. On the ERE, the greatest nest densities occurred on the island; predation is often lower on islands (Johnson et al. 1992). Where nest densities were highest, nests were often found only a few metres apart.

High nest densities may be beneficial or detrimental to geese, depending on whether habitat is limited. High densities may offer some protection against predation, while simultaneously offering a

bonanza for predators (cf. Sherwood 1968). Yet, if densities are too high, females may 'dump' eggs in other nests (Ogilvie 1978 in Ray 2011). Intense competition and attacks

by neighbouring ganders may lead to nest abandonment (Munro 1958; Brakhage 1965; Weigand, Pollok, & Petrides 1968; Howard Breen 1990). The proportion of geese in the

population that breed may decline, as some pairs move to other areas, or remain as non-breeders (Johnson et al. 1992).

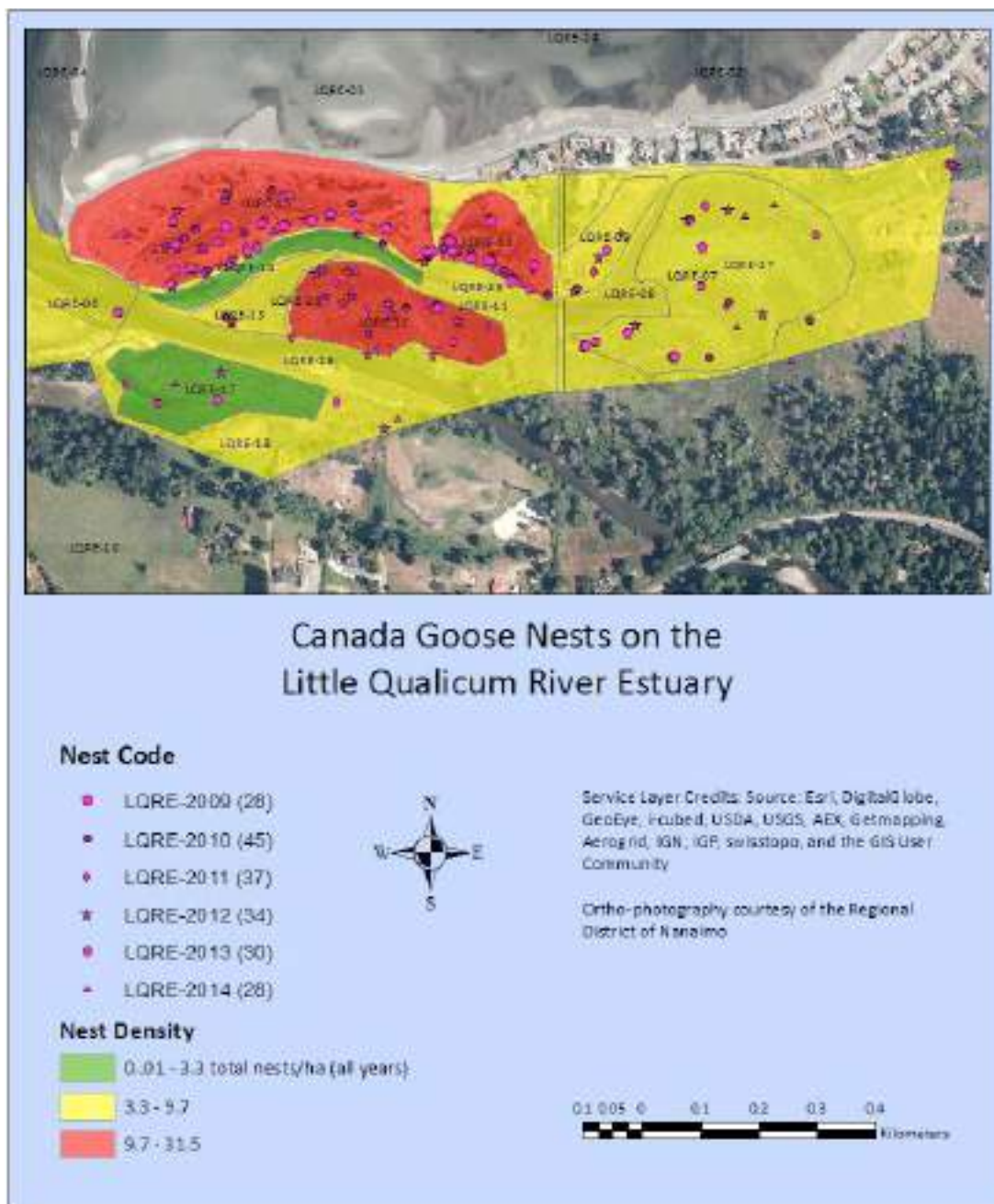


Figure 9-9. Canada Goose nests on the Little Qualicum River estuary, 2009 to 2014 (n=202).

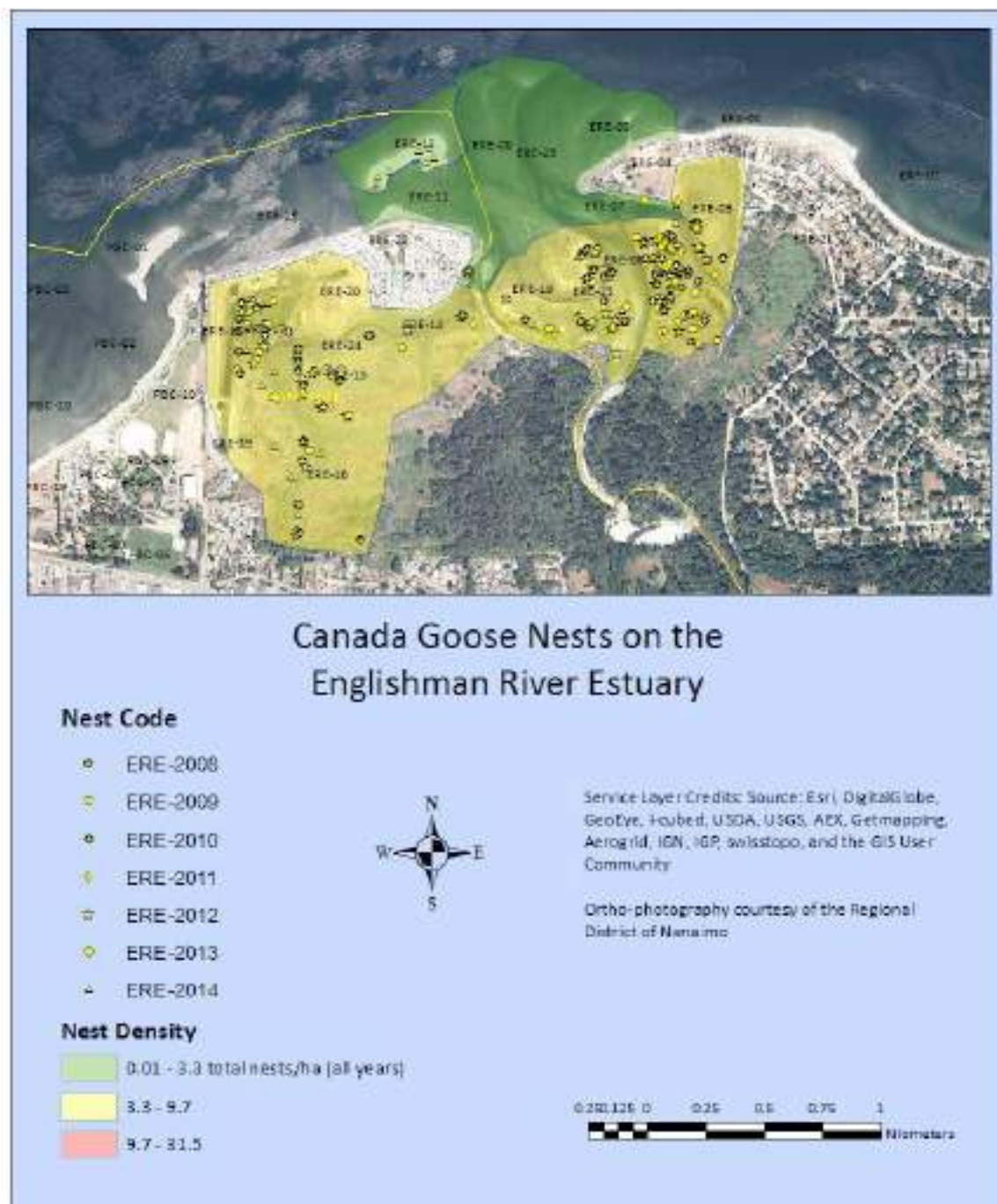


Figure 9-10. Canada Goose nests on the Englishman River estuary, 2008-2014 (n=318). Some data were unavailable (i.e., locations for 43 nests in 2009, re-nest locations).

Chapter 10 - Population Trends

Highlights

This chapter discusses population trends derived from our data and compares them with external datasets. With Chapter 6, Population Structure, it contributes to Goal 1 (setting population objectives).

Multiple types of analyses were used to assess population trends, yet we were unable to determine whether Canada Goose populations are increasing or decreasing. Even when goose surveys from 1989 to 1993, and 2005/2006 were included, there was no obvious trend. External datasets, the Coastal Waterbirds Survey and Christmas Bird Count showed weakly increasing or possibly cyclic trends.

As there is probably the least amount of mixing between local residents and other types of migrants during the nesting season, routine population counts during the 2012 and 2013 nesting seasons were used to estimate the size of the local resident population. The maximum count was 443 in 2013. Missing were undetected nesting birds and geese that left the region to moult.

Peak overwintering and moult counts were considerably higher than counts in other seasons, ~1,500 birds in 2014. However, both peak counts included additional survey areas. The highest count during the spring migration period was 1,018 in 2013. During the autumn migration, it was 948 in 2012.

From 2011 to 2014, Canada Goose densities during the moulting period significantly increased at the ERE while they remained flat at the LQRE. These reflect the numbers of nests found on the estuaries over that time period, which have increased at the ERE and decreased at the LQRE.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

10.1 Statistical Analysis



Although other species were sometimes present, surveyors counted only geese.

10.11 Methods

A variety of statistical methods were applied to Canada Goose survey data to examine annual trends and seasonal differences from moult, winter, and routine population counts, from June 2011 to July 2014. Waterfront counts were excluded.

The number of surveys and survey sites visited differed among survey types, years, and seasons. To maximize the number of surveys included in analysis, the survey year was adjusted from a typical calendar year to a June to May 'Canada Goose year'.

Site-specific population counts were factored by area surveyed (derived from GPS and GIS mapping) to account for the size differences among survey sites. The resulting goose densities (birds per ha) were averaged by year, area, habitat, and season, weighted by the frequency of site visits to accommodate differences in observer effort between seasonal and spatial factors. This process gave more weight to the counts from the most frequently visited sites within a season. Non-parametric analysis of mean and scale (ANOM), based on the Kruskal-Wallis chi-square test, were applied to the weighted mean densities for comparisons tests.

Bird count data were characterized by a high proportion of zero counts; **during most surveys, geese were found on only 10% of the approximately 340 available sites** identified for routine population counts. These data more closely fit a skewed Poisson-type

distribution than a Gaussian or 'normal' distribution due to the high frequency of zero or low counts and low frequency of very high counts (Ter Braak et al. 1994). Missing values (i.e., under-sampling due to sites not routinely surveyed), over-sampling (of known or easily accessible sites), over-dispersion (high variance in relation to the mean), and serial correlation in the time-series introduce other problems into statistical analysis of trends for count data. These must be accounted for to correctly quantify variability (Pannekoek & Van Strien 1994; Van Strien et al. 2004).

Therefore, to examine the nature of inter-annual differences in mean goose densities for population counts, a log-linear trend analysis was performed via Poisson-type 'maximum likelihood' regression techniques (Pannekoek & Van Strien 1998; Van Strien et al. 2004; SAS Institute Inc. 2011), that are insensitive to deviations from normality in the data. These included three models:

1. Standard Poisson regression for count data, optimized for dispersion correction;
2. 'Zero-inflated' Poisson (ZIP), to accommodate the high frequency of zeros in the data; and
3. 'Zero-inflated' negative binomial (ZINB), to account for the uncorrected over-dispersion of the data by the Poisson model.

Because these count data statistical methods are inappropriate for density calculations (M. Drever, pers. comm. 2014; A. Van Strien, pers.



John Cooper, cradling a goose captured and collared at the nest, Englishman River estuary.

Multiple types of analyses were used to assess population trends. Inconsistencies in any one dataset matter less when other types of data are exhibiting significant trends in the same direction. Due to conflicting and mostly statistically insignificant results, we cannot report that Canada Geese in the region are increasing or decreasing at a given rate.

comm. 2014), population trend analyses were based on the natural logarithm of individual (unaggregated) site survey counts, utilizing the site-specific area estimates as an 'offset factor' to account for differences in area surveyed. In this way, the resulting population count variable emulated a density variable.

Goodness of fit statistics such as the 'corrected Akaike Information Criterion' (AICc) and the 'deviance ratio' (i.e., deviance value/degrees of freedom) were used to identify the most parsimonious model and the resulting coefficients for the slope of the trend line, if significant. The presence of a dispersion parameter significantly different from zero ($p < 0.05$) in the ZINB model is indicative of a persistent uncorrected dispersion issue, which, if present, determines the ZINB model to be most parsimonious.

A significant trend is obtained when the Wald Chi-Square statistic is significant at an $\alpha = 0.05$ level. The trend estimate is obtained from exponentiating the slope (i.e., the parameter estimate for the year variate in the model)

and its standard error to obtain 95% confidence limits. The exponentiated slope parameter indicates the predicted change in the count variable given a one-unit change in the year variable. For example, an exponentiated slope estimate of 1.15 ± 0.05 indicates an increase (i.e., positive trend) of 1.15 times the number of geese per year (i.e., a 15% annual increase) plus or minus 5%, indicating a range of increase of 10 to 20% per year.

10.12 Results

Within- and Between-Year Goose Abundance and Densities

When total goose counts and densities were examined by survey dates over the calendar year, they largely mimicked those for marked birds, with peaks in the moulting period and in the late winter and early spring (Figures 10-1, 10-2, and Table 10-1, see Chapter 6.5, Relative Abundance of Migrant Types and Subpopulations). Low numbers in the nesting and autumn migration periods were due, in part, to lower detectability (see Appendix C). Notably, there were record

Geese may be widely distributed over a large site, lowering densities; this is often the case with marine and agricultural sites. On the other hand, large numbers of geese can be found in very small areas; for example, 91 birds were found in a 0.09 ha pond in the Parksville Church Road area (site PCR-04) during a routine population count in the winter of 2012. Removing these outliers did not affect between-year statistical significance.

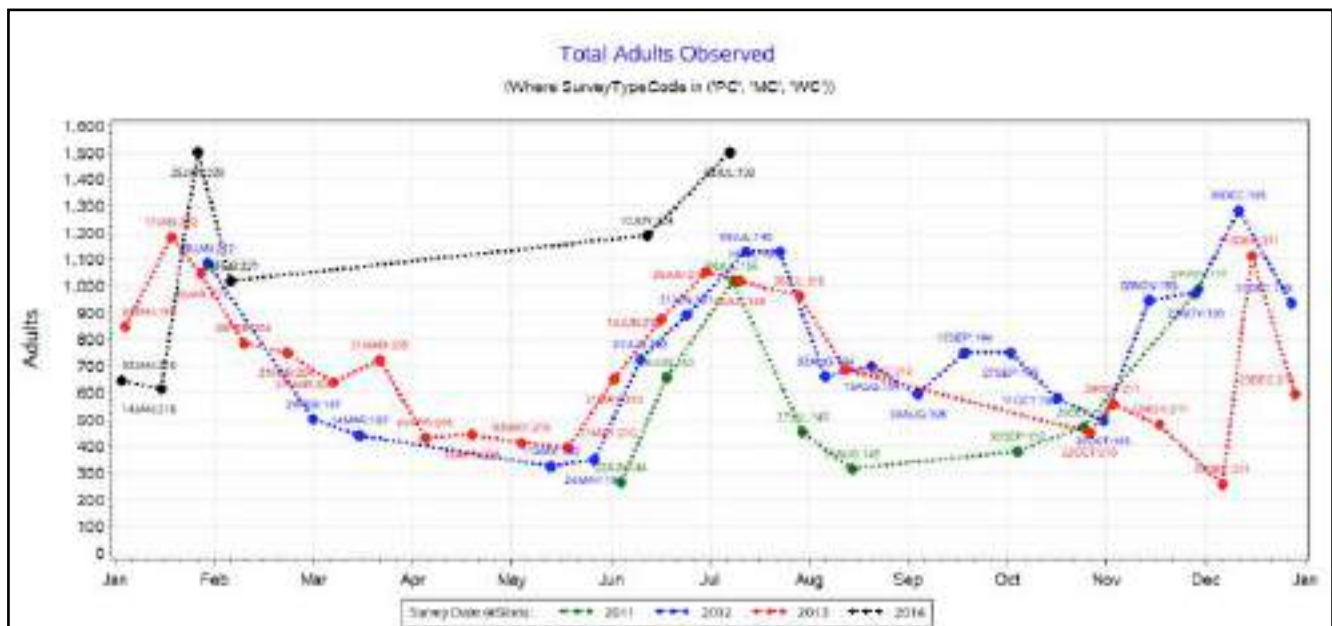


Figure 10-1. Total numbers of Canada Geese surveyed in the study area. Only AHY or unknown aged birds were included; juveniles were excluded. Tallies included moult, winter, and routine population counts across all sites, by survey date. Each data point is identified by survey date and the number of sites visited during the survey.

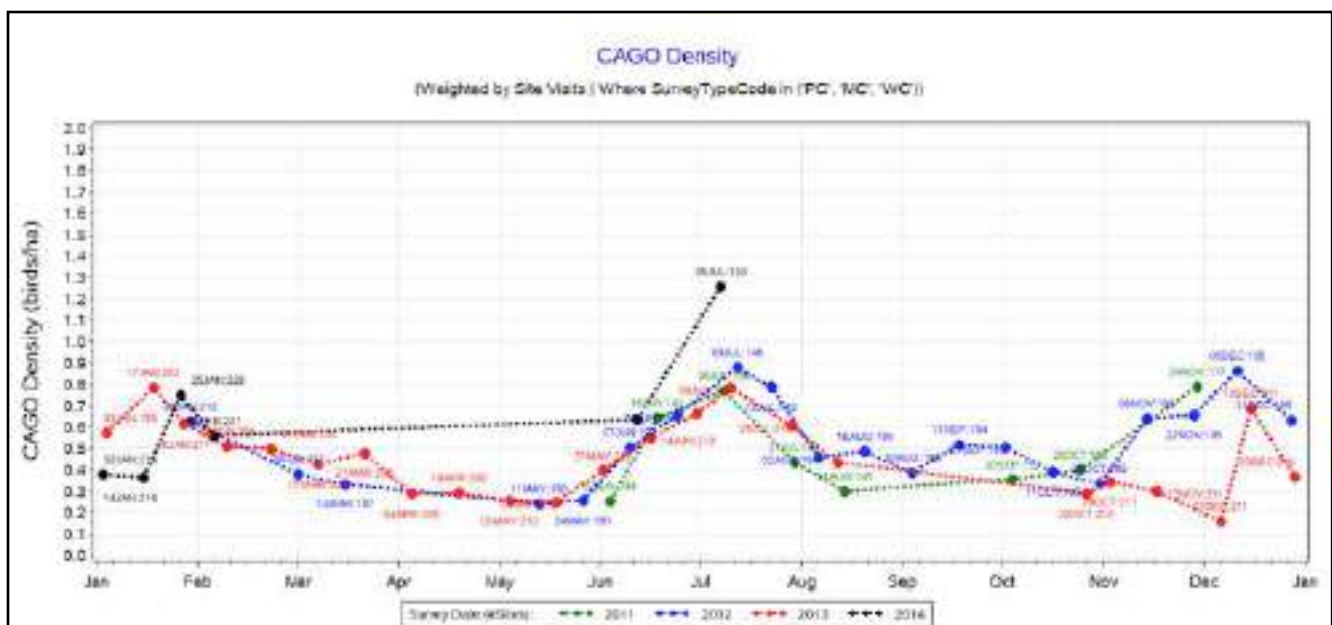


Figure 10-2. Canada Goose density (birds/ha) during moult, winter, and routine population counts, by survey date.

Table 10-1. Summary statistics for Canada Goose counted by survey type, season, and year. RPC=Routine Population Count. The lowest minimum and highest maximum number of geese per survey for each season are shown in red, for each season.

Survey Type	Year	Minimum CAGO/Survey	Maximum CAGO/Survey	Mean CAGO/Survey	Mean CAGO/Survey SD
Moult Count	2011		1020		
	2012		1129		
	2013		1020		
	2014		1502		
RPC - Moult	2011	264	661	423.5	177.5
	2012	662	1130	852.8	208.9
	2013	688	1053	894.8	156
	2014	1188	1188	1188	
Winter Count	2012		1084		
	2013		1046		
	2014		1501		
RPC - Overwintering	2012	992	992	992	
	2013	848	1285	1045.6	181.3
	2014	258	1113	645.2	305.1
RPC - Spring Migration	2011	443	503	473	42.4
	2012	642	786	725.5	61.3
	2013	1018	1018	1018	
RPC - Nesting	2012	326	350	338	17
	2013	395	446; 654 May 31	468.4	105.5
RPC - Autumn Migration	2011	169	472	284.6	163.7
	2012	497	948	688.8	148.2
	2013	453	559	498.3	54.6

Goose Densities Among Years

A non-parametric analysis of mean and scale (ANOM), applied to weighted mean Canada Goose densities, found significant differences ($pKW<.0001$) when site-specific goose density values were averaged across all surveys, aggregating all survey types and seasons (Figure 10-3). When partitioned by survey type however, density comparisons among years indicated strong significant differences only for routine population counts, not for moult or winter counts, whether aggregated across seasons or partitioned by seasons. Importantly, the level of error within a given moult or winter count was high, given these counts were only conducted annually. Yet, moulting birds cannot fly and are easier to count, and the precision of winter counts benefits from many experienced observers counting over a short period.

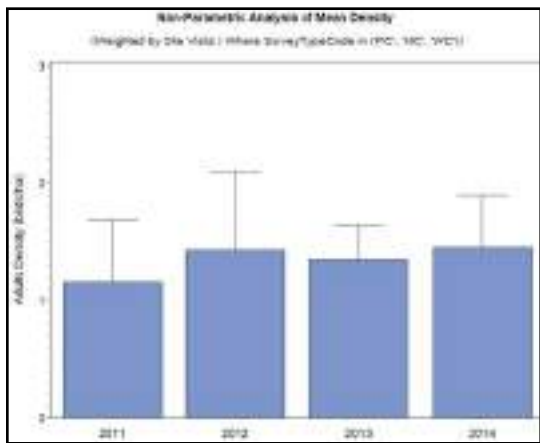


Figure 10-3. Comparison of annual mean Canada Goose densities (birds/ha), from moult, winter, and routine population counts across all seasons. Non-parametric Analysis of Means (ANOM) Kruskal-Wallis Chi-Square test ($pKW<.0001$). Only AHY or unknown aged birds were included; juveniles were excluded.

Population Trends

Although successful model convergence on parameter estimation occurred in all cases for all model types, the three model trend estimates did not always agree in significance or even in direction, indicating weak support for model fits.

For example, the ZINB linear trend models indicated there were significant, positive trends for moult counts and spring migration routine population counts, and significant, negative trends for nesting and overwintering routine population counts (Table 10-2).

The negative nesting period trend was based on only two years of data and therefore does not provide a reliable indicator. Nesting trends on the estuaries, apparent in the egg addling data, were gathered over a longer period (see Chapter 12.11, Egg Addling Program).

Table 10-2. Linear trend statistics for moult, winter, and population counts, 2011-2014.

Survey Type	Season	Selected Model	Based On	Slope	Std Error	Trend	Min	Max	Prob	Direction
MOULT	Moulting	ZINB	AICc & Over-Dispersion	0.308	0.135	1.36	1.05	1.77	0.022	+
WINTER	Overwintering	ZINB	AICc & Over-Dispersion	0.115	0.243	1.12	0.70	1.81	0.632	0
POPULATION	Moulting	ZINB	AICc & Over-Dispersion	-0.119	0.100	0.89	0.73	1.08	0.234	0
POPULATION	Fall Migration	ZINB	AICc & Over-Dispersion	0.049	0.222	1.05	0.68	1.62	0.827	0
POPULATION	Overwintering	ZINB	AICc & Over-Dispersion	-0.633	0.163	0.53	0.39	0.73	0.001	-
POPULATION	Spring Migration	ZINB	AICc & Over-Dispersion	0.410	0.198	1.52	1.03	2.24	0.035	+
POPULATION	Nesting	ZINB	AICc & Over-Dispersion	-0.515	0.214	0.60	0.39	0.91	0.016	-

The significant increase of moulting Canada Geese in the region from 2011 to 2014 (Figure 10-4), including a linear trend coefficient showing an average rate of growth of 36% over those years, may be deceiving. It is

largely attributed to a single survey, i.e., the 2014 moult count which exceeded 1,500 birds; an observer extended the search area to include large flocks of geese along Nanoose Bay towards Lantzville, whereas this area had

not been surveyed in earlier years. There was no similar trend for routine population counts during the same period (Figure 10-5). From 2011 through 2013, the moulting population was relatively stable at 1,000-1,200 geese.

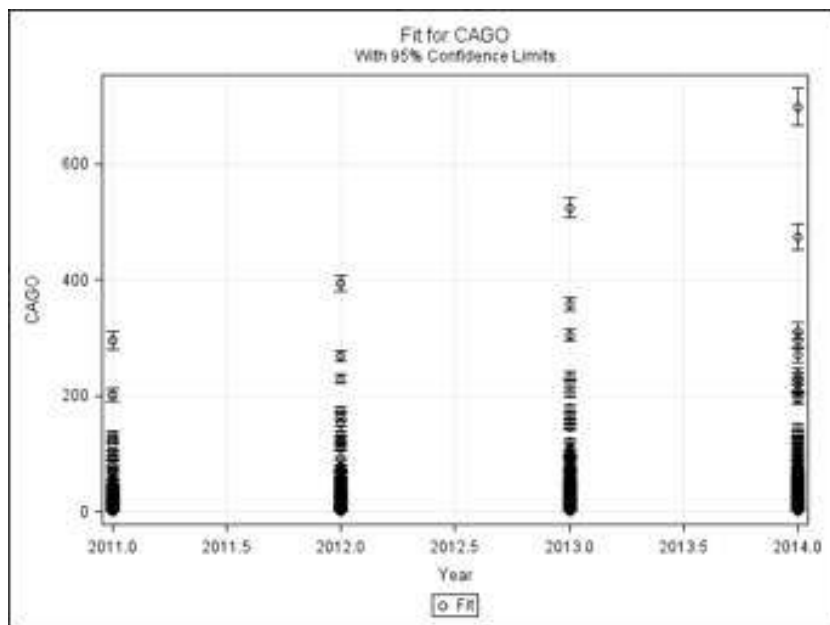


Figure 10-4. Poisson model results for moult count data, 2011 to 2014.

Limitations

The number of sites surveyed increased over time, as geese were discovered in new areas and permissions were granted to survey private properties. The number of site visits also increased. Therefore more sites were surveyed, more often, as the study progressed. Statistical significance in some analyses was attributed to these changes in survey effort, rather than to changes in goose populations, despite concerted efforts to incorporate effort in the analyses. This is explained in more detail in Appendix C.

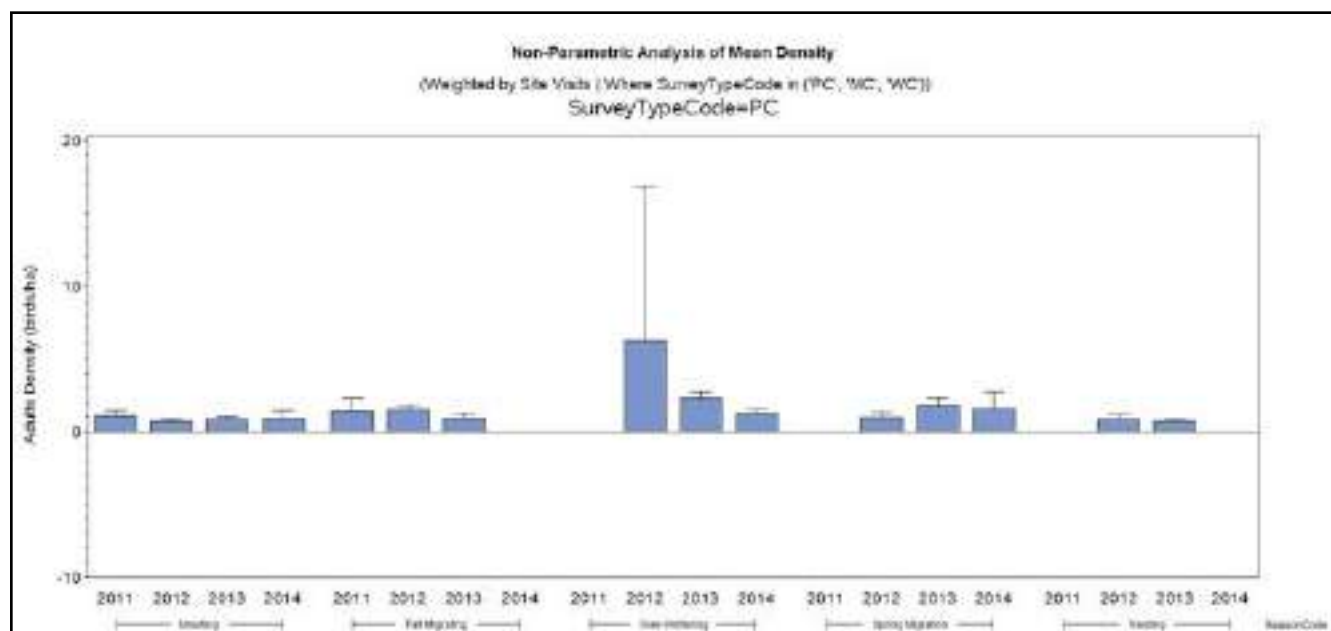


Figure 10-5. Mean Canada Goose density (birds/ha) for seasonal population counts.



Loafing geese at the mouth of the Craig Creek estuary. The CCE subpopulation does not nest at the CCE estuary; without this link their trends are more difficult to assess.

Similarly, routine population counts during the overwintering period showed a significant decrease over time (Figure 10-5), whereas the winter counts did not. The decline observed in population counts was attributed to a single outlier in 2012, where densities were inflated by a large flock observed on one small site. When the 2007 winter count was included, there was no significant trend.

There was a significant, positive trend in the number of geese present during routine population counts over the spring migration period. Yet, a significant negative trend was observed at the ERE over the same period ($p=0.017$), and the trend at the LQRE was insignificant ($p=0.341$).

When the population data were partitioned by banding estuary, there were trends indicative of the effectiveness of goose control and restoration efforts, or the lack thereof.

During the moulting period, the densities of Canada Geese at

the ERE significantly increased from 2011 to 2014 ($p=0.021$), while numbers were flat at the LQRE. This is reflected to some degree in the numbers of nests found and eggs added at each estuary, which have risen over time at the ERE, but decreased at the LQRE (see addling graphs in Chapter 12.2, No Action).

In the fall migration and overwintering periods, densities significantly increased at the LQRE ($p<0.001$ and $p=0.002$, respectively), whereas densities were static or slightly decreased at the ERE. The daytime use of these estuaries in seasons outside of the nesting and moulting periods may be dependent, in part, on the availability of preferred forage, which is improving at the LQRE and probably declining at the ERE. However, there are many other variables that could play a role, such as proximity and use of other feeding areas, levels of disturbance, and weather. This trend requires further investigation.

Insignificant trend model fits might be attributed to insufficient length of time-series, outliers in the data, unidentified model components (i.e., missing co-variables), or, barring those likely factors, no evident trend in the data. In addition, population trends may be non-linear, and therefore not apparent from these linear trend analyses. Initial analysis of trends using TRIM software (Van Strien et al. 2004) indicated apparent nonlinear effects in some (but not all) cases, and were inconclusive due to insufficient data (namely brevity of time-series in the contemporary population count dataset, and insufficient spatial resolution in historic data for inclusion for analysis and detection of long-term linear or non-linear time trends).

Overwintering Time Series

For an overview of population trends, we explored data for which we had a relatively long time series. There were nine surveys of 'overwintering' Canada Geese from 1989 through 2014. The CWS and MoE led six counts from 1989 through 2006, and the Guardians conducted surveys from 2012. This amalgamation of historical and contemporary data found a prominent spike in 2006 followed by a return to lower numbers in 2012 (Figure 10-6). Population growth in the early years was indicative of an increasing goose population as well as additional survey effort with new areas added over time. Foggy conditions in November 2005 prompted a second survey in January 2006, revealing greater numbers and motivating a shift to January overwinter counts in later years. 2005 also marked the opening of River's Edge in Nanoose Bay, a new rural subdivision with grassy areas, ponds, and pastures. A spike in goose numbers in January 2014 was attributed, in part, to additional survey areas in Nanoose Bay. No long-term, statistically significant trend was evident in this data.

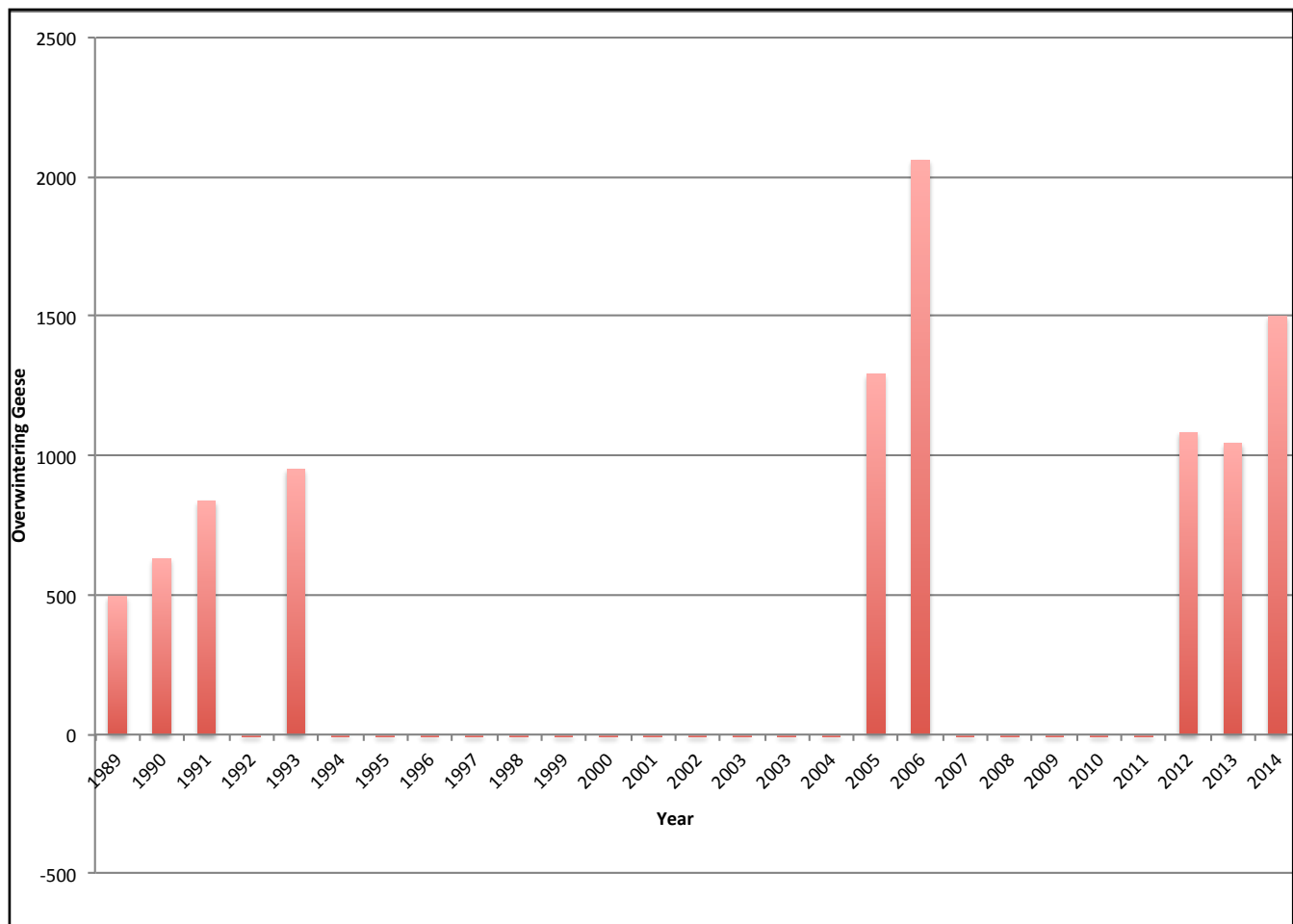
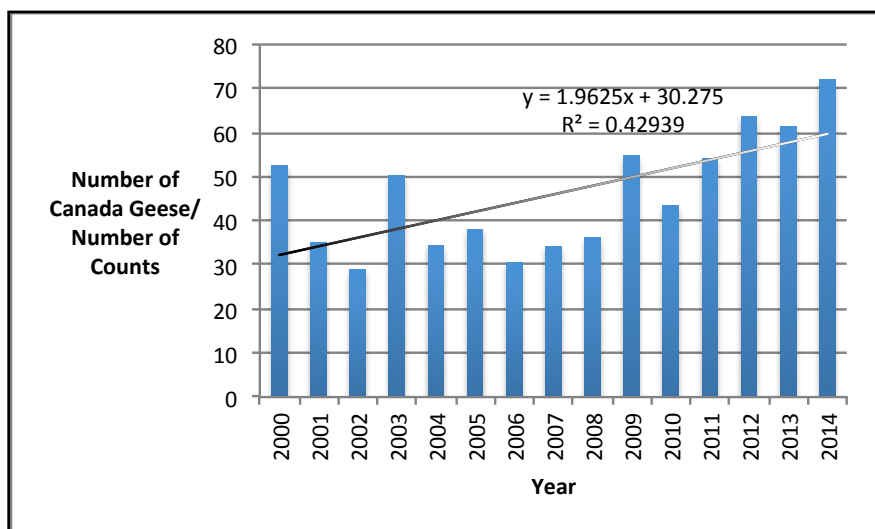


Figure 10-6. Autumn and January Canada Goose counts, 1989 to 2014 (n=9). Counts were conducted in late November for 1989 to 1991, 1993 and 2005, in mid-January in 2006, and late January from 2012 to 2014. Data were grouped by survey area. Effort was directly comparable for 2012 and 2013 counts only.

10.2 External Data Sources

10.21 B.C. Coastal Waterbirds Survey

While data for the Vancouver Island, Parksville - Qualicum Beach region showed an increasing trend, adding approximately 2 birds per year from 2000 through 2014, less than half of the variability in Canada Goose numbers was explained by year. Numbers were lowest in 2002 and 2006, whereas the 2006 CWS-led winter count was one of the highest ever recorded (see Figures 10-6 and 10-7). In a closer examination, using counts for the month of January only, numbers were very low and there was no significant linear trend (Figure 10-8).



B.C. Coastal Waterbirds Survey data were compiled by Karen Barry. These data are also available from Bird Studies Canada (see <http://www.bsc-eoc.org/volunteer/bccws/index.jsp?targetpg=bccwsdata>). The data were collected by volunteers trained to follow a standardized protocol. This protocol asks that volunteers count birds from September through April, and preferably monthly. Birds are located in three habitats: inland = above high tide (e.g., a pond, field), nearshore = from high tide out to 500 m from shore, and offshore = beyond 500 m from shore (K. Barry, pers. comm. April 4, 2014). To more accurately compare this data with our own, we selected only January surveys and contrasted these with our winter counts.

Figure 10-7. B.C. Coastal Waterbird Survey data for Canada Geese in region VIPQ (Vancouver Island, Parksville - Qualicum Beach), 2000 to 2014. September to April counts were summed and divided by the total number of counts. Surveys with zero Canada Goose counts were not included (K. Barry, pers. comm. April 4, 2014).

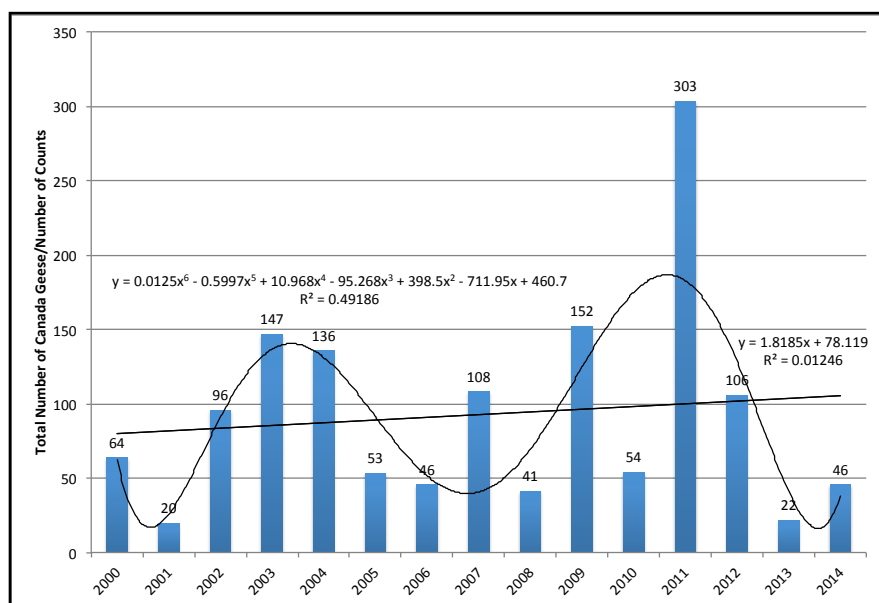


Figure 10-8. B.C. Coastal Waterbird Survey data for January, 2000 to 2014.

10.22 Christmas Bird Count

The Christmas Bird Count (CBC) is an annual one-day, volunteer-based survey coordinated by local naturalists and reported by the Audubon Society. Weather is known to strongly influence the number of birds observed. Prior to about the mid-1990s, the data collected for the BCPQ count circle was scant, the map was poor, and the circle centre was not described accurately. Since ~2000, counting effort has been more, but not entirely consistent. Over the last decade, data collection has been more detailed (S. Gray, pers. comm. January 16, 2015).

There are two CBC 'counting circles' within our region, i.e., BCPQ (Parksville-Qualicum) (Figure 10-9) and BCNB (NanOOSE Bay). The numbers of Canada Geese observed in the BCPQ circle have consistently increased since 2009, after fluctuating for many years (Figure 10-10). The linear trend line shows a mean increase of 20 birds per year from 1991 through 2014, yet the coefficient of determination is low ($r^2=0.18$), suggesting that only 18% of the variability in CBC goose counts is accounted for by year. Counts exceeded 1,400 birds in 1998, 1999, 2002, 2004, 2013, and 2014. Our regional counts over the overwintering period

exceeded 1,400 only in 2014. No data were available for the BCNB circle (Audubon Society 2015).

To the northwest is a third counting circle, the Deep Bay circle (BCDB), which extends south to the Big Qualicum River. Interestingly, CBC numbers in the BCDB circle did not reach 400 until 2003, and have been increasing since 2005 (Figure 10-11). The linear trend line showed an increase similar to the BCPQ circle (i.e., 20 birds per year), but the coefficient of determination was much higher ($r^2=0.47$). The trend was better explained by a polynomial line that was largely flat through the 1990s and early 2000s (order 3, $r^2=0.57$).

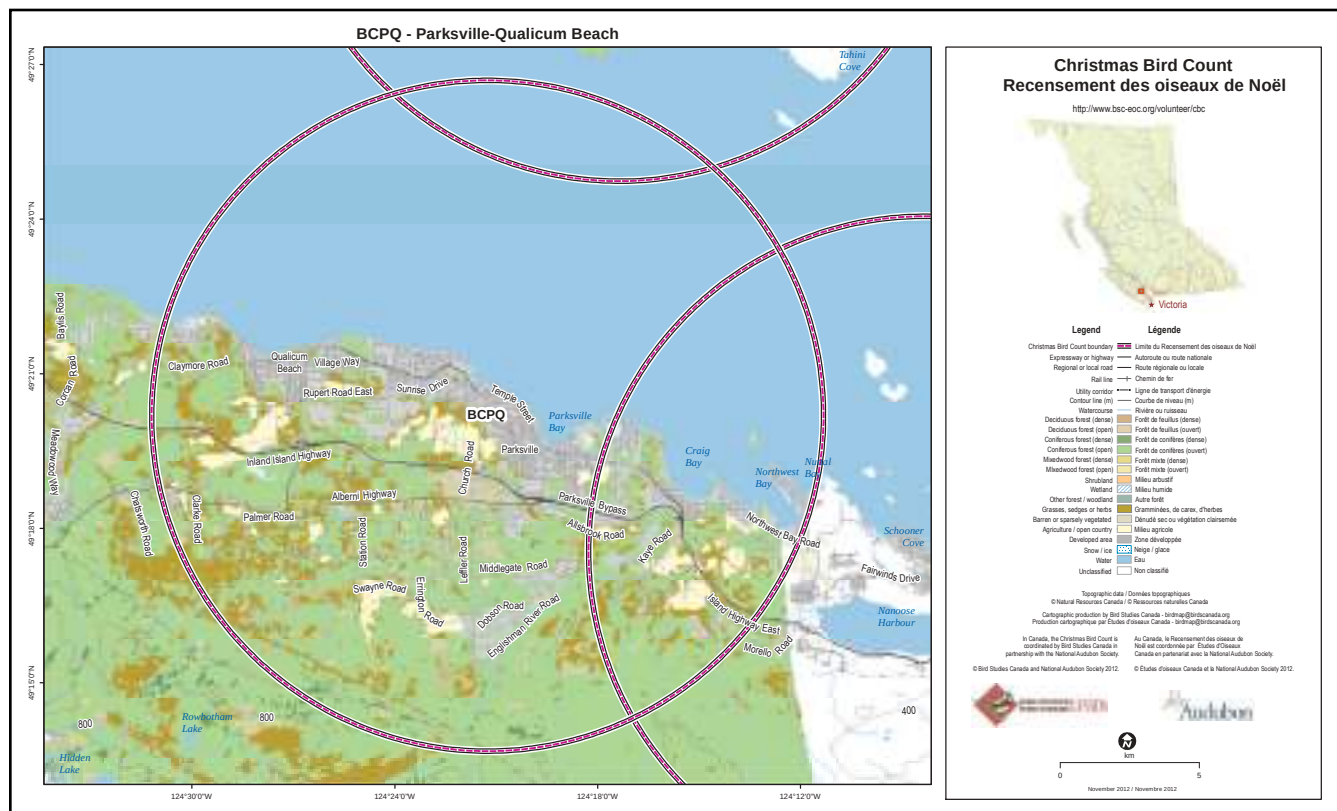


Figure 10-9. Christmas Bird Count circle BCPQ (Parksville - Qualicum Beach).

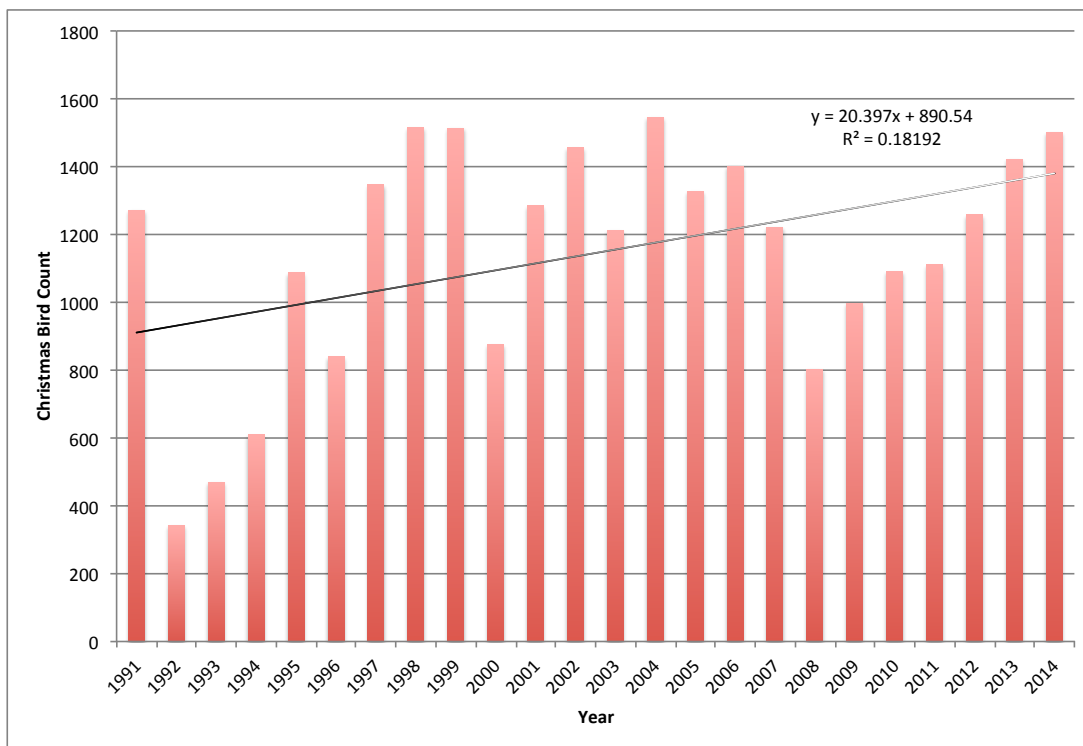


Figure 10-10. Canada Geese observed during the Christmas Bird Count in the BCPQ circle, 1991-2014.

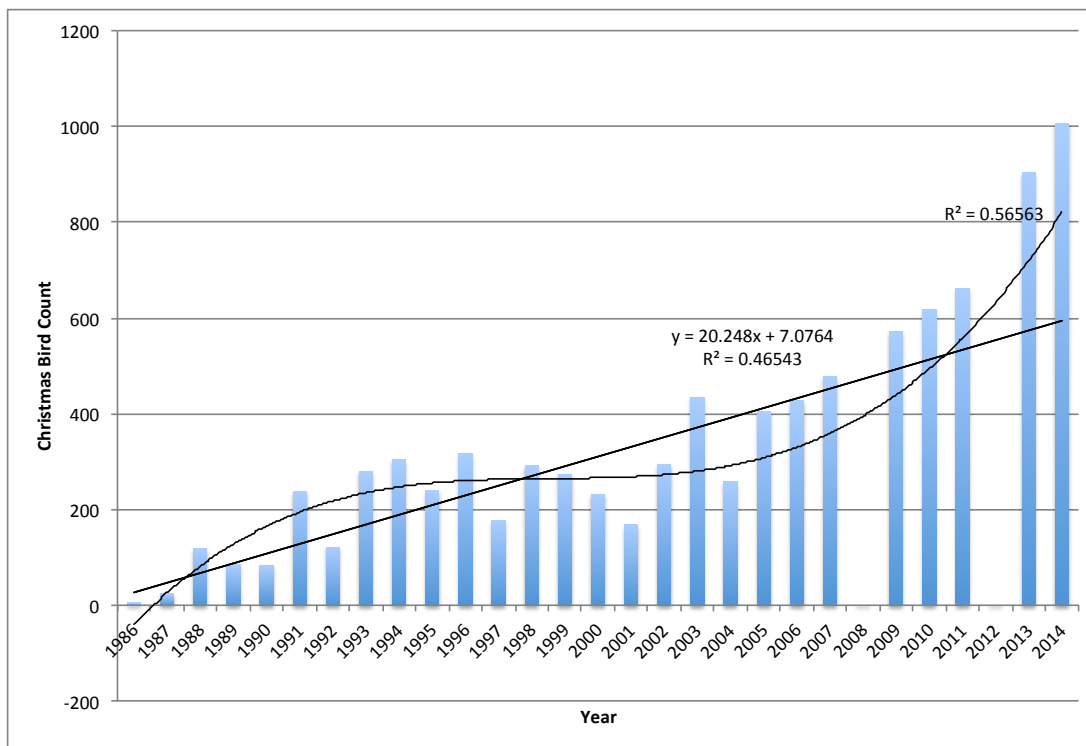


Figure 10-11. Canada Geese observed during the Christmas Bird Count in the BCDB circle, 1986-2014.



Aaron Ritchie, conducting surveys for the Guardians near the Snaw-naw-as First Nation reserve in Nanoose Bay, 2014

10.23 Study of Canada Geese in Parksville

Ritchie (2013) estimated the goose population in Parksville to be 678 ± 112 (SD), based on surveys conducted from July 2012 to January 2013. Counts fluctuated from 383 in late October to 1,480 in late December. More geese were found during morning surveys (mean = 262 ± 127 SD) than afternoon surveys (mean = 166 ± 63), although time of day did not significantly affect population estimates (Ritchie 2013). The high in December 2013 is consistent with our winter count in 2014 and with 2013 CBC data, confirming that this was a peak for overwintering Canada Geese.

Ritchie (2013) conducted weekly goose surveys and recorded marked birds within the City of Parksville and the San Pareil area of the RDN from July 2012 to January 2013, as part of his undergraduate degree program at Vancouver Island University. He estimated the resident population size using program MARK 6.2, and assessed whether the time of day that surveys were conducted (i.e., morning or afternoon) affected the statistical significance of the population estimate.

10.24 Other Data Sources

Several other data sources were considered in the development of this strategy.

B.C. banding records were examined to determine whether Canada Geese banded elsewhere had been recorded in our region from 2008 to 2014. No such records were found.

Breeding bird surveys were found to be poorly suited to the study of Canada Geese. They occur in June, when the birds are beginning to moult. The surveys occur along a predefined route, 24.5 miles (39.4 km) long, with 50 three-minute stops, each 0.5 miles (0.8 km) apart. At each stop, volunteers record the total number of each bird species seen or heard within about 400 m (Bird Studies Canada n.d.).

eBird was also explored for Canada Goose data in local and

nearby Important Bird Areas. There were few data based on a small number of sites.

As part of her undergraduate degree program at the University of Victoria, Spillette (2015) explored the use of several mark-re-sight models (i.e., Cormack-Jolly-Seber Model, Jolly-Seber Model, Brownie M1 Model, and Burnham Model) to assess survivorship of CCE-banded birds. Some of the statistical challenges she identified or examined included **tag loss**, homogeneity (migrant types), homogeneity (banding location), study range and emigration, and defining re-sight intervals. This work may serve a future Master's or PhD student in the University of Victoria's Department of Mathematics and Statistics (L. Cowen, pers. comm. May 26, 2015).

Other sources are described in Chapter 12, Management Options.



Tag loss was a factor in this study. Several LQRE and ERE-banded birds managed to free themselves of their collars. We used glue to secure the collars of CCE birds.

10.3 Life History by the Numbers

The key factors contributing to a larger regional population and greater Canada Goose densities include: a higher natality or birth rate, lower mortality rate, more immigration from other areas, and/or less emigration out of the region. Similarly, a smaller regional population and lower densities can be achieved by lowering the birth rate, increasing the mortality rate, limiting immigration, or encouraging emigration. This section explains how these factors affect population size, drawing from our own data wherever possible.

10.31 Natality

The natality or birth rate, sometimes referred to as reproductive output, is directly influenced by the number of breeding birds, breeding success, and the rate of re-nesting. The average clutch size of a Canada Goose population is a measure of its potential for reproduction (Brakhage 1965). (Eggs laid sequentially in a single nest are referred to as a 'clutch'.)

Breeding Birds

The proportion of birds that attempt to breed is determined by the age at which Canada Geese become capable of breeding. Canada Geese will choose mates at the age of two or three years (Howard Breen 1990). Some Canada Geese that nest successfully in earlier years do not attempt to nest later on (Johnson et al. 1992).

The age structure of the

population affects egg and gosling production. There are fewer young produced if there are fewer birds of breeding age. The number of breeding birds in any given year is dependent on the population size during the previous nesting season, the number of young they produced that have reached breeding age, the survival rates of breeding adults between the previous and current breeding season, and the likelihood that the birds will return to the nesting grounds (Johnson et al. 1992).

Brakhage (1965) suggested that certain females were dominant and others were subordinate. In his study, males determined the territories, but females determined the nest sites; the female hierarchy affected proximity to other nests, size of clutches, and even whether subordinate females laid eggs at all. It appears likely that dominance is age-related.

Our marked Canada Geese were not systematically aged. Of the 296 birds that were marked, only 26 were aged as juveniles/'hatch-year' (HY), 110 were adult/'after-hatch-year' (AHY), and 160 were of unknown age.

Breeding Success

'Breeding success' is self-explanatory in circumstances where managers have used various forms of birth control to limit goose production. However, most often it is a broad term encompassing egg success,

hatching success, and/or nest success. Cooper (1978) defined egg success as the percentage of eggs that hatch, hatching success as equivalent to nest success (unless referring to artificially incubated eggs, in which case it is a measure of fertility), and nest success as the percentage of nests producing one or more goslings.

In nature, some eggs do not hatch, due to infertility, breakage, displacement from the nest, chilling, desertion, or predation (Johnson et al. 1992). When populations are dense, the number of infertile eggs among subdominant birds may be greater (Johnson et al. 1992). Overcrowding and conflicts between nesting pairs can lead birds to abandon their nests (Ogilvie 1978 in Ray 2011). Losing eggs has less effect on the size of a population than losing goslings or adults, because the chance of an egg becoming a breeding adult is lower (Perrins & Birkhead 1983).

Cooper (1978) reported nest success rates close to 80% for first nests, in an area of Manitoba not subjected to excessive predation or flooding. Nesting success was 84% at George C. Reifel Migratory Bird Sanctuary in Delta, B.C., in 1973 (Dawe & Davies 1975).

Breeding success is linked with nest site selection, or more specifically, the availability and quality of nest sites. Good sight lines and vegetative cover help protect nests from predation (cf. Miller, Abraham, & Nol 2013), while nearby high quality forage

and drinking water minimize the length and number of recesses (cf. Cooper 1978). The tenacity of the parents likely plays a role as well.

Re-nesting

After an earlier clutch is destroyed or abandoned, or a brood is lost, Canada Geese may re-nest (Johnson et al. 1992). A re-nest differs from a 'continuation nest', where a female continues laying in a second nest, after losing eggs from the original nest before her clutch is complete (Brakhage 1965).

From 9 years of records for Canada Geese in a captive breeding program in Michigan, 70% of geese re-nested after their first clutch was removed (Weigand, Pollok, & Petrides 1968). Among Canada Geese breeding in Manitoba, 92% of pairs that lost their first nest made a second attempt, as either a re-nest or continuation nest (Cooper 1978). Of pairs that lost a nest at two days of incubation, 70% re-nested. None of the pairs that lost nests late in incubation made another attempt (Cooper 1978). Continuation nests are generally nearer original nests than re-nests (Brakhage 1965; Cooper 1978). Brakhage (1965) observed most continuation nests were within 100 m, while Atwater (1959) found a re-nesting bird had moved 24 miles. In Missouri, Weigand, Pollok & Petrides (1968) calculated an average re-nesting interval (between the termination of the first nest and the start of the second) of 16.7 days, Not



Clutches with 9 eggs were unusual. From 2008 through 2014, only 10 were found: one on the LQRE and 9 on the ERE. This one was found on April 26, 2010 (above). However, there were at least 93 nests with 8 eggs over the same period (below).



rates are higher where nest success rates are lower (Johnson et al. 1992).

Re-nest clutch sizes are reportedly smaller for all species of waterfowl, a consequence of hen exhaustion and diet (Johnson et al. 1992). Yet Cooper (1978) and others found that re-nest clutch sizes for Canada Geese were not significantly different from first nest clutches, and in some cases were larger.

Prior to 2015, there were three re-nests discovered among our marked birds, all at the ERE, one in 2012, one in 2013, and one in 2014. In 2015, there were two re-nests at the ERE and one at the LQRE (T. Clermont, pers. comm. 2015).

Clutch Size

Canada Geese are determinate layers, e.g., if eggs are removed, a goose will not lay more (or fewer) eggs than they would if eggs had not been removed (Cooper 1978). Therefore, clutch size is a measure of egg success. In *Birds of British Columbia*, clutch size ranged from 1 to 14 eggs, with 55% having 5 or 6 eggs, for 1,374 clutches (Campbell et al. 1990). The CWS (2010) reported that nests may contain 10 or more eggs, with an average of 5-6 eggs, and the MoE (1979) documented an average of 5 with a range of 4 to 7. Bellrose (1976) noted that nests with more than 8 eggs probably included some dumped by intruding females.

In our region, the mean clutch size, with 95% confidence, was 5.2 ± 2.2 eggs/clutch, for all nests found during the estuary-focused

egg addling program since 2002. As nests outside of the ERE and LQRE were a lesser priority, they were often searched later in the season, some after they had been predated; therefore this value is probably low. In fact, variability prior to 2010 was largely a reflection of 'survey' effort, as early egg addling crews visited the estuary only once or twice each nesting season. For nests discovered on the ERE and LQRE from 2011 through 2014, addling crews were consistently onsite when eggs were fresh, and mean clutch size was higher, 5.83 ± 0.94 eggs/clutch (95% confidence).

Annual mean clutch sizes varied from estuary to estuary (Figure 10-12), suggesting each subpopulation has a different age structure. The average clutch size from 2010 through 2014 was 5.6 for the ERE, and 5.8 for the LQRE. At the NBE and other sites, mean clutch sizes from 2012 to 2014 were 5.3 and 4.6, respectively; these lower values reflect a later egg addling schedule coupled with higher levels of predation, particularly on the outer islands.

Mean clutch sizes for the ERE and LQRE have risen since 2010, suggesting that these subpopulations are aging. Brakhage (1965) found older birds had larger clutches and greater nest success. Cooper (1978) linked clutch size to time of nest establishment. Later in the nesting season, clutches are smaller, perhaps due to the age of late nesters; younger birds of all species tend to lay smaller clutch sizes and many nest later (e.g., Cooper 1978; Johnson et al. 1992).

As clutch sizes are limited by protein reserves, they may reflect preferential nesting of older birds in better habitats (Johnson et al. 1992). As high levels of disturbance may deplete reserves, the increase in clutch size at the ERE suggests that the City of Parksville canine goose control program, which ran from 2009 through 2011, did not have a detrimental effect on the condition of the ERE population. Clutch size may also be related to individual genetics, photoperiod, and hormone levels (Johnson et al. 1992).

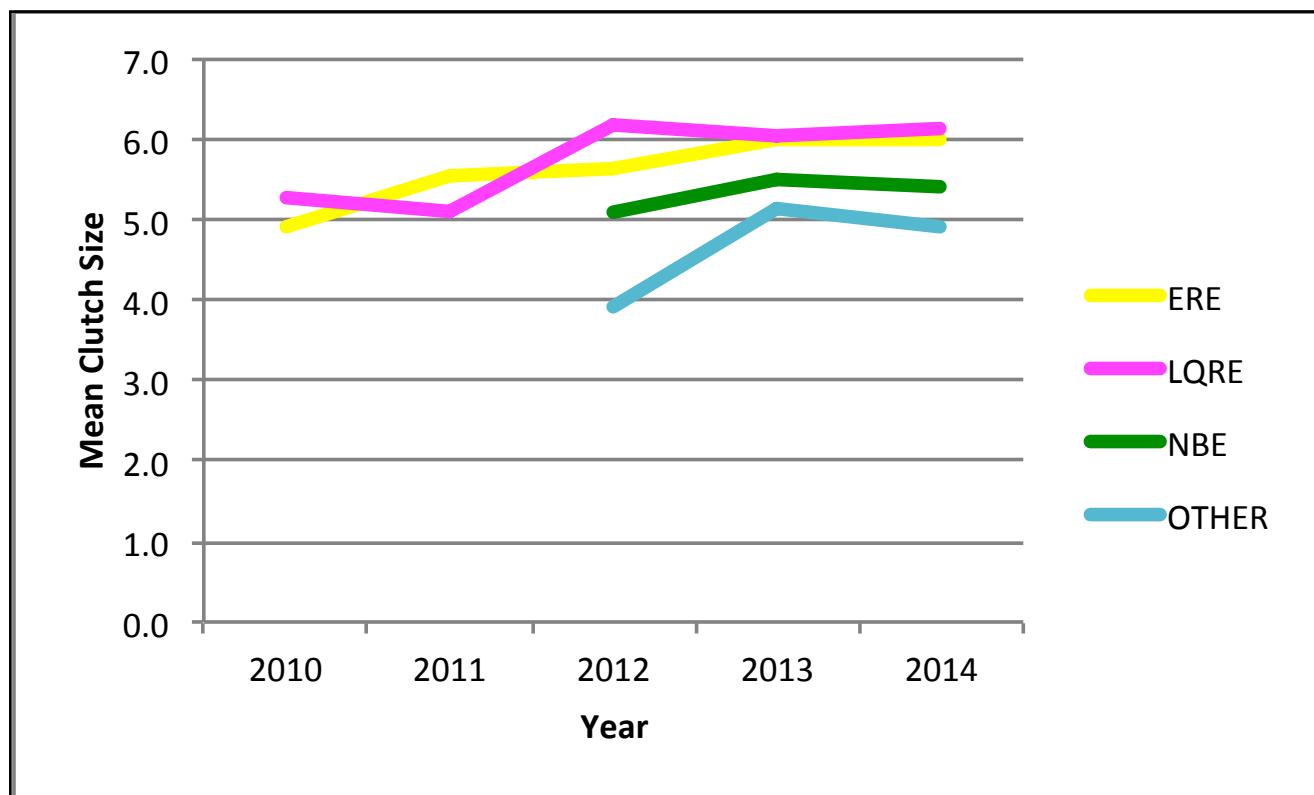


Figure 10-12. Mean clutch size by estuary, 2010-2014 (n=3,163).

Egg Size

Larger eggs may produce larger birds which may have higher survival rates (Johnson et al. 1992). Egg size can vary within clutches and between years for the same goose. However, there are notable relationships. Brakhage (1965), using a 1949 index by Romanoff and Romanoff (width/length*100), discovered that mean egg size rose until age 5, then became variable, but never

as high as age 5. Cooper (1978), using the same index, found that egg size increased with the age of the female up to year 5, then stabilized until extreme age (e.g., 18 years), when it declined. Cooper (1978) also found that egg size was correlated with the time of nest establishment, which is linked to the age of the female. (See also Chapter 8.2, Nesting).

In our study, egg size was examined to explore a link

between egg size and estuarine marsh productivity; the data will be analyzed in a later publication.



Calipers were used to measure eggs.

10.32 Mortality

Mortality is the death rate of the population, and the converse of survivorship (Perrins & Birkhead 1983). In general, larger birds have greater survivorship, although there is little evidence of lower survival rates for females relative to males (Johnson et al. 1992). And authors disagree whether juvenile/HY or adult/AHY geese have greater survivorship (or lower rates of mortality), with some reporting higher rates for one or the other. Higher rates of HY survival have been credited to a lack of reproductive costs, especially in urban habitats (cf. Smith, Craven, & Curtis 1999), and to parents escorting young into no hunting areas (Pilotte 2012 in Beaumont 2013). Lower rates of survival among AHY birds have been attributed to increased exposure to hunting pressure during moult migration (cf. Heller 2010). Lower rates of HY survival are attributed primarily to naivety during hunting seasons (Beston et al. 2014).

Most, but not all authors agree that urban, resident Canada Geese enjoy better survival rates than rural and migrant geese due to less hunting pressure and predation (USFWS 2002; Balkcom 2010; Beston et al. 2014). In an urban Arizona setting, Ray (2011) calculated a mortality rate of just over 6%, although this was based on just two years of data.

Known predators of Canada Goose eggs and goslings include river otters, mink, weasels,

raccoons, Bald Eagles and other raptors, gulls, crows, dogs, and humans (e.g., Sherwood 1968). Die-offs due to disease have occurred but are uncommon (Sherwood 1968; Howard Breen, 1990).

Hunting is not allowed at any of the banding sites, because of their conservation lands status, firearm discharge restrictions, or both. However, marked birds were targeted by hunters (as noted by a local hunter). See more on hunting in Chapter 12.12.

In jurisdictions exposed to severe weather conditions, survivorship and productivity have been known to fluctuate with thermal stresses (Beston et al. 2014). However, our weather is typically mild and likely has little effect on mortality rates.

Gosling Survival

Gosling survivorship is highly variable. Johnson et al. (1992) defined gosling survivorship as the probability that an individual hatchling will survive to fledge, while some other authors look at survivorship over the entire first year. Higher rates of gosling survival is linked to older parents and earlier hatch times (Johnson et al. 1992).

Bellrose (1976) found 70% of breeding pairs fledged an average of 4 young, representing a rate of production of 2.8 young per nesting pair (MoE 1979). Mortality rates were highest in the first year (39 to 65%), and less in subsequent years (32 to 52%) (Bellrose 1976). In B.C., 2,033 broods included 1 to 27 young, with 56% having 4 to 6;

mixed broods were considered 10 or more (Campbell et al. 1990); Campbell et al. (1990) did not indicate whether the young lived to fledge. Smith, Craven, and Curtis (1999) reported mortality rates for urban-born juveniles ranging from 77% (23% survival) to the first moult, to more than 90% to the first hunting season. In contrast, Brakhage (1965) reported gosling mortality ranged from 20 to 36% annually, averaging 32% over 3 years; 90% were lost within the first two weeks of life. Beston et al. (2014) reported a survival rate of 66% for rural HY geese in New Jersey, and a rate of 83% for urban HY birds. Pilotte et al. (2014) reported survival rates of 82% for juveniles, and 76% for yearlings in Quebec. Heller (2010) found juvenile survival rates for juveniles ranged from 63 to 95%, with a grand mean of 78%. High survival rates were attributed to the social structure of Canada Goose populations (Howard Breen 1990); family groups generally stay together for nearly a year (Johnson et al. 1992).

Adult Survival

Population growth rates for long-lived species like Canada Geese are most sensitive to the survival of breeding-aged birds (Beston et al. 2014). Adults can live for 20 years or more (Douvillie & Friley 1957; Bellrose 1976; CWS 2010).

The oldest known wild goose was banded as an adult and recaptured 28 years and 5 months later (Klimkiewicz 2000 in USFWS 2002). Yet, Howard



M033, paired with M046, laid 6 eggs in 2012, 7 eggs in 2013, and 6 eggs in 2014. While M033 was seen only at the Englishman River estuary and in Parksville each season, M046 was also observed at the Craig Creek estuary.

Breen (1990) noted that most die before their tenth year and only a few survive to fifteen. Of 1,600 Dusky Canada Geese recaptured on the Copper River Delta in Alaska, four were found to be more than 17 years of age, and one of them was still reproductively active (Campbell 1991). Two others were at least nineteen. As suggested in Chapter 7.25, Local Residents and Long-distant Migrants, northern-breeding Canada Geese probably have shorter lifespans than their temperate-breeding counterparts.

Adult survival is supported by strong social structures, including pair bonds (Heller 2010). Pair bonds are formed prior to the first breeding season and typically last for life. Only when a mate dies, will a goose or gander seek another mate (MoE 1979). Mates stay close together when feeding, resting and flying. When a mate is lost, the remaining bird is more vulnerable. It calls, searches, and spends time away from the flock, until it mates again before the next breeding season (Howard Breen 1990).

The USFWS (2002) amalgamated various studies to find adult survival rates ranging from 65 to 85%. In New Jersey, Beston et al. (2014) recorded average survival rates for both urban and rural AHY geese of 72%. Pilotte et al. (2014) reported survival rates were 82% for adult Canada Geese in Quebec. Heller (2010) found rates from 67 to 76% in Iowa, with a grand mean of 72%.

10.33 Immigration and Emigration

Young ganders are more likely to disperse from nesting and rearing areas (Beston et al. 2014). Ray (2011) reported emigration rates of 36 to 38% for urban geese in Scottsdale, Arizona, based on the number of collared geese not seen a year later, excluding known mortalities. She also found immigration rates ranging from 2 to 13%, based on the the number of new geese collared in the second year.

012T was an emigrant banded at the CCE in July 2012. It used the ERE during the following autumn, winter, and spring migration seasons. It was last seen at the ERE in July 2013.



Chapter 11 - Management in Other Jurisdictions

Highlights

This chapter documents management approaches for nuisance Canada Geese in certain international, national, and regional jurisdictions, contributing to Goal 4 (examining management in other jurisdictions and identifying options appropriate for this region). For brevity, it does not provide a complete history associated with goose management in these jurisdictions. Recognize that management approaches may change; please check with individual jurisdictions for more up-to-date information.

Canada Geese are considered nuisance animals in many jurisdictions. In 18 of 20 countries participating in the European Network on Invasive Alien Species, the Canada Goose holds one of two top spots among 9,511 invasive species and is considered a serious threat to biodiversity. In some European countries, Canada Geese outnumber native goose populations. In certain countries, destruction of eggs and birds is allowed, while in others, calls for hunting, egg sterilization, and culling are underway. The Network adheres to the slogan, "If you can't beat 'em, eat 'em".

In New Zealand, egg sterilization and culls during the moult were conducted by the Wildlife Service between 1976 and 1987. A 1995 management plan proposed culling where hunting could not maintain populations. By 2000, control measures were shown to be moving birds to other areas.

The Pacific Flyway Council had requested the western United States be excluded from some U.S. regulations to control Canada Geese. An airport control order, nest and egg depredation order, and public health order are available to Pacific Flyway states, but orders to control overabundant migratory bird populations and to control resident Canada Geese - which would allow culling of goslings and adults, are only available to states along the Atlantic, Central, and Mississippi Flyways. Nonetheless, U.S. cities have considerable latitude to deal with urban goose problems under U.S. Fish and Wildlife Service (USFWS) depredation permits. For example, Anchorage, Alaska and Seattle, Washington conducted a series of annual culls beginning in 1996 and 1997, respectively.

In 2014, the Pacific Flyway Council proposed, and the USFWS agreed to combine interior and coastal frameworks for Canada Geese, noting that harvests alone would not completely address agricultural depredation. The hunting seasons, dates, and limits were to be altered in several states to encourage greater harvests. Quotas were to be increased on Dusky Canada Geese in Washington and Oregon.

The USFWS maintains an e-permits website, whereby anyone in the conterminous U.S. can register for federal authorization to destroy resident Canada Goose nests and eggs. Some states do not participate in this program and/or have additional or similar requirements.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 11 - Management in Other Jurisdictions

More Highlights

U.S. Department of Agriculture (USDA) Wildlife Services has provided support in many aspects of goose management, including capture and euthanasia. Where geese could not be captured or otherwise controlled, small numbers were selectively removed with a pellet gun or shotgun. Culled geese suitable for human consumption were donated to qualified charitable organizations. Wildlife Services personnel were also responsible for hazing, nest destruction, addling, and relocations.

The National Wildlife Research Center, an arm of the USDA Wildlife Services program, was instrumental in developing a chemical repellent to discourage geese from using grassy areas. The Center also tested drugs to inhibit bird reproduction.

USDA Wildlife Services provides goose management services on a cost-reimbursable basis. Funding has been provided by resource owners, private businesses, and local, state, or federal funding agencies.

There are a variety of State-funded Canada Goose control programs. For example, the Wisconsin Department of Natural Resources provides grants to local and tribal governments, to reimburse damage abatement and control projects (i.e., 50% reimbursement up to a maximum of \$5,000). In Michigan, the Department of Natural Resources conducts nearly half of Canada Goose roundup activities. The state's resident Canada Goose program is financed by hunters and permit fees.

The Patuxent River tidal marshes in Maryland were restored by allowing hunting in a wetland sanctuary, removing ~1,700 Canada Geese over a 4 year period, and by planting and fencing.

Washington's Seattle Goose Program was launched as a pilot project by non-profit groups in 2006. The program was designed to help Seattle Parks and Recreation resolve its human-geese conflicts without culling. Volunteers located nests for addling and oiling; hazed geese with lasers, kites and dogs; and cleaned feces from beaches and recreation areas.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 11 - Management in Other Jurisdictions

More Highlights

The Capital Regional District on Vancouver Island commissioned the production of a technical report and strategy to manage Canada Geese. Population trends and seasonal abundance and distribution were estimated using historical data and monthly goose surveys conducted by volunteers. Goose exclosures were erected on area farms to assess crop losses. Funding from the Agricultural and Environmental Initiative supported much of the work. A threshold and population target of 1,000 geese was set, based on the number of geese in the region in 1985. The regional working group collaborated with CWS and the Province to conduct the first goose cull on Vancouver Island in summer 2015.

The Campbell River Environmental Committee began monitoring Canada Geese in 2013 in response to grazing pressure on the Campbell River estuary. Exclosures were installed in spring 2014, and with the help of the Guardians, 199 birds were banded during the summer of 2015. The Campbell River Indian Band may harvest moulting birds on reserve lands to help reduce the goose population.

A problem analysis published in 1991 documented stakeholder concerns and efforts to control Canada Goose populations in the Fraser Valley. Relocations to areas where geese could be hunted had taken place from 1987 through 1990. Egg addling programs had begun at key breeding sites in 1988. In the analysis, farmers asserted that scare permits did not work and they were too busy to chase birds.

In 2013, the Vancouver Airport Authority led the first annual Canada Goose workshop on the Lower Mainland and created an informal partnership, the Lower Mainland Canada Goose Working Group. Group members, including staff from CWS, began mapping population abundance and distribution using existing data. A Google Earth-based Conflict Mapping Project was launched in 2014 to engage communities and document where human-goose conflicts were occurring. A Terms of Reference was drafted to formalize the group's existence, along with a problem statement, goals and objectives, research questions, a list of potential stakeholders, and a communications strategy. The communications strategy noted that Environment Canada is not responsible for dealing directly with the birds or their actions, or mitigating damage that the birds may cause.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 11 - Management in Other Jurisdictions

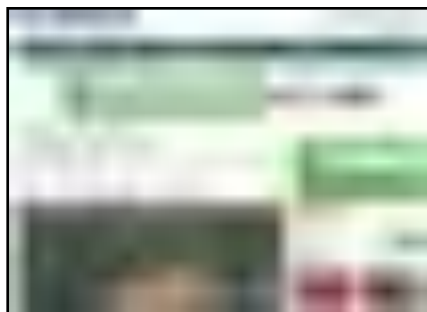
More Highlights

The Okanagan Valley Goose Management Committee was formed in 1995, and an action plan with strategies to manage Canada Geese was endorsed in 2006 following public meetings in Vernon, Kelowna, Penticton, and Osoyoos. Of greatest concern was the level of contamination on area beaches. The Okanagan Valley Goose Management Program was established in 2007 as a partnership among local governments and an Irrigation District. The City of Kelowna contributed \$75,000 to the \$136,000 program, and committed to spending an additional \$90,000 to control and clean-up after geese on City-owned properties. The program conducted aerial population surveys during the moult in 2011 and 2014, banded birds in 2012, and estimated gosling production with post-nesting ground surveys in 2014. Banding was largely funded by the Western Canada Turfgrass Association. The flagship of the program was annual egg addling, with a goose hotline to coordinate goose sightings and addling crews.

One of the Okanagan Valley Goose Program partners, the Town of Osoyoos, requested the Union of B.C. Municipalities (UBCM) endorse a resolution for more Canada Goose kill permits from senior governments, as addling had limited effect. The UBCM endorsed the resolution in 2013. That year, CWS permitted the Town to kill up to 10 adult birds per week at two sites: a horse racing facility and a golf course, with no blinds or decoys, and the geese could not be kept by the hunter. A owl rehabilitation centre in Oliver agreed to take some of the birds.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

11.1 International



Other jurisdictions struggle with the same issues we experience here. See <http://www.telegraph.co.uk/news/earth/wildlife/9160190/Canada-geese-cull-is-scrapped.html>

Canada Geese are native to North America (i.e., Canada, U.S., Mexico, and Greenland), and are considered nuisance animals in many jurisdictions. Beauty of Birds.com (2011) noted they are also native to eastern Siberia, eastern China, Japan, and a number of Caribbean islands (i.e., Bahamas, Cayman Islands, Cuba, Haiti, Puerto Rico, Saint Pierre and Miquelon, Turks and Caicos), although other authors dispute this (cf. Jansson, Josefsson, & Weidema 2008).

They were deliberately introduced to Great Britain in 1665, to New Zealand in 1905, Germany in 1928, Sweden in 1929, Denmark in 1930, and Norway in 1936 (Thomson 1922 in Winn 2001; Jansson, Josefsson, & Weidema 2008). Other early introductions were unsuccessful in establishing populations (e.g., Dawes 2008).

Today, Canada Geese are observed in most countries around the North Sea and along the Atlantic coast, in parts of central and eastern Europe, northern Russia, and New Zealand (Campbell et al. 1999; Banks et al. 2004; various authors in Jansson, Josefsson, & Weidema 2008). In some European countries, Canada Geese now outnumber native goose populations (Jansson, Josefsson, & Weidema 2008). New introductions of Canada Geese are regarded as a serious threat. Dawes (2008), for example, warned that Canada Geese had entered Australia and called for immediate eradication.

Interestingly, Canada Goose populations in Scandinavia are believed to have originated from

only 5 individuals, four from a zoo in Germany and one from North America, and despite losses in genetic variation over time, the species has continued to increase its range (Jansson, Josefsson, & Weidema 2008).

11.11 United States

Regulations

Legislation for managing resident Canada Geese in the U.S. is found in the Code of Federal Regulations, Title 50 (Wildlife and Fisheries), Chapter 1, Subchapter B, Part 21 (Migratory Bird Permits), Section 21.26 (Special Canada Goose permit), 21.49 (Control order for resident Canada Geese at airports and military fields, 21.50 (Depredation order for resident Canada Geese nests and eggs), 21.51 (Depredation order for resident Canada Geese at agricultural facilities), 21.52 (Public health control order for resident Canada Geese), and Subpart E (Control of Overabundant Migratory Bird Populations), 21.61 (Population control of resident Canada Geese). Sections 21.49, 21.51, and 21.52 allow culling of goslings and adults, in addition to other lethal and non-lethal controls. These regulations cover states along the Atlantic, Central, and Mississippi Flyways only. The USFWS may issue depredation permits in situations that do not fall under the depredation orders (J. Sands and T. Smith, pers. comm. February 17, 2015).

The Pacific Flyway Council requested the western states not be included in all of the regulations



Directed management vs. 'vigilante bird justice'. See http://www.thestar.com/life/2010/07/15/deadly_summer_for_canada_geese_in_the_us.html

Canada Geese; only the airport control order, the nest and egg depredation order, and the public health control order are available to the Pacific Flyway States (USFWS 2006).

Section 21.61 regulates a population control program, "implemented under the authority of the Migratory Bird Treaty Act to reduce and stabilize resident Canada Goose populations when traditional and otherwise authorized management measures are unsuccessful, not feasible in dealing with, or applicable, in preventing injury to property, agricultural crops, public health and other interests from resident Canada Geese". Managed take allows hunting August 1-31, extends shooting hours, and removes daily bag limits. Following one full operational year of Sections 21.49 through 21.52, any of the states or tribes may request approval for the population control program. Once approved, the government may "without permit, kill or cause to be killed under its general supervision, resident Canada Geese" under a suite of conditions (e.g., no baiting, no live decoys, etc.).

The USFWS maintains an e-permits website, whereby anyone in the conterminous U.S. can register for federal authorization to destroy resident Canada Goose nests and eggs (see <https://epermits.fws.gov/ercgr/gesi.aspx>). Some states do not participate in this program and/or have additional or similar requirements (e.g., WA, OR).

In 2014, the Pacific Flyway Council proposed, and the USFWS

agreed to combine interior and coastal State frameworks for Canada Geese, to increase the hunting season length in WA, OR, and CA from 100 to 107 days, to change opening date in these states from the Saturday closest to October 1 to the Saturday closest to September 24, to increase bag limits in CA to 10, to increase bag limits in OR on hunt days on or before the last Sunday in January to 6, and to increase quotas on Dusky Canada Geese in WA and OR, among other things. The Service acknowledged that harvests alone would not completely address agricultural depredation issues and encouraged the States in the Pacific Flyway to work towards implementing other approaches detailed in the Flyway's Canada Goose depredation plan (Federal Register 2014).

Management Actions

Along the Atlantic Flyway at least, hunting has been liberalized, egg treatments are widespread, and culling operations have grown. In some jurisdictions, goose numbers have peaked and are falling, while in others populations continue to grow (Best et al. 2014).

The USDA Wildlife Services assists the USFWS, State governments, and many others with goose management. The USDA (1999) reported that its Wildlife Services personnel were trained and certified in the use of a capture drug to contain geese outside of the moulting period, 30 days in advance of or during the hunting season. Where geese could not be captured or otherwise controlled, small numbers were selectively removed

with a pellet gun or shotgun. Geese captured and euthanized that were suitable for human consumption were donated to qualified charitable organizations. Wildlife Services personnel also assisted with hazing, nest destruction, addling, and relocations (USDA, 1999).

The Patuxent River tidal marshes in Maryland (introduced in Chapter 5.2, The Need for Action, Estuaries) were restored by allowing hunting in a wetland sanctuary, thereby removing approximately 1,700 Canada Geese over a 4 year period, and re-establishing wild rice through a large-scale fencing and planting program (Haramis & Kearns 2006).

In general, U.S. cities have had considerable latitude to deal with urban and resident goose problems. The City of Seattle is a case in point. In 1987, the Seattle Waterfowl Committee was formed to deal with the growing numbers of Canada Geese. A year-long study by the University of Washington recommended 90% reductions in 1990, 80 to 90% reductions in 1991, and smaller reductions later on, as necessary. From 1989 to 1994, the USDA Wildlife Services program facilitated the translocation of 7,342 geese to eastern Washington and Idaho. From 1992 to 1998, Wildlife Services added more than 6,000 eggs, but numbers continued to grow. In 1997 and 1998, Wildlife Services captured and euthanized 578 geese from the city and area (USDA, 1999). Culling continued annually for several years, in public parks, private golf courses, and on

the University of Washington campus. This motivated Paws and the Humane Society of the U.S. to launch the Seattle Goose Program, a program to help Seattle Parks and Recreation explore more humane methods of resolving human-goose conflicts. A pilot project from 2006 to 2008 provided volunteers who located goose nests for addling and oiling; hazed geese with lasers, kites, and dogs; and cleaned goose poop from beaches and recreation areas (Paws n.d.).

To reduce populations of 'urban' Canada Geese in Anchorage, Alaska, a similar program was undertaken from 1996 to 1998. The USFWS, USDA Wildlife Services, Alaska Department of Fish and Game, municipalities, and conservation groups formed a working group to plan culls and other activities, and senior governments carried out various facets of the plans (T. Smith, pers. comm. February 17, 2015).

The National Wildlife Research Center, the research arm of the USDA Wildlife Services program, was instrumental in developing the chemical repellent methyl anthranilate, used to discourage geese from using grassy areas. It also tested drugs to inhibit bird reproduction (USDA 1999).

Funding

USDA Wildlife Services programs are not federally funded; a congressional mandate requires they help with goose management, however no monies are available to do so. Therefore, controls undertaken by USDA

Wildlife Services personnel are implemented on a cost-reimbursable basis (USDA 1999; T. Smith, pers. comm. February 17, 2015). Funding was usually provided by resource owners, private businesses, or local, state or federal funding agencies (USDA 1999).

Some State governments have taken the lead, funding and/or implementing goose management. The Wisconsin DNR (2007) provided \$25,000 worth of annual grants to towns, cities, villages, counties, or tribal governments in urban areas, to help develop wildlife plans and/or implement specific damage abatement/and or control measures for Canada Geese. The program provided 50% project reimbursement up to a maximum of \$5,000 (Wisconsin DNR 2007). In Michigan, the Department of Natural Resources (DNR) conducts ~46% of the goose roundup activities in the state, while others manage the rest. Half of the costs of Michigan's resident Canada Goose program come from hunter dollars, and the other half from permit fees (Michigan DNR 2015).

11.12 Europe

The Canada Goose is registered in 18 of 20 countries participating in the European Network on Invasive Alien Species (NOBANIS), holding one of two top spots among 9,511 species. (The other is Canadian Waterweed (*Elodea canadensis*), Oh Canada!) This organization adheres to the slogan, "If you can't beat 'em, eat 'em" (NOBANIS Secretariat 2013).

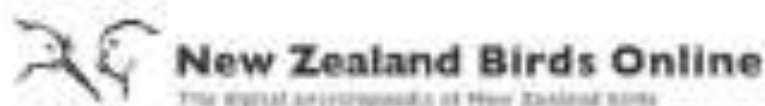
Canada Geese in Britain are widespread, and deemed responsible for destruction of bank-side vegetation, eutrophication of waterbodies, and aircraft strikes at Heathrow Airport, among other things (Owen et al. 1998 in Winn 2001). They are a recognized game species that can be shot throughout the year (British Association for Shooting & Conservation 2013). Special licenses designed to protect public health and air safety, prevent crop damage, and to conserve wild bird populations allow destruction of eggs and birds (Owen et al. 1998 in Winn 2001).

In France in 2011, Canada Geese were not hunted but agencies and scientists were calling for hunting, egg sterilization, and culls. There, geese are a threat to wetland biodiversity, primarily by excluding other species from nesting territories. They had also caused closures of outdoor swimming pools, and other typical urban nuisance problems. From several hundred birds at the end of the 1990s, populations had increased to more than 5,000 by 2011, with half in the Paris area. “For reasons that remain obscure, their numbers have

started increasing very fast” (Vincent 2011). Vincent (2011) noted that Canada Geese are on a list of 100 invasive species posing a serious threat to biodiversity in Europe.

11.13 New Zealand

In New Zealand, ‘sedentary’ [nonmigratory] Canada Geese are established on the South Island. They were protected until 1931, when farmers were allowed to disturb and destroy geese on their pastures. The species was declared a game bird in 1973. Between 1976 and 1987, the Wildlife Service conducted moult-culling drives and egg-pricking operations in certain areas. The South Island Canada Goose Management Plan was developed in 1995, whereby organized culls were to be used if recreational hunting could not maintain populations at target levels. By 2000, only two areas were at target levels, as control measures were simply moving the birds to other areas (various authors in Winn 2001).



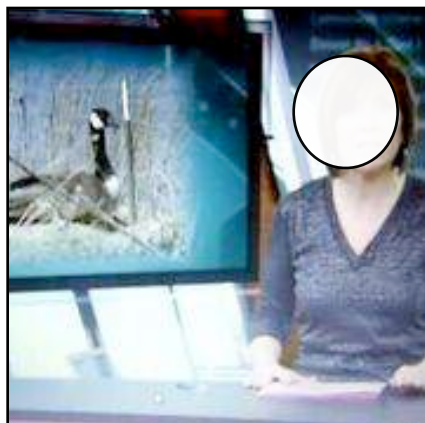
Canada goose
Branta canadensis (Linnaeus, 1758)

Order: [Anseriformes](#)
 Family: [Anatidae](#)
 New Zealand status: [Introduced](#)
 Conservation status: [Introduced](#) and [Native](#)
 Other names: [Canada goose](#)

Geographical variation: A native North American goose with an extensive history of population decline and subsistence and with each subspecies distinguished by size and plumage. The taxonomy associated with these groupings remains stable but there is growing agreement for two species to be recognized, a large-bodied *B. canadensis* and a small-bodied *B. hutchinsii* with each of which are several geographic races accorded sub-species status. The New Zealand population is primarily descended from an importation of 50 birds in 1905. The size and plumage characteristics of these birds, when observed in 1970, matched those of the then largest race assigned, *B. canadensis* [mauiensis](#).

The New Zealand population of Canada Geese is primarily descended from an importation of 50 birds in 1905 (New Zealand Birds Online, from <http://nzbirdsonline.org.nz/species/canada-goose>)

11.2 National



In just a few years, the views and policies of our regulatory agencies have shifted, partly because of news coverage and a growing awareness of the problems.

The position of federal regulators in Canada has changed significantly from the inception of this project in 2007, when grave concerns for endangered Dusky Canada Geese outweighed any urgency to address the impacts of 'resident' Canada Geese. The Guardians were instructed to avoid using the term 'overabundant', in favour of 'locally overabundant', as the former was a 'legal' term. We were asked not to mention culling (the 'C' word) as a potential management tool, as this was viewed as highly unpopular. And we were instructed to gather the supporting science for mandatory management planning. Fast forward to 2014. Distinguishing resident birds from migratory birds, and from Canada Geese migrating to and from the lower 48 states in

particular, is of little concern, as nearly all temperate-breeding populations are perceived as 'locally overabundant'. Applications for kill and cull permits are encouraged (e.g., I. Whitehorne, pers. comm. June 18, 2014). CWS is engaged with several working groups (e.g., Capital Region, Lower Mainland, Okanagan) that are attempting to manage nuisance Canada Goose populations. CWS staff have provided timely and forthright information as well as advice regarding data analysis for this strategy.

The agency's involvement in Snow Goose and cormorant management is described elsewhere in this document (Chapters 4 and 12, respectively).

11.3 Regional

11.3.1 Capital Region

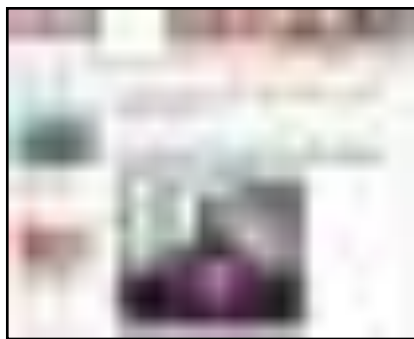
The Capital Region's Regional Canada Goose Management Strategy Working Group was formed in May, 2010 and has met monthly. It has focused on understanding and mitigating crop loss and damage, and health and environmental impacts to parks and recreation areas, as well as improving aviation safety at the Victoria International Airport. The group has learned from the regional deer management program and has examined sharing resources and integrating program activities (Canada Goose meeting

in Central Saanich, March 14, 2013).

A 2012 technical report (see <https://www.crd.bc.ca/docs/default-source/regional-planning-pdf/regional-canada-goose-management-strategy-technical-report-.pdf?sfvrsn=0>) informed the group's management strategy in the same year (see <https://www.crd.bc.ca/docs/default-source/regional-planning-pdf/regional-goose-management-strategy-.pdf?sfvrsn=0>). The technical report, commissioned by the Working Group and developed by EBB Environmental Consulting,

examined historical data, conducted a crop loss impact analysis with goose exclosures on area farms, and mapped potential goose habitat using Landsat satellite imagery, Capital Regional District (CRD) ortho-photography, the Sensitive Ecosystem Inventory (SEI), and field surveys. Volunteers conducted monthly goose surveys which informed a series of population models. Maps and charts were created depicting seasonal abundance and distribution.

The strategy outlined three management scenarios and a



In the CRD, there was plenty of news coverage regarding a cull, e.g., <http://www.cheknews.ca/c-r-d-to-go-ahead-with-canada-geese-cull-what-do-you-think-104900/>

series of mitigation techniques suitable for the region, including habitat modification, water management (with habitat modification), hazing, relocation, egg addling, hunting, kill permits, and 'regionally implemented, managed goose kills'. Kill-to-support-scaring permits were differentiated from kill-to-remove permits, and managed goose kills were deemed illegal within the current regulatory framework. A review of local government policies (e.g., feeding wildlife) and the development of a guide of sorts to ease permit processes for landowners and managers were recommended. A thousand geese was determined to be the population target and the threshold above which serious impacts occurred; this was the estimated number of geese in 1985. Surveys over the breeding and rearing periods, as well as leg-banding during the moult were suggested. The strategy also included a communications plan for engaging stakeholders and the general public (CRD 2012).

Funding was secured from the Agricultural and Environmental

Initiative to support 2013-14 initiatives (CRD 2015). The Steering Committee and Working Group created a website (see <https://www.crd.bc.ca/project/goose-management>) and an educational brochure that asserted migratory geese are not present in the summer and are rarely present in urban locations (which is not the case here) (CRD 2015). The group hosted an egg addling workshop in January, 2014 for ~40 people, mainly from the Saanich Peninsula agricultural community (K. St. Claire, pers. comm. January 9, 2015). A similar workshop in 2015 was postponed due to low registration (CRD 2015). The group worked with the Province and Environment Canada on an application to conduct a cull in the summer of 2015 (K. St. Claire, pers. comm. January 9, 2015).

Armed with a permit to cull 250 geese on agricultural lands, project partners killed 50 birds in Central Saanich in 2015, providing the carcasses to a nearby raptor centre (T. Clermont, pers. comm. 2015).

Canada Geese below Hatley Castle, Royal Roads University, Colwood, B.C.





Canada Goose roundup and banding at the Campbell River estuary, July 3, 2015. Photo by Tim Clermont.

11.32 North Island

The Campbell River Environmental Committee (CREC) began monitoring Canada Goose populations in May, 2013, in response to losses of habitat following extensive and expensive restoration efforts on the Campbell River estuary. The local population in the vicinity of the estuary was estimated to be less than 200. More than 1,000 birds were present during the moulting period in 2013 and 2014. Three exclosures were installed on the estuary in spring 2014 (CREC, pers. comm. to T. Clermont, January 15, 2014).

The group banded 199 birds during the 2015 moult. The Campbell River Indian Band may take moulting birds on reserve lands to help reduce the goose population (CREC, pers. comm. to T. Clermont, January 15, 2014; T. Clermont, pers. comm. September 2015).

11.33 Lower Mainland

In 1991, CWS published *Canada Geese in the Fraser Valley: A Problem Analysis*. Relocations to areas where geese could be hunted had taken place in 1987, '88, '89 and '90. New areas had closed to hunting as a result of municipal firearms restrictions. The analysis documented complaints from a wide variety of stakeholders, including farmers who stated that scare permits did not work and they were too busy to chase birds. Egg addling programs were initiated at key breeding sites, such as Stanley Park and Burnaby Lake in 1988. Populations were expected to stabilize, based on fall counts and

the success of addling programs (Breault and McKelvey 1991). Over the last 10-20 years, some areas experienced marked increases in wintering Canada Geese, while others show no trend or were variable (Lower Mainland Canada Goose Working Group email 2014).

The Vancouver Airport Authority led a Canada Goose workshop in October, 2013, and another in June, 2014. A preliminary map was created showing areas of conflict and places where geese were known to congregate. A Google Earth-based Conflict Mapping Project was launched in August, 2014, to engage communities and document where people were experiencing conflicts with geese. Members of a newly formed group, including CWS and Ducks Unlimited staff, began mapping population abundance and distribution using a variety of existing data (i.e., Christmas Bird Counts; ~3,000 re-sight records of Canada Geese banded on the Lower Mainland dating back to the 1960s; banding records for birds banded elsewhere and sighted on the Lower Mainland; Coastal Waterbird Surveys, Breeding Bird Surveys, CWS Goose Blitz Data (i.e., annual fall counts coordinated with ground and aerial surveys, ca. 1985 – 1995) (Lower Mainland Canada Goose Working Group email 2014).

Also in 2014, the Lower Mainland Canada Goose Working Group developed a Terms of Reference (ToR) to formalize its existence, and began working on the precursors to a collaborative management strategy: a problem statement, goals and objectives (e.g., a socially determined

population size, aimed at reducing conflict; 50% reduction in crop damage by 2020; zero annual air traffic safety incidents related to Canada Geese) and research questions. The group created a list of potential stakeholders, and a draft communications strategy that aimed to facilitate internal discussions within member organizations; develop communications materials (e.g., fact sheets, press releases, how-to videos) and processes (e.g., outreach person or coordinator, social media); and enable accurate and consistent messaging from group members to the media and public. The group asserted, “Environment Canada is responsible for the management and conservation of goose populations, but is not responsible for dealing directly with the birds or their actions, or mitigating damage that birds may cause”, a fundamental statement with which we disagree.

The second Lower Mainland Canada Goose workshop was held January 26, 2015. The group expected to finalize its ToR and communication strategy. It was looking for commitment from stakeholders, particularly cities and municipalities (D. Bradbeer, pers. comm. January 9, 2015).

11.34 Okanagan Valley

The Okanagan Valley Goose Management Committee was struck in 1995. An action plan with strategies to manage Canada Geese was endorsed in 2006 (Okanagan Valley Goose Management Program 2015).

Plan development included public meetings in Vernon, Kelowna, Penticton, and Osoyoos. Population data was compiled from Christmas Bird Counts, aerial surveys, and band recoveries from the 1980s. However, overall goose numbers were of less concern than the concentration of geese on area beaches and the results of water quality samples, which indicated contamination was reaching threshold levels (Robertson Environmental Services & Ophiuchus Consulting 2006).

The action plan included educating the public and increasing awareness (e.g., signage, encouraging participation through nest reporting); examining and changing bylaws; habitat modification; relocating geese away from sensitive areas (e.g., popular recreational areas); promoting fall hunting; hazing geese from public areas; expanding addling programs; using other lethal controls as a last resort; monitoring goose numbers by way of brood counts and annual surveys; and monitoring water quality at beaches (Robertson Environmental Services & Ophiuchus Consulting 2006; Osoyoos Lake Water Quality Society 2014).

The Okanagan Valley Goose Management Program was established in 2007. It is a partnership between the City of Kelowna, Central Okanagan Regional District, Regional District of Okanagan Similkameen, District of West Kelowna, City of Vernon, City of Penticton, Town of Lake Country, Town of Osoyoos, Town of Oliver, District of Peachland,

District of Summerland and Glenmore Ellison Irrigation District (Okanagan Valley Goose Management Program 2015). Its focus is to reduce populations, and large concentrations of geese in heavily used public areas in particular (City of Kelowna 2009).

The flagship of the Program is annual egg addling. The first year of the program realized more than 1,170 addled eggs in 216 nests between Osoyoos and Vernon (City of Kelowna 2009). Trained contractors begin the addling season by identifying mating pairs and nesting sites. The public is asked to assist by reporting lone geese, pairs of geese, or nest locations on private or public land. They are advised to keep away from goose nests and avoid touching eggs (Okanagan Valley Goose Management Program 2015). In 2013, the Union of B.C. Municipalities (UBCM) endorsed a resolution from the Town of Osoyoos requesting CWS be more permissive in the issuance of kill permits, as addling has had limited effect (Fletcher 2013; UBCM 2013). Failing an agreement to do so by CWS, the Province was asked to take the initiative to provide kill permits to affected local governments for goose population reduction.

There had been a series of UBCM resolutions related to problem Canada Geese: in 2002, sponsored by Osoyoos; 2003, sponsored by Kent; 2010, sponsored by North Saanich; 2010, sponsored by Osoyoos; and 2011, sponsored by Metchosis (UBCM 2012).



Local media help the Okanagan Valley Goose Management Program reach out to the public. See <http://infotel.ca/newsitem/goose-management-activities-beginning-in-west-kelowna/it18931>

Reliable information regarding culls (e.g., if and when they occurred, how many geese were killed) was difficult to obtain online. The Vancouver Sun (2008) reported that Kelowna and Osoyoos had applied for special permits to cull geese. Walkinshaw (2009, October), reporting for the Penticton Western News, said that the Penticton Council had voted unanimously for a permit to cull Canada Geese, concerned about the slow progress of the goose management program. Earlier in the year, Kelowna had received a permit to cull 50 geese. In Summerland, a child had fallen ill after landing in water contaminated with goose feces, requiring hospitalization (Walkinshaw 2009). In 2013, CWS endorsed the Town of Osoyoos goose management plan and provided a permit to kill up to 10 adult birds per week at its Desert Park horse racing facility and the Osoyoos Golf course, without blinds or decoys, and the geese could not be kept by the hunter. A local hunter agreed to do the work for \$30 per goose, to cover his license, shells, and fuel. The South Okanagan Rehabilitation Centre for Owls in Oliver agreed to take some of the birds (Osoyoos Times 2013).

In 2012, geese were leg-banded (red bands for Penticton, green for Kelowna, and white for Vernon geese). In 2013, all birds were fitted with yellow leg bands (Okanagan

Valley Goose Management Program 2015).

In June, 2014, post-nesting ground surveys were conducted to estimate the gosling proportion of the population (9.5%) and identify areas that were missed during the adding season. In June and July, aerial surveys found that populations had not increased since the last surveys in 2011 (Okanagan Valley Goose Management Program 2015).

At the time the Okanagan Valley action plan was written, municipalities in the Okanagan Valley were collectively spending more than \$100,000 each year to manage Canada Geese (Robertson Environmental Services & Ophiuchus Consulting 2006). In 2007, the program was expected to cost \$136,000; Kelowna contributed \$75,000 and committed to spending an additional \$90,000 to control (haze, relocate, and modify habitats) and clean up after geese on City-owned lands (City of Kelowna 2009). Banding was paid by a grant from the Western Canada Turfgrass Association with staff time donated by LaHawk Ltd. and Wise Wildlife Control (Okanagan Valley Goose Management Program 2015).

Chapter 12 - Management Options

Highlights

This chapter introduces management options, contributing to Goal 4.

An egg addling program began in our region in 2002 at the Englishman River estuary. Later, the program included Nanoose Bay and Marshall-Stevenson units of Qualicum National Wildlife Area, other parts of the Little Qualicum River estuary, parts of Errington, Canadian Forces Maritime Experimental and Test Ranges base in Nanoose Bay, Winchelsea and Yeo Islands, and some private properties. The addling program prevented at least 5,345 eggs from hatching, or at least 2,088 new breeding birds in the population.

Without an addling program or other coordinated intervention to curtail Canada Goose populations, there are typically more independent and often undesirable efforts to control geese, such as draining of wetlands, inhumane methods of killing, and harassment of non-target species.

A successful addling program is dependent on a very high proportion of nests being found and treated for many consecutive years. The success of the regional addling program has been constrained by several interrelated factors: manpower and funding; a long season, with early and late nesters; limited access to private properties; and the conspicuousness of Canada Goose nests.

Even the most successful addling program will have negative consequences. It may prompt birds to leave known nesting grounds to re-nest or nest in successive years in areas that are remote or inaccessible to addling crews. Failed nesters that stay in the area probably feed more often than they would while incubating eggs, increasing grazing pressure on vulnerable estuarine resources. Addling may also exacerbate problems elsewhere, by encouraging failed nesters to moult-migrate.

Senior governments tend to promote hunting as the best way to reduce populations of nuisance geese, yet many studies examined in the preparation of this strategy have concluded that hunting is insufficient on its own. Twenty-one percent of our marked Canada Geese were known to be shot by hunters, from 2008 to 2014.

Sixty-eight percent of all birds shot were killed within the study area. The remainder were shot elsewhere on Vancouver Island, on the Lower Mainland, in Alberta, and in the western United States.

Early fall hunting seasons are intended to harvest local geese, while later seasons target both residents and migrants. Three (18%) of 17 marked birds shot in the region in September were confirmed local resident (LR+) migrant types.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 12 - Management Options

More Highlights

More than half of the marked geese shot by hunters were banded at the Little Qualicum River estuary. Seventy-two percent of marked geese that were shot outside of the region had never been observed on huntable sites here. Of local resident (LR) migrant types, all birds banded at the Little Qualicum River estuary were 'huntable', i.e., they were observed on huntable sites in the region. By contrast, one third of local residents banded at the Englishman River estuary and two thirds of those banded at the Craig Creek estuary were huntable in our region.

Hunting often moved Canada Geese into areas that were more protected, however geese may also be able to anticipate hunting seasons. A Quebec study found that many Canada Geese moved away from areas where hunting was allowed to places where firearm discharge was prohibited or hunter numbers were low, several weeks prior to the start of hunting season. Adults accompanied by goslings were more likely to move to safe sites, than geese without young.

CWS has asserted that further liberalization of hunting, enabled with an overabundant designation, would do little because the number of hunters and areas where people are allowed to hunt are declining.

Since 2000, the number of hunters and goose harvest estimates in our region have fluctuated. In the 1-5 management unit (Maple Bay north to the Little Qualicum River estuary), numbers were up (e.g., 170 hunters in 2012 when the bag limit changed, with nearly 1,600 geese harvested in 2011 and 2012), while in unit 1-6 (from the Little Qualicum River estuary north to Campbell River), numbers were mostly down (e.g., less than 40 hunters, and fewer than 100 geese harvested in 2012). Federal hunter surveys covering a large area of B.C. showed a dramatic decrease in hunter numbers from 1971 to 2013, yet harvest estimates were very similar in those two years (i.e., ~5000 birds harvested in both 1971 and 2013), with wild fluctuations in between.

Land grants in the late 1800s and early 1900s, together with increasing human populations and associated development have led to a preponderance of privately held lands that are closed to hunting. However, all farmers surveyed in the preparation of this strategy had hunted geese or allowed and encouraged others to hunt. One had been harassed for allowing hunting.

Some residents feed geese, even when they are aware of the adverse effects of Canada Geese and efforts to mitigate them. There are currently no bylaws to discourage people from feeding geese, despite the deleterious effects it may precipitate (e.g., aggressive birds and related injuries, poor nutrition and associated diseases).

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 12 - Management Options

More Highlights

There are many ways to foster 'goose unfriendly' habitats, keeping in mind that Canada Geese are highly adaptable and resilient. The Guardians installed exclosures and snow fencing on the estuaries, a temporary and experimental solution. The City of Parksville inadvertently reduced goose use of its community park by erecting fencing along the beach. A farmer altered the timing of seeding and harvesting of his forage crops. Other techniques, untested in our region, include using bamboo stakes, dense or tall plantings, suspended grids or parallel lines (of wire, for example), and steepened banks to reduce access, visibility, and opportunities to take flight. Planting coarse grass species, mowing less frequently, or applying approved chemical deterrents may reduce palatability.

Scare techniques achieved limited success and survey respondents understood they were simply moving the problem elsewhere. They used trained and untrained dogs, trained raptors, scare shells, laser light, and utility and all-terrain vehicles, mainly to protect properties from damage and fouling. The City of Parksville's Canine Goose Control Program, which operated from 2009 to 2011, included an awareness campaign to prevent the use of untrained dogs and to distinguish Canada Geese from Brant, a provincially blue-listed species present in large numbers during the spring migration.

There are many hazing techniques that have been used elsewhere with varying degrees of success. Some may be unlawful under local bylaws or require permits. Prior to use, all should be assessed for their impacts to other people, pets, and non-target species.

Hunting pressure may be increased by opening new areas to hunting, even for a day or weekend; creating incentives for hunters; encouraging landowners with geese to allow access to hunters; and further reducing hunting restrictions. A one-year exception prohibiting the discharge of firearms within city limits was granted by the City of Port Alberni, to allow designated, licensed hunters to shoot Canada Geese on the Somass River estuary. Currently, all of the estuaries in the region are closed to hunting; however parts of the LQRE, NBE, and even the ERE may be sufficiently far from residences to enable safe and legal hunting. Or, it may be necessary to move urban and otherwise protected Canada Geese into areas where hunting can occur (by hazing or roundup and transport).

From survey responses and interviews, it is apparent that scare, damage and danger permits have been used by most sectors. However, they are probably underutilized due to lack of awareness (i.e., some people do not know they exist) and onerous permitting processes (i.e., complicated applications, barrier-laden requirements, lengthy waiting times). Some respondents that had attempted addling found it to be neither feasible or successful.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

Chapter 12 - Management Options

More Highlights

Culling is a sensitive topic, particularly when people who believe that animals have rights similar to humans meet those who have lost all tolerance for nuisance geese. Most people hold positions somewhere in between, or none at all. Hunters may wish populations to remain high or to grow. Most people do not wish geese to suffer, and many reject wasteful or debasing treatment of carcasses. A standard operating procedure for preventing animal suffering while performing 'depopulations' was created by MFLNRO in 2014, but the use of carcasses remains largely unresolved. The logistical challenges of coordinated capture, transport, killing, and disposal have been led in the U.S. by government agencies but are only monitored by senior governments here. These concerns have relegated culling to a 'last resort' control measure.

In the U.S., the large-scale capture and euthanasia of resident Canada Geese began in 1996. It has since expanded into many jurisdictions, and is described as the most efficient and cost-effective way to reduce the size of an urban flock, second only to hunting. Still, some communities have been unable to afford to cull or have avoided culling to prevent polarizing their communities in conflict. Culled birds captured during the summer months can be processed for human consumption and donated to charitable organizations (i.e., food banks). Culling of Canada Geese has also occurred in New Zealand since 1993.

There is precedence for culling of birds in Canada. For example, in B.C., Barred Owls were culled to protect at-risk Spotted Owls. In Ontario's Point Pelee National Park, 'hyperabundant' cormorants were culled to protect ecosystems and species at risk. Canada Geese were culled on Vancouver Island's Saanich Peninsula in July, 2015.

Only one mid-island farmer had registered for the B.C. Ministry of Agriculture Wildlife Program, a free compensation program available to qualifying livestock and forage producers.

USDA economists found that for every dollar spent on wildlife damage management programs to control Canada Geese, \$1.31 to \$5.56 could be saved in damage and maintenance costs.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

12.1 Status Quo



A gosling among addled eggs. Eggs that are close to hatching are not addled.

12.11 Egg Addling Program

To control rising Canada Goose populations and reduce grazing pressure on the ERE, an egg sterilization program was initiated in 2002. The Nanoose Bay unit of the Qualicum National Wildlife Area, encompassing the estuaries of the Nanoose and Bonnell Creeks (NBE), was added in 2003. The program was expanded to the LQRE and parts of Errington in 2004. City of Parksville staff joined the addling crew in 2004, but thereafter opted to pay Guardians members and hires to do the work. Hamilton Marsh was searched for nests in 2007. In 2012 and 2013, Guardians personnel also addled eggs at the Canadian Forces Maritime Experimental and Test Ranges (CFMETR) base in Nanoose Bay, Winchelsea Island, Yeo Island, and on some private properties (This timeline was derived from Manning, Cooper and Associates 2003, 2005, 2006; Lynch 2007; Morrison 2013; Guardians of Mid-Island Estuaries Society 2014 and email sources).

Addling was conducted by trained volunteers or paid personnel under permit from CWS (cf. Manning, Cooper and Associates 2003, 2005). The program typically operated through the incubating period of the nesting season, with most nest searches occurring during April and May. Addling crews observed geese on the nesting grounds as early as February and as late as June, to look for early nests and re-nesting pairs.

Addling was usually performed in the first two weeks of incubation,

to prevent the embryo from developing and hatching; eggs that are just laid cannot be addled, as the membranes will not detach from the shell, and eggs that are shaken too close to hatching may result in injured or deformed young. Each egg was vigorously shaken until the membranes detached, then marked and replaced in the nest; often a sloshing was felt and heard.

The justification for addling, rather than removing or destroying eggs, is to prevent the geese from re-nesting. When the eggs are addled and left in the nest, the goose will continue to incubate them. If the pair stays with this nest late into the nesting season, they are unlikely to re-nest. Canada Geese have been known to incubate infertile or dead eggs for up to 91 days, while others have deserted the nest at 28 days, the length of a typical incubation period (Brakhage 1965; Cooper 1978); Cooper found an average of 42 days, for what he termed 'overtime incubation'.

From 2010 to 2014, the estuaries were thoroughly searched over many visits. In earlier years, visits were more sporadic. Nests were examined each visit to sterilize any new eggs or eggs that could not be addled previously, and to document whether nests had been depredated and abandoned. From 2010 through 2014, the eggs were measured for length and width with calipers. Egg and clutch sizes were explored to determine whether changes in estuarine vegetation or in disturbance (e.g., harassment) affected reproductive

Chapter 12.2, No Action, describes the results of the egg addling program.



There are risks associated with egg addling. Crews must defend themselves against aggressive birds and navigate difficult topography.

output and subsequent juvenile survival (cf. Johnson et al. 1992). Locations were recorded with a Garmen handheld GPS unit.

Geese can be very aggressive when defending their nests. For safety, addling crews included at least two people. Any work on the estuaries, which frequently entails navigating uneven ground, a dendritic network of tidal channels, mudflats, and river crossings, were usually done in pairs or groups.

Although we did not have any serious health and safety issues, individuals working around geese and eggs should be aware of the risks, including risks of exposure to pathogens; the Public Health Agency of Canada's *Fact Sheet: Guidance on Precautions for the Handling of Wild Birds* is available at <http://www.phac-aspc.gc.ca/influenza/fs-hwb-fr-mos-eng.php>.

Several survey respondents expressed interest in participating in the addling program. However, program success has been constrained by several interrelated factors, including 1) manpower and funding; 2) a long season, with early and late nesters; 3) limited access to private properties with nesting Canada Geese, and 4) the difficulty in finding nests, which are often concealed.

A successful addling program is dependent on a very high proportion of nests being found and treated for many consecutive years (J. Cooper, pers. comm. 2003). CWS (2010) suggested that addling programs continue until birds die naturally or leave the area due to failed nests.

Effects of Addling

Egg addling contributes to regional population control primarily by reducing the annual recruitment of young. However, the program itself may contribute to its own ineffectiveness as successive failed nests may motivate pairs to leave their preferred nesting grounds and move into other areas, some of which may be more difficult to find. Failed nesters may migrate to moult, lessening local impacts but increasing them elsewhere. On the upside, moult migrants may be exposed to greater hunting pressures than they would face at home (Sheaffer et al. 2007; Heller 2010). See Chapter 12.2, No Action, for additional information.

Addling Versus Other Hatch Prevention Techniques

CWS (2010) suggests that destroying eggs is less complicated and may be just as effective. It recommends using egg sterilization techniques, including addling and oiling, only where there is reason to believe that geese will re-nest if eggs are destroyed. *Best Practices for Sterilizing Goose Eggs* is available to addling permit applicants (CWS 2010).

Of three re-nests of marked pairs recorded prior to 2015, only one had incubated addled eggs; the other two nests were predated before any eggs could be addled. When eggs are destroyed, geese that do not re-nest are likely to do one of two things: 1) feed more often on vulnerable estuarine resources, or 2) leave the area. If geese remain on the estuary, sterilizing eggs is preferential to destroying them.

12.12 Hunting

Hunting is considered the most important source of mortality for adult geese (CWS 2010), and government agencies everywhere promote it as the best way to address nuisance problems involving migratory game birds. Many studies that have examined whether hunting is effective in reducing populations of temperate-nesting geese have concluded that, while an important control measure, it is generally insufficient as a standalone option (cf. Huang 2010; Beaumont 2014). Twenty-two percent of our marked birds were reported to have been shot by hunters, to September 13, 2014.

Early fall hunting seasons (i.e., September seasons), are intended to harvest local Canada Geese,

whereas later fall seasons and spring hunting seasons target both residents and migrants (cf. Lindberg & Malecki 1994; Beaumont 2014).

Just over 30% of the 66 marked birds shot between October 10, 2009 and September 13, 2014 were killed in September. Of these 20 birds, 17 were shot within the study area. Three were local resident migrant types (i.e., LR+), 6 were emigrants, and the remainder were not assigned a migrant type due to insufficient information.

Huntability of Marked Geese

Goose populations that confine their movements to urban and other non-huntability areas cannot be controlled by hunting. Each marked Canada Goose was assessed to determine whether

they had been observed on any sites deemed huntability within existing hunting regulations and local government bylaws. Huntability was not examined in terms of access, i.e., whether permission to hunt would be granted or not, or age. (See Chapter 10.32, Mortality, for a brief discussion of age-related mortality.)

Of the 66 birds shot, 48 (73%) were killed within the study area. Eight were killed elsewhere on Vancouver Island, 3 on the Lower Mainland, 1 in Alberta, and 6 in western U.S. states. Of the 66 birds, more than half were banded at the LQRE (Figure 12-1). These findings concur with reports from CWS (2010) that most marked birds are shot near to where they are banded.

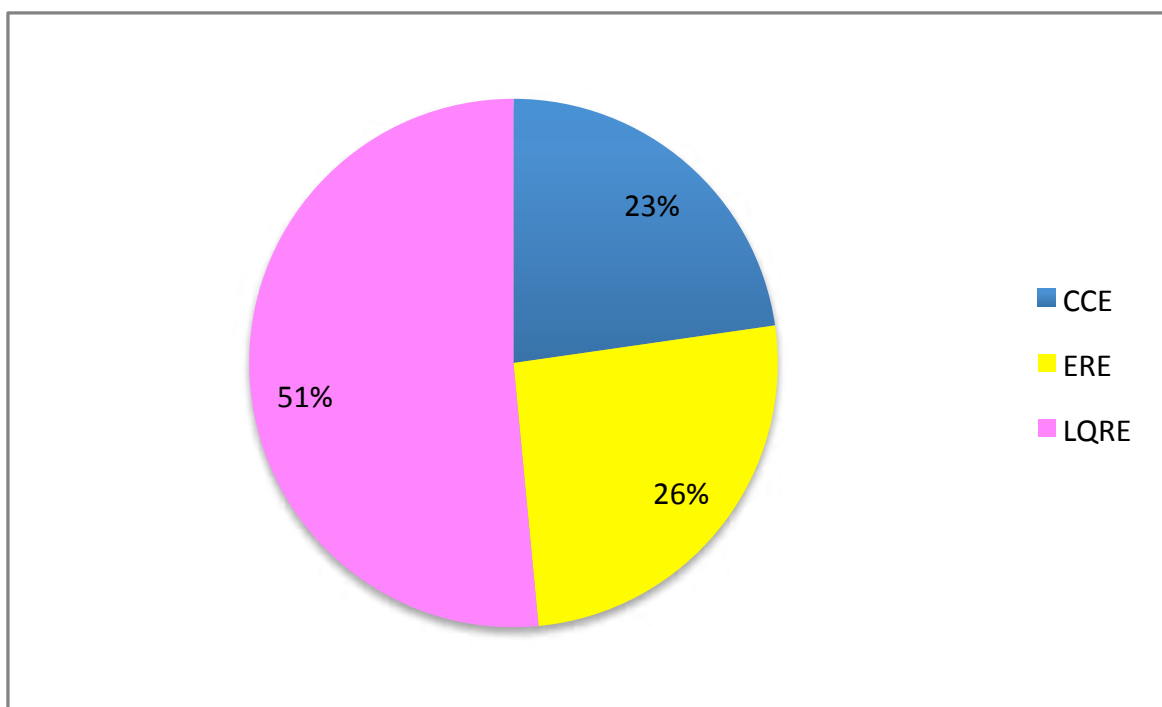


Figure 12-1. Marked Canada Geese killed by hunters, by banding location (n=66).

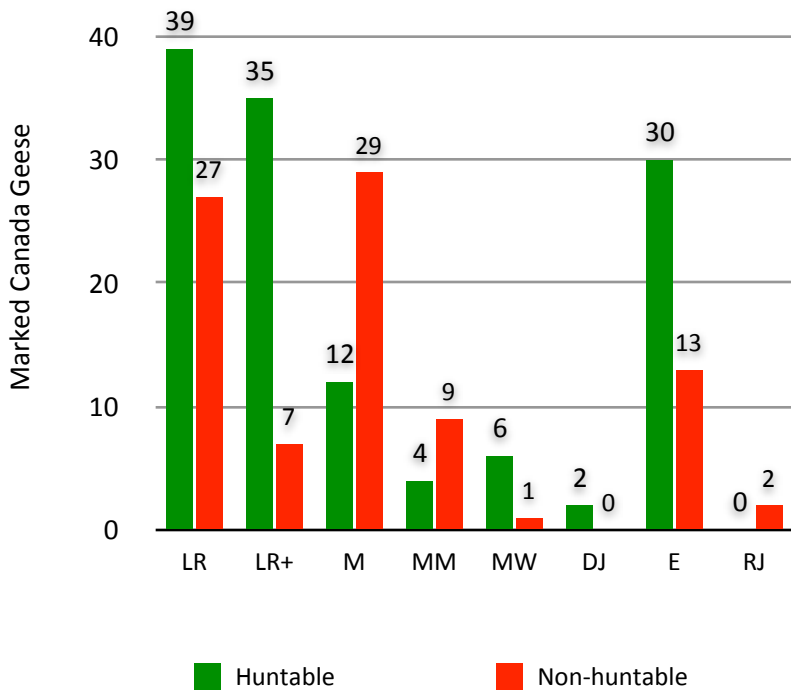


Figure 12-2 suggests that local residents are more huntable than migrants. However, migrant Canada Geese may frequent non-huntable areas here, but are huntable elsewhere. In fact, 72% of our marked geese that were shot elsewhere had not been observed on huntable sites here (Figures 12-3 and 12-4).

Approximately one third of ERE local residents were huntable, while two thirds of CCE local residents were huntable, and all of LQRE local residents were huntable.

Figure 12-2. Huntability of Canada Goose Migrant Types (n=216). (See Chapter 6.4 for descriptions of migrant types.)

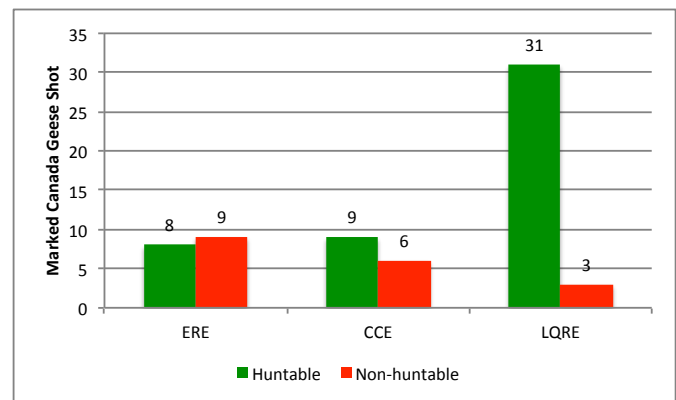
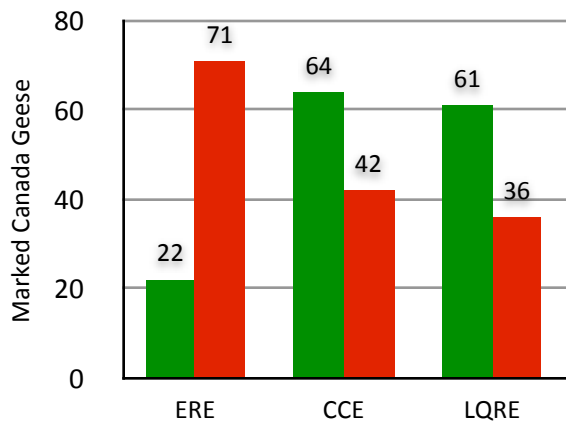
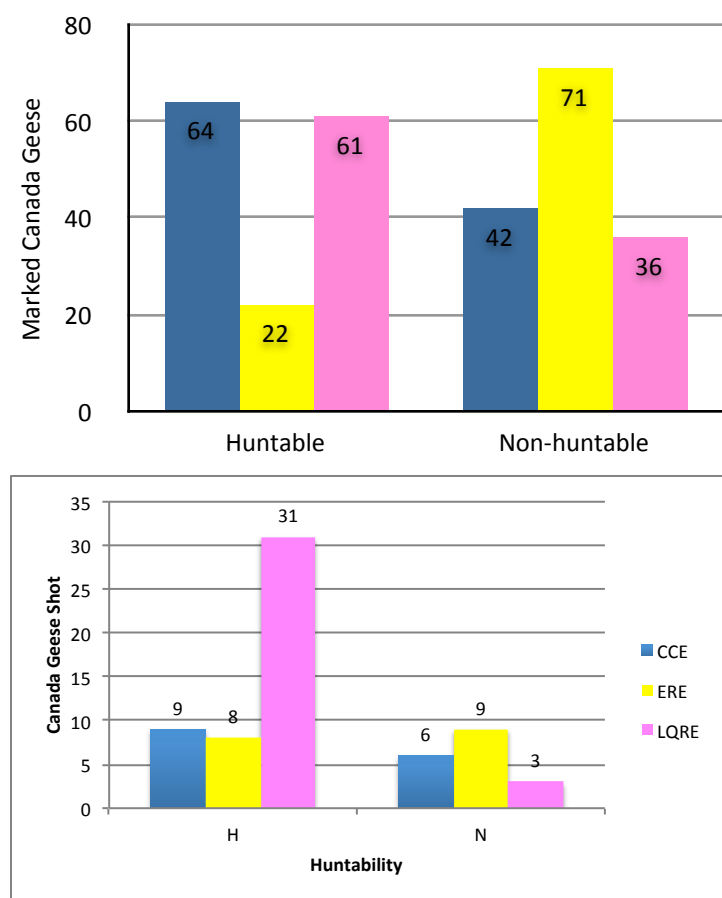


Figure 12-3. Regional huntability of marked Canada Geese (left) (n=296) and regional huntability of shot, marked Canada Geese (right) (n=66), by banding estuary.



As a cohort, ERE-banded birds were far less huntable than Canada Geese banded at the CCE and LQRE. Still, slightly more non-huntable ERE birds were killed than those deemed huntable.

Limitations

Our survey sites excluded several private properties where hunting was known to occur, and possibly other huntable sites that have not yet been identified.

Figure 12-4. Regional huntability of Canada Geese banded at each estuary (upper) (n=296) and regional huntability of shot, marked Canada Geese (lower) (n=66).

In a study of radio-collared Canada Geese in Quebec, Beaumont et al. (2013) demonstrated that many geese moved from areas where hunting was allowed to places where firearm discharge was prohibited or hunter numbers were low, several weeks prior to the start of a special early hunting season intended to reduce populations of local geese. Furthermore, they were more likely to move to non-huntable areas if they were accompanied by juveniles, or had abandoned or lost their broods.

The birds stayed in non-huntable areas until late in the hunting season, when there were notably fewer hunters but still quality feeding opportunities in agricultural fields. The authors believed that Canada Geese have the ability to risk assess, based on prior knowledge and tradition.

In our area, geese moulting on the estuaries exhibited at least daily movements to both urban and rural habitats in late summer and early autumn, as soon as they could fly. Although hunting

precipitated the movement of Canada Geese from agricultural areas to more protected (e.g., urban) environments, this did not appear to be as prolonged as movements observed in Quebec. As a result of the addling program, most pairs were not accompanying juveniles so they may have been less likely to stay in non-huntable areas. Most Canada Geese spent the autumn in and near the City of Parkville, and used the estuaries, regardless of whether it was hunting season (Figure 12-5).

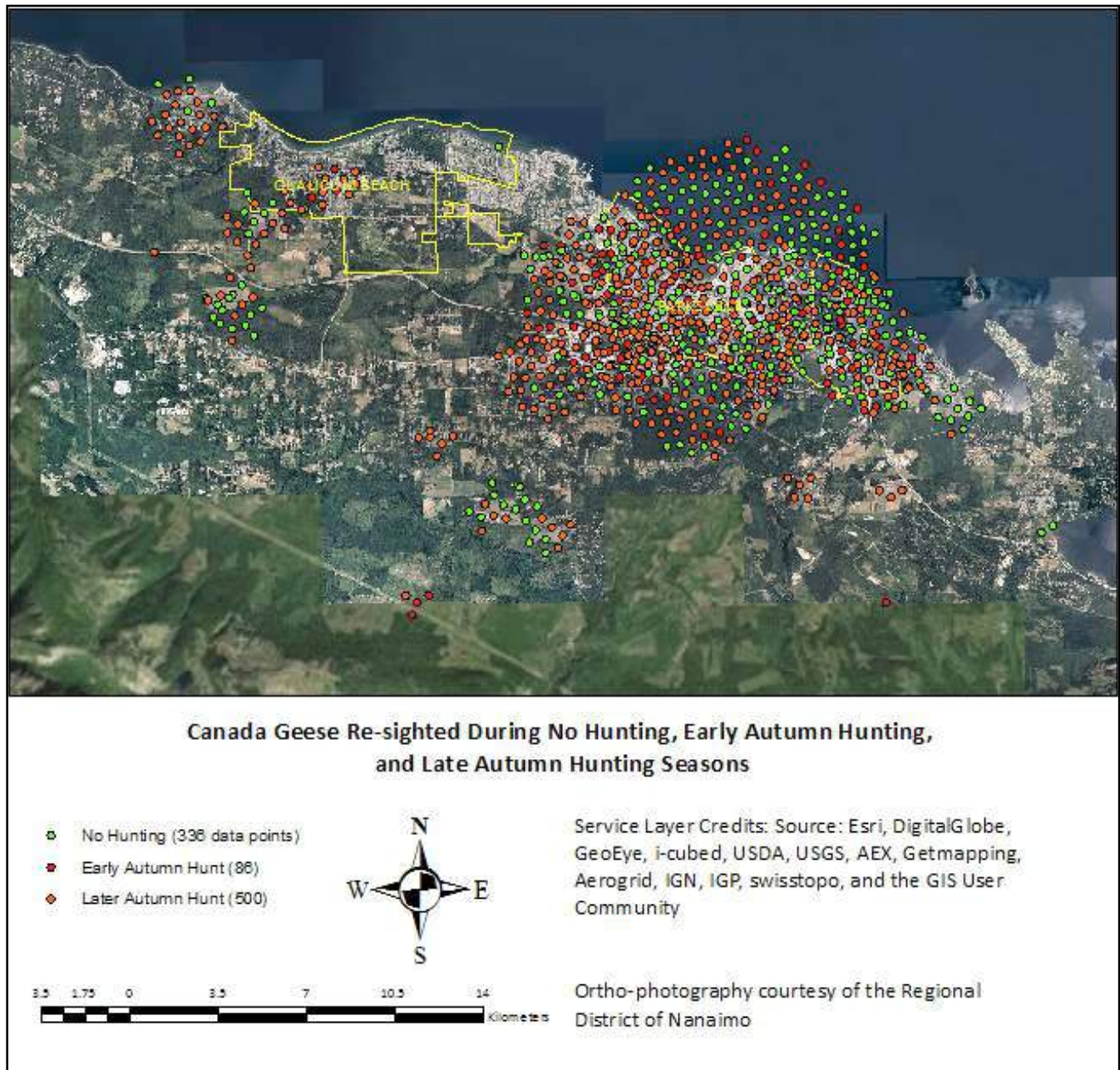


Figure 12-5. Canada Geese re-sighted in autumn, by hunting season, 2008-2013 (n=944). Stacked dots have been digitally dispersed.

Hunters have pointed to the success of opening day, the first day of each hunting season, as evidence that many geese do not anticipate the hunt. In our area, hunters reported that the opening

weekend in September was the best hunt of the year (survey respondent, 2014; hunter report to T. Clermont, pers. comm. 2014). In the eastern U.S., the effect of harvest on bird movement was

strongest during the early days of the hunting season (Hestbeck, Nichols, & Malecki 1991), and hunting success declined as the season progressed (cf. Lindberg & Malecki 1994).

Hunter Numbers

According to CWS' National Wildlife Research Centre, the number of active waterfowl hunters in federal management zone 1 has dramatically declined since the 1970s; this zone

encompasses most of the province, including our study area. Over the last decade, numbers stabilized at fewer than 2000 hunters (Figure 12-6) (Gendron & Smith 2014). Provincial data for management units 1-5 (Maple Bay north to the LQRE) and 1-6 (LQRE north to

Campbell River) (see map, Figure 12-7) showed no obvious trends between 2000 and 2013 (Figure 12-8). Increased bag and possession limits, beginning in 2012, may have motivated more individuals to hunt in unit 1-5 that year.

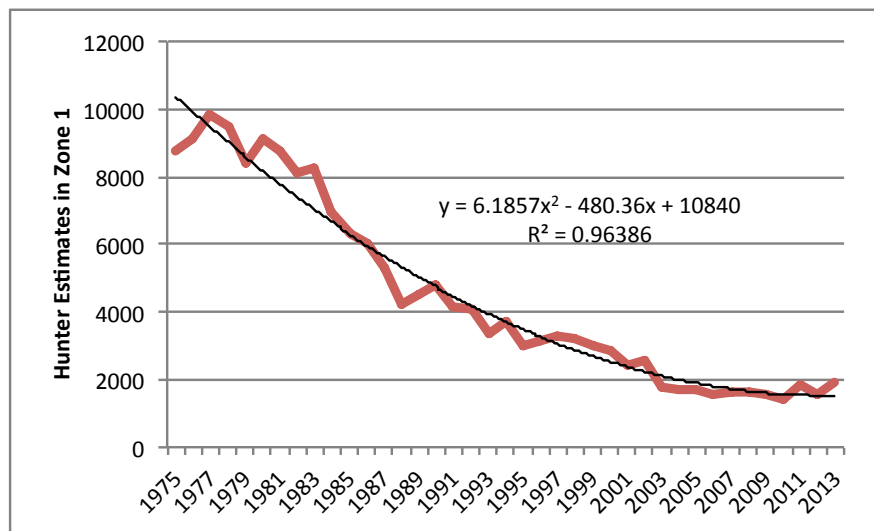


Figure 12-6. Active waterfowl hunters in B.C. Zone 1, 1975 to 2013 (Gendron & Smith 2014).

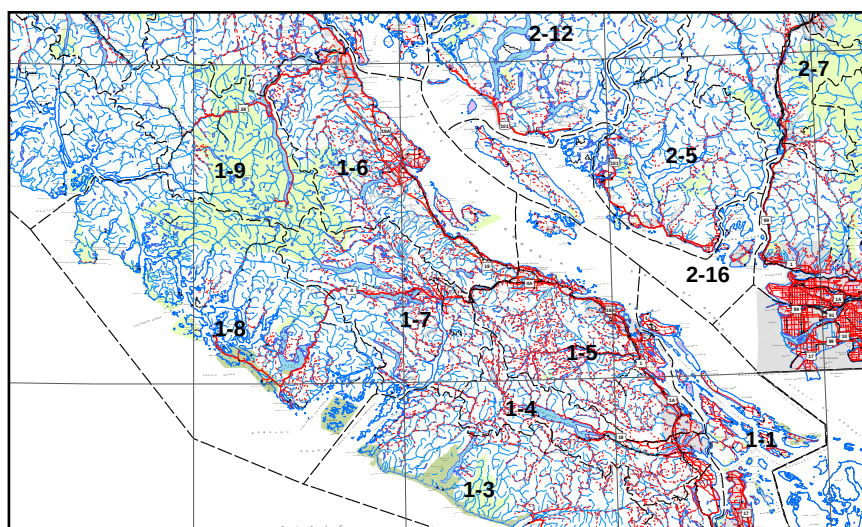
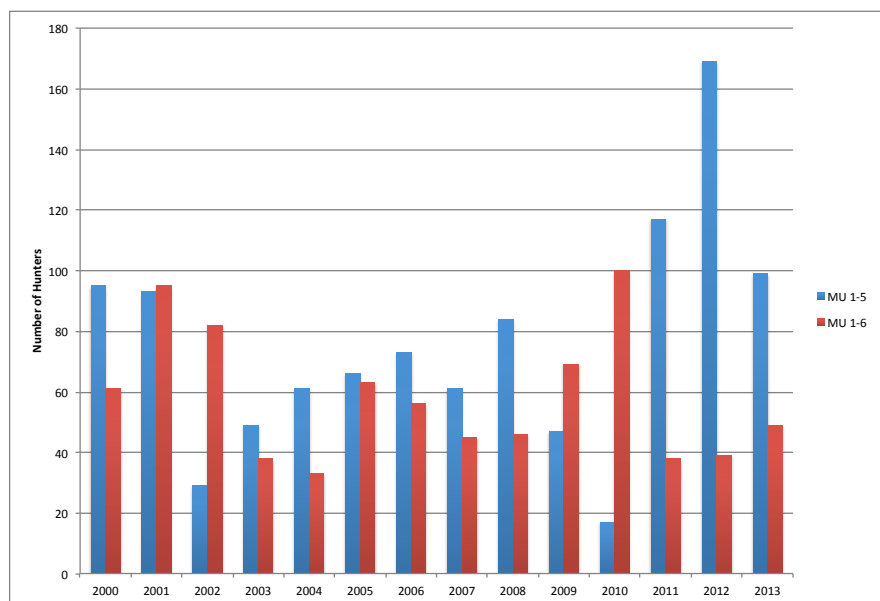


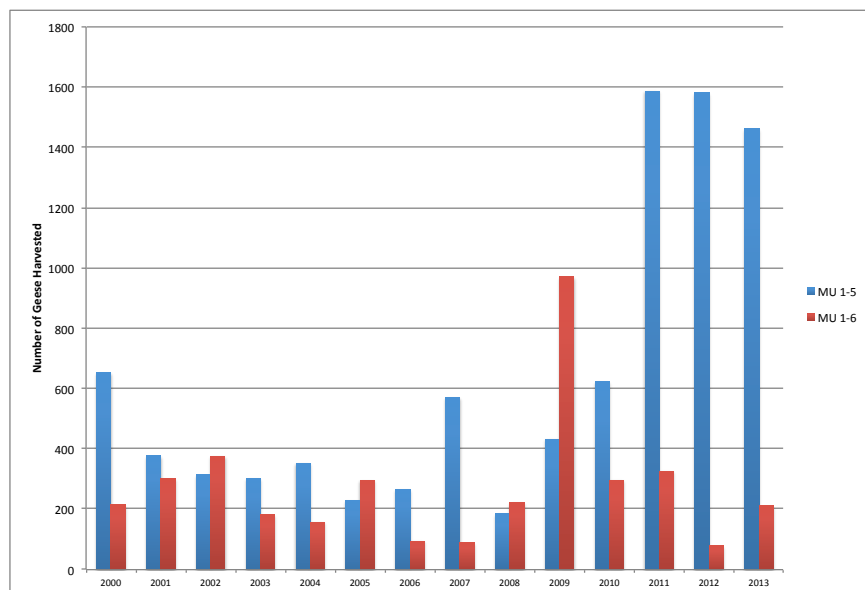
Figure 12-7. Provincial fish and wildlife management units, available at http://www.env.gov.bc.ca/fw/wildlife/docs/mu_maps/south%20western.pdf. Our study area lies within management zones 1-5 and 1-6.



By contrast, the number of goose hunters in B.C.'s Fraser Valley has increased by 50% over the last five years, from 2,000 to 3,000 (J. Evans, pers. comm. to T. Clermont, June, 2015).

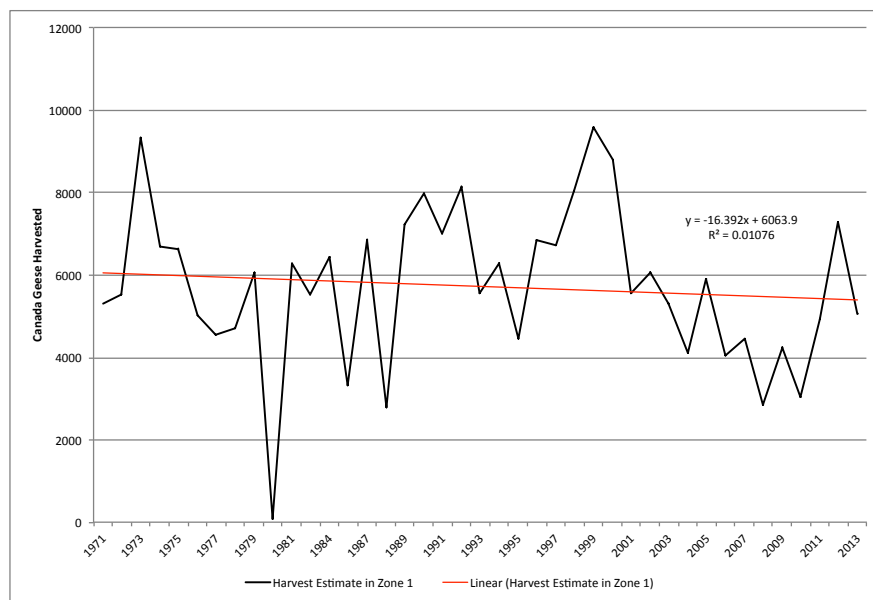
Figure 12-8. Goose hunters in Management Units 1-5 and 1-6, 2000-2013 (M. Chutter, pers. comm. to D. Janz, December 29, 2014). Provincial hunter sample based on annual hunter questionnaires.

Harvest Estimates



The number of geese harvested in management unit 1-5 peaked in recent years (2011 to 2013), whereas there was a new low in unit 1-6 in 2012 (Figure 12-9). Peaks in unit 1-5 reflect the hunter numbers there (Figure 12-8), and suggest a comparatively larger goose population.

Figure 12-9. Geese harvested in Management Units 1-5 and 1-6, 2000-2013 (M. Chutter, pers. comm. to D. Janz, December 29, 2014). Provincial hunter sample based on annual hunter questionnaires. Canada Geese were not differentiated from other geese.



Federal harvest estimates for B.C. zone 1 reveal Canada Goose harvests in 1971 and 2013 were similar, however estimates fluctuated by thousands of birds over the intervening 42 year period (Figure 12-10).

Importantly, goose populations increased substantially over this period, whereas the federal hunter and harvest numbers did not.

Figure 12-10. Harvest estimates for Canada Geese in B.C. Zone 1, based on federal data, 2000-2013 (Gendron & Smith 2014).

Available Hunting Areas

A widely held belief is that hunters are limited by the number of available and accessible hunting areas (cf. E. Lok, pers. comm. December 1, 2004). East-central Vancouver Island is characterized by a preponderance of privately held lands, a consequence of land grants in the late 1800s and early 1900s. As the island has developed, more areas have been closed to hunting and the discharge of firearms (CWS 2010).

Our surveys found that most farmers hunt on their lands, or allow or encourage others to hunt. One Nanoose Bay farmer commented that more and more

hunters are asking for permission to hunt. A farmer in the French Creek area had permitted hunting in the past, but found the cattle and horses were “greatly disturbed with guns around”. An Errington couple would allow more hunting, if they could be assured they would not be harassed; they reported incidents where neighbours - not adjacent but distant neighbours, had disrupted their busy store, loudly complaining about hunting on the farm. Two farmers allowed goose hunting by hunting clubs. One set up a permanent blind and calls the Nanaimo Fish and Game Club when he sees geese during the hunting seasons. The other farmer

called the Hidden Valley Conservation Club “our most successful venture to date” [in controlling geese], while noting the hunting season is only 4 months of the year. (Note: The hunting season is limited to 3.5 months, or 107 days, by the *Migratory Birds Convention Act*.)

Local Hunter Report

In four years, a local hunter and his buddies shot 138 Canada Geese over 24 days in our region (Table 12-2). His hunting effort increased over time, partly due to increased bag and possession limits. His hunting areas were widespread, and included sites outside of the region.

Table 12-2. Local hunter report. Some hunters reported bands, and others did not. Geese shot include White-fronted Geese and Cackling Geese.

Date	Number of Hunters	Number of Geese Shot	Hunting Area
2011 September 10	5	25 (limit)	Qualicum
2012 October 16	unknown (min 3)	23	Qualicum
2012 October 20	unknown (min 2)	17	Errington
2012 November 7	unknown (min 3)	27 (total 67 in 2012)	Gabriola island*
2013 September 7 (opening day)	unknown	4	Gabriola island
2013 September 8	unknown	9	unknown
2013 October 26	unknown (min 2)	15	Nanoose Bay
2013 October 29	unknown	8	Nanoose Bay
2013 late December	2	14 (total 50 in 2013)	Nanoose Bay
2014 January 4	unknown (min 3)	22	Gabriola island
2014 February 22	5	47	Gabriola island
2014 September 7	unknown	2	Qualicum
2014 September 9	unknown	8	Nanoose Bay
2014 September 13	unknown	2	Nanoose Bay
2014 October 11 (opening day)	unknown	10	Nanoose Bay
2014 October 25	unknown	1	Gabriola island
2014 November 15	unknown	1	Nanoose Bay
2014 November 16	unknown	2	Nanoose Bay
2014 November 17	unknown	1	Nanoose Bay
2014 November 23	2	1 (total 97 in 2014)	Nanoose Bay
Total hunting days: 21 from September 2011 through November 2014, 15 in our region; 6 in the September season	Total hunter days: at least 37, 24 in our region	Total CAGO shot: 239, 138 in our region	*Gabriola Island sites outside of our region



Natural barriers, in the form of Large Woody Debris, have protected an isolated stand of sedges on the ERE. One resolute goose was observed infiltrating the perimeter.

12.13 Use of Permits by Landowners

According to our limited surveys, scare permits and damage and danger permits (i.e., egg sterilization and kill permits) have been extensively used. The City of Parkville and others have acquired permits for addling, hazing using raptors, and reportedly for dog programs. (Federal permits are not required to use dogs to haze geese.) Most farmers used permits to scare and/or kill geese outside of the hunting season; two had arrangements with hunting clubs to manage geese.

The Fairwinds community/golf club addled eggs for several years, mainly on the small islands offshore from Schooner Cove. One farmer reported addling eggs whenever nests were found. A Parkville residents' association attempted egg addling once or twice, and found it to be neither "feasible" or "successful".

A common complaint regarding permits was remembering to apply in time; considerable damage was done while waiting for permits to be processed.

12.14 Goose Unfriendly Habitats

Creating goose unfriendly habitats is one of two non-lethal ways of controlling Canada Geese; the other is hazing (see Chapter 12.15).

No Feeding

Feeding may attract and sustain more animals in an area than would otherwise be supported by natural food resources (USDA 1999). However, it is unclear how much of a difference it makes in areas where

overall food resources are abundant.

The City of Parkville does not have a bylaw preventing the feeding of Canada Geese or any other wildlife, and the City staff I spoke with had not observed or received reports of residents feeding Canada Geese (A. Metcalf, W. Payne, pers. comm. November 2014).

However, some residents of Parkville's Craig Bay Estates feed geese, despite discouragement by their strata councils. To date, the councils have not instituted any penalty for feeding geese.

According to one survey respondent, many people enjoy watching the geese, but few feed them, and the vast majority of owners are thankful for Canada Goose control efforts.

Feeding wildlife may have many detrimental effects (e.g., children being injured by geese habituated to approaching humans for handouts, poor nutrition from unnatural diets). Eckberg (2010), who studied Canada Goose issues in Rochester, Minnesota, noted that a debilitating condition called Angel Wing, thought to be the result of a nutritional imbalance from being fed too much bread, afflicts many urban Canada Geese and renders them flightless.

Barriers

Barriers can be effective if they exclose areas from geese, prevent geese from landing or taking flight, restrict movement when they are moulting and flightless, and/or cause them to feel more vulnerable by blocking escape routes or lines of sight (cf. Conover & Kania 1991; Ray 2011).

See also 12.31 Goose Unfriendly Habitats, in Additional Non-lethal Controls.



Planted sedges protected by orange snow fencing outside of a fenced enclosure, Little Qualicum River estuary, summer 2014



Red-winged Blackbirds (*Agelaius phoeniceus*) perching on enclosure, Little Qualicum River estuary, June 3, 2014

Conover and Kania (1991) found that Canada Geese could be excluded by increasing the flight clearance angle to greater than 13° by planting trees around lawns or small bodies of water. Also effective was placing shrubs to reduce a bird's ability to detect predators at distances beyond 9 m - particularly when combined with distress calls and other forms of harassment.

Estuary Enclosures and Fencing

Experimental Canada Goose enclosures installed on the LQRE and ERE (12 and 6 enclosures, respectively) in 2010 were constructed from green Bezinal-coated fencing supported by 7 and 8-foot painted metal t-posts, and crisscrossed at the top with white polyshock cord or twine. The fencing and cord were flagged to prevent bird collisions and entanglement (Clermont 2010, June; September). One enclosure required limited maintenance, when goslings were observed slipping under them. Monitoring plots were established inside the enclosures, but also outside of them on the upstream side. This deliberate act was based on the premise that the geese might avoid these areas if their lines of sight were limited by the fencing. Monitoring could then compare areas protected by enclosures, areas screened by enclosures, and open areas. As expected, nesting and grazing Canada Geese appeared to avoid using areas immediately behind the enclosures, on their upstream side. On the ERE, due to the loss of substrate/marsh platform, enclosures were installed only along the perimeter or along

its farthest upstream reaches; they were too far away from congregating Canada Geese to show visible differences in grazing and grubbing.

In May, 2013, bright orange snow fences were erected to protect plantings along the main dendritic channel at the LQRE marsh, anchored to existing enclosures. Again, geese avoided the areas upstream of the fencing, allowing natural regeneration of vegetation to occur. Although the fencing did not obstruct the channel, it provided a visual 'pinch point' along the channel beyond which most geese would not venture. Thus, the combination of the enclosures and snow fencing effectively protected the entire mid-upper marsh area above the fencing normally accessible from the channel. Based on this success, a larger fence was installed across the entrance to the main channel of the marsh in May 2014, to prevent moulting birds from accessing the area. Photo-monitoring showed some vegetative recovery in areas behind the fence. The recovery was short-lived, as the fence collapsed within a month due to the weight of accumulated algae.

All non-lethal controls will have unintended consequences for non-target species, some positive, others negative. Enclosures on the LQRE were often used as perches by Red-winged Blackbirds (*Agelaius phoeniceus*), a positive effect. Other species may avoid the enclosures.

Fencing

The City of Parksville installed fencing along the beach, primarily to restore foreshore vegetation, but



Fencing along the beach, designed to restore foreshore ecosystems, also restricted Canada Goose access to upland habitats, particularly during the flightless moulting period.

also to discourage Canada Geese from walking from Parksville Bay onto the grass in the community park. Since the fencing was erected, there has been less fecal matter on the walkway along the beach (A. Metcalf, W. Payne, pers. comm. November 2014).

By contrast, owners at Craig Bay Estates have built short fences along the water to deter geese from leaving the ponds, but this has had little effect (survey respondent, November 2014).

Drainage

Two out of the five farmers surveyed had taken steps to prevent geese from depredating their crops and pasturelands by improving drainage to ensure there was no standing water to attract them. Despite reporting few Canada Goose problems at the Qualicum airport, the Town of Qualicum Beach intended to fill a depression to avoid ponding and attracting waterfowl near the airport (B. Weir, pers. comm. November, 2014). While it is important to reduce risks to aircraft from geese, drainage for most other purposes may be inappropriate. The USFWS (2002) considers draining waterbodies to be unreasonable and “aesthetically unacceptable” (p. II-2). A majority of the world’s wetlands have been lost to drainage (Biebighauser 2007;

2011; Davidson 2014), and even seasonal wetlands are considered important for their ecological values and ecosystem services.

Inaccessible or Unpalatable Food Sources

To discourage geese from foraging crops to bare ground, a Nanoose Bay farm now times the harvest of its rye/wheat forage crops to ensure plants grow taller before winter. This practice also provides more forage in spring, allowing the farmer to feed his cattle, rather than graze them on wet fields.

The sports field in Parksville’s community park had been a favoured grazing spot for Canada Geese. Yet, after the grass turf was replaced, few geese visited the field. What changed? The drainage was much better than before. The new substrate under the grass turf was sand, not organic matter, and the grass, a ryegrass and Kentucky Bluegrass mix, was kept green with fertilizer. Since these grasses are known to be highly palatable to geese (Conover 1991; Washburn & Seamans 2012), City staff speculated that the new grass may taste different due to the sandy substrate. As organic material built up over time, it would become more attractive to geese (A. Metcalf, W. Payne, pers. comm. November 2014).



Urban goose, City of Parksville



Roundups, such as this one at Craig Bay in July 2012, provide a good indication how much effort it takes to move geese. Many people, all along the shoreline and in boats, were necessary to herd the flightless geese. Photo by Charlene Lee.

12.15 Hazing

Some survey respondents reported using a wide range of techniques to scare geese (e.g., one had used dogs, raptors, scare shells, laser light, and utility vehicles), while others had used only one or two techniques. All reported limited success.

Hazing with Dogs

More than any other hazing method, dogs have been used to deter and chase geese on both public and private lands. The City of Parksville Canine Goose Control Program began early in 2009. The program was deemed 'pretty successful'. A dog trainer managed ~50 volunteers with pairs of dogs, to chase, but not harm geese. Owners were identified with an ID badge. The dogs, wearing bright yellow scarves to identify them as goose control dogs, were required to be on leash (consistent with local bylaws) except when working in the community park, Springwood Park playing field, City Hall and Parksville Community and Conference Centre. The \$8,700 program (\$2,400 annually, less in the final year) was initially funded in 2008, and ran until 2011 when the trainer became unavailable (City of Parksville 2009; A. Metcalf, W. Payne, November 2014). Importantly, an advertising campaign preceded the program, to generate interest and participation, to help ensure untrained canines would not be chasing geese as a result of the program, and to raise awareness of the differences between Canada Geese and Brant.

Brant are a provincially blue-listed species that rests and feeds on the foreshore of the PQBWMA and Rath Trevor Park during their

spring migration to Alaska. During the months of March and April, these beaches are closed to dogs, as the Brant are highly sensitive to the presence of dogs and take flight at the least provocation.

A similar control program was developed to chase Canada Geese off grassy areas and footpaths in a Parksville residential development, forcing them to take flight or find refuge in the strata's settling ponds. A dog trainer was paid for one weekend course each year, and dogs were trained to promptly and consistently return to their owners when called. They were allowed to be off leash only when chasing geese, and were required to wear a red bandana to identify them as goose patrollers. The program was in abeyance when the geese are moulting. Interest in the program has waned, as the dogs become dirty with feces and there was a growing feeling that they may be getting ill or diseased from participating. As an alternative, residents sometimes 'walked' the geese to the water from the grass (survey respondent, 2014).

Administrators at Parksville Elementary School explored the possibility of using trained dogs to chase the geese from school property, but could not proceed without the support of the School Division's Operations and Maintenance Department (survey respondent, 2014).

A Nanoose Bay golf course employs a falconer with a border collie, while a French Creek course has a dog that chases geese off of the course.

All farmers had dogs, and used them to chase geese, with varying

See also 12.32 Hazing, in Additional Non-lethal Controls.



Geese become accustomed to people, traffic, and other sights and sounds of urban environments.

levels of success. Every survey respondent that reported using dogs to scare geese also used human power (employees, farm kids) to harass them. One farmer acknowledged that he was merely moving the problem elsewhere.

Dog programs to control geese have been employed in many other jurisdictions. In New Jersey, Dow Jones & Co. eliminated Canada Goose problems on its property this way, after finding other harassment techniques were aesthetically unacceptable or too expensive. The company used border collies year-round, for 15-30 minute sessions, 1-3 times per day. The dogs received no special training, instinctively herding the geese into a pond, then swimming into the pond to encourage the geese to take flight. 'Invisible fencing' was used to enclose the dogs. The cost of implementation in 1990 was \$9,400 for dogs and fencing, with annual maintenance costs of \$2,000 paid for dog food and veterinary

care (Castelli & Sleggs 2000).

Hazing with Raptors

The City of Parksville employed a falconer with "Eddy the Eagle" to harass geese from 2010 to 2012, spending nearly \$26,600. City staff noted the dogs covered more space in a given time, when compared with the eagle (A. Metcalf, W. Payne, pers. comm., November 2014). A Nanoose Bay golf course spends more than \$3,000 per month employing a goose control person with an eagle and a border collie (survey respondent, 2014). Unlike hazing with dogs, hazing with raptors requires a federal permit.

Hazing with Equipment

Survey respondents reported using utility vehicles and All Terrain Vehicles to move geese, and laser light or cracker shells to scare them. Cracker shells are typically employed using a firearm, and so require a permit from Environment Canada.

12.2 No Action

With 'no action', any current programs to curtail Canada Goose population growth would be discontinued. Hunting would be the primary means of control, augmented by piecemeal damage and danger permits and hazing techniques used by private landowners.

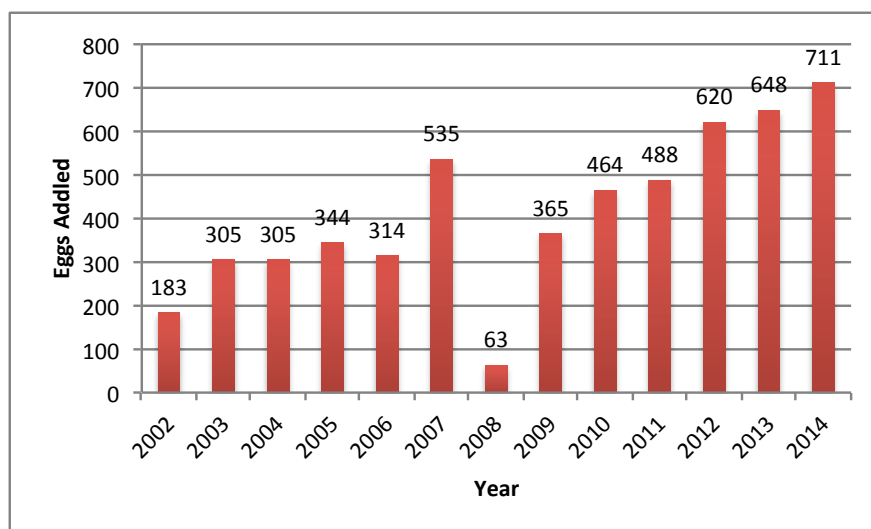
To measure the effectiveness of 'no action', we can simply examine how effective the egg addling program has been.

The estuary-focused addling program removed at least 5,345 eggs from local Canada Goose populations from 2002 through 2014 (Figure 12-11).

Approximately 80% of eggs produce viable young (cf. Cooper 1978; Dawe & Davies 1975), about 66% of goslings survive their first year (a conservative estimate, cf. Brakhage 1965; Bellrose 1976; Smith, Craven, & Curtis 1999; Heller 2010; Beston et al. 2014), and ~74% survive to their second

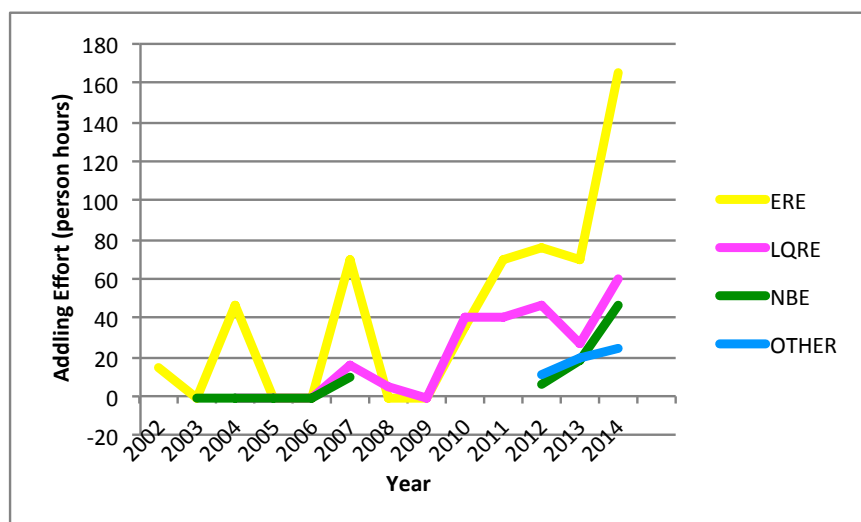
year (USFWS 2002; Heller 2010; Beton et al. 2014). Assuming Canada Geese have the potential to breed at age 2 (cf. Brakhage 1965), at least 2,088 breeding-aged Canada Geese were removed from the population over the twelve-year period. In other words, by addling 2.6 eggs, one adult was prevented from breeding.

An additional 585 eggs were addled in 2015, at the LQRE and ERE only (T. Clermont, pers. comm. 2015).



The number of eggs added has increased over recent years (Figure 12-11), however this is not entirely related to a growing number of breeding geese. Adding effort fluctuated over time, becoming more consistent from 2010-2014 (Figure 12-12). Data were missing for 2008 and 2009.

Figure 12-11. Canada Goose eggs added at all sites, 2002-2014 (n=5,345). Data were missing for 2008 and 2009.



When funding for adding crews was not a limiting factor, the level of effort was directly related to the number of nests and eggs found. More nests and eggs require more person hours. Additional searching may also find more nests, with diminishing returns as the season progresses.

Figure 12-12. Adding effort at the ERE, LQRE, Nanoose Bonnell estuaries (NBE) and other sites, 2002-2014. Unknown effort = -1, no effort = 0.

In 2009, the adding dataset for the LQRE was largely unusable due to a well-intentioned person operating without an adding permit. Here, one marked egg was replaced in the nest, together with a rock, and other eggs were likely removed.

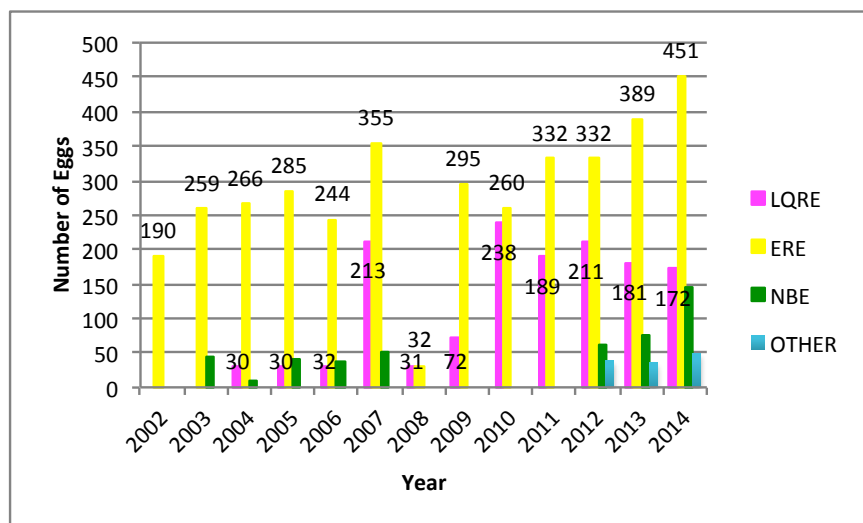




ERE: Goose productivity high and rising

The ERE, as the largest estuary (~115 ha), has consistently supported more nests and eggs than the LQRE or other sites (Figures 12-13 and 12-14). In 2015, there were 73 nests, 2 re-nests, and 461 eggs found, surpassing the fecundity record of the previous year. There were also five broods observed on the estuary during the nesting season, suggesting some nests were missed (T. Clermont, pers. comm. 2015).

Figure 12-13. Nests found at the ERE, LQRE, NBE, and other sites, 2002-2014 (n=1,069). Data are missing for 2008 and 2009.



LQRE: Goose productivity down

Since 2010, the number of nests discovered on the LQRE has decreased (Figures 12-13 and 12-14). In 2015, there were 25 nests, 1 re-nest, and 149 eggs (T. Clermont, pers. comm. 2015).

NBE: Goose productivity up

By 2014, the nest count at the NBE had nearly equaled numbers at the LQRE, with less search effort on the NBE (Figure 12-13). There were also 104 goslings observed at the NBE during the 2014 moult count, suggesting ~20 nests were undetected.

Figure 12-14. Canada Goose eggs at the LQRE, ERE, NBE, and other egg adding sites, 2002-2014 (n=5,681).

Without an addling program or other intervention to curtail Canada Goose populations, independent actions to control geese will inevitably increase. The USDA (1999) predicted an increase of undesirable, cumulative impacts (e.g., draining of wetlands, inhumane methods of killing, harassment of non-target species) with any decrease in government assistance (as governments had taken the lead in the U.S.), primarily because independent initiatives would be poorly monitored and those taking action would have low accountability.

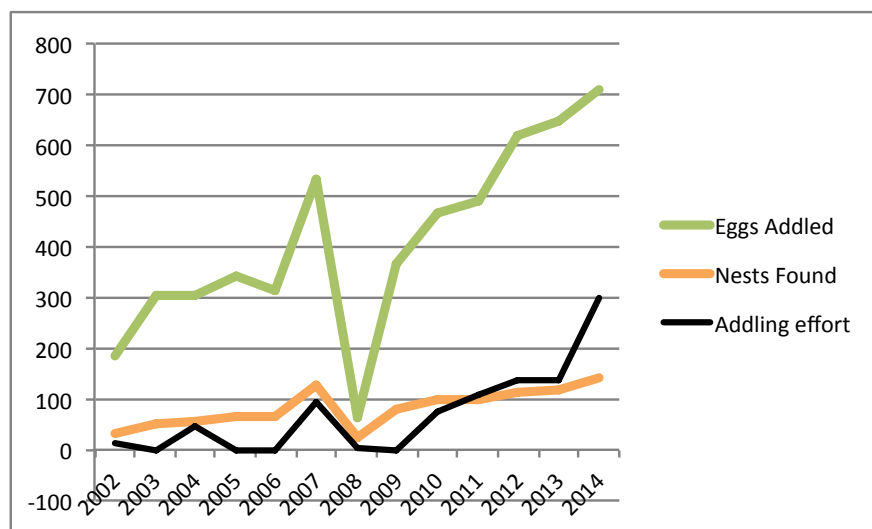


Figure 12-15 shows the level of effort, nests found, and eggs added for all adding program sites from 2002 through 2014.

Figure 12-15. Total numbers of nests and eggs added, with adding effort (person hours), 2002-2014 (n=1,069 nests and 5,345 eggs). Data were missing for 2008 and 2009.

12.3 Additional Non-lethal Controls

Those attempting to control Canada Geese typically use multiple methods applied with trial and error. However, there are numerous reviews describing non-lethal (and lethal) techniques, sometimes with conflicting opinions; see Ray (2011), CWS (2010), as well as many of the federal and state CAGO control reports or web pages (e.g., Maryland Department of Natural Resources, n.d.; USDA 1999; USDI 2005). The following provides a snapshot of common approaches.

12.31 Goose Unfriendly Habitats

Modifying habitats to be less inviting to geese can reduce the overall ability of the landscape to support geese, i.e., its carrying capacity for geese. However,

Canada Geese are highly adaptable. They have been known to nest in woodlands, in flower gardens, and on rooftops, for example.

Barriers

Bamboo stakes may have some promise as Canada Goose deterrents on the estuaries. The stakes guard preferred feeding areas, and birds are reluctant to navigate through them (K. Ashley, pers. comm. December 2014). Bamboo has been used in the restoration of eelgrass beds (Boyer & Wyllie-Echeverria 2010), albeit not to deter geese.

Dense plantings, tall enough to prevent adult geese from seeing over them, can deter Canada Geese from moving upland along shorelines or from ponds (CWS 2010). This is

particularly effective during flightless periods (USDA 1999). Although a frequently suggested management technique, vegetative barriers may not be supported everywhere. An online petition protesting a vegetative buffer along a Minnesota lake was signed by more than 600 people, who argued that crippled geese could not access food onshore (Eckberg 2010). And for some people, the aesthetics and enjoyment of lawn adjacent to water are more important than preventing Canada Geese from using these areas (USDA 1999).

Grids or parallel lines of wire, cable, twine, rope, or tape can be suspended above the surface of ponds or over new plantings. These and other visible deterrents (e.g., strung CDs that



This feeding area is weedy and has not been fertilized.

move in the wind) can be used to block flight paths and make areas less desirable (CWS 2010). It may be helpful to take prevailing wind directions into account, as geese prefer to take off into the wind (cf. Martin & Guignon 1983).

Making Feeding Areas Inaccessible or Unpalatable

There are several ways to make terrestrial habitats such as grassy areas less attractive to geese. Canada Geese like short, tender, young shoots, so planting coarse grass species, fertilizing less, and/or mowing less frequently to allow grass to become tall and coarse, *may* lead them to seek more palatable food elsewhere. Canada Geese prefer gentle slopes from aquatic to upland areas, so steepening these slopes and allowing vegetation to grow tall along the slope can discourage geese while protecting the bank from erosion. Breaking up vast grassy areas into smaller sites enclosed by shrubs or other tall structures can encourage geese to go elsewhere (cf. Maryland Department of Natural Resources n.d.). These techniques work best if there is a good alternative feeding source nearby (Conover 1991).

Chemical goose repellants have been used with varying degrees of success to prevent feeding on grass and other vegetation (USDA 1999; Ayer 2009; CWS 2010; Huang 2010). Ideally, the product will affect only the taste of vegetation, and not be harmful to wildlife or humans; it is important to check with the product supplier as a permit may be required for its use (CWS 2010). Frequent mowing may influence the longevity and efficacy of

chemical deterrents on grassy areas (Ayers 2009).

Methyl anthranilate, a registered repellant for Canada Geese in Canada and the U.S. (USDA 1999; Health Canada 2012), is marketed under the trade names Rejex-It™ Migrate for Agriculture and Turf Bird Repellent, and as ReleX-iT™ (Health Canada 2012). It repels Canada Geese when it comes into contact with eyes, nostrils and mouth. It has low toxicity to terrestrial organisms, including mammals and birds, but may adversely affect aquatic organisms (USDA 1999; Health Canada 2012). Methyl anthranilate is naturally occurring in grapes, and is used to produce the sugar-substitute saccharin (International Agency for Research on Cancer 1999). When assessing its effectiveness, the USDA (1999) reported mixed results.

Anthraquinone is a digestive irritant, and is sometimes combined with a plant growth suppressant to make it more cost-effective (USDA 1999; Ayers 2009). Accepted for use as a bird repellant at American airports since the late 1990s, anthraquinone is also used for textile dyes and as a pulp and paper additive. It was phased out of use by the European Union in 2008 and is “possibly carcinogenic to humans” (International Agency for Research on Cancer 2012, p. 66).

Ray (2011) suggested lime as a potential grazing repellant for Canada Geese. For a short time, it produces a caustic effect on the oral mucosal lining (Belant et al. 1997 in Ray 2011).

Hesse, Rea, & Booth (2009), in

their discussion of wildlife management around airports, documented the use of chemical deterrents on nesting and roosting sites. I was unable to find any examples where repellants were used on goose nesting and roosting sites.

Removing Domestic Waterfowl

Birds learn to locate food resources by watching other birds. Domesticated waterfowl act as decoys, luring Canada Geese into ponds and other areas. Domesticated waterfowl may be farmed, kept for aesthetic reasons, or congregate and stay in areas where they are fed, all with similar results. Importantly, concentrating domestic and wild birds in an area has been known to spread diseases (USFWS 2002).

There are discrepancies in the literature as to whether Mute Swans attract or repel Canada Geese; some say the territorial nature of the swans make them an effective deterrent, while the U.S.D.A. and others maintain they are only territorial while they are nesting. There are also other reasons to refrain from keeping swans, such as the potential proliferation of exotic species, damage to aquatic habitats, and aggression towards people (USFWS 2002). Such rationale can be overcome by using swan decoys; the sellers of these claim they are successful Canada Goose deterrents (e.g., <http://shop.tjb-inc.com/floating-white-swan-decoy-for-canada-geese-control-in-water-gardens--ponds-p1335.aspx>).

Bait and Lure Crops

Bait and lure crops may appear out of place in this section, as they are not 'goose unfriendly habitats'. However, they are 'carrot' habitat modification tools meant to discourage geese from using more vulnerable habitats, and so act in much the same way as 'stick' tools (e.g., barriers, goose repellants). It is important to note that bait in this context does not refer to baiting to lure birds for hunting (which may be permitted as a special provision should Canada Geese be designated as overabundant). Rather, lure crops may be planted, or bait (usually grains) deposited to attract wildlife away from more valuable resources. Baiting may also be used with capture nets to round up geese for banding, relocation, or extermination, within the conditions of a federal permit.

Lure crops are known to be largely ineffective where food resources are plentiful (USDA 1999), and are only available for short periods of time (USFWS 2002), so are considered inappropriate for most year-round urban goose problems. The effectiveness of baiting is also limited by the availability of alternative food resources (USDA 1999), and geese must be kept out of the vulnerable habitats (e.g., by hazing or with barriers) (USFWS 2002).

A key question remains, how available are alternative food sources in our region, and does this differ by season? CWS (e.g., CWS 2011) has stated that the rise in Canada Goose populations can be attributed, in part, to ever-

expanding food resources as humans modify the landscape, whereas the Guardians and others (e.g. MVIHES 2009; Dawe et al. 2011) have determined that once plentiful estuarine food sources have been dramatically diminished.

Bait and lure crops are sure to draw others species of waterfowl and their predators. Bait pads require frequent cleaning to prevent illness among its users. And such areas concentrate animals, making them more susceptible to pathogens and parasites.

12.32 Hazing

Most hazing programs have met with little success, as geese readily habituate to scaring techniques, move to other areas where they are not wanted (including areas where owners may suffer significant damages that they can ill afford), and then return once hazing is suspended (CWS 2010; Huang 2010; Ray 2011). Preusser et al. (2008) in Ray (2011) found that geese usually moved less than 2 km from hazing sites and often returned multiple times after hazing. Effective hazing requires that geese be chased every time they arrive, and employs multiple techniques to overcome habituation (CWS 2010); this is time-consuming and can be expensive. Certain types of hazing (e.g., chasing by dogs) may not be appropriate when geese are nesting or flightless during the moult, as the birds may be harmed if they cannot fly away or stay to defend their eggs. Migrants are

generally (but not always) more responsive to hazing than resident birds (cf. USDA 1999), therefore Cackling or Dusky Canada Geese may be targeted.

An experiment conducted in Scotland assessed hazing as a tool to manage Barnacle Geese (*Branta leucopsis*) depredating agricultural lands. Human 'goose scarers', supported by gas guns and plastic tapes, hazed geese from 'scare fields' to 'refuge fields' where farmers received payment to allow the geese to graze. Working in daylight hours over a 4 month period, 7-8 scarers were able to reduce the number of geese in scare areas by 50%; despite all efforts, a core group of geese remained faithful to the scare area. The scheme cost more than it saved in crop yields.

Recommendations included using fewer people over a more focused time period, while monitoring birds for body condition and ensuring refuge areas were sufficient (Percival, Halpin, & Houston 1997).

Hazing on the Estuaries

Hazing on the estuaries is difficult at any time of year, and especially during high tides, because geese can access water at multiple points or across broad expanses. Once pairs establish territories and build nests on the estuarine marshes, the stage is set for ongoing damage. Hazing is less effective when geese are nesting or raising broods, as parents are less likely to leave eggs or young behind (CWS 2010). During the pre-moult period, the birds often swim along the shorelines to their favourite moulting sites. Geese

that are hazed during the moult will not be able to travel very far (CWS 2010). Therefore, mitigating damage from Canada Geese from March through August by hazing would require nearly constant vigilance, and possibly alternative measures such as baiting in less ecologically sensitive areas in proximity to present moulting sites (cf. CWS 2010). Hazing on the nesting grounds will move breeding geese onto other sites, some of which may be much more difficult for egg addlers to find.

To haze the geese from the estuaries to huntable areas during autumn, winter, and early spring hunting seasons will require simultaneous hazing efforts in other non-huntable areas, of which there are many. A well-coordinated, pilot effort would be necessary, ideally with several days of pre-observation to study birds movements, cooperation from landowners, and substantial manpower employing a variety of hazing techniques.

Hazing Techniques

Hazing techniques mentioned in the literature and not used by our survey respondents are described here. They have been applied with varying degrees of success, and what works for one site may not work for another. The effectiveness of a given technique will depend upon the nature of the problem, the character of the landscape, and the skill with which it is applied.

Hazing techniques may be visual, auditory, or both. Visual techniques include dead Canada Goose decoys (e.g. at [http://](http://www.wildlifecontrolsupplies.com/animal/NWSDG01K.html)

www.wildlifecontrolsupplies.com/animal/NWSDG01K.html), swan

decoys (mentioned in 9.31 Removing Domestic Waterfowl), statues of owls or eagles, helium balloons and kites with graphics of large eyes or shaped like large birds of prey, scarecrows of predators or gun-toting humans, flashing or strobe lights, lasers (e.g., <http://www.wildlifecontrolsupplies.com/animal/NWSV000/BPL001.html>, <http://aviandissuader.com>), waving flags, shiny banners, streamers, flagging, and reflective tape (Smith, Craven, & Curtis 1999; USDA 1999; Blackwell, Bernardt, & Dolbeer 2002; CWS 2010; Eckberg 2010; Huang 2010; Ray 2011; K. Ashley, pers. comm. to C. Wightman, May 2014).

Auditory techniques include goose alarm and alert calls, predatory calls, propane cannons, air horns and sirens (CWS 2010; Eckberg 2010). Scare devices requiring a permit from Environment Canada include those discharged from a firearm, such as cracker shells, screamers, and bangers (Smith, Craven, & Curtis 1999; USFWS 2002; CWS 2010).

Audio-visual techniques include pyrotechnics and remote-controlled boats (USFWS 2002; Eckberg 2010). The City of Nanaimo uses a remote-controlled vehicle (K. Bridges, pers. comm. February 10, 2015). In some areas, motion-activated water sprinklers may be an effective hazing tool (CWS 2010).

Each technique must be considered for safety and legal implications, and public acceptance. It is important that

birds are not touched or handled. Hazing with firearms or with aircraft (e.g., drones) requires a permit. Some hazing techniques may contravene local government noise bylaws, or meet with public disapproval. Pyrotechnics, for example, may be prohibited in certain areas, and may cause injuries, start fires, and upset people and pets (USDA 1999). Hazing methods should also be assessed for their impacts to other species, particularly at-risk or sensitive species.

12.33 Adult Sterilization

In the U.S., Canada Geese have been baited with oral contraceptives during the breeding season. Nicarbazin, sold in the product OvoControl™, decreases egg production and hatching rates. Its use is limited to urban nesting sites where geese can be regularly fed. To be effective, geese must consume at least one ounce of bait per day for at least 21 days prior to nesting, and throughout the

nesting period. Its effects dissipate within a few weeks (USDA 2011).

Also in the U.S., ganders have been “vasectomized” to reduce recruitment. It is probably best suited for reducing small resident populations, as males must first be identified, then captured and surgically treated (Hundren et al. 2000 in Ray 2011). As this method typically affects only reproductive output from one female per gander, its effectiveness is limited (USDA 1999).

12.4 Additional Lethal Controls

Sometimes, non-lethal control methods are employed when lethal controls would have been more effective and biologically sound (USDA 1999). Lethal methods are sometimes necessary to reduce goose-human conflicts (CWS 2011). Lethal controls may enhance the efficacy of non-lethal controls; for example, when some members of the flock are killed, it scares remaining geese into other areas and may make them easier to scare in general (CWS 2011). (Often, though, surviving geese move to the estuaries or other areas where they are unwanted.)

12.41 Additional Hunting

There are two ways to increase hunting pressure on Canada Goose populations: 1) to expand hunting opportunities, and 2) to move Canada Geese into areas where hunting can occur.

Hunting opportunities can be expanded in several ways: 1) open

areas currently closed to hunting, even for a short time; 2) increase the number of hunters through encouragement programs or hunter incentives (including financial incentives); 3) encourage landowners with geese to allow access to hunters; and 4) further reduce hunting restrictions (extend seasons, increase bag and possession limits, allow equipment and techniques that are currently prohibited). Birds can be moved into huntable areas by hazing, or by roundup and transport.

The LQRE, ERE, CCE, and NBE are currently closed to hunting. However, parts of the ERE, LQRE, and NBE may be far enough from residences to enable safe and legal hunting. DUC secured an exception to a Port Alberni bylaw prohibiting the discharge of firearms within city limits. Designated, licensed hunters are allowed to shoot Canada Geese for one year, starting in September 2014, on

DUC conservation lands at the Somass River estuary. There is an option to extend following a report on conservation work in the estuary (Plummer 2014; D. Buffett, pers. comm. November 2014). Further afield, in Rochester, Minnesota, an early season Canada Goose hunt inside of the city’s game refuge earned the city national acclaim, including a title as one of the best cities for hunters to live in (Eckberg 2010).

Additional hunting opportunities may also be considered for golf courses, if there are areas where proximity of neighbours is not a concern. In Connecticut, 16 golf courses had active hunt programs; hunting occurred daily on 4, weekly on 4, and whenever geese were present on the remaining 8. Seventy-five other courses had requested state assistance to develop a hunting program (Huang 2010). Ray (2011) suggested archery and

entanglement (i.e., snares and nets) followed by removal as a way to take birds off of golf courses and other sites where discharge of firearms may be wholly inappropriate.

Also in Connecticut, a survey of farmers found that some were unaware that hunting was allowed on their lands, and subsequently initiated contact with hunters. Most farmers that were already hunting or allowing hunting wanted expanded seasons and bag limits (Huang 2010).

12.42 Additional or Expanded Kill Permits

There are at least two ways to ramp up the effectiveness of kill permits: 1) expand the egg addling program into new areas, and 2) encourage other landholders with Canada Geese to use kill permits. The Guardians have been asked on several occasions to addle eggs on properties currently outside of the program. A local hunter, on behalf of several farmers, contacted a Guardians member to determine how to secure kill permits to manage geese (pers. comm. October 2014). A campaign to raise awareness of these control options, and additional funding for addling will be needed if these methods are to make a marked reduction in the regional Canada Goose population.

12.43 Culling

Culling - the selective, lethal removal of wild animals, has collective benefits that most other control methods do not have. Like

hunting and permits to kill adult birds, it decreases the adult population, and so eliminates many costly and labour-intensive years spent addling eggs and chasing geese from one area to another. It typically targets a larger number of birds at one time, can be applied directly to a problem (sub)population, and its effects are obvious and immediate (cf. USFWS 2002, USDI 2005). There are also fewer risks that surviving members of the flock will return or cause problems elsewhere. Still, repopulation is anticipated, as nearby populations continue to grow and suitable habitats remain available. Females that escaped capture because they had moult-migrated (or for other reasons) will return to nest.

Ethics

Culling is a sensitive topic, sometimes motivating impassioned discussions and even organized conflict. Animal rights advocates have fiercely defended animals threatened with selective extermination, be they Canada Geese, deer, rabbits, wolves, or any other species, because they believe these animals have rights similar to humans. They may be opposed to any form of stressor or control, including hazing (USDA 1999), believing that humans should learn to tolerate and even appreciate these animals (USDA 2004). The U.S. organization, Love Canada Geese, supports a webpage entitled Canada Goose Hall of Shame, which lists the worst offending communities in Canada: Kelowna, Osoyoos, Penticton, and Vancouver, B.C.; Vancouver made the list because it

relocated juvenile geese, while Kelowna threatened, but did not undertake, a cull (LoveCanadaGeese.com 2014). Although most animal welfare organizations do not oppose wildlife damage controls (USDA 1999), the B.C. Society for the Prevention of Cruelty to Animals (BC SPCA n.d.) and others promote non-lethal methods and a respectful attitude towards urban geese.

On the other hand, there are people who have lost all tolerance for the nuisance animals, and are willing to reduce the problem by any means necessary (cf. Huang 2010). Most people hold positions somewhere in between, or no position at all. Hunters may wish populations to remain high or even grow.

These are ethical discussions about humaneness and justice, and individuals perceive them differently. Most people don't want the geese to suffer, and some are focused on determining the most humane extermination method. One survey respondent rejected the use of firearms for culling, but only as a public safety issue. A hunter viewed his participation in depopulation efforts as helping the City contain maintenance costs, assisting affected farmers struggling to make a living, and supporting local food initiatives. Disposal has come up repeatedly in meetings; many people reject any wasteful or debasing treatment of carcasses and will accept culling only as long as the birds are used for food. All of these factors, along with the logistical issues of coordinated

capture, transport, killing, and disposal, make culling a challenge. In the U.S., senior governments manage and oversee culls, whereas here they only participate as monitors. Not surprisingly, culling is generally seen as a control measure to pursue only when all others have been exhausted.

“Depopulations”

A number of stakeholder groups in the province have requested permits to cull, or conduct local ‘depopulations’, leading senior governments to address some of the aforementioned logistical issues (BC MFLNRO 2014; CWS 2011b).

In May 2014, in response to requests from the Capital Regional District, the B.C. MFLNRO produced the standard operating procedure (SOP) for performing depopulations of resident Canada Geese. The main intent of the SOP was to prevent animal suffering. The described procedures must be performed by veterinarians or individuals who have had training in wildlife handling and management specifically related to humane euthanasia techniques. Appropriate permits must be obtained from Environment Canada and the B.C. MFLNRO. The SOP recommends herding Canada Geese into an enclosed area during the moult period, described as mid-May to late July, then transporting them to a location away from public access to avoid ‘aesthetically displeasing’ the public. Another document, *Best practices for capturing, transporting and caring for relocated Canada Geese*, necessary

for capturing and moving the birds to a location that avoids distressing the public, is available at <http://www.ec.gc.ca/mbc-com/default.asp?lang=en&n=07368A95-1>. It is noteworthy that we have conducted four separate roundups for marking geese in early July, a busy tourism period, with little fanfare.

There have been several methods used for the euthanasia of geese, with no single option that stands out as the best choice. Recommended methods include cervical dislocation with mechanical assistance, and the use of a non-penetrating captive bolt device, the latter delivering a large concussive force, rendering the animal irreversibly unconscious. If not used for food, the carcasses must be buried at an approved site or incinerated at a facility with adequate capacity for the size of depopulation that is performed. All personnel should be comfortable with these tasks and trained to carry out their roles correctly and safely. Alternatively, a mobile poultry processing unit may be used; this method may be more cost-effective, safe and efficient than training new staff (BC MFLNRO 2014).

CWS developed *Best Practices for Killing Birds and Disposing of Carcasses* (CWS 2011b), available at [https://www.ec.gc.ca/Publications/95FAFB79-3856-4752-8309-1F95D0E4101D%5CCOM1425_BP-for-disposing-of-carcasses-\(EN\)march-2012.pdf](https://www.ec.gc.ca/Publications/95FAFB79-3856-4752-8309-1F95D0E4101D%5CCOM1425_BP-for-disposing-of-carcasses-(EN)march-2012.pdf). Gunshots, a carbon dioxide chamber (i.e., inhalant gases), stunning and

decapitation, and commercial poultry processing were preferred methods for killing Canada Geese. If pharmaceutical agents were used to dispatch geese, carcasses must be incinerated or limed and buried; they cannot enter the food chain (CWS 2011b).

Culling in Other Jurisdictions

Large-scale capture and euthanasia of Canada Geese in urban settings first began in the U.S. in 1996 (cf. Maryland Department of Natural Resources n.d.; T. Smith, pers. comm. February 17, 2015), and have since expanded into many jurisdictions. The U.S. Department of Interior’s Fish and Wildlife Service (2005) described culling and delivering the birds to food banks as an efficient and cost-effective way to reduce the size of an urban flock, second only to hunting. It requires a federal permit from the USFWS that documents other control techniques attempted, and their results. Landowners are encouraged to hire USDA Wildlife Services or a state-licensed control company to do the work (Maryland Department of Natural Resources n.d.; USDI 2005).

Roundups and culling have precipitated a generalized mild resistance, and spawned a few well-organized advocacy groups (such as Love Canada Geese, mentioned above) (Eckberg 2010). The provision of birds to food banks, and the airplane crash into the Hudson River in 2009 appear to have tempered opposition to Canada Goose culling in America (cf. Smith, Craven, & Curtis 1999). Huang (2010), who studied the societal acceptance of aggressive



Double-crested Cormorants (*Phalacrocorax auritus*). Photo from Trudy Chatwin.

population control techniques in Connecticut, found that all stakeholder groups surveyed agreed that population reduction was “not only acceptable, but needed” (p. 34); importantly, Huang’s groups did not include the general public. Nineteen towns wanted to reduce populations but found lethal control cost-prohibitive. Five other towns felt that the State should provide grants or conduct roundups and euthanize birds. Two towns rejected culling to avoid polarizing their communities. Huang concluded that there was a general lack of fortitude to implement controversial management techniques in the face of vocal minorities, yet asserted that population reduction through aggressive means was the only long-term solution.

Culling has occurred overseas as well. For example, in New Zealand, the Department of Conservation and Ministry of Agriculture and Forestry granted \$100,000 to set up a moult cull program throughout the country. Up to 18,000 birds were culled on public conservation lands by Federated Farmers, using a variety of site-specific methods (Cogle 2012). This was the latest in a series of culls dating back to 1993 (Spurr & Coleman 2005). At least one of the culls resulted in conflicts with organized groups, such as the Goose Guardians (Win 2001).

Cormorants

While cormorants are not protected by the *Migratory Birds Convention Act*, the culling of ‘hyperabundant’ Double-crested Cormorants (*Phalacrocorax auritus*) on Middle Island in Lake Erie and Ontario’s Point Pelee National Park

provides some valuable lessons. There are also some parallels between Carolinian Canada and east-central Vancouver Island; many ecosystems and species are at the northerly extent of their range. When survey data collected by CWS, Ontario Parks, and nearby universities showed the cormorants were damaging the ecosystems and associated species at risk, Parks Canada invested \$380,000 to implement the Middle Island Conservation Plan (Dobbie 2008). Culling was one of three management approaches, the other two being removal of nests and nest-building material to protect species at risk and discourage nesting around them, and installation of scarecrows to discourage nest building (Dobbie 2008; Parks Canada 2010).

Culling began in 2008 and is expected to carry on through 2015. Prior to hatching, small number of Parks Canada personnel shot cormorants associated with nests in trees using sound-suppressed, small calibre rifles. Carcasses were not removed, to avoid disturbing sensitive flora. Follow-up monitoring and carrying capacity modeling were important aspects of the plan (Dobbie 2008; Parks Canada 2010). According to Cormorant Defenders International (n.d.), less than 250 birds were killed in 2008, 1,600 in 2009, and 3,300 in 2010.

The plan was supported by the local Humane Society and SPCA (Parks Canada 2013). However, Cormorant Defenders International prepared a 93 page document refuting the rationale for the culls, including the term



Barred Owl (*Strix varia*)

‘hyperabundance’ (Kent MacKay & White 2008). The authors argued that there was no evidence that few cormorants existed on the island prior to the 20th century. Shooting was described as cruel, while cervical dislocation was “morally reprehensible” and possibly illegal under the Criminal Code of Canada (pp. 47-50).

Other Avian Species

In 2013, the Province initiated a control program for Barred Owls (*Strix varia*) deemed necessary to protect a handful of remaining pairs of Spotted Owls (*Strix occidentalis*). The Barred Owls had been outcompeting the Spotted Owls, which are federally endangered and provincially red-listed. By the time the program was announced, it had already relocated 73 and authorized the shooting of 39 Barred Owls within a 5 km radius of confirmed

Spotted Owl sightings (CBC 2013). While culls are never popular and this was no exception (cf. Wilderness Committee n.d.), the remainder of the initiative proceeded with little fanfare. (Note: It is beyond the scope of this paper to discuss the myriad examples of animal culls for conservation or other purposes.)

Social License

In this section, I have elaborated on the challenges of obtaining the social license to cull Canada Geese. This is not to suggest that culling is an inappropriate management tool, but to inform managers that, should they choose this option, awareness-building and education will be necessary, and there is always a possibility that no amount of justification will be enough to dissuade activism.

12.5 Renewable Resources

Pioneering farmers raised Canada Geese for food, although they were probably not a preferred species, and for down and as live decoys to lure migrating geese for hunting (cf. University of California 1977). Farmed flocks provided stock for introductions and relocations (see Chapter 1, Background), and it is likely that flocks of live decoys were released after the practice was outlawed in the U.S. in 1935 (USFWS 2002).

Today, domesticated Canada Geese are for sale in the U.S. (see, for example, <http://www.efowl.com/>

Canada_Goslings_p/1080.htm or <http://www.metzerfarms.com/CanadaGeese.cfm?Breed=Canada&BirdType=Goose&ID=CAN&CustID=17075>). Sellers provide non-transferable permits. (Federal legislation prohibits the sale, barter and purchase of wild geese (USFWS 2002)).

Here in B.C., raising Canada Geese without a permit will land you in trouble (CBC News 2012, January 17). Aviculture permits are available, but the birds must be bred in captivity. Conditions of the permit include requirements to control flight through pinioning

and wing clipping, as well as use of pens and facilities maintenance (E. Lok, pers. comm. January 9, 2015).

Yet, there is, or could be, a demand for Canada Goose products. Local farmers were interested in producing goose sausage and in marketing whole birds (survey respondent, 2014).

Down is considered a by-product for poultry farmers, albeit a lucrative one (Downmark n.d.). Hutterites raising geese on the Canadian prairies are renowned for their down, which is derived from mature, free-ranging small flocks (Robertson 2010).



Canada Goose™ apparel cashes in on the iconic bird, without using its down.

Interestingly, clothing manufacturer Canada Goose™, a company that has been in existence for nearly 60 years, uses goose and duck down from Hutterite birds - not Canada Geese, but white domestic varieties. Over the past decade, its sales grew 4000% to \$200 million (Financial Post 2014, October 16).

In the U.S. geese captured within the conterminous U.S. during the summer months can be processed for human consumption and donated to charitable organizations. Feathers cannot be sold (USFWS 2002). Keefe (1996) reported costs of \$18 to \$25 per goose, for capture and processing

for human consumption; these did not include holding captured geese for any length of time prior to processing.

Currently, wild-sourced Canada Geese cannot be raised or sold for human or pet consumption in Canada, nor can culled birds be offered to food banks. Canada Goose feathers are considered wildlife parts, and cannot be sold by anyone other than some First Nation members.

Regulations and policies regarding the use of non-hunted wild game for consumption are discussed in Chapter 4.9, Processing Non-hunted Wild Game for Consumption.

12.6 Compensation

There has only been one program registrant on the mid-island for the B.C. Ministry of Agriculture's Agriculture Wildlife Program, from the community of Hilliers (G. Fowler, pers. comm. January 12, 2015). This is a free compensation program available to qualifying livestock and forage producers for low value livestock forage crops, grown mainly for silage, hay, or pasture (BC Ministry of Agriculture and Lands (MAL) 2008); G. Fowler, pers. comm. January 12, 2015). Damage associated with Canada Geese, and any other waterfowl species, includes plant removal, plant yield reduction (grazing), weed introduction and infill, soil sealing (ponding, reduced drainage), minor excavations (root grubbing), and grit consumption. In the

Hilliers case, waterfowl and ungulate damage were both assessed (G. Fowler, pers. comm. January 12, 2015).

Most wildlife damage to forage grasses occurs over the winter months, and fields must be assessed prior to harvesting or other field activities (e.g., harrowing, manure spreading, aerating, fertilizing) that may mask the damage. Generally, assessments are conducted from February to April, prior to the first cuts in May or June. Later damage may be assessed, but there is generally less damage due to waterfowl migration and the availability of alternative foods (G. Fowler, pers. comm. January 12, 2015).

Silage corn assessments are conducted from June to October,

and are generally based on a single inspection per field. While geese are one of the first animals to damage corn crops, later damage by other animals such as bear, deer, and elk is typically greater (G. Fowler, pers. comm. January 12, 2015).

Damages to crops grown for human consumption are not covered by this program, as these fall under the Crop Insurance/Production insurance program. Crop insurance programs have coverage premiums, production (yield) guarantees, and are delivered on a crop scale, versus an individual field scale. Human food crops are considered to be at greater risk from weather events, disease, and pests (G. Fowler, pers. comm. January 12, 2015).

By contrast, the South Dakota Department of Game, Fish, and Parks instituted a \$250,000 program in 1996 to reduce crop damage by geese. The program was funded by a \$5 surcharge on all hunting licenses. Landowners were given free access to State-led abatement techniques such as egg addling (Dieter & Anderson 2009).

National Wildlife Research Center economists (USDA 2011, November) showed that as resident Canada Goose populations increased, so did the costs associated with damages and control measures. They discovered that for every dollar spent on wildlife damage management programs to control Canada Geese, \$1.31 to \$5.56 could be saved in damage and maintenance costs.

Table 12-3 provides a SWOT (strengths, weaknesses, opportunities, threats) analysis of management techniques discussed in this chapter.

Table 12-3. SWOT analysis of management options

Technique	Strengths	Weaknesses	Opportunities	Threats
egg addling	reduces annual recruitment; lowers re-nesting rates; established program with significant experience and leadership	must continue for many consecutive years; failed nesters may moult-migrate; failed nesters may nest or re-nest in more remote or isolated areas; effectiveness is constrained by availability of manpower, funding over a prolonged period (may be expensive (\$)); limited access to private properties; addling crews difficult to populate due to time of year and physical demands; inexperienced crew members	failed nesters that moult-migrate and linger in more northerly areas may be exposed to greater hunting pressure; access to private properties and successful nest searches may be increased by building awareness, leadership, and training	crews may be exposed to safety and health risks; opponents prevent access to properties or harass crew members
hunting	increases mortality rates; four seasons and increased bag and possession limits have precipitated greater harvests in management unit 1-5	some geese confine their movements to non-huntable sites; season designed to target local resident geese; exclusivity and costs of hunting clubs may prevent new and lower income hunters from hunting geese, reducing hunter numbers overall; farmers reluctant to open properties to hunting because of stress to farm animals	temporarily open areas to hunting or encourage landowners to allow hunting; promote goose hunting to encourage people to hunt, or hunt more often; encourage hunting in jurisdictions where our marked birds were shot; reduce hunting restrictions; move geese into huntable areas	hunting moves survivors into non-huntable areas, including vulnerable estuaries; hunting opponents and NIMBYism vilify hunters and discourage landowners from allowing access; perceived safety issues prevent hunting in estuaries and peri-urban settings

Technique	Strengths	Weaknesses	Opportunities	Threats
use of permits by landowners	addling reduces reproductive outputs, use of kill permits increases mortality rates	scare permits move birds to other areas; some are unable to addle or dislike doing it; some cannot implement a kill permit without help	assist people who don't know how to access or use permits; reduce or eliminate processing times; connect potential permit-holders with addling crews and hunters to implement them	processing times are prohibitive
no feeding policies or bylaws	feeding may sustain more geese than would be supported by natural food resources, injure people, or cause debilitating conditions in geese (e.g., Angel Wing)	require enforcement, which may be time-consuming and \$	introducing feeding bylaws and/or policies may help raise awareness of the problem of local overabundance	
barriers	prevent geese from landing or taking flight, restrict movement when flightless, cause them to feel vulnerable by blocking escape routes and lines of sight	no effect on population size; may be expensive (\$), may block waterfront views or be unsightly	natural barriers may have multiple benefits (e.g., as habitat for other species, flood protection)	goose unfriendly habitats may be detrimental or hazardous to other species (e.g., bamboo stakes may prevent access by other waterfowl, grid lines may entangle)
drainage	reduces features that attract geese	no effect on population size; reduces seasonal or permanent wetlands, which are rare and have many important values; \$		goose unfriendly habitats may be detrimental or hazardous to other species (e.g., other species that use the wetlands)

Technique	Strengths	Weaknesses	Opportunities	Threats
inaccessible or unpalatable food sources	discourage geese from feeding	no effect on population size; some solutions may be temporary (e.g., new turf); \$	altering the timing of harvests may provide additional benefits to farmers	goose unfriendly habitats may be detrimental or hazardous to other species; some chemical deterrents may be toxic or carcinogenic to humans, also; some alternative plantings suggested in the literature are invasive plants
removing domestic waterfowl	prevents concentrations of mixed domestic and wild fowl, known to spread diseases			
bait and lure crops	draw geese away from sensitive habitats and other sites where they are unwanted	effectiveness limited by the availability and quality of alternate food resources; attract other species and predators	may also be used to round up geese for banding, relocation, or extermination	without regular cleaning, bait pads may cause illness; bait and lure crops concentrate animals, making them more vulnerable to pathogens and parasites
hazing with dogs	scares geese from patrolled areas; canine programs have been successful in our area and other jurisdictions	moves birds to other areas; dogs not allowed on the PQBWMA during March and April and now have to be controlled at all times; bureaucratic gridlocks (e.g., for schools); requires willing trainers and dogs; \$	hazing may move geese into areas where hunting can occur or kill permits may be used	hazing activities may be detrimental or hazardous to other species (e.g., dogs may chase Brant); dogs may become ill from contact with goose feces; geese may move to areas where they cause significant damage; nesting or flightless birds cannot travel very quickly or very far, and may be injured by dogs

Technique	Strengths	Weaknesses	Opportunities	Threats
hazing with raptors	scares geese from patrolled areas	less effective than dogs per unit area; \$; raptors are not permitted to injure or kill geese but have the instinct to do so	hazing may move geese into areas where hunting can occur or kill permits may be used	goose unfriendly habitats may be detrimental or hazardous to other species; geese may move to areas where they cause significant damage
hazing with equipment (e.g., vehicles, predator decoys and calls, lasers, reflective tape, alarms and alert calls, cracker shells, propane cannons, drones, etc.)	scares geese from targeted areas, at least temporarily	geese readily habituate to some hazing techniques; certain geese may remain faithful to a site, returning again and again; techniques may work on one site but not another; may be time-consuming and \$; may upset people and pets	hazing may move geese into areas where hunting can occur or kill permits may be used	goose unfriendly habitats may be detrimental or hazardous to other species; geese may move to areas where they cause significant damage; some techniques may be unsafe, illegal, or unacceptable to the public in certain contexts
adult sterilization (i.e., oral contraceptives, gander vasectomies)	gander vasectomies prevent offspring from the mated pair	oral contraceptives must be added to bait and consumed every day for 21 days prior to nesting and throughout the nesting period, and its effects wear off in a few weeks; vasectomy involves capture and surgery, and only affects one female per gander		bait pads require regular cleaning to prevent illness; bait pads on the nesting grounds may attract predators and non-target species

Technique	Strengths	Weaknesses	Opportunities	Threats
culling	decreases a goose population, eliminating the need for many costly and labour-intensive efforts; when applied to a large number of birds at one time, the effects are obvious and immediate; fewer risks that survivors will return or cause problems elsewhere	logistics (e.g., capture, transport, killing, and disposal) are often challenging; \$	generates ethical discussions centred on humaneness and justice; carcasses may be used for food; sound-suppressed, small-calibre firearms may be safely used by experienced shooters on a well-defined site within a specific time period (see Cormorants)	repopulation is likely to occur, as moult-migrants return to nest, and as nearby populations grow and suitable habitats remain available; there may be considerable opposition, or a small but vocal one; safety issues if firearms are used in areas typically closed to hunting
renewable resources			demands for goose products (e.g., meat, down); new regulations for First Nations	
compensation	pays farmers for damage to forage crops	other field activities may mask damage; damage to crops grown for human consumption are covered by crop insurance programs, which are administered differently and require premiums	a portion of hunting license fees may be used to fund compensation programs (and restoration efforts on estuaries and other damaged sites); wildlife damage management programs may save damage and maintenance costs	

Chapter 13 - Carrying Capacity Highlights

This chapter discusses the concept of carrying capacity and its usefulness in setting limits or targets for goose populations. It contributes to Goal 5, integrating population, temporal, and spatial information and objectives into a strategic direction to inform management planning for the region.

Carrying capacity is often defined as the size of the population that can be sustained without degrading the health of the animal or its environment. It suggests there is an ideal number of animals, below which no damage would occur. It assumes that the environment establishes a limit to the growth of populations, and that populations grow until they stabilize at the limit. In practice, carrying capacity is very difficult to assess. Out of 342 sites identified as available goose habitat, geese were observed on only 232 of them, and flocks were frequently concentrated on only a handful of sites. Although mid-island estuarine marshes have been unable to sustain goose populations without degradation, it is unlikely that Canada Geese have exceeded the carrying capacity of the region, or that ecological factors will soon constrain the growth of goose populations.

We have likely exceeded our social carrying capacity for Canada Geese, as populations have adversely affected the tourism and agricultural sectors, sports and recreation, and the overall quality of life of community members.

Alternative measures to carrying capacity, such as Limits of Acceptable Change, Limits for Defining Change in Ecological Character, and Thresholds of Potential Concern, have been used in other jurisdictions to assess various environmental conditions and socioeconomic tolerance for change. These hold some promise for managing locally overabundant Canada Geese and affected resources or assets.

Citations, excluded here for brevity, can be found in the text of the document's chapters. Please do not cite highlights without consulting the chapters.

13.1 Biological Carrying Capacity



Canada Geese on the lower Little Qualicum River estuary (upper) where tall sedges growing on a thick marsh platform have been replaced by Sea Milkwort (*Glaux maritima*) and algae over gravelly substrates (lower).

Some have suggested that the degradation of the marshes has occurred because the number of geese have exceeded the carrying capacity of the estuaries or the region, and recovery will require reducing populations to a capacity that these areas can support (e.g., Dawe & Stewart 2010; Dawe et al. 2011).

Carrying capacity is often defined as the size of the population that can be sustained without degrading the health of the animal or its environment (Wagar 1964 in Cole & Stankey 1997; Cole & Stankey 1997; Freedman 2004). Yet, it is an elusive concept (Price 1999). Do populations grow to carrying capacity, or far beyond them? How are the boundaries of this environment identified? What indicators and thresholds are used to establish that the health of the population or the environment is diminishing? When the population is distributed over several types of habitats, on what basis is carrying capacity determined? Social factors such as family sizes or age structure of the population influence distribution and abundance, so what effect do they have on carrying capacity?

There is inherent complexity in identifying constraints on populations, and how these constraints operate (Price 1999). Every population is restricted in its growth potential by a range of conditions, such as the food supply, competition, predation, disease, parasites, and environmental variability, as well as by the dynamic interactions of these factors (Williams et al. 2001; del

Monte-Luna et al. 2004). What conditions are limiting our regional population or subpopulations, and how resilient are they to shifts in these conditions?

There are two major assumptions underlying the concept of carrying capacity: that the environment establishes a limit to the growth of populations, and that populations grow until they stabilize at the limit (Price 1999).

Canada Geese are 'leveling species', meaning that population sizes and densities tend to fluctuate within narrow limits but are otherwise relatively stable (Perrins & Birkhead 1983; Price 1999). Occasionally, leveling species grow wildly, such as when they are introduced into habitats with a vast abundance of resources but few predators or parasites. In these cases, populations tend to grow until resources are exhausted, causing them to crash (Price 1999).

Quebec's Greater Snow Goose Management Round Table reported, "these species [i.e., overabundant Greater Snow Geese] are not subject to nature's regulation; that is, their populations are not controlled by the carrying capacity of their environment, by competition or predators, or by the impact of human activities such as hunting or habitat encroachment" (Anonymous, 2013, p. 1). Truth or rant, this could also apply to Canada Geese.

It is also questionable whether the local environment establishes a limit to the growth of goose populations.

In their study of the carrying capacity of marshes for moulting geese in Greenland, Madsen et al. (2011) directly linked the condition of the marshes to carrying capacity, and certainly, few ungrazed areas and the loss of the marsh platforms are evidence of excessive numbers of geese on our estuaries. It is possible that the number of birds the area can support is limited by the condition of the estuarine marshes. These marshes are used year-round, and the greatest numbers of geese coincide with the highest levels of primary productivity on the estuaries, i.e., during the moult. Most upland sites are vacant at this time.

In a study of freshwater wetlands in Ohio, Brasher, Steckel, and Gates (2007) found that energetic carrying capacity for waterfowl declined each year by more than 80% between autumn and spring migration, a direct result of granivory (i.e., feeding on seeds and grains) and vegetative decomposition. While we have not investigated precisely when most grubbing of marsh platforms occurs, we expect the overwintering and spring migration periods are key times. Estuarine marshes are critical habitats when other areas are frozen.

Carrying capacity may be more broadly limited by the availability of freshwater, which in our area is restricted to select streams, springs along the foreshore, freshwater marshes, lakes, ponds, and estuaries. Although we have not classified estuaries as a freshwater habitat, they are of course linked to streams and also

have a freshwater lens on their surface that diminishes towards the marine environment. Canada Geese need freshwater for drinking and depend on these habitats for critical life stages, such as nesting and moulting. Barker, Cumming, and Darveau (2014) found that the abundance and distribution of most waterfowl species can be predicted most frequently by hydrological variables.

Yet, outside of the moulting period, our estuarine sites are part of larger 'habitat complexes' that include nearby meadows or lawns. Rarely are most suitable sites occupied or all available food eaten. Out of 342 sites identified as available goose habitat, geese were observed on only 232 of them. Flocks were frequently concentrated on a relative handful of sites. Sometimes geese were clustered on one site, but avoided a nearly identical site nearby, for no apparent reason. With an abundance of vacant potential habitat, it is unlikely that we are nearing a regional carrying capacity. Similarly, despite known problems with Canada Geese and a harvest surplus in excess of 20%, Puget Sound was declared to be well below carrying capacity (USDA 1999).

And, if carrying capacity were linked to estuarine ecosystems, the poor condition of the marshes should be suppressing carrying capacity, yet there is some evidence to the contrary, i.e., decreasing numbers of nests at the LQRE which is rehabilitating, and increasing numbers at the ERE where restoration is solely

needed. (Keep in mind that numbers of nesting birds at the LQRE are probably dropping due to the effect of addling, more than the condition of the estuary.)

To determine whether the condition of estuarine marshes is limiting or even influencing carrying capacity, we would need to track geese 24/7 using telemetry, calculate how much time they spend in each habitat, and analyze and compare the composition and nutritive quality of the vegetative resources in each habitat.

Additionally, the notion that reducing populations below a specific number will solve our problems, is ripe with complexity. If the 'too many geese' problem is related to 'too much goose habitat', then we may in fact need to significantly reduce the carrying capacity of non-estuarine habitats to revive estuarine ecosystems - by modifying grassy and ponded areas, altering farm practices, and implementing other control techniques. Yet there is a risk that reducing habitat elsewhere may inadvertently increase use of the estuaries.

Price (1999) noted, "carrying capacity is supposed to be a natural limit that regulates the growth of populations, but its existence is hard to document apart from its presumed effect (p. 18). Less complex, but not uncomplicated, is the concept of social carrying capacity.

13.2 Social Carrying Capacity



Canada Goose in Parksville Community Park

In most Canada Goose management strategies and plans, population targets are based on social carrying capacity, not biological carrying capacity. This is sometimes called 'wildlife acceptance capacity' or 'cultural carrying capacity', and is the maximum population that is acceptable to people (USDA 2004). Here, it is clear that Canada Geese have adversely impacted our communities in many ways, affecting the tourism and agricultural sectors, sports and recreation, and the overall quality

of life of community members. With tourists saying they'll never return because of the prevalence of goose feces; locals refusing to swim, walk and golf in favourite areas; and potential risks to the health of children and the elderly, it is clear that local goose populations have reached intolerable levels. Some of the more vociferous community members have stated that the geese are invasive and populations should be reduced to zero. We have likely exceeded our social carrying capacity for Canada Geese.

13.3 Alternatives to Carrying Capacity

Disagreement over the concept of carrying capacity engendered the Limits of Acceptable Change (LAC) and other measures that may be useful in assessing environmental conditions and the socioeconomic tolerance for Canada Geese. Developed by the U.S. Forest Service in 1985 (Cole & Stankey 1997), the LAC assessment was founded on the notion that capacity is a relative concept rather than an absolute number (Ashor 1985). LAC were designed as compromises, to balance conflicting recreation and wilderness protection mandates (Brunson 1997). As such, the assessment involved determining which conflicting goal would ultimately constrain another, identifying standards - absolute limits defining minimally acceptable conditions (not desired conditions or unacceptable conditions), monitoring to determine whether the standards

have been met, and developing appropriate management prescriptions for when the standards are not met (Cole & Stankey 1997).

Using LAC, Canada Geese would be managed in accordance with limits set for the region's estuaries, farms, community parks, school grounds, golf courses, and so on. The extent of Lyngbye's Sedge - Herbaceous Vegetation community, diversity and abundance of dabbling ducks, and the duration juvenile salmonids are in the estuary are some indicators that may be considered for mid-island estuaries. In wilderness situations, 'acceptable' future conditions are typically those within the natural historic or pre-settlement range of variability, whereas non-wilderness situations tend to require a new kind of sustainable condition (Brunson 1997). Ideally, LAC for sedge

communities would reflect vegetative conditions known to exist in the 1970s (Dawe & Lang 1980; Kennedy 1982; Dawe & White 1982, 1986), prior to the first records of breeding geese. However, it may be necessary to contemplate a new sustainable condition, considering losses to marsh platform, climate change, and other conditions that are irreversible in the short-term.

In 2012, LAC were redefined for Ramsar-designated wetlands as 'Limits for Defining Change in Ecological Character' (LDCEC). Article 3.2 of the Ramsar Convention requires countries to monitor and report if the ecological character of a Ramsar wetland has changed; LAC/LDCEC have been used by several countries for notification and to trigger additional higher-level management (Ramsar 2012; Rogers et al. 2013). An Australian

example is available at <http://www.environment.gov.au/system/files/resources/0c0185c8-8e0b-4194-a6ca-d0f795bef410/files/21-eed-ch-4-5.pdf>. (See also Table 13-1)

Table 13-1. Examples of Limits of Acceptable Change for Gippsland Lakes Ramsar Site, Australia (Australian Department of Sustainability, Environment, Water, Population and Communities 2010).

Indicator for critical component/ process/service for the LAC	Relevant timescale	Limits of acceptable change	Spatial scale/ temporal scale of measurements	Underpinning baseline data
Abundance and diversity of waterbirds	Medium Term	The absence of any of the following species in five successive years will represent a change in character: [list of species]. (one of several criteria)	Sampling to be undertaken at least twice a year (during summer) at stations containing favourable habitat.	Records for these species are reliable. Birds Australia and Department of Sustainability data can be used to assess this qualitative LAC.
Marine sub-tidal aquatic beds	Long Term	Total seagrass extent will not decline by greater than 50% of the baseline value of Roob and Ball 1997 (i.e., 50% of 4,330 ha) in two successive decades at a whole of site scale. (one of several criteria)	Sampling to occur at least twice within the decade under consideration. Baseline mapping against which this LAC can be tested is within Roob and Ball 1997.	Recent quantitative data describes seagrass condition at various sites but over a limited timeframe. There is no available seagrass condition data prior to listing.

A similar assessment, 'Thresholds of Potential Concern' (TPC) was used in a South African national park to manage invasive plants (Southwestlearning.org n.d.). TPC are based on the premise that ecosystems are in perpetual flux, and that the eradication of all invasive or problem species is neither feasible or practical. TPC define the envelope of conditions within which desirable ecosystem states may fluctuate (Southwestlearning.org n.d.). Rates of movement towards or away from thresholds indicate how the ecosystem is tracking, and provides a measure of its resilience (Rogers et al. 2013). TPC for Kruger National Park in South Africa are shown at http://www.southwestlearning.org/download_product/812/0 (See Table 13-2 for an example).

Table 13-2. An example of Limits of Acceptable Change for Kruger National Park, South Africa (Whyte et al. 1999 in Southwestlearning.org n.d.).

Criterion	Measure	Within-zone TPC	Whole-park TPC
Erosion/piosphere	Bare ground index	When affected area > unaffected area (i.e., index > 50%) or when affected area < 5% (latter to guarantee some eroded habitat in any zone)	When aggregated whole-park bare ground index less than 2.5% or > 25%.

More recently, LAC were used in concert with TPC to assess wetland condition and vulnerability in Australia. (Rogers et al. 2013). Compared to LAC, TPC trigger management intervention at a finer scale. Roger et al. (2013) identified 4 ecological values with which to set LAC: vital habitat, representativeness, distinctiveness, and diversity (See Table 13-3 for an example). Indicators included integral vegetative communities, certain threatened and endangered species, species representing different guilds of waterbirds, and specialist fish species, among others. TPC were derived from the status of the asset under management and known threats to the condition of the asset (See Table 13-4 for an example). A 'red-amber-green' choropleth map was produced and scored to show the status of each indicator - red meaning the threshold had been crossed (Rogers et al. 2013).

Table 13-3. An example of Limits of Acceptable Change for Lowbidgee wetlands, Australia (Rogers et al. 2013).

Value	Component or process	Limit of acceptable change
Diversity	Supports extensive area and diversity of wetland habitat including Black Box woodland, lignum shrubland and spike rush	Reduction in extent of Black Box woodland and lignum shrubland by 20% each, reduction in extent of spike rush by 20% (measured post-flood against previous post-flood benchmarks)

Table 13-4. An example of thresholds of potential concern for Lowbidgee wetlands, Australia (Rogers et al. 2013).

Selected value/ component	Threat/condition indicator	Threshold of potential concern	Goal
Diversity/Black Box woodland, lignum shrubland and tall spike rush	Clearance of Black Box woodland, lignum shrubland and spike rush	Any loss to clearance of Black Box woodland, lignum shrubland, and spike rush	Restoration of Black Box woodland, lignum shrubland and spike rush

Chapter 14 - Strategic Direction Highlights

This chapter provides recommendations for management with abridged supporting rationale. It outlines general responsibilities and timelines, as well as deliverables, targets or indicators specific to each objective or action item.

14.1 Responsibilities

Primary Objective:

1. Urge CWS to lead a regional working group that adequately funds Canada Goose management plans and action items.

A key question is, who is responsible for goose management? Responsible managers will commit sufficient resources to implement long-term solutions, as failing to do so will inevitably result in reversing the successes gained through the addling program and other initiatives.

Managers include those who have regulatory responsibility for Canada Geese, i.e., CWS and MFLNRO, as well as landowners and land managers. As the problem of local overabundance stems from introductions or relocations of geese from other areas already experiencing adverse impacts, the agencies that initiated and implemented these hold most of the responsibility for damages today. Responsibility also rests on the non-profit organizations that urged governments to move geese to sites on Vancouver Island, although volunteers and lobbyists are mostly unaccountable. Several municipal leaders and others have suggested a class action lawsuit be launched to require senior governments to take action and to pay for damages caused by excessive numbers of geese. In the U.S., federal and state governments have led and implemented culling initiatives, enabled provision of geese to food banks, and paid for agricultural damages, among other things. Both leadership and just compensation packages should be contemplated by senior governments here. Nonetheless, community leaders and their staff have effectively created urban

meccas for Canada Geese, with grassy areas juxtaposed with settling ponds and beaches. The City and school district administrators have refrained from taking bold steps to keep geese out of play areas.

Ideally, CWS and MFLNRO will lead a regional working group in MABR that dedicates and pools senior and local government resources and leverages monies from other stakeholders (e.g., estuary property landowners and land managers, golf course managers, farmers) to address the full breadth of problems caused by geese. In other B.C. jurisdictions, local governments, non-profit organizations, and other stakeholders are leading localized or piecemeal initiatives, whereas geese are not constricted by jurisdictional boundaries. Senior government leadership of multiple regional groups will allow for cohesive, seamless management efforts, as committed staff familiar with goose impacts, management options and their responses minimize trial and error initiatives and polarization within communities.



Captive geese at the Englishman River estuary, July 2010.

14.2 Population Objectives

14.21 Population Abundance

Although we have learned a great deal about the abundance of our regional Canada Goose population and subpopulations, there is more work to do before we can develop accurate model projections. Collectively, the multiple datasets examined in this study exhibited weak (i.e., statistically insignificant) and sometimes conflicting population trends. The lack of a clear linear trend was attributed to a number of factors, such as shifting spatial coverage and survey effort, an insufficient period of data collection, and a poor understanding of other contributing factors. The Coastal Waterbirds Survey and Christmas Bird Count, external datasets produced by volunteers, showed weakly increasing or possibly cyclic trends. In the absence of a statistically significant weight of evidence, we cannot report that Canada Geese in the region are increasing or decreasing at a given rate.

In recent years, the size of our regional overwintering population has remained relatively static, showing no statistically significant inter-annual differences since 2011. The total number of Canada Geese observed during routine population surveys in the overwintering season ranged from 992 to 1,285 in 2012 and 2013, respectively. However, a winter count in 2014 documented just over 1,500 geese. While the peak observed

during the winter of 2005-06 (2,061 geese) remains unrivaled, this higher-than-usual winter count may be of management concern. Only continued population monitoring can determine whether this crest represents a new trend upwards, a peak in a recurring cycle, or a standalone high. In 2014, moulting populations were also high, reaching nearly 1,200 birds during routine population counts, and more than 1,500 birds during the moult count when the southeast shoreline of Nanoose Bay was included. Notably, Canada Goose surveys in January and July each year provide the best snapshot of the overall size of our regional population and its effect on specific sites.

The highest count for geese in the nesting season was 446 in 2013, based on routine population counts conducted over only two years. (Routine population counts during the nesting season were only conducted for 2012 and 2013.) This value probably represents the bulk of the breeding and non-breeding local resident population. However, it neglects undetected nesting birds and moult out-migrants. Should addling crews consistently survey both breeding and non-breeding geese on and near the nesting grounds, a trend for local resident populations might emerge.

In recent years, our breeding subpopulations have fluctuated

in different directions, likely contributing to the lack of an overall population trend. At the LQRE, the number of nests have declined, and densities of birds during the moulting period have remained flat. At the ERE, densities of moulting birds have increased. At the ERE and NBE, nest numbers have also increased. This suggests that we are, in the main, losing ground. For those who have partaken in the struggle to reduce Canada Goose populations, it is important to remember that twelve years of egg addling have prevented at least 2,088 birds from becoming breeding adults. Given an average clutch size of 5.8 eggs, the addling program has prevented more than 6,000 additional eggs *per year*. (This assumes that half the birds are female, and that they nest locally. Many factors are disregarded in the calculation, such as mortality rates, immigration/emigration etc., as described in Chapter 10.3, Life History by the Numbers.

14.22 Population Structure

One of the most important findings of our study was to discover that moulting birds were not necessarily 'resident', i.e., they encompassed a variety of migrant types, including visitors from the U.S. and Alberta, and from other parts of Vancouver Island and the Lower Mainland. Despite strong site fidelity, Canada Geese are on the

move, whether due to climate change, habitat preferences and availability, or some other force. Due to these voluntary movements, and forced movements through translocations, a local flock of Canada Geese at nearly any time of year probably represents a genetic fusion of North American subspecies. Even the purity of the red-listed Dusky Canada Goose is in question; it was introduced to Washington in the 1950s, and populations there are now considered to be of three types: migrants, residents, and hybrids.

Currently, CWS sets regional (i.e., province-wide) population objectives for temperate-breeding Canada Geese, meaning that the same objectives apply to Canada Geese across B.C. Population objectives are the same for areas that have always supported breeding geese and those that have not. They are the same whether management units have 2000 hunters or 200. Population objectives should be based on the capability of habitats to support them. Consideration should also be given to sociocultural limitations, such as the number of hunters or monies available to control overpopulations.

Notably, no Dusky Geese were observed in the region during our study. However, Dusky Canada Geese could be protected in Canada where they are known to occur, by requiring hunters to learn to properly identify them, as is the case in

Washington and Oregon. Related to the management of distinct subpopulations is the relevance of B.C. and Canada's participation on the Pacific Flyway Council, a self-proclaimed policy and regulation-setting body. Canada does not recognize or use the Pacific Flyway subspecies for management purposes, nor the subspecies-specific Canada Goose management plans that have been developed. Canadian regulatory definitions and programs are inconsistent with those across the border. Canada's representation on this Council should be clarified or made explicit, and a more thorough integration of Canadian and U.S. policies and regulations considered.

It is surprising to many that Canada Geese have not been formally evaluated for overabundance. CWS biologists have justified this by saying that an overabundance designation would have little effect due to insufficient numbers of hunters and access to hunting areas. Given that 1) resident Canada Geese are designated as 'overly abundant' in parts of the U.S., 2) hunter numbers and goose harvests have risen in several provincial management units in recent years, 3) survey respondents have expressed interest in hunting or allowing hunters access, and 4) the overabundance designation can be applied to geese in some areas while excluding other areas, this evaluation should

proceed. And, it should proceed for temperate-breeding geese only, rather than the entire species.

It is important to apply the lessons learned in the subarctic estuarine marshes. Once goose herbivory was deemed a significant conservation issue, and it was recognized that population sizes and the survival rate of adult goose populations were detrimental to estuarine ecosystems, the *Migratory Bird Regulations* were amended and new tools invoked to help manage overabundant species (CWS Waterfowl Committee 2013). As the additional hunting opportunities afforded the 'overabundant' designation quickly halted the growth of Greater Snow Geese populations, it is plausible that similar efforts would work in concert with egg addling to reduce Canada Goose populations. If the designation, and the tools that accompany it prove insufficient, then the regulations should be amended to invoke new tools, such as bait and capture, and mechanisms that allow for greater use of geese as a renewable resource.

Snow Goose managers have recognized that goose populations have not decreased (only stabilized) since the overabundance measures were invoked, that geese adapt quickly to different management measures, and that new approaches must be considered (Anonymous 2013). We should examine their recommendations, and even consider integrating

Population Objectives:

2. Urge CWS to amend the process to set population objectives for temperate breeding geese.
3. Urge CWS to designate temperate-breeding Canada Geese as overabundant.

certain Snow Goose and temperate Canada Goose management initiatives (e.g., communication platforms) to take advantage of economies of scale (see Anonymous 2013 at http://www.ec.gc.ca/nature/FB11C691-2F04-4E8F-B4BF-88B5441BD6F3/900_SnowGeeseinQuebec2013-2018ActionPlan_e%20-v6%20FINAL-s.pdf).

Coastal estuarine marshes are too rare and valuable to be shortchanged by protecting animals that are common, widespread, and in this case, of a bloodline that was mostly introduced to the region.

14.3 Spatial Objectives

14.31 Distribution

Our study identified a number of Canada Goose hotspots, but none supported greater, year-round numbers than our mid-island estuaries. Across all seasons, population surveys conducted from 2011 through 2014 indicated Canada Goose counts were highest at estuarine sites (i.e., Craig Bay/CCE, LQRE, NBE and ERE sites). The highest year-round densities of geese occurred on sites with freshwater. (Recall that estuarine marshes are also freshwater sites.) Goose densities were also high on City of Parksville sites. These areas deserve focused management attention.

Canada Geese concentrate on the estuaries during the nesting season and for many pre-nesting rituals (e.g., jockeying for nesting territories). During the moult, Canada Geese were found almost exclusively in estuarine, freshwater, and marine habitats. During the fall and winter, geese used estuaries, agricultural fields, and greens/lawns and meadows - particularly those associated with freshwater.

Introduced birds were the catalysts for escalating goose populations, and abundant conservation lands and urban goose habitats promoted residency and entrenched the current population size and distribution. Disturbances from people and dogs, hunting pressure, agricultural practices, weather, and climate change all influence goose mobility, yet site fidelities keep many of them close to home.

Mid-island estuaries, and the LQRE, ERE, and CCE in particular, have borne the brunt of Canada Goose impacts. They require restoration to enhance the functioning of marsh ecosystems and reverse some of the impacts from Canada Geese. This strategy outlines basic restoration needs ahead of a more comprehensive restoration plan. Implementation of Canada Goose management plans are essential to avoid frivolous restoration efforts, and protect remaining sensitive ecosystems from further damage.

Spatial Objectives:

4. Develop management plans that are specific to each management zone.

Spatial Objectives, LQRE:

5. Commit to a long-term egg addling program.
6. Promote hunting.
7. Explore limited, coordinated hunting on the LQRE.
8. Attach transmitters to a subset of LQRE-nesting geese and monitor by satellite telemetry.
9. Encourage farmers to pursue and use kill permits outside of hunting seasons.
10. To maintain existing wetlands, including seasonal wetlands, suggest alternate habitat modifications to farmers and others.
11. Maintain and monitor LQRE exclosures until the estuarine marsh has recovered. Apply experimental restoration techniques as necessary.

14.32 Management Zones

Based on the year-round distributions of LQRE, ERE, and CCE subpopulations, three management zones have been identified.

1. LQRE zone: Includes the LQRE, Town of Qualicum Beach west to Qualicum Bay, parts of French Creek and West and East Errington, south to Sunnymere fields and Hamilton Marsh (Figure 14-1).
2. ERE zone: Includes the ERE and City of Parksville, and parts of French Creek, West and East Errington (Figure 14-2).
3. CCE zone: includes the CCE and Craig Bay, Nanoose Bay, and west Lantzville. The CCE zone overlaps the ERE zone in the ERE, where CCE-banded birds are known to nest, and in east Errington (Figure 14-3).

Little Qualicum River Estuary Zone

As the number of nests on the LQRE have decreased, and all LQRE-banded birds were huntable in our region, this cohort may be managed by egg addling, hunting, and kill permits. A long-term commitment to the egg addling program and a more concerted hunting effort (e.g., incentives to participate in the early autumn and spring hunts) should be considered. Opening the LQRE to hunting, similar to the limited opening on the Somass estuary in Port Alberni, could expedite the reduction of this subpopulation and reduce the costs of egg addling and efforts to encourage and coordinate hunting.

As half of LQRE-banded birds were either emigrants (39% of LQRE

birds) or Vancouver Island migrants (11%), any management plan associated with this cohort should be developed in collaboration with managers in other regions, Comox Valley and Campbell River in particular. To determine whether our addling adversely affects other areas, a sample of Canada Geese nesting on the LQRE should be collared, and preferably fitted with tracking devices, and their movements monitored after they have abandoned their addled eggs. Sex and age should be determined, if possible. Do the geese stay in the region or moult-migrate? How far do they travel? Hunters must be discouraged from taking these birds until sufficient data have been collected. In 2012, the CWS initiated a study of Canada Geese in Toronto, using satellite transmitters to track their movements (Hughes 2012); this effort may be a suitable model to emulate.

To discourage drainage of wetlands, alternative habitat modification measures should be recommended. It may also be necessary to protect wetlands with bylaws and policies, and/or to finance alternate modifications.

Exclosures on the LQRE must be maintained until Canada Goose numbers have decreased and vegetative productivity within and outside of exclosures is similar. Additional planting and large woody debris (LWD) may be required.

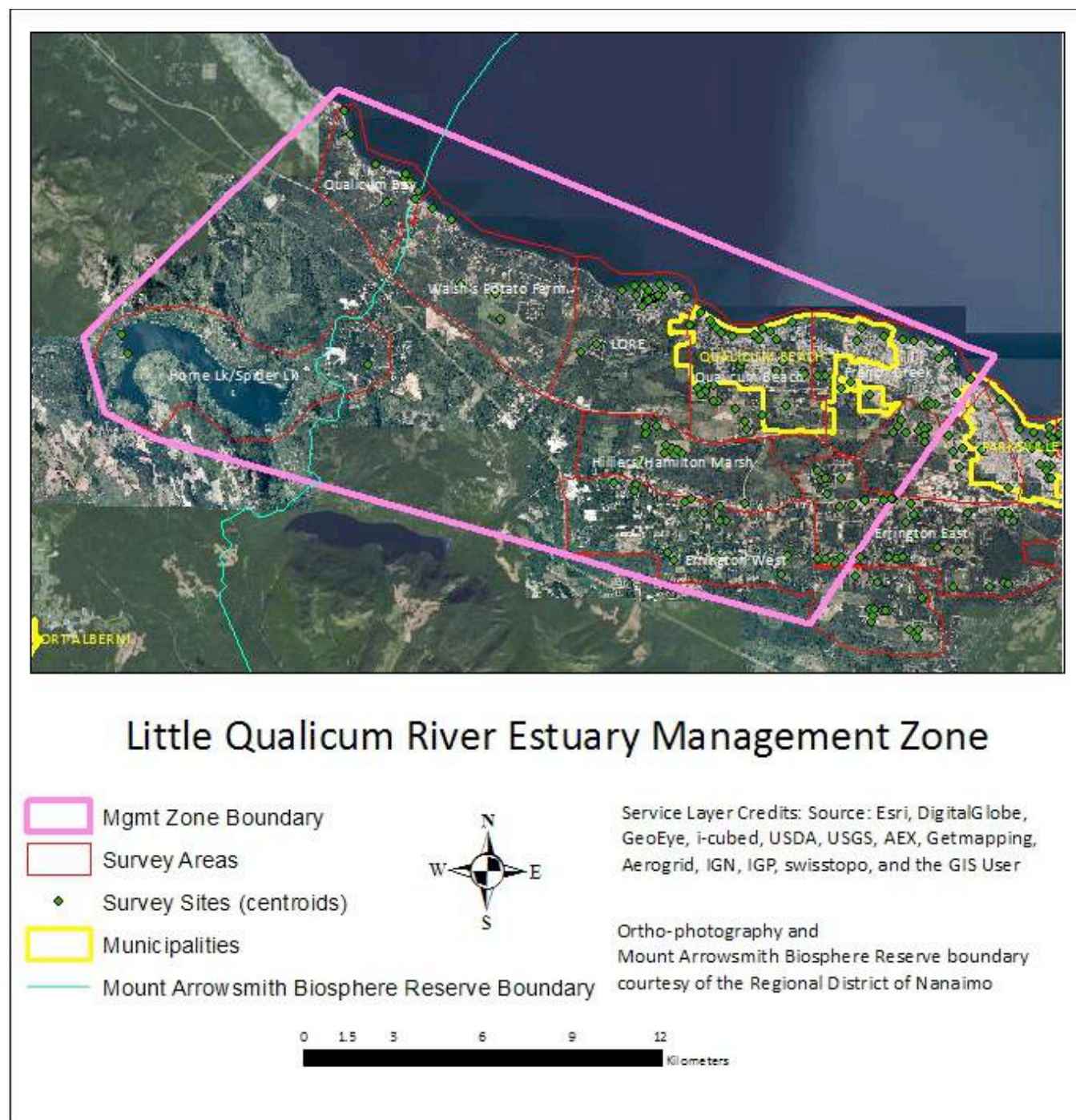


Figure 14-1. Little Qualicum River Estuary Management Zone

Spatial Objectives, ERE:

12. Capture and cull as many birds as possible during the moulting period.
13. As an alternative to culling, organize several large-scale hazing events to push geese into huntable areas.
14. Continue an egg addling program until the population is diminished.
15. Promote techniques to create goose unfriendly habitats and facilitate sharing of experiences and expertise.
16. Reduce exposure of children and seniors to goose feces.
17. Begin restoration of the ERE, using a variety of experimental techniques.

Englishman River Estuary Zone

The number of nests and moulting birds on the ERE have risen in recent years despite increased addling efforts. At least 45% of ERE-banded birds were local residents, and two-thirds of them were not huntable. Most stayed within the City, ERE, CCE and Craig Bay. Therefore, egg addling and hunting are insufficient to slow the growth of this cohort.

A roundup and cull is the most efficient way to decrease this subpopulation, with follow up to manage returning non-breeding geese, moult migrants, and in-migrants. A roundup during the moulting period is easier than attempting to capture geese when they can fly, and will remove resident as well as non-resident nuisance birds.

An alternative to culling is organized hazing into areas where the geese can be hunted. While this may be more acceptable to people, hazing geese from the estuaries and the City into areas that can be hunted will require extensive coordination, and cooperation from city staff, hunting groups, farmers, and other landowners. To achieve a significant reduction in the ERE subpopulation will likely require several such events. It will be challenging to sustain the interest and support needed.

The logistics of both methods are complicated and public acceptance will undoubtedly be contingent upon community members understanding the rationale and follow up for such control measures. If a cull is planned, policy changes to allow

the birds to be used for food will increase public acceptance.

The use of goose unfriendly habitats should be promoted, and expertise shared through workshops or a website. Goose avoidance of the new Parksville Community Parks sports fields should be formally monitored; if the grass-on-sand formula is successful in deterring geese over a period sufficiently long to be cost-effective elsewhere, it should be replicated on all fields used by young children.

Until a large reduction in Parksville's goose population is realized, a greater effort should be made to reduce the exposure of children and senior citizens to goose feces. This may require hazing on school fields, scheduling sporting events for children on the fields at Parksville Community Park, and washing walkways near facilities frequented by seniors, for example.

The ERE is heavily degraded and existing exclosures are doing little to restore it. This estuary requires a variety of bold experimental restoration efforts, such as large woody debris/exclosure structures to protect remaining stands of preferred species, structures to capture and deposit pulses of sediment from the river to rebuild the marsh platform, and planting in denuded areas with sufficient substrate. However, without a substantial decrease in goose numbers, most techniques are doomed to fail.

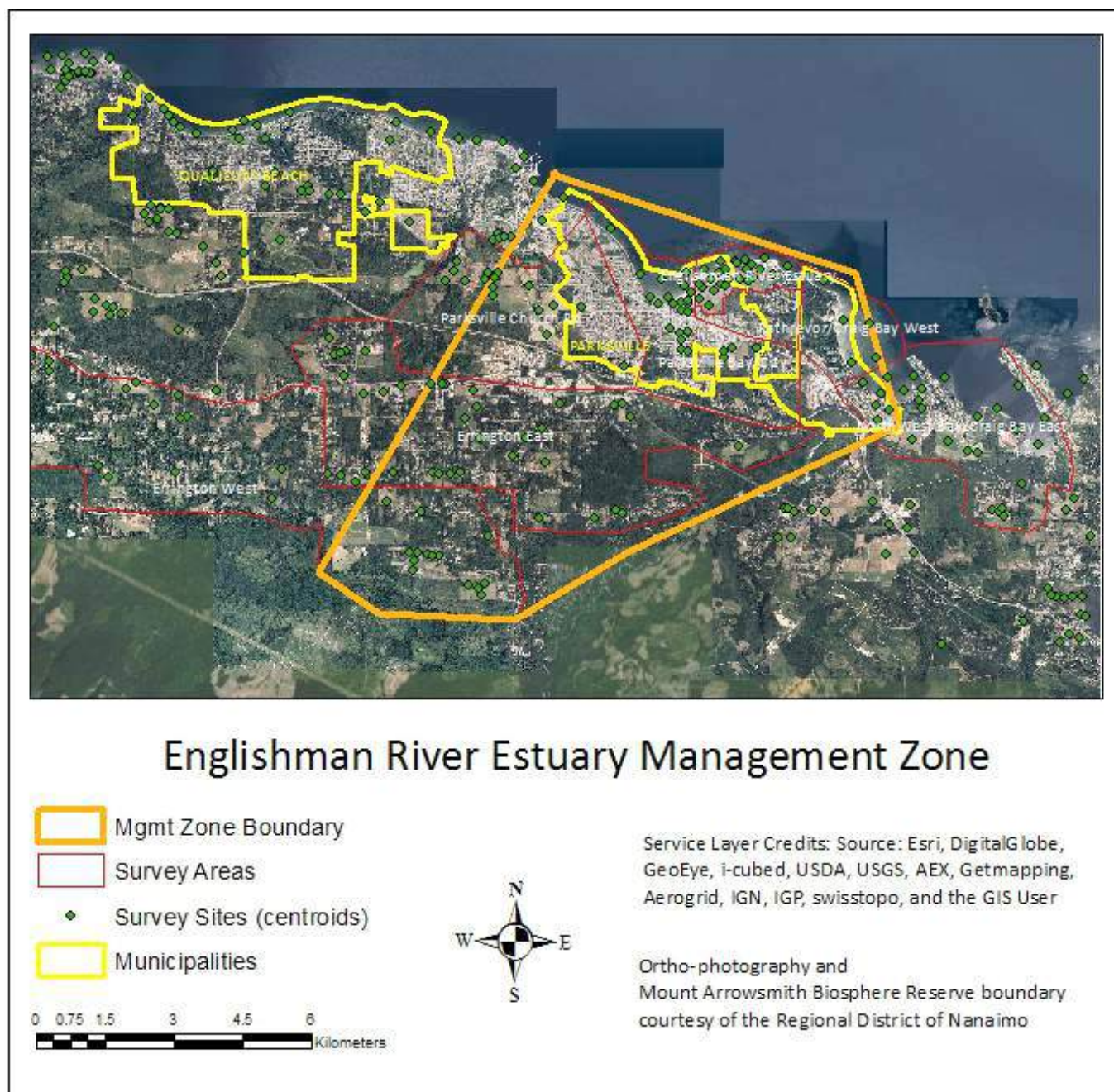


Figure 14-2. Englishman River Estuary Management Zone

Spatial Objectives, CCE:

18. In concert with ERE initiatives, plan a cull during the moulting period.
19. In concert with ERE initiatives, as an alternative to culling, organize hazing events to push geese into hutable areas.
20. Expand the egg addling program to encompass more areas and stakeholders.
21. Promote hunting.
22. Encourage limited, coordinated hunting of Canada Geese on the NBE.
23. Encourage hazing in non-hutable areas during hunting seasons.
24. Encourage affected farmers to pursue kill permits outside of hunting seasons.
25. Promote techniques to create goose unfriendly habitats and facilitate sharing of experiences and expertise.
26. Install goose exclosures on the CCE.

Craig Creek Estuary Zone

Mark-re-sight efforts have shown there is some mixing between CCE and ERE-banded birds, particularly on the estuaries. Fourteen 'T' birds nested on the easternmost part of the ERE, and one was paired with an ERE 'M' bird. Yet, this cohort was more widely distributed than the other two, and much more so than the ERE-banded birds - extending its reach to the NBE and Nanoose Peninsula, and to many farmlands in Nanoose Bay and Errington. It also had the highest proportions of moult migrant (15% of all CCE-banded birds), moult-winter resident (6%), and LR+ (27%) migrant types, suggesting its overall distribution lies beyond MABR boundaries.

Because CCE birds are already nesting on the ERE, culling ERE-banded birds without taking similar action at the CCE would likely result in more CCE birds using spaces vacated by ERE birds and an expansion of this subpopulation. Similarly, hazing to hutable areas would require simultaneous efforts in both jurisdictions. However, a broad distribution suggests that reducing this cohort will require greater diligence over a longer period, and more collaboration with managers outside of the region.

Here, a more comprehensive range of controls is necessary. The addling program should be expanded by enlisting the help of communities to find nests, ensuring the small outer islands are checked, promoting the use of addling permits among farmers, and collaborating with all permittees to

get a more complete picture of nesting CCE birds. Encouraging landowners to allow hunting, promoting hunting as an important means of control, and opening the NBE to hunting for short periods is recommended. Hazing geese out of non-hutable areas during hunting seasons can be encouraged to increase takes. Practices that create goose unfriendly habitats should be promoted, particularly along the periphery of Craig Bay.

The CCE is degrading, with overgrazed and denuded areas and some loss of the marsh platform. Goose exclosures, similar to those constructed at the LQRE and ERE, should be installed on the CCE estuarine marsh to protect remaining vegetation and the marsh platform, and to facilitate restoration of degraded areas.

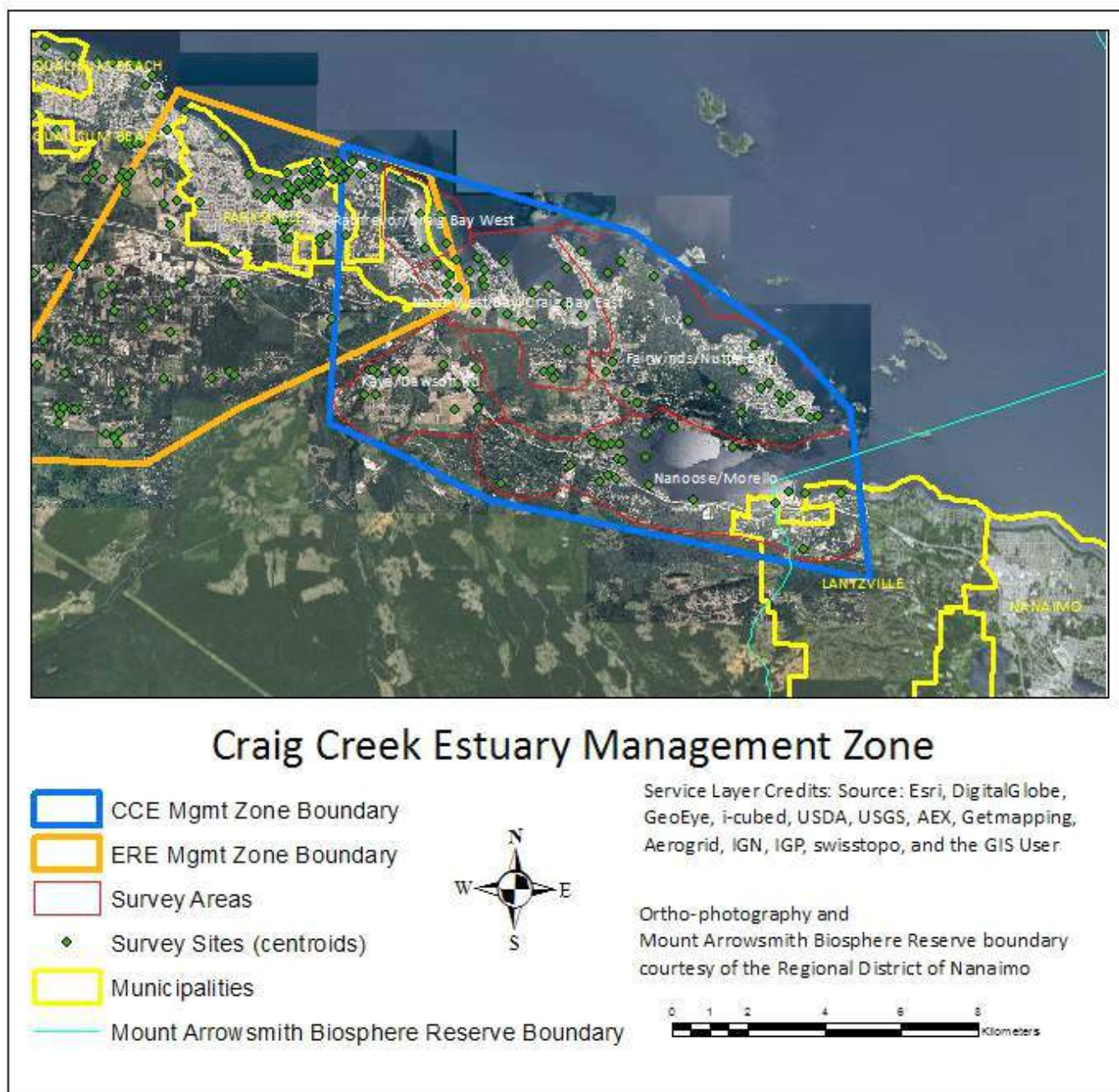


Figure 14-3. Craig Creek Estuary Management Zone

14.4 Temporal Objectives

Temporal Objectives:

27. Protect estuarine marshes year-round, with exclosures, fencing, LWD structures, and hazing until goose populations are substantially diminished.
28. Round up Canada Geese during the moulting period and transfer them to an appropriate farm or culling facility.
29. Capture Canada Geese at their nests for research purposes or to cull them.
30. Organize hunts on the LQRE and NBE during the spring hunting season.
31. Haze birds into huntable areas during the early autumn hunting season.
32. Promote hunting of traditional migrants during regular hunting seasons.

Canada Geese use the estuaries year-round. Marsh damage is a cumulative effect, stemming from large numbers of grazing geese over the summer growing season and moulting period. Overgrazed channel edges cause invertebrates, fish, and other species to seek overstream vegetation elsewhere, if they can find it. Then, outside of the summer months when above-ground vegetation is least available, resident and migratory geese grub the roots and rhizomes, damaging the marsh platform and reducing the area where vegetation can grow. Inputs to the detrital food web are reduced, and overall nutrient cycling is disrupted, affecting local and linked habitats. Channels fill with sediment or are flushed away with the tides. This cycle repeats, year after year.

Most terrestrial habitats, such as urban parks and agricultural fields benefit from an annual reprieve during the moulting season and the peak of the vegetative growing season. Estuaries only experience a reprieve of sorts after the moulting period, when flocks tend to forage elsewhere. Still, they return to roost, and will feed if other areas are exposed to hunting pressure. Large flocks of migrants arrive in the fall, and some stay for the winter. By the time geese begin to nest in the spring, the estuaries have had little time to recover. Therefore, reducing goose populations throughout the year is necessary to prevent further estuarine

damage.

Although we have identified 14 different migrant types, these can be amalgamated into three for management purposes: 1) full and part-time local residents (LR, LR+, MWR, a few M), 2) in-migrants (MM; M that revisit the region, including traditional migrants that stop in the area and move on; RJ; DJ and E that return as they reach breeding age), and 3) out-migrants (DJ, E, and M that do not return).

Management efforts should focus on reducing numbers of migrant types that cause the most damage in the area, namely full and part-time resident Canada Geese and in-migrants, and on preventing them from breeding and otherwise lingering on the estuaries and other areas where they are unwelcome. To target most non-breeding residents and in-migrants, and breeding residents that stay near the nesting grounds, population reduction should occur on the moulting areas. To target other breeding residents and potential offspring, population reduction must occur on the nesting grounds.

Roundups are best accomplished during the moult when birds cannot fly, and other methods, such as hunting and hazing are inappropriate at this time.

LQRE birds captured at the nest may be fitted with marks and/or transmitters and released. Only some birds can be captured at the nest by stealth and salmon

nets; the most aggressive will defend the nest and are easier to capture, while timid birds will fly away. As the less dominant birds are generally the least aggressive and most likely to leave the area after addling, other techniques such as trapping may need to be considered.

Hunting on the LQRE and NBE is best accomplished late in the spring hunting season, to take a

maximum number of breeding geese on their territories. Hazing into hunting areas is best accomplished during the first autumn hunt, when the majority of target birds are still in the area. Later hunts to target large flocks of traditional migrants are also necessary to reduce pressure on agricultural lands and some golf courses.

14.5 Social Objectives

Social Objective:

33. Examine health risks to people, livestock, and pets.
34. Urge senior governments to allow culled geese to be used for food.
35. Develop a communication protocol that includes interaction with other Canada Goose management committees or working groups and naturalist groups.
36. Engage stakeholders and the public regarding goose impacts and control techniques.
37. Urge CWS to make permits for controlling geese easier to obtain.
38. Consult and collaborate with First Nations.

In all management zones, there must be follow-up on the risk assessment commissioned by CWS (see Chapter 5, The Need for Action), to address important knowledge gaps identified by Fraser and Fraser (2010) on behalf of the Canadian Cooperative Wildlife Health Centre. Suggestions included improving traditional water quality indicators, and mitigating risks through fecal waste management and other strategies. They also recommended that the CWS invest in monitoring and research to develop an evidence-based risk assessment, and form a working group to develop national standards for the management of peri-urban goose populations.

While CWS should lead this effort, Island Health and Vancouver Island University could be encouraged to test shorelines near resorts as well as farm ponds, and frequently used terrestrial sites that attract geese (e.g., beach sand, grassy play areas) for harmful concentrations

of bacteria. In addition to helping assess risk to people and livestock, this is important to allay fears regarding the vulnerability of dogs used in hazing programs.

As other non-hunted wild game are consumed in Canada, and non-hunted migratory birds are donated as food in the U.S., it is without merit that senior government legislation and policies require or encourage managers to dispose of edible goose carcasses. CWS' concern that allowing birds killed under permit to be eaten would provide hunting opportunities outside of hunting seasons does not reconcile with the breadth of this problem nor the agency's assertion that there are fewer hunting opportunities due to a dearth of hunters and sites to hunt. An inspection system with standards for wild geese is needed and should be expedited to ease the burden on local governments and others concerned about opposition to managed kills.

Collaboration with other regions is necessary to discover where our part-time local residents are residing at other times of year, where our in-migrants are coming from, how many out-migrants our region is producing and where they are going. Sharing of management techniques and outcomes is also important.

Conversations with stakeholders prior to and during the development of this strategy have indicated the value and importance of meeting community needs, as well as ecological needs, with each management plan. Additional community members should be surveyed to identify other goose-related problems, to quantify damages and spending on controls, and to record attempts to control geese and the challenges and successes associated with those attempts. Impact surveys present a suite of opportunities for goose managers: to raise awareness of previously documented impacts and control techniques, to explore tolerances and attachments to Canada Geese, and to engage concerned citizens in open dialogue regarding the acceptability (e.g., humaneness)

of various methods of control.

Engagement should not end with a management plan. Rather, the management plan should promote ongoing communication. For example, hazing Canada Geese in most circumstances requires care and consideration for the birds and for other people. Given that Canada Geese are affecting conservation lands, urban and suburban areas, agricultural lands, etc., the availability and vulnerability of nearby habitats should always be considered. Hazing efforts should be coordinated with others who may be affected.

Survey respondents and others expressed some frustration over permitting processes to scare and kill geese. Not knowing how to apply for permits, applying too late to manage the processing time, having to provide extensive justification for permits, and trying to cope with permit restrictions (e.g., use of blinds) were some of the problems identified. Given the reports of expensive damage by Canada Geese, and the limitations of compensation programs, farmers require an easier road to controlling geese. Legislators and

farmers alike may benefit from a notification process similar to that used by the provincial government for straightforward changes in and about a stream (i.e., Section 9, *Water Act, 1996* applications) and Fisheries and Oceans Canada's Fish Protection Program. Applications are submitted online, and if the applicant does not hear from the Habitat Officer within a specified number of days, he or she may proceed without further ado.

Consultation and collaboration with First Nations groups and members are both important and valuable in goose management efforts. Canada Geese frequent reserve lands and adjacent estuaries and foreshores, and are likely to be a problem for First Nation communities. As these communities tend to have younger populations, health risks to children from goose feces must be considered. Importantly, First Nations have some latitude to manage geese by virtue of Aboriginal rights and title (e.g., through traditional harvesting rights and contemporary treaty agreements (See Chapter 4, Current Regulatory and Policy Framework)).

Guardians and CWS on the Little Qualicum River estuary, June 2014



Canada Geese are truly a part of Canadian culture. Honking geese during a TV interview in the lead-up to the 2015 federal election drew a spate of Tweets (CBC 2015, September 8). <http://www.cbc.ca/m/news/politics/canada-election-2015-trudeau-interview-geese-tweets-1.3220761>



14.6 Monitoring

Monitoring Objective:

39. Urge CWS to develop a monitoring program for temperate-nesting Canada Geese and a predictive population model encompassing multiple regions and interacting goose (sub)populations.

A standardized monitoring program, with indicators, will help assess the efficacy of management programs, better inform population models and predict future challenges and opportunities. A LAC and/or TPC program should be considered, that links monitoring to models to management actions to monitoring, in a cyclic fashion. In Ontario, the CWS has modeled the provincial temperate-breeding population and is using the results to improve management and monitoring programs (Hughes 2012). A similar program here should encompass all of the interacting goose (sub)populations on Vancouver

Island (and beyond, if necessary). Parts of this management strategy (e.g., 10.3, Life History by the Numbers) and survivorship estimates (from future University of Victoria math students, for example) offer a range of variables suitable for developing a comprehensive population model. When combined with estuarine monitoring, population thresholds can be determined, facilitating long-term management of geese and population numbers and trends that promote marsh rehabilitation. It is important that any monitoring program maintain consistency in its surveys and not rely on volunteers.

14.7 Timelines

This strategy focuses on solutions that provide long-term results, as most repetitive, short-term efforts (such as hazing) will prove largely inconsequential and costly. Although dialogue regarding controversial methods of control is necessary, the USDA (1999) showed that postponing lethal controls leads to substantially greater numbers of

geese being killed at a later date. Canada Goose populations grow, other methods are proven ineffective, and lethal controls are eventually implemented. Objectives should be incorporated into management plans and implemented within a 5-year period, with follow up as necessary.

14.8 Actions

Action items, in the form of management objectives, are prioritized with deliverables, targets, and indicators in Table 14-1.

Table 14-1. Management objectives.

Section	Objectives	Priority	Deliverables	Indicators/Targets
Responsibilities	1. Urge CWS to lead a regional working group that adequately funds Canada Goose management plans and action items.	1	Regional working group, management plans, funding agreements.	Amount of federal and leveraged funding for plans and programs, number of CWS and MFLNRO staff assigned to regional Canada Goose management
Population Objectives	2. Urge the CWS to amend the process to set population objectives for temperate-breeding Canada Geese.	1	Population objectives are set separately for temperate-breeding Canada Geese.	Population objectives are lower for temperate-breeding Canada Geese than objectives for migratory Canada Geese.
Population Objectives	3. Urge the CWS to designate temperate-breeding Canada Geese as overabundant.	1	Temperate-breeding Canada Geese are designated as overabundant.	Hunter use of new opportunities provided by an overabundance designation (survey), increase in numbers of hunters and harvested geese in the 1-5 and 1-6 management zones
Spatial Objectives	4. Develop management plans that are specific to each management zone.	1	Zone-based management plans	Number of management plans developed and implemented
LQRE Zone	5. Commit to a long-term egg addling program.	1	Egg addling program	Funding for program, recruitment is zero on LQRE
LQRE Zone	6. Promote hunting (LQRE zone outside of LQRE).	3	Consultation targeted to hunters, incentives for hunters	Increase in numbers of hunters and harvested geese in 1-5 and 1-6 management zones
LQRE Zone	7. Explore limited, coordinated hunting on the LQRE.	2	At least one hunt on the LQRE	Number of adults using the LQRE is reduced
LQRE Zone	8. Attach transmitters to a subset of LQRE-nesting geese and monitor by satellite telemetry.	3	Non-LR migrant types monitored over the seasons	Funding for satellite telemetry equipment and monitoring program, at least 5 birds tracked over 1+ years

Section	Objectives	Priority	Deliverables	Indicators/Targets
LQRE Zone	9. Encourage affected farmers to pursue and use kill permits outside of hunting seasons.	3	Farmers are protecting crops by controlling geese outside of the hunting season	Number of farmers using permits has increased, number of permits issued has increased
LQRE Zone	10. To maintain existing wetlands, including seasonal wetlands, suggest alternate habitat modifications to farmers and others.	1	Resources developed (e.g., fact sheet or brochure) re importance of wetlands and alternatives to drainage, distribution campaign	All wetlands are protected that were proposed for drainage because of geese, number of people contacted
LQRE Zone	11. Maintain and monitor LQRE exclosures until the estuarine marsh has recovered. Apply experimental restoration techniques as necessary.	1	Guardians maintain exclosures, monitor marsh recovery, and apply experimental restoration techniques such as anchored LWD.	Funding for maintenance and monitoring, vegetation and salinity data collected once every two years
ERE Zone	12. Capture and cull as many birds as possible during the moulting period.	1	At least one cull	Number of adults using the ERE is reduced
ERE Zone	13. As an alternative to culling, organize several large-scale hazing events to push geese into huntable areas.	1	At least one hazing/hunting event	Number of adults using the ERE is reduced
ERE Zone	14. Continue an egg addling program until the population is diminished.	1	Egg addling program	Funding for program, recruitment is zero on ERE
ERE Zone	15. Promote techniques to create goose unfriendly habitats and facilitate sharing of experiences and expertise.	1	Development of resources (e.g., webpages, guidebook), distribution plan (e.g., workshop, mailing list), ongoing sharing of experiences (e.g., dropbox, listserve, coordinator)	Number of goose unfriendly habitats in development, number of goose unfriendly habitats successfully created
ERE Zone	16. Reduce exposure of children and seniors to goose feces.	1	Mitigation plan	Plan developed and implemented, number of children and seniors protected from unnecessary exposure to goose feces

Section	Objectives	Priority	Deliverables	Indicators/Targets
ERE Zone	17. Begin restoration of the ERE, using a variety of experimental techniques.	1	LWD exclosures and sediment traps installed, sedges planted and protected from goose herbivory	Funding for installation, maintenance, and monitoring, number of LWD exclosures installed, species composition and forage height in exclosures in July, depth of sediment captured, occurrence of plants in sediment traps, number of sedges planted, survival of plants
CCE Zone	18. In concert with ERE initiatives, plan a cull during the moulting period.	1	see Objective 12	see Objective 12
CCE Zone	19. In concert with ERE initiatives, as an alternative to culling, organize hazing events to push geese into huntable areas.	1	see Objective 13	see Objective 13
CCE Zone	20: Expand the egg addling program to encompass more areas and stakeholders.	1	Egg addling program	Funding for program, recruitment is zero on NBE, numbers of nests found and eggs addled, number of goslings observed reduced
CCE Zone	21: Promote hunting.	2	Consultation targeted to hunters, incentives for hunters	Increase in numbers of hunters and harvested geese in the 1-5 management zone
CCE Zone	22. Encourage limited, coordinated hunting of Canada Geese on the NBE.	2	At least one hunt on the NBE	Number of adults using the NBE is reduced
CCE Zone	23: Encourage hazing in non-huntable areas during hunting seasons.	2	Hazing program during hunting seasons	Number of hazing initiatives during hunting seasons, increase in harvested geese in the 1-5 management zone
CCE Zone	24. Encourage affected farmers to pursue kill permits outside of hunting seasons.	3	See Objective 9	See Objective 9

Section	Objectives	Priority	Deliverables	Indicators/Targets
CCE Zone	25. Promote techniques to create goose unfriendly habitats and enable sharing of expertise.	1	See Objective 15	See Objective 15
CCE Zone	26: Install goose exclosures on the CCE.	1	Guardians install exclosures and monitor marsh recovery	Funding for installation, maintenance and monitoring, vegetation and salinity data collected once every year
Temporal Objectives	27. Protect estuarine marshes year-round, with exclosures, fencing, LWD structures, and hazing until goose populations are substantially diminished.	1	See Objectives 11, 17, and 26	See Objectives 11, 17, and 26
Temporal Objectives	28. Round up Canada Geese during the moulting period and transfer them to an appropriate farm or culling facility	1	See Objective 12	See Objective 12
Temporal Objectives	29. Capture Canada Geese at their nests for research purposes or to cull them.	1	See Objective 12	See Objective 12
Temporal Objectives	30. Organize hunts on the LQRE and NBE during the spring hunting season.	2	See Objectives 7, 22	See Objectives 7, 22
Temporal Objectives	31. Haze birds into huntable areas during the early autumn hunting season (all zones, with focus on CCE zone).	2	See Objectives 23	See Objective 23
Temporal Objectives	32. Promote hunting of traditional migrants during regular hunting seasons (LQRE and CCE zones, with focus on CCE zone).	3	Consultation targeted to hunters, incentives for hunters	Increase in numbers of hunters and harvested geese in the 1-5 and 1-6 management zones
Social Objectives	33. Examine health risks to people, livestock, and pets (all zones).	1	Standardized testing of beaches, ponds, heavily used terrestrial areas	Levels of bacteria are zero, follow up studies if levels are elevated

Section	Objectives	Priority	Deliverables	Indicators/Targets
Social Objectives	34. Urge senior governments to allow culled geese to be used for food (all zones).	1	Captured wild Canada Geese can be held in pens prior to transport and donation to food banks and/or other food distribution venues.	Funding for holding, processing, and transport of captured geese to food banks and/or other food distribution venues, number of geese held, processed, donated
Social Objectives	35. Develop a communication protocol that includes interaction with other Canada Goose management committees or working groups and naturalist groups.	2	Communication protocol with CWS	CWS central coordinator, number of meetings among working groups
Social Objectives	36. Engage stakeholders and the public regarding goose impacts and control techniques.	1	Stakeholder and public engagement in zone-based management plans	Number of surveys, number of communities with public open houses, number of stakeholders and members of the public engaged
Social Objectives	37. Urge the CWS to make permits for controlling Canada Geese easier to obtain.	1	Online permitting process, simple (e.g., one-page) guide	Increase in number of permit applications
Social Objectives	38. Consult and collaborate with First Nations.	1	First Nations represented on regional working group	Goose management on reserves is integrated with other sites in the region
Monitoring Objective	39. Urge CWS to develop a monitoring program for temperate-nesting Canada Geese and a predictive population model encompassing multiple regions and interacting goose (sub)populations.	1	Multi-region monitoring program	Predictive models for Vancouver Island

15.1 Personal Communications

Ken Ashley, B.C. Institute of Technology; Karen Barry, Bird Studies Canada; David Bradbeer, Vancouver Airport Authority; Andre Breault, Canadian Wildlife Service; Kevin Bridges, City of Nanaimo; Ken Brock, Canadian Wildlife Service; Dan Buffett, Ducks Unlimited Canada; Campbell River Environmental Committee; Drew Chapman, B.C. Parks; Myke Chutter, B.C. Ministry of Environment; Tim Clermont, Crown Land Securement Program; John Cooper, Cooper, Beauchesne & Associates; Bruce Cousens; Kevin Fort, Canadian Wildlife Service; Graeme Fowler, B.C. Ministry of Agriculture, Glen Gibson, Vancouver Island Health Authority; Sandra Gray; Erika Lok, Canadian Wildlife Service; Don Marshall, Town of Qualicum Beach; Dr. Jim McClendon, Canadian Food Inspection Agency; Alan Messner, Canadian Food Inspection Agency; Al Metcalf, City of Parksville; Guy Monty; Danielle Morrison; Warren Payne, City of Parksville; Sean Pendergast, B.C. Ministry of Forests, Lands, and Natural Resource Operations; Aaron Ritchie; Dr. Ken Roblesky, retired, CFIA/B.C. Ministry of Agriculture; Joseph Sands, U.S. Fish and Wildlife Service Migratory Birds and Habitat Programs; Blain Sepos, Oceanside Tourism Association; Terry Smith, U.S. Department of Agriculture, Animal Health and Plant Health Inspection Service, Wildlife Services, Washington/Alaska; Kim St. Claire, Capital Regional District Parks; Bob Weir, Town of Qualicum Beach; Ivy Whitehorne, Canadian Wildlife Service; Craig Wightman, B.C. Conservation Foundation

15.2 Literature Cited

- Allan, J. R., J. S. Kirby, and C. J. Feare. 1995. The biology of Canada geese (*Branta canadensis*) in relation to the management of feral populations. *Wildlife Biology* 1.
- Anderson, M. G., and R. D. Titman. 1992. Spacing Patterns. Page 635 pp. in B. D. J. Batt, A. D. Afton, M. G. Anderson, C. Davison Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu, editors. *Ecology and Management of Breeding Waterfowl*. University of Minnesota Press, Minneapolis, MN.
- Ankney, C. D. 1996. Embarrassment of riches: Too many geese. *Journal of Wildlife Management* 60:217–223.
- Anonymous. 2013. Snow Geese in Quebec: 2013-2018 Action Plan. A product of a January 2012 workshop with members of the Greater Snow Goose Management Round Table. Page 20 pp. Quebec City, Quebec. Available from http://www.ec.gc.ca/nature/FB11C691-2F04-4E8F-B4BF-88B5441BD6F3/900_SnowGeeseinQuebec2013-2018ActionPlan_e%20-v6%20FINAL-s.pdf.
- Ashor, J. L. 1985. Recreation Management in the Bob Marshall Wilderness Complex: An Application of the Limits of Acceptable Change Concept and Transactive Planning Theory. Master of Science in Recreation Management. University of Montana.
- Atwater, M. G. 1959. A Study of Renesting in Canada Geese in Montana. *Journal of Wildlife Management* 23:91–97.
- Audubon Society. 2015. Audubon Christmas Bird Count. Available from <http://netapp.audubon.org/CBCObservation/>.
- Australian Department of Sustainability, Environment, Water, Population and Communities. 2010. Gippsland Lakes Ramsar site: Ecological Character Description. Chapter 4-5. Available from <http://www.environment.gov.au/system/files/resources/0c0185c8-8e0b-4194-a6ca-d0f795bef410/files/21-ecd-ch-4-5.pdf>.

-
- Ayers, C. R. 2009. Effects of Mowing on Anthraquinone for Deterrence of Canada Geese and Survey of Canada Goose Fecal Contaminants. Master of Science thesis. North Carolina University, Raleigh, North Carolina. Available from <http://www4.ncsu.edu/~csdepern/documents/Thesis.pdf>.
- Bairlein, F., and O. Hüppop. 2004. Migratory Fuelling and Global Climate Change. Pages 33–47 in A. Møller, W. Fiedler, and P. Berthold, editors. *Advances in Ecological Research: Birds and Climate Change*. Elsevier, Oxford, U.K.
- Balkcom, G. D. 2010. Demographic Parameters of Rural and Urban Adult Resident Canada Geese in Georgia. *The Journal of Wildlife Management* 74:120–123.
- Banks, R. C., C. Cicero, J. L. Dunn, A. W. Kratter, P. C. Rasmussen, J. V. Remsen Jr., J. D. Rising, and D. F. Stotz. 2004. Forty-Fifth Supplement to the American Ornithologists' Union Check-List of North American Birds. *The Auk* 121:985–995.
- Barker, N. K. S., S. G. Cumming, and M. Darveau. 2014. Models to predict the distribution and abundance of breeding ducks in Canada. *Avian Conservation and Ecology* 9:7.
- Batt, B. D. J. 1992. Introduction: The Waterfowl. in B. D. J. Batt, A. D. Afton, M. G. Anderson, C. D. Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu, editors. *Ecology and Management of Breeding Waterfowl*. University of Minnesota Press, Minneapolis and London.
- Batt, B. D. J. 1997. Arctic ecosystems in peril: report of the Arctic Goose Habitat Working Group. Page 120 pp. Arctic Goose Joint Venture Special Publication. U.S. Fish and Wildlife Service, Washington, D.C. and CWS, Ottawa, Ontario.
- B.C. Centre for Disease Control, Food Protection. 2012. Standards for the Donation of Culled Game Meat. Prepared in collaboration with B.C. Ministry of Health and the Five Regional Health Authorities: Vancouver Coastal, Fraser, Interior, Northern and Vancouver Island. Available from <http://www.bccdc.ca/NR/rdonlyres/69C8FF46-BE87-4C55-9C54-4D77ACC9DE8E/0/StandardsfortheDonationofCulledGameMeatsFINALDec2012.pdf>.
- B.C. Conservation Data Centre. 2014. Species Summary: *Branta canadensis occidentalis*. B.C. Ministry of Environment. Available from <http://a100.gov.bc.ca/pub/eswp/speciesSummary.do?id=19759>.
- BC Conservation Data Centre (BC CDC). 2014. BC Species and Ecosystems Explorer. BC Ministry of Environment, Victoria, BC. Available from <http://a100.gov.bc.ca/pub/eswp/> (accessed January 10, 2014).
- BC Ministry of Agriculture and Lands (BC MAL). 2008. 2008 Interim Wildlife Damage Compensation Program (Standing Forage). B.C. Ministry of Agriculture and Lands. Available from http://www.al.gov.bc.ca/production_insurance/plans/Wildlife/2008%20IWDCP%20%20Brochure%20ver3.6.pdf.
- BC Ministry of Environment. 1979. Preliminary Canada Goose Management Plan for British Columbia. Fish and Wildlife Branch.
- BC Ministry of Forests, Lands and Natural Resource Operations. 2014. Standard Operation Procedure (SOP): Canada Goose euthanasia for depopulation. Page 6.
- B.C. Society for the Prevention of Cruelty to Animals (BC SPCA). n.d. Urban Wildlife. Available from <http://www.sPCA.bc.ca/welfare/wildlife/urban-wildlife/>.
-

-
- B.C. Wildlife Federation (BCWF). 2012, March. Wild Game Provided to the Needy. BCWF News. Available from <http://peachlandsportsmen.com/Mar2012Newsletter.pdf>.
- Beaumont, M., J. Rodrigue, and J.-F. Giroux. 2013. Movements and habitat use by temperate-nesting Canada Geese during the postbreeding period in southern Quebec. *Avian Conservation and Ecology* 8:3.
- Beauty of Birds.com. 2011. Canada Geese. Available from <http://beautyofbirds.com/canadageese.html>.
- Bellrose, F. C. 1976. Ducks, geese and swans of North America. Stackpole Books, Harrisburg, PA.
- Best, R. J., and P. Arcese. 2009. Exotic herbivores directly facilitate the exotic grasses they graze: mechanisms for an unexpected positive feedback between invaders. *Oecologia* 159:139–150.
- Beston, J. A., T. C. Nichols, P. M. Castelli, and C. K. Williams. 2014. Survival of Atlantic Flyway Resident Population Canada Geese in New Jersey. *Journal of Wildlife Management* 78:612–619.
- Biebighauser, T. R. 2007. Wetland Drainage, Restoration, and Repair. The University Press of Kentucky, Manufactured in China.
- Biebighauser, T. R. 2011. Wetland Restoration and Construction: A Technical Guide. Upper Susquehanna Coalition, Manufactured in China.
- Bird Studies Canada. n.d. Breeding Bird Surveys. Available from <http://www.bsc-eoc.org/volunteer/bbs/index.jsp?targetpg=index&lang=EN>.
- Blackwell, B. F., G. E. Bernhardt, and R. A. Dolbeer. 2002. Lasers as Nonlethal Avian Repellents. *Journal of Wildlife Management* 66:250–258.
- Blue Carbon Portal. 2013. What is Blue Carbon? Available from <http://bluecarbonportal.org> (accessed July 13, 2014).
- Böhning-Gaese, E., and N. Lemoine. 2004. Importance of Climate Change for the Ranges, Communities and Conservation of Birds. Pages 211–236 in A. Møller, W. Fiedler, and P. Berthold, editors. *Advances in Ecological Research: Birds and Climate Change*. Elsevier, Oxford, U.K.
- Boonstra, T. A., M. E. Clark, and W. L. Reed. 2009. Maternal resource variation across the laying sequence in Canada geese *Branta canadensis maxima*. *Avian Biology* 40:520–528.
- Boyчук, E. 2014, February 14. Great Backyard Bird Count appeals for public's help: Novice and expert bird-watchers unite for four days in a massive, worldwide bird counting project. CBC News. Available from <http://www.cbc.ca/news/technology/great-backyard-bird-count-appeals-for-public-s-help-1.2530721>.
- Boyer, K. E., and S. Wyllie-Echeverria. 2010. Eelgrass Conservation and Restoration in San Francisco Bay: Opportunities and Constraints. Final Report for the San Francisco Bay Subtidal Habitat Goals Project.
- Brakhage, G. K. 1965. Biology and Behavior of Tub-Nesting Canada Geese. *Journal of Wildlife Management* 29:751–771.
- Brasher, M. G., J. D. Steckel, and R. J. Gates. 2007. Energetic Carrying Capacity of Actively and Passively Managed Wetlands for Migrating Ducks in Ohio. *Journal of Wildlife Management* 71:2532–2541.
- Breault, A., and R. W. McKelvey. 1991. Canada Geese in the Fraser Valley: A Problem Analysis. Technical Report Series No. 133. Canadian Wildlife Service, Pacific and Yukon Region.
-

-
- British Association for Shooting & Conservation. 2013. Quarry Species & Shooting Seasons. Available from <http://basc.org.uk/game-and-gamekeeping/quarry-species-shooting-seasons/>.
- Bromley, R. G., and T. C. Rothe. 2003. Conservation Assessment for the Dusky Canada Goose (*Branta canadensis occidentalis* Baird). General Technical Report PNW-GTR-591. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon. Available from <http://www.arlis.org/docs/vol1/54830739.pdf>.
- Brunson, D. N. 1997. Beyond Wilderness: Broadening the Applicability of Limits of Acceptable Change. Proceedings - Limits of Acceptable Change and related planning processes: progress and future directions, May 20-22, Missoula, MT. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT. Available from http://www.fs.fed.us/rm/pubs_int/int_gtr371/int_gtr371_005_009.pdf.
- Calvert, A. M., G. Gauthier, E. T. Reed, L. Bélanger, J.-F. Giroux, J.-F. Gobeil, M. Huang, J. Lefebvre, and A. Reed. 2007. Evaluation of the special conservation measures for Greater Snow Geese: Report of the Greater Snow Goose Working Group. Page 85 pp. + appendices. Arctic Goose Joint Venture Special Publication. Canadian Wildlife Service, Sainte-Foy, Quebec. Available from http://www.agjv.ca/images/stories/pdf/rap_gest_snowgoose_an.pdf.
- Campbell, B. H. 1991. Longevity records for the Dusky Canada Goose (*Branta canadensis occidentalis*). *Northwestern Naturalist* 72:34–35.
- Campbell, W. R., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser, and M. C. E. McNall. 1990. The Birds of British Columbia: Introduction and Loons Through Waterfowl. UBC Press in cooperation with Environment Canada (Canadian Wildlife Service), Vancouver, BC.
- Canadian Geographic and the Royal Canadian Geographical Society. 2015. The National Bird Project. Available from <http://www.canadiangeographic.ca/nationalbird/>.
- Canadian Wildlife Service. 2011b. Best Practices for Killing Birds and Disposing of Carcasses: Canada Goose Management. CW66-293/2-2011E-PDF. Canadian Wildlife Service. Available from [https://www.ec.gc.ca/Publications/95FAFB79-3856-4752-8309-1F95D0E4101D%5CCOM1425_BP-for-disposing-of-carcasses-\(EN\)march-2012.pdf](https://www.ec.gc.ca/Publications/95FAFB79-3856-4752-8309-1F95D0E4101D%5CCOM1425_BP-for-disposing-of-carcasses-(EN)march-2012.pdf).
- Canadian Wildlife Service. 2010. Handbook: Canada and Cackling Geese: Management and Population Control in Southern Canada. Available from [https://www.ec.gc.ca/mbc-com/6D2B893B-C671-41AF-8439-713305DB384C/Handbook_Canada_Cackling_Geese_e\[1\].pdf](https://www.ec.gc.ca/mbc-com/6D2B893B-C671-41AF-8439-713305DB384C/Handbook_Canada_Cackling_Geese_e[1].pdf).
- Canadian Wildlife Service. 2011. Frequently Asked Questions: Canada Geese. CW66-294/1-2011E-PDF. Available from <http://www.ec.gc.ca/Publications/351D3606-71DA-48D4-9310-A21241EFD68D/FrequentlyAskedQuestionsCanadaGeese.pdf>.
- Canadian Wildlife Service Waterfowl Committee. 2011. Migratory Birds Regulations in Canada: July 2012. CWS Migratory Birds Regulatory Report No.36. Available from https://ec.gc.ca/Publications/EAE372DF-2945-4D7F-B453-43EAA37DE5D5%5CCOM157_eng.pdf.
-

-
- Canadian Wildlife Service Waterfowl Committee. 2013a. Population Status of Migratory Game Birds in Canada: November 2013. CWS Migratory Birds Regulatory Report Number 40. Environment Canada, Canadian Wildlife Service. Available from http://ec.gc.ca/rcom-mbhr/default.asp?lang=En&n=4BC9CF8D-1#_fig31a.
- Canadian Wildlife Service Waterfowl Committee. 2013b. Proposals to Amend the Canadian Migratory Birds Regulations (including Regulation Proposals for Overabundant Species), December 2013. CWS Migratory Birds Regulatory Report No. 41. Environment Canada, Ottawa. Available from <http://ec.gc.ca/rcom-mbhr/4B228CD0-EB7F-44F2-A0B1-59E283057E30/December-Report-2013-ENG-FINAL.pdf>.
- Capital Regional District (CRD). 2012. Regional Canada Goose Management Strategy. Prepared by EBB Environmental Consulting for the Regional Canada Goose Management Strategy Working Group. Available from <https://www.crd.bc.ca/docs/default-source/regional-planning-pdf/regional-goose-management-strategy-.pdf?sfvrsn=0>.
- Capital Regional District (CRD). 2015. Regional Canada Goose Management Strategy. Available from <https://www.crd.bc.ca/project/goose-management>.
- Carter, K. 2005. The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stage: Implications for Klamath Basin TMDLs. California Regional Water Quality Control Board, North Coast Region. Available from http://www.swrcb.ca.gov/northcoast/water_issues/programs/tmdls/shasta_river/060707/28appendixaetheeffectsoftemperatureonsteelheadtroutcohosalmonandchinooksalmonbiologyandfunction.pdf.
- Caruso, D. 2009, June 11. NYC to gas 2,000 geese. Odessa American Online. Available from http://www.oaoa.com/news/article_7e681f52-d05c-592a-8084-a34019f5f600.html?mode=jqm.
- Castelli, P. M., and S. E. Sleggs. 2000. Efficacy of border collies to control nuisance Canada geese. Wildlife Society Bulletin 28:385–392.
- Castelli, P. M., and R. E. Trost. 1996. Neck Bands Reduce Survival of Canada Geese in New Jersey. The Journal of Wildlife Management 60:891–898.
- CBC News. 2012, January 17. B.C. woman fights to get back tame Canada Goose. CBC News online. Available from <http://www.cbc.ca/news/canada/british-columbia/b-c-woman-fights-to-get-back-tame-canada-goose-1.1296109>.
- CBC News. 2013, January 27. Shooting of owls OK'd to protect endangered species. CBC News online. Available from <http://www.cbc.ca/news/canada/british-columbia/shooting-of-owls-ok-d-to-protect-endangered-species-1.1308126>.
- CBC News. 2014, February 24. Wild game meat to be served by Quebec restaurants. CBC News online. Available from <http://www.cbc.ca/news/canada/montreal/wild-game-meat-to-be-served-by-quebec-restaurants-1.2549277>.
- Checkett, J. M., J. M. Coluccy, and R. D. Drobney. 2001. Polygyny in Canada Geese: An Unusual Example of Nest Sharing. The Wilson Bulletin 113:109–110.
-

-
- City of Eden Prairie. 2008. City of Eden Prairie Canada Goose Management Plan. Available from <http://www.edenprairie.org/home/showdocument?id=1073>.
- City of Kelowna. 2009. Goose Management. Available from <http://www.kelowna.ca/CM/page1268.aspx>.
- City of Parksville. 2009, July 28. Canine Goose Control Program - City of Parksville. News Release.
- Clermont, H. 2009. Englishman River and Little Qualicum River Estuarine Marsh Draft Rehabilitation Plan. Guardians of Mid-Island Estuaries.
- Clermont, H. 2010a. Englishman River Estuary Project: Egg Sterilization and Banding Program, Canada Goose Exclosures. Project Update. Guardians of Mid-Island Estuaries.
- Clermont, H. 2010b. Little Qualicum River Estuary Project: Egg Sterilization and Banding Program, Canada Goose Exclosures. Project Update. Guardians of Mid-Island Estuaries.
- Clermont, H. 2014. Qualicum National Wildlife Area Draft Management Plan. Prepared for Environment Canada, Canadian Wildlife Service.
- Cogle, F. 2012. Moults culls destroy 18,000 Canada geese. Timaru Herald. New Zealand. Available from <http://www.stuff.co.nz/timaru-herald/news/6224164/Moults-culls-destroy-18-000-canada-geese>.
- Cole, D., D. J. V. Drum, D. E. Stalknecht, D. G. White, M. D. Lee, S. Ayers, M. Sobsey, and J. J. Maurer. 2005. Free-living Canada Geese antimicrobial resistance. *Emerging Infectious Diseases* 11:935–938.
- Cole, D. N., and G. H. Stankey. 1997. Historical Development of Limits of Acceptable Change: Conceptual Clarifications and Possible Extensions. *Proceedings - Limits of Acceptable Change and related planning processes: progress and future directions*, May 20-22, Missoula, MT. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT. Available from http://www.fs.fed.us/rm/pubs_int/int_gtr371/int_gtr371_005_009.pdf.
- Coluccy, J. M., R. D. Drobney, and D. A. Graber. 2002. Consequences of Neckband and Legband Loss from Giant Canada Geese. *The Journal of Wildlife Management* 66:353–360.
- Conover, M. R. 1991. Herbivory by Canada Geese: Diet Selection and Effect on Lawns. *Ecological Applications* 1:231–236.
- Conover, M. R. 2009. Gang Brooding in Canada Geese: Role of Parental Condition and Experience. *Condor* 111:276–282.
- Cooper, J. A. 1978. The History and Breeding Biology of the Canada Geese of Marshy Point, Manitoba. *Wildlife Monographs, Supplement to the Journal of Wildlife Management* 42:87 pp.
- Cooper, J. A. 1995. The Potential Health Hazards of Consuming Metropolitan Twin Cities Canada Geese. University of Minnesota, Department of Fisheries and Wildlife, St. Paul, MN.
- Cormorant Defenders International. n.d. The Double-crested Cormorant: slaughtered for convenience! Available from <http://www.zoocheck.com/cormorant/>.
- Cousens, B., and C. Lee. 1996.
- Cousens, N. B. F., J. C. Lee, and D. A. Blood. 1996. Management plan for Hamilton Marsh. Part 1 - Historical perspective, existing conditions and wetland management options. Prepared for MacMillan Bloedel Limited.
- CRD Regional Canada Goose Management Strategy Working Group. 2014. Regional Canada Goose Management Strategy, April 2014 Update. Capital Regional District.
- Crooks, S., J. Rybczyk, K. O'Connell, D. L. Devier, K. Poppe, and S. Emmett-Mattox. 2014. Coastal Blue Carbon Opportunity Assessment for the Snohomish Estuary: The Climate Benefits of Estuary Restoration. Report
-

- by Environmental Science Associates, Western Washington University, EarthCorps, and Restore America's Estuaries. Available from http://www.estuaries.org/images/stories/RAEReports/snohomish_report.pdf.
- D'Alpaos, A. D. 2011. The mutual influence of biotic and abiotic components on the long-term ecomorphodynamic evolution of salt-marsh ecosystems. *Geomorphology* 126:269–278.
- Davidson, N. C. 2014. How much wetland has the world lost? Long-term and recent trends in global wetland area. *Marine and Freshwater Research* 65:934–941.
- Dawe, N. K., W. S. Boyd, R. Buechert, and A. C. Stewart. 2011. Recent, significant changes to the native marsh vegetation of the Little Qualicum River estuary, British Columbia; a case of too many Canada Geese (*Branta canadensis*)? *British Columbia Birds* 21:11–31.
- Dawe, N. K., W. S. Boyd, T. Martin, S. Anderson, and M. Wright. 2015. Significant marsh primary production is being lost from the Campbell River estuary: another case of too many resident Canada Geese (*Branta canadensis*)? *British Columbia Birds* 25.
- Dawe, N. K., and R. Buechert. 1995. Bird Use of the Little Qualicum River estuary, Vancouver Island, British Columbia 1975-1979. Technical Report Series Number 40. Environment Canada, Canadian Wildlife Service.
- Dawe, N. K., R. Buechert, and D. E. C. Trethewey. 1998. Bird Use of Baynes Sound - Comox Harbour, Vancouver Island, British Columbia 1980-1981. Technical Report Series No. 286. Canadian Wildlife Service, British Columbia.
- Dawe, N. K., and B. D. Davies. 1975. A nesting study of Canada geese on the George C. Reifel Migratory Bird Sanctuary, British Columbia. *Syesis* 8:1–7.
- Dawe, N. K., and S. D. Lang. 1980. Flora and Fauna of the Nanoose Unit, Qualicum National Wildlife Area. Environment Canada, Canadian Wildlife Service.
- Dawe, N. K., T. Martin, and K. Morrison. 1994. Vancouver Island Canada Goose Survey 1991 & 1993. Canadian Wildlife Service and BC Ministry of Environment.
- Dawe, N. K., G. Monty, and T. Clermont. 2006. Nanoose, Parksville, Qualicum Beach, & area Canada Goose surveys: 23 November 2005 & 18 January 2006.
- Dawe, N. K., and K. Morrison. 1989. Vancouver Island Canada Goose Survey 1989. Canadian Wildlife Service and BC Ministry of Environment.
- Dawe, N. K., and K. Morrison. 1991. Vancouver Island Canada Goose Survey 1990. Canadian Wildlife Service and BC Ministry of Environment.
- Dawe, N. K., and A. C. Stewart. 2010. The Canada Goose (*Branta Canadensis*) on Vancouver Island, British Columbia. *British Columbia Birds* 20:24–40.
- Dawe, N. K., and E. R. White. 1982. Some aspects of the vegetation ecology of the Little Qualicum River estuary, British Columbia. *Canadian Journal of Botany* 60:1447–1460.
- Dawe, N. K., and E. R. White. 1986. Some aspects of the vegetation ecology of the Nanoose-Bonell estuary, Vancouver Island, British Columbia. *Canadian Journal of Botany* 64:27–34.
- Dawes, J. 2008. Canada Geese - A New Incursion into Australia. Pestat, PTY Ltd. Available from <http://www.feral.org.au/wp-content/uploads/2010/03/CanadaGeese0803.pdf>.
- Del Monte-Luna, P., B. W. Brook, M. J. Zetina-Rejón, and V. H. Cruz-Escalona. 2004. The carrying capacity of ecosystems. *Global Ecology and Biogeography* 13:485–495.

- Desjardins, L. 2014, June 25. Goose attack injures Ontario cyclist. Radio Canada International. Available from <http://www.rcinet.ca/en/2014/06/25/goose-attack-injures-ontario-cyclist/>.
- Dickson, D. L. 2012. Seasonal Movement of King Eiders Breeding in Western Arctic Canada and Northern Alaska. Technical Report Series Number 520. Canadian Wildlife Service, Edmonton, Alberta.
- Dieter, C. D., and B. J. Anderson. 2009. Molt migration by giant Canada geese in eastern South Dakota. Human-Wildlife Interactions.
- Dobbie, T. 2008. Point Pelee National Park of Canada: Middle Island Conservation Plan. Parks Canada. Available from <http://www.pc.gc.ca/eng/pn-np/on/pelee/plan/plan1.aspx>.
- Douville, C. H., and C. E. Friley. 1957. Records of Longevity in Canada Geese. *The Auk* 74:510.
- Downmark. n.d. Down and Feather Quality. Available from <http://business.financialpost.com/2014/10/16/parka-king-canada-geese-targets-world-from-its-toronto-factory/>.
- Eckberg, D. J. 2010. Icon Under Fire: The Giant Canada Geese of Rochester, Minnesota. Bachelor of Arts, Honors Senior Project. University of Minnesota, Department of Geography.
- Ernst, R. A., and W. S. Coates. 1977. Raising Geese. Leaflet 2225. University of California, Division of Agricultural Sciences. Available from <http://animalscience.ucdavis.edu/avian/geese.pdf>.
- European Network on Invasive Alien Species (NOBANIS). 2013. News from the NOBANIS secretariat. NOBANIS News No. 7. Available from <http://www.nobanis.org/files/NOBANIS%20News%20No.%207,%202013.pdf>.
- Federal Register. 2014. Migratory Bird Hunting; Proposed Frameworks for Late-Season Migratory Bird Regulations. A Proposed Rule by the Fish and Wildlife Service. Available from <https://www.federalregister.gov/articles/2014/08/22/2014-19855/migratory-bird-hunting-proposed-frameworks-for-late-season-migratory-bird-hunting-regulations#h-25>.
- Filion, T., S. Kidd, and K. Aguirre. 2006. Isolation of *Cryptococcus laurentii* from Canada Goose guano in rural upstate New York. *Mycopathologia* 162:363–368.
- Fisheries and Oceans Canada. 2014. Area 14 Pacific Region Sanitary Closures. Available from <http://www.pac.dfo-mpo.gc.ca/fm-gp/contamination/sani/area-secteur-14/area-secteur-14-eng.html>.
- Fletcher, T. 2013, September 23. B.C. communities want Canada Goose kill permits. Abbotsford News. Abbotsford, BC. Available from <http://www.abbynews.com/news/224927682.html?mobile=true>.
- Fraser, E., and S. Fraser. 2010. A Review of Potential Health Hazards to Humans and Livestock From Canada Geese (*Branta canadensis*) and Cackling Geese (*Branta hutchinsii*). Prepared for the CWS by the Centre for Coastal Health on behalf of Canadian Cooperative Wildlife Health Centre. Available from http://www.ccwhc.ca/publications/Health_Hazards_from_Canada_Geese_February_2010.pdf.
- Freedman, B. 2004. Environmental Science: A Canadian Perspective Third edition. Pearson Education Canada, Toronto, Ontario.
- Gendron, M. H., and A. C. Smith. 2014. National Harvest Survey. Available from <http://www.ec.gc.ca/reom-mbs/enp-nhs/index.cfm?do=def&lang=e>.
- Giles, M. M. 2010. Home Range, Habitat Selection, and Migratory Pathways of Canada Geese Wintering at the Santee National Wildlife Refuge. Master of Science thesis. Clemson University, South Carolina.
- Gillam, C. 2013, October 6. Monsanto Wins Lawsuit Filed by U.S. Organic Farmers Worried About Seed Contamination. Huffington Post and Reuters. Available from http://www.huffingtonpost.com/2013/06/10/monsanto-wins-lawsuit_n_3417081.html.

-
- Granholm, S. 1988. Canada Goose. Life history accounts for species, California Wildlife Habitat Relationships System. California Department of Fish and Game, California Interagency Wildlife Task Group, Sacramento, CA.
- Greer, D. 2003, May 14. Raising the bar. Northern News Services. Available from http://www.nnsl.com/frames/newspapers/2003-05/may14_03harv.html.
- Groepper, S. R., P. J. Gabig, M. P. Vrtiska, J. M. Gilsdorf, S. E. Hygnstrom, and L. A. Powell. 2008. Population and spatial dynamics of resident Canada Geese in southeastern Nebraska. *Human-Wildlife Conflicts* 2:270–276.
- Guardians of Mid-Island Estuaries Society. 2014. Central Vancouver Island Estuary Rehabilitation and Resident Canada Goose Management Project Report: 2014 Update.
- Hansen, H. A., and W. H. Oliver. 1951. The Status of Resident Canada Geese in South-Central Washington, Spring, 1950. *The Murrelet* 32:2–7.
- Haramis, G. M., and G. D. Kearns. 2007. Herbivory by Resident Geese: The Loss and Recovery of Wild Rice Along the Tidal Patuxent River. *Journal of Wildlife Management* 71:788–794.
- Health Canada. 2012. Methyl Anthranilate. Registration Decision RD2012-04. Health Canada Pest Management Regulatory Agency. Available from http://www.hc-sc.gc.ca/cps-spc/alt_formats/pdf/pubs/pest/decisions/rd2012-04/rd2012-04-eng.pdf.
- Heller, B. J. 2010. Analysis of Giant Canada Goose Band Recovery Data in Iowa and the Mississippi Flyway. Master of Science thesis. Iowa State University, Ames, Iowa.
- Hesse, G., R. V. Rea, and A. L. Booth. 2009. Wildlife management practices at western Canadian airports. *Journal of Air Transport Management*:1–6.
- Hestbeck, J. B. 1995. Population study and management of Atlantic Flyway Canada Geese. *Journal of Applied Statistics* 22:877–890.
- Hestbeck, J. B., J. D. Nichols, and R. A. Malecki. 1991. Estimates of Movement and Site Fidelity Using Mark-Resight Data of Wintering Canada Geese. *Ecology* 72:523–533.
- Howard Breen, K. 1990. The Canada goose. Voyageur Press, Stillwater, Minnesota.
- Huang, M. T. 2010. Movement Patterns and Sub-Population Structure of Resident Canada Geese in Connecticut. PhD Dissertation. University of Connecticut.
- Hughes, J. 2012, May 27. Environment Canada's Strategy to Manage Burgeoning Populations of Canada Geese. Ottawa, Ontario. Available from http://nfwcc.com/presentations/presentations/36_Jack_Hughes.pdf.
- Hupp, J. W., J. I. Hodges, B. P. Conant, B. W. Meixell, and D. J. Groves. 2010. Winter Distribution, Movements, and Annual Survival of Radiomarked Vancouver Canada Geese in Southeast Alaska. *The Journal of Wildlife Management* 74:274–284.
- International Agency for Research on Cancer. 1999. Saccharin and its Salts. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans* 73:517–624.
- International Agency for Research on Cancer. 2012. Anthraquinone. *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans* 101:41–70.
- Isaac-Renton, M., J. R. Bennett, R. J. Best, and P. Arcese. 2010. Effects of Introduced Canada Geese (*Branta canadensis*) on Native Plant Communities of the Southern Gulf Islands, British Columbia. *Ecoscience* 17:394–399.
- Jansson, K., M. Josefsson, and I. Weidema. 2008. NOBANIS - Invasive Alien Species Fact Sheet: *Branta canadensis*. From Online Database of NOBANIS. North European and Baltic Network on Invasive Alien
-

- Jeffries, R. L., R. F. Rockwell, and K. F. Abraham. 2003. The embarrassment of riches: agricultural food subsidies, high goose numbers, and loss of Arctic wetlands - a continuing saga. *Environmental Reviews*, NRC Research Press 11:193.
- Johnson, D. H., J. D. Nichols, and M. D. Schwartz. 1992. Population Dynamics of Breeding Waterfowl. Page 635 pp. in B. D. J. Batt, A. D. Afton, M. G. Anderson, C. Davison Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu, editors. *Ecology and Management of Breeding Waterfowl*. University of Minnesota Press, Minneapolis, MN.
- Kadlec, J. A., and L. M. Smith. 1992. Habitat Management for Breeding Areas. Page 635 pp. in B. D. J. Batt, A. D. Afton, M. G. Anderson, C. Davison Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu, editors. *Ecology and Management of Breeding Waterfowl*. University of Minnesota Press, Minneapolis, MN.
- Keefe, T. 1996. Feasibility Study on Processing Nuisance Canada Geese for Human Consumption. Prepared for Minnesota Department of Natural Resources, Forest Lake, Minnesota.
- Kennedy, K. A. 1982, May. Plant Communities and Their Standing Crops on Estuaries of the East Coasts of Vancouver Island. Master of Science thesis. University of British Columbia, Vancouver, BC.
- Kent MacKay, B., and L. White. 2008. A Critical Analysis of Point Pelee National Park's Rationale for Killing the Middle Island Cormorants. Cormorant Defenders International, Born Free USA United with Animal Protection Institute, Animal Alliance of Canada. Available from <http://www.zoocheck.com/cdiwebsite/CDI%20Middle%20Island%20Cormorant%20Report%20PDF.pdf>.
- Kereki, C. J. 2007. Optimal Migration Routes of Dusky Canada Geese: Can They Indicate Estuaries in British Columbia for Conservation? Master of Resource Management thesis. Simon Fraser University, Burnaby, BC.
- Kossack, C. W. 1950. Breeding habits of Canada geese under refuge conditions. *American Midland Naturalist* 43:627–649.
- Kotanen, P. M., and K. F. Abraham. 2013. Decadal changes in vegetation of a subarctic salt marsh used by Lesser Snow and Canada Geese. *Plant Ecology* 214:409–422.
- Krapu, G. L., and K. J. Reinecke. 1992. Foraging Ecology and Nutrition. Page 635 pp. in B. D. J. Batt, A. D. Afton, M. G. Anderson, C. Davison Ankney, D. H. Johnson, J. A. Kadlec, and G. L. Krapu, editors. *Ecology and Management of Breeding Waterfowl*. University of Minnesota Press, Minneapolis, MN.
- Kullus, H., M. Coles, J. Rhyhan, and L. Clark. 2002. Prevalence of *Escherichia coli* serogroups and human virulence factors in faeces of urban Canada geese (*Branta canadensis*). *International Journal of Environmental Health Research* 12:153–162.
- Lehikoinen, E., T. H. Sparks, and M. Zalakevicius. 2004. Arrival and Departure Dates. Pages 1–31 in A. Møller, W. Fiedler, and P. Berthold, editors. *Advances in Ecological Research: Birds and Climate Change*. Elsevier, Oxford, U.K.
- LGL Limited and B.C. Conservation Foundation. 2012. Habitat Utilization and Improvement Opportunities in the Englishman River Estuary. Prepared for B.C. Conservation Foundation.
- Lindberg, M. S., and R. A. Malecki. 1994. Hunting Vulnerability of Local and Migrant Canada Geese in Pennsylvania. *The Journal of Wildlife Management* 58:740–747.
- Lok, E. 2011, September 27. Management of Canada Geese. Available from <http://www.ubcm.ca/assets/Library/Convention/Convention~2011/Presentations/September~27/Management~of~Urban~Wildlife/Lok-Urbn%20Geese.pdf>.
- LoveCanadaGeese.com. 2014. Canada Goose Hall of Shame. Available from <http://>

-
- Lynch, L. 2007. Canada Goose Egg Addling Program 2007, Vancouver Island. Prepared for The Nature Trust of British Columbia.
- Madsen, J., C. Jaspers, M. Tamstorf, C. E. Mortensen, and F. Rig  t. 2011. Long-Term Effects of Grazing and Global Warming on the Composition and Carrying Capacity of Graminoid Marshes for Moulting Geese in East Greenland. *Royal Swedish Academy of Sciences* 40:638–649.
- Manning, Cooper and Associates. 2003. Canada Goose Egg Addling Program on Nature Trust Lands, Cowichan Valley, Englishman River and Nanoose Bay, 2003. Prepared for the Nature Trust of British Columbia.
- Manning, Cooper and Associates. 2005. Canada Goose Egg Addling Program on Lands Managed by The Nature Trust: Cowichan Valley, Englishman River, and Nanoose Bay, 2005. Prepared for The Nature Trust of British Columbia.
- Manning, Cooper and Associates. 2006. Canada Goose Egg Addling Program on Lands Managed by The Nature Trust: Cowichan Valley, Englishman River, and Nanoose Bay, 2006. Prepared for The Nature Trust of British Columbia.
- Martin, K., and D. Guignon. 1983. Canada Goose Numbers, Daily Movements and Foraging Patterns on Prince Edward Island. *Proc. N.S. Inst. Sci.* 33:107–114.
- Maryland Department of Natural Resources. n.d. Controlling Conflicts with Resident Canada Geese in Maryland. Available from http://www.dnr.state.md.us/wildlife/Hunt_Trap/waterfowl/geese/ResGeeseProblem.asp.
- McConnell, B. 2013, October. Ross’s Goose could be deemed overabundant. *Canadian Geographic*. Available from http://www.canadiangeographic.ca/magazine/oct13/ross_geese_nunavut.asp.
- Michigan Department of Natural Resources (DNR). 2015. Resident Canada Goose Management Frequently Asked Questions. Available from http://www.michigan.gov/dnr/0,4570,7-153-10370_12145_25065-232661--,00.html.
- Mid-Vancouver Island Habitat Enhancement Society. 2009. Caring for the Englishman River Estuary: A bioinventory and volunteer monitoring project.
- Miller, V., K. F. Abraham, and E. Nol. 2013. Factors affecting the responses of female Canada Geese to disturbance during incubation. *Journal of Field Ornithology* 84:171–180.
- Missouri Dept. of Conservation. 2002, July 21. Missouri officials remove 500 nuisance geese from six areas. *Lawrence Journal*. Available from <http://news.google.com/newspapers?nid=2199&dat=20020721&id=fbBTAAAAIBAJ&sjid=1zgNAAAAIBAJ&pg=1707,156390>.
- Morrison, D. 2013. Central Vancouver Island Estuary Rehabilitation and Resident Canada Goose Management. Project Report. *Guardians of Mid-Island Estuaries*.
- Munro, D. A. 1958. Factors Affecting Reproduction of the Canada Goose (*Branta canadensis*). Pages 542–556. *Proceedings of the XIIth International Ornithological Congress, 1958*. Canadian Wildlife Service, Ottawa, Helsinki, Finland.
- Ontario Ministry of the Attorney General. 2004. *Farm to Fork: A Strategy for Meat Safety in Ontario*. Report of the Meat Regulatory and Inspection Review ISBN: 0-7794-6427-3. Available from <http://www.attorneygeneral.jus.gov.on.ca/english/about/pubs/meatinspectionreport/cover-toc.pdf>.
- Osoyoos Lake Water Quality Society. 2014. Canada Geese (or, the Scoop on Goose Poop). Available from <http://olwqs.org/index.php/geese>.
- Osoyoos Times. 2013, September 4. Council strongly supports upcoming Canada Geese cull, but only at Desert Park and Osoyoos Golf Course. Osoyoos, BC. Available from <http://www.osoyoostimes.com/council-strongly-supports-upcoming-canada-geese-cull-but-only-at-desert-park-and-osoyoos-golf-course/>.
-

-
- Pacific Estuary Conservation Program. 1999. Pacific Estuary Conservation Program.
- Pacific Flyway Council. 2008. Pacific Flyway Management Plan for the Dusky Canada Goose. Page 38 pp. + appendices. USFWS Unpublished report. Dusky Canada Goose Subcommittee, Pacific Flyway Study Committee, Portland, Oregon. Available from http://pacificflyway.gov/Documents/Dcg_plan.pdf.
- Pannekoek, J., and A. Van Strien. 1998. TRends & Indices for Monitoring data (TRIM). Statistics Netherlands, Voorburg. Available from <http://www.ebcc.info/trim.html>.
- Parks Canada. 2010. Point Pelee National Park of Canada Management Plan. Parks Canada. Available from <http://www.pc.gc.ca/eng/pn-np/on/pelee/plan/plan8.aspx>.
- Parks Canada. 2013. Saving Middle Island - Point Pelee National Park. Available from <http://www.pc.gc.ca/eng/pn-np/on/pelee/plan/plan1/plan4.aspx#f>.
- Paws. n.d. Seattle Goose Program. Available from <http://www.paws.org/about/paws/history/seattle-goose-program/>.
- Percival, S. M., Y. Halpin, and D. C. Houston. 1997. Managing the distribution of Barnacle Geese on Islay, Scotland, through deliberate human disturbance. *Ecological Conservation* 82:273–277.
- Perrins, C. M., and T. R. Birkhead. 1983. *Avian Ecology*. Blackie & Son, Glasgow.
- Pilotte, C., E. T. Reed, J. Rodrigue, and J.-F. Giroux. (n.d.). Factors Influencing Survival of Canada Geese Breeding in Southern Quebec. *Journal of Wildlife Management* 78:231–239.
- Plummer, E. 2014, June 12. Goose hunting in city limits gets approval. *Alberni Valley Times*.
- Price, D. 1999. Carrying Capacity Reconsidered. *Population and Environment: A Journal of Interdisciplinary Studies* 21:5–26.
- Ramsar. 2012. Limits of Acceptable Change. 11th Meeting of the Conference of the Parties to the Convention on Wetlands, Bucharest, Romania, 6-13 July 2012. Available from <http://archive Ramsar.org/pdf/cop11/doc/cop11-doc24-e-limits.pdf>.
- Ray, E. 2011. Population dynamics and habitat selection of resident urban Canada Geese (*Branta canadensis*), Scottsdale, AZ. Master of Science thesis. Arizona State University, Phoenix, AZ. Available from http://repository.asu.edu/attachments/56864/content/Ray_asu_0010N_10829.pdf.
- Rivers, D. O., and F. T. Short. 2007. Effect of grazing by Canada Geese (*Branta canadensis*) on an intertidal eelgrass *Zostera marina* meadow. *Marine Ecology Progress Series* 333:271–279.
- Robertson Environmental Services, and Ophiuchus Consulting. 2006. Okanagan Regional Goose Management Strategy and Action Plan. Final Report. Prepared for Okanagan Regional Goose Management Committee, Kelowna, BC.
- Robertson, G. 2010, February 25. Year of the Goose. *Globe and Mail*. Available from <http://www.theglobeandmail.com/report-on-business/rob-magazine/year-of-the-goose/article4307839/?page=all>.
- Rogers, K., N. Saintilan, M. J. Colloff, and L. Wen. 2013. Application of thresholds of potential concern and limits of acceptable change in the condition assessment of a significant wetland. *Environmental Monitoring and Assessment* 185:8583–8600.
- Salomonsen, F. 1968. The molt migration. *Wildfowl* 19:5–24.
- SAS Institute Inc. 2011. SAS/STAT® 9.3 User's Guide. Cary, NC, USA. Available from <http://support.sas.com/documentation/cdl/en/statug/63962/PDF/default/statug.pdf>.
- Shaw, H. 2014, October 16. Parka king Canada Goose targets world from its Toronto factory. *Financial Post*. Available from <http://business.financialpost.com/2014/10/16/parka-king-canada-goose-targets-world->
-

-
- Sheaffer, S. E., R. A. Malecki, B. L. Swift, and J. Dunn. 2004. Molt Migration of Atlantic Flyway Resident Population Canada Geese. New York Cooperative Fish and Wildlife Research Unit. Available from http://www.dnr.state.md.us/wildlife/Hunt_Trap/waterfowl/geese/moltmigresgeese.asp.
- Sheaffer, S. E., R. A. Malecki, B. L. Swift, J. Dunn, and K. Scribner. 2007. Management Implications of Molt Migration by the Atlantic Flyway Resident Population of Canada Geese, *Branta canadensis*. *Canadian Field Naturalist* 121:313–320.
- Sherwood, G. A. 1968. Factors limiting production and expansion of local populations of Canada Geese. Pages 73–85 [195 pp.] in R. L. Hine and C. Schoenfeld, editors. *Canada Goose management*. Dembar Educational Research Services, Madison, Wisconsin.
- Sibley, D., I. McLaren, A. Wilson, and M. Stackhouse. 2010, October 4. Distinguishing Cackling and Canada Goose. Available from <http://www.sibleyguides.com/2007/07/identification-of-cackling-and-canada-goose/>.
- Sifleet, S., L. Pendleton, and B. C. Murray. 2011. State of the Science on Coastal Blue Carbon: A Summary for Policy Makers. NI R 11-06. Nicholas Institute for Environmental Policy Solutions. Available from <http://nicholasinstitute.duke.edu/sites/default/files/publications/state-of-science-coastal-blue-carbon-paper.pdf>.
- Smith, A. E., S. R. Craven, and P. D. Curtis. 1999. Managing Canada Geese in Urban Environments: A Technical Guide. Page 42 pp. Jack Berryman Institute Publication 16. Cornell University Cooperative, Ithaca, New York.
- Smith, D. W., and K. M. Dickson. 2000. Management of Canada Geese in the Lower Fraser Valley, southwestern British Columbia. *Canadian Wildlife Service Occasional Paper No. 103, Towards Conservation of the Diversity of Canada Geese (Branta canadensis)*. Ottawa, Ontario.
- Smith, T. J., III. 1983. Alteration of Salt Marsh Plant Community Composition by Grazing Snow Geese. *Holarctic Ecology* 6:204–210.
- Southwestlearning.org. n.d. Thresholds of Potential Concern. Available from http://www.southwestlearning.org/download_product/812/0.
- Spears, T. 2013, July 22. Pooping Canada geese may have spread genetically modified wheat, documents show. *Ottawa Citizen*. Available from URL is no longer available.
- Spillette, R. 2015. Capture-Recapture Analysis of Invasive Canadian Goose Populations. University of Victoria, Department of Mathematics and Statistics.
- Spurr, E. B., and J. D. Coleman. 2005. Review of Canada Goose Population Trends, Damage, and Control in New Zealand. Landcare Research Science Series No. 30. Landcare Research, Lincoln, Canterbury, New Zealand. Available from http://www.mwpress.co.nz/_data/assets/pdf_file/0013/70501/LRSS_30_-_Review_Canada_Goose.pdf.
- Subcommittee on Pacific Population of Western Canada Geese. 2000. Pacific Flyway Management Plan for the Pacific Population of Western Canada Geese. Pacific Flyway Study Committee (c/o USFWS, MBMO), Portland, Oregon. Available from https://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/cangeese/Final_EIS/Pac%20Pop%20West%20CG%20-%20plan.pdf.
- Surrendi, D. C. 1970. The Mortality, Behavior, and Homing of Transplanted Juvenile Canada Geese. *Journal of Wildlife Management* 34:719–733.
- Teillet, D. 2013. Submission to the NWMB for Proposed Changes to the Migratory Birds Regulations.
-

-
- U.S. Department of Agriculture. 2011. Questions and Answers: OvoControl. Factsheet. USDA Wildlife Services, Animal and Plant Health Inspection Service. Available from http://www.aphis.usda.gov/publications/wildlife_damage/content/printable_version/fs_ovocontrol.pdf.
- U.S. Fish and Wildlife Service (USFWS). 2002. Draft Environmental Impact Statement: Resident Canada Goose Management. U.S. Department of Interior Fish and Wildlife Service in cooperation with U.S. Department of Agriculture APHIS Wildlife Services.
- USFWS. 2006. U.S. Fish and Wildlife Service Issues Final Decision on Resident Canada Goose Management. Available from http://www.fws.gov/pacific/news/2006/ResidentGoose_NR.pdf.
- USFWS Division of Migratory Bird Management. 2008, December. Birds of Conservation Concern 2008. Available from <http://www.fws.gov/migratorybirds/newreportspublications/specialtopics/bcc2008/bcc2008.pdf>.
- USFWS, Migratory Bird Program. 2011, November. Birds of Management Concern and Focal Species. Available from <http://www.fws.gov/migratorybirds/currentbirdissues/management/BMC%20Focal%20Species%20November%202011.pdf>.
- U.S. Department of Health and Human Services, Public Health Service. 2008. Letter Health Consultation: 2008 Nuisance Geese, Lansing, Michigan. Available from http://www.atsdr.cdc.gov/HAC/pha/2008NuisanceGeese_LHC_3-3-2008/2008NuisanceGeese_LHC_3-3-2008.pdf.
- U.S. Department of the Interior, Fish and Wildlife Service. 2005. Final Environmental Impact Statement: Resident Canada Goose Management. U.S. Fish and Wildlife Service. Available from <http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/cangeese/finaleis.htm>.
- Vancouver Airport Authority. 2013. 2013 Environment Report. Annual Report. YVR. Available from http://yvr.ca/Libraries/2013_Annual_Report/2013_Environmental_Report.sflb.ashx.
- Vancouver Island Health Authority. n.d. Beach Reports. Available from http://www.viha.ca/mho/recreation/beach_reports.htm (accessed December 20, 2014).
- Vancouver Island Health Authority. 2014. Central Vancouver Island Beach Sampling Results 2014. Available from <http://www.viha.ca/NR/rdonlyres/706943F9-E0D3-4FFB-BD3D-3176FA3A94A4/0/CIBeachSamplingReport2014FINAL.pdf> (accessed December 20, 2014).
- Vancouver Sun. 2008, June 24. Abundant Canada Geese a menace. Available from http://www.canada.com/vancouver/news/story.html?id=35d7132a-56db-4810-9f04-c64a8f2acf50#_federated=1.
- Van Strien, A., J. Pannekoek, W. Hagemeijer, and T. Verstrael. 2004. A Loglinear Poisson Regression Method To Analyse Bird Monitoring Data. Pages 33–39 in A. Anselin, editor. Bird Numbers 1995, Proceedings of the International Conference and 13th Meeting of the European Bird Census Council. Pärnu, Estonia. Available from <http://www.ebcc.info/wpimages/other/04-VanStrienH.pdf>.
- Victoriaweather.ca. 2015. School-Based Weather Station Network. Available from <http://www.victoriaweather.ca>.
- Vincent, C. 2011, September 27. Canada geese, an invasive species soon to be culled. The Guardian. Available from <http://www.theguardian.com/environment/2011/sep/27/france-considers-canada-geese-cull>.
- Walkinshaw, B. 2009, October 9. City takes aim at reducing local goose population. Penticton Western News.com. Penticton, BC.
- Warren, K. 2006. Identification Field Guide to the Geese of the Willamette Valley and Lower Columbia River. Second Edition. Available from http://www.dfw.state.or.us/resources/hunting/waterfowl/goose-permits/Goosefieldguide_2ndEdition_final.pdf.
-

- Washburn, B. E., and T. W. Seamans. 2012. Foraging Preferences of Canada Geese Among Turfgrasses: Implications for Reducing Human-Goose Conflicts. *Journal of Wildlife Management* 76:600–607.
- Washington and Oregon Departments of Fish and Wildlife. n.d. Pacific Northwest Goose Management. Available from <http://wdfw.wa.gov/publications/01015/wdfw01015.pdf>.
- Washington Department of Fish and Wildlife. 2014. Washington State Migratory Waterfowl & Upland Game Seasons. Available from <http://wdfw.wa.gov/publications/01635/wdfw01635.pdf>.
- Weigand, J. P., M. J. Pollok, and G. A. Petrides. 1968. Some Aspects of Reproduction of Captive Canada Geese. *Journal of Wildlife Management* 32:894–905.
- Wilderness Committee. n.d. Spotted Owls Need Real Protection Now. Available from https://www.wildernesscommittee.org/campaigns/wildlife/spotted_owl.
- Wildlife Ministers' Council of Canada. 1990. A Wildlife Policy for Canada. Published by Authority of the Minister of Environment, Canadian Wildlife Service, Ottawa.
- Williams, B. K., J. D. Nichols, and M. J. Conroy. 2001. *Analysis and Management of Animal Populations*. Academic Press, San Diego, California.
- Wilson-Raybould, J. 2011. Governance Toolkit: A Guide to Nation Building. Governance Toolkit. B.C. Assembly of First Nations. Available from <http://www.bcafn.ca/toolkit/governance-bcafn-governance-tool-3.32.php>.
- Win, A. 2001. Seasonal Grazing of Canada Goose (*Branta canadensis*) on High Country Farmland, Canterbury, New Zealand. Master of Science thesis. Lincoln University, Canterbury, New Zealand. Available from https://researcharchive.lincoln.ac.nz/bitstream/10182/2678/4/win_thesis.pdf.
- Wisconsin Department of Natural Resources (DNR). 2008. Resident Canada Goose Management in Wisconsin. PUB WM-474-2007. Wisconsin DNR and USDA. Available from <http://dnr.wi.gov/topic/WildlifeHabitat/documents/managemoose.pdf>.
- Wright, N., L. Boyer, and K. Erikson. 2012. Nearshore Eelgrass Inventory Final Report. Prepared for the Islands Trust and Islands Trust Fund.

Appendices

Appendix A. Survey Sites

Appendix B. Calendars

Appendix C. Limitations

Appendix D. Encounter Histories

A. Survey Sites

Seventeen survey areas (see Figures 1-2, 6-1 and 6-2) were further divided into 342 survey sites, to enable surveyors to specify where geese were observed. The survey sites associated with each estuary are shown below, in Figures A-1, A-2 and A-3.

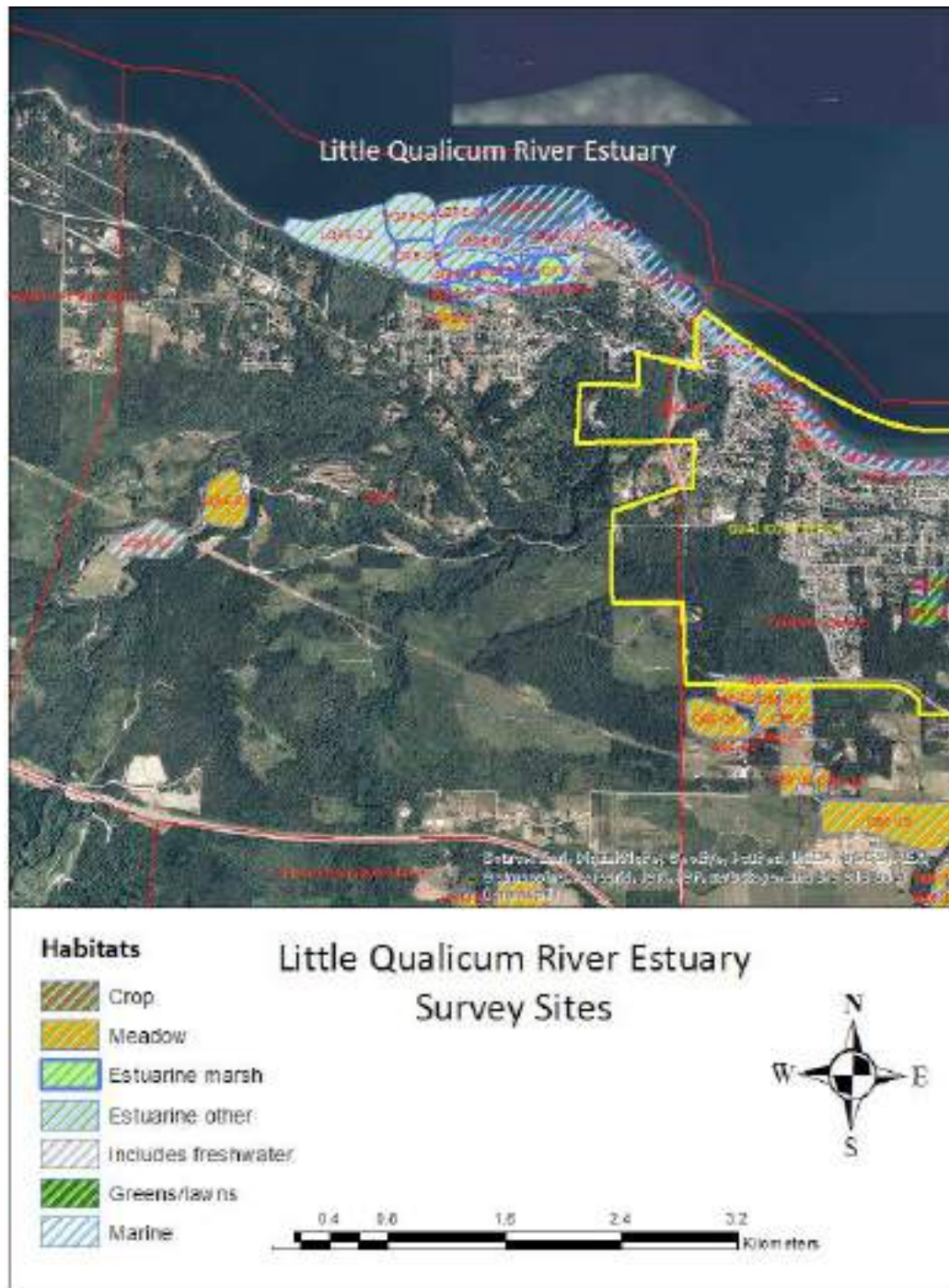


Figure A-1. Little Qualicum River estuary survey sites. The Town of Qualicum Beach is east of the estuary, outlined in yellow. Survey site codes are red.

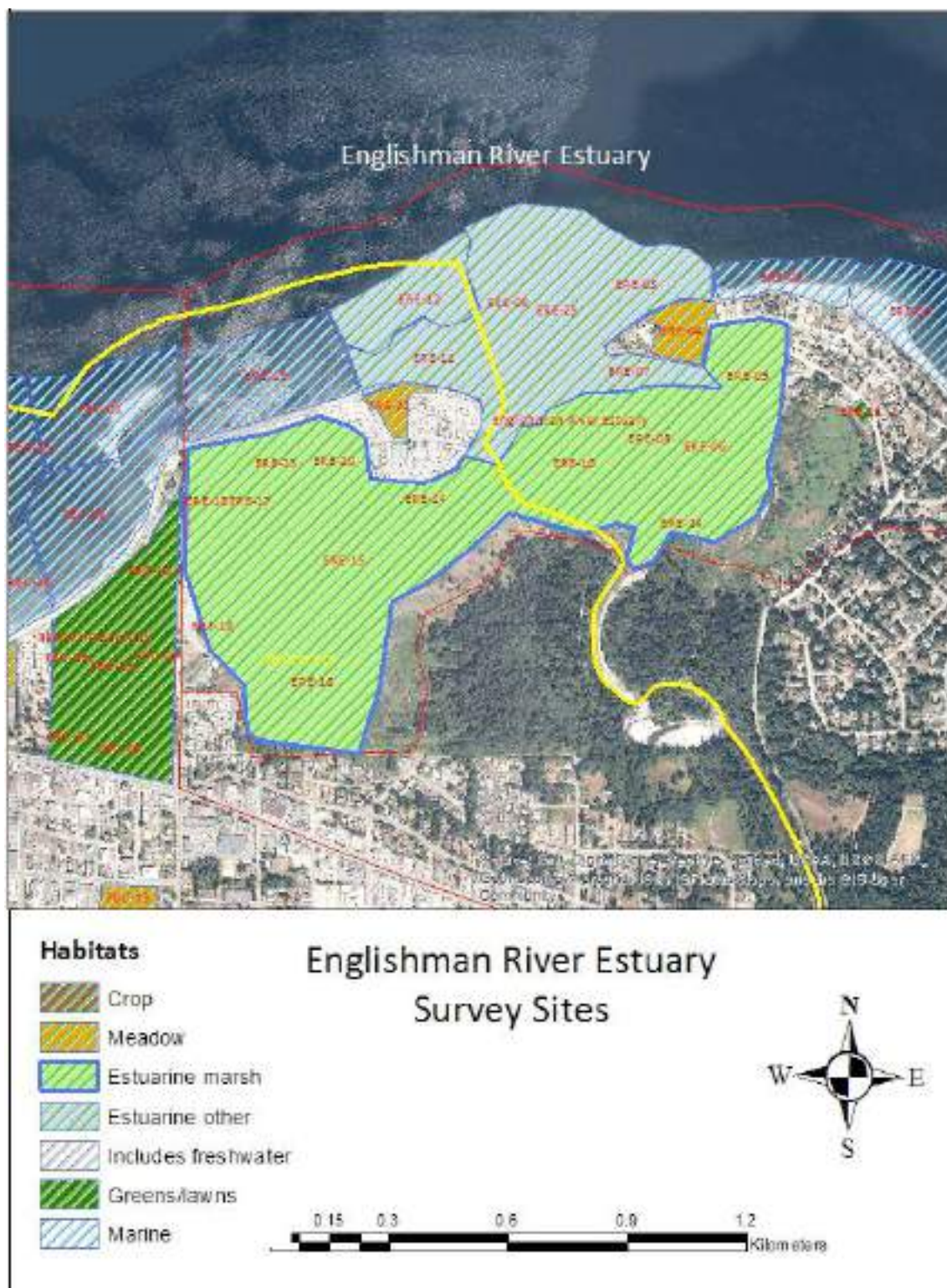


Figure A-2. Englishman River survey sites. The City of Parksville - Regional District of Nanaimo boundary bisects the estuary (west of the yellow line is the City of Parksville). Survey site codes are red.

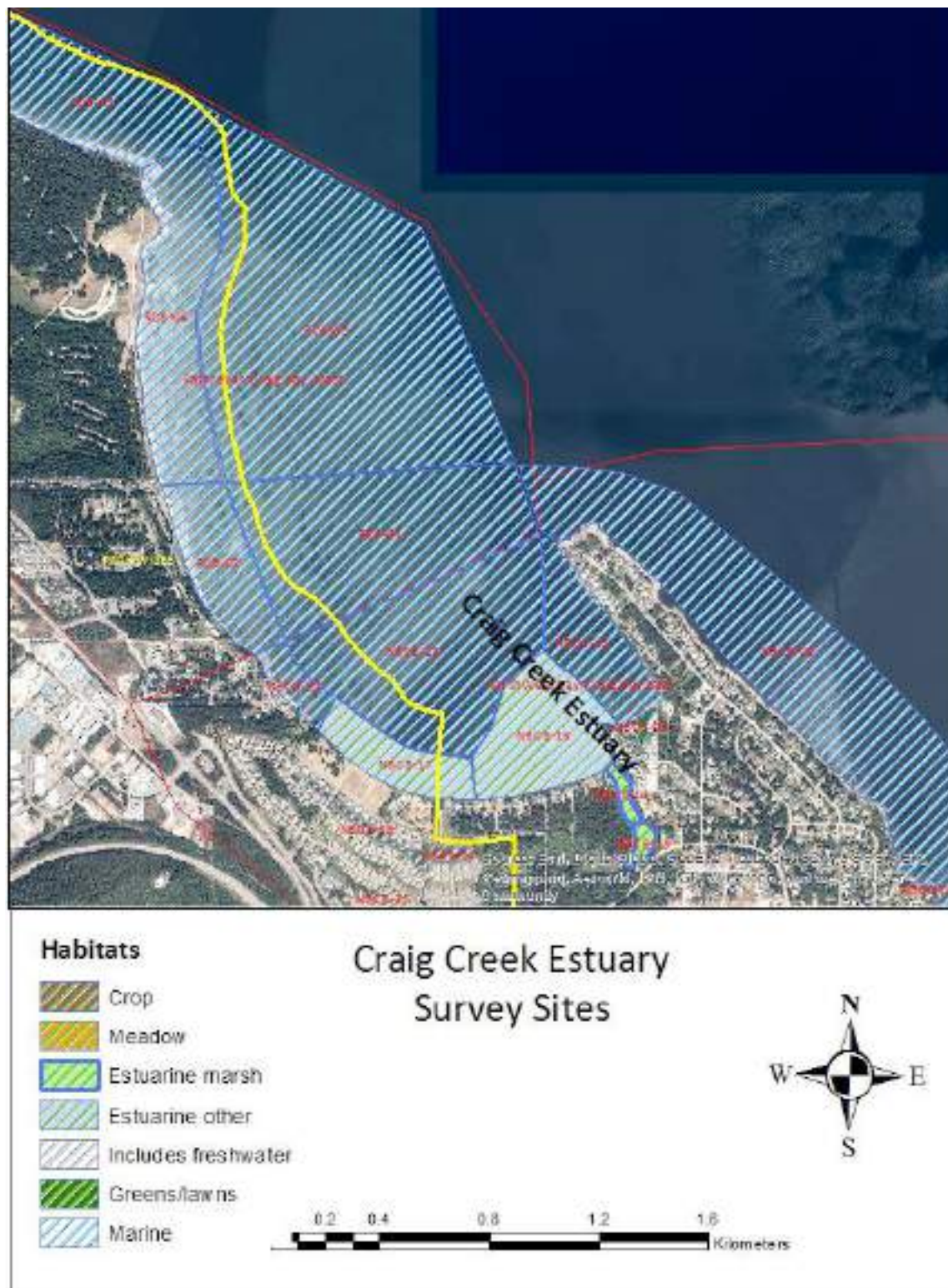


Figure A-3. Craig Creek estuary survey sites. West of the yellow line is the City of Parksville, east is part of the Regional District of Nanaimo. Survey site codes are red.

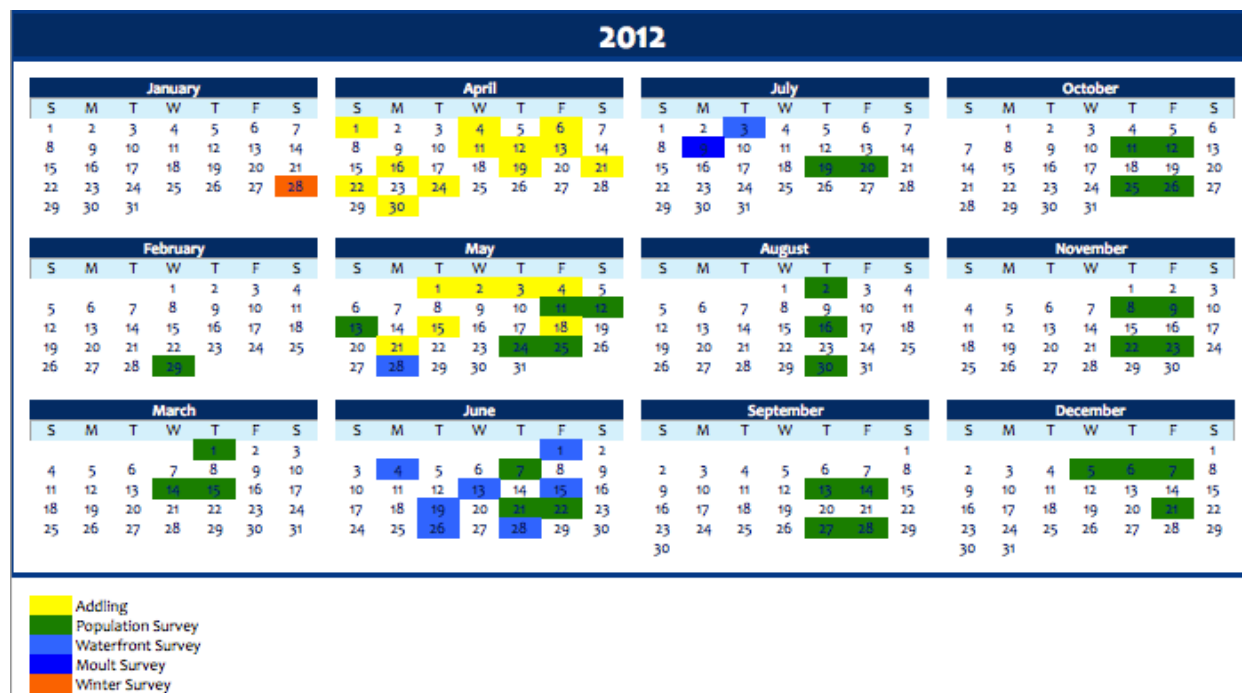


Figure B-3. Survey calendar, 2012.

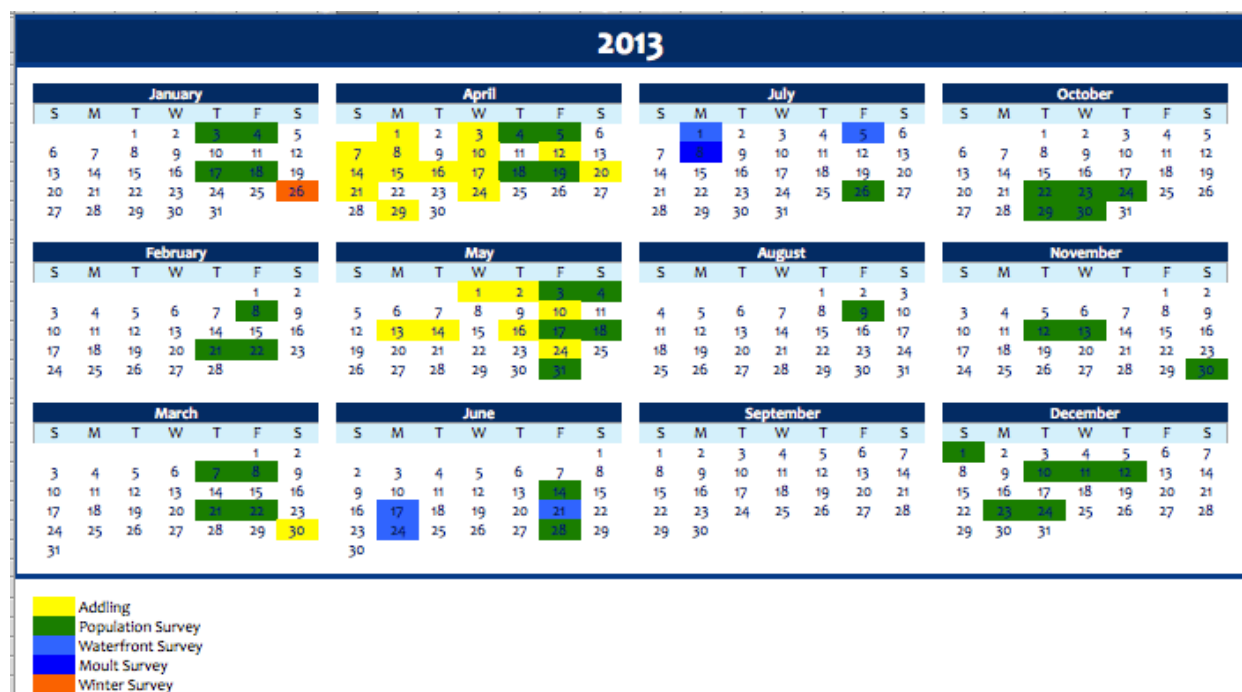


Figure B-4. Survey calendar, 2013.

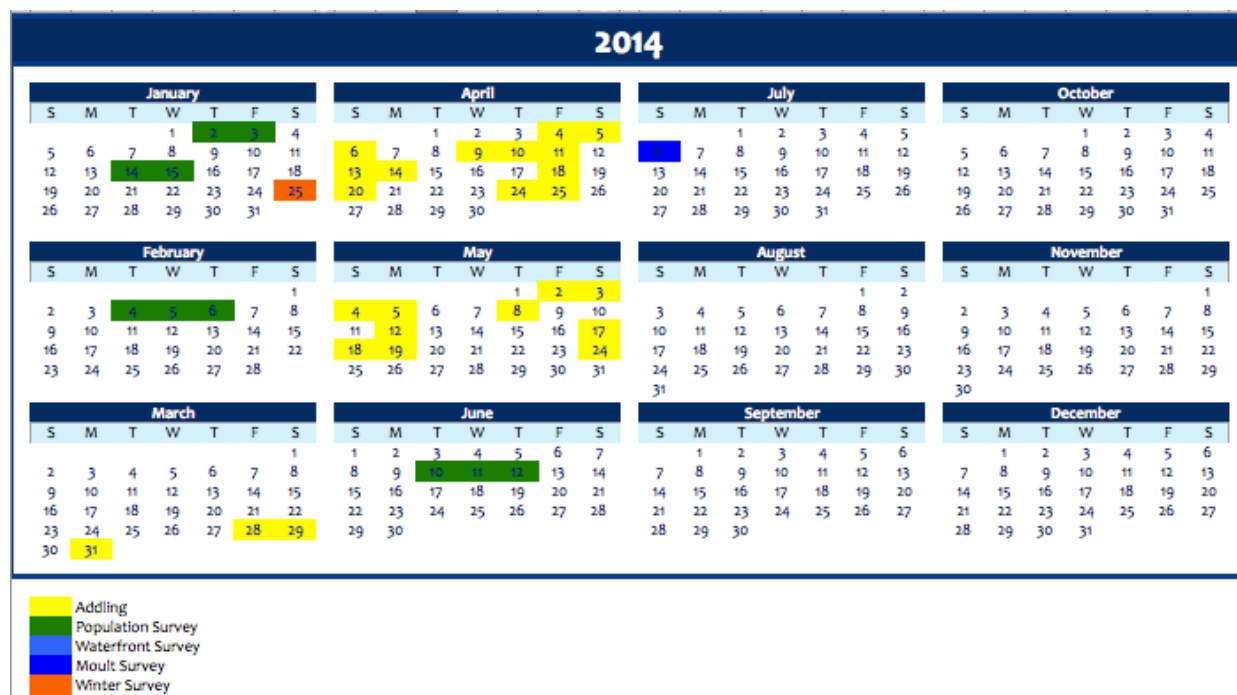


Figure B-5. Survey calendar, 2014.

C. Limitations

Seasonal Detection

Depending on the season, Canada Geese may be over- or under-counted. During nesting and brood-rearing, they avoid being seen by quickly crouching down and using vegetation to screen themselves. By contrast, moulting geese are concentrated in a few waterfront areas where they were more readily counted. During the spring and fall migration periods, they might use several different sites in a day, and could be in flight between sites when geese were counted. If geese were fitted with tracking devices, and surveys were consistent (using the same methods with no change in surveyors), we may better understand how visibility and detection influence the variability of survey counts within and between seasons.

Survey Effort

Canada Goose numbers were confounded by the extent and frequency of surveys (Figures C-1 and C-2). Additionally, there were several kinds of surveys and quasi-surveys, including banding, adding counts, population surveys, moult surveys, and winter surveys. Adding counts, which are conducted in late March, April, and May were not true surveys, as they involve repeated trips to the Englishman River and Little Qualicum River estuaries to sterilize eggs; documenting collars or bands was a secondary activity.

For each type of survey, and sometimes for individual surveys, there were variations in the number of surveyors, boundaries, time of day, and duration (cf. Perrins & Birkhead 1983). Further, our surveys did not consider tidal fluctuations, which definitely influenced how geese used the estuaries and other intertidal areas. Sampling intensity often reflected the availability of volunteer biologists/biological technicians and funding for paid staff. Access to privately-owned sites limited the survey effort, at least until permissions were granted.

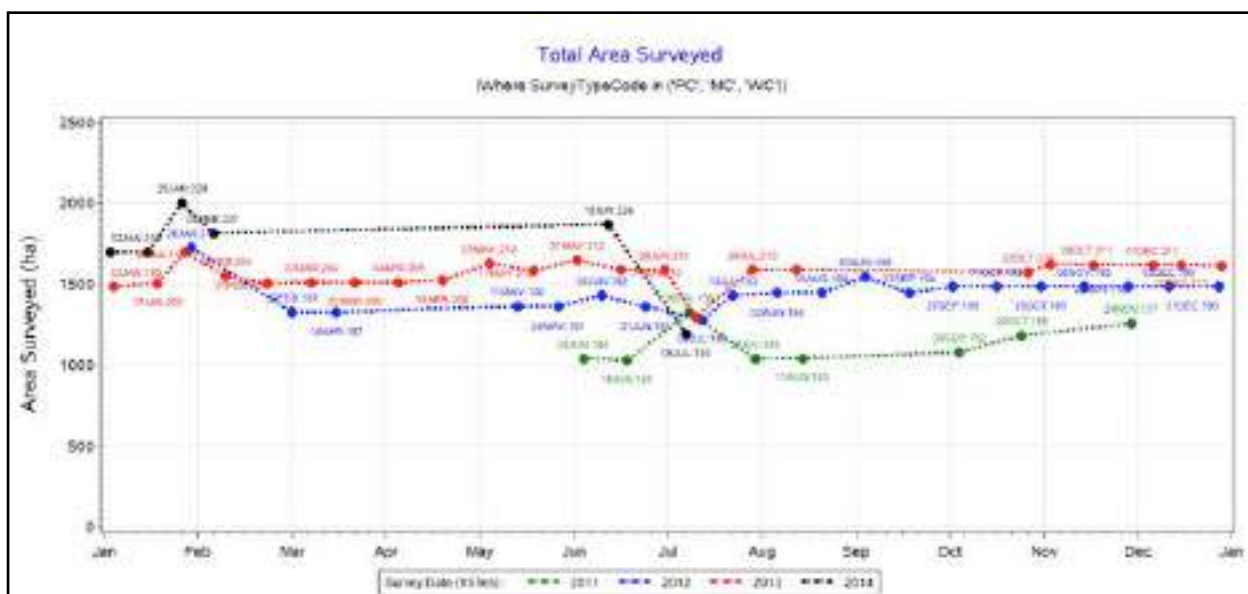


Figure C-1. Total area surveyed (in ha) during moult, winter, and routine population counts, across all sites, by survey date.



Figure C-2. Total site visits during moult, winter, and routine population counts, by survey date.

Figure C-3 shows the number of survey days each year. September surveys were only conducted once in 2011 (Sep 30), and twice in 2012 (Sep 13-14, 27-28). Contrast this with the month of June, when population surveys were conducted twice each month in 2011, 2012, 2013 and 2014 (See the calendars, Figures B-1 to B-5). The number of re-sighted birds, and the number of birds observed generally, will appear to be markedly lower in September when compared with June, simply because there were fewer surveys. Figures C-4 and C-5 demonstrate the before and

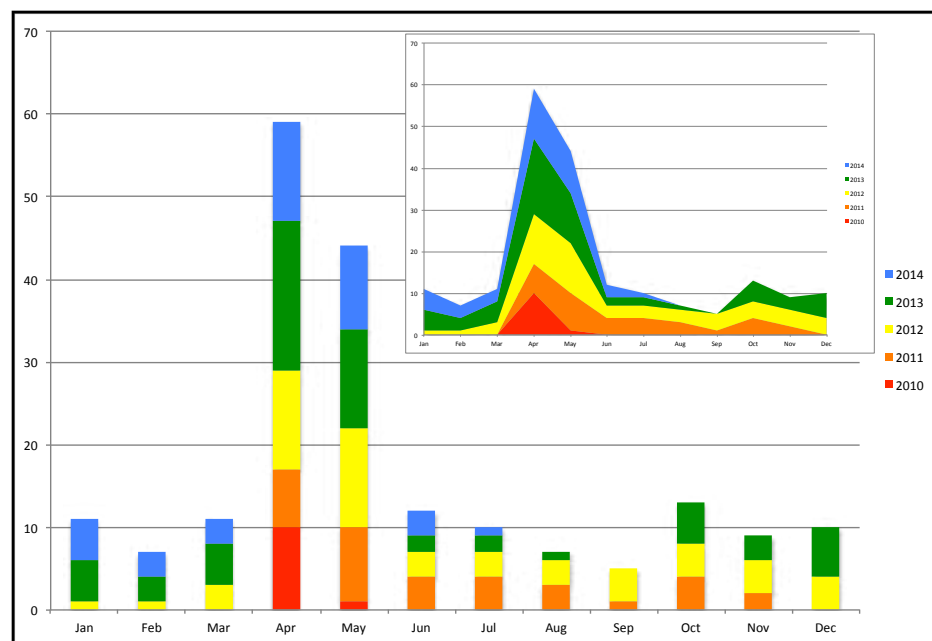


Figure C-3. Number of survey days each year, including addling counts, population surveys, winter surveys, and moult surveys. Banding counts, waterfront surveys, volunteer submissions and data submitted by the banding office were not included. The inset includes the same data, shown as a stacked area graph.

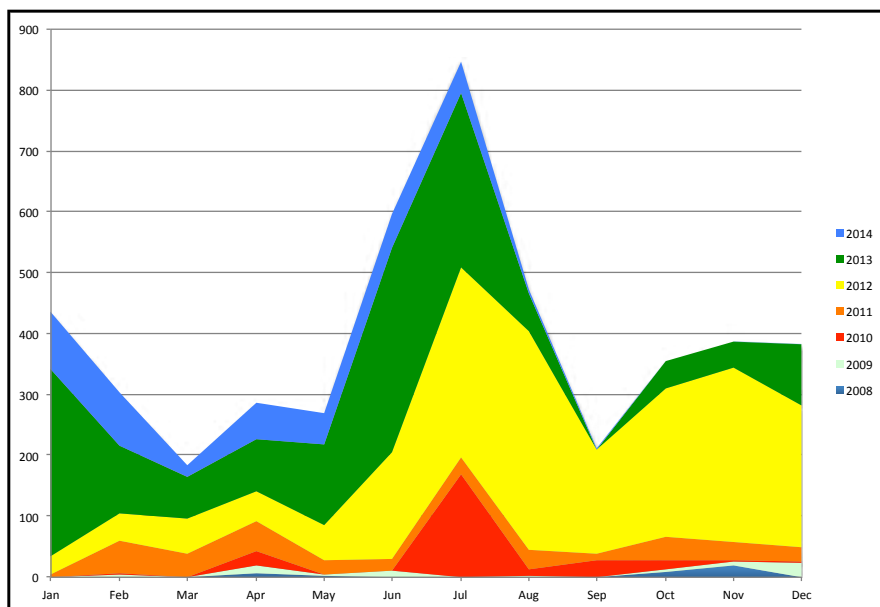


Figure C-4. Marked Canada Geese re-sighted each month for all years, 2008-2014 (n=4,371).

In both figures, goose numbers spiked during the moult in July. This peak encompassed Canada Goose roundups and banding in 2010 and 2012 (85 at the LQRE: 70 at ERE, and 106 at CCE). Excluding the banding dates resulted in a lower, flatter peak, but otherwise had little effect on the overall shape of the graph, as counts were done immediately afterwards and almost all marked birds were re-sighted.

In the graph uncorrected for effort (Figure C-4), a secondary peak occurred in January when the greatest numbers of birds were overwintering, and at the height of the nesting period in April.

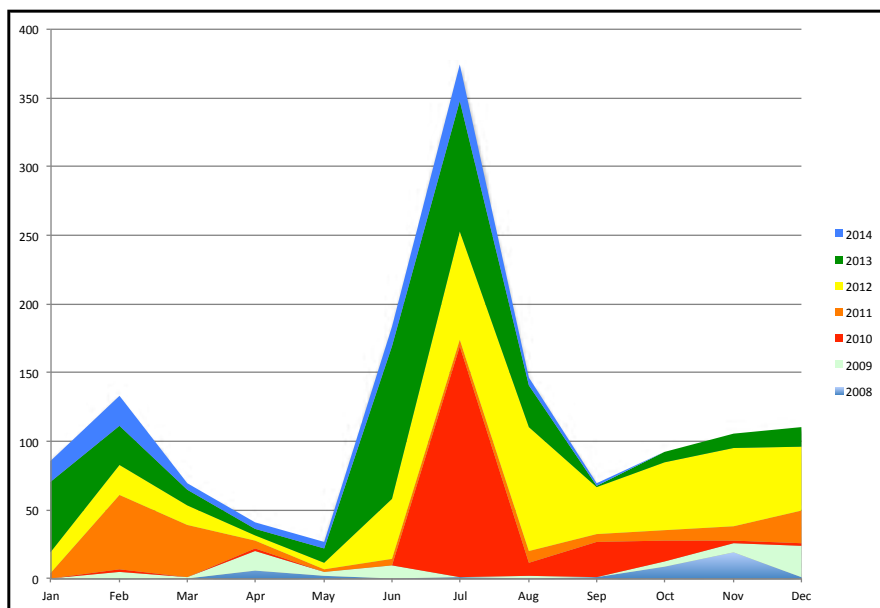


Figure C-5. Marked Canada Geese re-sighted each month for all years, 2008-2014 (n=4,371), with a measure of sampling intensity (sum of each month across years = monthly count totals / (number of surveys in the month + 1). Numbers along the y axis are relative, not absolute.

In the graph corrected for sampling intensity (Figure C-5), the peak shifts from the overwintering season to the spring migration period, showing that more marked geese were observed at this time of year. (Note that winter counts did not consistently identify marked birds.) The peak nesting period in April all but disappeared, due to the large number of sample days during the egg adding period.

D. Encounter Histories

In this section are summaries of marked Canada Goose encounter histories and associated maps for each migrant type. These exemplify typical home ranges and have been re-sighted more than others. 'Season' refers to the Canada Goose season, not the calendar season.

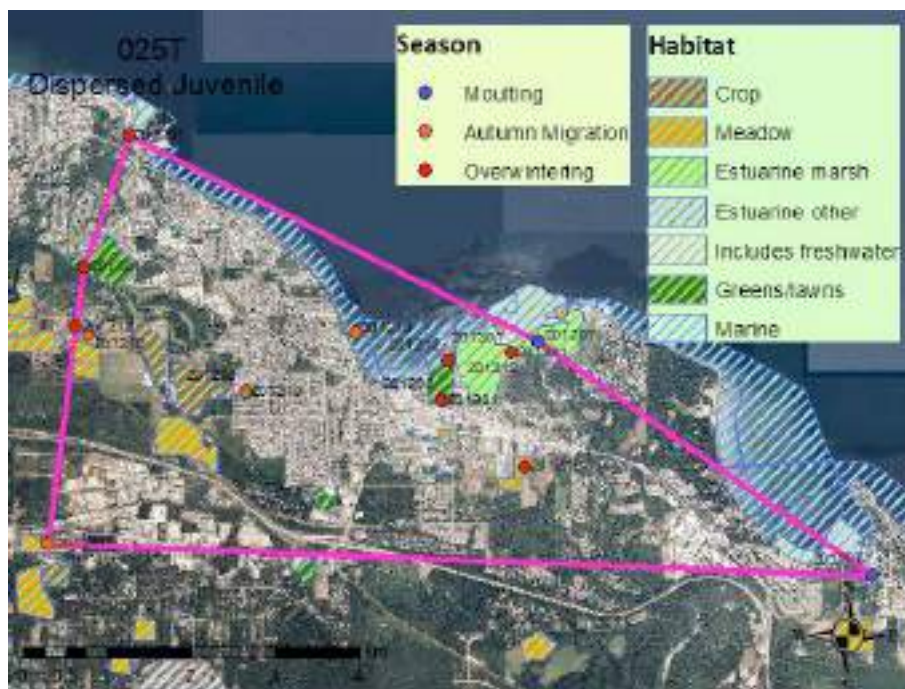
In many cases, there are two types of home range maps for each bird: minimum convex polygon (MCP) maps, and kernel density estimation (KDE) maps.

A MCP is the smallest polygon that encompasses all of the sites (or in this case, the centres of the sites) where the individual goose has been observed. It does not indicate whether the bird has been sighted more frequently in some areas than others. In the MCP maps below, the home range is shown as a pink border. It connects the dots, drawing a perimeter around all of the sites where the bird was observed. Due to overlapping symbols, not every observation date will be visible.

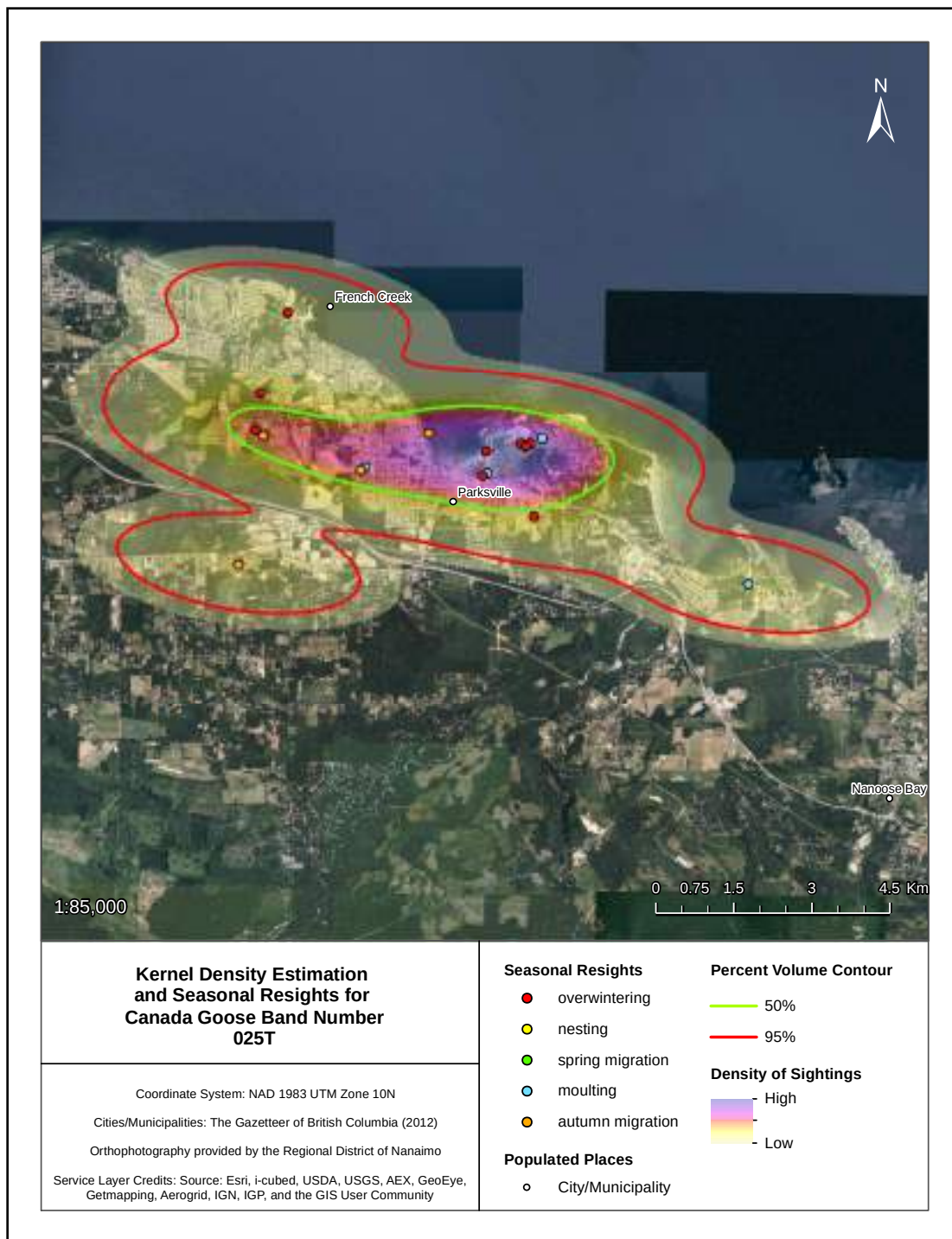
KDE mapping measures the density of the records within each grid cell in the study area, and uses this to estimate the probability that an individual goose will use neighbouring cells. KDEs are converted to percentage volume contours (PVCs) that identify areas where the goose is likely to occur 50% of the time (often referred to as the core range) and 95% of the time.

Dispersed Juvenile

025T was banded at the CCE in July 2012 as a hatch-year bird. It used the ERE and French Creek estuaries during the following winter. It was last seen in the area in January 2013.



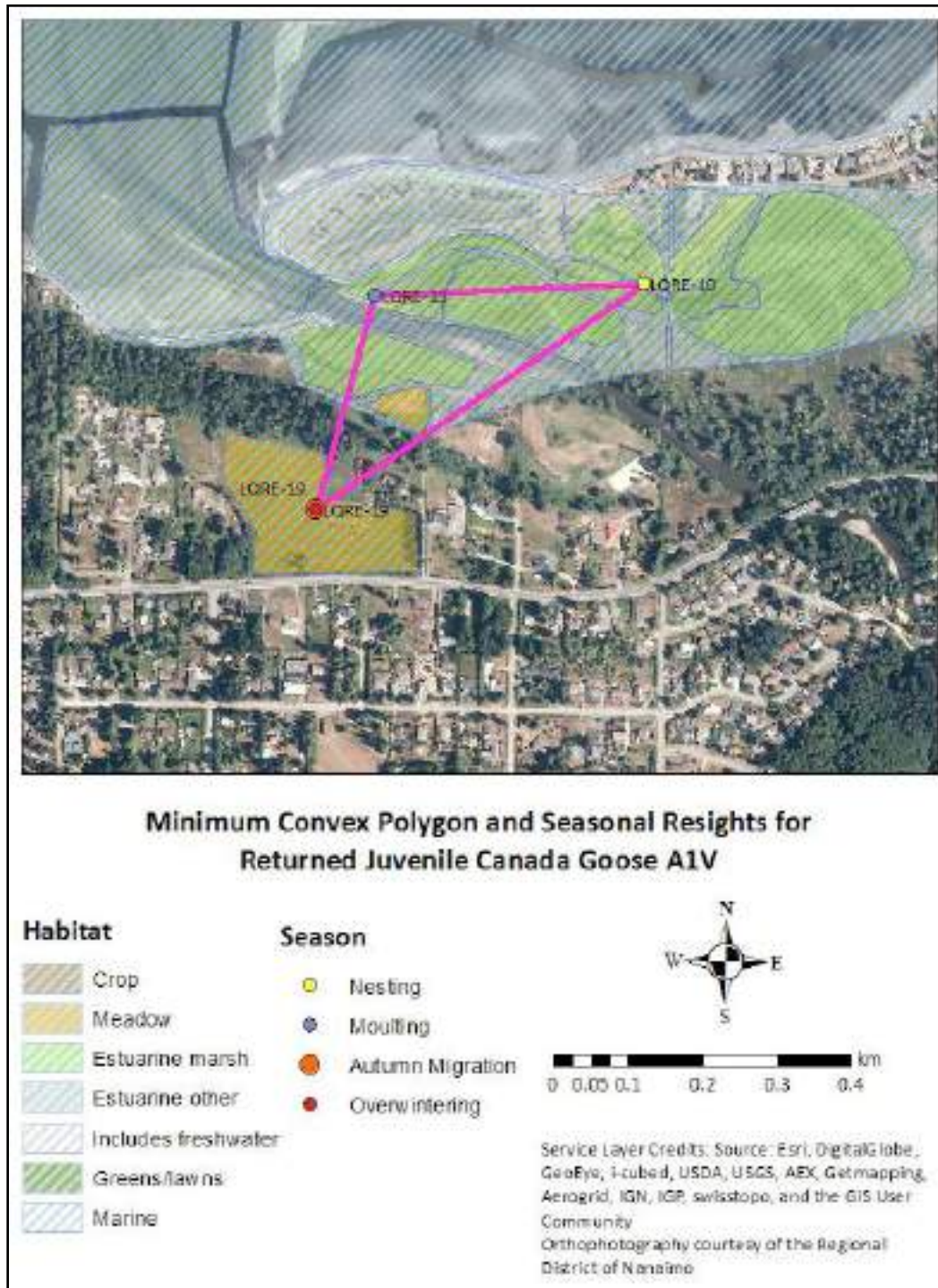
MCP map for Dispersed Juvenile 025T



KDE map for Dispersed Juvenile 025T

Returned Juvenile

A1V was banded at the LQRE in June 2009 as a hatch-year bird. She returned to the area in November 2012, and nested at the LQRE the following spring. Her three eggs were added on April 17, 2013.



MCP map for Returned Juvenile A1V

Emigrant

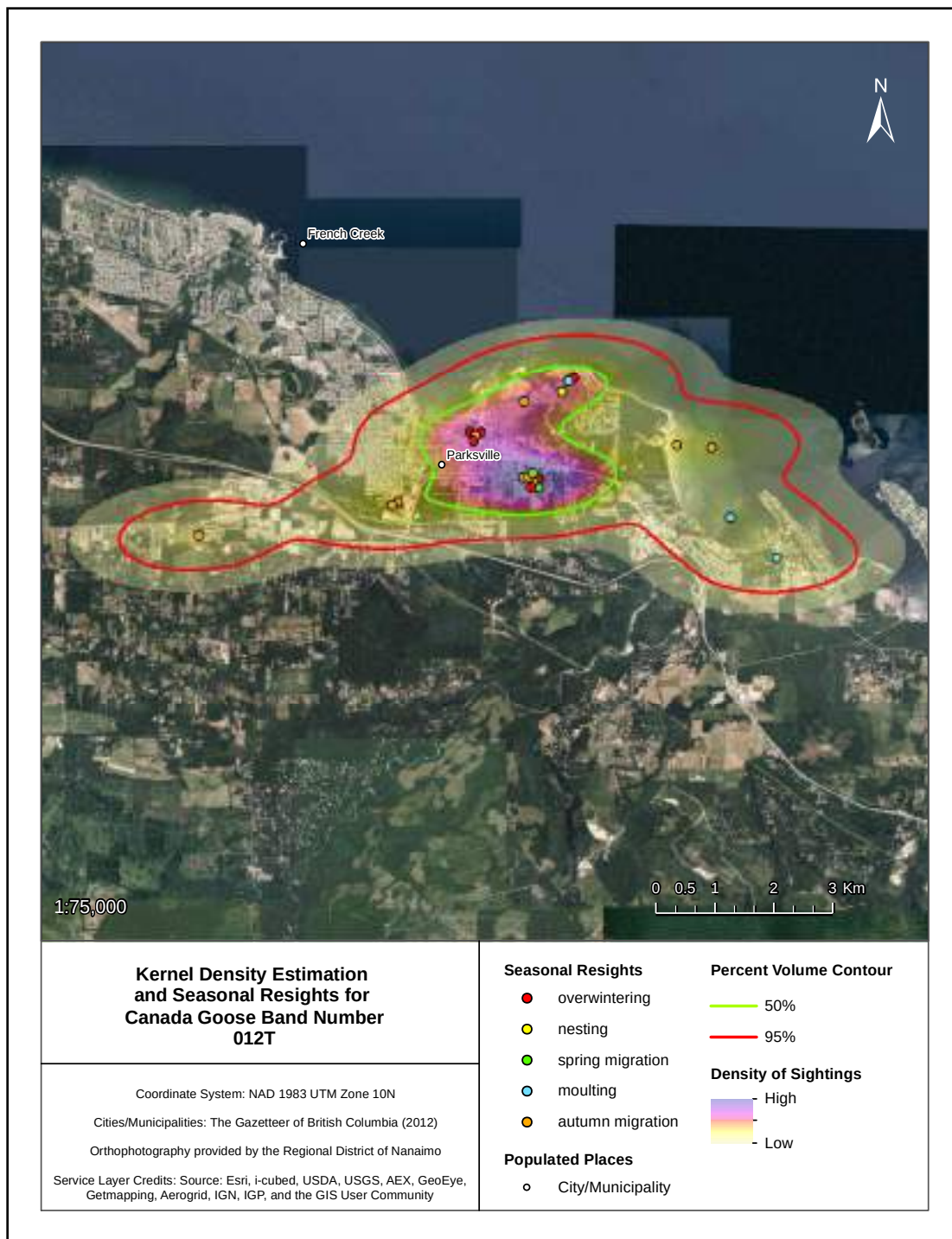
012T was banded at the CCE in July 2012. It used the ERE during the following autumn, winter, and spring migration seasons. It was last seen in the area, at the ERE, in July 2013.



Emigrant 012T (left), 012T with M017 (right)



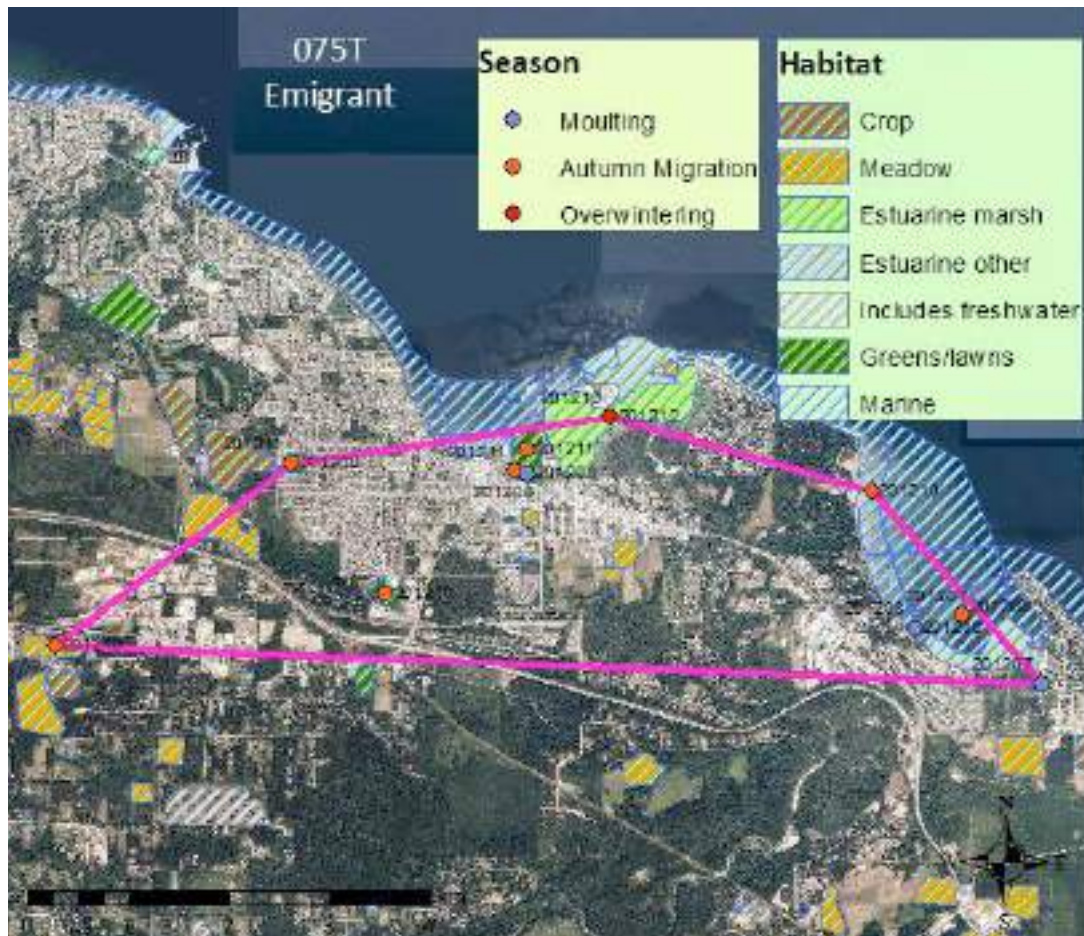
MCP map for Emigrant 012T



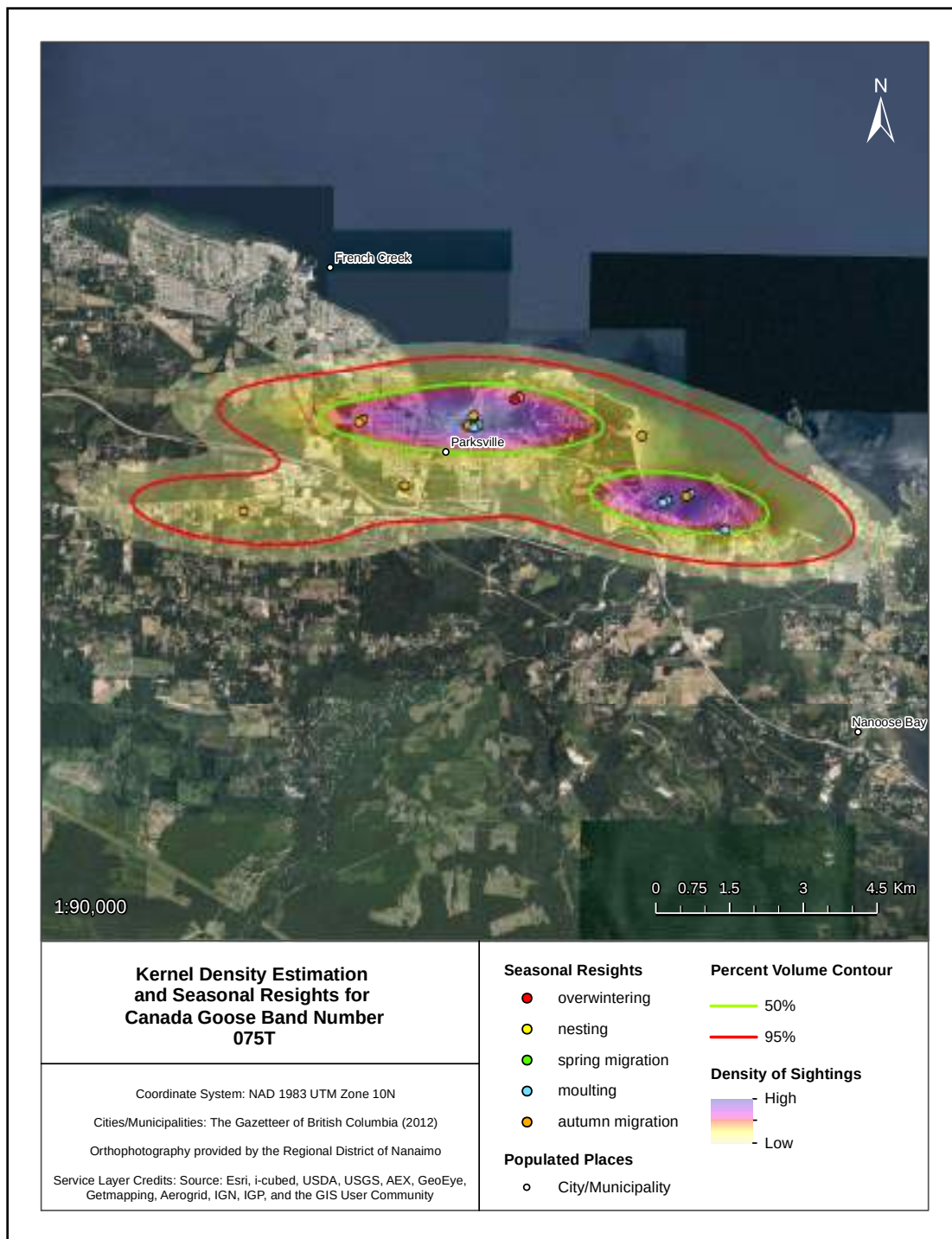
KDE map for Emigrant 012T

Emigrant

075T was banded at the CCE in July 2012, and had a home range similar to that of 012T. It used the ERE during the autumn and winter. It was last seen in the area in December 2012.



MCP map for Emigrant 075T



KDE map for Emigrant 075T

The local residents in each subpopulation use the landscape differently. M033 was banded at the ERE in 2010. Paired with M046, she laid 6 eggs in 2012, 7 eggs in 2013, and 6 eggs in 2014. She was seen at the ERE and in Parksville in each season.



Minimum Convex Polygon and Seasonal Resights for Local Resident Canada Goose M033

Habitat

- Crop
- Meadow
- Pasture/marsh
- Pasture/other
- Industrial/warehouse
- Urban/wild
- Marine

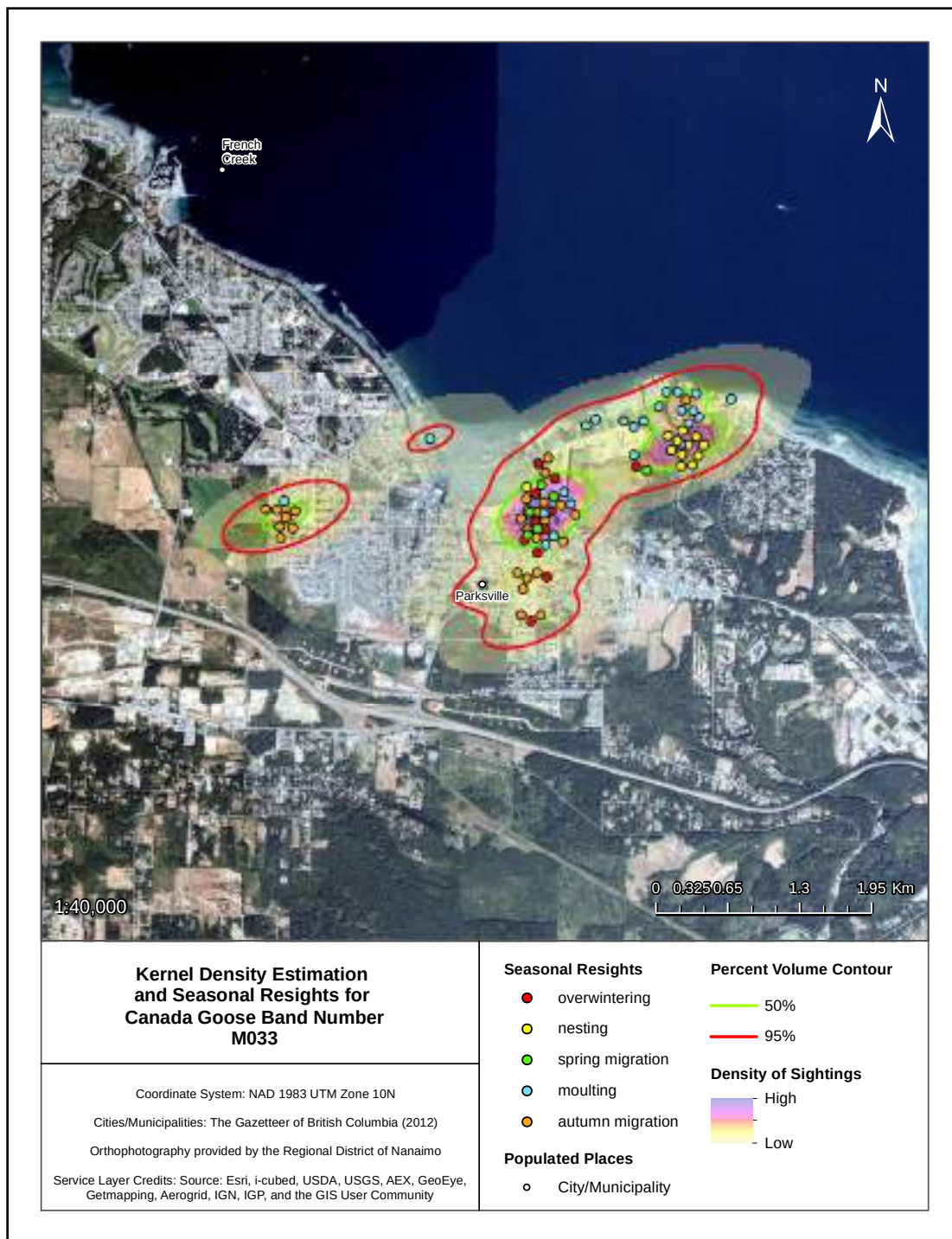
Season

- Spring Migration
- Nesting
- Molting
- Autumn Migration
- Overwintering

Scale: 0 0.2 0.4 0.6 0.8 1.0 1.2 1.4 1.6 km

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, iSatellite, IGN, USGS, Aero, GeoEye, GeoEye, IGN, HP, Swire, and the 30m Jan 2000 imagery. Orthophotography courtesy of the Regional Office of Toronto.

GUARDIANS OF MID-ISLAND ESTUARIES SOCIETY



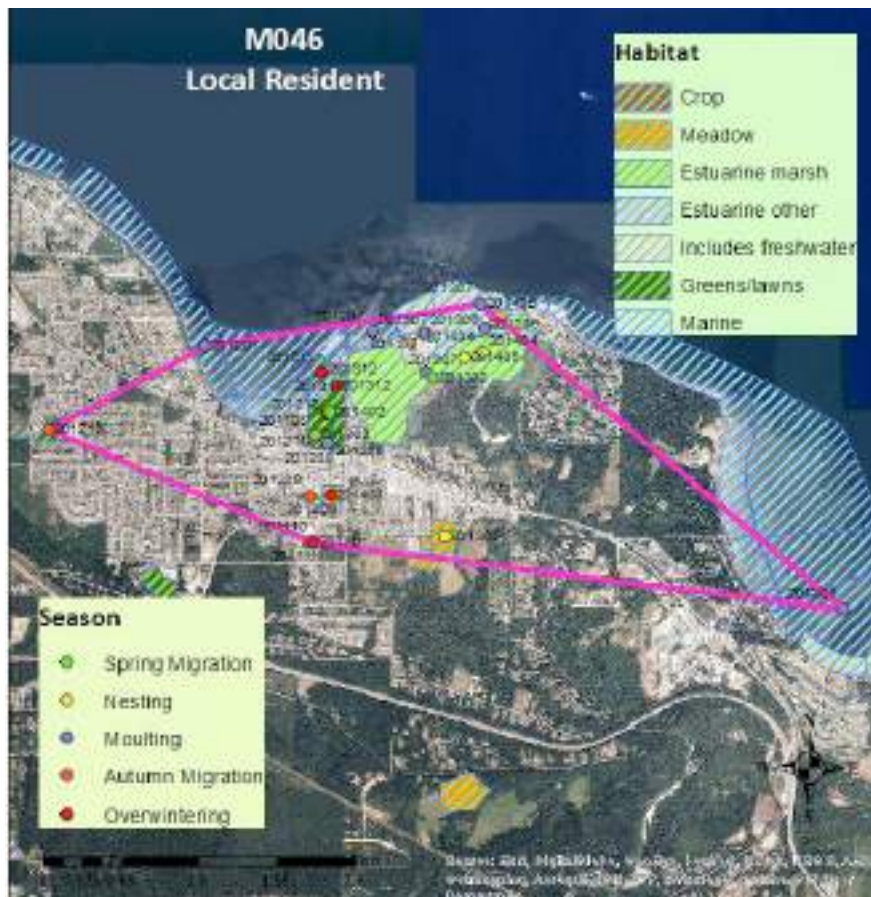
KDE map for Local Resident M033

Local Resident

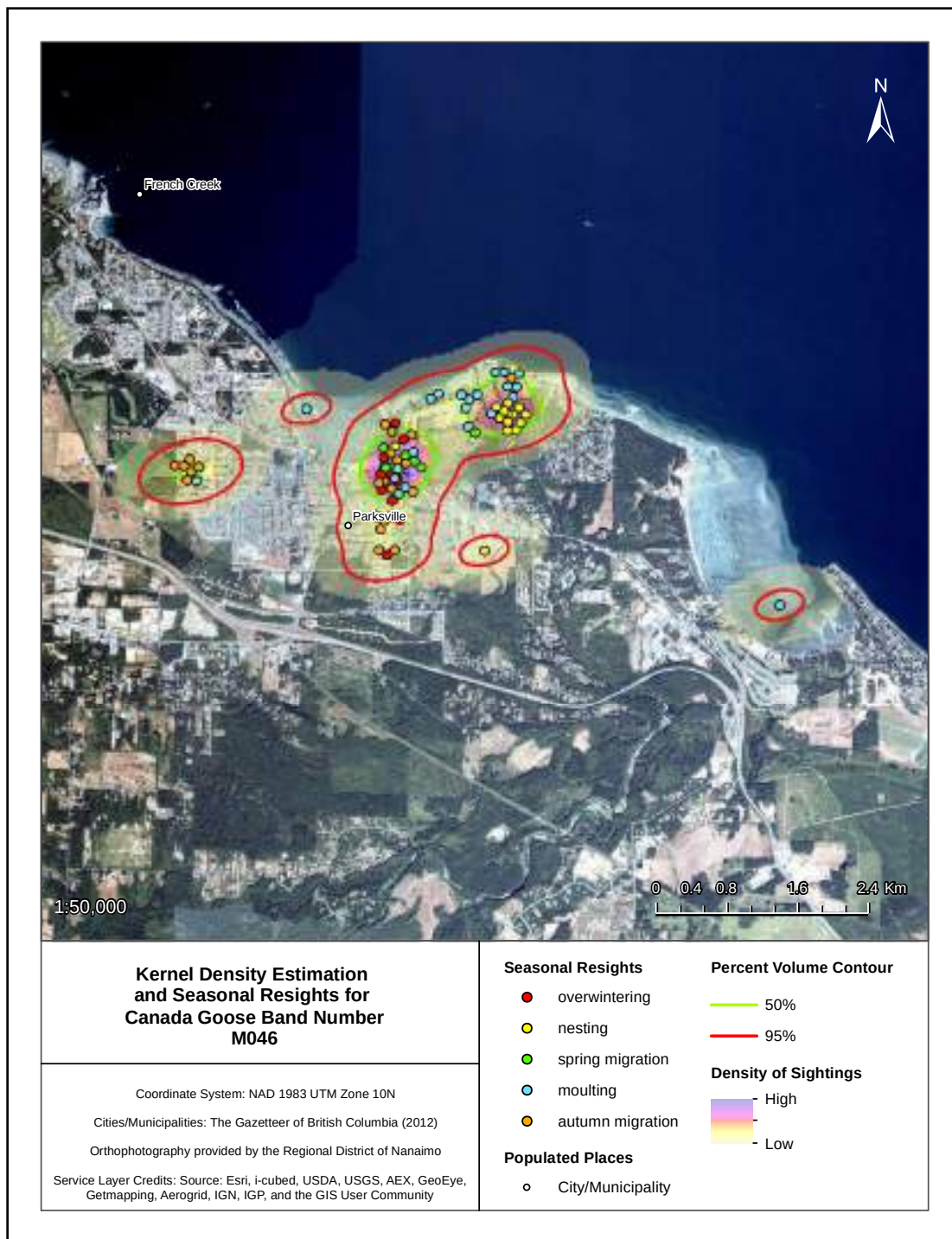
M046 is a gander banded at the ERE in 2010. He was paired with M033 (described above), and had a similar distribution. His moulting range included the CCE.



M033 and M046 on the nesting grounds



MCP map for Local Resident M046



KDE map for Local Resident M046

Local Resident

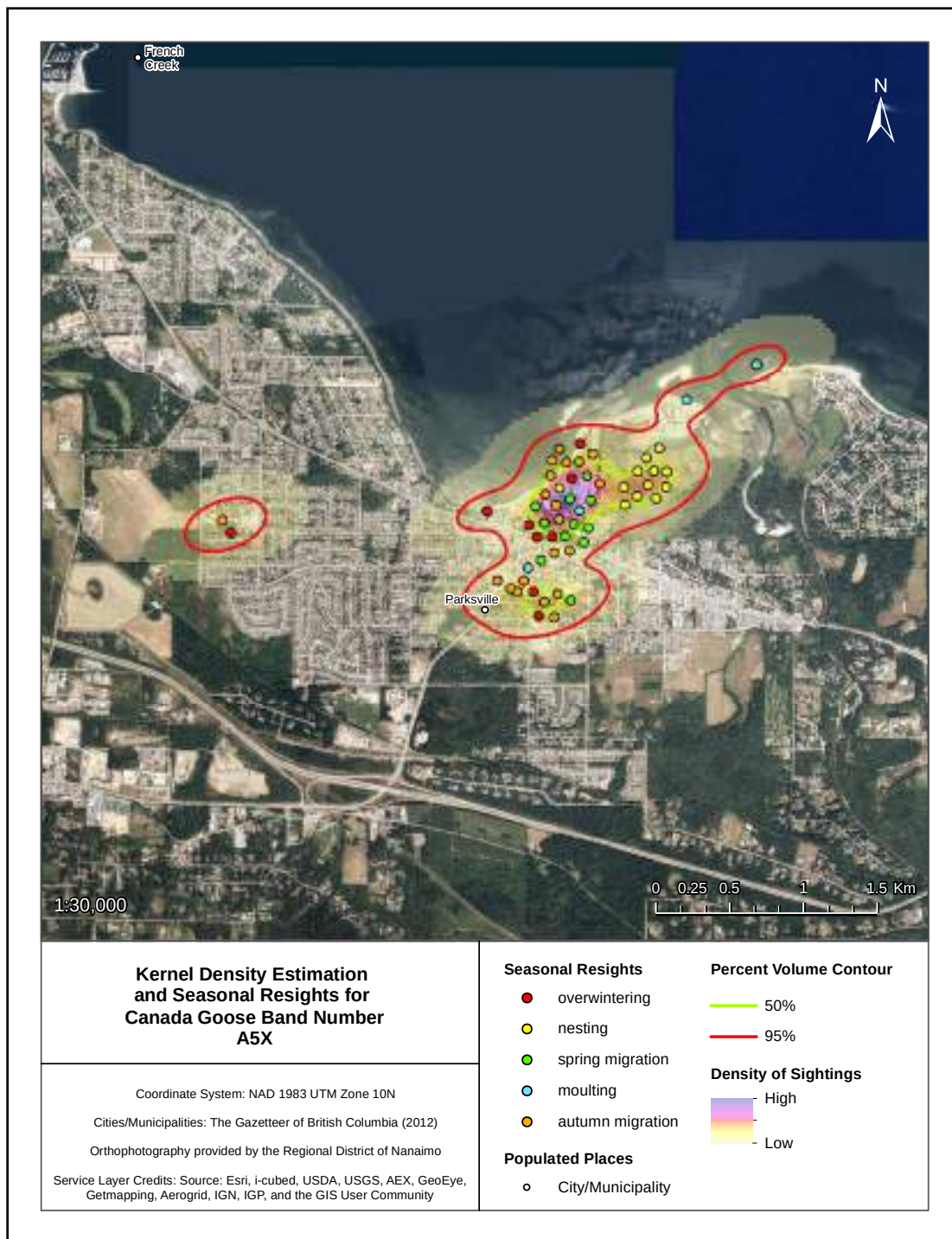
A5X was a nesting female banded at the ERE in April, 2008, incubating 8 eggs. A5X was incubating 6 eggs when her mate, A5M, was banded in 2009. They also nested on the ERE in 2011 (7 eggs), 2012 (8 eggs), 2013 (8 eggs), and 2014 (5 eggs Apr 5, 6 eggs Apr 28, 6 eggs May 5, 4 eggs May 19). Based on available data, A5X was primarily a resident of Parksville Community Park, never moving beyond the ERE and city limits. However, this leg-banded bird was not as visible as collared birds, particularly when swimming or standing in vegetation. She may have a larger range than shown here.



A5X defending her nest. Photo by Guy Monty.



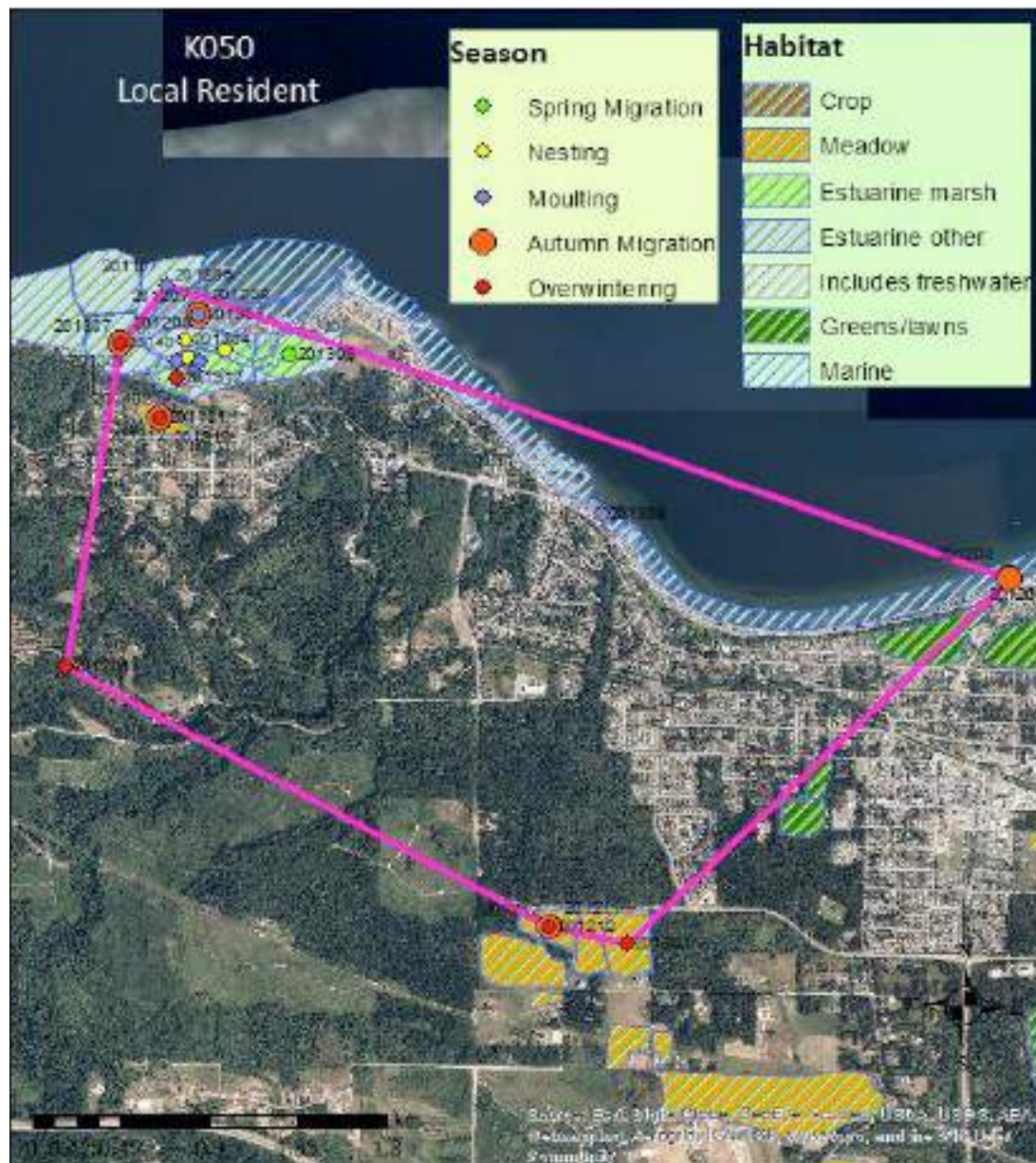
MCP map for Local Resident A5X



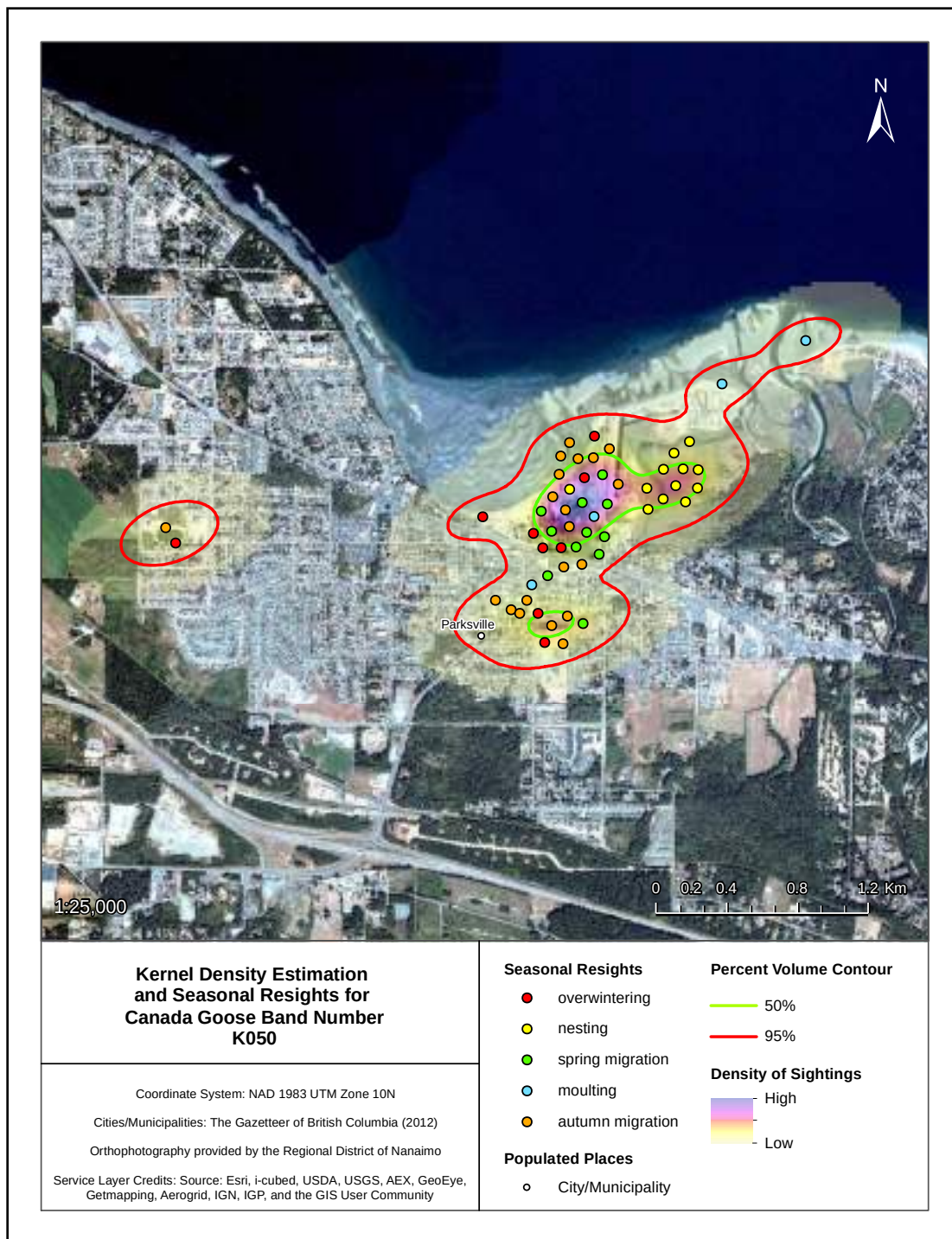
KDE map for Local Resident A5X

Local Resident

K050 was banded at the LQRE in 2010. It frequented the LQRE and nearby Windhaven Farm, and nested at the estuary in 2011. Its home range was typical of local resident “K” birds that do not frequent the Sunnymere/Hamilton Marsh area.

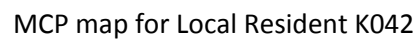


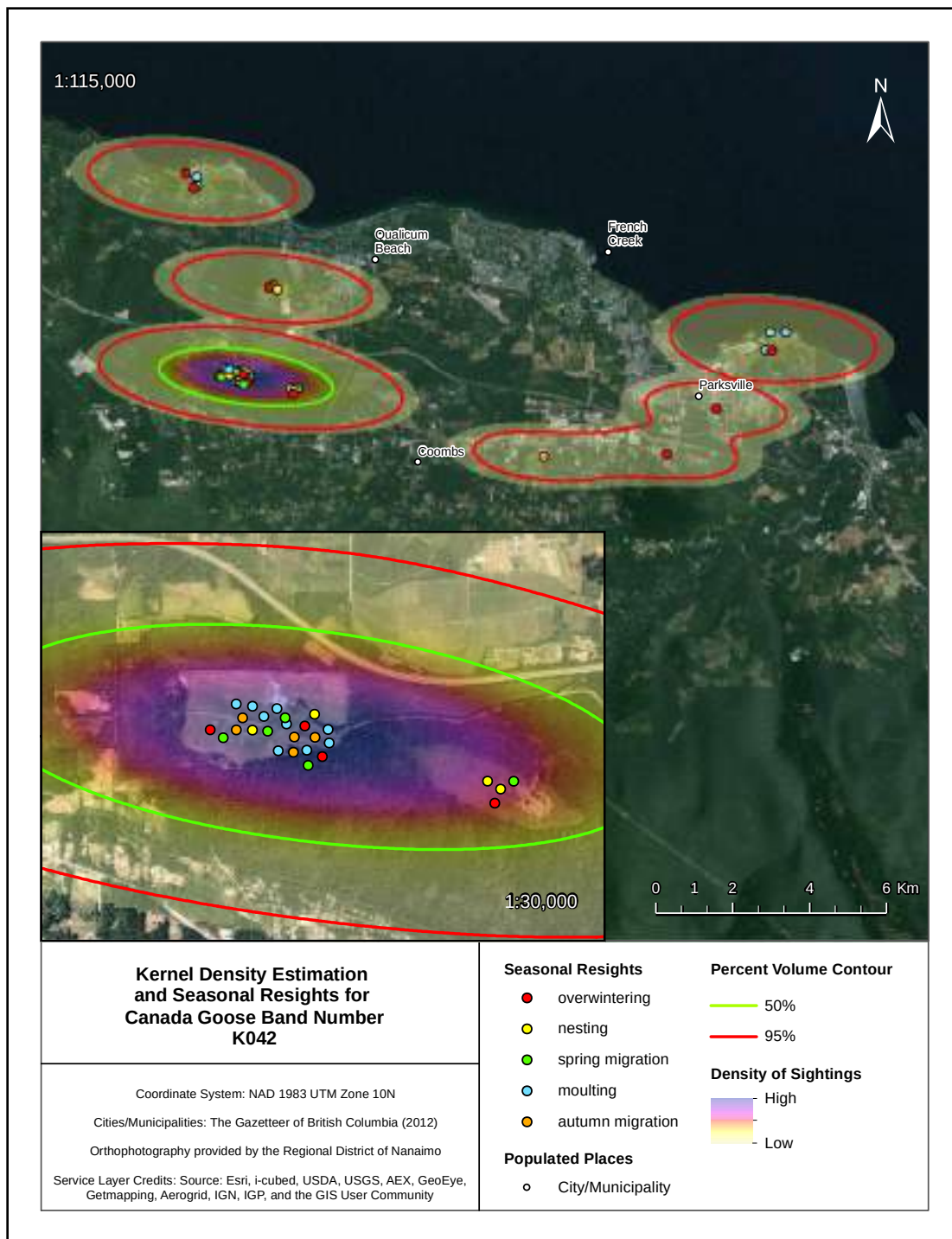
MCP map for Local Resident K050



KDE map for Local Resident K050

K042 was banded at the LQRE in 2010. It was seen most frequently at Sunnymere Farm and Hamilton Marsh, and probably nested at Hamilton Marsh in 2013. It was observed at the LQRE in January 2014, and at the ERE in June and July, 2013.





KDE map for Local Resident K042

Local Resident

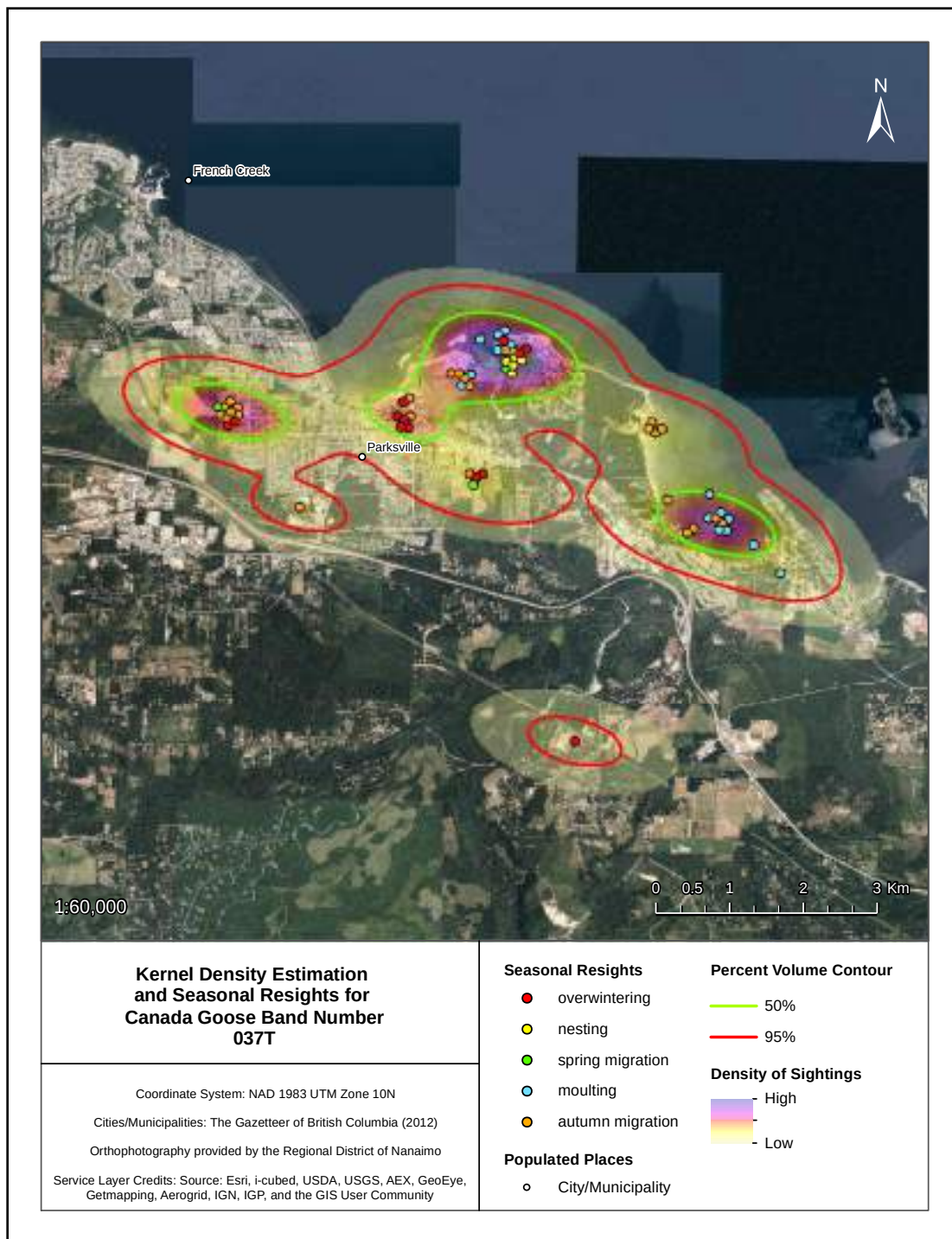
037T and 014T were local residents banded at the CCE in July 2012. Their ranges were identical, and they are included here to demonstrate how similar Canada Goose movements can be. 037T and 014T rarely ventured beyond the CCE and ERE and City of Parksville.



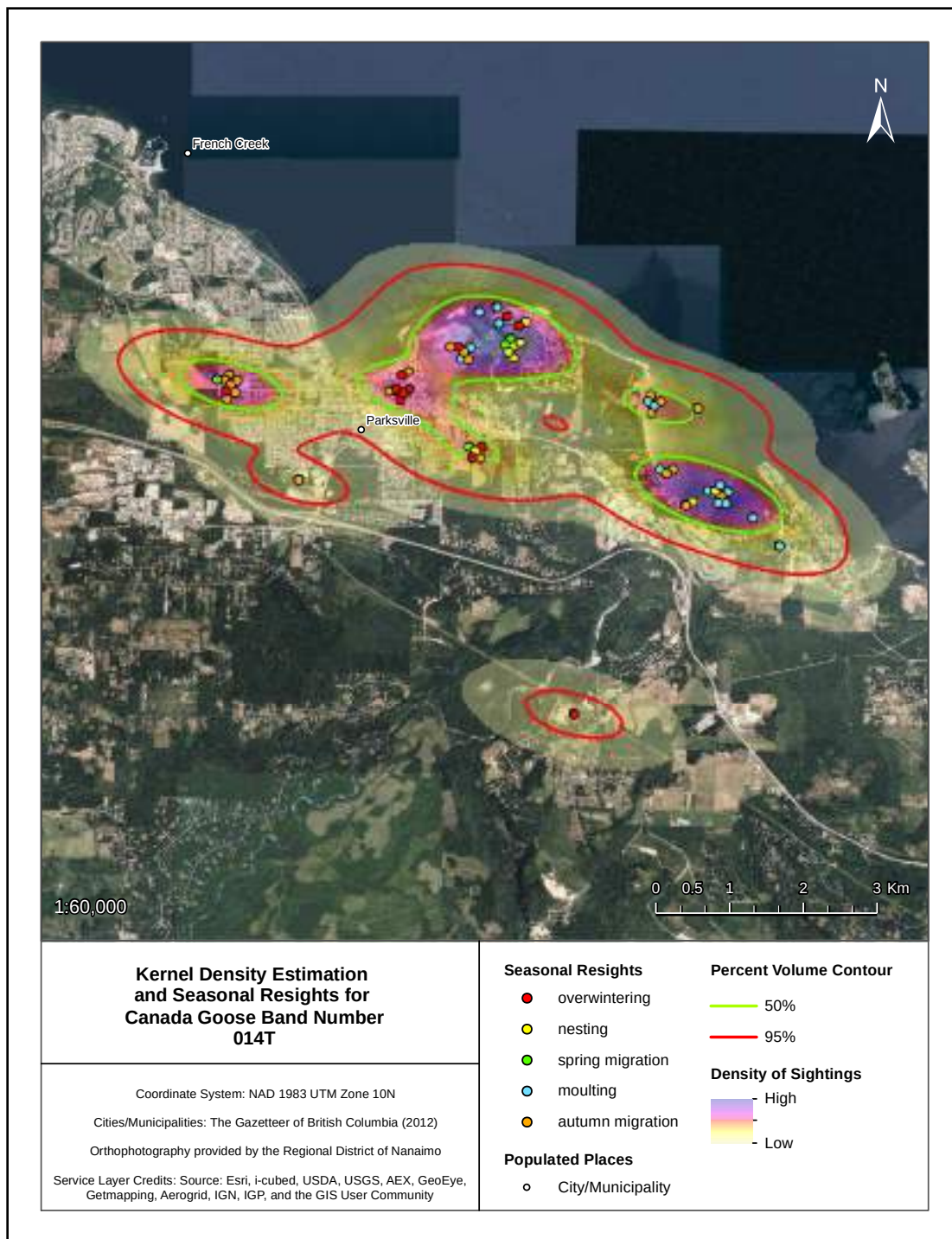
MCP map for Local Resident 037T



MCP map for Local Resident 014T



KDE map for Local Resident 037T



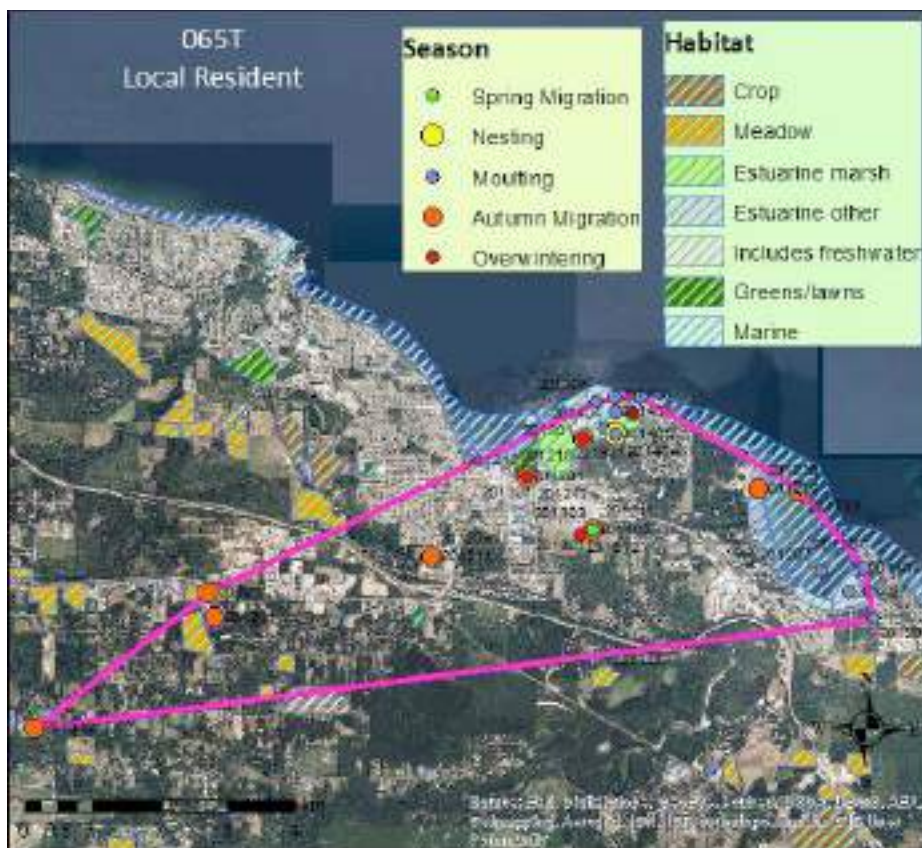
KDE map for Local Resident 014T

Local Resident

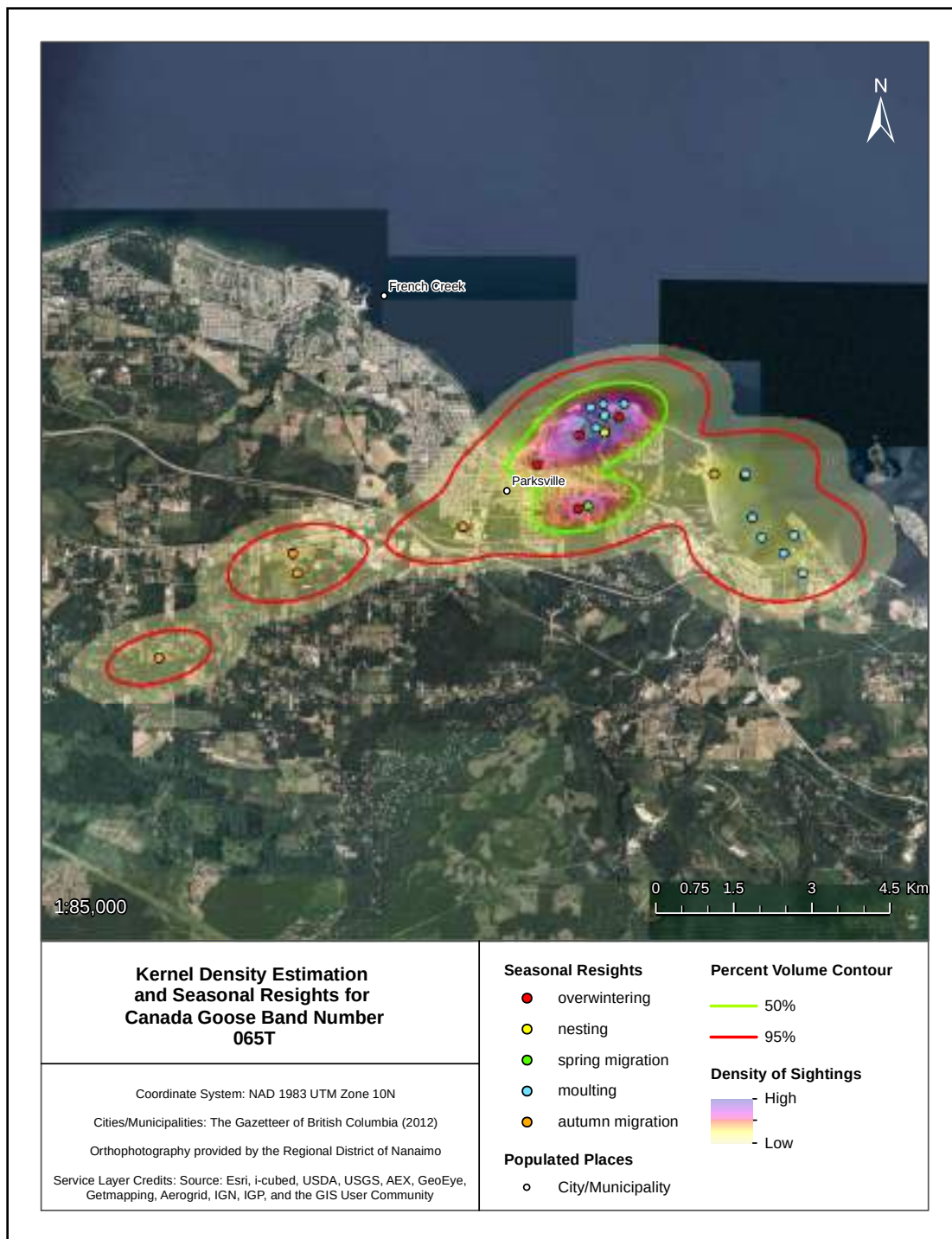
065T was also banded at the CCE in July 2012. It was on the ERE during the 2013 and 2014 nesting seasons, but was not observed nesting. During much of the autumn, it was found in Errington, as far as Belle Lake. In other seasons, it was found on the CCE, ERE and within city limits.



Local Resident 065T



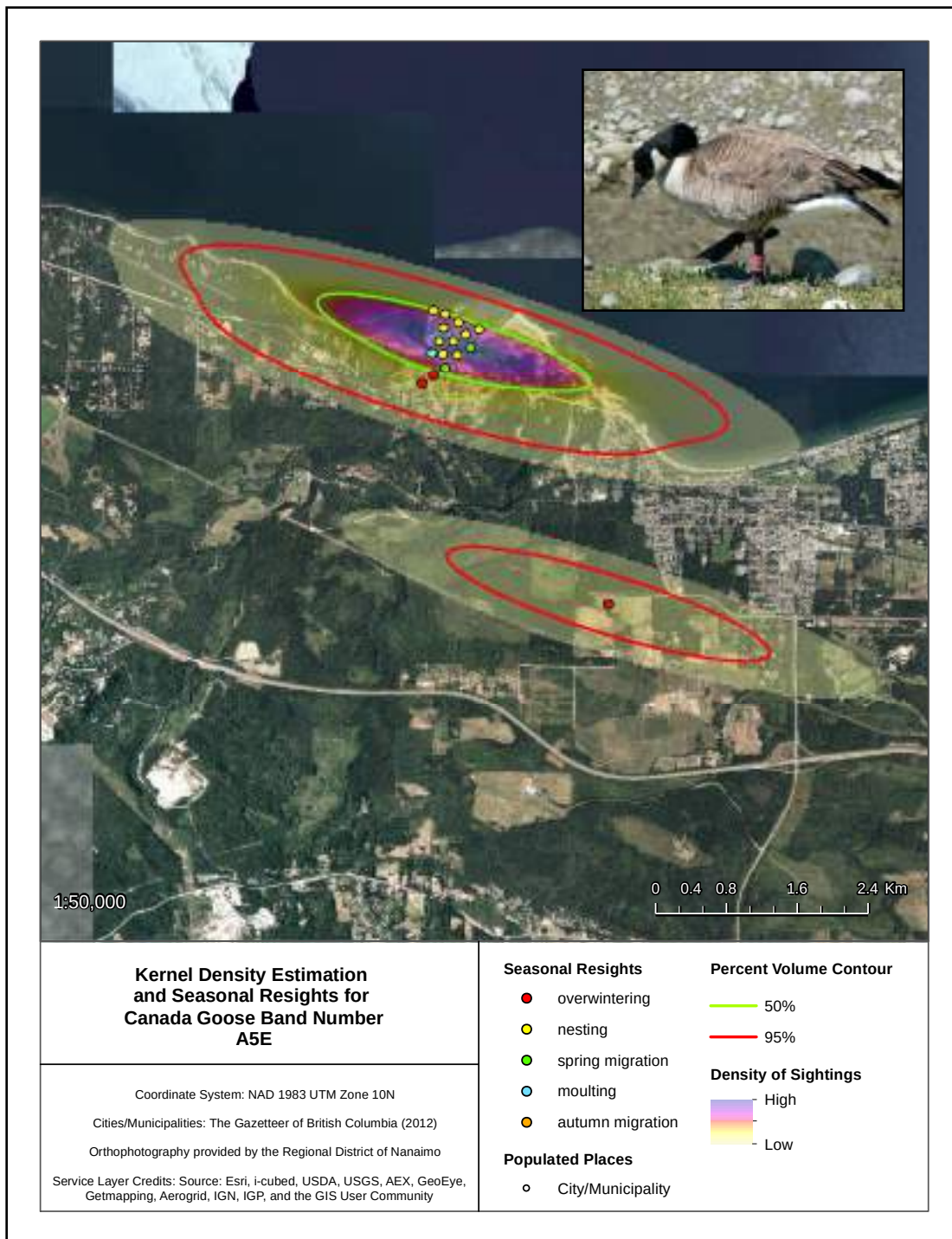
MCP map for Local Resident 065T



KDE map for Local Resident 065T

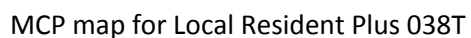
Local Resident Plus

A5E was a female banded at the LQRE in May, 2009; she was incubating 5 eggs. She nested at the LQRE in 2010 (6 eggs), 2011 (8 eggs), 2012 (7 eggs), and 2013 (8 eggs). A5E has never been observed in the area in the autumn.



KDE map for Local Resident Plus A5E

038T was banded at the CCE in July 2012. Its range during most of the year did not reach beyond the ERE and CCE estuaries and city limits. It used the estuaries for three consecutive moult seasons, and was not observed during the nesting seasons. 038T, and other Canada Geese that are absent only during the nesting season, may be local residents that nest outside of our search area.

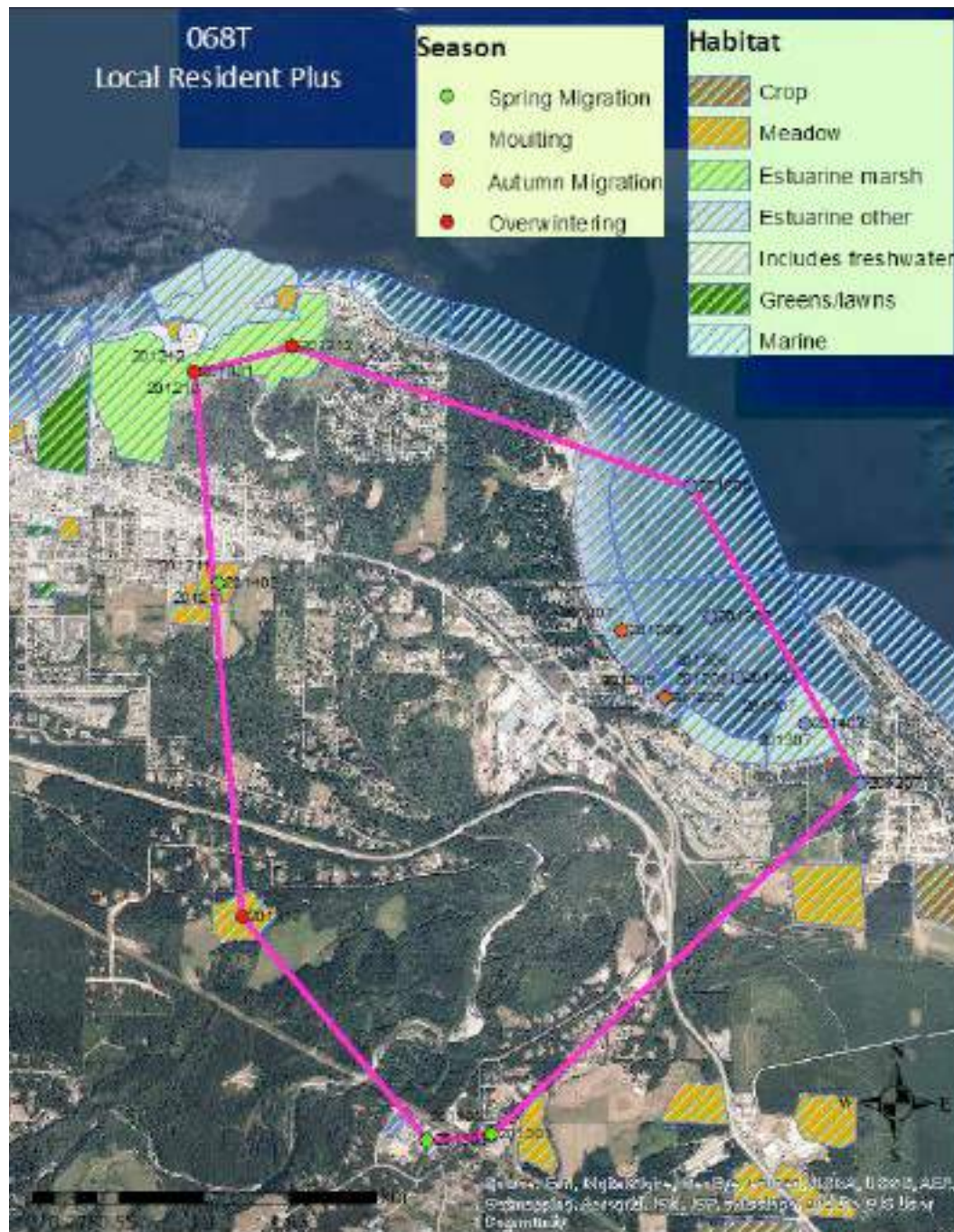




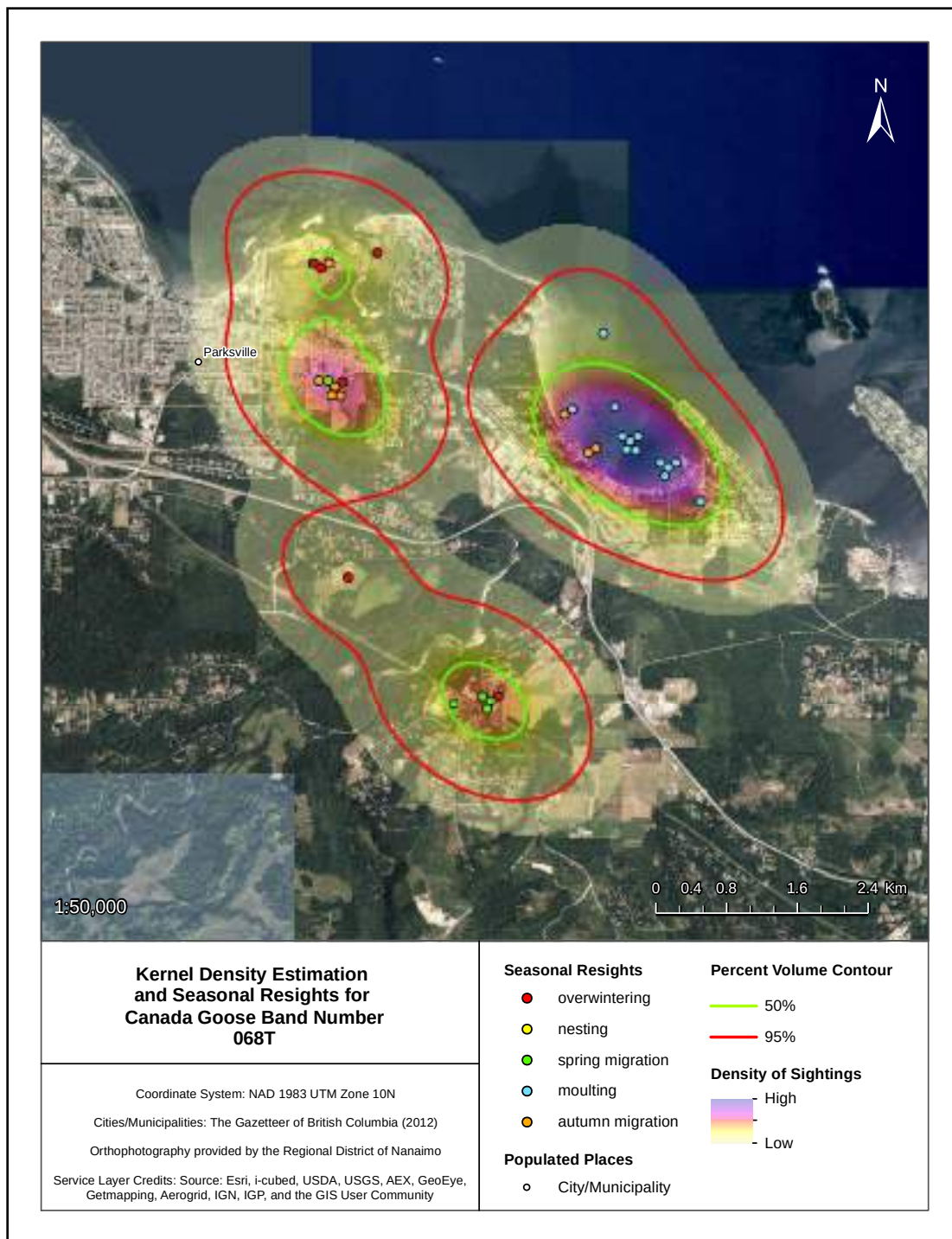
KDE map for Local Resident Plus 038T

Local Resident Plus

068T was banded at the CCE in July 2012. Aside from its frequent movements within the city and on the CCE and ERE, it was found in the River's Edge community from January through March 2013, and in Errington in December 2013. There were no records for 068T during the nesting season.

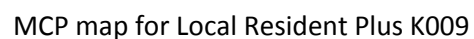


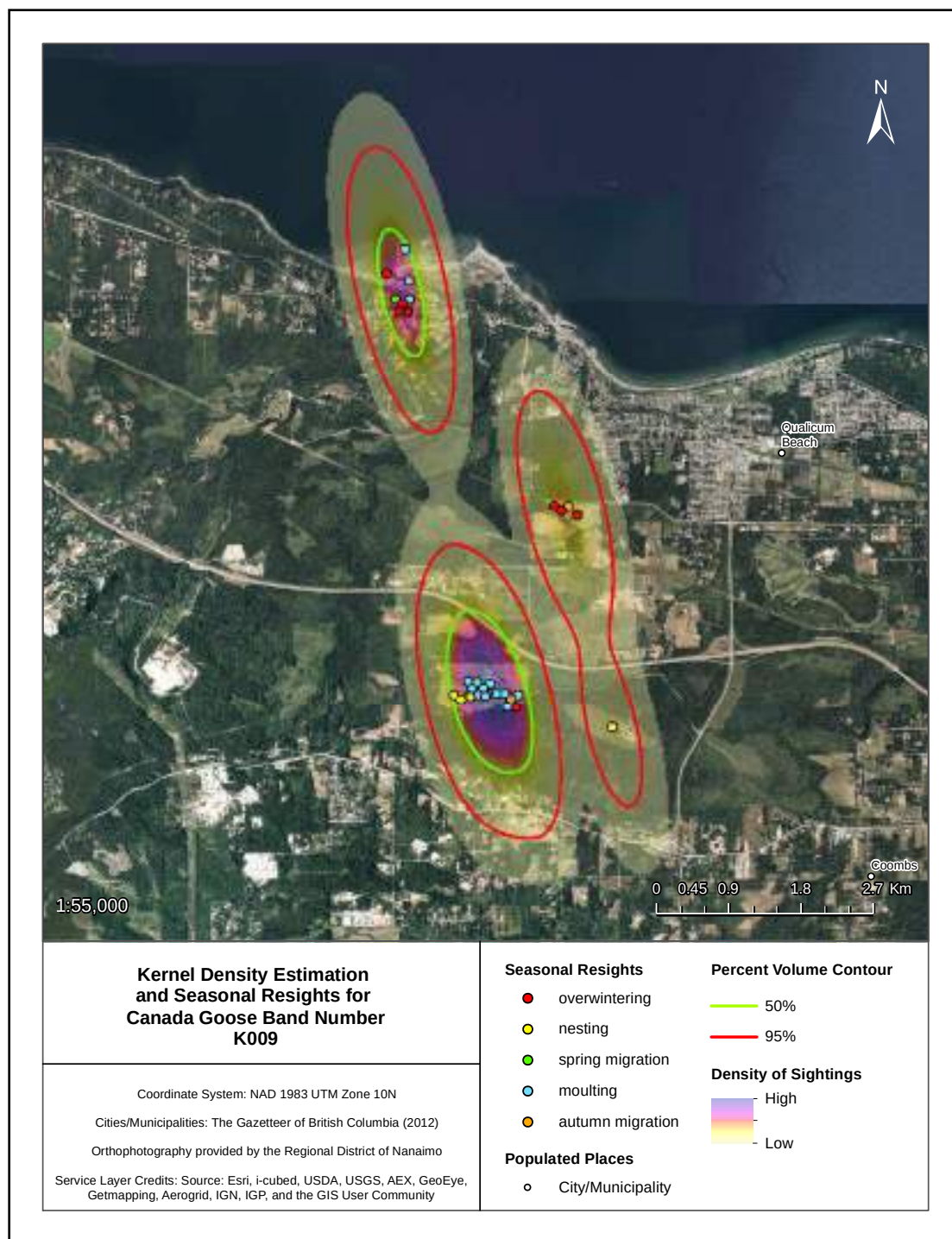
MCP map for Local Resident Plus 068T



KDE map for Local Resident Plus 068T

K009 was banded on the LQRE in 2010, and was observed at the LQRE again in July 2011 and January 2014. During most seasons, including the nesting seasons of 2011 and 2013, K009 was observed in the Hamilton Marsh/Sunnymere area.

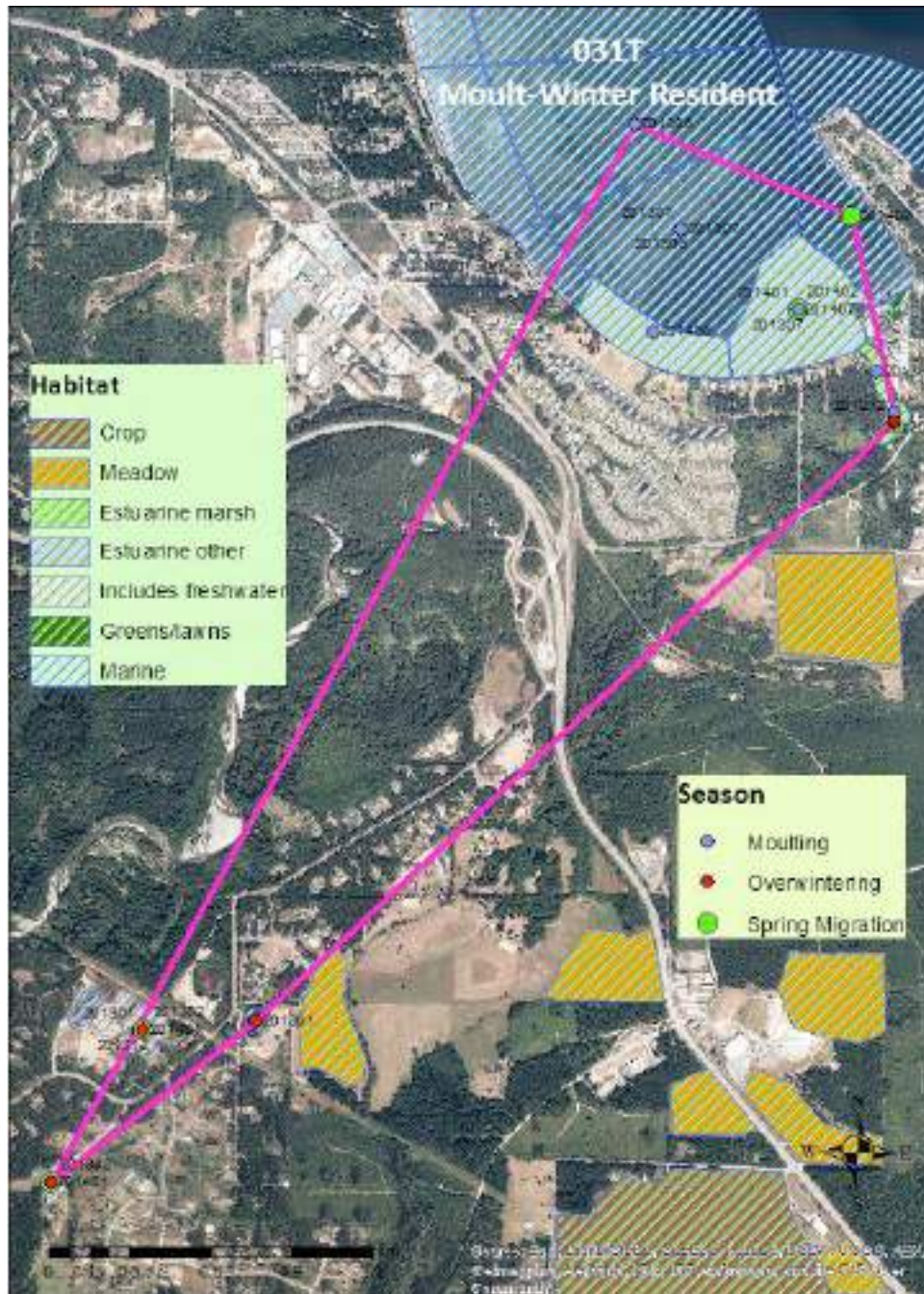




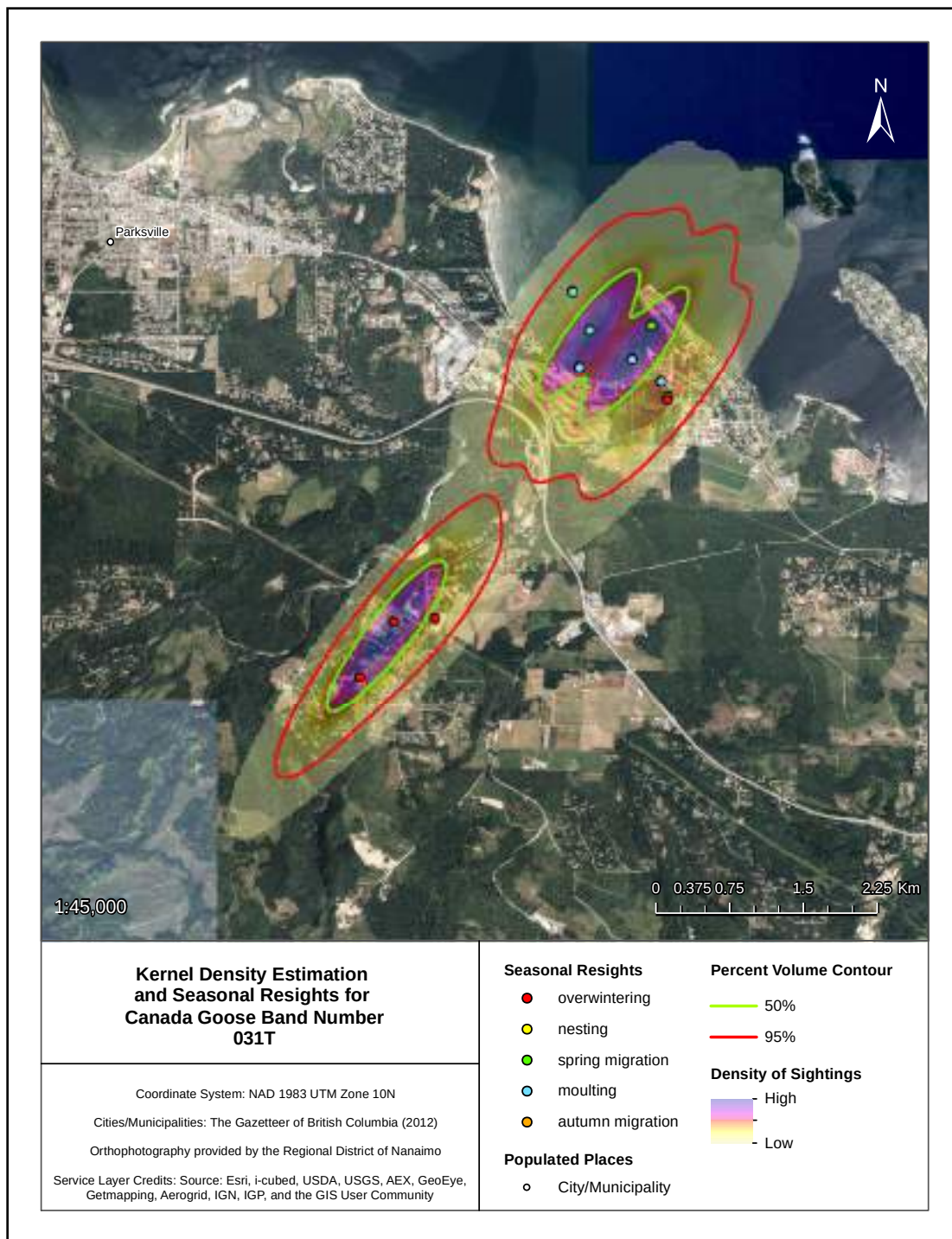
KDE map for Local Resident Plus K009

Moult-Winter Resident

031T was banded in July 2012 at the CCE. Since then, it has been observed in the area during the months of January, February, June, July, and December. In each of these months, 031T was found in the Craig Creek estuary/Craig Bay. It was also observed in Nanoose Bay's River's Edge community in December, January, and February.



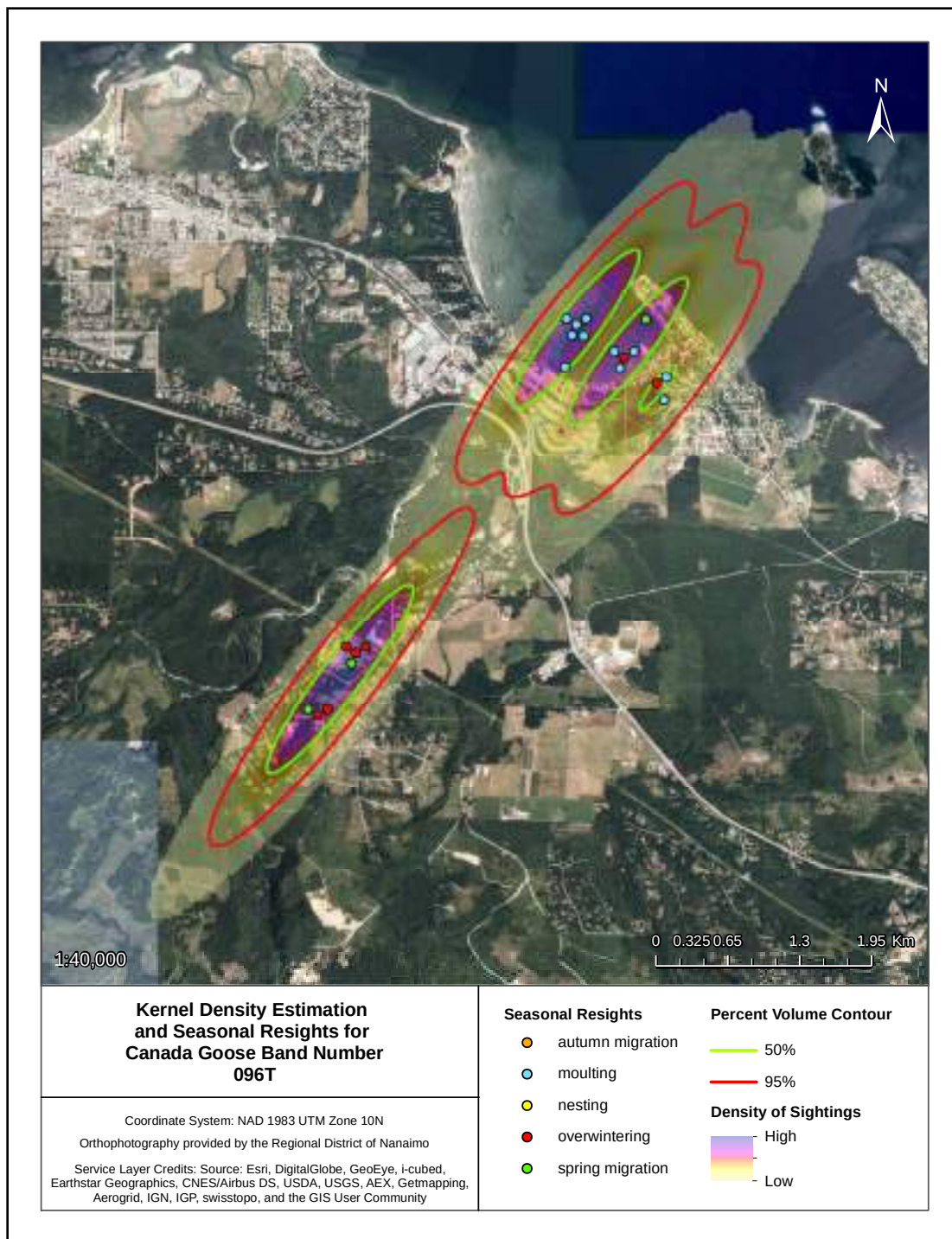
MCP map for Moult-Winter Resident 031T



KDE map for Moulting-Winter Resident 031T

096T was also a moult-winter resident. Its home range was similar to that of 031T.

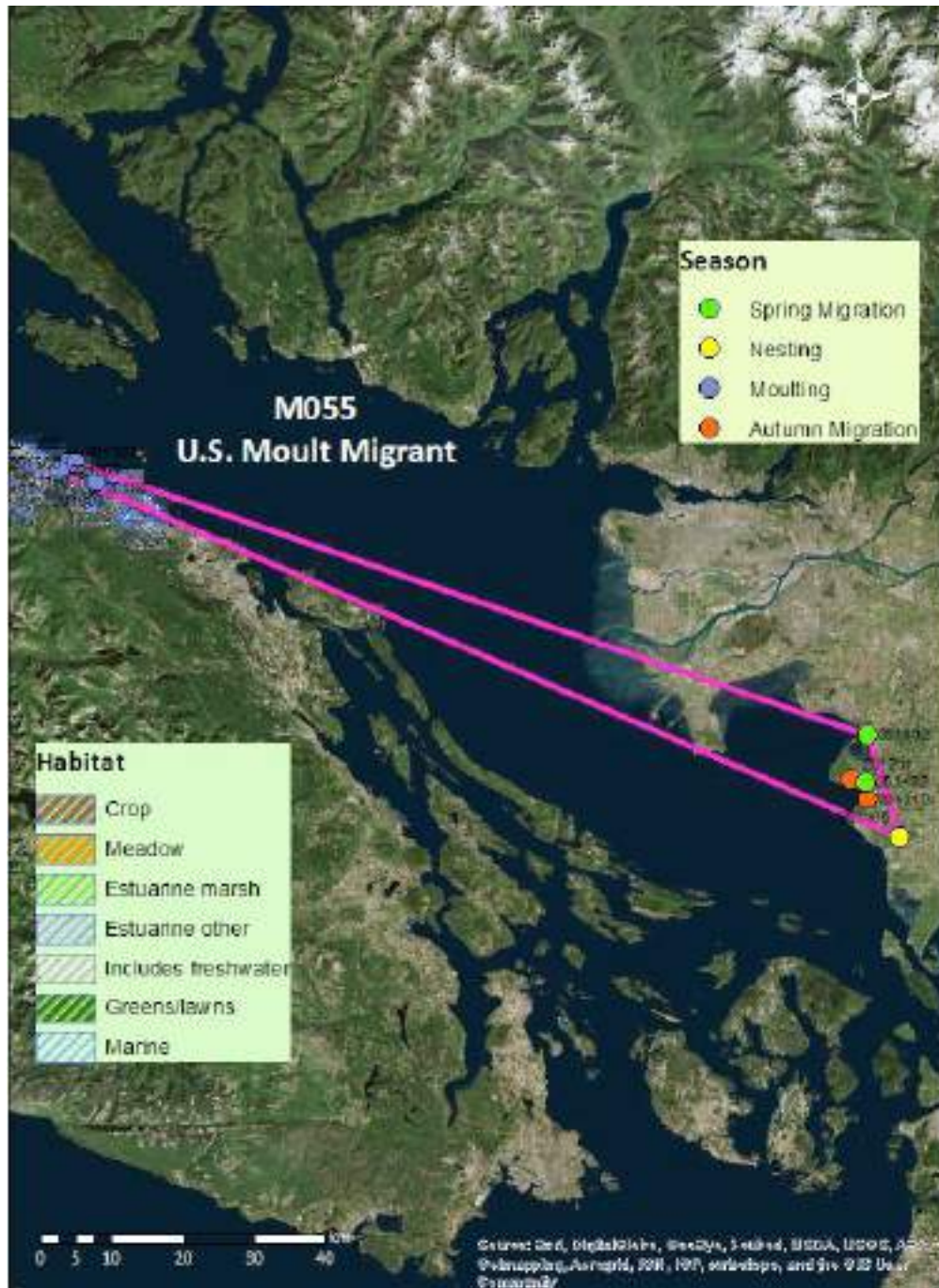




KDE map for Moulting-Winter Resident 096T

Moul Migrant

M055 was banded at the ERE in July 2010. It was spotted in Washington during the spring migration, nesting, and autumn migration periods. Still, it came back to the area (i.e., the ERE and CCE) to moult in 2011, 2012, and 2013.



MCP map for Moul Migrant M055



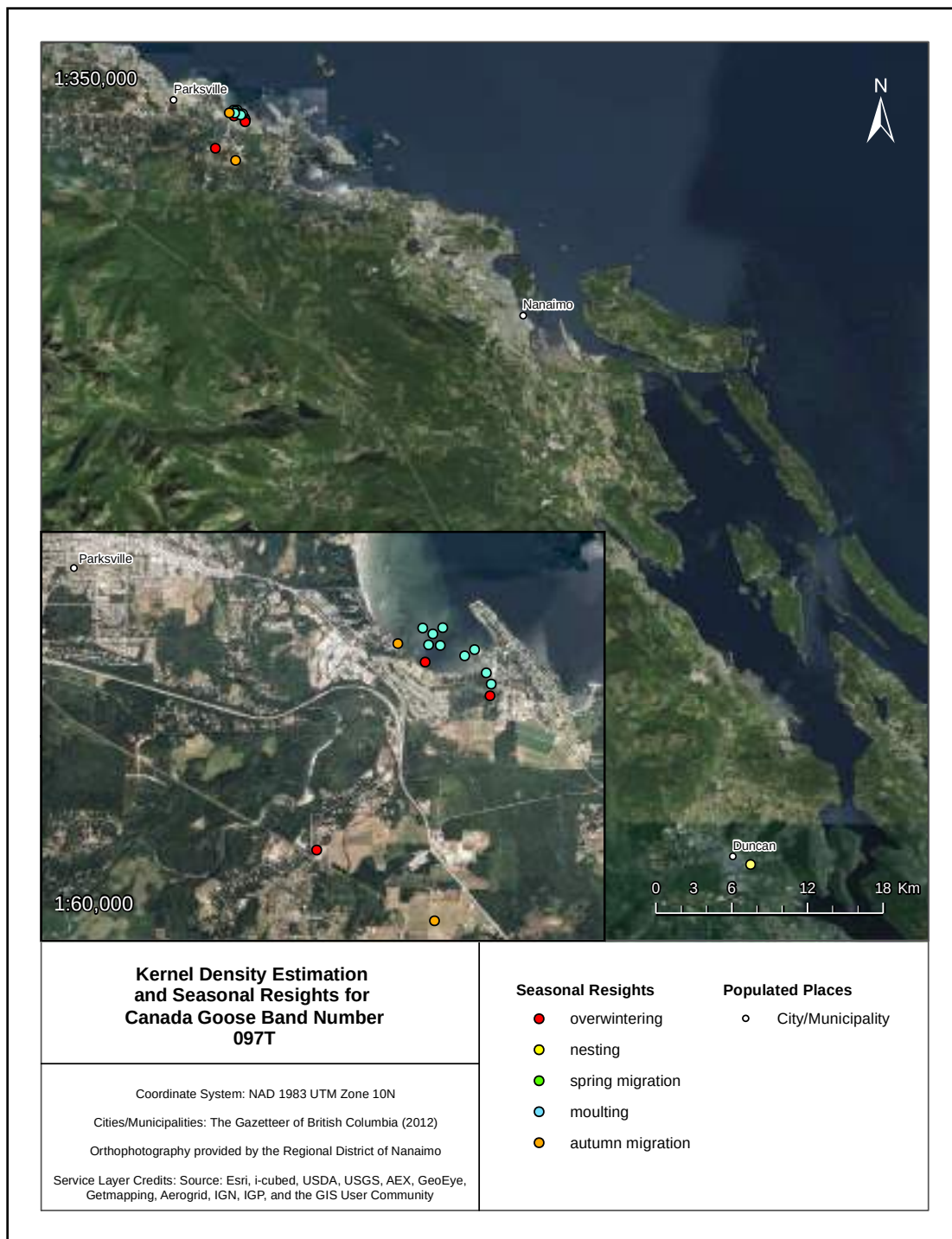
Re-sights for Moulting Migrant M055

Migrant

The movements of migrants were mostly unpredictable, and K077 is a good example of this. K077 was banded on the LQRE in July 2010. She nested on the edge of the mill pond at the LQRE in 2011, incubating 4 eggs. In September that year, she was observed northwest of Bowser, yet returned to the area in October. From mid-December 2011 through the end of May 2012, K077 was not encountered. She was seen regularly at the LQRE from June to October 2012, and then went missing until early March. In 2013, she returned and stayed on the LQRE from late March through July, but was not associated with an addled nest. K077 was last seen in the region at the LQRE in July 2013.



MCP map for Migrant K077



Re-sights for Migrant 097T

Migrant

097T was banded at the CCE in July 2012. It stayed in the area until at least January, then nested in the Cowichan Valley. By mid-June, it had returned to the CCE to moult. It was spotted in Nanoose Bay's River's Edge community in late October, 2013.



MCP map for Migrant 097T

U.S. Migrants and Moults Migrants

Most of the 13 geese assigned a U.S. migrant type were re-sighted in America during the spring and fall migrations. Five were shot there, during all seasons aside from the nesting season.

CAGO	Spring Migration	Nesting	Moulting	Autumn Migration	Overwintering
022T - MM	California 2013	missing	CCE return 2013	NBCB 2012	NBCB Dec 2012-Jan 2013
024T	California 2013 shot	missing	banding only	NBCB 2012	NBCB, PBC 2012
066T - MM	California 2013	missing	CCE return 2013	NBCB 2012	NBCB Dec 2012-Jan 2013, Dec 2013
070T	Oregon 2014	NBCB end of May 2013	CCE return 2013	missing	missing
M027	missing	missing	Washington 2011 shot	Oregon 2010	missing
M042	missing	missing	banding only	Washington 2014 shot	missing
M043	missing	missing	banding only	missing	Oregon 2010 shot
M050	missing	missing	banding only	Washington	missing
M055 - MM	Washington 2014	Washington 2011	ERE return 2011, 2012, 2013	Washington 2010, 2012	missing
M058	missing	missing	Oregon 2011	missing	Oregon 2014 shot
M059	Oregon 2011	missing	banding only	Oregon 2010	missing
M063	Washington 2011	missing	banding only	Oregon 2010	Washington 2011 shot
M067	Washington 2011	missing	banding only	Washington 2010	missing