

Abundance, distribution, movement, and mortality of Canada Geese (*Branta canadensis*) in Nanaimo, British Columbia

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Abstract: Since being introduced to Vancouver Island in the 1960s and 1970s, the Canada Goose (*Branta canadensis*) has become increasingly abundant. Abundant goose populations have been implicated in human-goose conflicts in recreational areas, and causing significant damage to estuaries and crops. A few communities have developed management strategies to address these impacts, but planning for such strategies in Nanaimo has been limited by a lack of information about the abundance, distribution, and movement patterns of the local goose population. The goal of this study was to assess the Canada Goose population within the City of Nanaimo and nearby outlying areas, in order to support a management strategy for the Canada Goose population in the Nanaimo area. This objective was achieved using a combination of regular count surveys and bird banding. To monitor movements of Nanaimo-area geese, 400 individuals were captured (200 in June 2016 and 200 in June 2017) and fitted with metal leg bands and plastic neck collars. Results from regular surveys suggest that Canada Goose abundance in Nanaimo fluctuated seasonally. The majority of the Canada Goose population on Vancouver Island was thought to be resident; however, sightings of collared individuals indicate that much of the population (52%) may actually disperse seasonally. This study documented seasonal abundance and distribution in Nanaimo as well as local, regional, and long-distance movement of collared Canada Geese. This information can provide a basis for informed management decisions.

Keywords: Canada Goose; *Branta canadensis*; bird banding; neck collar; VIU Bird Banding Project; Nanaimo; Vancouver Island.

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Introduction

The Canada Goose (*Branta canadensis*) is a large and prominent bird found throughout North America (Mowbray *et al.* 2002). Although native to British Columbia, it was formerly only a migrant or winter resident over most of Vancouver Island, with a small breeding population of Vancouver Canada Geese (*Branta canadensis fulva*) on the north end of the island (Campbell *et al.* 1990; Dawe and Stewart 2010). Popular with hunters and nature enthusiasts alike, government and private organizations introduced Canada Geese to many areas in southern British Columbia, including Vancouver Island, several decades ago, peaking during the late 1960s and 1970s (Campbell *et al.* 1990). The objective of these introductions was to establish a population of geese for hunting and wildlife viewing (Dawe and Stewart 2010; Capital Regional District 2012). Canada geese are highly adaptable birds, and Vancouver Island offers a wide range of suitable habitats. Local studies have shown a high degree of site fidelity among female

Canada geese, which often return to nest in the very same area they were hatched (Clermont 2015). The combination of these factors has created a hybridized breeding population of Canada Geese on Vancouver Island, which was comprised from at least three subspecies brought from the North American interior. Since the late 1990s, this increasing population of geese has grown to problematic levels (Dawe and Stewart 2010). Audubon Christmas Bird Count data indicate that the Nanaimo winter population has increased (Figure 1). This introduced population of geese is known to foul sports fields, parks, and beaches with droppings, and can cause significant economic losses to farmers (Campbell *et al.* 1990; Capital Regional District 2012; Clermont 2015). In addition, the geese have caused profound, long-lasting negative impacts to coastal British Columbia estuaries and other sensitive ecosystems (Isaac-Renton *et al.* 2010; Dawe *et al.* 2011; Clermont 2015; Dawe *et al.* 2015). It is expected that without proper management initiatives, Canada Goose populations in the region will continue to grow extensively, resulting in an

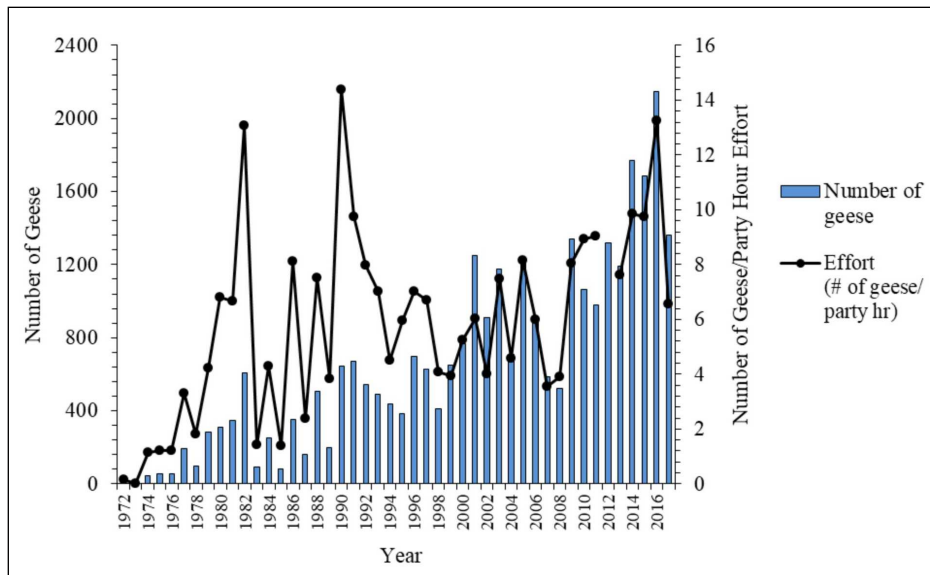


Figure 1: Christmas Bird Counts of Canada Geese (*Branta canadensis*) in Nanaimo, B.C., 1972–2017 from Audubon Society (2018). Counts are conducted on a single day, and occur between mid-December and early January of each year (Note: no effort data for 2012).

escalation of goose-related problems (Capital Regional District 2012).

The objective of this project was to assess the abundance, distribution, and movement of Canada Geese within the City of Nanaimo and nearby outlying areas, in order to generate data necessary to develop a management plan for Canada Geese in the Nanaimo area. These data can also be used to support the development of a regional Canada Goose management strategy for southeastern Vancouver Island, with the goal of mitigating goose-related problems across the region.

Methods

Regular Surveys

A detailed survey route throughout Nanaimo served as the backbone for this project. The purpose of the survey was to quantify Canada Geese in the Nanaimo area throughout the year. The survey route started at farm fields beside the Duke Point Highway in Cedar and finished at Winchelseaview Golf Course in Upper Lantzville. Most of the sites were viewable from the roadside, but some required a brief walk to a particular viewpoint. Volunteers on Protection Island conducted a count for Newcastle Island during the same time period as the survey; when volunteers were unavailable, the Newcastle Island count was performed from the Millstone Estuary with the use of a spotting scope. Surveys commenced on 30 June 2016, and were conducted at approximately three-week intervals; the final survey was conducted on 18 June 2018. Each survey started at approximately 09:00, and the route was travelled in the same direction every time. Geese were enumerated at each site by counting both the total number of geese and

the number of collared geese (see Banding and Collaring below). If possible, neck collar codes were recorded (when present). When necessary, Vortex Crossfire 10x42 binoculars and a Vortex Nomad 20-60x60 spotting scope were used as visual aids.

Banding and Collaring

In addition to the surveys, metal leg bands and plastic neck collars were applied to 400 Canada Geese over two years (200 geese in June 2016 and 200 geese in June 2017). An additional 100 geese were fitted solely with metal leg bands in June 2017. The bands and collars used were standard issue for large-bodied Canada Geese, commonly used in the North American Bird Banding Program (USGS 2016). Collars specific to this project were white with black lettering, denoted by a three-digit code followed by the letter “P” (2016 collar codes ranged between 000P – 199P; 2017 collar codes ranged between 201P – 400P). The use of neck collars enabled identification of individuals in the field, which provided valuable information to estimate the distribution and movement of geese in the area (Johnson and Sibly 1989). In addition, collared geese were distinguishable within a flock and represented a portion of the overall population, which allowed estimation of overall abundance.

Late June and early July is the moult period for Canada Geese on Vancouver Island, and is an opportune period to capture geese easily. The 2016 roundups and banding took place at Westwood Lake, Hammond Bay, Departure Bay, and the Nanaimo River Estuary from 23 to 27 June. The 2017 roundups and banding took place at Lantzville, the Nanaimo River Estuary, and Newcastle Island from 23 to 30 June. Each banding session was completed with a crew of 12 to 15 people. Prior to commencing each roundup, a pen was constructed in a suitable location to contain the

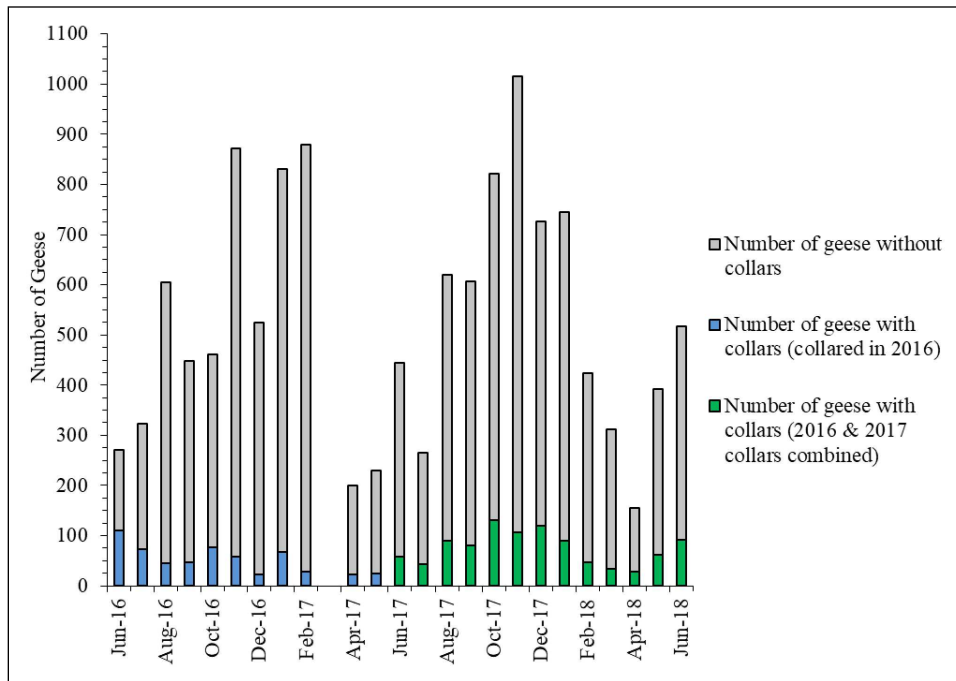


Figure 2: Regular survey results of Canada Geese (*Branta canadensis*) in Nanaimo, B.C., between 30 June 2016 and 18 June 2018. Bars represent total number of geese observed. The number of collared geese observed is shown in blue (2016-banded geese only) and green (2016 and 2017-banded geese combined). There was no survey conducted during March 2017.

flightless geese. The materials for the pen consisted of 1.2 m high orange plastic snow fencing and 1.8 m long steel stakes for fence posts. For each roundup, the pen was constructed in a circular, corral-type manner, approximately 7 m in diameter with two compartments inside. An opening in the pen approximately 3 m wide faced the water body for the geese to enter, and additional lengths of fencing extended out from the opening to act as a funnel. Several canoes, kayaks, and a small powerboat were used to roundup the geese and herd them into the pen.

All banding took place on the ground within the pen. Individual geese were captured from the flock with a large dipnet. Each goose was held upside down and held securely with its legs while facing towards the bander. The bander then applied the leg band to the right tarsus of the goose with banding pliers (PL2H; Avinet, Inc.) specifically designed for the size of leg band used. Once the leg band was applied, the goose was flipped around to apply the neck collar. A thin bead of plastic adhesive (E6000; Eclectic Products) was applied to the seam of the collar to prevent removal or stretch of the collar. Collars were applied with the letter at the top. Banded geese were then moved to the holding compartment in the pen, where they were held until the final release. Geese were released in groups to reduce the chance of Bald Eagle (*Haliaeetus leucocephalus*) attacks.

Public Engagement

Public engagement in the project was used to increase the frequency of collar observations. The project was ad-

vertised through posters, local newspapers, radio, TV, and social media to raise public awareness. A website was created to provide background information for the project (vi-u.ca/gooseproject) and included a collar report form. Collars could also be reported through the Canadian Wildlife Service Bird Banding Office or the United States Geological Survey Bird Banding Laboratory (reportband.gov), which are commonly used by both birding enthusiasts and hunters for reporting bird bands in North America.

Results

Abundance: Regular Surveys

The number of Canada Geese observed during regular surveys varied seasonally, ranging from 155 to 1,016 geese (Figure 2). On average, these counts suggest a 58% increase in Canada Goose abundance between the summer and winter periods. These seasonal fluctuations were reasonably consistent between years, but the proportion of collared geese observed within the population gradually declined over time. Peak counts occurred during the fall migration of each year (October and November), while the lowest counts occurred during the breeding period of each year (April and May).

Distribution and Movement

Distribution and movement of individual collared geese varied considerably. Geese were reported as far

south as Redwood, Oregon, and as far north as Sointula, B.C., while some geese remained in the Nanaimo area and could often be observed at the very location where they were banded (Figure 3). In the weeks following banding each year, large flocks of collared geese were observed near their respective banding sites; however, many geese did not remain in the local area and were not seen again locally. From September 1 of each banding year, 132 geese (66%) from the 2016 group and 149 geese (75%) from the 2017 group were reported in the local area. One-hundred twenty geese (60%) of the 2016 group were observed in the local area during summer 2017. By contrast, only 75 geese (38%) from the 2016 group and 115 geese (58%) from the 2017 group were reported in June and July 2018. One-hundred eight geese (54%) from the 2016 group were observed in the Nanaimo area during the winter period of 2016/17; 78 geese (39%) from the 2016 group and 146 geese (73%) from the 2017 group were observed in the Nanaimo area during the 2017/18 winter. Forty-three geese (11%) were reported in the United States. Of these geese, 27 geese (14%) were from the 2016 group, while 16 geese (8%) were from the 2017 group. Observations of 30 geese (15%) from the 2016 group and 38 geese (19%) of the 2017 group were too infrequent (≤ 2 reports) to determine their movement habits.

Collared individuals (110 geese; 28%) were reported from many areas on Vancouver Island, outside of the Nanaimo area. Of these, 74 geese (37%) were from the 2016 group, while 36 geese (18%) were from the 2017 group. Eleven geese (3%) were reported on neighbouring Gulf Islands, including Ballenas Island, Gabriola Island, Lasqueti Island, Maude Island, and Snake Island. Additionally, three geese (<1%) were observed on the Sunshine Coast and three geese (<1%) were observed in the Lower Mainland (Figure 4; Table 1).

Local resident geese used a relatively small home range, although certain individuals tended to move about the Nanaimo area more freely (Figure 5). The most local resident geese were observed from the individuals banded at Lantzville (90%), Hammond Bay (86%), Westwood Lake (69%), Departure Bay (68%), and Newcastle Island (63%) (Figure 6). By contrast, the Nanaimo River Estuary group had the fewest local residents, with 47% of Nanaimo River Estuary geese reported locally during the winter period of each year. These observations correlated with distant reports, where 56% of the Nanaimo River Estuary group was reported outside the local area, while Departure Bay (49%), Westwood Lake (46%), Newcastle Island (40%), Lantzville (26%), and Hammond Bay (8%) groups had fewer reports of geese that dispersed outside of the local area.

Sixteen geese (4%) observed in the United States were known to return to Nanaimo during the summer periods.

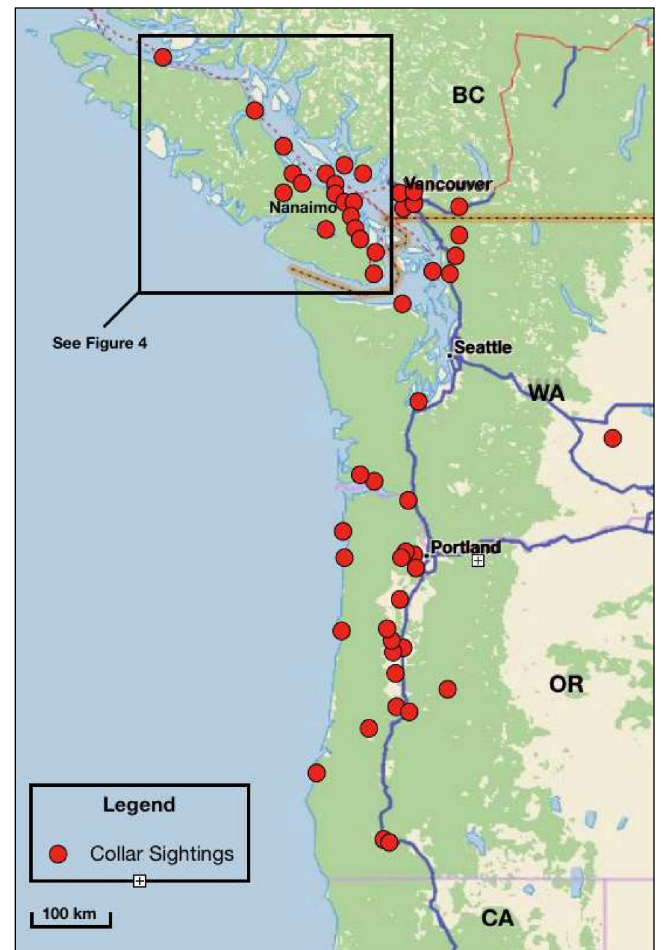


Figure 3: Map of the Pacific Northwest coast showing collar report locations of Canada Geese (*Branta canadensis*) in British Columbia, Washington, and Oregon from 24 June 2016 to 30 June 2018. Points represent sites where collared geese were reported, and do not correspond to frequency of reports or number of collared geese observed. Map courtesy of Garmin International Inc.

Of these, 13 geese (81%) were from the Nanaimo River Estuary group, and one goose each from the Departure Bay group, Lantzville group, and Newcastle Island group. Of the Nanaimo River Estuary group, three geese have been observed in the United States during both winter periods and in Nanaimo during each summer period since banding in 2016. One goose from the Nanaimo River Estuary group was confirmed to be nesting in Oregon, while one goose from the Newcastle Island group was confirmed to be nesting in Saanich. Finally, one goose was observed returning from Oregon to Parksville during the winter period.

Mortality

Hunting was the primary cause of death among documented mortalities (Table 2). A total of 38 collared geese (9%) were known to have been harvested by hunters.

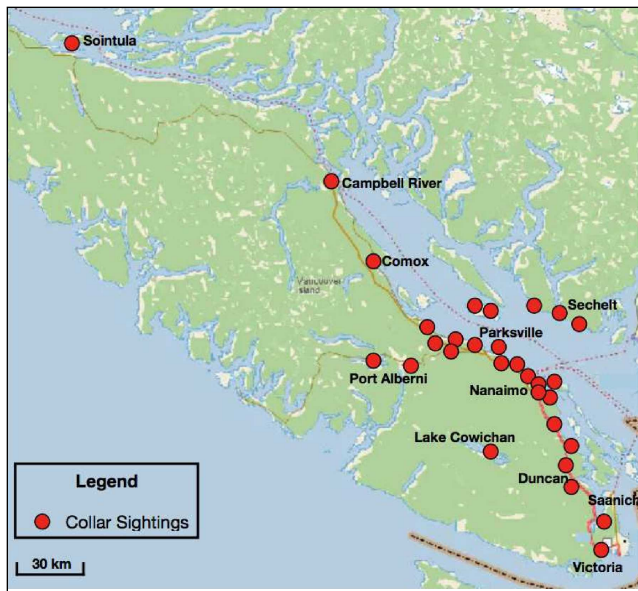


Figure 4: Map of the Vancouver Island region and B.C. mainland coast, showing collar report locations of Canada Geese (*Branta canadensis*) from 24 June 2016 to 30 June 2018 in Sointula, Campbell River, Comox, Courtenay, Port Alberni, Errington, Parksville/Qualicum, Lasqueti Island, Halfmoon Bay, Sechelt, Roberts Creek, Lantzville, Nanaimo, Gabriola Island, Cedar, Chemainus, Duncan, Lake Cowichan, Esquimalt, and Saanich. Points represent sites where collared geese were reported, and do not correspond to frequency of reports or number of collared geese observed. Map courtesy of Garmin International Inc.

Other sources of mortality included Bald Eagle attacks (3 geese; <1%) and vehicle strikes (2 geese; <1%), while two geese (<1%) died of unknown causes. Thirteen geese (3%) were known to shed their collars, of which nine geese (5%) were from the 2016 group and four geese (2%) were from the 2017 group. Collars from four geese (1%) were found on local beaches, one goose was shot without its collar (<1%), and eight geese (2%) were identified by their leg bands.

Discussion

Formerly, the majority of the Canada Goose population on Vancouver Island was thought to be resident; however, results from this study suggest that a significant portion of the goose population dispersed seasonally. Total goose numbers observed during regular surveys increased considerably between the summer and winter periods during both years of the study; while the number of collared geese decreased immediately after banding each year but then stabilized and remained relatively constant. These results suggest that there was emigration of summering geese and immigration of wintering geese. The distribution of reports of collared geese, combined with the absence of many collared individuals in the local area after the summer period, provided evidence that many geese dispersed from the Nanaimo area. Collared goose reports indicated that a local resident population exists, but the majority of geese may only use the Nanaimo area for certain stages of their annual life cycle, rather than year-round.

Abundance: Regular Surveys

The variation in regular survey counts between seasons suggested that many more geese use the Nanaimo area as winter habitat than as summer habitat. A higher proportion of collared geese overwintered in the local area during winter 2017/18 than during winter 2016/17; however, winter 2016/17 was much colder than usual for Nanaimo, which may have affected the distribution of wintering geese. From mid-December 2016 to mid-February 2017, several lengthy bouts of cold weather caused freshwater bodies to freeze, including the larger lakes in the area, and fields were covered in snow and ice for extended periods. During these periods, the vast majority of geese were observed in marine areas, but many individuals may have emigrated from the central Vancouver Island region in search of more hospitable conditions. By contrast, winter 2017/18 was typical for Nanaimo, with temperatures re-

Table 1: Summary of the distribution of reports of collared Canada Geese from 1 September 2016 to 30 June 2018. Several geese were reported to leave the local study area for short periods of time and then return again; a small portion of the geese (~5%) reported outside the study area are also included in the local sightings.

Year banded (<i>n</i> = 200/year)	2016		2017	
	Proportion of total (%)	Number of geese	Proportion of total (%)	Number of geese
Reported locally after Sep 1 of year banded	66	132	75	149
Reported locally through first winter	54	108	73	146
Reported locally through second winter	48	78	n/a	n/a
Reported elsewhere on Vancouver Island	37	74	18	36
Reported on Gulf Islands	1	1	3	6
Reported on Mainland BC	2	3	2	3
Reported in USA	14	27	8	16
Reported ≤ 2 times	15	30	19	38

maining at or above freezing with very little snow observed at low elevations. Regular survey counts were similar between each winter of the study, but the higher proportion of collared geese observed during winter 2017/18 suggested that goose distribution may have been altered by the abnormally cold winter of 2016/17. Despite fluctuations in collared goose abundance between each winter of the study, regular survey results suggest that a substantial portion of the Nanaimo goose population dispersed seasonally.

Distribution and Movement

Collared goose report data provided insight into the distribution and movement of Canada Geese in the Nanaimo area. In November of each year, notable increases in count totals suggested there was substantial immigration of geese into the Nanaimo area. Following the increase, count totals remained relatively constant throughout the winter period of each year, which suggested that a group of geese, independent of the summer geese, may have arrived each year to spend the winter. The presence of F-series neck collars (banded in Campbell River in the summer of 2015) in some flocks provided evidence that a portion of these geese dispersed from neighbouring Vancouver Island communities. Greater White-fronted Geese (*Anser albifrons*), Lesser Snow Geese (*Chen caerulescens caerulescens*), and Cackling Geese (*Branta hutchinsii*) were also observed with some flocks of Canada Geese. These goose species are uncommon to the Nanaimo area and nest in the Arctic (Campbell et al. 1990, Mowbray et al. 2002). Furthermore, historical records showed that several Canada Geese banded in the northern interior of British Columbia were harvested by hunters on Vancouver Island over multiple winters (Dawe and Stewart 2010). These factors raised the possibility that a portion of the wintering Canada Goose population may have been long-distance migrants. However, gathering information about individuals within the wintering population of geese would require banding during the winter, which is logistically challenging because flight-capable geese are able to escape capture.

Banding and collaring geese in six separate locations provided unexpected results. Each banding group exhib-

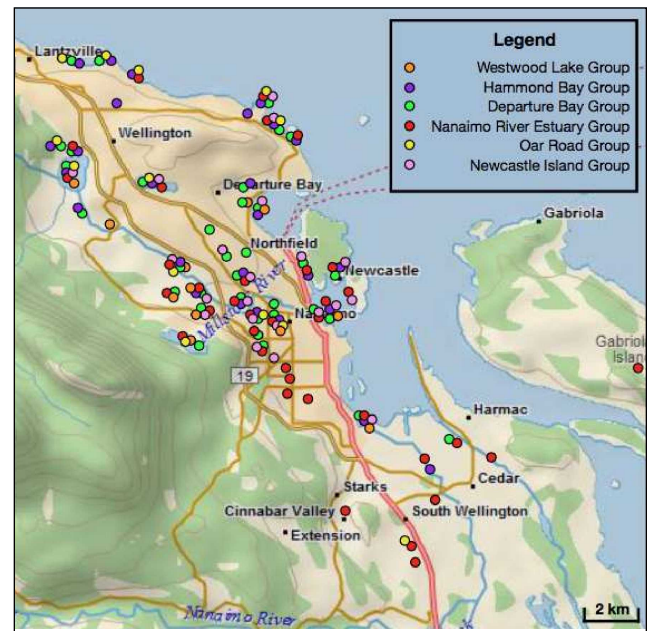


Figure 5: Distribution of collared Canada Geese (*Branta canadensis*) by banding group in Nanaimo, B.C., from 24 June 2016 to 30 June 2018. Points represent sites where collared geese were reported, and do not correspond to frequency of reports or number of collared geese observed. Map courtesy of Garmin International Inc.

ited distinct characteristics with regards to distribution and movement, and had relatively distinct home ranges. The majority of geese banded in the urban areas (Westwood Lake, Hammond Bay, Departure Bay, and Newcastle Island) rarely strayed from localized home ranges within these urban areas. This behaviour indicated that these geese, and the other individuals that associate with them throughout the year, may cause much of the human-geese conflict in Nanaimo. The majority of problems with geese in Nanaimo are related to fouling of beaches and swimming areas, grassy areas such as lawns, sports fields, golf courses, and cemeteries (K. Brydges, pers. comm. 2017). Presumably, these resident geese attract other geese into these areas, further exacerbating conflicts. By contrast, the majority of distant collared goose reports were from geese banded in rural areas (Nanaimo River Estuary and

Table 2: Summary of collared goose mortality (24 Jun 2016 to 30 Jun 2018).

Year banded (n = 200/year)	2016		2017	
	Proportion of total (%)	Number of geese	Proportion of total (%)	Number of geese
Harvested by hunters	12	23	8	15
Killed by Bald Eagle	1	2	<1	1
Killed by vehicle strike	<1	1	<1	1
Killed by unknown cause	1	2	0	0
Reported shed collar	5	9	2	4
Total collars removed from population	19	37	11	21
Total collars assumed remaining	82	163	90	179

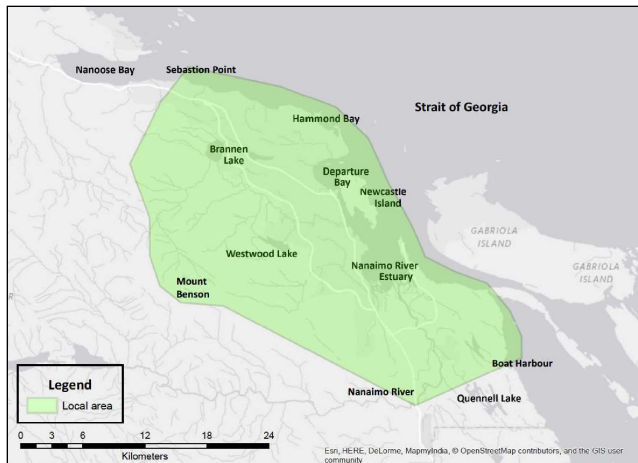


Figure 6: “Local area” used to define local resident geese. A line between the southernmost part of the Nanaimo River and Boat Harbour served as the southeast boundary for the area; Mount Benson bordered the area to the south and west; Blunden Point (end of Sebastian Road, Lantzville) served as the northernmost point; and the Strait of Georgia and the Gulf Islands served as the boundary to the north and east. Collared geese reported within this area during the winter period (1 December to 28 February) were defined as local resident geese.

Lantzville). These two groups also had the lowest proportion of local resident geese. The diversity in distribution and movement habits between the various groups is further evidence that the Nanaimo Canada Goose population is far more complex than previously believed.

Collared goose reports from the USA suggested that a substantial portion of the summer goose population may be comprised of geese that dispersed from distant locations to Nanaimo specifically to breed and/or to moult. Collar report data confirmed that several geese banded in 2016 travelled to the USA during winter and returned to Nanaimo during summer 2017. One individual was reported in the USA in winter 2016/17, Nanaimo in summer 2017, the USA in winter 2017/18, and Nanaimo in summer 2018. By contrast, two geese were observed nesting in areas well outside of Nanaimo (Saanich and Oregon) during summer 2017, which suggested that another portion of the population may be comprised of immature and/or non-breeding geese dispersing from other areas (i.e. these geese visited Nanaimo to moult when they were banded, but did not return), or that geese hatched in Nanaimo may disperse to other areas once mature (i.e. fidelity to the Nanaimo area may not be strong in certain individuals). One goose was observed returning to Parksville in January 2018 after spending the fall period in Oregon, which is contrary to typical movement patterns. These observations are examples of complexities within the population that were previously unrealized. The dispersal of geese from other populations along the west coast of North America likely pose challenges for management initiatives.

Mortality

Results suggest that the overall mortality rate of Canada Geese in Nanaimo is relatively low. Hunting was the primary source of mortality over the course of the study. There were few reports of natural predation of collared geese, with Bald Eagles being the only reported predator. In some areas, Bald Eagles may have a significant impact on goose reproduction through predation of goslings. However, this is difficult to confirm as the few juvenile geese captured were not large enough to collar. The only other cause of death reported was vehicle strikes. Eight geese were known to have shed their collar and were confirmed alive and still in the area by identification of leg bands; additionally, four other collars were found washed up on local beaches, but have not been associated with living geese. It is unknown whether these geese shed their collars or died, so predation rates may in fact be higher than results suggest. However, overall mortality rates of Canada Geese in the Nanaimo area appear to be low, which is likely a significant contributing factor to the substantial population growth in the area.

This study identified within-year trends in Canada Goose abundance in the Nanaimo area. The Canada Goose population varied seasonally each year, with higher abundances occurring in winter than in summer. The behaviour and distribution of collared geese provided insight into population dynamics of Canada Geese in the Nanaimo area, which provided some explanation for seasonal variations in abundance. Results suggest that the local resident population is smaller than previously thought, and the population is otherwise comprised of individuals who use the Nanaimo area only for a portion of their annual life cycle. Count data, along with the distribution and movement of collared geese, indicated that a post-summer emigration of geese occurred each year despite a simultaneous increase in overall abundance. Additionally, the overall number of collared geese declined as the study progressed, yet count data remained relatively consistent through each year. This suggested that seasonal immigration and emigration of different individuals may have coincided, and that the departure of one group of geese masked the arrival of another group of geese. Prior to this study, this phenomenon may have provided the illusion that the local goose population was a relatively constant group of individuals, when in fact the population is composed of a dynamic group of individuals with varying life strategies.

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