Trends in bird populations in the Comox Valley, British Columbia, Canada, from 1976 to 2006

Arthur M. Martell

Comox Valley Naturalists Society, Box 3222, Courtenay, B.C. V9N 5N4; e-mail: amartell@shaw.ca

Abstract: Changes in numbers of birds in the Comox Valley, British Columbia, from 1976 to 2006 were examined based on two counts each year, conducted in May and December, in the Comox Christmas Bird Count circle. A total of 44 species of coastal birds (coast/wetland habitat) and 58 species of upland birds (forest/woodland, scrub/successional, grassland and suburban/urban habitats) were reported sufficiently frequently for analysis. The trends are discussed in relation to the North American Breeding Bird Survey counts and to climate change.

Coastal birds showed a much greater tendency to population decrease and a lesser tendency to population increase than upland birds. Coastal birds tended to be significantly more abundant in winter than in spring and 34% of the species showed significant positive trends and 25% of the species showed significant negative trends on one or both counts. Harlequin Duck showed a significant decline in spring but not in winter. However, the numbers in both seasons decreased from 1976 to the mid-1990s and then increased. Western Grebe showed significant declines on both counts; examination of the annual numbers showed a great variability among years on both counts, but clear declines to the late 1990s and a possible slight recent recovery in numbers. Bald Eagle showed significant, steady increase in numbers on both counts.

Almost half of the species of upland birds (46%) showed significant positive trends on one or both counts and only 10% showed significant negative trends. Differences by migration status were pronounced, with only 19% of 16 neotropical migrants showing significant positive trends compared with 57% of 42 short-distance migrants and residents combined; the proportion of species showing significant decreasing trends was similar (12% and 10%, respectively). Most of the species of upland birds that showed an increasing trend are species that concentrate in winter (sparrows, blackbirds, urban/suburban birds). Bewick's Wren, aerial foragers (Violet-green Swallow, Barn Swallow) and finches (Purple Finch, Evening Grosbeak) showed significant negative trends and are of particular concern.

Key words: Comox Valley, population trends, Christmas Bird Count, spring migration, climate change, waterfowl, waterbirds, shorebirds, landbirds, Harlequin Duck, *Histrionicus histrionicus*, Western Grebe, *Podiceps occidentalis*, Bald Eagle, *Haliaeetus leucocephalus*, Bewick's Wren, *Thryomanes bewickii*, Violet-green Swallow, *Tachycineta thalassina*, Barn Swallow, *Hirundo rustica*, Purple Finch, *Carpodacus purpureus*, Evening Grosbeak, *Coccothraustes vespertinus*.

Introduction

The Comox Valley, British Columbia, is recognized internationally for its Important Bird Areas (IBA Canada 2004), particularly for wintering waterbirds, and has been the focus of ornithological work for over a century (Brooks 2006). The Comox Valley Naturalists Society (formally the Comox-Strathcona Natural History Society) began conducting a Christmas Bird Count (National Audubon Society 2005) in the area in 1961 and began conducting a Spring Bird Count in 1976 using the same count circle. This paper examines the trends in numbers of some bird species in two seasons over a 31-year period from 1976 to 2006.

The landscape of the Comox Valley has changed considerably over time due to residential and industrial development as well as increasing recreational use, and those changes are reflected in bird populations using the Valley. The human population of the three major communities in the Comox Valley (Comox, Courtenay, Cumberland) increased steadily from 14,789 to 36,838 from 1976 to 2006 (B.C. Ministry of Labour and Citizens' Services 2007). The Comox Valley has been rapidly losing its sensitive ecosystems. From 1992 to 2002, at least 5% of the sensitive ecosystems were lost and at least 30% of modified ecosystems such as older second growth forests (60-100 yrs) and seasonally flooded agricultural fields disappeared (B.C. Ministry of Environment. 2005). Based on the change in population, the total loss of those habitats since 1976 would be over twice that observed from 1992 to 2002. Vermeer (1994) noted the importance of the Courtenay River estu-

ary to waterbirds and that the estuary had suffered much from development and pollution. He cautioned that if the environmental perturbations continued, waterbird populations may decline and urged that frequent monitoring be done.

Methods

I examined changes in numbers of birds in the Comox Valley based on two counts conducted each year in the same count area in a similar manner. The Comox Christmas Bird Count (CBC) began in 1961, with only four participants, and a Spring Bird Count (SBC) using the same count circle, began in 1976. For consistency, I chose to use only the data collected from 1976 to 2006. The Comox CBC circle is centered on the old Comox Post Office (49º40'26"N, 124 55'39"W) and has the standard diameter of 24.1 km (15 mi). The count circle is divided into 12 count areas and 11 teams normally conduct the count from early morning to late afternoon following a relatively standard pattern to cover the entire count circle. The median date (and range) for the SBC was May 3 (April 29-May 7) and for the CBC was December 20 (December 17-24). The median (and range) of participants for the SBC was 34 (24-48) and for the CBC was 42 (27-54). The number of participants increased from 1976 to 1996 for both counts but the number of teams remained the same each year and, consequently, the number of team hours was relatively stable, although the exact number of team hours was not calculated each year. Many of the participants took part in both counts each year.

A total of 215 species was recorded during the SBC. For analysis, I chose only those 96 species[1] recorded at least 90% of the time over the 31 counts in order to minimise "zero" observations. A similar approach to the CBC added 6 species. The CBC was not conducted in 1996; I estimated numbers for that count to be the average of those observed from 1994 to 1998. I also included Wood Duck in the analyses; although it was not recorded until 1988, it was recorded regularly since then.

I conducted statistical analyses using MS Excel 2000 Statistical Analysis ToolPak. I evaluated the significance of trends in annual numbers through log-transform linear regression: ln (n + 0.23), where "n" is the annual number and 0.23 is the constant recommended by Collins (1990). In order to evaluate the difference in the relative proportions of the populations counted on the SBC and the CBC, I calculated a mean and range of numbers observed on each count. I used only the shorter 1997 to 2006 count period to minimize the effect of long-term trends on numbers. I tested the significance of the differences in means by t-test assuming unequal variances on log-transformed data [ln (n + 0.23)]. This was done to help evaluate the relative biological importance of differences in trends between counts; differences in means were considered to reflect differences in the populations.

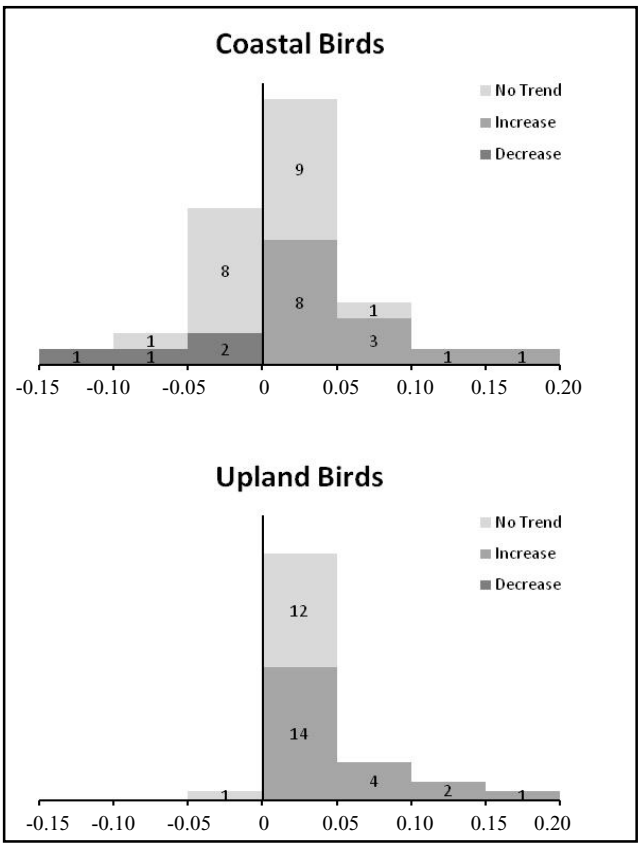

Figure 1. Histograms of trends (% change per year) in bird populations based on Christmas Bird Counts showing frequency of significant decreases, significant increases and non-significant trends.

In order to examine patterns in temporal trends related to life history, each species was assigned a migration status (neotropical migrant, short-distance migrant, year-round resident) and a primary habitat (coast/wetland, forest/woodland, scrub/successional, grassland, suburban/urban) based on Downes and Collins (2007), Sauer *et al.* (2005), DeGraaf and Rappole (1995) and Campbell *et al.* (1990a, 1990b, 1997, 2001). Each species was also assigned to a primary foraging guild based on Ehrlich *et al.* (1988). Differences among the number of species in each of these classes were measured by χ^2 test.

Results

For ease of presentation, results for birds associated with coast/wetland habitat (hereafter, coastal birds) are presented

[1] Herring Gull and Thayer's Gull were combined and a total for Scaup (*Aythya* species) was included.

Table 1. Birds of coastal and wetland habitats: trend (% change per year) in numbers from 1976 to 2006 and the 1997-2006 mean number (range in parentheses) on the SBC and the CBC.

Species	Trend[1]		Mean (Range)[2]	
	SBC	CBC	SBC	CBC
Waterfowl				
Brant	-2.4		**400** (3-1009)	6 (0-30)
Canada Goose	**8.3*** **	**18.9*** **	55 (12-111)	**313** (158-576)
Trumpeter Swan		**7.7*** **	2 (0-6)	**1629** (1195-2939)
Wood Duck[3]	**13.6*** **		**10** (4-22)	1 (0-3)
American Wigeon	5.3	**3.0** **	98 (12-224)	**2300** (1367-3514)
Mallard	**5.3*** **	**2.8*** **	232 (130-392)	**3514** (2019-4939)
Northern Shoveler	4.2	1.4	60 (0-441)	8 (1-21)
Northern Pintail		**-3.2***	9 (0-24)	**229** (63-362)
Green-winged Teal	**9.2** **	**10.9*** **	61 (7-345)	**167** (63-278)
Greater Scaup	-4.5	-0.9	119 (32-318)	**638** (257-1414)
Scaup total[4]	**-6.2** **	-0.1	119 (32-319)	**814** (258-2157)
Harlequin Duck	**-1.6***	-0.8	120 (75-195)	**198** (105-412)
Surf Scoter	1.7	1.1	1160 (217-2898)	1556 (284-2571)
White-winged Scoter	**-3.2***	0.7	315 (60-1199)	**1576** (130-2835)
Black Scoter	-0.7	-1.7	67 (4-194)	**288** (50-593)
Long-tailed Duck	2.0	-0.3	29 (2-137)	**179** (31-620)
Bufflehead	0.3	**1.7** **	95 (14-181)	**526** (233-960)
Common Goldeneye	**-8.9** **	0.0	8 (0-24)	**447** (194-696)
Common Merganser	1.7	2.4	119 (50-194)	**171** (96-346)
Red-breasted Merganser	**3.4***	**3.3***	192 (50-484)	206 (24-424)
Waterbirds				
Pacific Loon	-6.0	**-7.7***	23 (0-48)	99 (0-470)
Common Loon	-1.0	0.7	48 (24-90)	**142** (29-618)
Horned Grebe	**-3.7***	-0.9	25 (1-55)	**104** (26-260)
Red-necked Grebe	1.7	**4.6** **	34 (5-81)	**97** (15-205)
Western Grebe	**-9.3*** **	**-10.8***	68 (1-230)	283 (5-2122)
Double-crested Cormorant	0.8	**3.7***	10 (2-40)	**50** (11-117)
Pelagic Cormorant	**-5.5** **	-1.1	9 (2-17)	**58** (12-177)
American Coot		-5.1	0 (0-1)	**24** (0-105)
Bonaparte's Gull	**-6.6*** **		212 (79-531)	0 (0)
Mew Gull	1.0	2.3	129 (41-299)	**621** (84-1539)
Herring Gull/Thayer's Gull[5]	-2.5	3.6	22 (1-90)	**200** (39-496)
Glaucous-winged Gull	-1.1	**2.0***	766 (285-1212)	**5840** (2925-9244)
Pigeon Guillemot	1.2		**13** (4-31)	7 (0-21)
Marbled Murrelet	5.0		**15** (1-39)	6 (0-16)
Shorebirds				
Black-bellied Plover	-0.3	**7.4***	21 (5-35)	**163** (20-293)
Greater Yellowlegs	**6.2** **		**9** (1-28)	0 (0-1)
Black Turnstone		-1.1	12 (0-73)	**197** (14-528)
Sanderling		5.6	19 (0-94)	**68** (5-237)
Western Sandpiper	4.4		152 (0-538)	0 (0)
Dunlin	0.1	**7.2***	427 (45-1359)	**2640** (395-5002)
Other Coastal Birds				
Great Blue Heron	1.4	-0.6	67 (32-94)	48 (10-61)
Osprey	2.6		4 (1-7)	0 (0)
Bald Eagle	**4.7*** **	**2.9** **	148 (77-242)	173 (97-260)
Northwestern Crow	-1.7	**-3.3*** **	381 (257-501)	**1047** (511-3428)
Belted Kingfisher	1.5	0.9	16 (7-27)	17 (11-28)

[1] Significance of trend: *P <0.05, **P<0.01, ***P<0.001
Missing values indicate no observations or too many nil values for analysis
[2] Significantly greater values in **bold**; P<0.05
[3] Trend from 1988 to 2006 only because Wood Duck was not observed prior to 1988.
[4] Includes Greater Scaup, unidentified scaup and Lesser Scaup, which are uncommon and were not consistently identified by observers.
[5] Herring Gull and Thayer's Gull combined because they were not consistently identified by observers.

separately from those associated with forest/woodland, scrub/successional, grassland and suburban/urban habitats (hereafter, upland birds). A total of 44 species of coastal birds (Table 1) and 58 species of upland birds (Table 2) were reported sufficiently frequently for analysis. Coastal birds showed a significantly greater tendency for population declines than upland birds on the CBC ($\chi^2 = 6.96$, df = 2, P = 0.031; Figure 1) but not on the SBC. The presentation of results will focus on species of particular importance in the Comox Valley and those showing the greatest trends, and will include short, species-specific discussion as appropriate. Scientific names of the species are presented in an appendix.

Table 2. Birds of upland habitats: trend (% change per year) in numbers from 1976 to 2006 and the 1997-2006 mean number (range in parentheses) on the SBC and the CBC.

Species	Trend[1]		Mean (Range)[2]	
	SBC	CBC	SBC	CBC
Neotropical Migrants				
Band-tailed Pigeon	-0.8		**82** (35-131)	1 (0-5)
Rufous Hummingbird	0.7		**92** (70-135)	0 (0-1)
Pacific-slope Flycatcher	**9.3*** **		34 (2-59)	0 (0)
Cassin's Vireo	2.2		7 (2-17)	0 (0)
Tree Swallow	-3.4		32 (11-70)	0 (0)
Violet-green Swallow	**-1.6***		299 (199-522)	0 (0)
Northern Rough-winged Swallow	0.2		33 (6-72)	0 (0)
Barn Swallow	**-4.6*** **		71 (16-114)	0 (0)
Orange-crowned Warbler	-0.2		130 (74-235)	0 (0)
Yellow Warbler	4.3		33 (3-51)	0 (0)
Black-throated Gray Warbler	**7.3***		20 (4-48)	0 (0)
Townsend's Warbler	3.3		26 (5-55)	0 (0)
MacGillivray's Warbler	0.4		8 (0-21)	0 (0)
Common Yellowthroat	**7.4*** **		57 (33-96)	0 (0)
Wilson's Warbler	3.0		9 (1-28)	0 (0)
Chipping Sparrow	-2.2		16 (6-32)	0 (0)
Short-distance Migrants				
Turkey Vulture	**7.8*** **		**24** (4-41)	0 (0-1)
Red-tailed Hawk	1.7	**3.3***	5 (2-7)	8 (4-13)
Merlin	**8.4*** **	**5.9****	**7** (3-11)	4 (1-9)
Killdeer	-0.2	0.6	38 (26-57)	50 (3-160)
Red-breasted Sapsucker	**7.4*** **		**17** (5-27)	3 (0-7)
Northern Flicker	**2.3****	**2.2****	56 (29-79)	72 (36-102)
Brown Creeper	0.2	1.3	9 (1-16)	12 (6-21)
Golden-crowned Kinglet	0.4	0.5	64 (21-162)	**383** (250-630)
Ruby-crowned Kinglet	1.2	2.2	4 (0-9)	**24** (3-67)
American Robin	0.4	1.4	**871** (626-1093)	190 (61-408)
Yellow-rumped Warbler	3.8		**58** (37-69)	1 (0-5)
Spotted Towhee	**3.3*** **	**3.8*** **	185 (141-254)	218 (118-366)
Savannah Sparrow	0.8		**152** (63-438)	1 (0-7)
Fox Sparrow	-3.8	**3.9****	6 (0-14)	**68** (21-155)
Song Sparrow	**1.6****	**3.8*** **	183 (125-234)	222 (157-318)
White-crowned Sparrow	-0.4	**9.5*** **	**66** (29-112)	18 (3-46)
Golden-crowned Sparrow	-0.9	**10.9*** **	69 (18-131)	94 (48-209)
Dark-eyed Junco	4.0	**2.6****	47 (3-311)	**1139** (674-2299)
Red-winged Blackbird	**2.8*** **	**18.4*** **	212 (175-274)	220 (88-484)
Brewer's Blackbird	**1.5***	**10.6****	75 (41-125)	**390** (116-684)
Brown-headed Cowbird	**-1.9***		**37** (15-69)	1 (0-4)
Purple Finch	**-2.8****	0.3	51 (32-79)	40 (5-148)
Pine Siskin	-0.4	0.0	446 (33-845)	1332 (30-3754)
American Goldfinch	0.7		**32** (9-64)	3 (0-24)
Evening Grosbeak	**-7.6***		**19** (0-110)	8 (0-47)
Residents				
Ring-necked Pheasant	**3.0***	**8.3****	**35** (14-64)	14(5-20)
California Quail	4.8		10 (4-23)	12 (0-57)
Rock Pigeon	**4.4*** **	**3.6*** **	148 (91-230)	**381** (158-628)
Downy Woodpecker	2.7	**3.5***	7 (4-15)	16 (9-36)
Hairy Woodpecker	-0.2	1.9	5 (2-11)	**9** (0-22)
Pileated Woodpecker	1.5	**3.1***	**15** (10-19)	7 (3-12)
Steller's Jay	**4.1***	**4.2***	23 (5-54)	**107** (23-206)
Common Raven	**6.0*** **	**2.8****	177 (47-337)	157 (107-226)
Chestnut-backed Chickadee	1.4	**1.7****	167 (103-245)	**395** (263-489)
Bushtit	**5.3***	0.1	16 (2-30)	32 (0-76)
Red-breasted Nuthatch	3.3	**8.1****	23 (12-47)	21 (4-54)
Bewick's Wren	**-2.3****	-0.5	20 (12-45)	15 (3-37)
Winter Wren	1.8	0.8	60 (28-81)	61 (17-135)
Varied Thrush	-1.0	3.4	11 (1-48)	**57** (1-177)
European Starling	0.5	**1.7***	843 (489-1211)	**2302** (1103-3593)
House Finch	**4.2*** **	**3.3****	116 (83-146)	**179** (86-282)
House Sparrow	2.0	2.2	30 (6-57)	42 (0-97)

[1] Significance of trend: *P <0.05, **P<0.01, ***P<0.001; Missing values indicate no observations or too many nil values for analysis
[2] Significantly greater values in **bold**; P<0.05

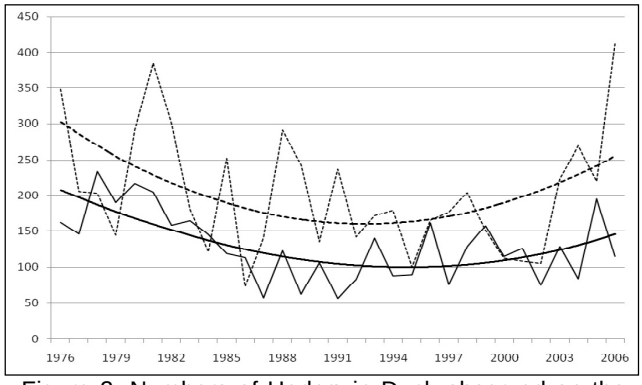

Figure 2. Numbers of Harlequin Duck observed on the Comox Spring Bird Count (solid line) and Christmas Bird Count (dotted line) from 1976 to 2006.

Coastal birds

Coastal birds tended to be significantly more abundant in winter (CBC) than in spring (SBC) (Table 1). Over a third of the species (34%) showed significant positive trends and a quarter of the species (25%) showed significant negative trends on one or both counts.

Waterfowl

Most species of waterfowl were significantly more common, or as common, in winter than in spring; Brant, Wood Duck and Northern Shoveler were exceptions. Canada Goose, Trumpeter Swan and most dabbling ducks showed significant positive trends; the notable exception was Northern Pintail, which showed a significant decline. Scaup total (almost exclusively Greater Scaup) showed a significant decline in spring but not in winter when they were significantly more common. That decline, therefore, may be due to timing of spring migration rather than an overall change in population. In general, trends in waterfowl numbers from this study were consistent with the continental trends (North American Waterfowl Management Plan 2004). The increase in Canada Goose and Trumpeter Swan are also consistent with the general trends in southwestern British Columbia (Campbell *et al.* 1990a).

Wood Duck was not recorded on the counts prior to 1988, then increased significantly, but appears to have stabilized since the late 1990s. The Courtenay & District Fish & Game Protective Association constructed a large number of nest boxes in the mid-1980s but did not provide long-term maintenance. Similarly, numbers of Wood Duck in the Fraser River lowlands increased dramatically in the 1970s due to construction of nest boxes, but declined in the 1980s due to inadequate maintenance of those boxes (Campbell *et al.* 1990a).

One-third of the sea ducks showed a significant negative trend and only two species (Bufflehead, Red-breasted Merganser) showed a significant positive trend. White-winged Scoter and Common Goldeneye showed significant declines in spring but not in winter when they were significantly more common. Those declines, therefore, may be due to timing of spring migration rather than an overall change in populations. Populations of many species of sea ducks in North America are in decline, including White-winged Scoter, but Common Goldeneye and Red-breasted Merganser are considered to be increasing and Bufflehead does not show a trend (North American Waterfowl Management Plan 2004, 2007).

Harlequin Duck showed a significant decline in spring but not in winter. However, the numbers in both seasons decreased from 1976 to the mid-1990s and then increased (Figure 2). Smith *et al.* (2000) noted that Harlequin Duck populations should be watched carefully because demographic parameters and strong site fidelity make them susceptible to unnoticed population declines. The Comox Valley is a particularly important area for Harlequin Duck (Campbell *et al.* 1990a, Badzinski *et al.* 2008).

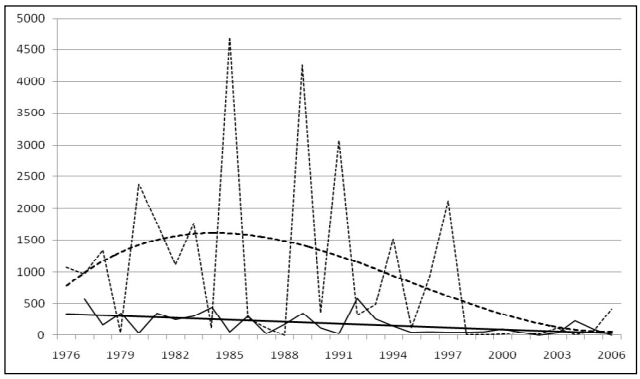

Figure 3. Numbers of Western Grebe observed on the Comox Spring Bird Count (solid line) and Christmas Bird Count (dotted line) from 1976 to 2006.

Waterbirds

Over a third (36%) of the species of waterbirds showed a significant negative trend and only three (Red-necked Grebe, Double-crested Cormorant, Glaucous-winged Gull) showed a significant positive trend. The positive trend for Double-crested Cormorant is consistent with that observed in other parts of the Strait of Georgia (Vermeer and Devito 1989). Nesting Glaucous-winged Gull in the southern Strait of Georgia increased from 1960 to 1986 (Vermeer *et al.* 1989) but then decreased to 1999, possibly due to increased frequency of colony disturbance, particularly by Bald Eagle (Sullivan *et al.* 2002).

Pacific Loon showed a significant negative trend in winter, largely due to high counts in 1977, 1981, 1982 and 1983 (1585, 734, 458 and 638, respectively), while counts in other years averaged only 78 (median 44, range 0-470). The decline, therefore, may be more likely due to differences in winter distribution than to general changes in the population. The significant negative trends for Horned Grebe and Pelagic Cormorant were shown only in spring, when

numbers were significantly smaller than in winter, and may be more related to timing of spring movements than to changes in population.

Western Grebe showed significant declines on both counts. This is consistent with the trend seen on British Columbia CBCs from 1976 to 2006 (National Audubon Society 2005). Examination of the annual numbers showed a great variability among years on both counts, but clear declines to the late 1990s and a possible slight recent recovery in numbers (Figure 3). Results from the British Columbia Coastal Waterbird Survey (BCCWS) also suggest a recent increase after 90-95% decline over the past 30 years (Badzinski *et al.* 2008). In contrast, Burger (1997) examined pooled CBC data from 25 coastal sites in British Columbia for the period 1957 to 1994 but reported no evidence of a decline in the overall wintering population, although he noted a considerable year-to-year variation in local wintering populations. The variation in numbers observed on the Comox counts, therefore, may reflect variation in wintering areas rather than a general decline. Continently, Western Grebe populations are considered to be stable (Kushlan *et al.* 2002). The coastal water of the Comox Valley has been considered an important area for Western Grebe (Burger 1997, Dawe *et al.* 1998).

Bonaparte's Gull showed a significant negative trend in spring that was influenced by particularly high counts prior to 1985. Migration through the Comox Valley is in late April and early May (Dawe *et al.* 1998) so variation could be due to timing of migration or location of food, or both. North American Breeding Bird Survey (BBS) counts show a strong decrease from 1968 to 2006, but this is also influenced by particularly high counts in the late 1970s (Downes and Collins 2007).

Shorebirds

Black-bellied Plover and Dunlin showed significant positive trends in winter and Greater Yellowlegs showed a significant positive trend in spring, although numbers recorded were small. Continental populations of Black-bellied Plover and Dunlin are considered to be declining and Greater Yellowlegs show mixed, non-significant trends (Morrison *et al.* 2001) but West Coast populations were not included in that analysis. The decrease reported in autumn numbers of yellowlegs in the Comox Valley (Martell and Sedgwick 2007) was not reflected in spring numbers. The autumn count was conducted on only a portion of the SBC circle but reflected a number of counts over a month period (September) rather than a single day. Because Greater Yellowlegs were migrating at the time of the SBC, the increase may be related to timing of spring movements rather than to changes in population.

Other coastal birds

Bald Eagle showed significant, steady increase in numbers on both counts and numbers did not differ significantly between winter and spring counts (Figure 4). Blood and

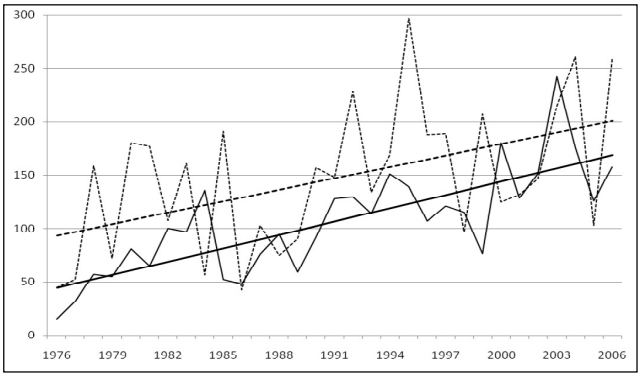

Figure 4. Numbers of Bald Eagle observed on the Comox Spring Bird Count (solid line) and Christmas Bird Count (dotted line) from 1976 to 2006.

Anweiler (1994) reported that populations on the south coast of British Columbia had stable or increasing populations since the 1960s and the BBS for coastal British Columbia shows a significant increase (Downes and Collins 2007). Contrary to these observations, the BCCWS showed a recent significant decrease in numbers (Badzinski *et al.* 2008). The increase in Bald Eagle is likely a recovery from previous decline caused by environmental contaminants.

Northwestern Crow numbers declined significantly on the CBC and declined steadily, but not significantly, on SBC (Figure 5). Based on BBS counts, Verbeek and Butler (1999) found a significant range-wide increase from 1966 to 1979 and no significant change from 1980 to 1995. They found results from the CBC difficult to interpret and suggested that changes in local abundance might reflect shifts in distribution rather than population changes. Similarly, an undocumented change in roosting areas could account for the changes observed on the Comox counts rather than a true population decline, but I have no supporting evidence.

Upland birds

Upland birds varied in abundance with migration status. The 16 species of neotropical migrants were present only in

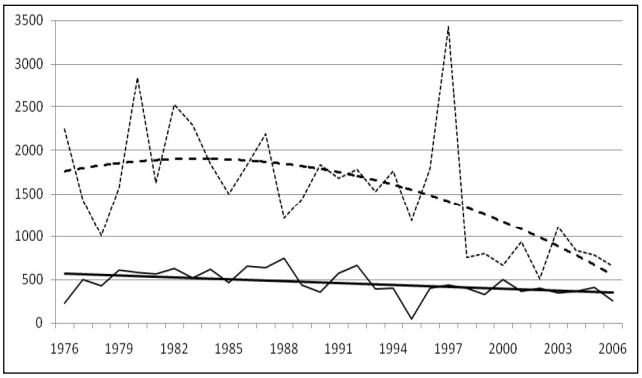

Figure 5. Numbers of Northwestern Crow observed on the Comox Spring Bird Count (solid line) and Christmas Bird Count (dotted line) from 1976 to 2006.

spring. The 17 species of residents tended to be more abundant or as abundant in winter as in spring, while the 25 species of short-distance migrants were present in both seasons but varied in relative abundance (Table 2). Almost half of the species of upland birds (46%) showed significant positive trends on one or both counts and only 10% showed significant negative trends. Differences by migration status were pronounced, with 19% of 16 neotropical migrants showing significant positive trends compared with 57% of 42 short-distance migrants and residents combined; the proportion of species showing significant decreasing trends was similar (12% and 10%, respectively). However, upland birds did not show any significant differences in trends by migration status, primary habitat or primary foraging guild.

Neotropical migrants

Three of 16 species of neotropical migrants (Pacific-slope flycatcher, Black-throated Gray Warbler, Common Yellowthroat) showed significant positive trends and two species (Violet-green Swallow, Barn Swallow) showed significant negative trends, but most species (69%) did not show a significant trend. The BBS counts for coastal British Columbia for the period 1986 to 2006 also showed no significant trend for most (75%) of these 16 species of neotropical migrants; only one species (Chipping Sparrow) showed a significant increase and three species (Tree Swallow, Barn Swallow, Orange-crowned Warbler) showed a significant decrease (Downes and Collins 2007). The decline in swallows is consistent with the recent decline in aerial foragers reported for eastern North America (Birds Ontario 2007). However, because many neotropical migrants were only passing through the Comox Valley at the time of the SBC, differences in numbers could relate to timing of migration as well as to changes in numbers in the population. Although this appears to be true for Pacific-slope flycatcher, Black-throated Gray Warbler, Common Yellowthroat and Barn Swallow, which are more abundant in the month following the SBC than the month before, it does not appear to be the case for Violet-green Swallow whose numbers are as high before as following the SBC.[2]

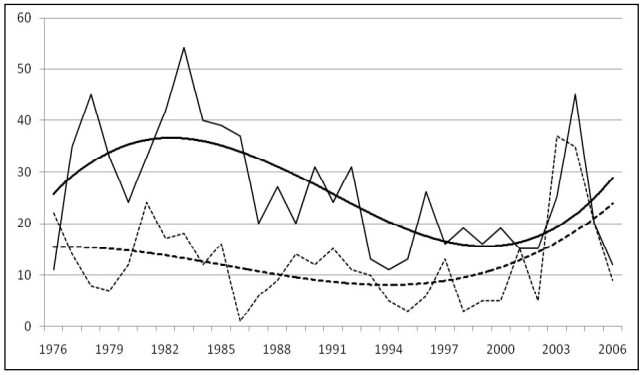

Figure 6. Numbers of Bewick's Wren observed on the Comox Spring Bird Count (solid line) and Christmas Bird Count (dotted line) from 1976 to 2006.

Short-distance migrants

Most of the 25 species of short-distance migrants (52%) showed significant positive trends on one or both counts and only three species (Brown-headed Cowbird, Purple Finch, Evening Grosbeak) showed significant negative trends; 36% of the species showed no significant trend. In contrast, the BBS counts for coastal British Columbia for the period 1986 to 2006 showed no significant trend for most (84%) of these 25 species of short-distance migrants; no species showed a significant increase and four species (Killdeer, Dark-eyed Junco, Pine Siskin, American Goldfinch) showed a significant decrease (Downes and Collins 2007).

Many of the short-distance migrants are species that move to the Comox Valley in winter from other areas, as reflected in the differences in mean numbers between the SBC and the CBC, while others are essentially absent in winter but arrive in spring, such as Turkey Vulture and Brown-headed Cowbird. Because of this, the significant trends shown by Turkey Vulture and Brown-headed Cowbird may be due to variation in spring arrival date rather than to a change in numbers in the population. Turkey Vulture appears to be more abundant following the SBC than before.[2]

Red-tailed Hawk and Merlin each showed a steady, significant positive trend. Although numbers are small, the increase was similar to that shown by Bald Eagle, and may also reflect populations recovering from previous declines caused by environmental contaminants. Red-breasted Sapsucker and Northern Flicker also showed significant positive trends.

All six species of wintering sparrows (Spotted Towhee, Fox Sparrow, Song Sparrow, White-crowned Sparrow, Golden-crowned Sparrow, Dark-eyed Junco) showed significant positive trends. The only sparrows not to show a significant trend were Chipping Sparrow, a neotropical migrant, and Savannah Sparrow, primarily a spring migrant. This suggests either a significant increase in all wintering populations or an increased concentration of wintering birds in the Comox Valley. Similarly, Red-winged Blackbird and Brewers Blackbird winter in large numbers in the Comox Valley and each showed a significant positive trend.

In contrast, Purple Finch and Evening Grosbeak each showed a significant negative trend. Spring numbers for Purple Finch decreased sharply in the early 1990s (mean number was 101 for 1976-1992 and 51 for 1993-2006) but winter numbers were relatively stable throughout. It is not clear what may have caused the sharp decrease in the early 1990s. Purple Finch also showed a significant negative trend

[2] Unpublished data from counts made in the Comox Valley from late-March to late-May 2005 to 2007.

in fall migration in central California from 1979 to 1999 (Ballard *et al.* 2003). Evening Grosbeak numbers were extremely variable with peaks usually every three to five years, but recently numbers have remained low. Evening Grosbeak was virtually absent on the CBC from 1995 to 2004 and were low on the SBC from 1999 to 2006. Some of these fluctuations are likely related to its nomadic and erratic nature although recent extensive spruce budworm outbreaks in the interior of the province could account for the reduced numbers on the coast (Campbell *et al.* 2001). Cannings (2007:15-19) noted that in the interior of British Columbia, Evening Grosbeak was more common in winter than in summer in the 1960s but that the reverse was true by 1995. He also noted that they became scarcer in both seasons beginning in 2000. He suggests that the changes may have been due to the outbreak in spruce budworm from 1978 to the late 1990s. Evening Grosbeak has shown serious declines across North America (National Audubon Society 2007; Butcher and Niven 2007).

Residents

Most of the 17 resident species (65%) showed significant positive trends on one or both counts and only Bewick's Wren showed a significant negative trend; 29% of the species showed no significant trend. In contrast, the BBS counts for coastal British Columbia for the period 1986 to 2006 showed no significant trend for most (88%) of these 17 species of residents; no species showed a significant increase and only two species (Bewick's Wren, European Starling) showed a significant decrease (Downes and Collins 2007).

Common Raven showed a significant positive trend on both SBC and CBC. Common Raven has varied in numbers in the Comox Valley in the past. It was uncommon there from 1916 to 1932 but became more common from 1933 to 1937 (Pearse 1938). The increase observed in this study may be part of a longer term trend.

Bewick's Wren was the only resident species to show a significant negative trend (Figure 6). The trend was significant only on the SBC, possibly due to increased detectability of birds in spring. Bewick's Wren showed a significant decrease on BBS in coastal British Columbia from 1986 to 2006 (Table 3) and also showed a significant negative trend in fall migration in central California from 1979 to 1999 (Ballard *et al.* 2003).

Many of the resident species that showed a significant positive trend are urban (Rock Pigeon, European Starling, House Finch) and suburban (Downy Woodpecker, Pileated Woodpecker, Steller's Jay, Chestnut-backed Chickadee, Bushtit, Red-breasted Nuthatch) birds often found at backyard feeders. Many of these species forage in flocks in winter and, likely as a result, are recorded in greater numbers on the CBC than on the SBC.

Ringed-necked Pheasant, an introduced species, showed a significant positive trend on both counts. An examination of the annual numbers, however, showed a pattern of increase from the mid-1980s to a peak in the mid-1990s and then a decline. This pattern is suggestive of an introduction in the mid-1980s. Ring-necked Pheasant were introduced to the Comox Valley in 1955 (Campbell *et al.* 1990b) but I did not find any record of later introductions.

Discussion

Long-term trends

Count methodology

The methodology used for Christmas Bird Counts is subject to a number of biases that compromise analyses, such as differences in observer skill, circle coverage, number of participants and weather. Interpreting the results of CBC counts, therefore, requires a good understanding of the history of the count, who participated, how those participants

Table 3. Comparison of trends detected by the North American Breeding Bird Survey (BBS) for the Northern Pacific Rainforest (BCR 5), British Columbia (Downes and Collins 2007) and by the Comox SBC and CBC. Species with significant (P<0.05) trends on the BBS are listed.

Species	Breeding Bird Survey			Comox 1976-2006	
	1968-2006	1968-1985	1986-2006	SBC	CBC
Bald Eagle	4.3*	-	0.6	4.7*	2.9*
Killdeer	-3.8	-	-6.7*	-0.2	0.6
Belted Kingfisher	-4.4*	-3.4	-6.1	1.5	0.9
Common Raven	4.8*	16.3	-1.5	6.0*	2.8*
Tree Swallow	-3.3	2.0	-5.1*	-3.4	-
Barn Swallow	-2.7	3.0	-6.0*	-4.6*	-
Bewick's Wren	-5.7	4.5	-10.5*	-2.3*	-0.5
Varied Thrush	1.3	10.3*	-0.3	-1.0	3.4
European Starling	-3.4*	6.3	-7.3*	0.5	1.7*
Orange-crowned Warbler	-2.7	-1.2	-4.2*	-0.2	-
Chipping Sparrow	-2.3	3.1	11.0*	-2.2	-
Dark-eyed Junco	-2.9	-0.5	-4.6*	4.0	2.6*
Pine Siskin	-1.8	12.0	-6.7*	-0.4	0.0
American Goldfinch	-7.5*	-11.0	-10.4*	0.7	-

Significance: *P <0.05

behaved, and how circle coverage changed (Droege 2008). The counts used in this study were conducted each year by many of the same observers following a similar approach and covering the count circle in a similar manner, which should minimize at least some of the inherent biases. It is usually recommended that data be adjusted for 'party hours' because both the number of participants and teams have often varied over time (Butcher *et al.* 1990). In this study, the number of teams and hours spent in the field were relatively constant, although the number of participants increased. The number of party hours was, therefore, similar each year and the numbers counted were not adjusted.

Timing of counts

The Spring Bird Count was conducted at a time when spring migration was still underway and when winter birds were still dispersing. Consequently, trends in numbers of some species could be due either to actual changes in populations or to timing of movements. The decreasing trends observed for some waterfowl (Scaup, White-winged Scoter, Common Goldeneye) and waterbirds (Horned Grebe, Pelagic Cormorant) could have been due to earlier movements from winter concentrations and the increasing trends in Bonaparte's Gull and Greater Yellowlegs could have been due to earlier arrival dates. Likewise, the increasing trends observed for some neotropical migrants (Pacific-slope Flycatcher, Black-throated Gray Warbler, Common Yellowthroat) and Turkey Vulture could have been due to earlier arrival dates. Unpublished data from counts made in the Comox Valley from late-March to late-May 2005 to 2007 show that many neotropical migrants and some short-distance migrants are still in migration when the SBC is conducted; numbers are much greater in the month following the SBC than in the month preceding the SBC. However, for most coastal and upland birds the trends observed appear to reflect differences in population size.

Comparison with BBS

In order to see if the Comox counts reflected the BBS counts, I compared significant trends observed on the BBS for coastal British Columbia (Northern Pacific Rainforest) with those observed on the Comox counts (Table 3). Of the 14 species with significant BBS trends, only 4 species (Bald Eagle, Common Raven, Barn Swallow, Bewick's Wren) were significant on the SBC counts, and all matched the direction of the BBS trends. The Comox counts may have reflected breeding populations for these species. Two additional species (Eurasian Starling, Dark-eyed Junco) were significant on the CBC counts but showed a different direction of trend from the BBS. The Comox counts likely reflected wintering counts for these species. The remaining 8 species showed significant trends on the BBS but were not significant on the Comox counts. Differences in trends observed on the Comox counts compared with the BBS may be due to difference in the populations being monitored (*cf.* Francis and Hussell 1998). The BBS is not well represented in or near the Comox Valley, and the BBS is largely restricted to roadside habitats. Also, several of the species monitored on the Comox counts breed outside of coastal British Columbia and are not well represented on the BBS on their breeding range.

Trends

Even setting aside those species that were likely affected by timing of migration or movements, coastal birds showed a much greater tendency to population decrease and a lesser tendency to population increase than upland birds. Because of the traditional importance of the Comox Valley to waterfowl and waterbirds, the declines, especially for Harlequin Duck and Western Grebe, are a concern and reinforce the need to monitor those populations.

Declines have been documented for many species of neotropical migrants (Rappole and McDonald 1994, Robbins *et al.* 1989). However, Francis and Hussell (1998) found that in Ontario many species that were declining appeared to have increased and showed a positive trend from 1961 to 1997. Most of the species of upland birds that showed an increasing trend on the Comox counts are species that concentrate in winter (sparrows, blackbirds, urban/suburban birds) and their predators (Red-tailed Hawk, Merlin). Those increases are despite the significant loss in habitat due to development. The decreasing trends for Bewick's Wren and aerial foragers (Violet-green Swallow, Barn Swallow) are unexplained but deserve continued monitoring and investigation.

Climate change

Many of the recent changes in bird populations and the timing of migration have been suggested to relate to recent changes in climate and to climate warming (Price and Root 2005). Earlier arrivals, earlier breeding dates and changes in distributions have been seen (*ibid.*). In addition, the average latitude of occurrence is shifting northward and has the potential for a 32% gross, 16% net, loss of species of neotropical migrants in the Pacific Northwest (*ibid.*). A trend towards earlier arrival dates has been reported in northeastern United States (Butler 2003), Manitoba (Murphy-Klassen *et al.* 2005) and British Columbia (Bunnell and Squires 2005). Short-distance migrants have shown higher incidences of advancing arrival dates compared with other groups (Butler 2003, Murphy-Klassen *et al.* 2005). In Manitoba, waterfowl appeared to be more sensitive to the effects of warming trends than other species (Murphy-Klassen *et al.* 2005).

Coastal British Columbia has warmed at a rate equivalent to 0.5ºC to 0.6ºC per century, or at roughly the same rate as the global average. Spring across most of British Columbia is now warmer, on average, than it was a century ago. On the coast, spring temperatures have increased by 0.8ºC. (B.C. Ministry of Water, Land and Air Protection

2002). The Comox Valley has shown statistically significant trends for 1950 to 2001 in annual minimum and average temperature, as well for spring, summer and autumn minimum temperature; increases are primarily observed in the spring season (Environment Canada 2005).

Long-term changes in climate could, therefore, have affected the abundance of some species on both the SBC and the CBC, although the effect would be expected to be greater on the SBC, which was conducted when many species were on migration. A long-term increase in temperature could advance the timing of migration and produce either an increase or a decrease in numbers observed depending on when the count occurred relative to the peak of migration for that species. That may account for the trends observed in Bonaparte's Gull, Greater Yellowlegs and some neotropical migrants (Pacific-slope Flycatcher, Black-throated Gray Warbler, Common Yellowthroat) and Turkey Vulture. Likewise, climate warming may have caused earlier movements from winter habitats in Scaup, White-winged Scoter, Horned Grebe and Pelagic Cormorant. Long-term changes in climate could also affect the quality of winter habitats, causing birds to change winter concentration areas over time. Although there is no direct evidence of that in the Comox Valley, such an effect could explain the trends observed in Pacific Loon, Western Grebe and many wintering upland birds (sparrows, blackbirds, urban and suburban birds).

Conclusion

Long-term counts of birds in the Comox Valley permitted detection of significant trends in the numbers of many coastal and upland birds in an area that traditionally has been important for wintering birds and has undergone considerable change due to development. The availability of both a spring as well as a winter count was important in understanding the dynamics of many species, even though the spring count was conducted during migration. Counts like these, conducted by dedicated amateur birders over time, are important in documenting the trends in local areas and compliment broader national and regional surveys.

Acknowledgements

I am indebted to the many members of the Comox Valley Naturalists Society who took part in the Christmas Bird Counts and Spring Bird Counts over the years. I would particularly like to thank Rob Butler and Neil Dawe for their review of the paper. The manuscript also benefited from comments from M. Drever, T. Dickinson, K. Martin and an anonymous reviewer.

Literature cited

Badzinski, S.S., R.J. Cannings, T. E. Armenta, J. Komaromi and P.J.A. Davidson 2008. Monitoring coastal bird populations in BC: the first five years of the Coastal Waterbird Survey (1999-2004). *British Columbia Birds* 17:1-35.

Ballard, G., G.R. Geupel, N. Nur and T. Gardali 2003. Long-term declines and decadal patterns in population trends of songbirds in western North America, 1979–1999. *Condor* 105:737–755.

Birds Ontario 2007. Atlas of the breeding birds of Ontario, 2001-2005. <www.birdsontario.org/atlas/about-book.html>. Accessed 2007 October 19.

Blood, D.A. and G.G. Anweiler 1994. Status of the Bald Eagle in British Columbia. Wildlife Working Report WR-62. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. 94 p. <http://srmapps.gov.bc.ca/apps/eswp/>. Accessed 2007 August 17.

B.C. Ministry of Labour and Citizens' Services 2007. BC Stats. <www.bcstats.gov.bc.ca> Accessed 2007 March 24.

B.C. Ministry of Environment 2005. Report: Sensitive Ecosystems Inventory (SEI): east Vancouver Island and the Gulf Islands (includes 2002 disturbance mapping). <http://srmwww.gov.bc.ca/appsdata/acat/html/deploy/acat_p_report_2124.html >. Accessed 2007 March 24.

B.C. Ministry of Water, Land and Air Protection 2002. Indicators of climate change for British Columbia, 2002. <www.env.gov.bc.ca/air/climate/indicat/pdf/indcc.pdf>. Accessed 2007 April 4.

Brooks, E. 2006. *The pioneer birdmen of Comox.* Booklet, Comox Valley Naturalists Society and Comox Archives & Museum Society, Box 3222, Courtenay, B.C. 20 p.

Bunnell, F.L. and K.A. Squires 2005. Evaluating potential influences of climate change on historical trends in bird species. Unpublished report. Biodiversity Center for Wildlife Studies, Victoria, B.C. 50 p. < http://wildlifebc.org/UserFiles/File/Climate&Birds.pdf>. Accessed 2007 April 8.

Burger, A.E. 1997. Status of the Western Grebe in British Columbia. Wildlife Working Report WR-87. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. 47 p. <http://srmapps.gov.bc.ca/apps/eswp/>. Accessed 2007 August 17.

Butcher, G.S. and D.K. Niven 2007. Combining data from Christmas Bird Count and the Breeding Bird Survey to determine the continental status and trends of North American birds. National Audubon Society, Washington, D.C. 34 p plus 3 appendices. <http://stateofthebirds.audubon.org/cbid/content/Report.pdf> Accessed 2007 September 3.

Butcher, G.S., M. R. Fuller, L.S. McAllister and P.H. Geissler 1990. An evaluation of the Christmas Bird Count for

monitoring population trends of selected species. *Wildl. Soc. Bull.* 18:129-134.

Butler, C.J. 2003. The disproportionate effect of global warming on the arrival dates of short-distance migratory birds in North America. *Ibis* 145: 484–495.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser and M.C.E. McNall 1990a. *The birds of British Columbia. Vol. 1. Nonpasserines: introduction and loons through waterfowl.* Royal British Columbia Museum, Victoria, B.C. 514 p.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser and M.C.E. McNall 1990b. *The birds of British Columbia. Vol. 2. Nonpasserines: diurnal birds of prey through woodpeckers*. Royal British Columbia Museum, Victoria, B.C. 636 p.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, M.C.E. McNall and G.E.J. Smith 1997. *The birds of British Columbia. Vol. 3. Passerines: flycatchers through vireos*. UBC Press, Vancouver, B.C. 693 p.

Campbell, R.W., N.K. Dawe, I. McTaggart-Cowan, J.M. Cooper, G.W. Kaiser, A.C. Stewart and M.C.E. McNall 2001. *The birds of British Columbia. Vol. 4. Passerines: wood-warblers through old world sparrows*. UBC Press, Vancouver, B.C. 739 p.

Cannings, R. 2007. *An enchantment of birds: memories from a birder's life.* Greystone Books, Vancouver, B.C. 211 p.

Collins, B.T. 1990. Using rerandomizing tests in route-regression analysis of avian population trends. p. 63-70 *in* J. R. Sauer and S. Droege (eds). *Survey designs and statistical methods for the estimation of avian population trends.* Biological Report 90(l). U.S. Fish & Wildlife Service, Washington, D.C.

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, Pacific and Yukon Region, B.C. 177 p.

DeGraaf, R.M. and J.H. Rappole 1995. *Neotropical migratory birds: natural history, distribution and population change*. Cornell University Press, Ithaca, N.Y. 676 p.

Downes, C.M. and B.T. Collins 2007. Canadian Bird Trends web site. Version 2.2. Canadian Wildlife Service, Environment Canada, Gatineau, Que. <www.cws-scf.ec.gc.ca/mgbc/trends/index.cfm >. Accessed 2007 October 14.

Droege, S. 2008. Managers' monitoring guide - Christmas Bird Count. USGS Patuxent Wildlife Research Center, Laurel, Md. <www.pwrc.usgs.gov/monmanual/techniques/christmasbirdcount.htm>**.** Accessed 2008 February 24.

Ehrlich, P.R., D.S. Dobkin and D. Wheye 1988. *The birder's handbook: a field guide to the natural history of North American birds.* Simon & Schuster Inc., N.Y. 785 p.

Environment Canada 2005. Temperature and precipitation: indicators of climate change. <www.ecoinfo.ec.gc.ca/env_ind/region/climate/climate_e.cfm>. Accessed 2007 April 4.

Francis, C.M. and D.J.T. Hussell 1998. Changes in numbers of land birds counted in migration at Long Point Bird Observatory, 1961-1997. *Bird Populations* 4:37-66.

IBA Canada 2004. Important Bird Areas of Canada. <www.ibacanada.com>. Accessed 2007 August 7.

Kushlan, J.A., M.J. Steinkamp, K.C. Parsons, J. Capp, M.A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R.M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J.E. Saliva, B.Sydeman, J. Trapp, J. Wheeler and K. Wohl 2002. Waterbird conservation for the Americas: the North American waterbird conservation plan, Version 1. Waterbird Conservation for the Americas. Washington, D.C. 78 p.

Martell, A. and B. Sedgwick 2007. Changes in numbers of some autumn bird migrants in the Comox Valley, British Columbia, Canada, from 1987 to 2005. *British Columbia Birds* 15:2-8.

Morrison, R.I.G., Y. Aubry, R.W. Butler, G.W. Beyersbergen, G.M. Donaldson, C.L. Gratto-Trevor, P.W. Hicklin, V.H. Johnston and R.K. Ross 2001. Declines in North American shorebird populations. *Wader Study Group Bull.* 94:34-38.

Murphy-Klassen, H.M., T.J. Underwood, S.G. Sealy and A.A. Czyrnyj 2005. Long-term trends in spring arrival dates of migrant birds at Delta Marsh, Manitoba, in relation to climate change. *The Auk* 122:1130–1148.

National Audubon Society 2005. Christmas Bird Count. <www.audubon.org/bird/cbc/history.html >. Accessed 2007 August 7.

National Audubon Society 2007. Common birds in decline. <http://stateofthebirds.audubon.org/cbid/>. Accessed 2007 September 3.

North American Waterfowl Management Plan 2004. North American Waterfowl Management Plan 2004. Strategic guidance: strengthening the biological foundation. Canadian Wildlife Service, U.S. Fish and Wildlife Service, Secretaria de Medio Ambiente y Recursos Naturales. 22 p.

North American Waterfowl Management Plan 2007. The Sea Duck joint venture. <www.seaduckjv.org>. Accessed 2007 October 24.

Pearse, T. 1938. A remarkable influx of ravens into the Comox District, Vancouver Island, B.C. *The Murrelet* 19:11-13.

Price, J.T. and T.L. Root 2005. Potential impacts of climate change on neotropical migrants: management implications. p.1123-1128 *in* C.J. Ralph and T.D. Rich (eds). Bird conservation implementation and integration in the Americas: proceedings of the third international Partners in Flight conference. Gen. Tech. Rep. PSW-

GTR-191. U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station, Albany, Calif. 1296 p.

Rappole, J.H. and M.V. McDonald 1994. Cause and effect in population declines of migratory birds. *The Auk* 11:652-660.

Robbins, C.S., J.R. Sauer, R.S. Greenberg and S. Droege 1989. Population declines in North American birds that migrate to the neotropics. *Proc. Natl. Acad. Sci.* 86:7658-7662.

Sauer, J.R., J.E. Hines and J. Fallon 2005. The North American Breeding Bird Survey, results and analysis 1966 - 2005. Version 6.2.2006. USGS Patuxent Wildlife Research Center, Laurel, Md. <www.mbr-pwrc.usgs.gov/bbs/ >**.** Accessed 2007 April 19.

Smith, C.M., F. Cooke, G.J. Robertson, I. Goudie and W.S. Boyd 2000. Population dynamics of Harlequin Ducks in British Columbia and Alberta. p.283-287 in L.M. Darling (ed.). Proceedings of a conference on the biology and management of species and habitats at risk, Kamloops, B.C., 15-19 Feb., 1999. Volume 1. B.C. Ministry of Environment, Lands and Parks, Victoria, B.C. and University College of the Cariboo, Kamloops, B.C. 490 p.

Sullivan, T. M., S.L. Hazlitt and M.J.F. Lemon 2002. Population trends in nesting Glaucous-winged Gulls, *Larus glaucescens*, in the southern Strait of Georgia, British Columbia. *Canadian Field-Naturalist* 116: 603-606.

Verbeek, N.A.M. and R.W. Butler 1999. Northwestern Crow (*Corvus caurinus*). No. 407. *in* A. Poole and F. Gill, editors. *The birds of North America*, The Birds of North America, Inc., Philadelphia, Pa. 24 p.

Vermeer, K. 1994. Waterbird populations in the Courtenay River estuary: a comparison with southern Vancouver Island estuaries. p.57-62 *in* R.W. Butler and K. Vermeer (eds). *The abundance and distribution of estuarine birds in the Strait of Georgia, British Columbia*. Canadian Wildlife Service, Occasional Paper Number 83, Ottawa, Ont.

Vermeer, K. and K. Devito 1989. Population trend of nesting Glaucous-winged Gulls in the Strait of Georgia. p. 88-93 *in* K. Vermeer and R.W. Butler (eds). *The ecology and status of marine birds in the Strait of Georgia, British Columbia*. Special Publication, Canadian Wildlife Service, Ottawa, Ont. 186 p.

Vermeer, K., K.H. Morgan and G.E.J. Smith 1989. Population trends and nesting habitat of Double-crested and Pelagic cormorants in the Strait of Georgia. p. 94-99 *in* K. Vermeer and R.W. Butler (eds). *The ecology and status of marine birds in the Strait of Georgia, British Columbia*. Special Publication Canadian Wildlife Service, Ottawa, Ont. 186 p.

Appendix: Scientific names of species mentioned in the article.

English name	Scientific name	English name	Scientific name
Brant	*Branta bernicla*	Great Blue Heron	*Ardea herodias*
Canada Goose	*Branta canadensis*	Turkey Vulture	*Cathartes aura*
Trumpeter Swan	*Cygnus buccinator*	Osprey	*Pandion haliaetus*
Wood Duck	*Aix sponsa*	Bald Eagle	*Haliaeetus leucocephalus*
American Wigeon	*Anas americana*	Red-tailed Hawk	*Buteo jamaicensis*
Mallard	*Anas platyrhynchos*	Merlin	*Falco columbarius*
Northern Shoveler	*Anas clypeata*	American Coot	*Fulica americana*
Northern Pintail	*Anas acuta*	Black-bellied Plover	*Pluvialis squatarola*
Green-winged Teal	*Anas crecca*	Killdeer	*Charadrius vociferus*
Greater Scaup	*Aythya marila*	Greater Yellowlegs	*Tringa melanoleuca*
Lesser Scaup	*Aythya affinis*	Black Turnstone	*Arenaria melanocephala*
Harlequin Duck	*Histrionicus histrionicus*	Sanderling	*Calidris alba*
Surf Scoter	*Melanitta perspicillata*	Western Sandpiper	*Calidris mauri*
White-winged Scoter	*Melanitta fusca*	Dunlin	*Calidris alpina*
Black Scoter	*Melanitta nigra*	Bonaparte's Gull	*Larus philadelphia*
Long-tailed Duck	*Clangula hyemalis*	Mew Gull	*Larus canus*
Bufflehead	*Bucephala albeola*	Herring Gull	*Larus argentatus*
Common Goldeneye	*Bucephala clangula*	Thayer's Gull	*Larus thayeri*
Common Merganser	*Mergus merganser*	Glaucous-winged Gull	*Larus glaucescens*
Red-breasted Merganser	*Mergus serrator*	Pigeon Guillemot	*Cepphus columba*
Ring-necked Pheasant	*Phasianus colchicus*	Marbled Murrelet	*Brachyramphus marmoratus*
California Quail	*Callipepla californica*	Rock Pigeon	*Columba livia*
Pacific Loon	*Gavia pacifica*	Band-tailed Pigeon	*Patagioenas fasciata*
Common Loon	*Gavia immer*	Rufous Hummingbird	*Selasphorus rufus*
Horned Grebe	*Podiceps auritus*	Belted Kingfisher	*Ceryle alcyon*
Red-necked Grebe	*Podiceps grisegena*	Red-breasted Sapsucker	*Sphyrapicus ruber*
Western Grebe	*Podiceps occidentalis*	Downy Woodpecker	*Picoides pubescens*
Double-crested Cormorant	*Phalacrocorax auritus*	Hairy Woodpecker	*Picoides villosus*
Pelagic Cormorant	*Phalacrocorax pelagicus*	Northern Flicker	*Colaptes auratus*

Appendix continued ▶

Appendix continued: Scientific names of species mentioned in the article.

◄ Appendix continued

English name	Scientific name	English name	Scientific name
Pileated Woodpecker	*Dryocopus pileatus*	Yellow-rumped Warbler	*Dendroica coronata*
Pacific-slope Flycatcher	*Empidonax difficilis*	Black-throated Gray Warbler	*Dendroica nigrescens*
Cassin's Vireo	*Vireo cassinii*	Townsend's Warbler	*Dendroica towsendi*
Steller's Jay	*Cyanocitta stelleri*	MacGillivray's Warbler	*Oporornis tolmiei*
Northwestern Crow	*Corvus caurinus*	Common Yellowthroat	*Geothlypis trichas*
Common Raven	*Corvus corax*	Wilson's Warbler	*Wilsonia pusilla*
Tree Swallow	*Tachycineta bicolor*	Spotted Towhee	*Pipilo maculatus*
Violet-green Swallow	*Tachycineta thalassina*	Chipping Sparrow	*Spizella passerina*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Savannah Sparrow	*Passerculus sandwichensis*
Barn Swallow	*Hirundo rustica*	Fox Sparrow	*Passerella iliaca*
Chestnut-backed Chickadee	*Poecile rufescens*	Song Sparrow	*Melospiza melodia*
Bushtit	*Psaltiparus minimus*	White-crowned Sparrow	*Zonotrichia leucophrys*
Red-breasted Nuthatch	*Sitta canadensis*	Golden-crowned Sparrow	*Zonotrichia atricapilla*
Brown Creeper	*Certhia americana*	Dark-eyed Junco	*Junco hyemalis*
Bewick's Wren	*Thryomanes bewickii*	Red-winged Blackbird	*Agelaius phoeniceus*
Winter Wren	*Troglodytes troglodytes*	Brewer's Blackbird	*Euphagus cyanocephalus*
Golden-crowned Kinglet	*Regulus satrapa*	Brown-headed Cowbird	*Molothrus ater*
Ruby-crowned Kinglet	*Regulus calendula*	Purple Finch	*Carpodacus purpureus*
American Robin	*Turdus migratorius*	House Finch	*Carpodacus mexicanus*
Varied Thrush	*Ixoreus naevius*	Pine Siskin	*Carduelis pinus*
European Starling	*Sturnus vulgaris*	American Goldfinch	*Carduelis tristis*
Orange-crowned Warbler	*Vermivora celata*	Evening Grosbeak	*Coccothraustes vespertinus*
Yellow Warbler	*Dendroica petechia*	House Sparrow	*Passer domesticus*

Tim Zurowski