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Relative abundance and range extensions of bird species in central Labrador

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Abstract

Bird communities in Labrador remain poorly described, including in the lower Churchill River valley, which lies within an offshoot of the boreal shield ecozone and features vegetation communities typically found more than 100 km to the south. Between 2006 and 2016, we conducted 1139 point counts in June and early July at 617 sites along 63 routes within and adjacent to the lower Churchill River valley. We documented 80 species during the surveys and a further nine species incidentally. The most numerous species were Swainson's Thrush (*Catharus ustulatus*), Ruby-crowned Kinglet (*Corthylio calendula*), and Dark-eyed Junco (*Junco hyemalis*). Relative bird abundance was highest in hardwood and mixedwood forests and lowest in areas dominated by Black Spruce (*Picea mariana*). Among the species we observed were 19 that we considered to be regionally rare, based on existing documentation. The most abundant of these were Least Flycatcher (*Empidonax minimus*), Cedar Waxwing (*Bombycilla cedrorum*), and Magnolia Warbler (*Setophaga magnolia*), each with more than 80 observations over multiple years, spanning 10 or more areas within the lower Churchill River valley. Almost all of the regionally rare species were strongly associated with either hardwood forests, large conifers, or dense riparian vegetation. These features are relatively widespread within the lower Churchill River valley, but scarce elsewhere in Labrador. It is unclear whether the results observed represent recent range expansions or our surveys were simply the first to document long-standing regional populations; regardless, we recommend that our records be considered in future revisions to range maps for these species.

Key words: Birds; boreal; distribution; habitat association; Labrador; range extension

Introduction

Accurate data on the distribution and abundance of birds are rare for much of northern Canada and biased toward the few areas that have more observers and somewhat greater accessibility. This applies to Labrador, where the only comprehensive publication on birds of the region remains *Birds of the Labrador Peninsula and Adjacent Areas* (Todd 1963), although it focussed largely on northeastern Ontario and northern Quebec. Only limited data pertain to the current boundaries of Labrador and are certain to be inadequate to describe current bird communities given the likelihood of changes in distribution and abundance over the course of several decades. A somewhat updated overview for the lower Churchill River was provided by Hunter and Associates (1981), with a summary of historical data supplemented by limited field work in 1980.

Over the past two decades, first breeding records for Labrador have been documented for Northern Harrier (*Circus hudsonius*, near Churchill Falls; Chubbs *et al.* 2000) and Black-headed Gull (*Chroicocephalus ridibundus*, on Lake Melville; Chaulk *et al.* 2004). Further, Whitaker's (2017) summary of research in the Torngat Mountains of Labrador documented confirmed breeding of Spotted Sandpiper (*Actitis macularius*) and seven songbird species far north of previously recognized range limits.

Other recent research on bird communities in Labrador has included small-scale studies associated with forest clearing (Simon *et al*. 2000, 2002; Schwab *et al*. 2001, 2006), exploration of microhabitat preferences of Boreal Chickadee (*Poecile hudsonicus*) and Cape May Warbler (*Setophaga tigrina*; Ethier and Wilson 2019), use of microphone arrays by Hennigar *et al.* (2019) to investigate effects of traffic noise on breeding forest birds near Happy Valley-Goose Bay (HVGB), and analysis of bird distribution in relation to vegetation and altitude in the Mealy Mountains east of HVGB (Lewis and Starzomski 2015). The increasing popularity of eBird (2019) is adding to the knowledge of bird distribution in central Labrador, as

are other citizen science efforts such as the Breeding Bird Survey (USGS 2018) and Christmas Bird Count (NAS 2018). However, the overwhelming majority of citizen science data are limited to the vicinity of HVGB and, to a lesser extent, along the Trans-Labrador Highway (TLH).

Whereas most of Labrador is within the taiga shield ecozone, the lower Churchill River valley and a narrow band along Lake Melville are within the boreal shield ecozone (ESWG 1996). This area is disjunct from the remainder of the boreal shield ecozone, which is otherwise largely restricted to below the southern boundary between Quebec and Labrador (80–150 km south of the lower Churchill River valley; Figure 1). Summers are warmer and winters less severe than in the adjacent taiga shield ecozone, especially in sheltered parts of the valley (Way *et al*. 2017). As a result, the area is known to support species more generally associated with boreal forests farther south, notably a greater diversity of plants, including stands of deciduous and mixed forest. However, despite its relative ecological richness within Labrador, Todd (1963) documented this area through only a single expedition in July and August of 1939. Much of the valley is remote and although accessible by canoe, is rarely travelled in that manner.

Although mostly undisturbed at the time of our research, part of the lower Churchill River valley was modified with the implementation of a dam at Muskrat Falls in 2019, creating a 101 km^2 reservoir upstream of Muskrat Falls, including 41 km^2 of newly flooded lands. A potential second dam at Gull Island has been proposed but is not yet scheduled for development.

To understand pre-development conditions and establish a baseline against which the effects of future land use changes can be evaluated, a comprehensive suite of field surveys was undertaken in 2006 and 2007, with supplementary efforts at certain locations in 2014–2016, as part of the environmental assessment of the Lower Churchill Hydroelectric Generation Project. The extent of coverage by these surveys greatly surpassed any previous landbird monitoring efforts in the region. The primary objectives of our study were to describe bird communities in the lower Churchill River valley by land cover type as a basis for future comparison, and to describe the distribution and abundance of species that are at the northern limit of their range in or near central Labrador.

Methods

Study area

Our primary study area was within ~3 km on either side of the lower Churchill River in central Labrador, from the Metchin River (53.313°N, 63.366°W) in the west to Lake Melville (53.334°N, 60.190°W) in the east, a linear distance of 210 km (270 km along the river; Figure 1). The actual width of the river valley varies; there are parts that are nearly a forested canyon and others where the slope is so gradual that there is no clear distinction of where the valley edge lies.

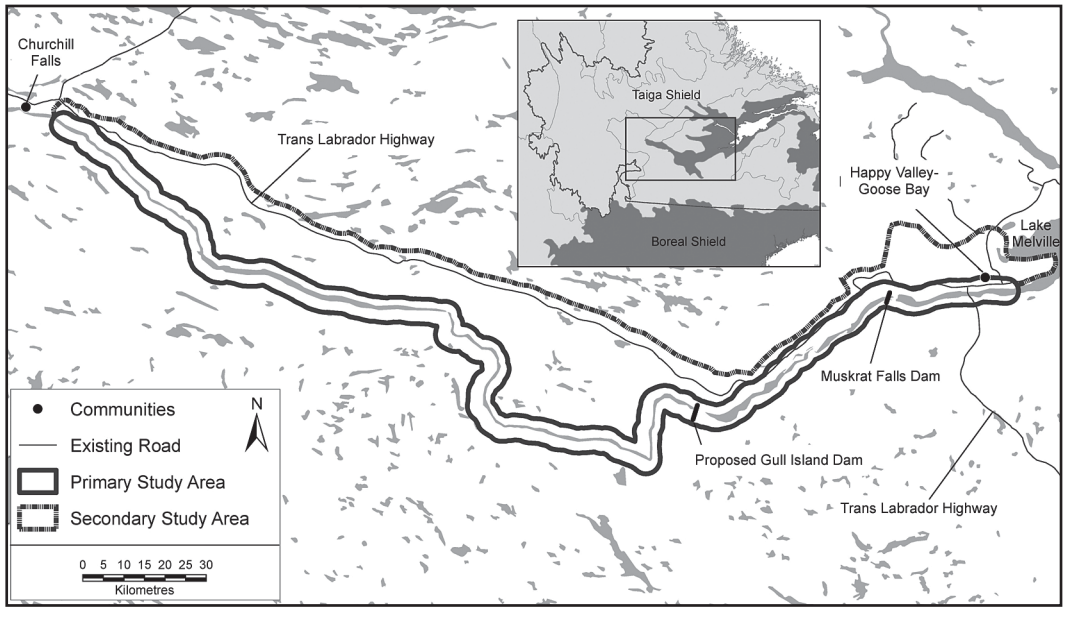

FIGURE 1. Location of the study area, with inset showing the relative distribution of the Boreal Shield and Taiga Shield Ecozones in Labrador.

Our focus was primarily within the river valley, but in areas where it was particularly narrow (e.g., upstream of Gull Island) or bordered by steep cliffs (e.g., parts of Lake Winokapau), some of our survey routes were on the adjacent plateau.

For comparative purposes we also conducted some surveys in two secondary study areas just north of the primary study area: 1) upland habitat near the TLH over a distance of nearly 150 km from east of Churchill Falls (53.492°N, 63.667°W) to north of Gull Island (53.068°N, 61.442°W), primarily along an existing power transmission line; and 2) ~25 km along the Goose River, from north of Muskrat Falls (53.393°N, 60.752°W) to Lake Melville (53.394°N, 60.386°W).

Land cover classification

The study area falls within the boreal shield ecozone, bounded on either side by the subarctic forest of the taiga shield ecozone (Figure 1). Black Spruce (*Picea mariana* (Miller), Britton, Sterns, and Poggenburgh) is the dominant tree species, with Balsam Fir (*Abies balsamea* (L.) Miller), Trembling Aspen (*Populus tremuloides* Michaux), and White Birch (*Betula papyrifera* Marshall) locally common on slopes and near the valley bottom. Small stands of White Spruce (*Picea glauca* (Moench) Voss) and Balsam Poplar (*Populus balsamifera* L.) are limited to a few flood plain locations along the lower Churchill River valley.

We identified seven distinct land cover categories within the study area (Table 1) and trained all field staff to classify sites consistently according to their definitions. Black Spruce (BS) is by far the most abundant land cover type in the study area, typically occurring as open stands with a carpet of Reindeer Lichen (*Cladonia rangiferina*) in uplands, and closed stands with Ostrich-plume Moss (*Ptilium crista-castrensis*) dominating the understorey on slopes and in lowlands. Mixed conifer forest (MC) is primarily found on floodplains, where large White Spruce or Balsam Fir trees are interspersed with some Black Spruce, and on Balsam Fir-dominated slopes, mostly in the area between Gull Island and Lake Winokapau. Mixedwood forest (MW) is mostly in floodplains and on southward facing slopes and is more frequent in the eastern half of the study area; deciduous trees are primarily Trembling Aspen. Hardwood forests (HA) are scarce in the study area, with larger stands mostly limited to along the Lower Churchill River east of Gull Island; Trembling Aspen is typically dominant, but in some stands White Birch is also common. Riparian (RI) areas were defined as the vegetation along river shorelines, typically comprising shrubs and forbs. Wetlands (WE) comprise marshes and wet meadows within the lower Churchill River floodplain (e.g., at Upper Brook), as well as upland Speckled Alder (*Alnus incana* subsp. *rugosa* (Du Roi) R.T. Clausen) swamps, fens, and bogs. The disturbed (DI) category primarily (>90%) comprises regenerating burns (e.g., at Metchin River and east of Edward's Brook), but also includes the area cleared for the work camp east of Gull Island.

Site selection

Surveys were conducted at 617 point count stations along 63 routes, 46 (73%) of which were in the primary study area, with the remainder split between the TLH uplands (n = 8; 13%) and Goose River (9; 14%; Figure 2a,b). We did not record the length or area of routes, nor the distance of individual point count stations from rivers or roads. The greatest concentration

Table 1. Categorization of land cover types in the lower Churchill River valley.

Land cover type	Description
Black Spruce (BS)	Open to closed forest with Black Spruce (*Picea mariana* (Miller) Britton, Sterns, and Poggenburgh), comprising >90% of trees; ground cover generally heavily dominated by Reindeer Lichen (*Cladonia rangiferina*) or feather mosses (*Ptilium* spp.)
Mixed conifer (MC)	Forest with coniferous species comprising >90% of trees, including at least 10% White Spruce (*Picea glauca* (Moench) Voss) or Balsam Fir (*Abies balsamea* (L.) Miller); ground cover generally mosses and forbs
Mixedwood (MW)	Forest with deciduous species (mostly Trembling Aspen, *Populus tremuloides* Michaux) comprising 10–49% of trees, mixed with Black Spruce, White Spruce, and/or Balsam Fir; ground cover varied
Hardwood (HW)	Forest with deciduous species (mostly Trembling Aspen) comprising >50% of trees; ground cover mostly forbs
Riparian (RI)	Shoreline vegetation, typically dominated by Speckled Alder (*Alnus incana* subsp. *rugosa* (Du Roi) R.T. Clausen), willows (*Salix* spp.), Sweet Gale *(Myrica gale* L.), grasses, and sedges
Wetland (WE)	Marshes, wet meadows, alder swamps, fens, and bogs; often surrounded by or even including some Black Spruce
Disturbed (DI)	Burns with <20 years of regeneration, and other disturbed lands

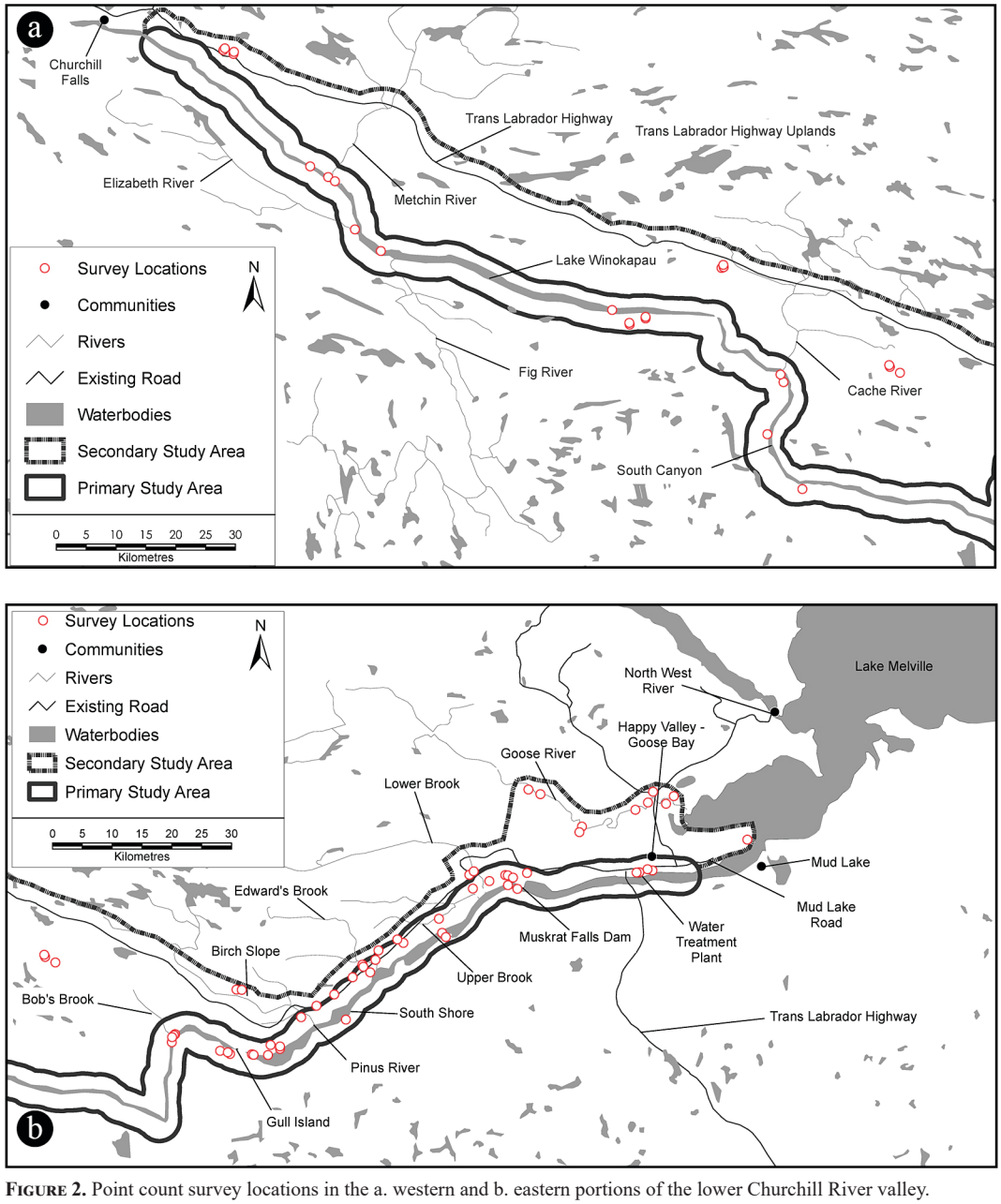

FIGURE 2. Point count survey locations in the a. western and b. eastern portions of the lower Churchill River valley.

of routes (24; 38%) was in the 50 km section between Muskrat Falls and Gull Island, within or immediately adjacent to the projected footprint of the future Muskrat Falls reservoir. Locations of all routes were constrained by requiring road access or suitable helicopter landing sites within 500 m, to maximize time available for surveys. Especially between Gull Island and Lake Winokapau, the combination of steep slopes and nearly continuous forest cover limited landing options considerably, and nearly all suitable access points were used. Elsewhere, less common land cover types (especially MC, MW, and HA) were generally targetted wherever accessible, to boost their limited sample size. Survey routes in the more widespread land cover types (most notable BS and WE) were selected arbitrarily from among accessible options

to provide a geographically balanced sample. Overall, 48% of routes were accessed by road and 52% by helicopter.

Each route comprised 6–13 point count stations, typically spaced 250 m to 350 m apart, and at least 100 m from any road. For routes near the river, roughly half of the stations were placed below the future reservoir level, and half above. Route design was also influenced by topographic limitations (e.g., rivers and steep slopes) and a preference for a looped layout for efficiency. Individual station locations were pre-selected using aerial imagery and ecological land classification mapping such that, at minimum, the 50 m radius around the point was in a single land cover type, and preferably 100 m. In the field, observers visually assessed each location prior to conducting the first survey and adjusted the position by up to 50 m to achieve greater land cover homogeneity. Global positioning system coordinates were taken at each survey point and flagging tape was placed to facilitate use of the identical location in future years.

Survey effort was greatest in 2006 and 2007, with baseline surveys in those two years accounting for 70% of the 1139 point counts conducted (Table 2). All routes surveyed in 2006 were repeated in 2007, except for seven along the Goose River, and 16 additional routes were covered in 2007 to address geographic gaps in the original sampling strategy and to target land cover types that were undersampled in 2006. Five of the original routes were revisited again in both 2014 and 2015, and six others in 2016. Eight new routes (13% of the total) were added in 2014 and 2015: six in or adjacent to the future Muskrat Falls reservoir and two near the Goose River delta.

Data collection

We collected bird data primarily through point counts, following a standard single-observer, fixed-radius protocol as described by Bibby *et al.* (2000). Each count was undertaken by a single observer with multiple previous years of boreal bird survey experience; across all years, 13 observers collected data, but there were no more than five in any single year. *Post hoc* data review showed no significant differences within years among observers in terms of mean number of species or individuals detected per point. All birds seen or heard were noted, although any flying past were flagged as incidental sightings and not included in analyses. Each individual was treated as a distinct observation. Distance to each observation was classified as being <50 m, <100 m, or ≥100 m from the observer. Care was taken to track the movements of individuals during a point count, to avoid double counting; if in doubt, the lower number was recorded. Surveys were timed to coincide with the peak of the breeding bird season from mid-June to early July (Table 2). Sunrise across the dates and locations of the survey ranged from 0435 to 0455, but because helicopter flight was not possible before civil dawn, and to avoid bias for sites accessible by road, all counts began after 0500 and ended by 0935. All counts were five minutes in duration.

We conducted a literature review to identify species considered to be regionally rare in the study area. We defined species as rare if they are classified as S1 (Critically Imperilled) in Labrador by NatureServe (2019), absent from Labrador according to maps in the most recent NatureServe (2019) or Birds of North America (Billerman *et al*. 2020) species accounts, or considered to occur in Labrador, but not within the study area according to at least three out of four field guides (Floyd 2008; Peterson 2012; Sibley 2016; Dunn and Alderfer 2017). For historical context, we referenced Todd (1963). We also compared our results with data from the four Breeding Bird Survey routes within our study area (Happy Valley: 1978, 1994–2001, 2003–2007, 2009–2011, 2013–2017; Goose Bay: 2016; Bob's Brook: 2011–2014, 2017; Main Wilson River: 2016–2017; USGS 2018), and eBird records from the Study Area (eBird 2019).

Data analysis

Birds detected before or after point counts, flying over during counts, over 100 m from point count locations, or while walking between counts were all noted as incidental observations. These were not used for calculations of relative abundance or assessment of land cover type association but were included in reporting the distribution of regionally rare species. We calculated relative abundance within each land cover type as the number of individuals detected per 100 point counts. We summarized results by land

Table 2. Breeding bird point count survey effort in central Labrador by year; TLH = Trans Labrador Highway.

Year	Survey dates	# routes	# points	Core focus
2006	24 June–4 July	39	342	Primary study area and Goose River
2007	11–28 June	48	450	Primary study area and TLH uplands
2014	18–25 June	9	108	Future Muskrat Falls reservoir
2015	20–25 June	10	121	Future Muskrat Falls reservoir
2016	20–26 June	14	118	TLH uplands

cover type and year, but for discussion of rare species, pooled results across all years.

For each of the regionally rare species, we compared their distribution from our field data with the published maps of NatureServe (2019), Birds of North America (Billerman *et al.* 2020), and the latest Smithsonian (Floyd 2008), Peterson (2012), Sibley (2016), and National Geographic (Dunn and Alderfer 2017) field guides. In each case, we estimated (to the nearest 50 km) the distance from the nearest edge of the previously mapped distribution to the farthest observation within the study area.

Results

Over the five years of field effort, we detected 80 bird species at point counts in the study area, with a single-year high of 73 species in 2007 (Table 3; Table S1). We observed an additional nine species

TABLE 3. Survey effort and summary results by year and primary land cover type (BS = Black Spruce, MC = mixed conifer, MW = mixedwood, HA = hardwood, RI = riparian, WE = wetland, DI = disturbed).

	Primary land cover type							
	BS	MC	MW	HA	RI	WE	DI	Total
2006								
Number of point count routes	32	22	19	7	14	16	6	39
Number of point count stations	111	40	62	22	65	33	9	342
Number of species observed	30	26	36	28	43	31	6	66
Number of individuals observed	300	153	291	106	394	183	34	1461
Mean # individuals/point count	2.7	3.8	4.7	4.8	6.1	5.5	3.8	4.3
2007								
Number of point count routes	40	20	24	10	18	20	9	48
Number of point count stations	158	52	82	35	70	33	20	450
Number of species observed	46	39	44	38	53	46	19	73
Number of individuals observed	711	300	536	302	416	237	87	2589
Mean # individuals/point count	4.5	5.8	6.5	8.6	5.9	7.2	4.4	5.8
2014								
Number of point count routes	10	5	5	2	1	2	2	10
Number of point count stations	49	18	31	2	6	2	0	108
Number of species observed	26	20	28	6	13	9	—	38
Number of individuals observed	240	135	218	9	27	13	—	642
Mean # individuals/point count	4.9	7.5	7.0	4.5	4.5	6.5	—	5.9
2015								
Number of point count routes	12	5	7	2	1	4	4	12
Number of point count stations	66	6	27	4	5	9	4	121
Number of species observed	30	15	25	13	9	12	12	43
Number of individuals observed	241	39	164	31	11	24	21	531
Mean # individuals/point count	3.7	6.5	6.1	7.8	2.2	2.7	5.3	4.4
2016								
Number of point count routes	14	7	5	0	6	8	4	14
Number of point count stations	52	9	9	0	12	12	24	118
Number of species observed	28	10	17	—	21	15	18	39
Number of individuals observed	219	49	38	—	75	62	91	534
Mean # individuals/point count	4.2	5.4	4.2	—	6.3	5.2	3.8	4.5
Total								
Number of point count routes	52	28	34	11	21	26	11	63
Number of point counts	436	125	211	63	158	89	57	1139
Number of species observed	60	44	52	40	62	51	52	80
Number of individuals observed	1711	676	1247	448	923	519	233	5757
Mean # individuals/point count	3.9	5.4	5.9	7.1	5.8	5.8	4.1	5.1

only incidentally. The five most numerous species each had an overall mean relative abundance of ≥35 individuals/100 point counts; in descending order of abundance they were Swainson's Thrush (*Catharus ustulatus*), Ruby-crowned Kinglet (*Corthylio calendula*), Dark-eyed Junco (*Junco hyemalis*), Yellow-rumped Warbler (*Setophaga coronata*), and Tennessee Warbler (*Leiothlypis peregrina*; Table 4). These five species accounted for 44% of all observations; the 10 most abundant species comprised 67%. Three of the species we observed are listed under Canada's *Species at Risk Act* (Government of Canada 2019): Olive-sided Flycatcher (*Contopus cooperi*; four observations), Bank Swallow (*Riparia riparia*; 43), and Rusty Blackbird (*Euphagus carolinus*; 16).

Land cover associations

Across all years, the mean number of individuals observed per point count was much higher in hardwood forest than any other land cover type (7.1 versus 5.9 in mixedwood forest and an overall average of 5.1); it was lowest overall in Black Spruce (3.9; Table 3). Results varied somewhat among years, especially for land cover types with smaller sample sizes, but Black Spruce was below average in all years, whereas mixedwood, hardwood, riparian, and wetland were each above average in all but one year of sampling.

In the Black Spruce land cover type, the five most abundant species (in descending order) were Ruby-crowned Kinglet, Dark-eyed Junco, Yellow-rumped Warbler, Swainson's Thrush, and Canada Jay (*Perisoreus canadensis*), ranging from 26 to 64 individuals/100 point counts (Table 4).

In mixed conifer forest, the five most abundant species were Swainson's Thrush, Ruby-crowned Kinglet, Tennessee Warbler, Yellow-rumped Warbler, and Dark-eyed Junco, ranging from 39 to 82 individuals/100 point counts; Northern Waterthrush (*Parkesia noveboracensis*) and White-throated Sparrow (*Zonotrichia albicollis*) also exceeded 30 individuals/100 point counts (Table 4).

In mixedwood forest, the five most abundant species were Swainson's Thrush, Tennessee Warbler, Ruby-crowned Kinglet, Black-throated Green Warbler (*Setophaga virens*), and Yellow-rumped Warbler, ranging from 40 to 86 individuals/100 point counts; White-throated Sparrow and Fox Sparrow (*Passerella iliaca*) also exceeded 30 individuals/100 point counts (Table 4).

In hardwood forest, the five most abundant species were Swainson's Thrush, Tennessee Warbler, Black-throated Green Warbler, Least Flycatcher (*Empidonax minimus*), and White-throated Sparrow, ranging from 54 to 89 individuals/100 point counts; Ruby-crowned Kinglet, Yellow-bellied Flycatcher (*Empidonax flaviventris*), and Fox Sparrow also exceeded 30 individuals/100 point counts (Table 4).

In riparian areas, the five most abundant species were Yellow Warbler (*Setophaga petechia*), Swainson's Thrush, Northern Waterthrush, Fox Sparrow, and White-throated Sparrow, ranging from 30 to 88 individuals/100 point counts (Table 4).

In wetlands, the five most abundant species were Ruby-crowned Kinglet, Dark-eyed Junco, White-throated Sparrow, Swainson's Thrush, and Fox Sparrow, ranging from 36 to 55 individuals/100 point counts; Lincoln's Sparrow (*Melospiza lincolnii*) and Canada Jay also exceeded 30 individuals/100 point counts (Table 4).

In disturbed areas, the five most abundant species were Dark-eyed Junco, White-throated Sparrow, Black-backed Woodpecker (*Picoides arcticus*), Hermit Thrush (*Catharus guttatus*), and Bank Swallow, ranging from 25 to 105 individuals/100 point counts (Table 4).

The top five species overall were among the five most common species in at least three of the seven land cover types within the study area (Table 4). Another ten species were among the top five in at least one land cover type and a further four species (Spotted Sandpiper; Yellow-bellied Flycatcher; Boreal Chickadee; Lincoln's Sparrow) accounted for at least 5% of observations in one or more land cover types (Table 4).

Extralimital records

Of the 80 species detected during point counts, 14 (18%) are considered to be regionally rare based on their NatureServe (2019) status for Labrador or range maps that show them to be absent from Labrador (Table 5). The most abundant of these were Least Flycatcher (118 individual bird observations), Magnolia Warbler (117), and Cedar Waxwing (*Bombycilla cedrorum*; 82). We observed an additional five regionally rare species only incidentally: Sora (*Porzana carolina*), Black-capped Chickadee (*Poecile atricapillus*), Bohemian Waxwing (*Bombycilla garrulus*), Black-and-white Warbler (*Mniotilta varia*), and Common Yellowthroat (*Geothlypis trichas*; Table 5).

Two of the species observed are shown as entirely absent from Labrador in all six range maps we reviewed (no audio recordings or photographs are available for these records). We documented Brown Creeper (*Certhia americana*) in five sites ranging from Lake Winokapau east to Gull Island, all in conifer-dominated land cover types, but with more than half of the records occurring in the regionally uncommon mixed conifer forest. We observed Song Sparrow (*Melospiza melodia*) in nine sites from Metchin River to east of HVGB, primarily (80%) in riparian areas and wetlands near the shoreline of the lower Churchill River and major tributaries, most notably Elizabeth River and Upper Brook.

TABLE 4. Relative abundance (number per 100 point counts) of common birds in the lower Churchill River valley by land cover type (BS = Black Spruce, MC = mixed conifer, MW = mixedwood, HA = hardwood, RI = riparian, WE = wetland, DI = disturbed), sorted by overall mean relative abundance (rank abundance in each land cover type in parentheses; top five species in each land cover type in bold). Common birds includes 19 species that accounted for >5% of observations in at least one land cover type, plus seven other species (*) that accounted for at least 1% of observations overall.

	BS	MC	MW	HA	RI	WE	DI	Total
Swainson's Thrush (*Catharus ustulatus*)	**39.2 (4)**	**81.6 (1)**	**86.3 (1)**	**88.9 (1)**	**51.9 (2)**	**36.0 (4)**	12.3 (9)	**55.5 (1)**
Ruby-crowned Kinglet (*Corthylio calendula*)	**64.4 (1)**	**68.8 (2)**	**49.8 (3)**	38.1 (6)	17.7 (11)	**55.1 (1)**	22.8 (6)	**51.4 (2)**
Dark-eyed Junco (*Junco hyemalis*)	**60.8 (2)**	**39.2 (5)**	30.3 (8)	28.6 (9)	13.9 (14)	**50.6 (2)**	**105.3 (1)**	**45.9 (3)**
Yellow-rumped Warbler (*Setophaga coronata*)	**47.5 (3)**	**40.8 (4)**	**39.8 (5)**	28.6 (9)	19.0 (10)	23.6 (9)	17.5 (7)	**37.0 (4)**
Tennessee Warbler (*Leiothlypis peregrina*)	22.7 (6)	**51.2 (3)**	**58.3 (2)**	**77.8 (2)**	24.7 (7)	24.7 (8)	5.3 (15)	**35.0 (5)**
White-throated Sparrow (*Zonotrichia albicollis*)	15.8 (8)	32.8 (7)	37.0 (6)	**54.0 (5)**	**29.7 (5)**	**49.4 (3)**	**50.9 (2)**	30.0 (6)
Fox Sparrow (*Passerella iliaca*)	19.9 (7)	28.0 (8)	32.2 (7)	33.3 (8)	**30.4 (4)**	**36.0 (4)**	10.5 (11)	25.7 (7)
Canada Jay (*Perisoreus canadensis*)	**25.7 (5)**	16.8 (9)	18.0 (10)	11.1 (16)	5.1 (25)	30.3 (7)	12.3 (9)	19.3 (8)
Black-throated Green Warbler (*Setophaga virens*)	7.8 (11)	11.2 (13)	**46.9 (4)**	**57.1 (3)**	17.1 (12)	4.5 (26)	—	18.8 (9)
Yellow Warbler (*Setophaga petechia*)	2.1 (17)	12.8 (12)	9.5 (15)	11.1 (16)	**88.0 (1)**	23.6 (9)	1.8 (24)	18.7 (10)
Northern Waterthrush (*Parkesia noveboracensis*)	5.3 (14)	36.0 (6)	21.8 (9)	19.0 (12)	**38.6 (3)**	23.6 (9)	1.8 (24)	18.3 (11)
American Robin* (*Turdus migratorius*)	7.6 (12)	14.4 (11)	18.0 (10)	15.9 (15)	10.1 (18)	11.2 (14)	15.8 (8)	11.8 (12)
Boreal Chickadee (*Poecile hudsonicus*)	12.2 (9)	16.0 (10)	16.1 (12)	6.3 (21)	6.3 (23)	5.6 (22)	8.8 (12)	11.5 (13)
Alder Flycatcher* (*Empidonax alnorum*)	1.4 (24)	8.0 (14)	8.5 (17)	19.0 (12)	23.4 (8)	22.5 (12)	3.5 (17)	9.2 (14)
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	2.3 (17)	8.0 (14)	14.7 (14)	36.5 (7)	5.1 (25)	3.4 (29)	—	7.5 (15)
Hermit Thrush (*Catharus guttatus*)	10.3 (10)	4.0 (22)	2.8 (26)	1.6 (32)	0.6 (50)	11.2 (14)	**26.3 (4)**	7.3 (16)
Magnolia Warbler* (*Setophaga magnolia*)	2.3 (17)	6.4 (19)	8.5 (17)	4.8 (23)	21.5 (9)	5.6 (22)	1.8 (24)	6.9 (17)
Least Flycatcher (*Empidonax minimus*)	0.9 (34)	4.8 (21)	6.6 (19)	**55.6 (4)**	9.5 (20)	3.4 (29)	—	6.8 (18)
Lincoln's Sparrow (*Melospiza lincolnii*)	1.6 (23)	3.2 (23)	1.4 (36)	4.8 (23)	16.5 (13)	31.5 (6)	5.3 (15)	6.5 (19)
Red-breasted Nuthatch* (*Sitta canadensis*)	2.3 (17)	7.2 (17)	15.2 (13)	4.8 (23)	3.8 (28)	2.2 (35)	1.8 (24)	5.5 (20)
Orange-crowned Warbler* (*Leiothlypis celata*)	5.0 (15)	2.4 (25)	9.5 (15)	19.0 (12)	1.9 (37)	2.2 (35)	1.8 (24)	5.5 (20)
White-winged Crossbill* (*Loxia leucoptera*)	6.4 (13)	3.2 (23)	6.2 (21)	3.2 (29)	3.8 (28)	5.6 (22)	1.8 (24)	5.2 (22)
Pine Siskin* (*Pinus spinus*)	3.9 (16)	7.2 (17)	6.6 (19)	9.5 (20)	7.6 (22)	—	—	5.1 (22)
Spotted Sandpiper (*Actitis macularius*)	0.5 (39)	2.4 (25)	0.9 (40)	—	29.1 (6)	1.1 (44)	—	4.7 (24)
Bank Swallow (*Riparia riparia*)	1.1 (24)	1.6 (29)	0.5 (41)	—	12.0 (15)	2.2 (35)	**24.6 (5)**	3.8 (26)
Black-backed Woodpecker (*Picoides arcticus*)	0.7 (36)	—	1.4 (36)	—	1.3 (42)	—	**31.6 (3)**	2.3 (31)

TABLE 5. Summary of observations of regionally rare birds in the lower Churchill River valley, 2006–2007 and 2014–2016 Land cover type: BS = Black Spruce, MC = mixed conifer, MW = mixedwood, HA = hardwood, RI = riparian, WE = wetland, DI = disturbed,

Species	Historical range in Labrador (sources*)	Sites observed (no. observations)	Land cover types observed (no. observations)	Years observed	Expansion of known breeding range (sources*†)
Sora (*Porzana carolina*) 1 incidental observation	Absent from Labrador (1,2,7); present around HVGB (4); limited to SW corner of Labrador (3,5,6)	Upper Brook (1)	WE (1)	2007	<50 km W from HVGB (4); >200 km E from SW Labrador (3,5,6); >600 km NE from Baie Comeau (1,2)
Downy Woodpecker (*Dryobates pubescens*) 2 point count observations 1 incidental observation	Absent from Labrador (2,5,6,7); limited to SW corner of Labrador (1) or southern edge of Labrador (3,4)	Birch Slope (1); Edward's Brook (1); Lower Brook (1)	MW (1) HA (2)	2007, 2014	>100 km N from S edge of Labrador (3,4); >150 km N from edge of range in E Quebec (1,2,5,6,7)
Yellow-bellied Sapsucker (*Sphyrapicus varius*) 4 point count observations 2 incidental observations	Absent from Labrador (4); present in SW Labrador (1,2,3,5,6); present around Gull Island (7)	Birch Slope (3); Edward's Brook (2); Lower Brook (1)	MW (2) HA (4)	2007, 2014, 2015	n/a (7); >150 km E from SW Labrador (1,2,3,5,6); >250 km NE from SW border of Labrador (4)
Least Flycatcher (*Empidonax minimus*) 77 point count observations 41 incidental observations	Absent from Labrador (1,2); present around HVGB (3,4,5,6,7)	Fig River (1); Lake Winokapau (1); Gull Island (5); Birch Slope (31); South Shore (5); Edward's Brook (15); Upper Brook (28); Lower Brook (9); Muskrat Falls (6); Water Treatment Plant (16); Goose River (1)	BS (6) MC (5) MW (20) HA (45) RI (36) WE (6)	2006, 2007, 2014, 2015, 2016	>150 km W from Happy Valley–Goose Bay (3,4,5,6,7); >400 km NE from Sept-Iles (1,2)
Red-eyed Vireo (*Vireo olivaceus*) 21 point count observations 15 incidental observations	Absent from Labrador (1,2,7); present around HVGB (3,4,5,6) and in SW Labrador (3)	Gull Island (4); Birch Slope (10); South Shore (2); Edward's Brook (3); Upper Brook (5); Lower Brook (7); Muskrat Falls (3); Water Treatment Plant (2)	BS (1) MC (1) MW (9) HA (22) RI (3)	2006, 2007, 2015	n/a (3,4,5,6); >350 km NW from N Newfoundland (1); >400 km NE from Anticosti Island (2)
Philadelphia Vireo (*Vireo philadelphicus*) 8 point count observations 1 incidental observation	Absent from Labrador (1,2,3,7); present around HVGB (4,6); rare in lower Churchill River valley (5)	Gull Island (2); Birch Slope (3); Edward's Brook (2); Upper Brook (1); Lower Brook (1)	BS (1) MW (2) HA (6)	2006, 2007, 2014	n/a (4,5,6); >250 km N from edge of range in E Quebec (1); >350 km NE from E of Sept-Iles (2,3)
Black-capped Chickadee (*Poecile atricapillus*) 1 incidental observation	Absent from Labrador (1,2,7); present around HVGB (3,4,5,6) and in SW Labrador (3,5,6)	Birch Slope (1)	HA (1)	2006	<50 km W from HVGB (3,4,5,6); >350 km NW from N Newfoundland (1,2)
Brown Creeper (*Certhia americana*) 5 point count observations 7 incidental observations	Absent from Labrador (1,2,3,4,5,6); historical record from HVGB (7)	Lake Winokapau (1); Cache River (3); South Canyon (1); TLH (2); Gull Island (5)	BS (3) MC (7) MW (2)	2006, 2007, 2016	n/a (7); >200 km N from edge of range in E Quebec (1,3,4,5); >350 km NE from E of Sept-Iles (2,6)

TABLE 5. *Continued.*

Species	Historical range in Labrador (sources*)	Sites observed (no. observations)	Land cover types observed (no. observations)	Years observed	Expansion of known breeding range (sources*†)
Winter Wren (*Troglodytes hiemalis*) 19 point count observations 25 incidental observations	Absent from Labrador (1,2,7); widespread in southern Labrador (3,4,5,6)	Metchin River (6); Elizabeth River (2); Lake Winokapau (1); South Canyon (4); Bob's Brook (2); Gull Island (19); Edward's Brook (1); Upper Brook (1); Lower Brook (1); Muskrat Falls (1); Goose River (2); Mud Lake Road (4)	BS (9) MC (14) MW (19) HA (1) DI (1)	2006, 2007, 2015, 2016	n/a (3,4,5,6); >150 km N from edge of range in E Quebec (1,2)
Golden-crowned Kinglet (*Regulus satrapa*) 7 point count observations 25 incidental observations	Absent from Labrador (1,2); present around HVGB (5,6,7); limited to SW Labrador (3,4)	Fig River (4); Lake Winokapau (4); Cache River (5); Gull Island (4); Pinus River (8); Lower Brook (2); Muskrat Falls (3); Water Treatment Plant (2)	BS (3) MC (18) MW (9) HA (2)	2006, 2007, 2014	>150 km W from Happy Valley–Goose Bay (5,6,7); >150 km E from SW Labrador (4); >200 km E from SW Labrador (3); >350 km NE from E of Sept-Iles (2); >400 km NE from Anticosti Island (1)
Bohemian Waxwing (*Bombycilla garrulus*) 8 incidental observations	Absent from Labrador (1,2,7); limited to SW Labrador (3,4); widespread in Labrador (5,6)	Birch Slope (8)	HA (8)	2007	n/a (5,6); >100 km E from E of Churchill Falls (3,4); >1000 km E from E coast James Bay (2); >2000 km E from Churchill, Manitoba (1)
Cedar Waxwing (*Bombycilla cedrorum*) 33 point count observations 49 incidental observations	Absent from Labrador (1,2,7); southern Labrador, extending to HVGB (3,4,5,6)	Metchin River (8); Elizabeth River (8); Cache River (1); Gull Island (4); Birch Slope (7); Edward's Brook (2); South Shore (2); Upper Brook (13); Lower Brook (3); Muskrat Falls (2); Water Treatment Plant (5); Goose River (2); Mud Lake Road (25)	BS (1) MW (11) HA (15) RI (38) WE (14) DI (3)	2006, 2007	n/a (5,6); >50 km N from limit of range in southern Labrador (3,4); >400 km N from E of Sept-Iles (1,2)
Purple Finch (*Haemorhous purpureus*) 4 point count observations 3 incidental observations	Absent from Labrador (1,7); limited to Central Labrador, including the lower Churchill River valley (2,3,4,5,6)	Elizabeth River (1); Pinus River (2); Lower Brook (1); Muskrat Falls (2); Water Treatment Plant (1)	BS (4) MC (2) MW (1)	2006, 2007, 2015	n/a (2,3,4,5,6); >300 km N from Quebec north shore (1)
Song Sparrow (*Melospiza melodia*) 10 point count observations 15 incidental observations	Absent from Labrador (1,2,3,4,5,6,7)	Metchin River (1); Elizabeth River (6); TLH (1); Gull Island (4); South Shore (2); Lower Brook (2); Upper Brook (4); Water Treatment (4); Mud Lake Road (1)	BS (3) MW (1) HA (1) RI (11) WE (9)	2006, 2007, 2014	>300 km N from edge of range in E Quebec (1,2,3,4,5,6)

Table 5. *Continued.*

Species	Historical range in Labrador (sources*)	Sites observed (no. observations)	Land cover types observed (no. observations)	Years observed	Expansion of known breeding range (sources*†)
Black-and-white Warbler (*Mniotilta varia*) 1 incidental observation	Absent from Labrador (1,2,7); present around HVGB (3,4,5,6)	Edward's Brook (1)	HA (1)	2007	<50 km W from HVGB (3,4,5,6); >350 km NW from N Newfoundland (1,2)
Nashville Warbler (*Leiothlypis ruficapilla*) 13 point count observations 2 incidental observations	Absent from Labrador (1,2,3,4); rare in Central Labrador (5); rare in SW and Central Labrador (6); historical records around HVGB (7)	Fig River (2); Bob's Brook (1); Pinus River (4); Birch Slope (1); Edward's Brook (1); Muskrat Falls (1); Water Treatment Plant (5)	BS (6) MW (8) HA (1)	2006, 2007	n/a (5,6); >150 km W from Happy Valley – Goose Bay (7); >300 km N from Quebec north shore (1,2); >400 km NE from Sept Iles (3); >400 km NE from Anticosti Island (4)
Common Yellowthroat (*Geothlypis trichas*) 2 incidental observations	Absent from Labrador (7); limited to southern edge of Labrador (1,2,3,4); rare in central Labrador (5); rare in SW Labrador (6)	Gull Island (1); Upper Brook (1)	WE (1) RI (1)	2006, 2016	n/a (5); >100 km E from SW Labrador (6); >100 km N from S edge of Labrador (1,2,3,4)
Cape May Warbler (*Setophaga tigrina*) 17 point count observations 9 incidental observations	Absent from Labrador (1,2,3,7); limited to SW Labrador (4); rare in SW Labrador and around HVGB (5,6)	Fig River (3); Gull Island (5); Edward's Brook (3); Upper Brook (2); Muskrat Falls (6); Water Treatment Plant (4); Mud Lake Road (3)	BS (6) MC (11) MW (9)	2006, 2007, 2014, 2015	>100 km E of SW Labrador (5,6); >250 km E from SW Labrador (4); >300 km NE from SW Quebec / Labrador border (3); >350 km NE from E of Sept Iles (1,2)
Magnolia Warbler (*Setophaga magnolia*) 78 point count observations 39 incidental observations	Absent from Labrador (1,2); present near HVGB (7); widespread in southern Labrador (3,4,5,6)	West T-line (1); Metchin River (4); Fig River (2); Lake Winokapau (2); Cache River (6); South Canyon (1); Bob's Brook (11); Gull Island (15); Birch Slope (3); Edward's Brook (5); Upper Brook (6); Lower Brook (2); Muskrat Falls (14); Water Treatment Plant (16); Goose River (23); Mud Lake Road (6)	BS (6) MC (19) MW (26) HA (5) RI (45) WE (6) DI (10)	2006, 2007, 2014, 2015, 2016	n/a (3,4,5,6); >350 km N from Quebec north shore (1,2)

*1. NatureServe (2019); 2. Rodewald (2019); 3. Dunn and Alderfer (2017); 4. Peterson (2012); 5. Sibley (2016); 6. Floyd (2008); 7. Todd (1963).
†No distance provided for species considered absent by Todd (1963) as distribution of most species not mapped.

Another two species are recognized by some references as occurring within Labrador, although only outside the study area. We found Downy Woodpecker (*Dryobates pubescens*) and Yellow-bellied Sapsucker (*Sphyrapicus varius*) at the same three sites (Birch Slope, Edward's Brook, and Lower Brook), within a span of <40 km along the north side of the lower Churchill River that supports a particularly high density of hardwood and mixedwood forest.

A further seven species have been previously documented as occurring within part of the study area but were found outside of mapped range during our surveys. Most notably, Least Flycatcher is recognized as having an outlier population around HVGB. We recorded it as far west as Fig River and Lake Winokapau, over 150 km to the west; however, 98% of observations were between Goose Island and HVGB. It was highly associated with mixedwood, hardwood, and riparian areas. Golden-crowned Kinglet (*Regulus satrapa*) has been mapped as occurring in southwest Labrador and around HVGB, but we found it to be widespread from Fig River to the HVGB Water Treatment Plant, primarily in association with large White Spruce in mixed conifer and mixedwood forest types. Cedar Waxwing is mapped as being absent from Labrador or limited to the southern edge of Labrador up to near HVGB, but we observed it at 13 sites from Metchin River to Lake Melville, heavily associated with riparian areas and wetlands, and secondarily with hardwood and mixedwood forest. Cape May Warbler is considered to have, at most, a limited distribution in Labrador, but we found it in seven sites from Fig River east to Lake Melville; it was restricted to conifer-dominated land cover types, but notably more common in mixed conifer and mixedwood forest than in areas dominated by Black Spruce. Additionally, for three species mapped as occurring around HVGB, we had single incidental observations upstream: Sora at Upper Brook, Black-capped Chickadee at Birch Slope, and Black-and-white Warbler at Edward's Brook.

We also confirmed the presence of three species that are shown by at least one reference to occur rarely within the study area. Sibley (2016) recognizes Philadelphia Vireo (*Vireo philadelphicus*) as rare in the lower Churchill River valley, consistent with our nine detections of the species at five sites between Gull Island and Lower Brook, almost all associated with hardwood and mixedwood forest. Floyd (2008) and Sibley (2016) have mapped Nashville Warbler (*Leiothlypis ruficapilla*) as rare in central Labrador, which aligns with our 15 observations at seven sites between Fig River and the Water Treatment Plant, all but one of which were in Black Spruce or mixedwood forest. Sibley (2016) also identified Common Yellowthroat as rare in central Labrador; we had only two incidental observations in riparian and wetland sites at Gull Island and Upper Brook, ~35 km apart.

Finally, we confirmed the presence of another five species that are shown to occur throughout the study area in some maps, but not others. Of these, Magnolia Warbler was the most abundant and widespread, with 117 individual bird observations at 16 sites spanning the entire study area, and across all land cover types, although most frequently in riparian and mixedwood forest. Winter Wren (*Troglodytes hiemalis*) was also numerous and widely distributed, with 44 observations at 12 sites along almost the full length of the lower Churchill River, especially in areas with mixedwood and mixed conifer forest. Purple Finch (*Haemorhous purpureus*) also occurred over a large area, at five sites from Elizabeth River to the Water Treatment Plant, but was scarce, with only seven observations in total, all associated with coniferous or mixedwood forest. Red-eyed Vireo (*Vireo olivaceus*) had a more restricted distribution, but was locally common, with 36 observations at eight sites between Gull Island and the Water Treatment Plant, overwhelmingly in hardwood and mixedwood forest. There was only one sighting of Bohemian Waxwing, a flock of eight individuals in hardwood forest on Birch Slope in 2007.

Discussion

Our lower Churchill River valley bird surveys represent the most extensive documentation to date of any landbird communities in Labrador. Between 2006 and 2016, we observed 80 species during point counts, predominantly (56; 70%) passerines and woodpeckers. This is an unusually high level of avian diversity for Labrador, but the overall bird community is fairly typical for boreal Canada (Kirk *et al.* 1996) and reflects the presence of several species that require the habitat diversity limited to the lower Churchill River valley.

Including incidental observations, the total of 89 species we observed is similar to the cumulative sum of 83 species documented on the HVGB Breeding Bird Survey route over 22 years of effort between 1978 and 2016 (USGS 2018). However, 16 species were observed on that route only once, and another two species (American Bittern [*Botaurus lentiginosus*] and European Starling [*Sturnus vulgaris*]) appear to be strictly limited to the area immediately around HVGB, as we did not observe them on any of our surveys in the lower Churchill River valley. Conversely, 11 of the species we observed have never been documented on the HVGB Breeding Bird Survey route: Green-winged Teal (*Anas crecca*), Semipalmated Plover (*Charadrius semipalmatus*), Least Sandpiper

(*Calidris minutilla*), Solitary Sandpiper (*Tringa solitaria*), Bald Eagle (*Haliaeetus leucocephalus*), Yellow-bellied Sapsucker, Brown Creeper, Golden-crowned Kinglet, Song Sparrow, Nashville Warbler, and Common Yellowthroat. Only two additional species have been observed on other Breeding Bird Survey routes in the region but not on our surveys: Surf Scoter (*Melanitta perspicillata*) at Bob's Brook in 2014, and Arctic Tern (*Sterna paradisaea*) at Main Wilson River in 2017 (USGS 2018).

The only previous study focussing extensively on the lower Churchill River valley was a historical review supplemented by limited field effort in 1980 (Hunter and Associates 1981). It reported 60 passerine and woodpecker species, compared to 56 in our study, but also included several species that were transient migrants not expected to be in the lower Churchill River valley during the breeding season (e.g., Horned Lark [*Eremophila alpestris*], American Pipit [*Anthus rubescens*]). Of the potential breeding species listed by Hunter and Associates (1981), the only ones we did not observe were Evening Grosbeak (*Coccothraustes vespertinus*), Chestnut-sided Warbler (*Setophaga pensylvanica*), and Blackburnian Warbler (*Setophaga fusca*). These three species are shown in recent range maps (e.g., Peterson 2012; Dunn and Alderfer 2017) as having range limits >400 km to the southwest, comparable to the distribution mapped in some field guides for species that we did observe in large numbers (e.g., Magnolia Warbler). Conversely, we found nine species for which Hunter and Associates (1981) reported no previous records: Downy Woodpecker, Least Flycatcher, Black-capped Chickadee, Brown Creeper, Winter Wren, Bohemian Waxwing, Philadelphia Vireo, Nashville Warbler, and Cape May Warbler. However, four of these species (Brown Creeper, Winter Wren, Philadelphia Vireo, and Cape May Warbler) were also documented by Hennigar *et al.* (2019) in the area north of HVGB in 2016 and 2017.

Abundance of some species has changed over time. For example, one to five Rusty Blackbirds were observed daily during surveys of the lower Churchill River valley in 1980 (Hunter and Associates 1981) whereas we had only 16 total observations over our 41 days of effort between 2006 and 2016, perhaps reflecting the significant long-term population decline of this species (COSEWIC 2017). Other bird populations may have been elevated during our study because of a Spruce Budworm (*Choristoneura fumiferana*) outbreak around HVGB that began in 2007 and peaked in 2013 but persisted broadly until 2016 (Lavigne 2019). In particular, Cape May Warbler and Tennessee Warbler are considered Spruce Budworm specialists, but Golden-crowned Kinglet has also been shown to respond particularly strongly to such events, and numerous others to a lesser extent (Holmes *et al.* 2009; Venier *et al.* 2009).

We found abundance and diversity to be consistently greatest in hardwood, mixedwood, and mixed conifer forests. These land cover types provide greater structural diversity than others, as they not only have a richer and more varied layer of ground vegetation and shrubs, but also are the only areas where large trees thrive, especially White Spruce. Within Labrador, these land cover types are largely limited to the boreal shield ecozone. Even within it, they occur primarily in the lower Churchill River valley floodplain and adjacent slopes. We also found above average bird abundance and diversity in many riparian areas, although many of these were narrow strips of vegetation adjacent to hardwood, mixedwood, or mixed conifer forests, and those associated land cover types may have contributed to the birds observed. Conversely, bird abundance and diversity tended to be lowest in Black Spruce forests and disturbed areas, which have the least structural complexity. This is consistent with the findings of Lewis and Starzomski (2015) at higher elevations in the Mealy Mountains east of HVGB, where vegetation was somewhat different, but vegetation structure was also strongly associated with the composition of the avian community.

Overall, we found Ruby-crowned Kinglet, Swainson's Thrush, and Dark-eyed Junco to be the most abundant breeding birds in the lower Churchill River valley; these were also among the top five species detected by Hennigar *et al.* (2019) north of HVGB. Each of these three species was among the two most abundant in three land cover types and occurred at least uncommonly in all others. Nonetheless, we found that the avian community differed notably among all seven land cover types. For the most part, observed land cover associations were typical (e.g., Billerman *et al.* 2020), and species with narrower ecological niches (e.g., Red-eyed Vireo in deciduous forest [Cimprich *et al.* 2020]; and Black-backed Woodpecker in recent burns [Tremblay *et al.* 2020]) were more restricted in their distribution than generalists (e.g., American Robin [*Turdus migratorius*], Vanderhoff *et al.* 2020). Only a few species deviated notably from typical habitat associations. Tennessee Warbler was most abundant in hardwood and mixedwood forest, as expected (Rimmer and McFarland 2020), but almost equally numerous in mixed conifer forest, which is unusual but perhaps explained by the limited extent of typically preferred habitat and the availability of a diverse understorey in mixed conifer stands. Conversely, Black-throated Green Warbler is generally associated with coniferous stands in most of its range (Morse and Poole 2020) but in our study area

was found on average five times more frequently in mixedwood and hardwood forests, possibly reflecting its preference for large-diameter trees (Robichaud and Villard 1999). Similarly, Yellow-bellied Flycatcher is typically considered to be a bird of moist spruce and fir forests (Gross and Lowther 2020), but in the lower Churchill River valley was far more abundant in hardwood forests.

Most of the birds observed during our study are typical of south-central Labrador. But there were 19 species that are generally considered rare or poorly documented in Labrador. Most of these are strongly associated with hardwood forests (Downy Woodpecker, Yellow-bellied Sapsucker, Least Flycatcher, Black-capped Chickadee, Red-eyed Vireo, Black-and-white Warbler), large mature conifers (Brown Creeper, Winter Wren, Golden-crowned Kinglet, Purple Finch, Cape May Warbler), or shrubby riparian zones (Cedar Waxwing, Song Sparrow, Common Yellowthroat). Their presence in the lower Churchill River valley is not surprising given that these vegetation types are reasonably common within the boreal shield ecozone. Many of these may be long-established peripheral populations, rather than evidence of range extensions, but given the limited historical data from the region it is impossible to know.

We only confirmed breeding for two of the regionally rare species (Downy Woodpecker and Yellow-bellied Sapsucker), as most of our effort was during short early morning point counts in June, which were not particularly conducive to observing nesting behaviour and too early for there to be fledged young of most species. However, we are confident that the remaining species are at least probable breeders, based on the total number observed in the study area and records in similar locations over multiple years. In particular, Magnolia Warbler (78 individual records) and Least Flycatcher (77) ranked among the 20 most abundant species overall at our point counts and were also observed incidentally on many other occasions. All 19 of the regionally rare species have previous eBird records for the study area (ranging from one in 2009 for Common Yellowthroat to >100 for Least Flycatcher spanning 1987–2018, and >1000 for Bohemian Waxwing during winter months since 2008), but entirely limited to HVGB and immediate surroundings (eBird 2019).

For some of these species (e.g., Hairy Woodpecker, Red-eyed Vireo, Cape May Warbler), recent editions of field guides have started to show small dots representing a disjunct population around HVGB, north of the limit of their continuous range. Floyd (2008) and Sibley (2014) have introduced a "rare" indicator to their maps and indicated that Nashville Warbler and Common Yellowthroat occur at low densities within the lower Churchill River valley and surrounding areas, consistent with our observations. However, our findings indicate that many of the species previously recognized as occurring in HVGB also are present to varying extents along much of the lower Churchill River valley. We acknowledge that it is uncertain whether our observations represent true range extensions, or simply the first documentation of long-established populations. Regardless, we encourage authors of future revisions to consider extending their mapping accordingly. This is particularly important for NatureServe (2019) and the Birds of the World series (Billerman *et al.* 2020). These are the leading references for bird species in North America, yet are the least reflective of current bird distributions, with Purple Finch being the only one of the regionally rare species to be shown as occurring in the lower Churchill River valley in either resource.

Although we documented the presence of many regionally rare species in the lower Churchill River valley, our survey effort was nonetheless not comprehensive. Our efforts focussed largely on forest birds, and while we found some waterbirds and raptors incidentally, the timing of our surveys was not optimal for detecting most of these species. Additionally, our field effort was constrained by access and was particularly limited in the western two-thirds of the study area, which is largely away from any roads, and where even helicopter landing options are scarce in some areas. We preferentially targetted uncommon land cover types that tend to support a broader diversity of birds (most notably hardwood and mixedwood forest and wetlands) but were not able to access all such locations in the study area. Undoubtedly, at least some individuals present within the 100 m point count radius were undetected during the 5 min sampling period. It is thus quite likely that our results underestimated the distribution and abundance of regionally rare species. However, it is also probable that the regional abundance of some of these species has declined since flooding of the Muskrat Falls Reservoir, given that many of them are closely associated with uncommon land cover types that were disproportionately extensive within that area. This was most notable of three species (Sora, Semipalmated Plover, and Least Sandpiper) that we observed only at Upper Brook. Conversely, there may be some rebound over time as novel riparian and other vegetation communities develop along the new shoreline. We therefore encourage further exploration and documentation of birds in the lower Churchill River valley, to assess the implications of this change to the landscape, and to monitor for potential further additions to the community.

Author Contributions

Writing – Original Draft: M.A.G. and K.R.; Writing – Review & Editing: M.A.G. and K.R.; Conceptualization: M.A.G.; Investigation: M.A.G. and K.R.; Methodology: M.A.G.; Formal Analysis: M.A.G. and K.R.

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SUPPLEMENTARY MATERIAL:

TABLE S1. List of 80 bird species observed on point counts, and nine species observed incidentally during the field program in the lower Churchill River valley, Labrador, in summer of 2006, 2007, 2014, 2015, and 2016.