Avian Communities of the Middle and Lower Yellowstone River: A Pilot Study

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Summary

The Yellowstone River is one of the longest free-flowing rivers in the lower 48 states. The Nature Conservancy in cooperation with the Yellowstone River Conservation District Council initiated a pilot study in the summer of 2005 to collect basic information about bird communities and habitats along the middle and lower portions of the river, from Springdale, Montana to the Missouri River confluence. This information will also be used to refine questions and study design for an expanded study in 2006-07, provide insight into the feasibility of field methods, and help identify logistical considerations.

A literature review was first conducted to compile existing information about bird communities along the river. Two programs document bird communities in the region. The Montana Bird Distribution database records the distribution of birds throughout the state, while the Breeding Bird Survey program monitors bird communities at locations throughout North America. However, these programs do not provide information on riparian birds specifically, and are based on either opportunistic sightings or localized and sparse sampling efforts. For this pilot study, birds were sampled using standardized bird survey methods, and surveys occurred along the length of the river corridor, providing a comprehensive, preliminary picture of the riparian bird communities found in mature cottonwood forest along the river.

Environmental characteristics vary along the 475 miles of river corridor within the study area. Four distinct ecoregions have been identified which differ in the geology of the river, dominant sediment materials, average water temperatures, and fish and plant communities. Riparian vegetation along the river consists of cottonwood forest patches in various stages of succession, and of various sizes and shapes. Sampling of bird communities spanned the length of the study area, and occurred in a variety of landscape settings in an effort to capture this variation. Birds were sampled between June 13 and July 1 within mature cottonwood forest in seven counties on lands of 15 private landowners and seven public areas. Birds were surveyed using standard point count methods; 42 point count surveys were conducted. Vegetation characteristics of each survey area were also documented.

Forty-one species of riparian birds were observed within mature cottonwood forest. Variation in species presence and abundance were evident across the study area. Mature cottonwood forest stands differed in habitat characteristics such as understory structure and plant species composition, and bird communities seemed to be influenced by these vegetation differences. Results indicated that certain species and groups of species (i.e. guilds) may be associated with particular habitat types, presumably because that habitat provides important unique food or nesting resources. Bird communities and species abundances also differed within sample areas across the four distinct ecoregions of the river, with certain species and guilds found in higher abundances within certain ecoregions. Many factors may be influencing the distribution of birds across habitat types and ecoregions, including environmental characteristics and human land uses.

This pilot study provides basic information about the distribution of riparian bird species and riparian habitats, as well as crucial information about the logistics associated with conducting bird surveys along the river. Knowledge gained from this study will help in designing a future study for addressing questions about potential cumulative impacts of human activities on riparian birds of the Yellowstone River.

Introduction

The Yellowstone River is the longest free-flowing river in the lower 48 states, running over 670 miles (1078 kilometers) from Yellowstone National Park to its confluence with the Missouri River in North Dakota, east of the Montana border. Studies along the upper reaches of the Yellowstone found that the river maintains relatively intact flood regimes, and sustains a wide range of successional stages of riparian vegetation communities (Hansen et al., 2003). These habitats support a variety of native species, with distinct bird communities and species associated with each successional stage (Hansen et al., 2003).

Major flooding in 1996 and 1997 lead to increased public concern about the impacts of human activities along the river, particularly bank stabilization, development within the floodplain, and invasive species. These events highlighted the need to collect and compile scientific data along the entire length of the river to be used for informing management decisions. In 1999, the Yellowstone River Conservation District Council was formed to address concerns about the cumulative effects of human activities along the middle and lower stretches of the river, and Congress authorized the US Army Corps of Engineers to conduct a comprehensive study focused on cumulative effects. In cooperation with the State of Montana and nongovernmental organizations like The Nature Conservancy, the US Army Corps of Engineers and the Council have been planning research projects to collect scientific information on environmental and socioeconomic aspects of the river. Biological studies have been designed to answer questions regarding the potential impacts of land and water management decisions on native species and habitats.

An earlier cumulative effects study along the upper Yellowstone River found that natural disturbance such as flooding is critical for maintaining native plant and animal communities (Hansen et al., 2003). Floods initiate succession in riparian vegetation by eroding away forest and sediment, and redepositing alluvial material downstream to create bare sites for the establishment of new vegetation. Disturbance created by flooding consequently results in the persistence of a full range of successional stages within the floodplain. Free-flowing rivers that maintain historic flood cycles generally exhibit a dynamic steady state of successional stages, where the proportion of early, middle, and late successional habitats are present in the floodplain in the same relative proportions over time. Riparian species are often associated with particular successional habitats; hence the presence of the full range of successional stages maintains habitat for a variety of native species. Human uses of land and water may alter historic flood regimes through water management efforts, which often limit erosion, river channel migration, and overbank flooding. These control measures reduce the impacts of flood disturbance and may inhibit the succession of riparian vegetation, leading to substantial changes in the extent, distribution, and structure of riparian habitats available to native species.

The Nature Conservancy in cooperation with the Yellowstone River Conservation District Council initiated this pilot study of riparian bird communities. Little is currently known about the factors influencing the distribution of bird species along the middle and lower stretches of the river, or about the potential impacts of land and water management on riparian bird communities. A two-year study will be conducted in the future to address some of these questions. In the summer of 2005, we conducted this pilot study to provide basic information about bird communities and habitats along the river which will be used in the future avian study to refine specific research questions, develop a detailed study design, provide insight into the feasibility of field methods, and help identify logistical considerations. Also, because most of

the land along the Yellowstone River is privately owned and access for research depends upon landowner cooperation, this pilot study served to inform local landowners about the future avian study. In addition to field work, a detailed literature and data review was conducted to compile existing information about bird communities of the middle and lower Yellowstone River. Here we report on the results of this pilot study. Specific objectives were to:

- Review existing literature for information about the bird communities of the middle and lower Yellowstone River;
- Provide a preliminary description of the distribution and abundance of bird communities and habitats along the river from approximately Springdale, Montana to its confluence with the Missouri River;
- Test field methods and provide information to refine research questions and study design for a future avian study.

Study Area

The lower and middle Yellowstone River study area extends approximately 475 river miles (764 km) from Springdale, Montana to the Missouri River confluence in McKenzie County, North Dakota (Figure 1). This section of the river runs through eleven counties (Figure 1). The six major tributaries are the Boulder, Stillwater, Clarks Fork, Bighorn, Tongue, and Powder Rivers. The geomorphology of the river includes braided reaches, with abundant side channels, wooded islands, and gravel bars, and more confined, straight reaches with fewer islands and gravel bars (Applied Geomorphology and DTM Consulting, 2004). Riparian vegetation consists of cottonwood forest in various stages of succession, as well as herbaceous and woody wetlands. Areal extent and species composition of riparian vegetation communities vary along the length of the river due to changes in topography, bedrock geology, climate, and land use.

Four distinct ecoregions have been identified within the study area based on previous geomorphic analysis (Applied Geomorphology and DTM Consulting, 2004; Figure 1). Ecoregions differ in the gradient and bedrock geology of the river, dominant sediment materials, average water temperatures, and fish and plant communities. The Mountain ecoregion extends approximately 95 river miles (153 km), from Springdale to the confluence with the Clarks Fork. The Transition ecoregion continues approximately 85 river miles (137 km) to the confluence with the Bighorn River. Continuing downstream, the Prairie I (approximately 149 river miles, 240 km) and Prairie II (approximately 148 river miles, 238 km) ecoregions are divided by the confluence with the Powder River. The Prairie II ecoregion extends to the confluence with the Missouri River.

Literature and Data Review

We searched published journal articles, government documents, and unpublished literature for information about breeding birds of the middle and lower Yellowstone River. We uncovered one list of bird species for Two Moon Park in Billings from contacts at Montana Audubon, but all other searches indicated that no studies of riparian bird communities have previously been conducted within the river corridor study area. However, two existing programs that document bird communities in the region may provide some information on riparian birds.

The Montana Bird Distribution database records the distribution of birds throughout the state, while the Breeding Bird Survey (BBS) program monitors bird communities at locations throughout North America. Here we describe these programs and summarize data by the four ecoregions for observations of bird communities within the Yellowstone River study area. We also review the findings of a comprehensive bird study conducted along the upper reaches of the Yellowstone River, from Gardiner to Springdale (Hansen et al., 2003). Information collected in that study does not fall within the boundaries of the middle and lower Yellowstone study area, but serves as a complement to this study to provide descriptions of riparian bird communities from the beginning of the river to its end.

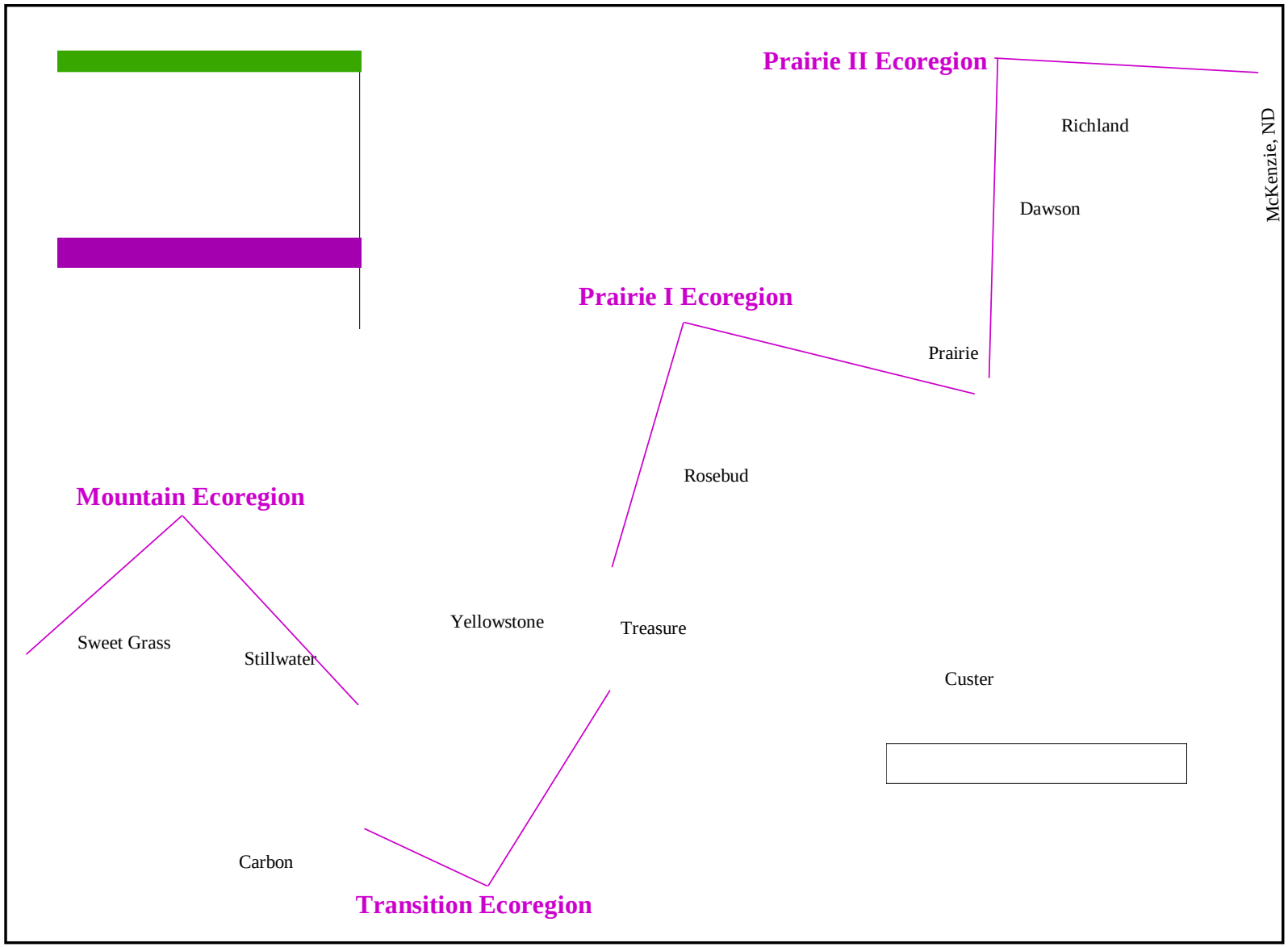
Montana Bird Distribution

The Montana Bird Distribution Database contains information about each bird species recorded in the state and the breeding, migratory, or wintering status of that species. Records within the database are submitted by volunteers based on opportunistic sightings, or as a result of official surveys conducted by private or government organizations (e.g. BBS). The database is maintained by Montana Audubon in Helena and is housed at the Montana Natural Heritage Program. Bird sightings have been documented in the database since 1991. Species and breeding status are summarized every five years for each Quarter Latitudinal/Longitudinal square (QLL) in the state (Figure 1), with the most recent report published in 2003 (Lenard, 2003).

The database is useful for understanding where birds generally occur in the state, but is limited in its capacity to specifically document the birds along the Yellowstone River. Data are reported at a coarse scale (the QLL; Figure 1) that does not provide information about birds in particular habitats, especially those that cover relatively small areas such as riparian zones. Additionally, because much of the data are collected opportunistically and not through standard survey methods, the database does not represent a complete picture of the species present or not present in the bird community; instead, it documents only those species that have been sighted. Lastly, eastern Montana has a low human population density, so records of bird sightings within this part of the state are often lacking or underreported.

The Montana Bird Distribution Database can, however, serve as a supplement to information collected through standard survey methods, and provide information on the occurrence of species that may not have been detected during surveys. We searched the database for records of breeding birds (i.e. present May through July) documented in each of the 17 QLL's that include the middle and lower Yellowstone River (Figure 1). Records were reported from the BBS routes along the river, the US Forest Service Northern Region Landbird Monitoring Program survey locations (which take place on Forest Service lands), and opportunistic sightings reported from birders. From those records, we isolated species that are found in riparian areas. Thirty-eight riparian bird species were documented within the QLL's of the Yellowstone River study area (Table 1). Many species were recorded within all of the four ecoregions, with the Transition ecoregion having the fewest species recorded. This may not reflect the actual bird communities found there, but may instead be attributed to the lack of people sighting and reporting birds in the region.

Figure 1. Middle and lower Yellowstone River study area.



Breeding Bird Survey

The BBS is a long-term, continental avian monitoring program designed to track the status and trends of North American bird populations. The monitoring program was initiated in 1966 by the US Fish and Wildlife Service and is now jointly coordinated by the USGS Patuxent Wildlife Research Center and the Canadian Wildlife Services' National Wildlife Research Centre. The data collected provide an index of population abundance that can be used to estimate population trends and relative abundances over time. Roadside point count surveys are conducted by skilled volunteer birders every year at the height of the breeding season. Each roadside survey route is approximately 24.5 miles (39.2 km) long, and is comprised of 50 point counts spaced at 0.5 mile (800 m) intervals. Observers count all birds seen and heard at each stop.

The BBS uses standardized survey methods, so provides a complete picture of species present along the survey that is comparable over time. However, bird survey results are reported at the level of the 24.5 mile route, which may pass through many different types of habitats. Even if a route does traverse the Yellowstone River, it is difficult to determine which of the birds along the route were detected in riparian areas, or even if the riparian zone was surveyed at all. Additionally, not many public roads enter into riparian areas, so opportunities to sample riparian habitats through BBS are limited. Despite these limitations, BBS data may be useful for understanding trends in bird communities in the Yellowstone River region over time, and may serve as a supplement to surveys conducted specifically within riparian habitats.

Here we summarize results from the three BBS routes located within the middle and lower Yellowstone River corridor. Two routes traverse riparian habitat, while one other passes nearby the river (Figure 1); routes are located in three of the four identified ecoregions. These routes are mostly situated in upland habitat, with riparian areas constituting a very small component of the area surveyed. We included only the species that are generally associated with riparian areas for this summary.

Abundance of species in 2003 and population trends from 1966 to 2003 are reported in Table 2. It would be inappropriate to compare absolute abundances of each species across routes (and consequently, ecoregions) because of the unknown differences in riparian sampling efforts that may be responsible for differences in bird communities. Additionally, due to the limited number of routes, these results do not provide reliable inference about bird populations along the Yellowstone River or the region in general. However, they provide baseline data for the diversity and relative abundance of species encountered at various locations along the river, and trends in bird communities at those locations over time.

For the route located near Reed Point (Figure 1), American Robin, Yellow Warbler, Mourning Dove, and House Wren were most abundant, while for the Laurel and Forsyth routes (Figure 1), Mourning Dove and European Starling were most abundant (Table 2). Trends in abundance over time within each route varied across routes for most species (Table 2). However, House Wren had consistently positive population trends, while Red-tailed Hawk, Western Wood-pewee, Gray Catbird, European Starling, and Bullock's Oriole were consistently stable. Several species, including Northern Flicker, Common Yellowthroat, and Common Grackle, had consistently (but not always significant) negative population trends across the three locations. Additionally, American Redstart and Black-billed Cuckoo had strong negative trends along the Reed Point route, but information was insufficient to determine trends at the other two locations.

Table 1. Comparison of the riparian bird species recorded for the Montana Bird Distribution (MBD) Database and the BBS within the four ecoregions of the middle and lower Yellowstone River study area. One BBS route was located within each of the Mountain, Transition, and Prairie I ecoregions; there was no BBS data for the Prairie II ecoregion. See Table 6 for scientific names of bird species.

Species	Mountain		Transition		Prairie I		Prairie II	
	MBD	BBS Reed Point	MBD	BBS Laurel	MBD	BBS Forsyth	MBD	BBS
Red-tailed Hawk	x	x	x	x	x	x	x	--
American Kestrel	x	x	x	x	x	x	x	--
Ring-necked Pheasant	x	x		x	x	x	x	--
Mourning Dove	x	x	x	x	x	x	x	--
Black-billed Cuckoo	x	x		x	x	x	x	--
Red-headed Woodpecker			x		x		x	--
Red-naped Sapsucker	x							--
Downy Woodpecker	x	x	x	x	x			--
Hairy Woodpecker	x	x		x				--
Northern Flicker	x	x	x	x	x	x	x	--
Western Wood-Pewee	x	x	x	x	x	x	x	--
Least Flycatcher	x	x		x	x	x	x	--
Plumbeous Vireo	x	x	x	x	x			--
Warbling Vireo	x	x		x	x	x	x	--
Red-eyed Vireo	x	x		x	x	x	x	--
Black-billed Magpie	x	x		x	x	x	x	--
American Crow	x	x		x	x	x	x	--
Tree Swallow	x	x	x	x	x	x		--
Black-capped Chickadee	x	x		x	x	x	x	--
White-breasted Nuthatch	x	x			x			--
House Wren	x	x	x	x	x	x	x	--
American Robin	x	x	x	x	x	x	x	--
Gray Catbird	x	x		x	x	x	x	--
European Starling	x	x	x	x	x	x	x	--
Cedar Waxwing	x	x		x	x	x	x	--
Yellow Warbler	x	x	x	x	x	x	x	--
American Redstart	x	x		x	x	x	x	--
Ovenbird	x			x	x			--
Common Yellowthroat	x	x	x	x	x	x	x	--
Yellow-breasted Chat	x	x		x	x	x	x	--
Spotted Towhee	x	x	x	x	x	x	x	--
Song Sparrow	x	x	x	x	x	x	x	--
Black-headed Grosbeak	x	x	x	x	x	x	x	--
Lazuli Bunting	x	x	x	x	x	x	x	--
Common Grackle	x	x		x	x	x	x	--
Brown-headed Cowbird	x	x	x	x	x	x	x	--
Bullock's Oriole	x	x	x	x	x	x	x	--
American Goldfinch	x	x		x	x	x	x	--

Table 2. Mean abundance of riparian bird species at point counts for each BBS route in 2003 and trends (% change) in abundance from 1966 to 2003 for routes that traverse the Yellowstone River. Sample sizes reported under each route indicate the number of years of sampling included in calculating trends. See Table 6 for scientific names of bird species.

Species	Reed Point Abundance	Reed Point % Change n = 26	Laurel Abundance	Laurel % Change n = 30	Forsyth Abundance	Forsyth % Change n = 14
Red-tailed Hawk	1.77	0.49	0.97	6.23	3.07	1.95
American Kestrel	1.73	-4.72^{+}	7.6	0.8	5.57	-4.94^{++}
Ring-necked Pheasant	1.31	-5.51^{+}	21.5	0.79	21.93	3.04
Mourning Dove	53.12	-0.52	41.4	-1.96	50	-5.53^{++}
Black-billed Cuckoo	0.88	-14.12^{++}	0.13	*	0.14	*
Downy Woodpecker	0.46	0.11	0.13	*	0	0
Hairy Woodpecker	0.12	*	0.07	*	0	0
Northern Flicker	6.5	-2.54	3.53	-8.52^{++}	5.07	-7.77
Western Wood-pewee	37.12	0.71	4.03	-2.21	4.21	7.58
Least Flycatcher	19.73	0.91	0.23	6.75	0.5	12.96
Plumbeous Vireo	1.23	12.39^{++}	0.03	*	0	0
Warbling Vireo	4.62	2.19	0.07	*	1.21	13.58
Red-eyed Vireo	0.08	*	0.03	*	0.07	*
Black-billed Magpie	10.42	-4.16^{++}	23	-0.88	6.43	8.17^{+}
American Crow	1.31	5.04	0.03	*	3.07	-0.47
Tree Swallow	5	4.25^{++}	1.3	3.12	0.57	0.74
Black-capped Chickadee	2.5	-0.16	0.77	-3.32	0.29	-9.64
White-breasted Nuthatch	0.65	4.1	0	0	0	0
House Wren	52.35	2.11^{++}	9.07	2.74^{++}	9.5	7.31^{++}
American Robin	86.19	0.56	16.3	-2.77^{+}	10.57	2.48
Gray Catbird	8.77	1.73	0.8	4.69	0.93	8.09
European Starling	44.42	-0.92	35.93	-1.01	99.36	0.37
Cedar Waxwing	8.35	7.34^{++}	0.3	-5.24	1.79	*
Yellow Warbler	53.38	1.64^{++}	8.33	-0.09	13.5	4.29^{+}
American Redstart	1.65	-12.13^{++}	0.07	*	0.07	*
Ovenbird	0	0	0.03	*	0	0
Common Yellowthroat	1.88	-1.66	2.93	-3.1	4.57	-7.9^{+}
Yellow-breasted Chat	5.08	3.84^{++}	2.17	9.62^{++}	4.5	-2.15
Spotted Towhee	40.85	-0.9^{+}	5.23	-5.13^{++}	3.5	9.2^{+}
Song Sparrow	4.69	3.63	0.5	12.46	0.5	*
Black-headed Grosbeak	4.38	4.04^{+}	0.27	-5.54	1	11.69
Lazuli Bunting	10.5	-0.11	0.97	3.21	0.29	*
Common Grackle	33.96	-1.5	8.83	-3.74	15.64	-11.68^{++}
Brown-headed Cowbird	47.12	-0.26	3.77	6.01^{+}	8.36	0.97
Bullock's Oriole	13.85	0.43	6.4	-1.64	4.71	5.03
American Goldfinch	17.42	-1.5	4.67	2.37	5.57	1.35

* = too few data to assess trends

$^{+}$ = statistically significant change at $\alpha = 0.05$

$^{++}$ = statistically significant change at $\alpha = 0.01$

There do not appear to be major discrepancies between the BBS and Montana Bird Distribution results for the three ecoregions for which there is BBS data (Table 1). Variations in the presence of species could be explained by differences in sampling methods previously discussed. The Montana Bird Distribution may represent rare species more often (e.g. Red-headed Woodpecker) due to the tendency of people to report rare sightings to this program, whereas BBS data may represent the more typical species present due to more consistent sampling and reporting efforts.

Upper Yellowstone River Study

In 2001 and 2002 a study of bird communities along the upper reaches of the Yellowstone River was conducted in conjunction with the Governor's Upper Yellowstone River Task Force (Hansen et al., 2003). The objectives of this study were to survey bird communities across different successional stages of vegetation and geomorphological reach types of the river. Researchers used standard point count methods (Ralph et al., 1993) to record birds at 130 locations between Gardiner and Springdale. Seventy-eight species of birds were observed in eight types of successional habitats across three types of river reaches. Bird communities differed across successional habitats, with numbers of species and total bird abundance greater in some habitats than others. Additionally, certain bird species were found in higher abundance in some habitats compared to others. Differences in bird communities and species abundance were also observed across the three distinct reach types of the river, likely because reaches supported different types and extents of successional habitats. Results from this study provided comprehensive information about how birds are distributed across different riparian habitats and reach types of the upper Yellowstone River. These results were used to inform members of the Task Force about the potential impacts of riverbank stabilization on riparian birds. Information collected during this study can be used with information gathered along the middle and lower Yellowstone to provide an understanding of bird communities along the entire length of the river.

Methods for Field Study

The goals of field sampling were to collect data on the distribution of birds across mature cottonwood habitats and ecoregions of the river, and to better understand the logistics of sampling birds within this large study area where most of the riparian forest is privately owned. We identified potential study sites for conducting bird surveys in riparian areas along the river using digital vegetation maps and aerial photos provided by the Council. Additionally, we consulted with the Council's Technical Advisory Committee members to gather input on potential sites. Only the 35 priority river reaches identified by the Council were considered for choosing potential study sites (Figure 1). For this pilot effort, we chose only mature cottonwood patches for sampling bird communities, in order to focus survey efforts and ensure adequate sample sizes. To provide the minimum area needed to conduct the bird survey, only cottonwood patches that were at least 150 meters wide were chosen. The size of the cottonwood patch and the surrounding landscape characteristics can substantially influence bird communities; we therefore attempted to locate surveys in a variety of patch types (small (< 75 hectares) or large (> 75 hectares)) and landscape settings (i.e. mostly surrounded by either urban, agricultural, or natural land uses) to capture the variation along the river. Additionally, cottonwood patches had

to be accessible by land in order to be considered as potential study sites. Sites situated on both private and public land were considered. We also attempted to locate surveys equally across the four ecoregions to ensure sampling coverage of the entire river corridor.

We initially identified 46 cottonwood patches as potential sites for bird surveys, with 33 located on private land and thirteen on public land (mostly Montana Fish, Wildlife, and Parks fishing access sites and other state owned lands). Parcels of land included within each patch were identified, and a list of parcel numbers and landowner names was compiled for each county. Lists were distributed to county Conservation District administrators, who then made initial contacts with landowners and documented if access was granted for conducting bird surveys. When the status of access had been determined for each parcel, administrators returned the lists to us with landowner contact information.

We then attempted to contact landowners on the parcel list who had agreed to allow access for conducting bird surveys. Once a landowner was contacted, a time was scheduled to meet with them, or they would give permission to access their land at a certain time without their presence. During the initial visit to potential study sites, patches were assessed to verify that the habitat was mature cottonwood and the patch was big enough to conduct surveys, and for determining the best access routes to sites. We obtained Global Positioning System (GPS) locations of landmarks that could be identified on aerial photos in order to later verify locations and boundaries of study sites. After the initial visit, cottonwood patches were assessed and specific survey locations were identified on aerial photos. Routes to these survey locations were documented for use in the field. The number of survey locations identified within a patch was dependent upon patch dimensions and the amount of time available for conducting surveys within the patch. Survey locations were at least 200 meters (approximately 650 feet) apart. We then returned to the study site in the morning to conduct bird surveys.

Fixed radius point counts were used for surveying bird communities (Ralph et al., 1993). Surveys were conducted no earlier than 15 minutes after sunrise, and no later than 10 a.m. After arriving at each point, the observer waited for two minutes to allow the birds to acclimate. All birds seen or heard within a 60 meter (200 foot) radius of the point were then recorded for ten minutes. The observer also recorded an approximate distance to each bird in four intervals from the point, including 0-15, 15-30, 30-45, and 45-60 meters. Recording distance intervals to birds allows for future analyses that provide bird density estimates corrected for variability in detection rates across species and habitats. Birds that flew over, but did not stop and use the habitat, were not counted.

After the survey was conducted, we collected information on general habitat characteristics within the sampling area, i.e. a 60 meter radius circle around the survey point. Structural characteristics of the survey location, such as canopy cover at different vertical layers, were estimated and dominant plant species were documented. All measurements were taken by a single person using ocular estimates, and are approximate. See Table 3 for a complete list of variables for which data was collected. Additionally, we recorded a GPS location for each survey point.

After field work was completed, bird community characteristics were summarized and analyzed. Data were compiled at the point level. Due to small sample sizes, we did not use statistical techniques to describe bird communities, but instead focused on general patterns of bird distribution. Patterns of bird use will provide valuable information about the types of species and abundances of birds using cottonwood forests within the sample areas.

Bird community characteristics included mean number of species detected per point survey (species richness), mean number of birds detected per point survey (total abundance), and mean number of birds detected within each guild per point survey (guild abundance). Guilds are groups of species that use similar resources based on three types of niches, including migration, foraging, and nesting characteristics. We grouped species into guilds using published natural history accounts. All species detected were categorized into one of two migratory guilds, including short-distance migrants/residents (birds that stay within the US over the winter or birds that do not migrate or only migrate locally), or Neotropical migrants (birds that overwinter in Central or South America). Migratory status was determined by considering only the portion of the species that breeds in Montana, since the migratory status of a single, widely distributed species can vary throughout the range of that species (e.g. migratory in northern North America, resident in the south). All species were also assigned to a foraging guild, which reflected the location where a species spent most of its time searching for food and the main method for foraging. Five foraging guilds were identified, including ground probers/gleaners, understory and lower canopy foliage gleaners, mid to high canopy foliage gleaners, bark foragers, and aerial foragers that flycatch or hawk insects. A sixth foraging guild was also identified to include species that use 'sit-and-wait' techniques to pounce on mammals or birds from a high perch. However, this guild consisted of only two species, so we did not include it in analysis. Finally, each species was assigned to a nesting guild, which was classified by the location of the nest in the vegetation strata, including ground nesters, understory nesters, midstory or high canopy nesters, and cavity nesters. Abundance of certain individual species was also included in analysis.

Table 3. Vegetation characteristics recorded at each bird survey site. Characteristics were recorded within a 60 meter radius circle surrounding the point count location. All vegetation variables were quantified using ocular estimates.

Variable	**Description**
Habitat Type	Category of habitat based on dominant species at different vegetation layers
Estimated age of stand	Average age in years of trees in the survey plot
Estimated average canopy height	Average height of trees in the canopy (above 15 meters)
Estimated average shrub height	Average height of vegetation in the understory layer (0.5 to 5 meters)
Percent canopy cover	Estimate of the percent of the plot that is covered by vegetation (including leaves, branches, and trunks) above 15 m high
Common canopy species	List of dominant species in the canopy layer
Percent midstory cover	Estimate of the percent of the plot that is covered by vegetation (including leaves, branches, and trunks) from 5 to 15 m high
Common midstory species	List of dominant species in the midstory layer
Percent understory cover	Estimate of the percent of the plot that is covered by vegetation (including leaves, branches, trunks, and grass/forbs) from 0.5 to 5 m high
Common understory species	List of dominant species in the understory layer
Percent Russian-olive in understory	Percent of understory cover (not percent of total plot) that is Russian-olive
Percent ground cover	Estimate of the percent of the plot that is covered by dead non-woody vegetation or live vegetation (including leaves, branches, trunks, and grass/forbs) less than 0.5 m high
Percent coarse woody debris ground cover	Estimate of the percent of the plot that is covered by downed woody debris less than 0.5 m high

We described bird community characteristics along the entire study area, as well as by habitat and ecoregion. Habitats were defined after field data collection was complete (not *a priori*), based on the results of the vegetation field observations at each survey location. Therefore, habitats were sampled opportunistically, not systematically. Ecoregions were the four distinct regions of the study area described previously in these methods, including the Mountain, Transition, Prairie I, and Prairie II ecoregions (Figure 1).

Results of Field Study

Landowner permission was first established by county offices around June 10, with all counties returning parcel information by June 20. Sampling sites were chosen opportunistically, with surveys conducted in as many cottonwood patches as we were able to gain access into. Surveys were conducted in fourteen of the 46 cottonwood patches initially identified for sampling. Five additional patches were added during the field portion of the study, for a total of 19 cottonwood patches sampled in seven counties on lands of 15 private landowners and seven public areas. We conducted 42 point count surveys in those 19 patches (Figure 1), visiting each point count survey location once between June 13 and July 1. Landowner permission information was first distributed in the western counties (i.e. Sweet Grass and Stillwater) and distribution proceeded from the west to the east throughout June. Consequently, sampling progressed west to east throughout the season, and we were not able to scatter the surveys randomly throughout the study area during the sampling time period. However, all sampling was completed by the beginning of July before breeding activity had substantially waned, in an effort to minimize the effects of sampling date on survey results. The number of surveys conducted within each patch was determined by landowner access, size of the patch, and time constraints. Ten surveys were conducted in seven cottonwood patches in the Mountain ecoregion, eight surveys in three patches in the Transition ecoregion, eight surveys in two patches in the Prairie I ecoregion, and 16 surveys in seven patches in the Prairie II ecoregion.

Point count survey methods depend upon bird vocalization as the primary way of detecting birds, and are therefore most effective for documenting songbird communities. Other types of birds, such as raptors, waterfowl, or upland gamebirds, which do not vocalize on a regular and predictable basis, are detected less consistently with these types of surveys. Therefore, our results will focus mostly on attributes of riparian songbird communities, including bird abundance, species richness, guild abundance, and individual species abundance.

Vegetation

Vegetation characteristics collected in the field provided a general description of mature cottonwood forest sites where birds were sampled. Cottonwood stands had relatively closed canopies with moderate midstory and understory cover that included Russian-olive as a substantial component (Table 4). Sampled areas also had a high percentage of ground-level cover (Table 4). These vegetation data were used to derive four distinct mature cottonwood habitat types. All habitats had either narrowleaf cottonwood (*Populus angustifolia*) or Great Plains cottonwood (*P. deltoides*), or a mix of the two, as the dominant overstory species (Table 5). We did not distinguish by cottonwood species in the designation of habitat types because canopy structure and growth form are relatively similar for the two species. Instead, the habitat

types differed in characteristics of the understory plant community, including the presence or absence of Russian-olive (*Elaeagnus angustifolia*). The four habitat types were:

- Cottonwood with herbaceous: Understory consisted of less than 30% shrub cover. Dominant understory species included grasses and forbs, with some snowberry (*Symphoricarpos* spp.).
- Cottonwood with native shrub: Understory consisted of more than 30% shrub cover, with Russian-olive constituting less than 50% of that shrub cover. Dominant understory species included Rocky Mountain juniper (*Juniperus scopulorum*), red-osier dogwood (*Cornus stolonifera*), wild rose (*Rosa woodsii*), snowberry, and boxelder (*Acer negundo*).
- Cottonwood with Russian-olive: Understory consisted of more than 30% shrub cover, with Russian-olive constituting greater than 50% of that shrub cover. Dominant understory species included Russian-olive, snowberry, and grasses.
- Cottonwood with green ash (*Fraxinus pennsylvanica*) and Russian-olive: Understory consisted of more than 30% shrub cover, with Russian-olive constituting more than 50% of that cover, and green ash representing a significant component of the community. Dominant understory species included Russian-olive, green ash, and grasses.

Since these four mature cottonwood habitat types were defined after field data collection was complete, habitats were sampled opportunistically, not systematically. Each point count survey location was designated as one of these four habitat types. Habitats sampled were not distributed evenly across the four ecoregions (Figure 2). The percentage of survey locations consisting of cottonwood with native shrub declined in abundance from west to east, while cottonwood with Russian-olive increased in that direction. Cottonwood with green ash and Russian-olive was sampled only in the ecoregion farthest east, Prairie II.

Table 4. Average values of vegetation characteristics observed at all mature cottonwood bird survey sites, as well as by habitat type and ecoregion.

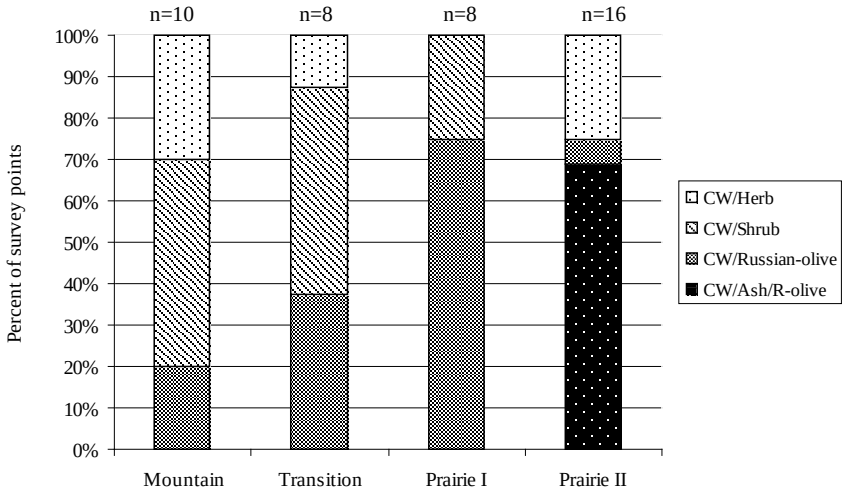
Variable	Mature Cottonwood n = 42	Habitat				Ecoregion			
		CW/ Herb n = 8	CW/ Shrub n = 11	CW/ Russian-olive n=12	CW/Ash/ Russian-olive n = 11	Mountain n = 10	Transition n = 8	Prairie I n = 8	Prairie II n = 16
Tree height (m)	22	22	22	23	22	24	22	23	21
Shrub height (m)	2.5	2	3	3	3	2.5	3	2.5	3
% Canopy cover	70	71	64	74	70	63	68	79	71
% Midstory cover	40	29	42	42	44	40	46	38	38
% Understory cover	48	19	65	53	48	49	62	50	40
% Understory cover that is Russian-olive	48	44	10	78	57	17	44	55	66
% Live ground cover	91	94	84	92	94	88	89	90	94
% Coarse woody debris	20	12	29	25	13	20	29	26	13

Vegetation characteristics differed across habitats, verifying the criteria used to define habitat types. Midstory cover was much lower in the cottonwood habitat with an herbaceous understory, while understory cover was high and Russian-olive cover low in cottonwood with a native shrub understory. Additionally, habitat types differed in the dominant midstory and understory plant species (Table 4). Vegetation characteristics of survey sites also differed across the four ecoregions. Occurrence of survey sites with Russian-olive was lowest in the Mountain ecoregion, and steadily increased from west to east, with highest occurrence in the Prairie II ecoregion (Figure 2). Canopy cover was highest in the Prairie I ecoregion, and understory cover highest in the Transition ecoregion (Table 4). Vegetation characteristics within mature cottonwood forests in general, and across habitats and ecoregions, influence bird communities, and will help to explain variation in the distribution of species along the Yellowstone River.

Bird Communities

Forty-one species and 846 total birds were detected across the 42 mature cottonwood survey sites (Table 6). Yellow Warbler (see Table 6 for scientific names) was the most abundant species, representing 18% of all birds counted. The five most abundant species accounted for 55% of all birds detected (House Wren 17%; Least Flycatcher 10%; Western Wood-pewee 5%; American Robin 5%). Mean abundances of these species at survey locations across the study area varied substantially (Table 7). House Wrens were detected at every survey site, and Yellow Warblers at all except one site. Only one individual was detected across all survey points for six species (Table 6). Approximately ten species (10.83 ± 0.47 SE) and 20 individual birds (20.19 ± 0.82 SE) were detected on average during each survey. Neotropical migrants, low (understory to midstory) canopy nesters, and understory foragers were the most abundant guilds within the three guild types in the study area, while short distance migrants/residents, ground nesters, and tree bark foragers were the least abundant guilds (Figure 3). Observed differences in abundance may be due to the unequal number of species within each guild. For example, the guild with ground nesters had the least number of species and the lowest abundance of all nesting guilds (Figure 3). However, some guilds were more abundant even when they had equal or fewer number of species compared with other guilds. For example, the ground foraging guild included the most species but the lower canopy guild had the highest abundance (Figure 3).

Figure 2. Distribution of survey sites by habitat type across ecoregions.



We summarized natural history traits for 40 of the 41 bird species encountered in mature cottonwood forest (Table 6) to provide a basic understanding of the habitats and resources that may be important for the species encountered along the Yellowstone River (Appendix 1). Natural history information was not included for the *Sphyrapicus* sapsucker since only the genus, not the individual species, was identified. Traits for each species were summarized from the Birds of North America accounts (see Appendix 1 for citations), which provide detailed literature reviews of the natural history characteristics known about most bird species found in North America. In our summary, we included information about the distribution of the species in North America; general breeding habitat characteristics; migratory status of the species in Montana; nest type and placement in the vertical vegetation strata; foraging location in the vegetation strata; main food eaten; nest parasitism status; rangewide population trend; and whether or not the species is a deciduous forest obligate (derived from descriptions of general breeding habitat). We also used this natural history information to classify bird species into guilds for data analysis (Table 6).

Birds by Habitat Type

Bird community characteristics differed across survey sites within various habitat types (Figures 4a, 4b). Mean number of birds and species per survey was highest in cottonwood with native shrub and cottonwood with ash and Russian-olive, where approximately 21 birds and 12 species were detected on average in each. Abundance and richness was lowest in cottonwood with herbaceous, with 18 birds and 9 species counted on average per survey. These results are similar to those reported from the avian study conducted along the upper reach of the Yellowstone River, where species richness and total bird abundance were highest in the cottonwood forest with a native shrub understory (Hansen et al., 2003).

Individual bird species were found in varying abundances within different habitat types (Table 7). For example, mean abundance of Red-eyed Vireo was lowest in cottonwood with native shrub, while mean abundances of Yellow Warbler, American Goldfinch, and Gray Catbird (Figure 5a) were highest in this habitat. Many species were most abundant in the cottonwood with ash and Russian-olive, including Yellow-breasted Chat, Ovenbird (Figure 5b), Mourning Dove, Common Yellowthroat, Spotted Towhee, and most woodpecker species. Abundances for Warbling Vireo, Least Flycatcher, Western Wood-pewee, and House Wren, were relatively stable across all four habitat types.

Table 5. Vegetation species observed at mature cottonwood bird survey sites, summarized by habitat type and ecoregion.

	Habitat				Ecoregion			
Vegetation Characteristic	**CW/Herb n = 8**	**CW/Shrub n = 11**	**CW/Russian-olive n=12**	**CW/Ash/Russian-olive n = 11**	**Mountain n = 10**	**Transition n = 8**	**Prairie I n = 8**	**Prairie II n = 16**
Dominant canopy species	Great Plains Cottonwood	Great Plains Cottonwood	Great Plains Cottonwood	Great Plains Cottonwood	Narrowleaf Cottonwood	Great Plains Cottonwood	Great Plains Cottonwood	Great Plains Cottonwood
Other canopy species	Narrowleaf Cottonwood	Narrowleaf Cottonwood	Narrowleaf Cottonwood	--	Great Plains Cottonwood	Narrowleaf Cottonwood	--	--
Dominant midstory species	Great Plains Cottonwood	Great Plains/ Narrowleaf Cottonwood	Great Plains Cottonwood	Great Plains Cottonwood	Narrowleaf Cottonwood	Great Plains Cottonwood	Great Plains Cottonwood	Great Plains Cottonwood
Other midstory species	Narrowleaf Cottonwood	Boxelder	Narrowleaf Cottonwood	Green Ash	Great Plains Cottonwood	Narrowleaf Cottonwood	Boxelder	Green Ash
	Rocky Mountain Juniper	Russian-olive	Boxelder		Russian-olive	Boxelder	Russian-olive	
	Boxelder	Willow	Russian-olive		Willow	Russian-olive		
					Rocky Mountain Juniper	Red-osier Dogwood		
						Willow		
Dominant understory species	Russian-olive	Red-osier Dogwood	Russian-olive	Russian-olive	Rocky Mountain Juniper	Russian-olive/ Red-osier Dogwood	Russian-olive	Russian-olive
Other understory species	Rocky Mountain Juniper	Russian-olive	Boxelder	Green Ash	Red-osier Dogwood	Wild Rose	Boxelder	Green Ash
	Green Ash	Rocky Mountain Juniper	Ribes	Rocky Mountain Juniper	Russian-olive	Willow	Wild Rose	Willow
	Willow	Wild Rose	Wild Rose	Red-osier Dogwood	Ribes	Boxelder	Willow	Red-osier Dogwood
	Boxelder	Snowberry	Willow		Wild Rose	Snowberry	Snowberry	Rocky Mountain Juniper
		Boxelder	Red-osier Dogwood		Willow			
		Willow						
Dominant ground species	Grass	Grass	Grass	Grass	Grass	Grass	Grass	Grass

Table 6. All bird species observed at survey sites along the middle and lower Yellowstone River. Species were assigned to three types of guilds based on natural history characteristics, including migration, nesting, and foraging strategies.

Common Name	Scientific Name	Total # of Birds Detected	Migratory Guild[1]	Nesting Guild[2]	Foraging Guild[3]
Red-tailed Hawk	*Buteo jamaicensis*	2	SDR	MSC	HAWK
American Kestrel	*Falco sparverius*	2	NTM	CAV	HAWK
Ring-necked Pheasant*	*Phasianus colchicus*	5	SDR	GRD	GND
Mourning Dove	*Zenaida macroura*	36	SDR	MSC	GND
Black-billed Cuckoo*	*Coccyzus erythropthalmus*	1	NTM	LOW	LCAN
Red-headed Woodpecker*	*Melanerpes erythrocephalus*	1	SDR	CAV	AIR
Unknown Sapsucker	*Sphyrapicus* spp.	1	--	--	--
Downy Woodpecker	*Picoides pubescens*	19	SDR	CAV	TREE
Hairy Woodpecker	*Picoides villosus*	13	SDR	CAV	TREE
Northern Flicker	*Colaptes auratus*	15	SDR	CAV	GND
Western Wood-pewee	*Contopus sordidulous*	42	NTM	MSC	AIR
Least Flycatcher	*Empidonax minimus*	85	NTM	LOW	AIR
Plumbeous Vireo*	*Vireo plumbeous*	2	NTM	LOW	LCAN
Warbling Vireo	*Vireo givus*	31	NTM	MSC	HCAN
Red-eyed Vireo*	*Vireo olivaceous*	18	NTM	LOW	HCAN
Black-billed Magpie	*Pica hudsonia*	9	SDR	LOW	GND
American Crow	*Corvus brachyrhynchos*	1	SDR	MSC	GND
Tree Swallow	*Tachycineta bicolor*	6	NTM	CAV	AIR
Black-capped Chickadee	*Poecile atricapillus*	11	SDR	CAV	LCAN
Red-breasted Nuthatch*	*Sitta canadensis*	1	SDR	CAV	TREE
White-breasted Nuthatch	*Sitta carolinensis*	7	SDR	CAV	TREE
House Wren	*Troglodytes aedon*	141	NTM	CAV	LCAN
American Robin	*Turdus migratorius*	39	SDR	LOW	GND
Gray Catbird	*Dumetella carolinensis*	10	NTM	LOW	GND
European Starling	*Sturnus vulgaris*	20	SDR	CAV	GND
Cedar Waxwing	*Bombycilla cedrorum*	3	SDR	LOW	HCAN
Yellow Warbler	*Dendroica petechia*	155	NTM	LOW	LCAN
American Redstart	*Setophaga ruticilla*	20	NTM	LOW	LCAN
Ovenbird*	*Seiurus aurocapilla*	11	NTM	GRD	GND
Common Yellowthroat	*Geothlypis trichas*	15	NTM	GRD	LCAN
Yellow-breasted Chat*	*Icteria virens*	31	NTM	LOW	LCAN
Spotted Towhee*	*Pipilo maculatus*	19	SDR	GRD	GND
Field Sparrow*	*Spizella pusilla*	1	SDR	GRD	GND
Song Sparrow	*Melospiza melodia*	9	SDR	GRD	GND
Black-headed Grosbeak	*Pheucticus melanocephalus*	7	NTM	LOW	HCAN
Lazuli Bunting*	*Passerina amoena*	11	NTM	LOW	LCAN
Common Grackle	*Quiscalus quiscula*	4	SDR	MSC	GND
Brown-headed Cowbird	*Molothrus ater*	16	SDR	NONE	GND
Bullock's Oriole	*Icterus bullockii*	3	NTM	MSC	HCAN
Baltimore Oriole*	*Icterus galbula*	2	NTM	MSC	HCAN
American Goldfinch	*Carduelis tristis*	21	SDR	LOW	GND

* Birds not observed during the upper Yellowstone River study

[1] SDR = Short-distant/Resident; NTM = Neotropical migrant

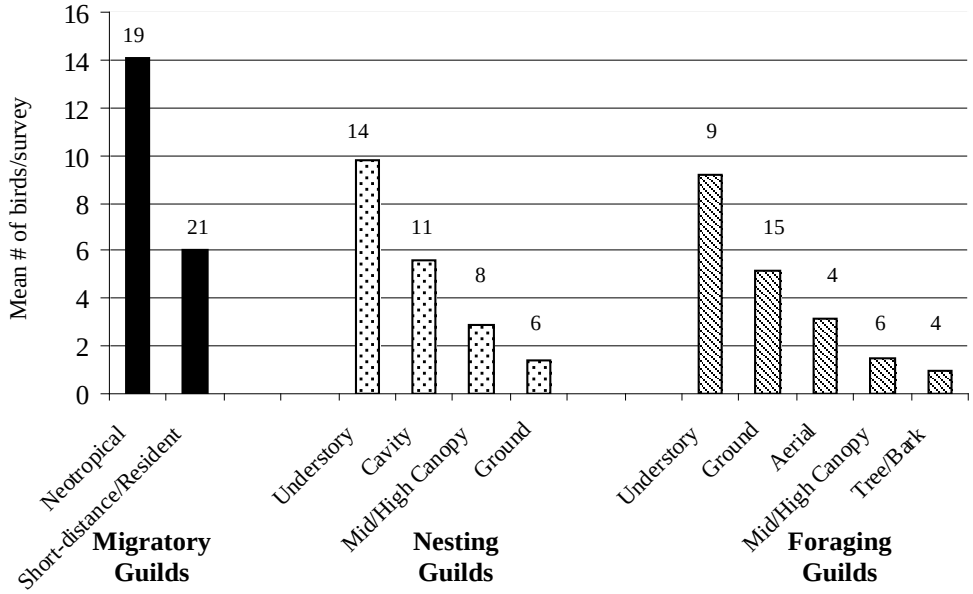
[2] CAV = Cavity; LOW = Understory; MSC = Mid/High canopy; GRD = Ground

[3] GND = Ground; AIR = Aerial; TREE = Bark/Branch; LCAN = Understory; HCAN = Mid/High canopy; HAWK = Ground hawk

Table 7. Mean abundance of bird species at all mature cottonwood survey sites, and within cottonwood sites by ecoregion and habitat type. Only species for which at least five individuals were observed across all survey sites (Table 6) are included in the table.

Species	**Mature Cottonwood n = 42**	**Ecoregion**				**Habitat**			
		Mountain n = 10	**Transition n = 8**	**Prairie I n = 8**	**Prairie II n = 16**	**CW/ Herb n = 8**	**CW/ Shrub n = 11**	**CW/Russian -olive n = 12**	**CW/Ash/ Russian-olive n = 11**
Ring-necked Pheasant	0.12	0.10	0.13	0.38	0	0	0.18	0.25	0
Mourning Dove	0.86	0.80	0.13	0.63	1.38	0.75	0.36	0.67	1.64
Downy Woodpecker	0.45	0.40	0.13	0.38	0.69	0.50	0.36	0.25	0.73
Hairy Woodpecker	0.31	0.10	0.13	0.50	0.44	0.25	0.18	0.33	0.45
Northern Flicker	0.36	0.20	0.13	0	0.75	0.38	0.27	0	0.82
Western Wood-pewee	1.00	1.10	1.25	1.12	0.75	1.13	1.18	1.08	0.64
Least Flycatcher	2.02	1.90	2.00	2.50	1.88	1.88	2.09	2.33	1.73
Warbling Vireo	0.74	0.60	1.00	0.63	0.75	1.00	0.73	0.58	0.73
Red-eyed Vireo	0.43	0	0.25	0.50	0.75	0.50	0.09	0.42	0.73
Black-billed Magpie	0.21	0.40	0.38	0	0.13	0.13	0.09	0.42	0.18
Tree Swallow	0.14	0.50	0	0	0.06	0.25	0.27	0	0.09
Black-capped Chickadee	0.26	0.30	0.25	0.13	0.31	0.25	0.36	0.17	0.27
White-breasted Nuthatch	0.17	0	0	0	0.44	0.13	0	0	0.55
House Wren	3.36	3.40	3.75	3.75	2.94	3.50	3.54	3.42	3.00
American Robin	0.93	1.60	0.25	0.38	1.13	1.25	1.36	0.17	1.09
Gray Catbird	0.24	0.80	0.25	0	0	0.13	0.73	0.08	0
European Starling	0.48	1.20	0.50	0	0.25	1.00	0.91	0	0.18
Yellow Warbler	3.69	4.60	4.13	3.50	3.00	3.00	4.27	4	3.27
American Redstart	0.48	0.20	1.25	0.63	0.19	0	0.73	0.75	0.27
Ovenbird	0.26	0	0.25	0.88	0.13	0.13	0.09	0.67	0.09
Common Yellowthroat	0.36	0	0.13	0.50	0.63	0.13	0.18	0.25	0.82
Yellow-breasted Chat	0.74	0	0.50	1.25	1.06	0.50	0.55	0.75	1.09
Spotted Towhee	0.45	0	0	1.00	0.69	0.25	0.09	0.67	0.73
Song Sparrow	0.21	0.70	0.25	0	0	0	0.55	0.25	0
Black-headed Grosbeak	0.17	0.40	0.13	0	0.13	0.25	0.27	0.08	0.09
Lazuli Bunting	0.26	0.10	0.25	0.25	0.38	0	0.09	0.33	0.55
Brown-headed Cowbird	0.38	0.70	0.25	0.13	0.38	0	0.73	0.17	0.55
American Goldfinch	0.50	0.70	1.13	0.38	0.13	0.13	0.91	0.75	0.09

Figure 3. Mean abundance of each guild in mature cottonwood. Numbers above bars indicate the number of bird species assigned to that guild.



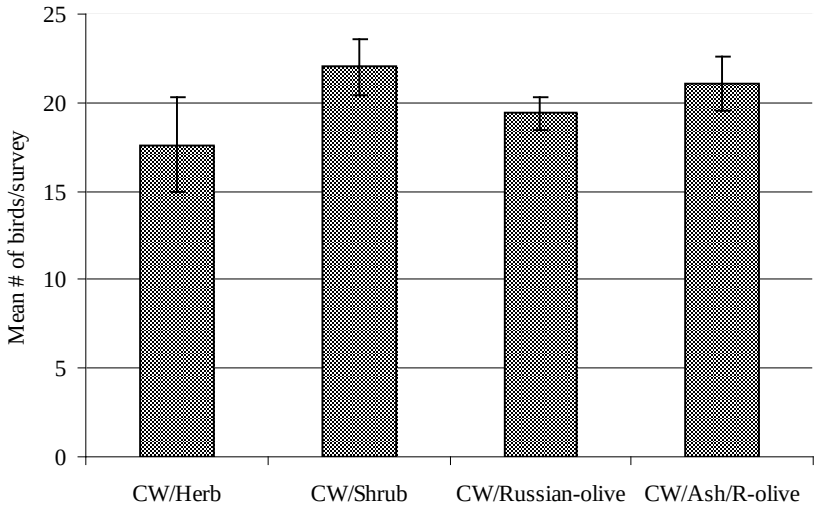
Birds by Ecoregion

Bird species richness and abundance differed slightly across survey sites within the four ecoregions (Figure 6). Species richness was highest at sites in the Prairie II ecoregion, with approximately 12 species detected on average per survey (Figure 6a) and lowest in the Mountain and Transition ecoregions, with around 10 species detected on average in each (Figure 6a). Total bird abundance was highest in the Mountain and lowest in the Transition ecoregion, with approximately 22 and 19 individuals detected on average, respectively (Figure 6b).

The presence and abundance of individual species also differed within survey sites of each ecoregion (Table 7). For some species, including Red-eyed Vireo, Yellow-breasted Chat, and Common Yellowthroat, abundances increased from west to east. For other species, such as Yellow Warbler, European Starling, and Gray Catbird, abundances decreased from west to east. Many species were predominant in one or two ecoregions, and had low abundances or did not exist in other ecoregions. For example, Spotted Towhee (Figure 7a) was found only in the two Prairie ecoregions, while Ovenbird was most abundant in Prairie I and American Redstart (Figure 7b) in Transition. Finally, abundances for some species, including Warbling Vireo, Least Flycatcher, and House Wren, stayed relatively stable across ecoregions.

Figure 4. Mean (a) bird abundance and (b) species richness across four mature cottonwood habitat types.

(a)



(b)

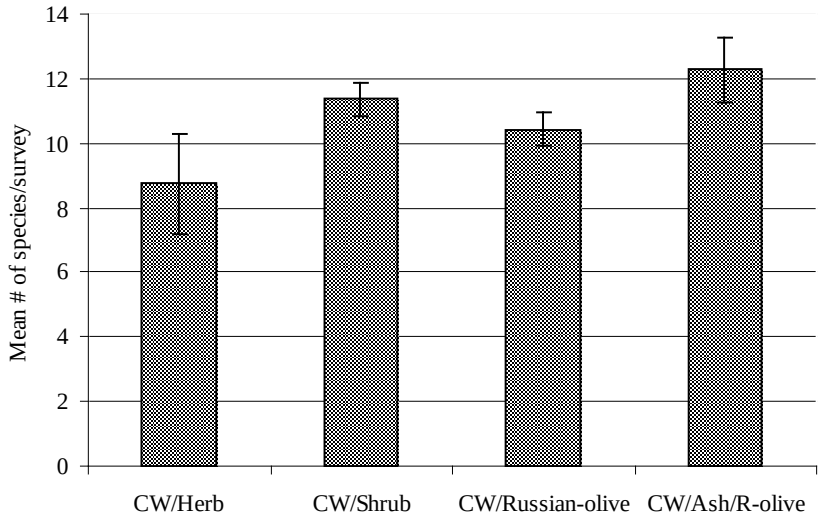
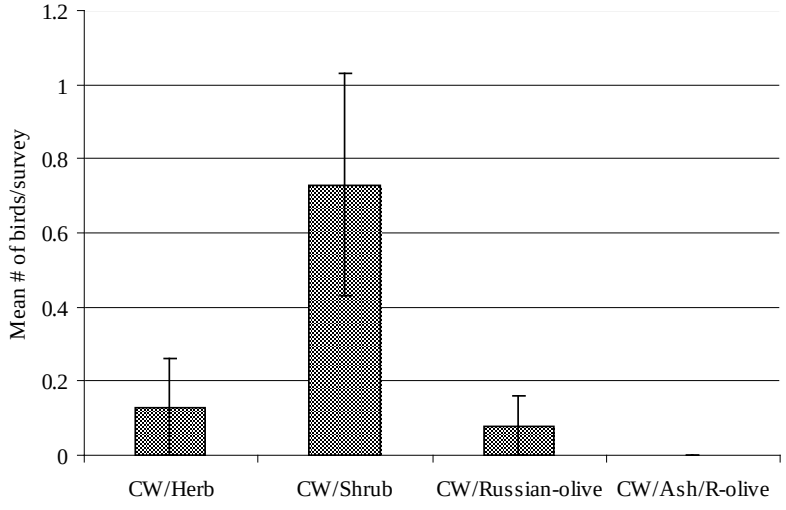


Figure 5. Mean abundance at survey sites across four habitats for (a) Gray Catbird and (b) Ovenbird.

(a)



(b)

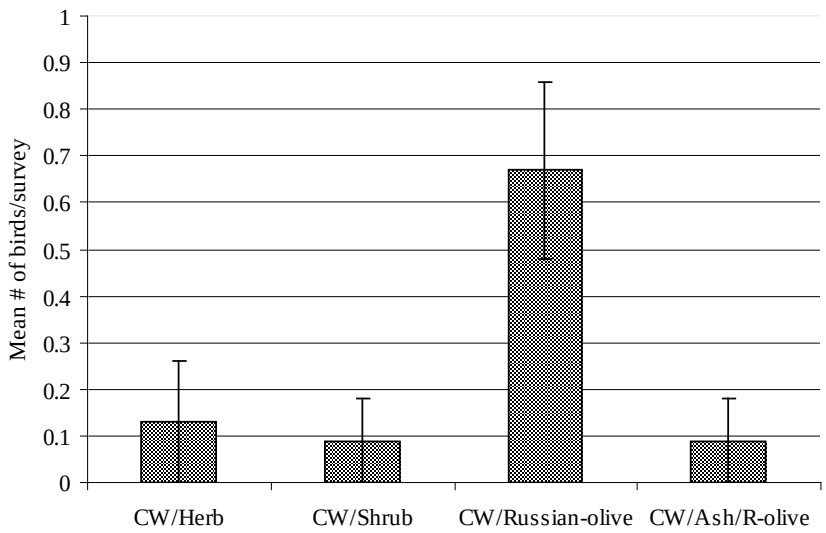
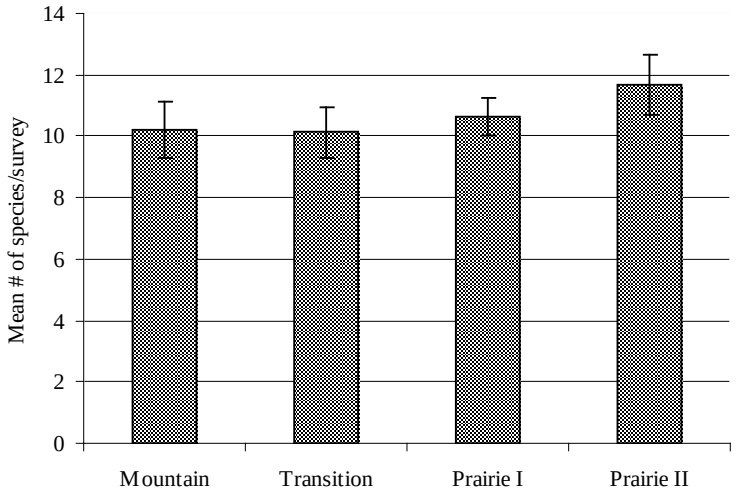


Figure 6. Mean (a) bird species richness and (b) abundance across four ecoregions.

(a)



(b)

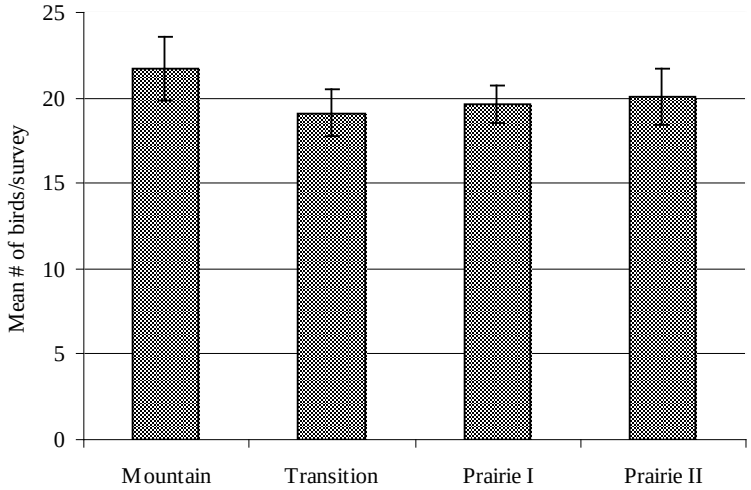
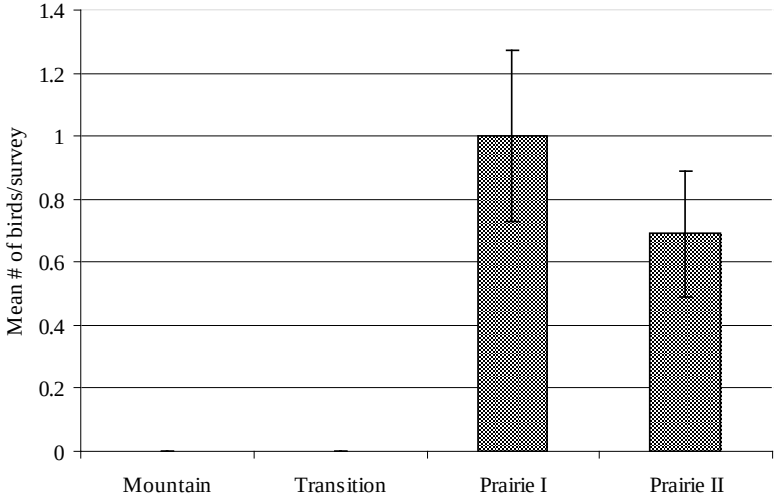
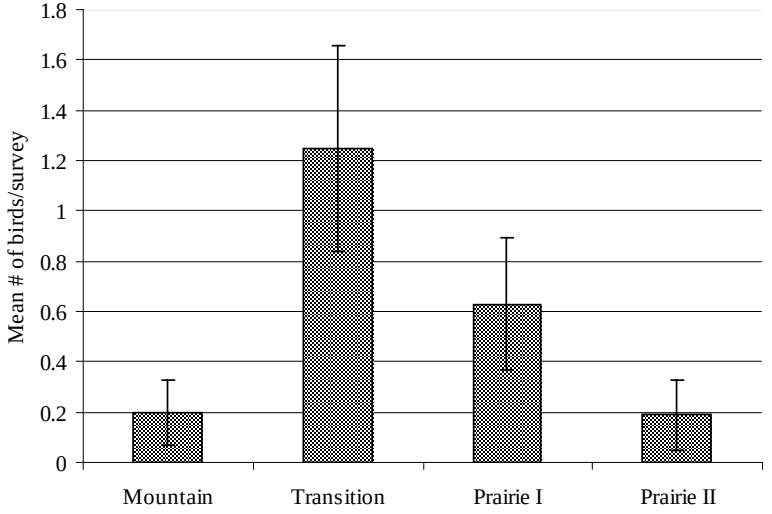


Figure 7. Mean abundance at survey locations across four ecoregions for (a) Spotted Towhee and (b) American Redstart.

(a)



(b)



Guilds by Habitat Type

The abundance of birds present within each guild varied at survey sites across habitat types (Figure 8). Cottonwood with herbaceous understory supported lowest abundances of ground and low nesting and foraging species compared to the other three habitat types (Figures 8a, 8b). This is not surprising, considering this habitat has the sparsest understory cover and presumably the fewest understory food resources and nest site locations. Neotropical migrants were also least abundant in cottonwood with herbaceous (Figure 8c). This could also be explained by the sparse understory cover, as many of the species included in this guild are understory foragers and nesters (Table 6). Conversely, cottonwood with native shrub understory, the habitat with the densest understory cover, supported high abundances of all of these guilds except ground nesters (Figure 8a). Ground nesting species achieved intermediate abundances in cottonwood with native shrub; these species may require more open understory cover for nesting than species that actually nest in the understory vegetation.

Cottonwood with Russian-olive also had a well-developed understory component, and supported high abundances of ground and lower canopy nesting species (Figure 8a), as well as understory foraging species (Figure 8b). Abundances of ground foragers were, however, low in this habitat. Species that forage on the ground may require the dense cover that is provided at ground level by native shrubs compared with taller Russian-olive shrubs. Neotropical migrants were also abundant in cottonwood forest with Russian-olive (Figure 8c), probably because most species in this guild are understory and lower canopy nesters and foragers (Table 6). Finally, cavity nesting species and short-distance migrants/residents were lowest in this habitat; these two guilds are probably closely related, as many short-distance migrants/residents are cavity nesters.

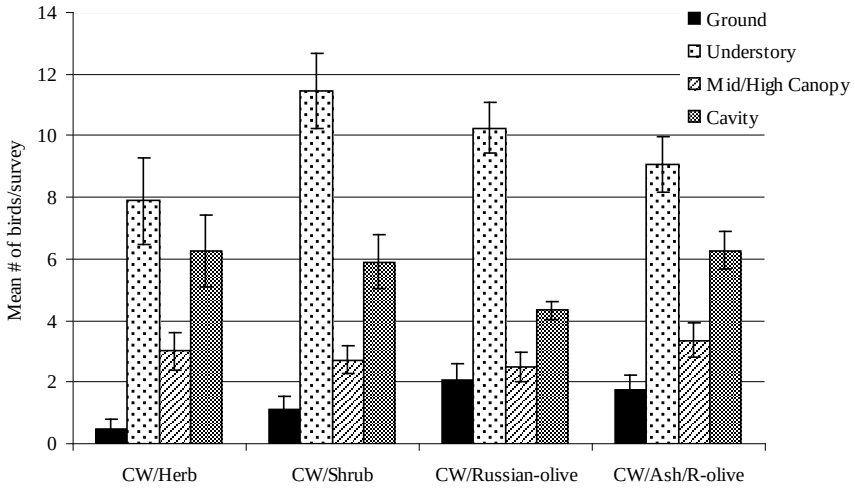
Cottonwood with green ash and Russian-olive supported the highest abundance of bark foraging species, and the lowest abundance of aerial foraging species compared with the other three habitat types (Figure 8b). This habitat has more cover in the midstory canopy layer due to the presence of both green ash and Russian-olive, which may impede aerial foraging. Additionally, short-distance migrants/residents achieved highest abundances in this habitat, probably due to the relatively high abundances of cavity nesters and ground foragers that also belong to this migratory guild (Figure 8c). Other guilds achieved intermediate abundances in this habitat type. Abundances of high canopy foragers or midstory and high canopy nesters stayed relatively stable across all habitats (Figures 8a, 8b). This is likely due to the dense cottonwood overstory that was present across all four habitat types.

Guilds by Ecoregion

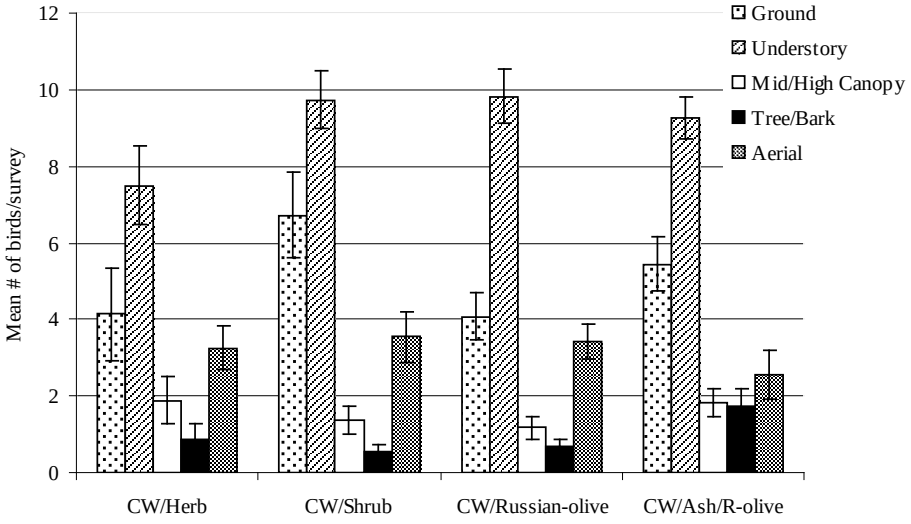
Relative abundances of guilds varied, with certain guilds found in higher or lower abundances across ecoregions (Figure 9). Birds nesting in the understory to midstory layers were most abundant in the Mountain and Transition ecoregions, decreasing in abundance from west to east (Figure 9a). Birds foraging in the understory were most abundant along the central part of the river, in the Transition and Prairie I ecoregions. Ground foragers were much more abundant in the Mountain ecoregion than in the other three ecoregions, while ground nesters were most abundant farther east in the Prairie I ecoregion (Figure 9b). Cavity nesters were found in highest abundances farthest west in the Mountain ecoregion, and farthest east in the Prairie II ecoregion (along with tree bark foragers, of which most species are also cavity nesters; Figure 9a). Consequently, short distance migrants/residents, of which many species are cavity nesters

Figure 8. Mean abundance of (a) nesting, (b) foraging, and (c) migratory guilds at survey sites across four habitat types.

(a)



(b)



(c)

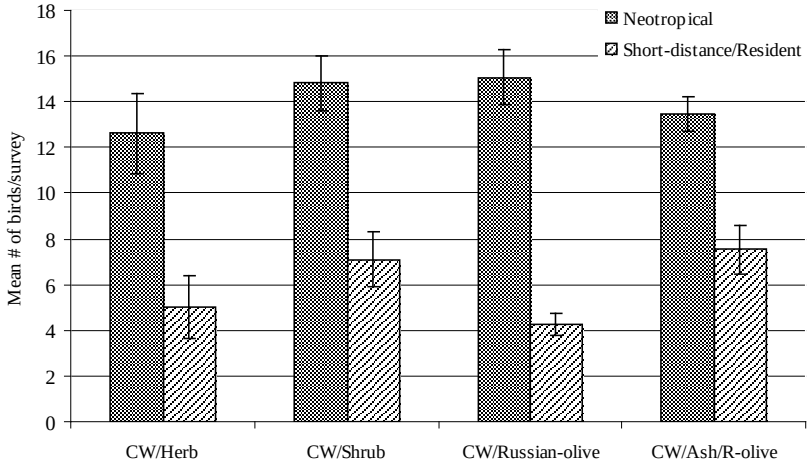
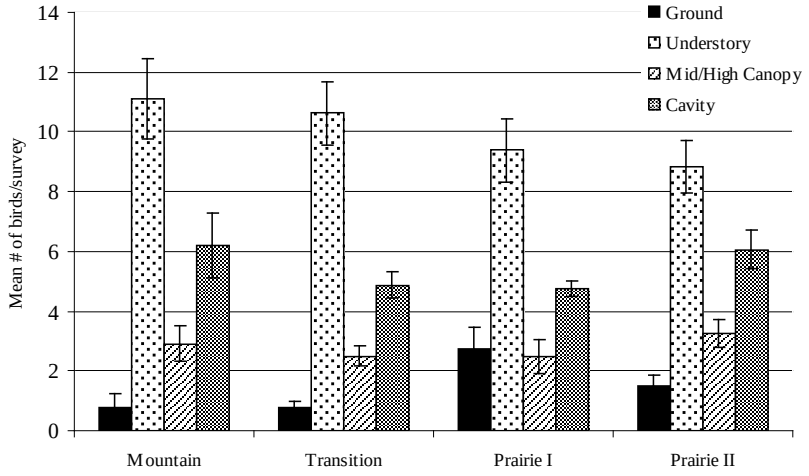
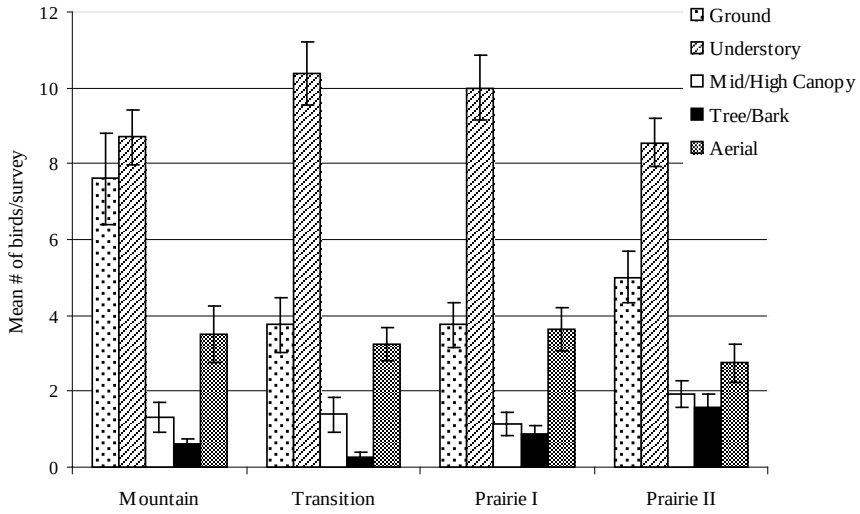


Figure 9. Mean abundance of (a) nesting, (b) foraging, and (c) migratory guilds at survey sites across four ecoregions.

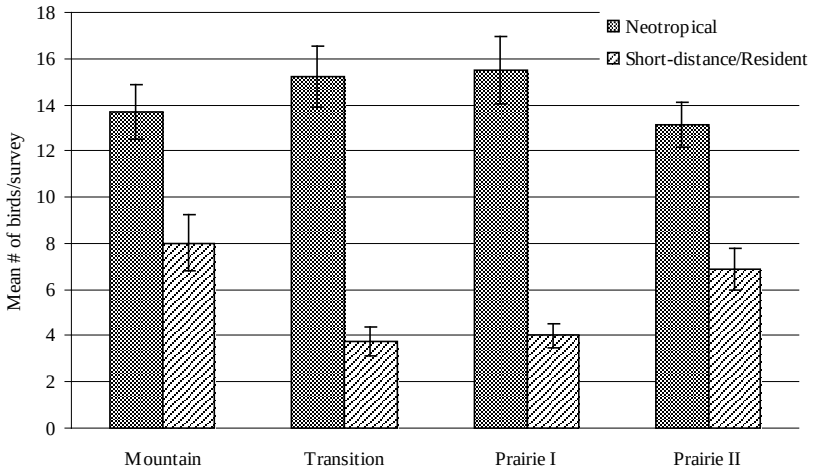
(a)



(b)



(c)



(Table 6), were also most abundant in the Mountain and Prairie II ecoregions (Figure 9c). Similarly, Neotropical migrants were most abundant in the central portion of the river (Figure 9c), likely due to high abundances of understory foragers that largely belong to this migratory guild (Table 6). Birds nesting and foraging in the midstory and canopy and aerial foragers were relatively equally distributed across survey sites within the four ecoregions (Figures 9a, 9b).

Discussion

In the western US, riparian areas represent a very small proportion of the overall landscape. However, these areas sustain some of the most diverse and abundant bird communities of all habitats (Dobkin et al., 1998). Results from this pilot study indicate that this is true for the riparian cottonwood habitats along the middle and lower Yellowstone River, which support unique, diverse riparian bird communities. Many of the bird species observed along the river are largely dependent upon deciduous riparian habitats in the western US (Appendix 1). Some of these species, such as the Least Flycatcher, House Wren, and Yellow Warbler are relatively common riparian inhabitants, while other species, such as the Black-billed Cuckoo, Ovenbird, and Bullock's Oriole are relatively rare or have localized distributions. A few of these riparian dependent species have been experiencing declining or potentially declining rangewide populations, including the Black-billed Cuckoo, Red-headed Woodpecker, Downy Woodpecker, American Redstart, and Bullock's Oriole (Appendix 1). The Black-billed Cuckoo and the American Redstart also exhibited substantial decreases in population numbers at one of the BBS routes along the Yellowstone (Table 2), suggesting that these birds may be experiencing local population declines in Montana as well. The Yellowstone River may therefore provide riparian habitats essential for maintaining populations of these species in the region and in the western US.

Very little is documented about the riparian bird communities of the lower and middle Yellowstone River. Two existing programs, the Montana Bird Distribution and the BBS, document bird communities in the region, but do not provide information on riparian birds specifically. This pilot study has been a first step toward gaining an understanding about how birds are distributed across the 475 miles of river that run from Springdale, Montana to the Missouri River confluence. Birds were sampled using standardized bird survey methods that are preferable to records based on opportunistic sightings or disjunct sampling methodology. Additionally, surveys occurred along the length of the river corridor, providing a more representative sample of bird communities than provided through localized efforts. Findings from surveys conducted during this pilot effort are comparable across survey sites, and provide a comprehensive, preliminary picture of the riparian bird communities found in mature cottonwood forest along the river.

A main goal of this pilot study was to provide a general description of breeding bird communities, and to explore the factors possibly influencing the distribution and abundance of bird species along the length of the river. More than forty species of riparian birds were observed during surveys within mature cottonwood forest (Table 6). All but twelve of those species had previously been documented along the upper reaches of the river (Table 6); species not recorded in the upper reaches were more characteristic of the ecoregions located further east along the river. Variation in species presence and abundance were evident within the study area. Mature cottonwood forest stands differed in habitat characteristics such as understory structure (Table 4) and plant species composition (Table 5), and bird communities seemed to be

influenced by these vegetation differences. Results indicated that certain species may be associated with particular habitat types, presumably because that habitat provides unique food or nesting resources important to that species. Bird communities and species abundances also differed within sample areas across the four distinct ecoregions of the river. Considering the large extent of the study area, many factors may be influencing the distribution of birds across habitat types and ecoregions. These include the limits of a certain species' rangewide distribution (e.g. bird species that reside predominantly in eastern North America may not extend very far west into Montana, and may therefore not inhabit local, suitable habitats), climate, and land use. These factors may affect whether a bird species is present in an area, the availability of food and nesting resources as well as competitor and predator community structure, which likely influence patterns in bird distribution.

This pilot study has provided basic information about the distribution of riparian bird species and communities and riparian habitats along the river. Due to the preliminary nature of the study, interpretation of results should not extend beyond this context. A somewhat opportunistic, rather than random, sampling scheme introduce potential biases that may influence patterns of bird distribution. Similarly, unequal sampling efforts and small sample sizes across habitats and ecoregions may cause results to reflect local patterns in bird communities, and inhibit inference to Yellowstone bird populations in general. However, this pilot effort will be extremely useful for the planning of the future, more comprehensive bird study. Patterns in bird and vegetation distribution identified during this study will help to formulate specific research questions and refine study design details for that future study.

This pilot study has also provided crucial information about the logistics associated with conducting bird surveys along the river. The data collected will allow for the evaluation of minimum sample sizes needed in the future to collect sufficient data for addressing particular questions, while also providing insight about logistical considerations for achieving those sample goals. Additionally, logistics associated with conducting bird surveys on private lands can be very complicated, and this study has identified potential challenges which will help to plan and prepare for gaining access to private lands in a timely manner in the future. Furthermore, conducting a "trial run" of surveys along 475 miles of river has provided invaluable insight about how to effectively sample such a large study area. In sum, information and knowledge gained from this study will substantially improve the efficiency of the future study, allowing for more data, and the right kind of data, to be collected for addressing questions about potential cumulative impacts of human activities on riparian birds of the Yellowstone River.

Acknowledgements

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Appendix 1. Rangewide distribution and natural history characteristics of bird species observed along the lower and middle Yellowstone River.

Species	Distribution	General Breeding Habitat	Migratory Status in Montana	Nest Type	Nest Strata	Foraging Strata	Main Food	Parasitism Status	Rangewide Population Trends	Decid. Forest Obligate	Citation
Red-tailed Hawk	Most of North America (NA)	Forest bordering open areas	Short-distance migrant	Open cup	Canopy of tree	Elevated perch for pouncing	Rodents	Not parasitized	Increasing	No	Preston and Beane, 1993
American Kestrel	Most of NA	Open habitats with scattered trees	Neotropical migrant	Secondary (old) cavity	Dead or dying tree	Elevated perch for pouncing	Insects & small rodents	Not parasitized	Stable	No	Smallwood and Bird, 2002
Ring-necked Pheasant	Central NA except west coast	Agricultural areas bordering grassland or woodland	Resident	Open cup	Ground in grass or shrubs	Ground gleaner	Seeds	Parasite	Possible declines	No	Giudice and Ratti, 2001
Mourning Dove	Most of NA	Open woodlands and edges	Short-distance migrant	Open cup	Midstory to canopy in tree	Ground gleaner	Seeds	Not parasitized	Stable with possible declines	No	Mirarchi and Baskett, 1994
Black-billed Cuckoo	Central & eastern NA	Younger deciduous or mixed forest	Neotropical migrant	Open cup	Understory to midstory in sapling or shrub	Canopy gleaner	Insects	Parasite; Rare Y-b Cuckoo host	Declining	Yes	Hughes, 2001
Red-headed Woodpecker	Eastern & central US	Deciduous semi-open woodlands with large trees	Short-distance migrant	Primary (newly excavated) cavity	Dead or dying tree	Midstory aerial forager, ground gleaner	Insects & seeds	Not parasitized	Declining	Yes	Smith et al., 2000
Downy Woodpecker	Most of US & Canada	Open, deciduous woodlands	Resident	Primary cavity	Dead or diseased tree	Probes trunk and branches	Insects	Not parasitized	Stable to increasing	Yes	Jackson and Ouellet, 2002
Hairy Woodpecker	Most of NA	Mature deciduous and conifer woodlands	Resident	Primary cavity	Dead or diseased tree	Probes trunk and branches	Insects	Not parasitized	Possible declines	No	Jackson et al., 2002
Northern Flicker	Most of NA	Open woodlands and edges	Resident	Primary cavity	Dead or diseased tree	Ground gleaner	Insects	Not parasitized	Declining	No	Moore, 1995
Western Wood-pewee	Western NA	Deciduous and conifer woodlands with open understory	Neotropical migrant	Open cup	Midstory to canopy in tree	Midstory or canopy aerial forager	Insects	Infrequent Brown-headed cowbird (BHCO) host	Declining (MT increasing)	No	Bemis and Rising, 1999

Species	Distribution	General Breeding Habitat	Migratory Status in Montana	Nest Type	Nest Strata	Foraging Strata	Main Food	Parasitism Status	Rangewide Population Trends	Decid. Forest Obligate	Citation
Least Flycatcher	Northcentral NA	Semi-open mature deciduous and mixed woodland	Neotropical migrant	Open cup	Understory to midstory in sapling or tree	Midstory or canopy aerial forager	Insects	Infrequent BHCO host	Stable	Yes	Briskie, 1994
Plumbeous Vireo	Western US & Mexico	Open conifer with shrub or deciduous woodland	Neotropical migrant	Open cup	Understory shrub or tree	Understory to canopy gleaner	Insects	Frequent BHCO host	Stable to increasing (little info)	Yes?	Curson and Goguen, 1998
Warbling Vireo	Western US & Canada	Mature deciduous or mixed woodlands	Neotropical migrant	Open cup	Midstory to canopy in tree	Canopy gleaner	Insects	Frequent BHCO host	Increasing	Yes	Gardali and Ballard, 2000
Red-eyed Vireo	Northcentral & eastern NA	Deciduous and mixed forest with shrubs	Neotropical migrant	Open cup	Understory to midstory tree or shrub	Midstory or canopy gleaner	Insects	Frequent BHCO host	Increasing	Yes	Cimprich et al., 2000
Black-billed Magpie	Western US & Canada	Thickets and forest near open areas	Resident	Open cup	Understory to midstory shrub or tree	Ground gleaner	Insects, seeds, & carrion	Not parasitized	Stable	No	Trost, 1999
American Crow	Most of US & southern Canada	Open areas with scattered trees or near forest edges	Resident	Open cup	Midstory to canopy in tree	Ground gleaner	Seeds	Not parasitized	Stable to increasing	No	Verbeek and Caffrey, 2002
Tree Swallow	Northern & central NA	Open areas with snags	Neotropical migrant	Secondary cavity	Dead or dying tree	Aerial forager	Insects	Rare BHCO host	Increasing	No	Robertson et al., 1992
Black-capped Chickadee	North-central NA	Deciduous and mixed forest	Resident	Secondary/ Natural cavity	Dead or dying tree	Probes trunk and branches	Insects	Not parasitized	Stable to increasing	No	Smith, 1993
Red-breasted Nuthatch	Western US & southern Canada	Mature conifer and mixed forest with abundant conifer	Resident	Primary/ Secondary cavity	Dead or dying tree	Probes trunk and branches	Insects	Not parasitized	Increasing	No	Ghalambor and Martin, 1999
White-breasted nuthatch	Most of NA except extreme north	Semi-open mature deciduous or mixed woodland	Resident	Secondary/ Natural cavity	Live or dead tree	Probes trunk and branches	Insects	Not parasitized	Stable	Yes	Pravosudov and Grubb, Jr., 1993

Species	Distribution	General Breeding Habitat	Migratory Status in Montana	Nest Type	Nest Strata	Foraging Strata	Main Food	Parasitism Status	Rangewide Population Trends	Decid. Forest Obligate	Citation
House Wren	Most of US & southern Canada	Open deciduous or mixed forest	Neotropical migrant	Secondary/ Natural cavity	Live or dead tree	Understory and midstory gleaner	Insects	Not parasitized	Increasing	Yes	Johnson, 1998
American Robin	Most of NA	Variety of forest and woodland	Short-distance migrant	Open cup	Understory tree, sapling, or shrub	Ground to midstory gleaner	Insects	Rare BHCO host	Stable to increasing	No	Sallabanks and James, 1999
Gray Catbird	Most of US & southern Canada	Shrub or sapling thickets	Neotropical migrant	Open cup	Understory shrub or sapling	Ground and understory gleaner	Insects	Rare BHCO host	Stable	Yes	Cimprich and Moore, 1995
European Starling	Most of NA	Open forest near human habitation	Short-distance migrant	Secondary/ Natural cavity	Live or dead tree	Ground gleaner	Insects, seeds, & fruit	Rare BHCO host	Stable to increasing	No	Cabe, 1993
Cedar Waxwing	Central NA	Open woodland with shrubs and saplings	Short-distance migrant	Open cup	Understory tree or shrub	Midstory and canopy gleaner	Fruit	Infrequent BHCO host	Stable to increasing	No	Witmer et al., 1997
Yellow Warbler	Most of US & Canada	Deciduous thickets and forest with shrubs	Neotropical migrant	Open cup	Understory sapling or shrub	Understory to canopy gleaner	Insects	Frequent BHCO host	Stable	Yes	Lowther et al., 1999
American Redstart	Northern & eastern NA	Deciduous woodlands with shrubs	Neotropical migrant	Open cup	Understory shrub or sapling	Midstory gleaner	Insects	Frequent BHCO host	Possibly declining	Yes	Sherry and Holmes, 1997
Ovenbird	Northcentral & northeastern US	Deciduous or mixed decid. forest with dense canopy	Neotropical migrant	Open cup	On ground in open	Ground gleaner	Insects	Frequent BHCO host	Stable	Yes	Van Horn and Donovan, 1994
Common Yellowthroat	Most of US & Canada	Thickets in wide variety of habitats	Neotropical migrant	Open cup	On ground in grass	Ground to understory gleaner	Insects	Frequent BHCO host	Stable	No	Guzy and Ritchison, 1999
Yellow-breasted Chat	Eastern US & patchy in western US	Patchy riparian and shrubby areas	Neotropical migrant	Open cup	Understory shrub	Understory gleaner	Insects	Frequent BHCO host	Stable	Yes	Eckerle and Thompson, 2001
Spotted Towhee	Western US & Mexico, southern Canada	Wide range of deciduous shrubby areas	Short-distance migrant	Open cup	On ground near shrub	Ground gleaner	Insects	Frequent BHCO host (little info)	Stable	No	Greenlaw, 1996

Species	Distribution	General Breeding Habitat	Migratory Status in Montana	Nest Type	Nest Strata	Foraging Strata	Main Food	Parasitism Status	Rangewide Population Trends	Decid. Forest Obligate	Citation
Field Sparrow	Eastern & central US	Successional oldfields and open woodlands	Short-distance migrant	Open cup	On ground or low in grass or shrub	Ground and understory gleaner	Insects	Frequent BHCO host	Declining	No?	Carey et al., 1994
Song Sparrow	Most of US & Canada	Wide range of forest, shrub, and riparian habitats	Resident/ Short-distance migrant	Open cup	On ground or low in grass or shrub	Ground and understory gleaner	Insects	Frequent BHCO host	Declining	No	Arcese et al., 2002
Black-headed Grosbeak	Western US	Forest with saplings or shrubs	Neotropical migrant	Open cup	Understory sapling or shrub	Understory and midstory gleaner	Insects	Rare BHCO host	Stable with possible declines	No	Hill, 1995
Lazuli Bunting	Western US	Wide variety of brushy habitats	Neotropical migrant	Open cup	Understory shrub or sapling	Ground and understory gleaner	Insects	Frequent BHCO host	Stable	No	Greene et al., 1996
Common Grackle	All but extreme western NA	Open and semi-open habitats with scattered trees	Short-distance migrant	Open cup	Canopy of tree	Ground gleaner	Insects	Not parasitized	Increasing	No	Peer and Bollinger, 1997
Brown-headed Cowbird	Central & southern NA	Forest and woodland near openings or agriculture	Short-distance migrant	None (nest parasite)	None (nest parasite)	Ground gleaner	Seeds	Parasite	Increasing	No	Lowther, 1993
Bullock's Oriole	Western US	Semi-open deciduous forest	Neotropical migrant	Open cup	Canopy of isolated tree	Canopy gleaner	Insects	Rare BHCO host	Declining	Yes	Rising and Williams, 1999
Baltimore Oriole	Eastern to central US & Canada	Deciduous open woodlands and edges	Neotropical migrant	Open cup	Canopy of isolated tree	Canopy gleaner	Insects	Infrequent BHCO host	Stable with possible declines	Yes	Rising and Flood, 1998
American Goldfinch	Most of US & southern Canada	Early successional forest near open areas	Short-distance migrant	Open cup	Understory shrub or sapling	Ground and understory gleaner	Seeds	Infrequent BHCO host	Stable	No	Middleton, 1993