**Intro:**

**Context – Landscapes throughout the west are degraded and in need of restoration. Restoration takes time and resources- is it worth it? Lots of restoration work & monitoring happens at small scales; we are doing it at a large scale. Often studies focus on single plant communities and ignore the interplay and importance of the larger landscape. Intermountain West is understudied, for plant communities/restoration/birds.**

**Status of western systems**

* What challenges do they face?
* Heavy anthropogenic land use, climate change, drought, weeds
* Literature on Intermountain west grasslands, shrublands, restoration- Chuck? Philip?

**Restoration**

* The need for restoration efforts to address the degradation of grassland, riparian, and shrubland ecosystems in the Intermountain West.
* Restoration philosophies- what are they?
* Active and passive restoration
* Debate over the relative effectiveness and cost-effectiveness of these approaches.
* Need for long-term studies to evaluate the effectiveness of restoration efforts
* Highlight restoration in grassland, riparian, and shrubland systems
* Birds are useful indicators of ecosystem health and restoration success.

**Decline of many western bird species**

* Highlight grassland, riparian, and arid shrubland species
* How the Intermountain West supports these populations and is understudied; Importance of low-elevation, intermountain west ecosystems, role in supporting biodiversity, providing ecosystem services, and acting as movement corridors.
* Key habitat features that may be altered with land use; widespread degradation of low-elevation systems due to human activities, such as agriculture, urbanization, and livestock grazing.
* Key habitat features or life history behaviors that may be altered in the future due to climate change, fire, weeds, or other factors
* Why bird numbers and diversity are important metrics

**Focus on importance of landscape and interplay of plant communities**

* Birds use a variety of communities for nesting, foraging, etc.
* Most studies focus on single plant communities and small areas

**Goals and hypotheses**

* Assess the effects of low-elevation plant community restoration on native bird density, species richness, and distribution.
* Show elements of vegetation change that may explain changes in bird patterns.
* Highlight the restoration actions that resulted in features used by birds
* Look at species-specific bird responses to restoration- few case study species.
* Demonstrate that restoration takes time and long-term monitoring may be needed
* Set up fine-scale, species’ specific studies done by UMBEL, our own shrubby draw mapping

**Hypotheses**

* We will see an increase in density, distribution, and richness for species reliant on deciduous woody cover. Those increases will occur where we can document an increase in these features due to restoration.
* Generalist grassland species may or may not experience population or distribution change, but more specialized species should increase as we create more diverse grassland systems.
* We may see a lag in response time, particularly in areas where plant communities had complete turnover and/or limited vegetation.
* We see species using multiple plant communities even when mainly tied to one for nesting (e.g., grasslands provide unique foraging opportunities for birds nesting in adjacent woody habitats)

**Significance**

* Restoration implications – timeframe and investment
* Conservation implications – species of concern

**Methods**

Property location and description (Figure 1)

**Define plant communities** (working on with Chuck)

Current plant community categories from bird surveys:

Floodplain forest; In or over Bitterroot River; Pond or slough; Streamside riparian; Open grassland; Agricultural; Residential area; Rock outcrop; Restoration; Regenerating logged area; Deciduous shrub;

Sagebrush; Bitterbrush; Draw with no woody vegetation; Draw with deciduous shrub canopy; Draw with *Populus* sp. Canopy; Draw with conifer canopy; Conifer forest; Conifer woodland; Flyover; Unknown

Heritage designates grasslands as Rocky Mountain Lower Montane, Foothill, and Valley Grasslands and the floodplain as Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland. Shrubby draws are either not classified or in some cases have the same designation as the floodplain.

**Restoration Treatments**

Describe restoration treatments in broad terms, including both active and passive changes to each plant community and when they occurred. (Philip and Chuck work to describe restoration treatments from 2010 to 2020.) Focus on intended and actual outcomes versus the minutiae of how we got there?

Metrics for plant community change:

At landscape scale:

* Some indication of the acres of study area in each defined plant community class and how they’ve changed over time (Chuck)
* Some index of woody vegetation change that could capture all points of interest (Kyle)
* Some index of woody vegetation complexity (Kyle)
* Some metric for productivity? (Kyle, brainstorm with Chuck)
* Something for grasslands that might cover structure or bare ground? (brainstorm with Chuck)

**BIRDS**

**Point Counts**

Our surveys encompassed 196 points though survey effort varied in some years. We spaced points approximately 250 m apart on a grid that began with a randomly generated initial point. Points encompassed all available plant communities within our low- and mid-elevation restoration areas and in many cases more than one plant community occurred in proximity to a given point. We conducted point counts from 15 May to 15 July in all years. Point counts began 15 minutes after sunrise and were completed approximately 4 hours later, somewhere between 10:00 and 11:00 Mountain Standard Time. We considered field conditions unacceptable for surveys if weather influenced bird activity (e.g. continuous rain, high winds, extreme heat) or we experienced conditions that limited visual or aural detections (e.g., wind, fog, anthropogenic noise). At each point, we noted survey conditions including date, first or second visit, time survey began and ended, Beaufort wind-scale code, amount of cloud cover, temperature, and any persistent non-avian noise.We surveyed birds for 10 minutes divided into two intervals of five minutes. For each detection, we noted species, abundance, sex, identification method (e.g., song, call, visual, other), horizontal distance to first detection, closest distance, and plant community used.

**Summary metrics:**

We calculated several bird summary metrics based on data at four-year intervals (2012, 2016, and 2020), years when we sampled all 196 points. We limited data to detections of native species <= 250 m of the point center. At each time interval, we calculated species richness and the average number of plant communities used for each point. To look at changes in species’ distribution, we calculated the percent change in number of points species occurred at during each time interval.

We used the “Heatmap (Kernel Density Estimation)” tool in QGIS (version 3.34.0) to map changes in species richness across the landscape.

To test if changes in species richness was related to changes in woody cover, we xxxxxx using values from Kyle’s analysis.

**Density Estimates:**

We used package Distance in R to build models, selected the top model using AIC selection, check model fit, and get density estimates for each species. We used Julian date, minutes since sunrise, observer, and year as covariates with hazard rate and half-normal key detection functions with polynomial and cosine adjustments.

We evaluated precision of density estimates for each species using the calculated coefficient of variation (CV). We considered estimates with a CV value <10 very good, 10-20 good, 20-30 acceptable, and anything >30 unacceptable due to large confidence intervals and reliability concerns.

**Changes in abundance and species richness across all native species:**

PR insert methods, including stats- did you correct for number of points sampled for both metrics as it varied by year?

**Case studies:**

We choose a handful of case-study species that represented a variety of bird life history behaviors. We mapped their distribution in 2012, 2016, and 2020. We also calculated the proportion of detections within each plant community in these years to see if plant community use changed over time.

**Results**

**Changes in Vegetation**

Plant community coverage changed over time, mainly in grassland and restoration plant communities (Figure 2).

We also saw changes in metrics like ……….. (Figure 3)

**Bird results**

We sampled a maximum of 196 and a minimum of 155 points every year from 2010 to 2020 (Table 1). We detected 167 native species within 250 m of a point. Vesper Sparrow and Western Meadowlark were by far the most detected species (Appendix I).

We saw a significant increase in the average abundance of native species per point, increasing from 35 species in 2010 to 45 in 2020 (Figure 4) (stats Philip). Species richness increased significantly from 11.11 species in 2010 to 15.15 in 2020 (Figure 5) (stats Philip).

We saw positive change in species richness all plant communities (Figure 6). We saw the least amount of positive change occurring in the grasslands, areas with low structural diversity. Most areas with the highest increase in species richness experienced some sort of active restoration aimed at woody vegetation improvement and had multiple plant communities available, including areas like the Orchard House where restored grassland plant communities surround an oasis of trees, shrubs, and water resources that we actively enhanced. Some areas with passive restoration also experienced nice increases, including the northern floodplain (e.g., reduction in deer numbers, ceasing annual fire). We saw some species’ loss in mid-elevation grasslands and shrublands, which appear to coincide with sagebrush thinning and/or ungulate forage treatments where diverse shrubland communities were converted to more simple forage monocultures and/or have high levels of annual weeds.

Input results from testing changes in species richness are related to changes in woody cover, using values from Kyle’s analysis.

**Density Estimates**

We modeled annual density estimates of the 23 most common species that averaged at least 50 detections a year. We observed significant positive trends for 10 species and a negative trend for one (Table 2).

**Species Distribution**

We had far more native species increase than decrease their distribution between 2012 and 2020 and (Table 3). Ten species increased their distribution by 100% or more and six of these nest in shrubs.

We saw increases in both species tied to developing features like shrubs for breeding, and flocking birds that were out and about foraging.

Orange-crowned Warbler, MacGillivray’s Warbler, Black-headed Grosbeak…….- shrubs for breeding

* Cedar Waxwings- late-breeding species that may have been out in flocks foraging during main survey time
* Red-winged Blackbirds- many flyovers? Birds from the floodplain coming into uplands to forage?
* Siskins and crossbills- vagrant, early breeders that were out foraging?

**Plant communities available/used**

The number of plant communities used at each point changed over time. In 2012, birds used an average of 3.67 plant communities (SD=1.49) per point while they averaged 4.68 (SD=1.74) in 2020.

The proportion of plant communities used changed over time (Figure 7).

**Case studies**

In addition to seeing overall positive trends in both bird density, abundance, and distribution, the response of individual species also highlights important aspects of restoration effects including:

* Difference in short- and long-term of density trends for some species
* Specific areas where distribution changed, like areas of active restoration
* Change in plant communities used
* Potential use and importance of plant communities for things other than breeding

**Lazuli Bunting**

* Why include? They are a focal species for several of our projects, they are shrub dependent so good indicator of shrub conditions, really nice increase in distribution and use of active restoration areas.
* Density went from 17.5 to 30.7 birds/km2 with a decline during the middle of the sampling period when restoration activities resulted in many areas in transition, to a low of 6.6 birds/km2 in 2013.
* Distribution increased 112% between 2012 and 2020
* Use of riverbottom forest, shrubby draws, and bitterbrush stays equal over time but increases in deciduous shrubs, restoration areas, residential. Guess better nesting substrate

**Grasshopper Sparrow**

* Why include? Focal species for several projects, Species of Concern in Montana, grassland specialist, insane increase
* Density- 8.1 to 39.4 birds/km2 with a slight decline in the midst of most active restoration; really nice bird-splosion between 2016 and 2017; would be good to investigate the major plant changes between those years.
* Distribution- increased 68% between 2012 and 2020, but a decline in 2016- when grasslands were largely toasted? (71 to 42 to 119 pts).
* Habitats used- may need to investigate more as our grassland categories really weren’t great; from what we have now, we see an increase in their use of Restoration areas.

**American Robin**

* Why include? Common, ubiquitous species that uses just about every plant community. Even so, saw a really nice increase and response to active restoration areas- maybe highlighting both nesting and foraging opportunities in shrubs
* Density- 7.55 to 22.6 birds/km2; dip in 2016
* Distribution- increased just 15% between 2012 and 2020
* Habitats used- Robins start to move out from detections dominated by riverbottom forest to more mid-elevation areas. Guessing more foraging opportunities, some options for nesting

**Western Wood-pewee**

* Why include? Pretty specialized habitat needs, occurs at low density and was almost entirely limited to floodplain. Saw a small increase in both density and distribution but one to watch moving forward as we see it moving into upland shrubby draws.
* Density- Increased from 3.0 to 4.42 birds/km2 with some variation between years but accentuated because the number so small.
* Distribution- increased 20% between 2012 and 2020
* Habitats used- Pewees are barely anywhere but riverbottom forest but move into several new plant communities with time, primarily the draws. Guess better nesting substrate- they are a tree nester. Important habitat components may include large tree diameters, open understory, edge characteristics, and dead trees or trees with dead limbs (BW Account).

**American Goldfinch**

* Why include? Vagrant, flocking species that moves to where things are good and breeds late. Point counts are likely finished before they are breeding. Good indicator of habitat conditions for things other than breeding like foraging
* Density- Unreliable density estimates early on; first year with a reliable estimate was 2012 with 5.4 birds/km2 ; increased to 37.8 birds/km2 by 2020. Had unreliable estimates 2013-2016.
* Distribution- increased 136% between 2012 and 2020
* Habitats used- The detections of goldfinches switch from mostly flyovers to more detections actually using low- and mid-elevation plant communities. Guessing these are primarily foraging observations. We saw them eating seeds from salsify & balsamroot, other forbs in the restored areas. Also thistle. They nest late, prob after point counts are done.

**Topics to still consider:**

**Native species that declined**- HOLA, LBCU?. Would like to be able to document a decrease in bare ground if we’re going to talk about HOLA; re-catogorizing grasslands may also help with explaining their trends.

**Trends in non-native species?**

EUST, HOSP, CAQU, GRPA?

Guessing quail didn’t show up with enough detections because they were absent in early years- might be one that would if we considered their detections from 2016 to 2020.

**Key Discussion Points:**

**Main points**

* We saw positive outcomes for birds using a variety of metrics
* We can link these outcomes to restoration activities and certain plant community changes (e.g., woody cover, increased availability of certain communities)
* Restoration can take a long time; activities themselves can cause short-term population changes
* Value of both active and passive restoration in less or more degraded systems. Focus on outcomes, not details of treatments.
* Longer-term monitoring- Would be useful to support continued monitoring and research to refine restoration strategies and improve conservation outcomes.
* Looking at the whole landscape vs single plant communities allows for the movement of individuals and birds between them and is more representative of actual landscapes.

**What are trends regionally for these species?**

* IMBCR data
* Sauer et al. 2020- BBS data

**Limitations**

* No assessment of reproductive success- tradeoff between sampling large areas, direct/indirect indicators of change
* No assessment of specific features birds are using- landscape metrics are coarse

**Directions that we may cover in other papers- set up future pubs**

* Longer-term monitoring for some species that occurred at too low of a density to calculate estimates but have increased distribution and positive population trends (e.g., OCWA)
* Studies that look at reproductive output- UMBEL in the draws and grasslands, MAPS data on the floodplain
* Studies that more specifically tie birds to habitat/plants- shrubby draws during migration

Grasslands: Farmland conversion, noxious species invasion, fire suppression, heavy grazing and oil and gas development are major threats to this system (Montana Natural Heritage Program 2025a).

Floodplain: This system faces multiple threats: residential and agricultural development, invasives, climate change, drought (Montana Natural Heritage Program 2025b).

Rocky Mountain Lower Montane, Foothill, and Valley Grassland — Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland.  Montana Field Guide.  Montana Natural Heritage Program Retrieved on March 4, 2025, from <https://FieldGuide.mt.gov/displayES_Detail.aspx?ES=7112>

Northern Rocky Mountain Lower Montane Riparian Woodland and Shrubland.  Montana Field Guide.  Montana Natural Heritage Program Retrieved on March 4, 2025, from https://FieldGuide.mt.gov/displayES\_Detail.aspx?ES=9155