Patterns of Passerine Abundance and Effects of Precipitation at a Banding Station in the California Bay Area

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Background

In California we have had a long history with droughts, and as the planet continues to be affected by climate change we expect this trend to continue. According to BirdLife International, State of the World's Birds Report, at least 40% of the world's bird population is in decline. The alarming drop in bird populations can be linked to industrialization, commercial agriculture, air pollution, and other detrimental factors. Coyote Creek Field Station (CCFS) has been collecting data since the early 1980s. CCFS is located on a riparian habitat positioned along Coyote Creek in Milpitas, CA and is operated by volunteers and staff from San Francisco Bay Bird Observatory. A total of 47 nets divided into three sets are operated three mornings a week year-round. Nets are opened approximately 30 minutes before sunrise and closed 5 hours after opening. Effort is recorded for each day where 1 net hour represents one net being open for one hour. Net runs occur every 30 minutes with trained personnel handling the extraction of all captured birds. All birds, new and recaptured, are recorded with capture date, time, and net. The station gets a wide variety of mostly passerines, each new bird caught is banded around its tarsus with a USGS aluminum band.

Our research question:

Do precipitation levels affect bird species abundance?

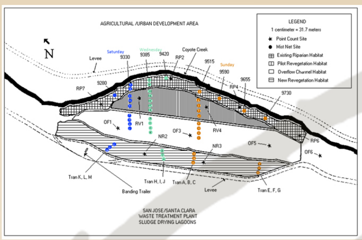


Figure 1 Coyote Creek Field Station Nets

Methods

We chose 18 different bird species to represent the overall populations that visit the field station. We chose our species to get the best variety based on genus, behavior, diet, migration habits and frequency of captures (AllAboutBirds.com, Sibley's Guide to Birds, Tattoni and LaBarbera [in review]). Species were then classified into resident, wintering, and migratory categories based on information previously collected at the station and with confirmation from our analysis. From these classification we chose three taxa of comparison birds that included a bird with both a resident and a migrating or wintering categories: sparrows, thrushes, and warblers.

We used bird capture data courtesy of CCFS from the years that aligned with available precipitation data, 1998 to the present. Precipitation data was collected from National Oceanic and Atmospheric Administration (NOAA) and Weather Underground. We looked for correlation between bird captures and precipitation at different lag periods, lag being how we analyze the delayed effect of precipitation (Fewster 2000; Schmidt et al. 2010).

A major part of our project was our use of a programming language called R to make ggplots, collect p-values and assess significance, and produce Generalized Additive Models, or GAMs for short. The GAM we used analyzed total captures per month of the 18 species chosen compared to total precipitation per month. The GAM gave us summarized data as well as graphs per year and for all time data was available. We also used the GAM to control for net hours because if the nets are open for only an hour, naturally there will be less birds caught than if the nets are open for 5 hours.

Results

- Clear patterns of resident / wintering / migratory species. See figure 2.
- Highly significant (< 0.001) p-values obtained from the GAMs indicated the amount of rainfall showed a correlation with some bird species' abundance. The correlation we saw was often positive, meaning more precipitation more birds. But for some birds the correlation was negative, meaning more precipitation less birds. See table 1.

SPECIES	STATUS	+ or -	p-value for 1 mo lag	+ or -	p-value 12 mo lag
American Goldfinch (AMGO)	resident		NS	+	4.74e-5***
Lesser Goldfinch (LEGO)	resident		NS	+	0.00627**
Song Sparrow (SOSP)	resident	-	0.0312*	-	0.0142*
Fox Sparrow (FOSP)	wintering		NS	+	0.00399**
Golden Crowned Sparrow (GCSP)	wintering	-	1.2e-7***		NS
American Robin (AMRO)	resident	+	2e-16 ***	-	0.000432 ***
Hermit Thrush (HETH)	wintering	+	1.6e-9***		NS
Swainson's Thrush (SWTH)	migratory		NS	-	3.48e-5***
Audubon's Warbler (AUWA)	wintering	+	5.92e-14 ***	+	2.23e-11 ***
Myrtle's Warbler (MYWA)	wintering	+	3.50e-16 ***	-	8.67e-07***
Wilson's Warbler (WIWA)	migratory	+	2.2e-7***	-	2.07e-07***
Yellow Warbler (YEWA)	migratory	+	0.024*	-	NS
Common Yellowthroat (COYE)	resident	-	0.00615**	-	0.00088***
Black Phoebe (BLPH)	resident		NS	+	0.0273*
Bushtit (BUSH)	resident		NS		NS
California Towhee (CALT)	resident		NS		NS
Chestnut-backed Chickadee (CBCH)	resident		NS		NS
Bewick's Wren (BEWR)	resident		NS		NS

Table 1 Table of Species included in study with residence status (resident / migratory / wintering) with correlation to 1 month and 12 month lag in p-values (positive number between 0 and 1). P-values shown indicate the strength of the correlation. P < 0.001 is our significance cutoff. NS = not significant. Negative or positive correlation to precipitation is shown for each value (+ or -), created with GAM.

Key to p values:

NS	$p > 0.05$	Not significant
*	$p \le 0.05$	
**	$p \le 0.01$	
***	$p \le 0.001$	Highly significant

- There seemed to be a pattern of wintering and migratory bird species being more affected by rainfall than resident bird species. See table 2.

Proportion with Highly Significant Correlation	1 month	12 month
Resident	1/10	3/10
Wintering	4/5	2/5
Migratory	1/3	2/3

Table 2 Table comparing correlation for resident/wintering/migratory species

- Of the 18 bird species examined, 5 were assessed to be in decline and 3 increasing in abundance. It was much more likely for a species in decline to have their numbers affected by rainfall according to our GAM analyses either through positive or negative correlation. In fact 4 of the 5 bird species assessed as in decline were significantly affected by rainfall. None of the three bird species assessed as increasing in abundance showed correlation with rainfall.

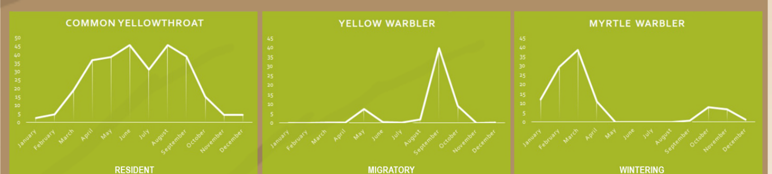
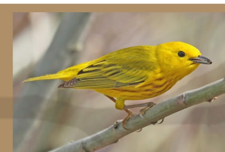


Figure 2 The resident species show a breeding pattern throughout the year, the migratory species show a pattern of them passing in and out of the area, and the wintering species show a pattern of wintering at the station.



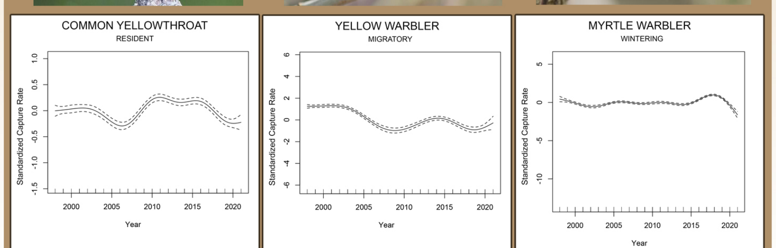


Figure 3 Graphs Created with R using GAM. Population patterns for 1998-2021 with the dashed line showing confidence interval. Controlled for banding effort (net hours), standardized capture rate is the y-axis. Graph shows average capture rate over time as it deviates from the overall average.

Conclusion

- Overall, migrating and wintering bird populations show more effect than resident bird populations. Migrating and wintering birds would have more opportunities to be affected by habitat loss, pollution, and other factors seeing as they visit multiple different areas. Migratory birds have the challenge of finding breeding habitat that could be less than ideal, and as they migrate the stops along the way may not have enough resources.
- This pattern was not seen with the American Robin, a resident species, because their diet consists largely of worms which need moisture, which makes the Robins far more susceptible to drought than seed and insect eating birds (Cady et al. 2019).
- We found bird species that were in decline were more likely to be affected by the occurrence of rainfall, indicating perhaps a greater vulnerability to climate change.
- Based on our data we cannot conclude that precipitation has either a negative or positive effect on birds, it would be more of a case by case situation. Attributing bird population trends on rainfall alone would neglect countless other factors that affect bird populations.
- Schmidt reports finding stronger relationships using a 1-2 month precipitation lag time, Cady et al. found a preference with 12 month lag time, whereas in our data set different lag times seemed possible (Schmidt et al 2010; Cady et al. 2019).

Erin and Katrina at CCFS

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