DESERT AVICACHING

Results and Discussion from the 2018 Season

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DESERT AVICACHING

SUMMARY

2018 marked the pilot season of Desert Avicaching, a citizen science program originating from geocaching and based on an earlier iteration of an avicaching game introduced by eBird and Cornell in 2016. The objective of avicaching is to encourage birders to collect data from under-visited locations to fulfill pre-established scientific objectives. Point Blue, the Sonoran Joint Venture, eBird, Cooper Ecological Monitoring, Inc., the Great Basin Bird Observatory, and the Bureau of Land Management partnered to design and promote Desert Avicaching to encourage avian data collection in Mojave and Sonoran Desert locations. In total, volunteers contributed 347.47 total survey hours across 409 unique eBird checklists submitted at 53 Desert Avicaching sites, from Feb 1 through June 15, 2018. Observers reported 16,033 birds considered to be in active migration, representing 102 identified species.

INTRODUCTION

The Sonoran Joint Venture (SJV) Technical Committee identified two high-priority data needs at its December 2015 meeting: 1) spatial distribution and population status for Bendire's Thrasher (*Toxostoma bendirei*) and LeConte's Thrasher (*Toxostoma lecontei*); and 2) all-species avian migrant diversity and abundance data across Mojave and Sonoran Desert habitats. Avian migrant data were desired to inform management and mitigation planning regarding alternative energy development in southern and eastern California.

At the December meeting the SJV Technical Committee also discussed "avicaching", a citizen science program that had been previously developed by eBird. Avicaching's objective was to encourage birdwatchers to collect eBird checklist data at infrequently-visited locations around Cornell University. "Avicachers" were awarded points for submitting eBird (www.ebird.org) checklists that followed specific avicaching protocol guidelines, provided that the data were collected at any of a roster of previously-designated avicaching locations in the area. Each avicaching location's point value was established relative to overall data needs; sites with high priority or which may have been more difficult to access could be assigned a higher number of points relative to other avicaching locations. Players' point totals were displayed on a publicly available leaderboard in a mildly competitive means of holding interest in the game throughout the count season.

With the support of the SJV Awards Program and assistance from SJV staff, Point Blue has worked to weave the threads introduced above into a citizen science program covering desert habitats in eastern and southern California and southern Nevada. Called "Desert Avicaching", our project was designed

to engage volunteers to help the SJV and eBird gather data across under-birded desert habitats during spring migration in 2018.

This report is loosely structured in an Introduction, Methods, Result format. This was Desert Avicaching's pilot season, and one objective of this report is to provide the reader with a thorough accounting of the lessons learned from this effort to inform further avicaching applications. As such, we have included discussion throughout the Methods and Results sections.

METHODS

Avicaching is a robust citizen science tool that can be adapted for a wide variety of project objectives, habitats, and species. However, each application may require unique modifications that best fit data objectives set by the application's designers. Avicaching's basics, described by eBird for its first (2016) application in near Ithaca, New York, are housed at https://ebird.org/science/applied-projects/avicaching. This framework was a useful starting point for Desert Avicaching, but it required subsequent modification to best fit data needs and volunteer capabilities.

Avicaching Sites

Desert habitats are persistently under-birded due to their remoteness, low population density, low road density, and harsh weather conditions. These factors belie their popularity among experienced birders that visit our deserts for their endemic species and to birdwatch at "migrant traps" that are found sporadically throughout the region. Migrant traps are bodies of water or well-vegetated oases surrounded by otherwise relatively inhospitable habitat that can attract large numbers of birds during migration. Notably, migrant traps draw out of range vagrant species that may otherwise be difficult to find in the region. Some of these migrant traps are very well-known throughout the birding community, and they receive a disproportionate amount of desert birding effort.

Migrant traps are by definition not representative of the desert habitats that surround them, and bird species and counts recorded at migrant traps may not reflect expected numbers and species composition of migrating birds that encounter solar facilities while transiting the region. We therefore did not include any migrant traps among our roster of avicaching sites, and we sought to select sites near solar facilities or in locations known to be potential thrasher habitat.

With regard to solar mitigation avicaching sites, we originally wished to find and establish our own avicaching locations near solar installations to be representative of the habitats around these facilities. Ground truthing all locations to ensure that volunteers could safely access them proved to be cost prohibitive however, and we instead took advantage of a relatively high number of previously established and rarely visited preexisting eBird hotspots that aligned well with developed solar facilities in the region (Figure 1).

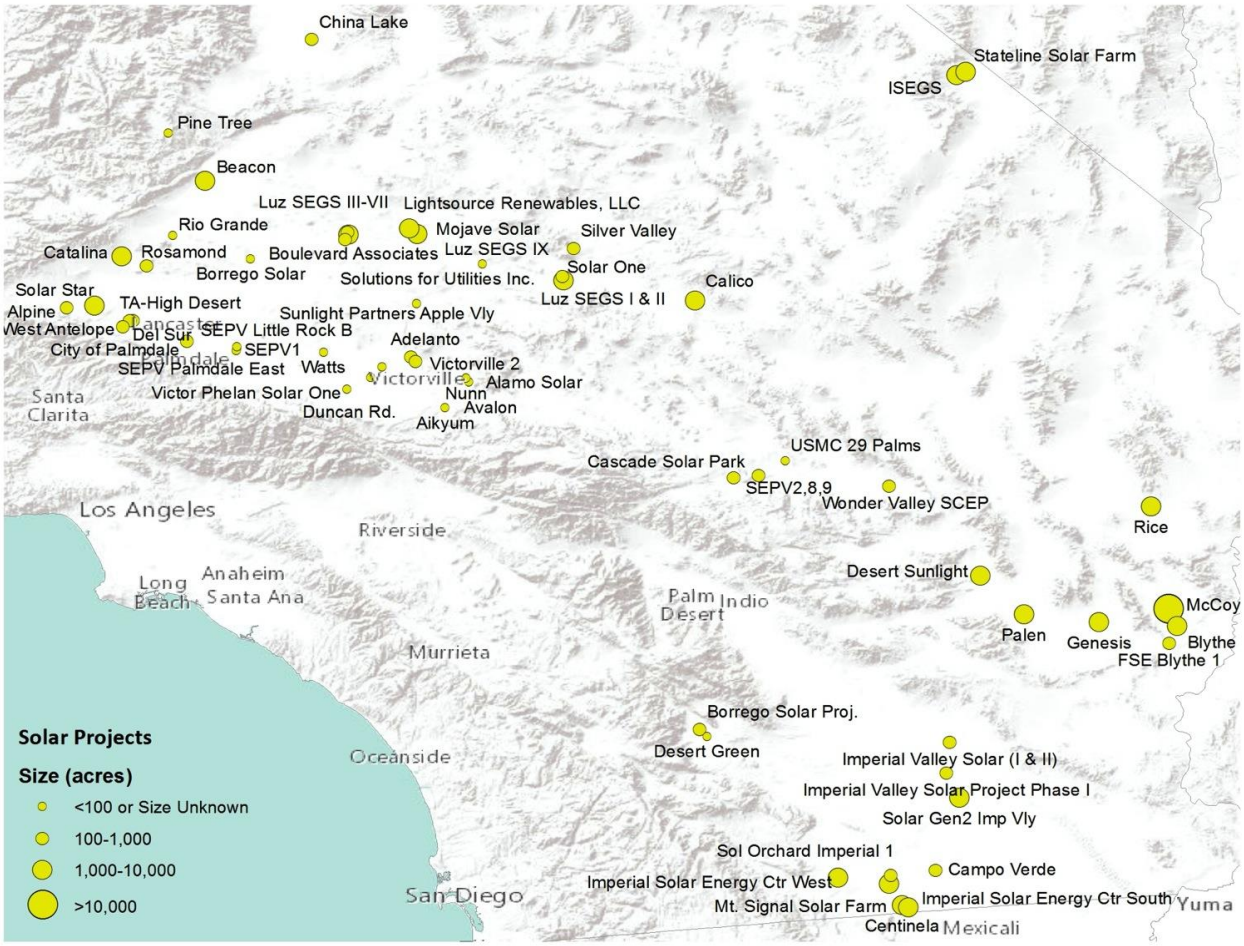

Figure 1. Locations of active solar sites built or approved as of 2014 (Cooper 2015).

With regard to desert thrasher avicaching sites, we selected from previously-surveyed thrasher research plots assessed by Point Blue (CA sites) and the Great Basin Bird Observatory (GBBO, NV sites) in 2017. These locations were found to hold a relatively high probability of thrasher occurrence during a modeling exercise conducted by the Desert Thrasher Working Group in 2016.

We sought to give Desert Avicaching participants a wide variety of potential locations to choose from, with points spread throughout the region. We believed this would 1) produce a higher quality data set with inputs from the entire region and 2) increase participation, giving volunteers a large menu to choose from that might best align with their home locations or with their favorite desert destinations. In total, 42 solar mitigation avicaching sites and 49 thrasher avicaching sites were established. Thrasher sites typically occurred in clusters, reflecting the Desert Thrasher Working Group's clustered plot study design. The 49 thrasher sites represent 20 distinct thrasher point clusters. Desert Avicaching locations are shown in a screenshot of an active Google map produced by the SJV in Figure 2, and sites are color coded by region and by avicaching point type (solar mitigation or thrasher).

Figure 2. Desert Avicaching locations, live version of map at https://sonoranjv.org/avicaching/

Survey Protocol

We considered several approaches to survey protocol, with a desire to produce a method that was a) robust enough to be comparable between surveys and sites yet b) easy to follow for volunteers that were potentially unfamiliar with conducting short-duration bird surveys.

We suggested to participants to conduct their avicaching surveys before 10am or after 7pm when possible, to maximize the participants' exposure to periods of higher flying rates found for migrating individuals. For a checklist to receive avicaching points (see below), observers were required to submit checklists of at least 20 minutes and up to 60 minutes in duration. We asked participants to begin and submit new checklists if they remained at the site for over 60 minutes, or if they traveled more than one mile during their survey.

The Desert Avicaching study period extended from February 1 through June 15, 2018. This interval was chosen to encompass spring migration and the thrasher breeding season. A small number of January checklists that were submitted prior to the official start of the game were included in analyses, as desert eBird data on wintering migrants (e.g., sparrows such as Bell's Sparrow (*Artemisiospiza belli*) are relatively few.

eBird Hotspots and Naming Convention

All solar mitigation avicaching sites were preexisting eBird hotspots that were recycled as Desert Avicaching eBird hotspots. Thrasher avicaching sites were preexisting Desert Thrasher Working Group study sites that were elevated to Desert Avicaching eBird hotspot status with the assistance of eBird hotspot volunteer editors from California and Nevada.

Assigning all avicaching sites the hotspot status had multiple advantages. It allowed participants to find and navigate to sites with their smartphones, using eBird's mobile app that includes a platform that displays the user's current location on an active Google map that is in turn overlaid with all eBird hotspot locations in the map's extent. It also enabled users to explore all Desert Avicaching sites using eBird's web-based Explore Hotspots tools that display eBird hotspots on maps, show recent visits by other eBird users to the hotspots, report all species observed at the hotspots, and provide links to all previously-submitted eBird lists at the hotspots.

"Desert Avicaching" was inserted as a suffix to each hotspot location's name. This helped participants locate avicaching sites and ensured that the site that they were navigating to was an avicaching site and not an ordinary eBird hotspot or one of the participant's personal eBird locations. Including Desert Avicaching in the location name also helped with data analysis, allowing for easy filtering of avicaching data from bulk downloads from eBird that need to be packaged at a County or State level.

Rules of the Game

Each eligible eBird checklist that was submitted at an authorized Desert Avicaching location and which followed survey protocol received one point; each point equated to one entry in a prize drawing held at the end of the study period. This scoring system was used to keep maintenance of the leaderboard and communication of point values to volunteers straightforward. In addition, the participants with the most checklists and most species observed also were awarded prizes.

The potential for project managers to prioritize and direct volunteer effort by awarding higher point totals for checklists submitted at high-priority locations is a fascinating facet of avicaching. Differential point values awarded on a site-specific basis frees project managers to steer effort to maximize volunteer resources, particularly if site-specific point values can be changed during the course of the

study period. This would appear to also have the potential to increase volunteers' engagement with the avicaching game, as changes in point values would need to be communicated to volunteers, and volunteers interested in improving their position in point standings would be motivated to explore the full roster of avicaching locations.

However, notwithstanding the additional effort and planning required in assigning site-specific point values, building a live leaderboard table that is updated with each participant's avicaching submission and which is available online requires significant programming resources. We are grateful to eBird for assisting us with the production and maintenance of a live leaderboard during our 2018 avicaching season, and it was beyond the scope of this project to build an avicaching game at the level of complexity required to have site-specific point values, particularly values that could change over the course of the study period.

Promotion and Strategic Communications

Desert Avicaching required a significant investment in promotion of the project to birders living in southern and eastern California and southern Nevada. Promotions needed to: 1) introduce the project and concept of avicaching to an audience that had never heard of it; 2) explain the need for data collected by volunteers; and 3) explain the rules and protocols to volunteers so that they would collect data in a preferred format. To meet these objectives, project promotion focused on in-person presentations to potential volunteers and on a combination of social media, web-based articles, and e-mail communications delivered to a network of organizations and individuals likely to further pass these media on to potential volunteers.

In order to increase general awareness of the game, as well as to target potential participants, the SJV used strategic communications techniques to support the Desert Avicaching pilot season. In addition to the in-person talks being given at local Audubon chapters and bird groups, we wanted to reach a larger audience by tapping into our online connections. The SJV first created a bilingual webpage hosted on the SJV website (https://sonoranjv.org/avicaching/) that provided background information on the game, objectives, rules, map of the Desert Avicaching locations, potential prizes, and a real-time leaderboard to keep track of volunteers' scores (leaderboard also stored at https://ebird.org/avicache/desert2018). The SJV published two articles, one that was promoted through our newsletter and hosted on our webpage, as well as an article that was posted on eBird's website (https://ebird.org/news/desert-avicaching-with-the-sonoran-joint-venture). We developed a social media toolkit to share with our partners that offered guidelines for how to promote the game on social media outlets. This included a series of suggested posts and graphics to use on their website, Facebook, and Twitter accounts. One of the major tactics was to always "tag" our major partners (eBird, Point Blue, Great Basin Bird Observatory, BLM), as well as the prize sponsors in order to reach a larger audience. We developed a series of hashtags to use to maintain consistency with the wording, and be able to track its use. The SJV regularly posted about Desert Avicaching, using participants and

images taken on visits to help spread the word, toolkit material, as well as original material as needed. We conducted a once a month prize drawing, as well as organized the end of the season prize giveaway. Finally, the SJV facilitated the communication between participants and receiving their prizes. The social media toolkit prepared by the SJV is provided at the end of this report in Appendix I.

We gave four in-person presentations to introduce Desert Avicaching to potential volunteers: the Pahrump, NV chapter of Red Rocks Audubon (fall 2017); the Las Vegas, NV chapter of Red Rocks Audubon (fall 2017); San Bernardino Audubon (winter 2018); and Pasadena Audubon (spring 2018). We also presented to the Arizona Bird Conservation Initiative (winter 2017) and the Partners in Flight Western Working Group (spring 2017) in order to describe avicaching and desert thrasher research to agency and research staff and to plant a seed for future discussion of potential applications of avicaching.

Prizes

Several organizations generously donated prizes for monthly and final avicaching awards. They include: the American Birding Association, Athlon Optics, BirdsEye Nature Apps, Point Blue Conservation Science, Wildwings Backyard Nature Store, and PhoneSkope.

RESULTS

This section presents analysis of both volunteer participation during our pilot season and of the data collected by volunteers.

Participation

Survey Hours

In total, 409 distinct eBird checklists were submitted from volunteers that surveyed Desert Avicaching locations during the winter and spring in 2018. These 409 checklists encompassed 270.8 distinct hours of volunteer avicaching survey time. eBird allows users to "share" checklists, such that if multiple observers birded together, the group's checklist is recorded in each observer's personal eBird account, and eBird records the data in its database as having originated from multiple eBird users. Many Desert Avicaching checklists were submitted from groups of observers as shared checklists. Counting effort for all observers involved with these shared lists, Desert Avicaching produced 347.5 cumulative survey hours of during the winter and spring in 2018. These totals represent only the duration of field surveys. We did not ask volunteers to record their travel times or gasoline costs to eBird Desert Avicaching locations. Conservatively, when given 1) the number of checklists and survey hours described above and 2) the amount of travel time and mileage required to fund a survey season across a landscape as large as the Desert Avicaching study area, we estimate that volunteers contributed over 500

cumulative hours of their time and $2,000-$3,000 in mileage to travel to and survey Desert Avicaching locations in 2018.

Observers

Seventy-two observers submitted checklists from Desert Avicaching locations from January 1 through June 15, 2018.

A minority of observers submitted the large majority of checklists, shown in Figure 3.

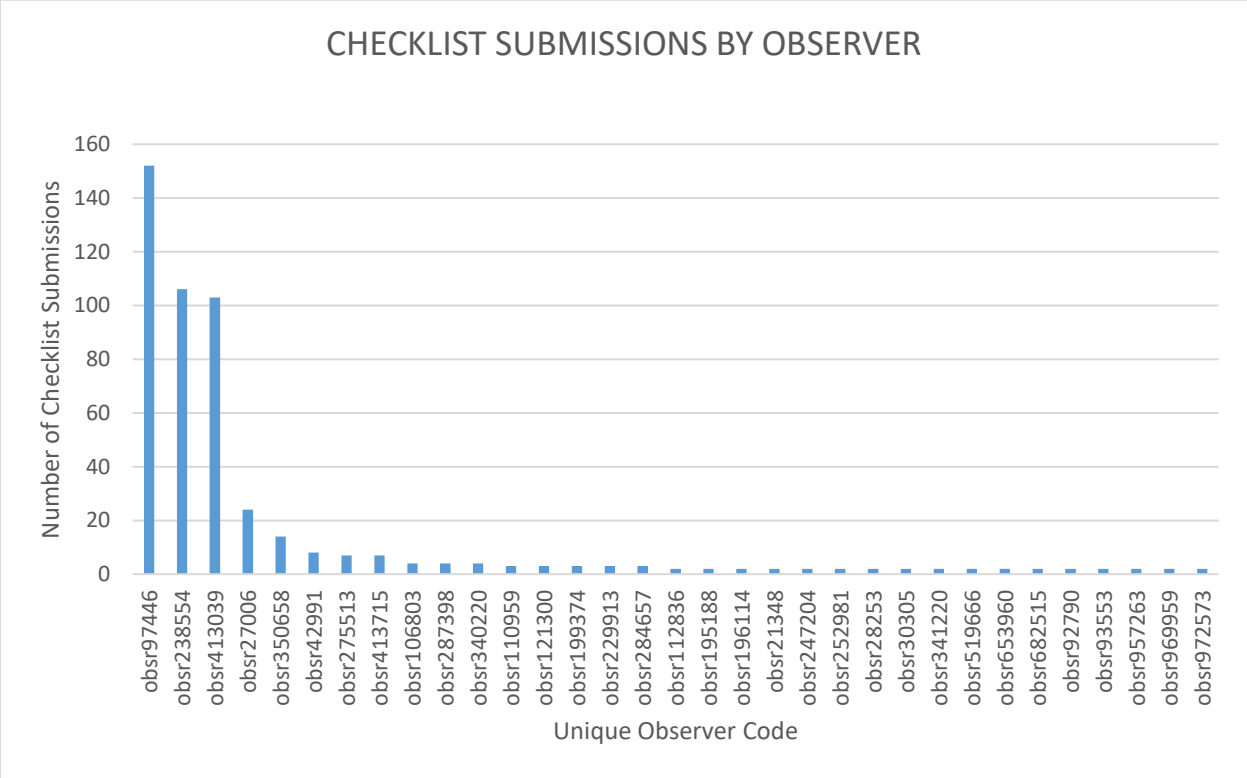

Figure 3. Number of checklist submissions by Desert Avicaching participant, 2018. The chart is right-truncated and does not show all observers that submitted lists.

Through a coarse lens, Figure 3 shows that there were essentially two types of volunteers that gathered Desert Avicaching data: 1) core observers that consistently birded at avicaching locations several times per week and several hours per day, often contributing checklists from multiple avicaching locations within one morning; and 2) casual observers that submitted less than five checklists over the entire study period.

This differential in individual participation patterns underscores an important value of avicaching as a citizen science tool. Avicaching simultaneously appeals to different types of volunteers. This presents

project managers with the opportunity to meet multiple goals through citizen science outreach. Desert Avicaching and its data objectives were scientifically compelling enough to attract experienced volunteers that collected large amounts of high-quality data (described below), yet it was interesting and novel enough to attract a relatively large number of casual volunteers that had a chance to learn about desert avian conservation, to experience desert habitats outside of typical migrant traps, and to contribute data to a regional citizen science project in the process. A project such as Desert Avicaching might have an internal objective of specifically targeting five to ten core observers that submitted checklists at the rate of the top three observers to increase the data set.

Desert Avicaching Sites and Spatial Patterns in Data Collection

Desert avicaching volunteers submitted checklists from 53 of the 91 advertised Desert Avicaching sites. This was essentially a blind trial of where volunteer participation would concentrate, as all sites were scored with the same point reward (one point), and individual locations were not specifically advertised or mentioned during project outreach and promotion.

A large majority of submitted checklists were submitted from Kern County (Table1). The Kern County portion of the western Mojave Desert holds several solar facilities (Figure 1) and Desert Avicaching hotspots (Figure 2), partially explaining the spatial distribution of checklist submissions.

Table 1. Unique eBird Checklists Submitted by County for Desert Avicaching in 2018

County	Unique Lists
Clark	36
Imperial	6
Inyo	3
Kern	278
Los Angeles	38
Riverside	4
San Bernardino	38
Sand Diego	6
Grand Total	409

Of likely higher importance to the spatial distribution of submitted avicaching checklists, the distribution was skewed toward population centers. Locations with the highest visitation rates were near where volunteers lived, enabling volunteers to visit locations often and repeatedly throughout the day. Figure 4 shows the distribution of Desert Avicaching sited visited in 2018, with sites weighted by the number of lists submitted there.

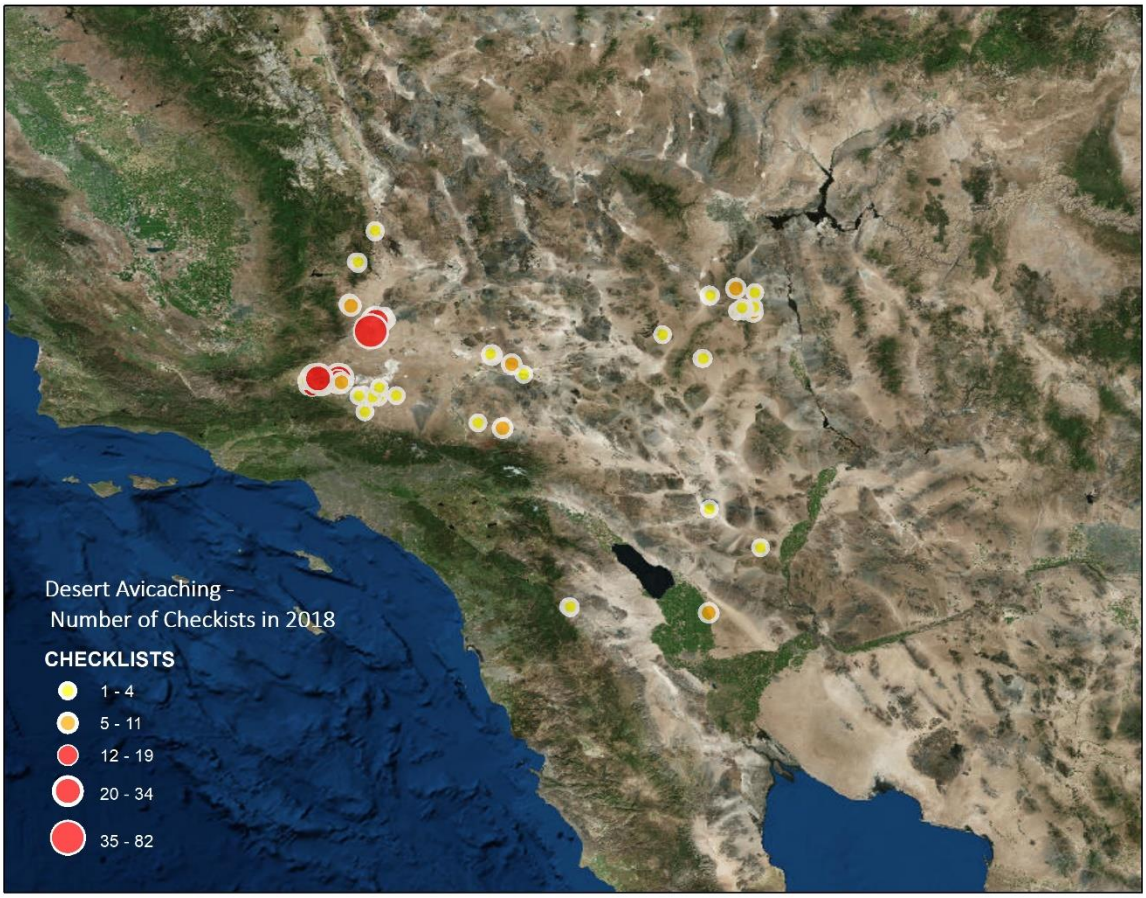

Figure 4. Desert Avicaching sites visited by volunteers in 2018, weighted by number of lists submitted from each location.

This connection between visitation rates and proximity to population centers is supported by comparing submissions from solar mitigation Desert Avicaching sites (336 unique submissions from 42 possible sites) with submissions from thrasher Desert Avicaching sites (73 unique submissions from 49 possible sites). Thrasher locations tended to be farther from population centers and received less attention from volunteers. As an exception, Butterbredt Canyon in Kern County was a thrasher location near other locations visited by the leading volunteers, and its cluster of three points were visited 17 times, more frequently than any other cluster of thrasher locations.

Avian Data Results

Observers submitted data for all bird species observed during their avicaching surveys. However, Desert Avicaching's data objectives focused on migrating birds and thrasher species, and results in this section focus on species from those groups.

Submission Statistics

Overall, a mean of 3.76 (S.D. = 3.22, 95% C.I. = 3.45 – 4.07) migrating species were observed per each checklist submission. A mean of 39.37 (S.D. = 88.20, 95% C.I. = 30.80 – 47.94) individuals suspected to be in migration were observed per each checklist submission. A cumulative total of 102 bird species were identified by observers as likely migrants, listed in Appendix II. Including detections that may have been identified to family or genus but not species, 16,033 individual birds thought to be in migration were observed during the 2018 study period.

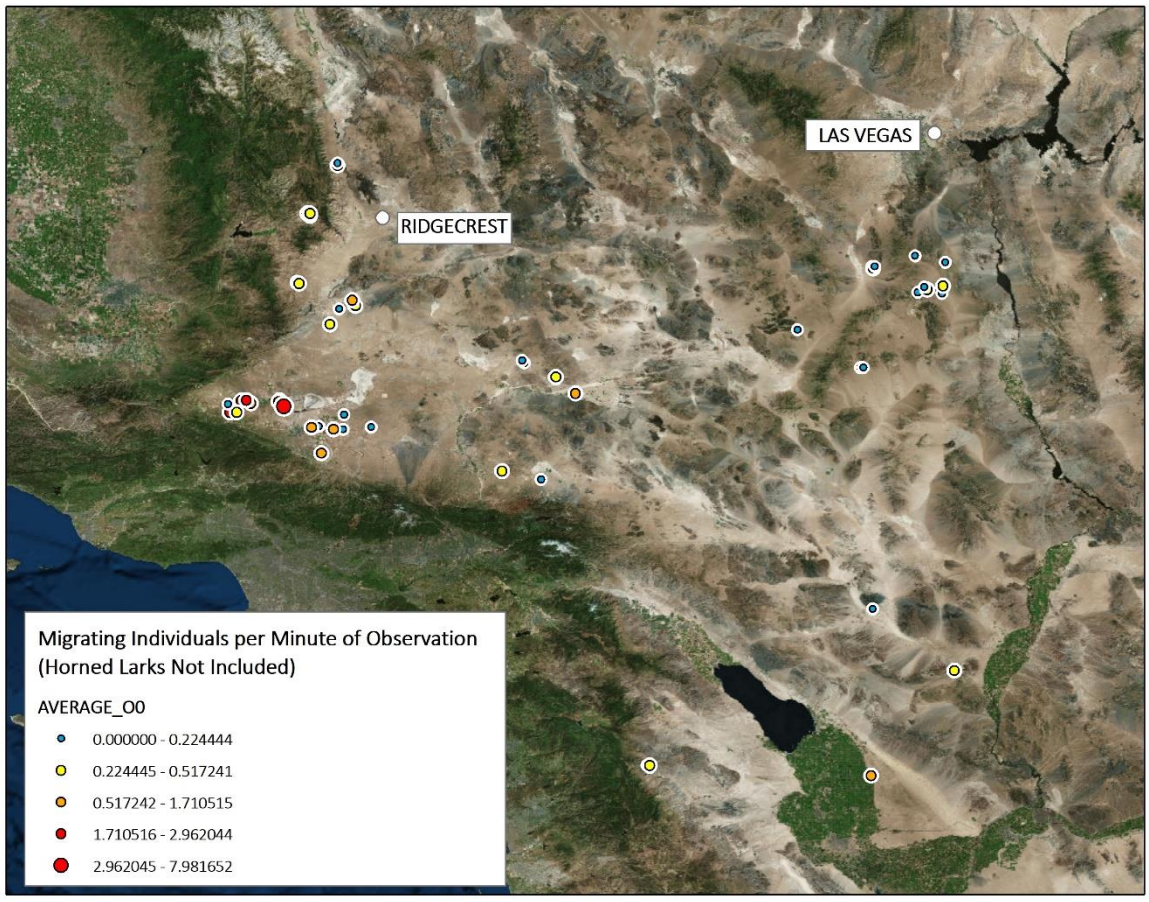

Figure 5. Migrating individuals per minute of observation at Desert Avicaching locations in 2018. Horned Larks were excluded from the figure due to occasionally large counts that would obscure results from other species shown above.

Species were conservatively classified migrants if they were generally encountered as likely to be migrating through the region, even though they may breed locally within the study area in specific and unusual habitats (e.g., agriculture), or if they only breed within the study area during wet years. An example is Horned Lark (*Eremophila alpestris*), with 6,318 individuals reported from 210 unique eBird checklists submitted. Horned Larks would not be expected to nest at a majority of the Desert Avicaching sites, and their high numbers at sites in the western Mojave Desert suggest that observers were recording flocks with mostly non-nesting, non-territorial birds from natal sites at unknown distances from the avicaching point.

Not including Horned Larks, observers recorded 0 to 7.98 migrating individuals per minute of observation at Desert Avicaching sites in 2018 (Figure 5). Sites across the Antelope Valley across the western Mojave Desert reported the highest rates of migrating birds (Figure 5), though habitat characteristics were not assessed during surveys. Notably, many of these locations were classified as solar mitigation points and were chosen for their relative proximity to planned or operating solar facilities.

Thrashers

LeConte's Thrashers were recorded on seven checklists, and four of these locations were solar mitigation sites and not thrasher sites. These were therefore new thrasher locations provided to the Desert Thrasher Working Group. Bendire's Thrashers were recorded on five checklists, and each sighting was taken at an established thrasher point.

Desert Avicaching assisted Desert Thrasher Working Group surveys with negative data as well. Numerous visits to thrasher locations in Kern County returned no Bendire's Thrashers. Bendire's Thrashers once were found to nest at these locations, which were scheduled to be surveyed by Point Blue. Negative data from avicaching volunteers allowed Point Blue to conserve time and crew resources to survey portions of the eastern Mojave Desert that would have otherwise been missed due to the project's large study area.

Comparison with Past Data Collected at Solar Facilities

Cooper (2015) summarized incidentally reported fatalities from four solar facilities in the region: the Ivanpah Solar Energy Generating Station (ISEGS), a "power tower"-type facility that concentrates reflected light to a central steam turbine tower in northeastern San Bernardino County; Genesis (west of Blythe, CA); Desert Sunlight (north of Desert Center, CA; and Solar One (east of Barstow, CA). Fatalities at these final three locations generally resulted from avian-infrastructure collisions with standard photovoltaic panels or troughs Fatalities at ISEGS tended to result from "solar flux" incidents, though collisions with infrastructure may have also occurred at this location.

Data from these four locations arrived from incidentally found carcasses collected on site, not from standardized post-construction monitoring studies that consider searcher efficiency, carcass persistence, and detection probability used to calculate estimated, species-specific mortality rates. Nonetheless, these fatality data provide a glimpse into the species that will likely be effected by solar facility operations into the future.

Data from the four locations listed above totaled 976 identifiable carcasses of 104 different bird species. Cause of death was generally not established for fatality, but the large majority of fatalities likely occurred from birds colliding with facility infrastructure or from injuries caused when birds passed through super-heated air that was warmed by reflected sunlight at ISEGS.

Cooper found that 1) small, migratory bird species bore a disproportionate share of risk; 2) diurnal migrants were at highest risk of fatality; 3) a group of species that Cooper referred to as "tight flockers" (e.g., Horned Lark, Savannah Sparrow, and Mourning Dove) faced higher risk; 4) aerial foraging species such as swallows and swifts bore a disproportionate share of risk; and 5) waterbirds were under-represented among all guilds with carcasses reported.

Species counts, the number of checklists from which the species was reported, the number of sites from which the species was reported, and the number of reported carcasses from four solar facilities as described above are provided in Appendix II. For the sake of continuity, species have been grouped according to a classification used by Cooper (2015) that attempted to combine traditional group identities with behaviors (e.g. flocking, or migration pattern). Definitions for those classifications are provided in Cooper (2015). We have also provided more universal guild classifications for each species. On rare occasions we have further clarified group classifications provided in Cooper to better reflect that species' status within the region.

Notably, avicaching counts often tracked incidental collision data well. Species groups used by Cooper (2015) that cumulatively represented the most collisions also tended to be the groups that were mostly seen during avicaching surveys (e.g., aerial foragers, Neotropic migratory birds (NTMB), tight-flockers with the most detections, and conversely, raptors and waterfowl with few detections. A caveat to this comparison is that collision fatalities from the four facilities listed above were not collected following standardized protocol. The species' collision counts therefore may not reflect accurate mortality rates of the species listed.

Differences between avicaching data and incidental collision reporting include scale. For example, Horned Larks were one of the most numerous species reported during incidental collision reporting. However, numbers reported from avicaching surveys reported Horned Lark numbers a magnitude higher than the next most common species observed. Species that were difficult to detect (hummingbirds) in migration were observed proportionately less often during avicaching surveys than during incidental collision reporting. Species found infrequently but in large groups (e.g., Snow Goose,

American White Pelican) were occasionally observed during avicaching surveys in the dozens or hundreds but were never found at solar facilities.

In addition to summary data provided in Appendix II, all avicaching data have been downloaded from eBird and are stored at Point Blue Conservation Science. Data have gone through QA/QC and have been filtered for migrating species. Additional analyses can include phenology and more detailed investigation of regional patterns in migration observed during the spring.

REFERENCES

Cooper, D. S. 2015. Industrial-scale solar projects and birds in the California desert: Assessing impacts & developing mitigation. Cooper Ecological Monitoring, Inc. Oak Park, CA.

Appendix I. Desert Avicaching Social Media Toolkit (designed by the Sonoran Joint Venture)

Desert Avicaching Social Media Toolkit

Background
On February 1, 2018 the Sonoran Joint Venture, Point Blue Conservation Science, Great Basin Bird Observatory, the Bureau of Land Management, and eBird are joining forces to launch the first-ever Desert Avicaching game.

Avicaching, originally created by the Cornell of Ornithology, is simply eBird + the idea of Geocaching: searching specific locations to spot as many birds as possible. The data collected by Avicachers fill in gaps in knowledge and help guide management and conservation decisions. Birders go designated eBird hotspots, observe birds, and submit their checklists. The result? Avicachers get a fun new game to play while birding, and we get valuable data to help guide future bird monitoring and conservation efforts. Even better, everyone who plays has the chance to win prizes donated by Desert Avicaching sponsors.

The game runs from February 1, 2018 through June 15, 2018. We will update the leaderboard weekly and will have monthly drawings for prizes, as well as an overall winner at the end of the game (the more checklists you submit, the better chance you have of winning).

In order for this to be successful, we need your help! We created this Social Media Toolkit with some ideas for promoting Desert Avicaching on your website, in your newsletter, and on your social media channels. Please feel free to adapt things as appropriate and share this Toolkit with anyone else who could help promote the game.

Thanks in advance!

HASHTAGS
#DesertAvicaching
#sonoranjv
#birding
#avicaching

FACEBOOK

Facebook pages for linking (at a minimum please tag the Sonoran Joint Venture so we can track things):
Sonoran Joint Venture
Point Blue Conservation Science
Great Basin Bird Observatory
eBird
BLM

Sample Facebook Posts
#DesertAvicaching: Geocaching + eBird in the desert! It is an opportunity for birders to help fill gaps in knowledge about desert birds in southern California--and win glorious prizes! Click through to learn how to play! http://sonoranjv.org/avicaching

On Feb 1, 2018 the Sonoran Joint Venture, Point Blue Conservation Science, and Great Basin Bird Observatory are collaborating with eBird and the BLM to launch #DesertAvicaching. It takes the fun of geocaching and adds eBird! Visit specific eBird hotspots, submit checklists, and help us fill in gaps in knowledge about birds and underbirded spots in southern California's desert. Visit the Avicaching webpage for more details and learn how you can play! http://sonoranjv.org/avicaching

TWITTER
Tag:
@SonoranJV
@PointBlueConsci
@greatbasinbirds
@BLMNational
@Team_eBird

Sample Tweets
Ready for #DesertAvicaching? If you're a #birder join @sonoranjv, @PointBlueConSci, @greatbasinbirds & @BLMNational to #eBird & fill gaps in knowledge about desert birds in SoCal & win prizes! The game starts 1 Feb 2018, so get your bins ready! http://sonoranjv.org/avicaching/

Play #DesertAvicaching and fill gaps in knowledge about desert birds in southern California--and win prizes! http://sonoranjv.org/avicaching

Bird off the beaten path with #DesertAvicaching and add some lifers to your list! http://sonoranjv.org/avicaching

What is #DesertAvicaching? The fun of #geocaching + #eBird! Go birding, submit checklists, help scientists better understand desert bird populations & have a chance to win prizes! http://sonoranjv.org/avicaching

SPONSORS
Consider tagging our sponsors, who generously donated prizes:

Facebook
American Birding Association
Athlon Optics
Birds Eye Nature Apps
PhoneSkope
Wild Wings Backyard Nature

Twitter
@phoneskopebirds
@athlonoptics
@BirdsEyeBirding
@aba

GRAPHICS
We created a Google Drive folder with some custom images for use on social media. We will add to this folder throughout the game, so check back monthly or feel free to use your own.

https://drive.google.com/drive/folders/1i2PQeJ1voGUrELY99wX6Q9NqRNM1Bait?usp=sharing

FOR MORE INFORMATION
Visit the Desert Avicaching webpage: http://sonoranjv.org/avicaching/.

See the eBird blog post: http://ebird.org/content/ebird/news/desert-avicaching-with-the-sonoran-joint-venture/

If you need help creating graphics or have questions about this Toolkit, the Desert Avicaching webpage, or the Avicaching Leaderboard, contact Jennie Duberstein (jennie_duberstein@fws.gov; 520-882-0837).

If you have questions about playing the actual Desert Avicaching game, contact Chris McCreedy (cmccreedy-RA@pointblue.org).

Appendix II. Species observed during Desert Avicaching surveys in 2018. Table also includes scientific names, traditional guild classification, cumulative total observed for each species during the avicaching study period, number of checklists from which the species was reported, number of avicaching sites from which the species was reported, number of collisions from which the species was reported from incidental collision data collected at four solar facilities, and species classification following Cooper (2015).

Species	Scientific Name	Guild	Count	Lists	Sites	Collisions	Classification
AERIAL FORAGERS							
Bank Swallow	*Riparia riparia*	Passerine	3	2	2	5	Aerial forager
Barns Swallow	*Hirundo rustica*	Passerine	178	32	9	17	Aerial forager
Black Swift	*Cypseloides niger*	Non-passerine	2	1	1	0	Aerial forager
Cliff Swallow	*Petrochelidon pyrrhonota*	Passerine	519	33	10	17	Aerial forager
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Passerine	1	1	1	7	Aerial forager
Tree Swallow	*Tachycineta bicolor*	Passerine	113	21	10	24	Aerial forager
Unknown Swallow	*Hirundinidae*	Passerine	425	34	11	N/A	Aerial forager
Vaux's Swift	*Chaetura vauxi*	Non-passerine	47	12	7	12	Aerial forager
Violet-green Swallow	*Tachycineta thalassina*	Passerine	10	6	5	13	Aerial forager
HUMMINGBIRDS							
Rufous Hummingbird	*Selasphorus rufus*	Non-passerine	4	4	4	13	Hummingbird
Unknown Hummingbird	*Trochilidae*	Non-passerine	7	7	6	N/A	Hummingbird
LARIDS							
California Gull	*Larus californicus*	Waterbird	15	7	4	1	Larid
Caspian Tern	*Hydroprogne caspia*	Waterbird	13	3	2	0	Larid
Ring-billed Gull	*Larus delawarensis*	Waterbird	25	1	1	2	Larid
Unknown Gull	*Laridae*	Waterbird	7	2	1	N/A	Larid
MISCELLANEOUS							
Black Phoebe	*Sayornis nigricans*	Passerine	5	5	4	1	Misc
Unknown Passerine	*Passeriformes*	Passerine	478	81	7	N/A	Misc
Unknown Sparrow	*Passerellidae*	Passerine	27	7	4	N/A	Misc
Woodhouse's Scrub-Jay	*Aphelocoma woodhouseii*	Corvid	2	1	1	0	Misc
NEOTROPIC MIGRATORY BIRDS (NTMB)							
American Robin	*Turdus migratorius*	Passerine	3	1	1	0	NTMB

Species	Scientific Name	Guild	Count	Lists	Sites	Collisions	Classification
Black-headed Grosbeak	*Pheucticus melanocephalus*	Passerine	13	8	4	3	NTMB
Black-throated Gray Warbler	*Setophaga nigrescens*	Passerine	1	1	1	4	NTMB
Blue Grosbeak	*Passerina caerulea*	Passerine	1	1	1	0	NTMB
Blue-gray Gnatcatcher	*Polioptila caerulea*	Passerine	13	11	6	9	NTMB
Bullock's Oriole	*Icterus bullockii*	Passerine	12	9	5	0	NTMB
Cassin's Vireo	*Vireo cassinii*	Passerine	3	2	2	1	NTMB
Common Yellowthroat	*Geothlypis trichas*	Passerine	8	6	2	3	NTMB
Dusky Flycatcher	*Empidonax oberholseri*	Passerine	2	2	2	0	NTMB
Fox Sparrow	*Passerella iliaca*	Sparrow	2	1	1	0	NTMB
Gray Flycatcher	*Empidonax wrightii*	Passerine	4	4	4	0	NTMB
Green-tailed Towhee	*Pipilo chlorurus*	Passerine	1	1	1	2	NTMB
Hammond's Flycatcher	*Empidonax hammondii*	Passerine	4	4	3	0	NTMB
Hooded Oriole	*Icterus cucullatus*	Passerine	2	2	2	0	NTMB
Hutton's Vireo	*Vireo huttoni*	Passerine	1	1	1	0	NTMB
Lazuli Bunting	*Passerina amoena*	Passerine	3	3	3	12	NTMB
Lincon's Sparrow	*Melospiza lincolnii*	Passerine	4	3	3	5	NTMB
MacGillivray's Warbler	*Geothlypis tolmiei*	Passerine	3	3	3	2	NTMB
Northern Flicker	*Colaptes auratus*	Non-passerine	12	5	3	2	NTMB
Orange-crowned Warbler	*Oreothlypis celata*	Passerine	10	9	4	7	NTMB
Pacific-slope Flycatcher	*Empidonax dificilis*	Passerine	7	7	4	0	NTMB
Ruby-crowned Kinglet	*Regulus calendula*	Passerine	13	7	7	5	NTMB
Song Sparrow	*Melospiza melodia*	Passerine	1	1	1	0	NTMB
Townsend's Warbler	*Setophaga townsendi*	Passerine	7	4	2	12	NTMB
Unknown Empidonax	*Empidonax sp.*	Passerine	10	10	9	N/A	NTMB
Unknown Warbler	*Parulidae*	Passerine	47	9	6	N/A	NTMB
Warbling Vireo	*Vireo gilvus*	Passerine	6	6	4	0	NTMB
Western Tanager	*Piranga ludoviciana*	Passerine	29	15	5	8	NTMB
Western Wood-Pewee	*Contopus sordidulus*	Passerine	5	4	4	1	NTMB
Wilson's Warbler	*Cardellina pusilla*	Passerine	98	32	10	15	NTMB

Species	Scientific Name	Guild	Count	Lists	Sites	Collisions	Classification
Yellow Warbler	*Setophaga petechia*	Passerine	11	10	3	20	NTMB
Yellow-rumped Warbler	*Setophaga coronata*	Passerine	115	37	14	96	NTMB
OWLS/NIGHTJARS							
Common Poorwill	*Phalaenoptilus nuttallii*	Non-passerine	3	2	2	2	Owl/Nightjar
Long-eared Owl	*Asio otus*	Raptor	1	1	1	0	Owl/Nightjar
PELICANIDS							
American White Pelican	*Pelecanus erythrorhynchos*	Waterbird	102	2	2	0	Pelicanid
RAPTORS							
Cooper's Hawk	*Accipiter cooperi*	Raptor	3	3	2	3	Raptor
Ferruginous Hawk	*Buteo regalis*	Raptor	9	7	6	0	Raptor
Golden Eagle	*Aquila chrysaetos*	Raptor	1	1	1	0	Raptor
Merlin	*Falco columbarius*	Raptor	4	4	2	0	Raptor
Northern Harrier	*Circus hudsonius*	Raptor	23	20	9	0	Raptor
Peregrine Falcon	*Falco peregrinus*	Raptor	1	1	1	1	Raptor
Sharp-shinned Hawk	*Accipiter striatus*	Raptor	3	3	3	0	Raptor
Swainson's Hawk	*Buteo swainsoni*	Raptor	35	29	7	0	Raptor
Unknown Accipiter	*Accipiter sp.*	Raptor	1	1	1	N/A	Raptor
SHOREBIRDS							
American Avocet	*Recurvirostra americana*	Shorebird	1	1	1	1	Shorebird
Black-bellied Plover	*Pluvialis squatarola*	Shorebird	1	1	1	0	Shorebird
Black-necked Stilt	*Himantopus mexicanus*	Shorebird	1	1	1	2	Shorebird
Greater Yellowlegs	*Tringa melanoleuca*	Shorebird	46	7	5	0	Shorebird
Least Sandpiper	*Calidris minutilla*	Shorebird	57	9	5	0	Shorebird
Long-billed Curlew	*Numenius americanus*	Shorebird	69	4	4	0	Shorebird
Semipalmated Plover	*Charadrius semipalmatus*	Shorebird	6	1	1	0	Shorebird
Spotted Sandpiper	*Actitis macularius*	Shorebird	1	1	1	2	Shorebird
Unknown Dowitcher	*Limnodromus sp.*	Shorebird	40	2	2	N/A	Shorebird
Unknown Shorebird	*Charadriiformes*	Shorebird	172	12	6	N/A	Shorebird
Western Sandpiper	*Calidris mauri*	Shorebird	4	2	1	0	Shorebird

Species	Scientific Name	Guild	Count	Lists	Sites	Collisions	Classification
Whimbrel	*Numenius phaeopus*	Shorebird	54	9	6	0	Shorebird
THRASHERS							
Bendire's Thrasher	*Toxostoma bendirei*	Passerine	5	5	4	0	Thrasher
Crissal Thrasher	*Toxostoma crissale*	Passerine	8	4	3	2	Thrasher
LeConte's Thrasher	*Toxostoma lecontei*	Passerine	19	14	7	0	Thrasher
Northern Mockingbird	*Mimulus polyglottos*	Passerine	89	66	16	2	Thrasher
Sage Thrasher	*Oreoscoptes montanus*	Passerine	91	34	16	0	Thrasher
TIGHT-FLOCKERS							
American Goldfinch	*Spinus tristis*	Passerine	21	3	3	0	Tight Flocker
American Pipit	*Anthus rubescens*	Passerine	5	1	1	25	Tight Flocker
Bell's Sparrow	*Artemisiospiza belli*	Sparrow	282	87	11	0	Tight Flocker
Brewer's Blackbird	*Euphagus cyanocephalus*	Passerine	371	42	7	16	Tight Flocker
Brewer's Sparrow	*Spizella breweri*	Passerine	29	17	11	0	Tight Flocker
Cedar Waxwing	*Bombycilla cedrorum*	Passerine	15	2	2	2	Tight Flocker
Chipping Sparrow	*Spizella passerina*	Passerine	13	7	4	5	Tight Flocker
Dark-eyed Junco	*Junco hyemalis*	Passerine	61	6	5	3	Tight Flocker
Horned Lark	*Eremophila alpestris*	Passerine	6318	210	21	22	Tight Flocker
Lark Sparrow	*Chondestes grammacus*	Passerine	62	23	10	2	Tight Flocker
Lawrence's Goldfinch	*Spinus lawrencei*	Passerine	121	10	5	0	Tight Flocker
Mountain Bluebird	*Sialia currucoides*	Passerine	8	2	1	1	Tight Flocker
Pinyon Jay	*Gymnorhinus cyanocephalus*	Corvid	50	2	1	0	Tight Flocker
Red-winged Blackbird	*Agelaius phoeniceus*	Passerine	354	37	7	4	Tight Flocker
Sagebrush Sparrow	*Artemisiospiza nevadensis*	Passerine	1	1	1	0	Tight Flocker
Savannah Sparrow	*Passerculus sandwichensis*	Passerine	166	50	15	20	Tight Flocker
Tricolored Blackbird	*Agelaius tricolor*	Passerine	143	20	5	0	Tight Flocker
Unknown Blackbird	*Icteridae*	Passerine	1285	62	7	N/A	Tight Flocker
Vesper Sparrow	*Pooecetes gramineus*	Passerine	2	2	1	0	Tight Flocker
Western Bluebird	*Sialia mexicana*	Passerine	2	1	1	0	Tight Flocker
Western Meadowlark	*Sturnella neglecta*	Passerine	530	110	14	15	Tight Flocker

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White-crowned Sparrow	*Zonotrichia leucophrys*	Passerine	1591	112	28	42	Tight Flocker
Yellow-headed Blackbird	*Xanthocephalus anthocephalus*	Passerine	311	25	6	4	Tight Flocker
WADERS							
Black-crowned Night-Heron	*Nycticorax nycticorax*	Wader	5	1	1	1	Wader
Great Egret	*Ardea alba*	Wader	39	13	6	0	Wader
Green Heron	*Butorides virescens*	Wader	1	1	1	0	Wader
Snowy Egret	*Egretta thula*	Wader	4	1	1	0	Wader
White-faced Ibis	*Plegadis chihi*	Wader	139	10	3	0	Wader
WATERFOWL							
Common Merganser	*Mergus merganser*	Waterfowl	2	1	1	0	Waterfowl
Gadwall	*Anas strepera*	Waterfowl	4	1	1	0	Waterfowl
Mallard	*Anas platyrhynchos*	Waterfowl	39	17	2	0	Waterfowl
Northern Shoveler	*Anas clypeata*	Waterfowl	1	1	1	0	Waterfowl
Ross's Goose	*Anser rossii*	Waterfowl	4	1	1	1	Waterfowl
Snow Goose	*Anser caerulescens*	Waterfowl	867	4	2	0	Waterfowl
Wood Duck	*Aix sponsa*	Waterfowl	1	1	1	0	Waterfowl
WRENS/TITS							
Bewick's Wren	*Thryomanes bewickii*	Passerine	2	2	2	1	Wren/tit
House Wren	*Troglodytes aedon*	Passerine	2	2	2	1	Wren/tit