A NOVEL LOCALITY FOR THE OBSERVATION OF THOUSANDS OF PASSERINE BIRDS DURING SPRING MIGRATION IN LOS ANGELES COUNTY, CALIFORNIA

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ABSTRACT: Avian migration is a spectacular phenomenon, representing the annual movements of billions of birds globally. Because the greatest diversity and numbers of birds migrate at night, opportunities to observe active migration are rare. At a number of localities in North America, however, observers can quantify movements of many typically nocturnal migrants during daylight where they continue after dawn. Such locations have provided much information about species-specific phenology, status, and orientation during migration. Localities where morning flights of land birds can be observed are unevenly distributed, however, and are little reported along the Pacific coast. Here we describe a novel location for the observation of spectacular morning flights of nocturnal migrants during spring migration at Bear Divide, in the western San Gabriel Mountains, Los Angeles County, California. In two years of informal surveys at the site, we have recorded at least one morning with an estimated ~13,500 individual birds passing. Our preliminary analyses suggest that the peak of a species' migration at Bear Divide is correlated with the latitude of a species' breeding, being later in the spring as that latitude increases. Our data from Bear Divide provide an independent perspective on migration as quantified by local radar. Further work at this locality may help inform our knowledge of migration phenology and population trends.

Morning flight is the phenomenon of migrating birds, generally nocturnal migrants, continuing migration into daylight hours. Morning flight has been hypothesized to involve mainly correction for displacement when birds find themselves flying over water (Gauthreaux 1978, Wiedner et al. 1992, Yaukey 2010, Archibald et al. 2017) or a continuation of nocturnal flight (Bingman 1980) when birds do not encounter a locality suitable for stopover before dawn. When birds are displaced by wind, they often use the morning hours to reorient their migration (Horton et al. 2016). Reorientation of nocturnal migrants during the early morning may occur as the mainland becomes vis-

ible or through orientation with the rising sun (Moore 1986). Morning flights are fairly well known in the eastern United States, especially at locations like Cape May, New Jersey, Taddousac Dunes, Quebec, and Lake Pontchartrain, Louisiana. Less well known are sites of visible morning flight in the western United States. One such location is Butterbredt Spring in eastern Kern County, California, where large numbers of migrating birds can be observed in morning flight in the spring. This flight is inland and not due to reorientation over water; rather, it is thought that these birds are "funneled" by a canyon oriented northwest–southeast and a lack of arboreal habitat in which to forage (Heindel 1991).

Observations of morning flight can illuminate what we know about avian migration (Van Doren et al. 2015). Studies of morning flight have provided vital information on the timing of passage (Heindel 1991, Sokolov et al. 1998, Archibald et al. 2017), status of species (Heindel 1991), orientation (Gauthreaux 1978, Bingman 1980, Archibald et al. 2017), and the interactions of weather and climate with avian migration (Pyle et al. 1993, Hüppop and Hüppop 2003, Swanson and Palmer 2009). Because of the dearth of reported localities of visible morning flight along the Pacific Flyway, much remains to be learned about migration of land birds in this region. For example, the large-scale movements of a few western birds, including the Phainopepla (*Phainopepla nitens*; Baldassarre et al. 2019), Black Swift (*Cypseloides niger*; Beason et al. 2012), and Wilson's Warbler (*Cardellina pusilla*; Ruegg et al. 2014), have been clarified only recently by spatial tracking and genomic methods. Field observations of birds in migration can supplement these methods to provide a more complete view into avian movements. In addition to field observation, recent advances in the processing of radar data (Sheldon et al. 2013, Van Doren and Horton 2018, Lin et al. 2019) allow for detailed observations of migration incidental to monitoring of weather by radar (La Sorte et al. 2015, Farnsworth et al. 2016)

On 11 May 2016, Maxwell observed hundreds of migrant land birds moving through a small saddle in the western San Gabriel Mountains in Los Angeles County, California. This location is just west of the Bear Divide Vista picnic area and is often called simply "Bear Divide." Hilly chaparral, with some nearby conifers, characterizes this area, and montane species such as the Mountain Quail (*Oreortyx pictus*) are common, as are birds breeding in chaparral such as the Wrentit (*Chamaea fasciata*), Rufous-crowned Sparrow (*Aimophila ruficeps*), and California Thrasher (*Toxostoma redivivum*). Bear Divide is a low pass, at 514 m above sea level. It is very narrow, with the surrounding hills quickly rising above 820 m (Figure 1). This topography appears to funnel birds that are flying north through this narrow gap, where they often fly within 1–2 m of the ground as they move over the pass.

After the initial discovery of visible morning flight at this site, we, in collaboration with other observers, informally surveyed the morning movement of birds there during spring 2019 and 2020.

METHODS

Observation began on most mornings 10–15 minutes before sunrise. In general, one to five observers were present, although on a few days we

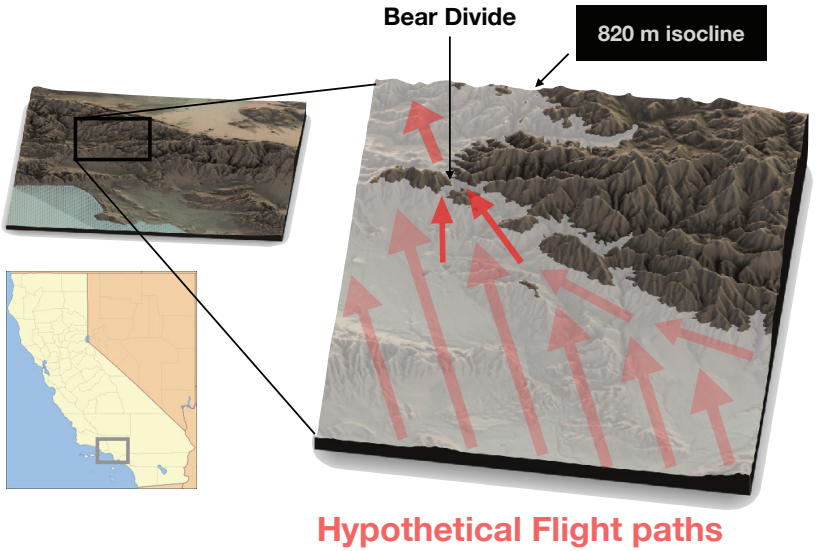

FIGURE 1. Bear Divide, in the western San Gabriel Mountains. Birds that are flying north or northwest over the Los Angeles basin encounter the San Gabriel Mountains and must either cross or attempt to go around them. If these birds follow the base of the mountains, Bear Divide is the first low (<820 m) pass they encounter. The broad, low base of the two canyons that feed into Bear Divide, combined with the narrow and steep topography at Bear Divide, may contribute to the large numbers of migrating birds that can be observed at the site.

assembled a larger group, especially in 2020. In all, 15,871 observer-hours were logged over 27 days between 27 March and 25 May. Effort was concentrated mostly on counting birds at the western saddle, but on occasions we observed at the picnic area, near the fire station, and along adjacent trails and fire breaks. In general, observation was completed between 08:30 and 10:00 Pacific Standard Time, depending on conditions. Most observation took place on days of favorable weather, and little to no observation was carried out on days when visibility was limited by fog or low clouds. We used current weather predictions, along with maps of forecast and live migration from https://birdcast.info (Van Doren and Horton 2018, Dokter et al. 2019), a product of the Cornell Lab of Ornithology, Colorado State University, and University of Massachusetts, Amherst, that, among other research efforts, applies data from weather-surveillance radar to predict and characterize bird migration in the contiguous United States.

The enormous number of birds moving through the study area at times proved challenging to count and identify. On slower days, we attempted to count and identify as many individuals as possible. On the more active days, we made intermittent 1- or 5-minute point counts of all birds, with one observer attempting to count every individual bird moving through the divide during the period but without attempting to identify the birds. On these

days, we began a new point count either at 30-minute intervals or whenever magnitude of the movement seemed to change. We then extrapolated these numbers through the beginning of the next count period. For identification, we attempted to track species composition, including nonspecific identifications such as "passerine sp.," warbler sp.," or "hummingbird sp." by relative abundance, and then extrapolated all of these categories to the total by multiplying our estimated percent abundance by the count total. Observers identified species in the field or from photographs.

We used the birds' dates of passage at Bear Divide to test the hypothesis that species breeding at higher latitudes migrate through Bear Divide later in the spring by using a hierarchical linear regression in a Bayesian context. We modeled individual records of migrating birds, representing the ordinal day of passage for individual i as a Gaussian random variable with mean μ_i and standard deviation σ_ε We further defined the expected date of passage for each individual as $\mu_i = \beta_{0,j} + \beta_1 \times \text{lat}_i$, where $\beta_{0,j}$ is a random intercept for each species j drawn from a hierarchical normal distribution, β_1 is a slope, and lat_i represents the latitude (in degrees) of breeding of individual i of species j. Since the exact latitude of breeding for each individual was unknown, yet the breeding range of each species is well documented, we treated lat_i as a random variable drawn from a uniform distribution bounded by the 95% quantile of latitudes of breeding for each species j. To define this range of latitudes, we extracted records for July from the full database at https://www.ebird.org. We then filtered out subspecies unlikely to occur, including resident Mexican subspecies of Vaux's Swift (*Chaetura vauxi*), eastern subspecies of Wilson's, Nashville (*Leothlypis ruficapilla*), and Orange-crowned (*L. celata*) Warblers, and eastern populations of the Chipping Sparrow (*Spizella passerina*) and Yellow Warbler (*Setophaga petechia*). Although the Myrtle Warbler (*S. coronata coronata*) undoubtedly occurs at Bear Divide, the vast majority of Yellow-rumped Warblers appear to be Audubon's (*S. c. auduboni*), so we excluded the breeding range of *S. c. coronata* from the analysis of breeding ranges. To ensure that fitted relationships of β_1 were not overly sensitive to eBird's filtering, we repeated the analysis but recalculated 95% quantiles while retaining all eBird records for each species for July.

We fit our model to the data with JAGS (Plummer 2003) using the statistical programming language R, version 3.5.3 (R Core Team 2019) and the package "R2jags" (Su and Yajima 2014). We used vague priors (i.e., normal with $\mu = 0$, $\tau = 0.001$). We ran three chains of 10,000 iterations thinned by 10 with a burn-in of 5000, yielding a posterior sample of 3000 across all chains. We checked convergence visually with traceplots and confirmed it with a Gelman–Rubin statistic <1.1 (Gelman 2004). To assess the model's fit, we calculated the marginal R^2 of the fixed effects, following Nakagawa and Schielzeth (2013).

We also used our data set to compare observed migration at Bear Divide with bird migration recorded at nearby weather stations. For detailed methods for analyzing radar data, see Dokter et al. (2011, 2019). Briefly, the National Oceanic and Atmospheric Administration (NOAA) and Amazon Web Services Cloud provide and host, respectively, the archive of the Next Generation Weather Radar (NEXRAD; Ansari et al. 2018). The NEXRAD network contains 143 WSR-88D stations recording weather data by radar in

the contiguous United States, and this sensor network incidentally records data on bird migration as well as data describing meteorological phenomena (Horton et al. 2016, Van Doren and Horton 2018, Dokter et al. 2019). We used established methods (Dokter et al. 2011) to extract vertical profiles of the density, speed, and direction of nocturnally migrating birds, using the rain-segmentation model MistNet to remove meteorological scattering (Lin et al. 2019). We calculated profiles for three radar stations, KSOX in the Santa Ana Mountains 97 km southeast of Bear Divide, KEYZ at Edwards Air Force Base 81 km northeast of Bear Divide, and KVTX in Los Angeles County, 48 km west-northwest of Bear Divide. We examined the predictive value of each, then compared the total individuals estimated in each morning's flight to the cumulative migration traffic per night (in numbers per kilometer) and migration traffic rate (in numbers per kilometer per hour), integrated over the altitude column from ~923 to 4000 m above sea level. Because KSOX provided the most predictive data, we restricted further analyses to data from that station only. Note that coverage below 923 m at KSOX is below the actual radar antenna—the station is 923 m above sea level. We used a linear regression to examine the relationships between total cumulative migration traffic per night and the total number of birds we estimated during morning flight at Bear Divide. Because the count data included outliers with large numbers of birds on a few days, we also ran a linear regression with log-normalized count data.

RESULTS

During the springs of 2019 and 2020, we recorded ~44,900 birds passing through Bear Divide. Peak passage occurred in late April (Figure 2), but substantial migration lasted at least from mid-March to late May. In general, migration was concentrated within the first 2–3 hours of the morning. Species composition clearly changed over the course of the spring (Figure 3). Appendix 1 lists details by species. We stress here that these results are preliminary, as effort was neither consistent nor standardized.

Species that breed at higher latitudes migrated through Bear Divide at later dates. On average, for every 1° of latitude of breeding range, a bird passed through 0.57 days later (95% credible interval: 0.54–0.60). The general sign and magnitude of this relationship still held (95% credible interval: 0.16–0.25) even without exclusionary filtering of June–July occurrence records for subspecies and subsets of species that clearly do not migrate through this portion of southern California. For the former model, the effect of latitude of breeding alone explained half of the variance in passage date (posterior mean of Nakagawa's marginal $R^2 = 0.50$).

We found a significant but barely predictive correlation between dawn flight counts at Bear Divide and movement observed at the KSOX radar, as interpreted by cumulative migration traffic per night, over the air column from 2000 to 3000 m above ground level ($p < 0.001$, adjusted $R^2 = 0.066$) (Figures 4 and 5). Fits to the data by hour were similar, being closest from about 22:00 to 02:00 Pacific Standard Time (Figure 6). Much of the stochasticity not explained by the linear model arose from nights (mornings?) with large movements of birds at Bear Divide that were not evident on the radar. This

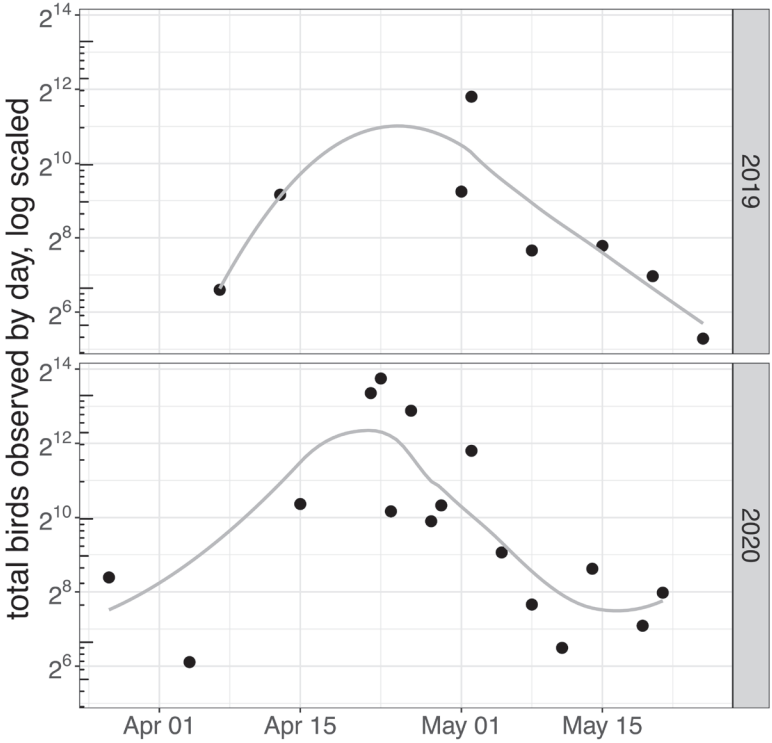

FIGURE 2. Total number of birds observed by day at Bear Divide during spring migration 2019 and 2020. In addition, we also counted in 2016 on 11, 17, and 19 May.

may be due to migrant birds accumulating in the Los Angeles basin to the northwest of the radar station in the Santa Ana Mountains, between the radar site and Bear Divide itself. When the count data were log-normalized, the correlation decreased somewhat (adjusted $R^2 = 0.02$), though the relationship remained significant ($p < 0.01$).

DISCUSSION

The magnitude of visible migration at Bear Divide makes it unique along the Pacific coastal flyway, so far as is known. The local topography seems to funnel migrating land birds through a narrow pass, where they often fly low. This site has already provided opportunity for both public engagement and scientific study of spring migration in coastal California. In general, the largest passage of birds occurs from mid-April to early May, though visits from March to June have been productive. Species composition varies substantially through the spring. Some groups of birds or species, such as raptors, thrushes, and flycatchers, seem to be underrepresented at Bear Divide in comparison to other sites in California where migration has been observed. However, some

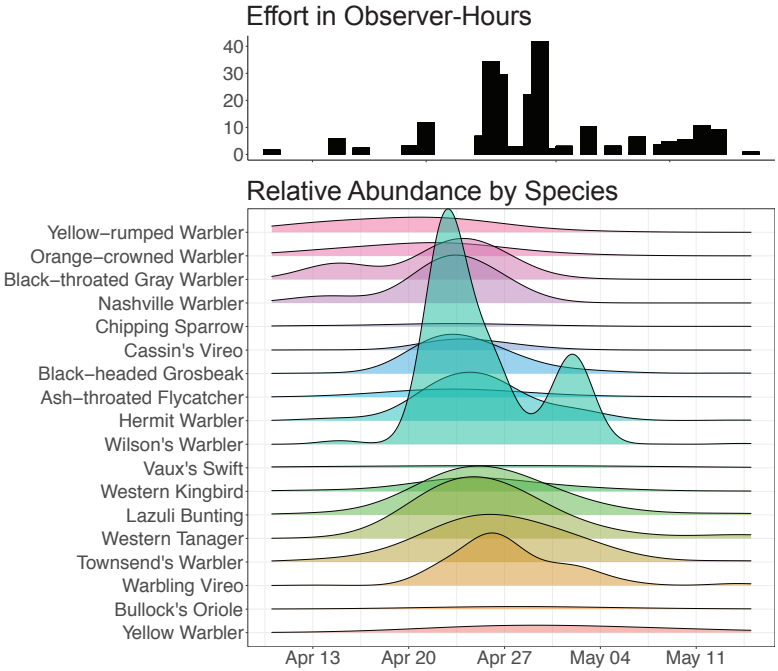

FIGURE 3. Timing of observation effort and relative seasonal abundance of the 18 most common migrant land birds at Bear Divide, ordered by mean date of peak passage.

individual days have seen notable passages of both thrushes and flycatchers; further study may reveal that these families use Bear Divide more than we have observed. The weather associated with passage of migrant birds may vary by location and season, but the most important predictors for the magnitude of spring migration are air temperature, surface pressure, and meridional wind (Van Doren and Horton 2018). We have also noticed that wind from the north can improve visibility of birds, as it appears to cause birds to fly closer to the ground and thus closer to observers. This behavior may reduce the amount of time birds spend flying into headwinds as they cross Bear Divide.

We found some, but rather little, predictive value in the raw radar data for forecasting the magnitude of visible migration at Bear Divide. This is likely due to the movement of birds at Bear Divide being largely dependent on local weather. Low clouds or fog in the Los Angeles basin or San Gabriel Mountains may cause birds to not move through Bear Divide, even if conditions were favorable for migration elsewhere the previous night. Much more research is needed into the relationship between radar detection and point estimates, particularly the likely complicated relationship between weather and buildup of migrants over multiple days. For example, the days of greatest movement at Bear Divide followed several days of apparently bad weather

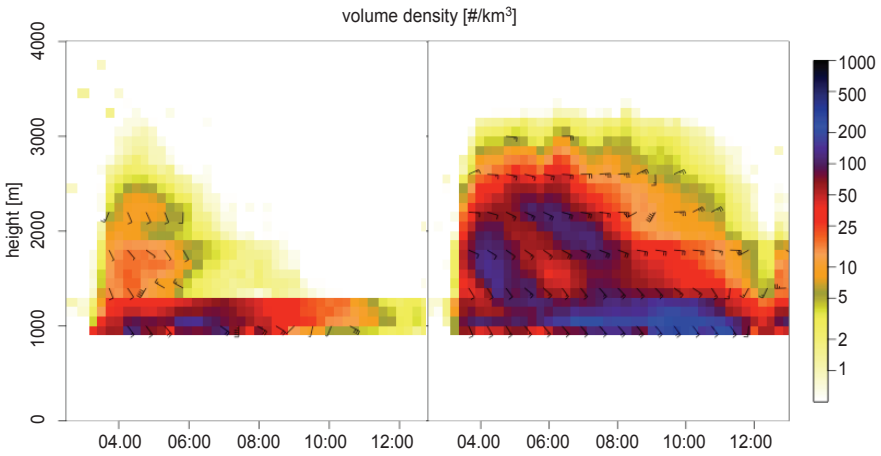

FIGURE 4. Volume density of migrating birds (number per cubic kilometer) detected by radar at the KSOX weather radar station in the Santa Ana Mountains, Orange County, California, expressed by height above the ground on the *y* axis and time of night on the *x* axis. Yellow colors indicate lighter migration traffic, purple colors heavier traffic. Times are in Greenwich Mean Time, so 4:00 is 21:00 Pacific Standard Time and 12:00 is 05:00 Pacific Standard Time. (A) 5 May 2019, the night before ~2000 birds were observed at Bear Divide. (B) 22 April 2019, the night before ~13,500 birds were observed at Bear Divide. Much heavier migration traffic is observed throughout the atmosphere, through the night and early morning hours.

for migration with few birds. Such weather may cause birds to accumulate in the Los Angeles basin, then all move at once when the weather becomes favorable. This effect would cause large movements of birds at Bear Divide without associated peaks in radar data at more distant sites.

Each species' seasonal status at Bear Divide is idiosyncratic, with a unique median passage date and degree of temporal clustering. We found that some of this difference in seasonality is explained by latitude of breeding range, with species that breed farther north migrating later in the spring. This parallels results found within Wilson's Warbler (Ruegg et al. 2014), in which populations breeding farther north migrate in spring at later dates. This result is in contrast to Hagan et al. (1991), who found the winter range, and not the breeding range, predicts timing of spring migration. We did not compare species by winter range because the coverage of the winter ranges of many of these species in eBird is very heterogeneous, and in the tropics such data can be strongly biased toward sites popular for ecotourism. Other sources of data on winter ranges, such as specimen collections, are at least as patchy.

The rather limited time we have spent at Bear Divide has already yielded important data. Because this site is so productive, with more systematic effort it could provide profound insight into the migration of land birds along the Pacific Flyway. We encourage other observers to undertake similar surveys of passing land birds at any site of visible dawn flight.

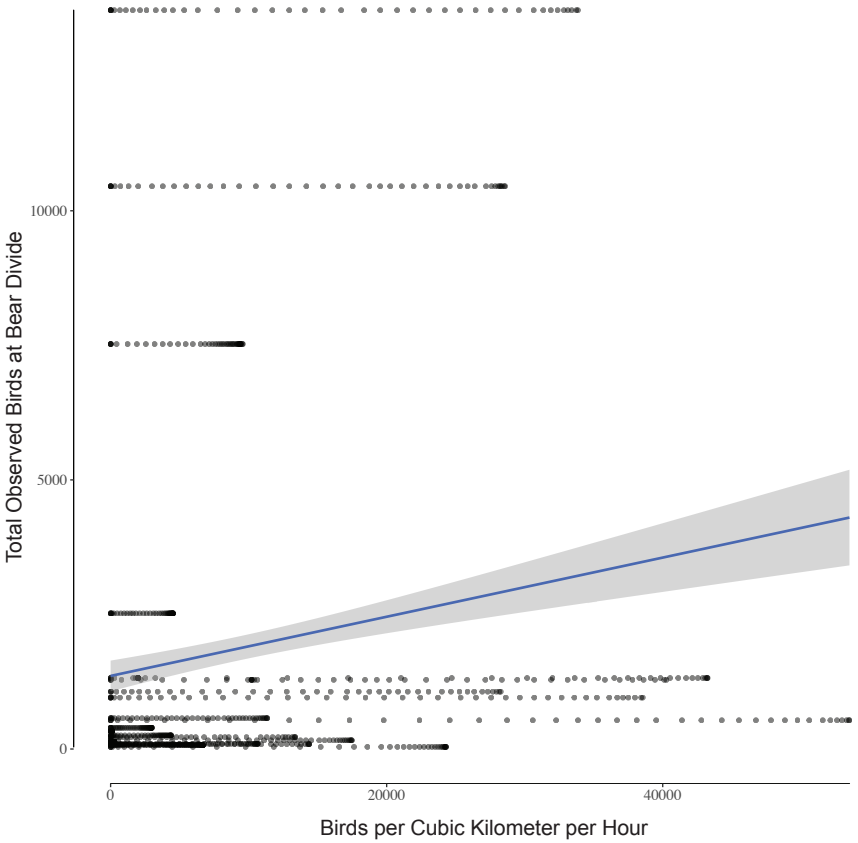

FIGURE 5. The relationship between total migration traffic detected by radar at the KSOX weather radar station in the Santa Ana Mountains, summed over each night, and total number of migrant birds counted in a morning at Bear Divide. Each point represents one night of migration, with migration traffic the previous night represented on the *x* axis, and total birds observed at Bear Divide the next morning on the *y* axis; the blue line represents correlation by linear regression; gray shading represents the 95% confidence interval. A weak (adjusted $R^2 = 0.066$) but significant ($p < 0.001$) relationship indicates that radar traffic does predict movement somewhat at Bear Divide, but that we still have much to learn about where these birds are coming from and when they are moving toward Bear Divide.

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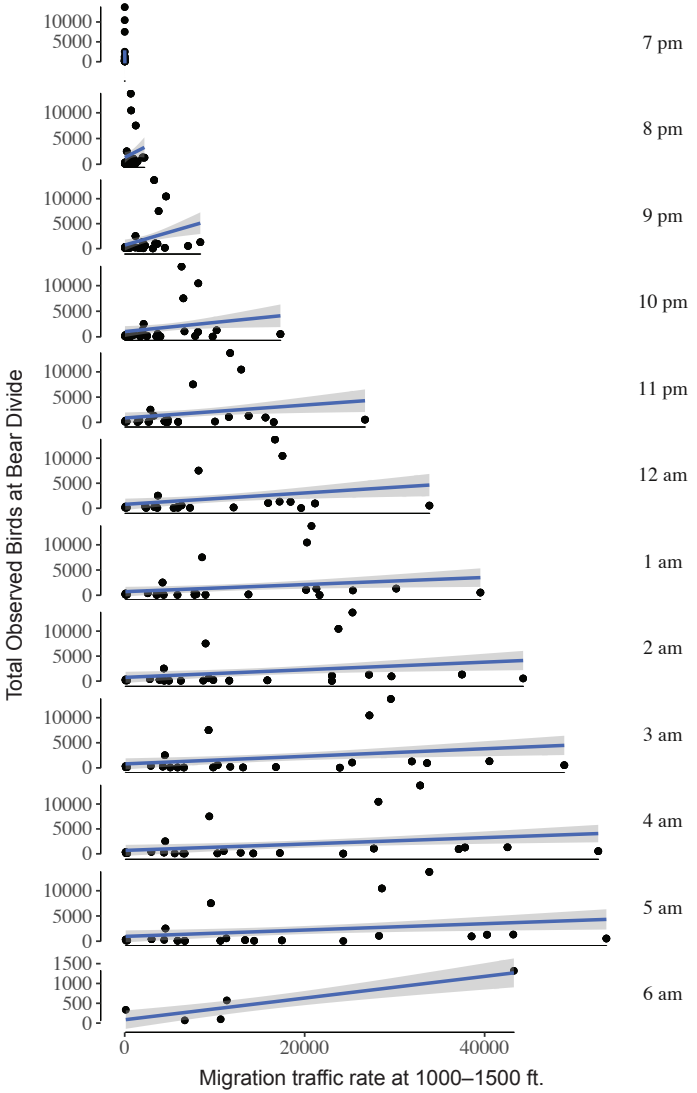

FIGURE 6. Relationships between hourly migration traffic (birds per cubic kilometer per hour) detected by radar at the KSOX weather radar station in the Santa Ana Mountains (*x* axes) and total number of birds counted in a morning at Bear Divide (*y* axes). Each point represents the total number of birds seen at Bear Divide the morning after the radar observation on the Y axis, and the migration traffic rate by hour, if detected that hour, on the x axis; blue lines represent correlation by linear regression; gray shading represents 95% confidence intervals. Migration traffic was recorded in the 06:00 hour on only 5 days, so the number of points per graph varies, aside from points being overprinted. Positive relationships indicate a predictive capability of the radar for that hour for bird movement observed at Bear Divide, and these correlations were most significant for the early morning hours.

White, a regular and enthusiastic volunteer and counter at Bear Divide, who tragically lost his life recently. We will always remember his enthusiasm, kind heart, and daily delivery of doughnuts.

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Appendix 1 Birds Recorded at Bear Divide, San Gabriel Mountains, Spring Migration, 2016–2020

Canada Goose (*Branta canadensis*), total 17, 13 Apr–2 May; high count 7, 2 May 2020.

Mountain Quail (*Oreortyx pictus*), total 66, 27 Mar–25 May; high count 5, 15 May 2019.

California Quail (*Callipepla californica*), total 56, 27 Mar–21 May; high count 5, 11 May 2016.

Band-tailed Pigeon (*Patagioenas fasciata*), total 128, 27 Mar–21 May; high count 10, 20 May 2019. It is unclear whether this species is a passage migrant or whether the individuals observed moving through the divide are making only local movements through the San Gabriel Mountains. Many observations of this species at Bear Divide are of birds flying south, implying local movement rather than migration.

Eurasian Collared-Dove (*Streptopelia decaocto*), total 5, 13 Apr–1 May; high count 3, 1 May 2019.

Mourning Dove (*Zenaida macroura*), total 78, 27 Mar–25 May; high count 7, 2 May 2019. As with the Band-tailed Pigeon, the extent to which these individuals represent local movements or migration is unclear.

Vaux's Swift (*Chaetura vauxi*), total 202, 13 Apr–2 May; high count 68, 2 May 2019. This species appears to be a major component of nonpasserine flight at Bear Divide in mid- to late April. Flights larger than the recorded high count seem likely.

Chimney Swift (*Chaetura pelagica*)/Vaux's Swift, 1, 2 May 2019.

White-throated Swift (*Aeronautes saxatalis*), total 73, 15 Apr–21 May; high count 13, 15 May 2019.

Black-chinned Hummingbird (*Archilochus alexandri*), total 26, 13 Apr–20 May; high count 13, 13 Apr 19. Many hummingbirds passing Bear Divide are not identifiable, but adult males of this species may be distinguished in flight by the distinctive sound made by their wings (Feo and Clark 2010). Individuals later in the spring may be local breeders (Garrett and Dunn 1981).

Anna's Hummingbird (*Calypte anna*), total 39, 13 Apr–25 May; high count 21, 26 Apr 2020. Like those of other hummingbirds and local residents, this species' identification in flight and categorization of status are problematic.

Costa's Hummingbird (*Calypte costae*), total 43, 13 Apr–25 May; high count 5, 2 May 2019. A common breeder at Bear Divide, this species may also occur as a migrant.

Rufous Hummingbird (*Selasphorus rufus*), total 36, 27 Mar–15 May; high count 17, 13 Apr 2019. Many *Selasphorus* hummingbirds pass through Bear Divide unidentified. Because Allen's Hummingbird (*S. sasin*) is very rare on the north slope of the San Gabriel Mountains (Clark 2017) and we have not confirmed it at Bear Divide, the vast majority of *Selasphorus* hummingbirds at this site are likely to be Rufous.

Rufous/Allen's Hummingbird, total 15, 22 Apr–19 May; high count 4, 5 May 2020.

Unidentified hummingbird, total 81, 7 Apr–19 May; high count 40, 24 Apr 2020.

Western Sandpiper (*Calidris mauri*), 11, 23 Apr 2020.

Turkey Vulture (*Cathartes aura*), total 14, 23 Apr–25 May; high count 4, 25 May 2019. The extent to which these birds are migrants or local residents is unclear.

Sharp-shinned Hawk (*Accipiter striatus*), 1, 27 Mar 2020, Raptors in general seem to be sparse at Bear Divide, possibly because our effort has been slight in the afternoon when more raptors are likely to be aloft. More work is needed to ascertain whether raptors use this area for migration.

Cooper's Hawk (*Accipiter cooperii*), total 2, 24 Apr, 2 May.

Swainson's Hawk (*Buteo swainsoni*), 1, 27 Mar 2020.
Red-tailed Hawk (*Buteo jamaicensis*), 21, 4 Apr–21 May; high count 2, 1 May 2019 and 2 May 2020.
Lewis's Woodpecker (*Melanerpes lewis*), total 2, 29 Apr 2020. One bird moving through Bear Divide appeared to be a passage migrant.
Acorn Woodpecker (*Melanerpes formicivorus*), total 47, 7 Apr–21 May; high count 9, 1 May 2019. These birds may be a mix of local residents and passage migrants. On some mornings, we have observed numbers of Acorn Woodpeckers flying north with other migrating birds.
Downy Woodpecker (*Dryobates pubescens*), total 2, 22 and 26 Apr. Although the species is considered to be resident throughout its southern California range (Garrett and Dunn 1981), both Downy Woodpeckers that we observed appeared to be moving through the pass; we did not detect this species as a local resident on any other days.
Nuttall's Woodpecker (*Dryobates nuttallii*), total 2, 1 and 17 May.
Hairy Woodpecker (*Dryobates villosus*), total 4, 28 Apr–20 May; high count 1.
Northern Flicker (*Colaptes auratus*), total 9, 7 Apr–21 May, high count 1.
Unidentified woodpecker, total 3, 15–29 Apr, high count 1.
American Kestrel (*Falco sparverius*), 1, 2 May 2020.
Olive-sided Flycatcher (*Contopus cooperi*), total 12, 22 Apr–19 May; high count 2, 22 Apr 2020. Uncommon passage migrant.
Western Wood-Pewee (*Contopus sordidulus*), total 30, 22 Apr–25 May; high count 5, 2 May 2020. Fairly common passage migrant.
Willow Flycatcher (*Empidonax traillii*), 1, 21 May 2020. Fairly common but late migrant in the region, and the dearth of records at Bear Divide may simply be a function of reduced observer effort in late May and early June.
Hammond's Flycatcher (*Empidonax hammondii*), total 11, 13–24 Apr; high count 5, 23 Apr 2020. In general, *Empidonax* flycatchers appear to be underrepresented at Bear Divide by comparison to localities nearby, especially desert migrant traps. Possibly they tend to move through vegetation rather than higher up and thus are missed by observers looking for birds in flight.
Gray Flycatcher (*Empidonax wrightii*), total 12, 13–29 Apr; high count 4, 23 Apr 2020.
Dusky Flycatcher (*Empidonax oberholseri*), 1, 23 Apr 2020.
Hammond's/Dusky Flycatcher, total 2, 24 Apr, 2 May.
Pacific-slope Flycatcher (*Empidonax difficilis*), total 30, 7 Apr–19 May; high count 10, 23 Apr 2020. The most common *Empidonax* flycatcher at Bear Divide was also the most vocal of the genus during our observations.
Empidonax sp., total 19, 22 Apr–14 May; high count 8, 23 Apr 2020.
Black Phoebe (*Sayornis nigricans*), total 6, 7 Apr–8 May; high count 2, 8 May 2020.
Say's Phoebe (*Sayornis saya*), total 2, 13 Apr, 5 May.
Ash-throated Flycatcher (*Myiarchus cinerascens*), total 380, 7 Apr–25 May; high count 270, 23 Apr 2020. A common migrant in mid to late April, this species may move through Bear Divide later in the morning than other birds. On the day of the high count for this species, the majority passed through later in the morning, from about 07:30 to 08:15.
Cassin's Kingbird (*Tyrannus vociferans*), total 39, 27 Mar–25 May; high count 8, 27 Mar 2020. At least one pair appears to be resident at the fire station, but flights of this species in late March appear to be regular migratory movements. This species is mostly resident in coastal southern California, so which breeding populations these birds represent is an open question.
Western Kingbird (*Tyrannus verticalis*), total 586, 27 Mar–21 May; high count 203, 23 Apr 2020. Common migrant at dawn and through the morning.
Cassin's Vireo (*Vireo cassinii*), total 296, 13 Apr–2 May; high count 135, 23 Apr 2020. Fairly common mid- to late April.

Warbling Vireo (*Vireo gilvus*), total 1492, 7 Apr–21 May; high count 608, 26 Apr 2020. Very common, some days one of the more common species.
Vireo sp., total 139, 23–29 Apr; high count 135, 23 Apr 2020.
Steller's Jay (*Cyanocitta stelleri*), total 4, 26 Apr–2 May; high count 2, 26 Apr 2020.
California Scrub-Jay (*Aphelocoma californica*), total 78, 27 Mar–21 May; high count 6, 7 Apr 2019.
American Crow (*Corvus brachyrhynchos*), total 4, 1–20 May; high count 2, 20 May 2019.
Common Raven (*Corvus corax*), total 90, 27 Mar–25 May; high count 13, 1 May 2019.
Mountain Chickadee (*Poecile gambeli*), 1, 24 Apr 2020.
Oak Titmouse (*Baeolophus inornatus*), total 6, 7 Apr–17 May; high count 3, 7 Apr 2019.
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*), total 14, 15 Apr–19 May; high count 4, 22 Apr 2020. In general, swallow movements at Bear Divide appear limited to small numbers, possibly because our observations focused on the early morning and did not cover the full day.
Tree Swallow (*Tachycineta bicolor*), total 10, 27 Mar 2020.
Violet-green Swallow (*Tachycineta thalassina*), total 24, 15 Apr–20 May; high count 6, 2 May 2019.
Barn Swallow (*Hirundo rustica*), total 22, 15 Apr–19 May; high count 5, 22 Apr 2020.
Cliff Swallow (*Petrochelidon pyrrhonota*), total 16, 15 Apr–2 May; high count 8, 22 Apr 2020.
Bushtit (*Psaltriparus minimus*), total 5, 27 Mar–21 May; high count 2, 27 Mar 2020.
Wrentit (*Chamaea fasciata*), total 61, 27 Mar–25 May; high count 5, 17 May 2016.
Ruby-crowned Kinglet (*Corthylio calendula*), total 7, 7 Apr–2 May; high count 2, 7 Apr 2019.
Red-breasted Nuthatch (*Sitta canadensis*), total 4, 24 Apr–2 May; high count 1.
White-breasted Nuthatch (*Sitta carolinensis*), total 6, 2–19 May; high count 4, 19 May 2016.
Blue-gray Gnatcatcher (*Polioptila caerulea*), total 20, 13 Apr–20 May; high count 3, 29 Apr 2020.
Rock Wren (*Salpinctes obsoletus*), total 6, 23 Apr–20 May; high count 1.
Canyon Wren (*Catherpes mexicanus*), total 3, 7 Apr–19 May, high count 1.
House Wren (*Troglodytes aedon*), total 16, 27 Mar–19 May; high count 4, 7 Apr 2019.
Bewick's Wren (*Thryomanes bewickii*), total 12, 27 Mar–19 May; high count 2, 27 Mar 2020.
European Starling (*Sturnus vulgaris*), total 19, 15 Apr–21 May; high count 3, 23 Apr 2020.
California Thrasher (*Toxostoma redivivum*), total 31, 27 Mar–25 May; high count 4, 17 May 2016.
Northern Mockingbird (*Mimus polyglottos*), total 6, 22 Apr–5 May; high count 1.
Western Bluebird (*Sialia mexicana*), total 47, 27 Mar–21 May; high count 6, 27 Mar 2020.
Townsend's Solitaire (*Myadestes townsendi*), total 5, 27 Mar–29 Apr; high count 2, 23 Apr 2020. It is unclear whether these individuals were local birds moving short distances or true migrants moving longer distances.
Swainson's Thrush (*Catharus ustulatus*), total 52, 26 Apr–21 May; high count 24, 2 May 2020. *Catharus* thrushes seem less numerous than expected at Bear Divide, though this may be due to their more nocturnal migratory habits. Recording of night flight calls at this location would provide more insight into the abundance of thrushes in this area as spring migrants.
Hermit Thrush (*Catharus guttatus*), total 12, 15–26 Apr; high count 8, 23 Apr 2020.
Catharus sp., total 9, 28–29 Apr; high count 7, 28 Apr 2020.
American Robin (*Turdus migratorius*), total 4, 27 Mar–24 Apr; high count 2, 24 Apr 2020.

Cedar Waxwing (*Bombycilla cedrorum*), total 207, 27 Mar–21 May; high count 45, 11 May 2016.
Phainopepla (*Phainopepla nitens*), 165, 22 Apr–21 May; high count 40, 11 May 2016. A regular migrant, especially in May. This species has been shown to make regular long-distance movements throughout western North America (Baldassarre et al. 2019), and our observations corroborate this result. These individuals may be moving between desert and woodland breeding areas.
American Pipit (*Anthus rubescens*), 1, 23 Apr 2020.
House Finch (*Haemorhous mexicanus*), total 158, 27 Mar–21 May; high count 20, 26 Apr 2020.
Purple Finch (*Haemorhous purpureus*), total 20, 27 Mar–23 Apr; high count 18, 27 Mar 2020.
Pine Siskin (*Spinus pinus*), total 6, 22 Apr–19 May; high count 2, 17 May 2016.
Lesser Goldfinch (*Spinus psaltria*), total 231, 27 Mar–25 May; high count 25, 21 May 2020. Fairly common migrant, but at least some likely represent local movements.
Lawrence's Goldfinch (*Spinus lawrencei*), total 487, 27 Mar–21 May; high count 75, 26 Apr 2020. Abundant migrant, but the extent to which individuals are moving locally or in migration is not understood.
American Goldfinch (*Spinus tristis*), total 14, 22–23 Apr; high count 10, 22 Apr 2020.
Chipping Sparrow (*Spizella passerina*), total 146, 7 Apr–15 May; high count 60, 22 Apr 2020.
Brewer's Sparrow (*Spizella breweri*), 1, 24 Apr 2020.
Black-chinned Sparrow (*Spizella atrogularis*), total 49, 4 Apr–25 May; high count 4, 8 May 2019.
Lark Sparrow (*Chondestes grammacus*), total 59, 27 Mar–21 May; high count 6, 7 Apr 2019.
Fox Sparrow (*Passerella iliaca*), total 3, 4–23 Apr; high count 1.
Dark-eyed Junco (*Junco hyemalis*), total 9, 27 Mar–19 May; high count 3, 19 May 2016.
White-crowned Sparrow (*Zonotrichia leucophrys gambelii*), total 4, 7–13 Apr; high count 2, 7 Apr 2019.
White-crowned Sparrow (subspecies uncertain), total 40, 27 Mar–29 Apr; high count 10, 22 Apr 2020.
Golden-crowned Sparrow (*Zonotrichia atricapilla*), total 8, 7 Apr–1 May; high count 3, 13 Apr 2019.
Lincoln's Sparrow (*Melospiza lincolnii*), total 10, 7–23 Apr; high count 8, 23 Apr 2020.
California Towhee (*Melozone crissalis*), total 76, 27 Mar–21 May; high count 10, 17 May 2016.
Rufous-crowned Sparrow (*Aimophila ruficeps*), total 23, 22 Apr–21 May; high count 6, 14 May 2020.
Green-tailed Towhee (*Pipilo chlorurus*), 1, 23 Apr 2020.
Spotted Towhee (*Pipilo maculatus*), total 55, 27 Mar–25 May; high count 6, 27 Mar 2020.
Yellow-breasted Chat (*Icteria virens*), 1, 22 Apr 2020.
Hooded Oriole (*Icterus cucullatus*), total 76, 13 Apr–21 May; high count 15, 26 Apr 2020. Uncommon migrant.
Bullock's Oriole (*Icterus bullockii*), total 159, 13 Apr–21 May; high count 30, 26 Apr 2020. Breeds near Bear Divide but also a common migrant, especially in late April.
Red-winged Blackbird (*Agelaius phoeniceus*), total 13, 27 Mar–2 May; high count 6, 1 May 2019.
Brewer's Blackbird (*Euphagus cyanocephalus*), 2, 24 Apr 2020.
Brown-headed Cowbird (*Molothrus ater*), total 5, 23–26 Apr; high count 2, 23 Apr 2020.
Unidentified blackbird, total 3, 15–22 Apr; high count 2, 15 Apr 2020.
Orange-crowned Warbler (*Leiothlypis celata*), total 641, 13 Apr–11 May; high count 200, 22 Apr 2020. Common migrant, mainly mid- to late April.

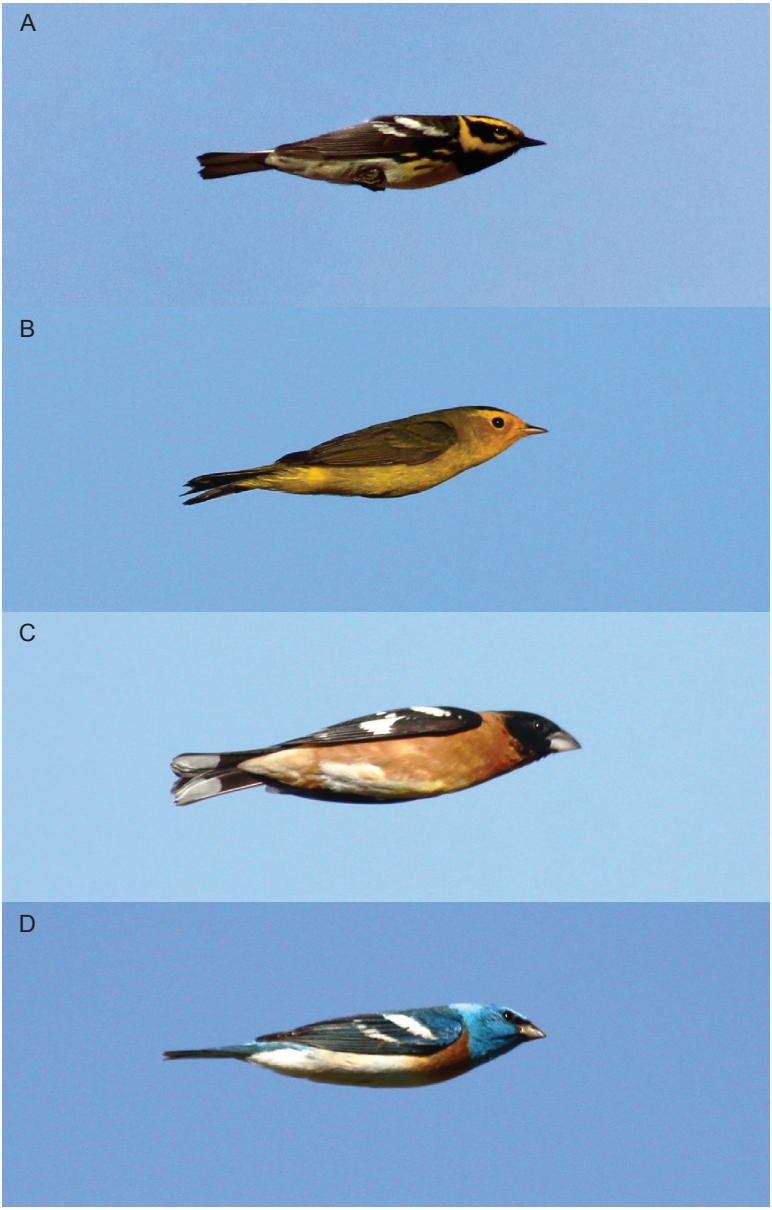

FIGURE 7. Four of the most numerous spring migrants passing over Bear Divide: (A) Townsend's Warbler (*Setophaga townsendi*), 2 May 2019; (B) Wilson's Warbler (*Cardellina pusilla*), 12 May 2021; (C) Black-headed Grosbeak (*Pheucticus melanocephalus*), 19 May 2021; (D) Lazuli Bunting (*Passerina amoena*), 29 April 2020.

Nashville Warbler (*Leiothlypis ruficapilla*), total 1352, 4 Apr–2 May; high count 400, 22 Apr 2020. Abundant migrant mid- to late April.

MacGillivray's Warbler (*Geothlypis tolmiei*), total 11, 13 Apr–5 May; high count 2, 13 Apr 2019. Most individuals of this species were observed in vegetation, not flying over the divide like other warblers. Its skulking habits suggest that many stay under cover at Bear Divide and go undetected.

Common Yellowthroat (*Geothlypis trichas*), total 3, 13 Apr–2 May; high count 1.

Yellow Warbler (*Setophaga petechia*), total 715, 13 Apr–25 May; high count 230, 26 Apr 2020. This species appears to be relatively scarce at dawn flight locations along the immediate coast (Paul Lehman pers. comm.) and more common inland at sites like Butterbredt Spring (Heindel 1991). The relative abundance of the Yellow Warbler at Bear Divide, especially in early May, hints at the site being connected to inland, rather than coastal, migratory movements.

Yellow-rumped Warbler (*Setophaga coronata auduboni*), total 237, 27 Mar–2 May; high count 141, 13 Apr 2019. Common migrant late March and early April, uncommon through early May.

Yellow-rumped Warbler (subspecies uncertain), total 787, 27 Mar–2 May; high count 300, 22 Apr 2020.

Black-throated Gray Warbler (*Setophaga nigrescens*), total 1380, 4 Apr–11 May; high count 380, 26 Apr 2020. Fairly common migrant in April and early May; peak passage occurs slightly before that of Townsend's Warbler.

Townsend's Warbler (*Setophaga townsendi*); Figure 7, 2087, 13 Apr–21 May; high count 760, 26 Apr 2020. Despite wintering locally, this species is a rather late migrant, with the main peak well after that of the Black-throated Gray Warbler, consistent with Townsend's more northerly breeding range.

Hermit Warbler (*Setophaga occidentalis*), total 1570, 13 Apr–21 May; high count 608, 26 Apr 2020. Fairly common migrant in April and early May

Townsend's × Hermit Warbler (hybrid), total 2, 22 Apr, 5 May. Two individuals with clearly intermediate characters were well photographed, suggesting that this hybrid may be more common within the large numbers of poorly seen warblers moving across the divide.

Wilson's Warbler (*Cardellina pusilla*); Figure 7, total 4954, 27 Mar–21 May; high count 1920, 23 Apr 2020. The most abundant migrant at Bear Divide, both in total numbers and on most individual days from mid-April to mid-March. Ruegg et al. (2014) found that in the West, southerly breeding populations move through migratory sites earlier in the spring, followed later by more northerly breeding populations.

Unidentified warbler, total 14,272, 4 Apr–25 May; high count 7436, 23 Apr 2020.

Summer Tanager (*Piranga rubra*), 1, 20 May 2019. A rare local breeder (*P. r. cooperi*) that also occurs regularly as a migrant to California at this time (*P. r. rubra*); we do not know from which population this individual originated.

Western Tanager (*Piranga ludoviciana*), total 3004, 13 Apr–21 May; high count 800, 22 Apr 2020. Abundant migrant at the divide through much of the period of spring movement.

Black-headed Grosbeak (*Pheucticus melanocephalus*), total 1259, 7 Apr–25 May; high count 500, 22 Apr 2020. Common migrant.

Blue Grosbeak (*Passerina caerulea*); Figure 7, total 5, 26 Apr–5 May; high count 1. Rare.

Lazuli Bunting (*Passerina amoena*), total 1998, 7 Apr–25 May; high count 608, 26 Apr 2020. Common migrant.

Unidentified passerine, total 3927, 4 Apr–14 May; high count 1487, 23 Apr 2020.