

Breeding Phenology of Birds in Sacramento County, California

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ABSTRACT

We used data from the recently completed Sacramento County Breeding Bird Atlas to assess the breeding phenology of 23 bird species. We compared our results to the published literature finding that, while most species' local breeding phenology matched published data, several species showed substantial deviations from those data. The Black Phoebe (*Sayornis nigricans*), California Scrub-Jay (*Aphelocoma californica*), Yellow-billed Magpie (*Pica nuttalli*), Cliff Swallow (*Petrochelidon pyrrhonota*), American Robin (*Turdus migratorius*), Northern Mockingbird (*Mimus polyglottos*), and House Finch (*Haemorhous mexicanus*) all showed extended breeding seasons with some exhibiting breeding behaviors early, some extending breeding later, and some showing both deviations. European Starlings (*Sturnus vulgaris*) showed a more truncated breeding season than expected, starting later and ending earlier than predicted by published data. Two species not considered to commonly produce more than one brood per season, the scrub-jay and Cliff Swallow, both showed evidence suggesting multiple broods. Because most published studies were conducted in non-urban settings, we also compared breeding phenology between birds observed in urban and non-urban environments in the county finding that several species breeding in both habitats showed somewhat longer breeding seasons in urbanized blocks. Our results suggest that the deviations in phenology from published data for most of these species may be due to individuals nesting in those urban settings.

The breeding phenology of birds, although one of the key aspects of natural history, has not been well-studied for most species in recent decades. Indeed, such observational studies are currently not in vogue. As one can see

Table 1. Breeding phenology based on published literature. Data are from studies in California, when available, or from North American studies at similar latitudes to California. Bold entries indicate that our data differ substantially from literature values. Differences are discussed in the text.

Species	Breeding Season	One Breeding Cycle	>one brood ^a	Sources
Mourning Dove	mid Feb–Sep	32–39 d	common	1,2,3,4,5,46,47
Red-shouldered Hawk	Feb–Jul	100–120 d	very rare	6,7,3,8,4,5
Swainson's Hawk	mid May–mid Jul	100–115 d	no	9,10,11
Red-tailed Hawk	Jan–Jul	110–125 d	no	3,7,12,4,5
Great Horned Owl	Jan–Jun	70–90 d	no	13,3,7,14,4,5
Black Phoebe	mid Mar–Jul	38–45 d	common	15,16,3,4,5
Western Kingbird	mid Apr–mid Jun	35–45 d	no	3,17,4,5
California Scrub-jay	Mar–Jul	45–60 d	uncommon	18,19,3,7,20,5
Yellow-billed Magpie	Jan–Jun	70–90 d	no	21,22,5
Tree Swallow	late Feb–mid Jul	33–50 d	Fairly common	3,7,5,23
Purple Martin	May–late Jul	47–68 d	no	24,25
Cliff Swallow	Mar–mid Jul	40–50 d	no	26,3,7,4,27,5
Oak Titmouse	mid Mar–mid May	37–45d	Very rare	28,3,4,29,5
Bushtit	Feb–Jul	38–44 d	common	30,31,3,7,4,5

Species	Breeding Season	One Breeding Cycle	>one brood ^a	Sources
House Wren	mid Mar–Jul	29–45 d	common	32,3,7,33,4,5
Western Bluebird	Apr–Jul	38–50 d	common	34,3,7,35,4,5
American Robin	mid Apr–mid Jul	29–38 d	common	3,7,4,36,5
Northern Mockingbird	Apr–early Aug	32–40 d	common	3,7,37,4,5
European Starling	Feb–Aug	40–45 d	common	3,7,4,5,38
House Sparrow	late Feb–Jul	32–36 d	common	3,7,4,5,39
House Finch	Mar–mid Jul	32–40 d	common	40,3,7,41,4,5
Brewer's Blackbird	Apr–Jul	33–42 d	very rare	42,43,3,7,4
Red-winged Blackbird	Late Apr–mid Jul	30–35 d	uncommon	44,3,7,4,45

^aDoes not include re-nesting after failed attempt, which is common among many species

¹Peters 1961, ²Sayre and Silvy 1993, ³Unitt 2004, ⁴Allen et al. 2016, ⁵Rose and Rose 2019, ⁶Wiley 1975, ⁷Hunter et al. 2005, ⁸Dykstra et al. 2008, ⁹Woodbridge 1987, ¹⁰Becharad et al. 2010, ¹¹Airola et al. 2019, ¹²Preston and Beane 2009, ¹³Marti 1969, ¹⁴Artuso et al. 2013, ¹⁵Irwin 1985, ¹⁶Wolf 1997, ¹⁷Gamble and Bergin 2012, ¹⁸Ritter 1983, ¹⁹Carmen 1988, ²⁰Curry 2017, ²¹Verbeek 1972, ²²Koenig et al. 2022, ²³Winkler et al. 2020, ²⁴Airola 2020, ²⁵Brown et al. 2021, ²⁶Mayhew 1958, ²⁷Brown et al. 2017, ²⁸Dixon 1949, ²⁹Cicero et al. 2017, ³⁰Addicott 1938, ³¹Sloane 2001, ³²Purcell et al. 1997, ³³Johnson 2014, ³⁴Grinnell and Linsdale 1936, ³⁵Guinan et al. 2008, ³⁶Vanderhoff et al. 2016, ³⁷Farnsworth et al. 2011, ³⁸Cabe 2020, ³⁹Lowther and Cink 2020, ⁴⁰Woods 1968, ⁴¹Badyaev et al. 2012, ⁴²Williams 1952, ⁴³Martin 2002, ⁴⁴Orians 1961, ⁴⁵Yasukawa and Searcy 2019, ⁴⁶Otis et al. 2008, ⁴⁷Airola 2008.

in most species accounts in Birds of the World (www.birdsoftheworld.org/bow/home), published research on breeding phenology of individual birds is frequently several decades old and most of those data are based on studies in very few locations. Given that breeding phenology is changing due to shifts in climate (Crick 2004, Møller et al. 2010, Charmantier and Gienapp 2013, Dunn and Møller 2014, and Scridel et al. 2018), and that phenology can vary greatly from location to location, more current work on breeding phenology in more locations is important. We used data collected for the recent Sacramento County Breeding Bird Atlas (Pandolfino et al. 2021) to assess breeding phenology of local breeding birds and to compare those data to published phenology studies. We also compared the breeding phenology in urban and non-urban areas for a number of species known to commonly breed in both habitat types.

METHODS

Data for this study came from observations collected for the recent Breeding Bird Atlas (BBA) of Sacramento County (Pandolfino et al. 2021). Unlike a traditional BBA, this atlas used eBird to compile data and collected data from throughout the full breeding season. Traditional BBAs, with blocks assigned to specific individuals, tend to produce an early bias in phenology due to the focus on collection of the first breeding behaviors observed for each block (see Pandolfino et al. 2021 for a full discussion).

We placed observed breeding behaviors into one of four breeding stages:

- *Nest-building*: carrying nesting material or nest-building;
- *Occupied nest*: nest with eggs or occupied nest;
- *Nest with young*: carrying food, nest with young, or adult carrying fecal sac;
- *Fledglings*: fledglings present, fledglings being fed (identified by plumage and behavior).

We limited our analyses to the 23 species for which we had at least 25 observations each from at least three of the four breeding stages. We qualitatively compared observed breeding phenology of those species to published breeding phenology data (Table 1), using data from California whenever possible.

To compare breeding phenology between birds nesting in urban and non-urban locations, we considered atlas blocks with at least 85% of the land cover noted by Yang et al. (2016) as developed as urban blocks. All breeding behaviors within those blocks were deemed as urban, all others as non-urban. We chose this threshold to provide sufficient data to make urban and non-urban comparisons between as many species as possible. Thus, our results regarding this comparison are conservative given that many of the blocks designated as non-urban included large areas of urbanization.

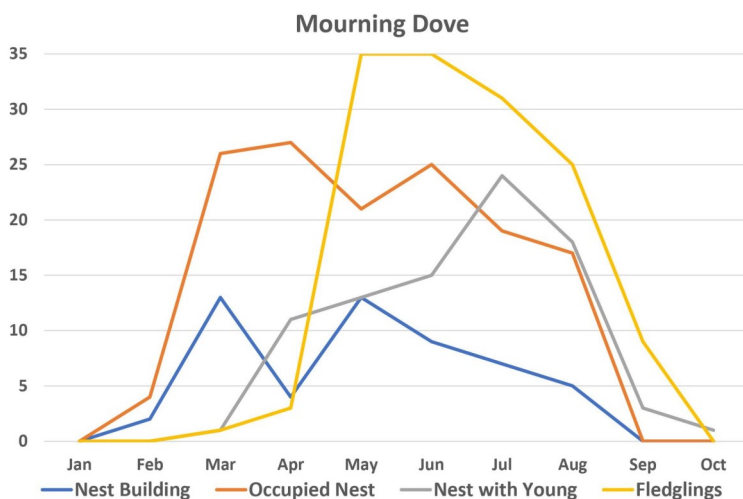


Figure 1. Number of observations for each breeding stage for the Mourning Dove by month.

RESULTS AND DISCUSSION

As expected, Mourning Doves (*Zenaida macroura*) showed the most extended breeding season (Figure 1) with high levels of activity from February through September. The phenology we observed was similar to that described by Airola (2008) in Sacramento County. Peters (1961) noted that this species may breed in any month of the year in the southern parts of its range, but we did not record breeding behavior before February or after September, except for a single observation of a nest with young in October. Breeding activity peaked in May and June, consistent with observations of Sayre and Silvy (1993).

Comparing the phenology of three Buteo species (Figure 2) showed that the two species present in the area year-round, the Red-shouldered Hawk (*Buteo lineatus*) and Red-tailed Hawk (*B. jamaicensis*), started their breeding season in winter (January–February), and it extended well into summer. Fledglings noted in July for both species are likely the products of re-nesting after early failure, since the long breeding cycles of these birds make multiple successful broods unlikely (Wiley 1975, Preston and Beane 2009). The migratory Swainson’s Hawk’s (*B. swainsoni*) breeding season began later, as expected, starting shortly after arrival in March and extending into August, consistent with other observations in Sacramento and adjacent counties (Airola et al. 2019).

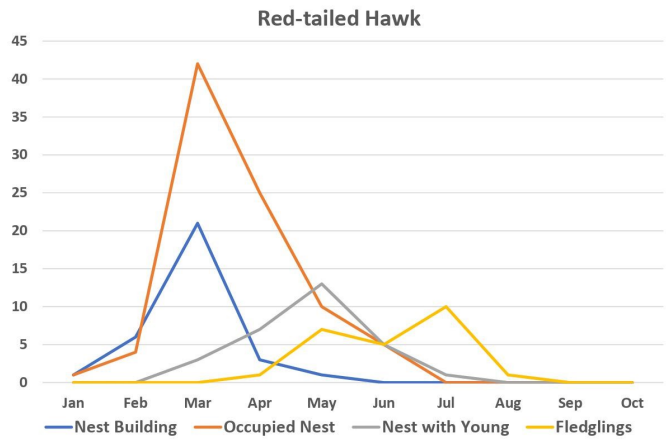
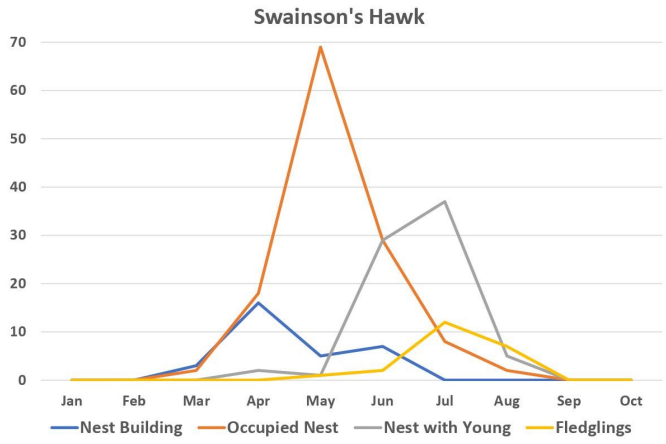
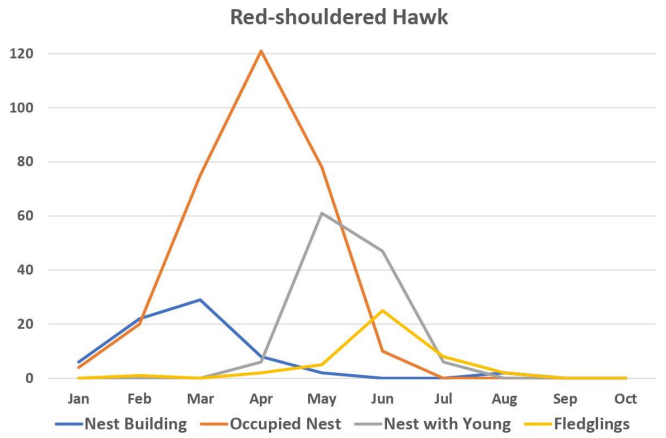


Figure 2. Number of observations for each breeding stage for three *Buteo* species by month.

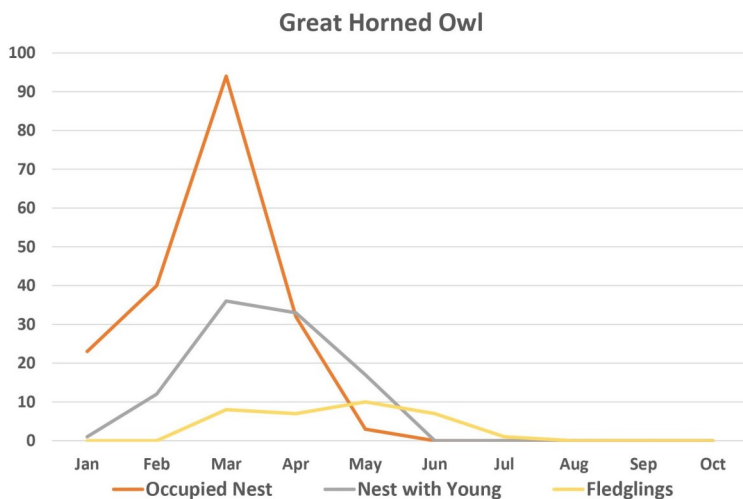


Figure 3. Number of observations for each breeding stage for the Great Horned Owl by month.

Many Great Horned Owls (*Bubo virginianus*) were already on eggs in January (Figure 3) with nestling observations peaking in early spring. Fledglings seen in June may have been from replacement clutches as noted by Marti (1969).

Somewhat analogous to the hawks discussed above, the resident flycatcher, the Black Phoebe (*Sayornis nigricans*), begins nesting early and has an extended breeding season (Figure 4). The broad peak of observed phoebe fledglings (April to August) suggests multiple broods per season, typical for this species (Wolf 1997), although the breeding season we observed was much longer than has been reported (Table 1). The migrant Western Kingbird (*Tyrannus verticalis*), which begins arriving in March, did not start nesting until April.

Both corvid species we examined displayed longer breeding seasons (Figure 5) than are typically reported for them (Table 1). The breeding season for the California Scrub-Jay (*Aphelocoma californica*) ran from mid-February through August and the broad range of nest-building (February–May) and fledgling observations (May–August) suggest multi-brooding, an uncommon occurrence for this species (Curry et al. 2017). As with nearly all species, however, we cannot rule out the possibility that a significant proportion of the population experienced early nest failure with subsequent nesting accounting for the broad peaks. The breeding season for Yellow-billed Magpies (*Pica nuttalli*) in our sample extended late into the summer (through July) which, given that double-brooding has not been documented for this species, may

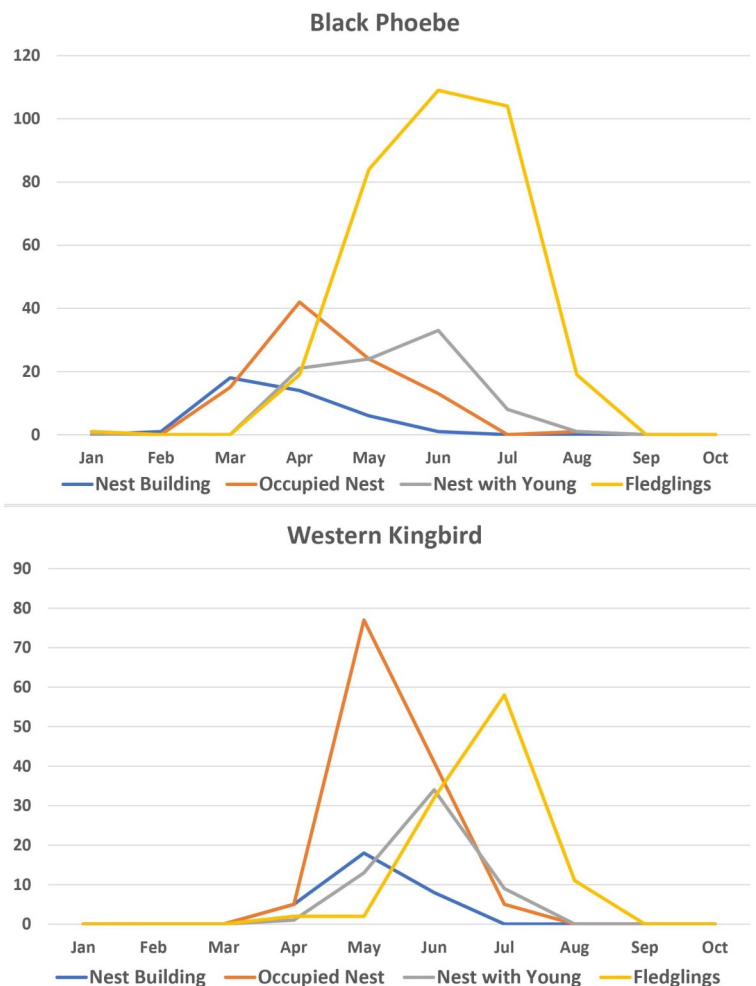


Figure 4. Number of observations for each breeding stage for two flycatcher species by month.

indicate a high rate of nest replacement or it may reflect the rather long breeding cycle of the magpie or some year-to-year variation in timing of nesting activities. In any case, determining the exact breeding season for this species is challenging given the extensive nest-building period (as long as 6–8 weeks) and the inaccessibility of their large spherical nests, often placed very high in trees (Verbeek 1973, Airola et al. 2021, Koenig et al. 2022).

Of the three swallow species analyzed, only the Cliff Swallow (*Petrochelidon pyrrhonota*) showed a notable deviation from expected phenology (Figure 6, Table 1). All breeding stages covered broad ranges of

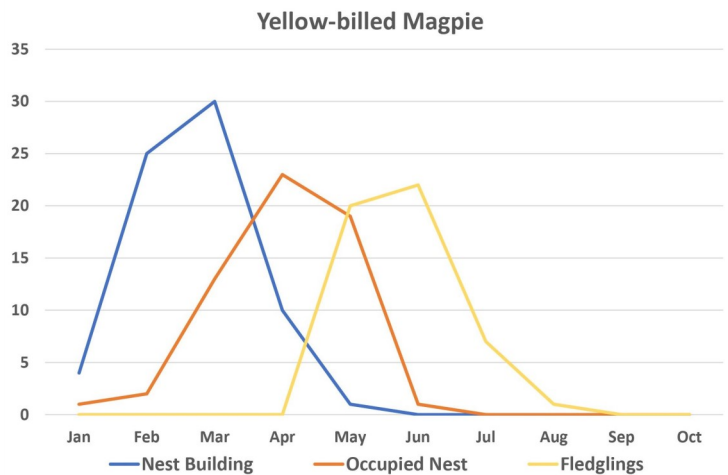
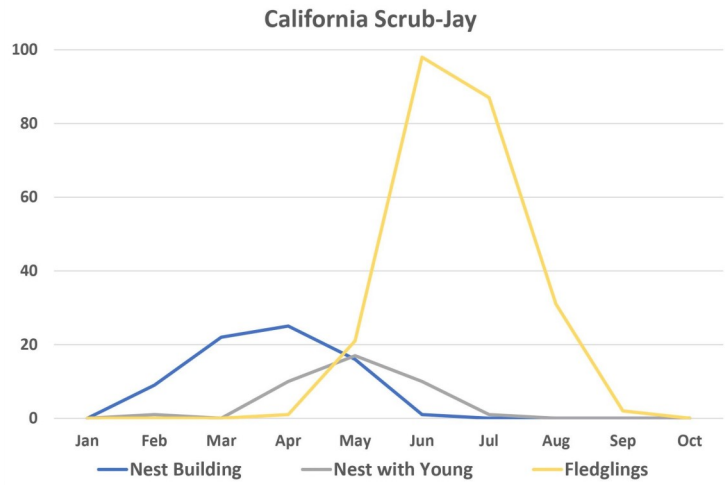


Figure 5. Number of observations for each breeding stage for two Corvid species by month.

time with nest-building extending into June and fledglings observed into early August. This suggests either double-brooding (rare for this species; Brown et al. 2017) or a high rate of re-nesting after failure. Nest-building by Tree Swallows (*Tachycineta bicolor*), which are present in Sacramento County in small numbers through the winter, begins as early as late February, and double-brooding is fairly common locally (D. Airola, pers. comm.) and in other southerly parts of the species' breeding range (Winkler et al. 2020). The presence of substantial numbers of fledglings in July suggests that more than one brood may be common in this area. Purple Martin (*Progne subis*) phenology matched that described by Airola (2020), as expected given that his data were solely collected in Sacramento County.

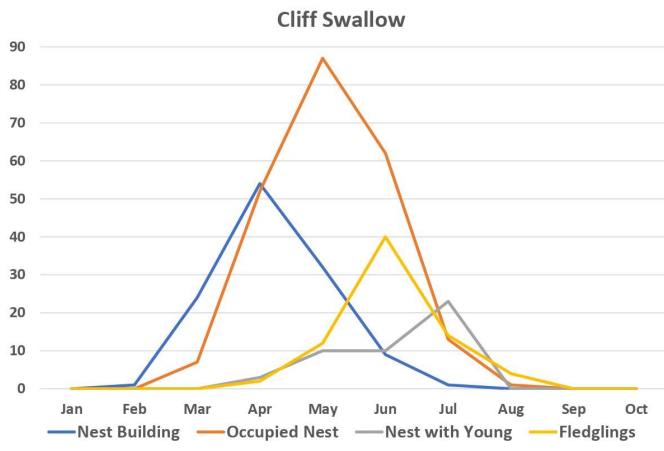
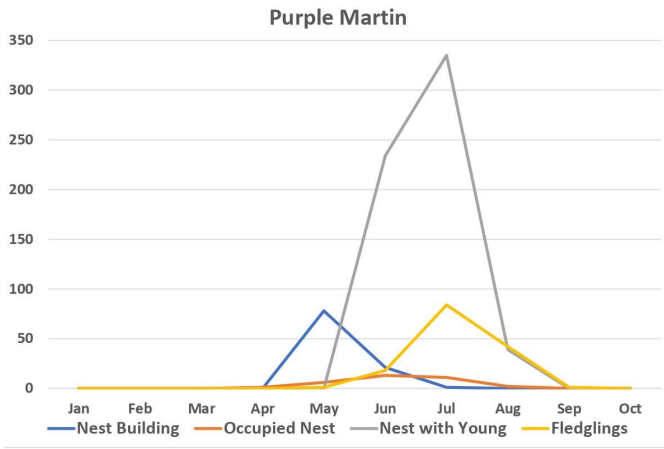
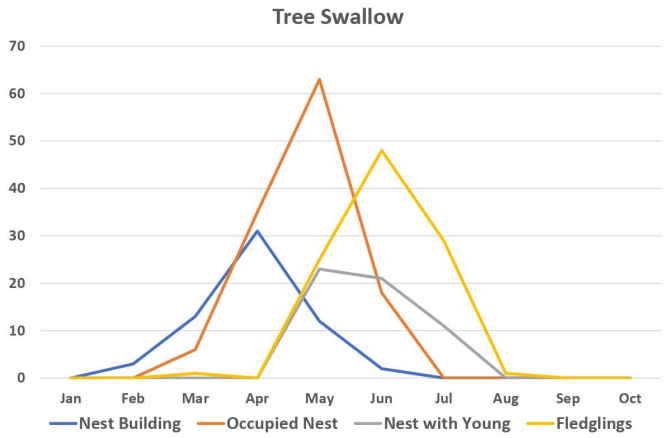


Figure 6. Number of observations for each breeding stage for three swallow species by month.

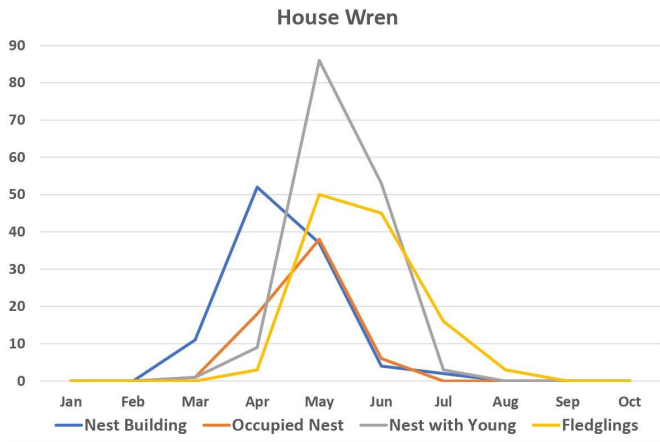
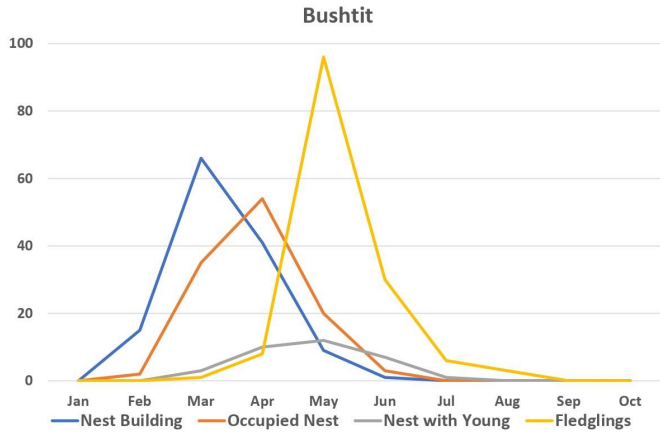
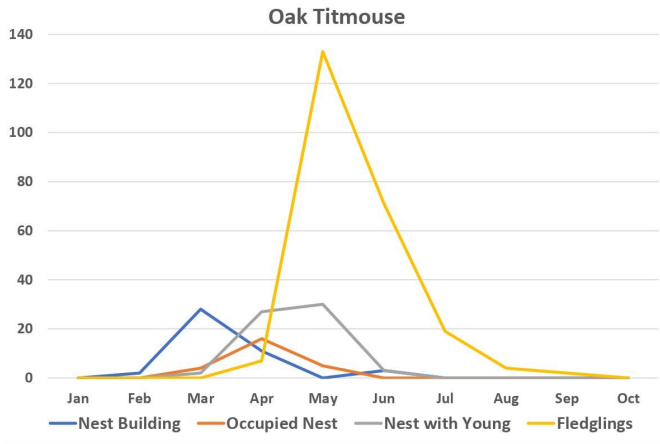


Figure 7. Number of observations for each breeding stage for the Oak Titmouse, Bushtit, and House Wren by month.



Figure 8. Number of observations for each breeding stage for two thrush species by month.

Observed breeding phenologies for the Oak Titmouse (*Baeolophus inornatus*), Bushtit (*Psaltriparus minimus*), and House Wren (*Troglodytes aedon*) were all consistent with published data (Figure 7, Table 1), and the extent of their breeding seasons were all sufficient to allow multiple broods. Nest-building among Bushtits, one of the earliest of our small passerines, began in February and continued well into May.

Between the two thrush species we examined (Figure 8), the Western Bluebird (*Sialia mexicana*) and American Robin (*Turdus migratorius*), only the robin showed deviation from expected breeding dates (Table 1). American Robin nest-building began in April, as expected from published data, but

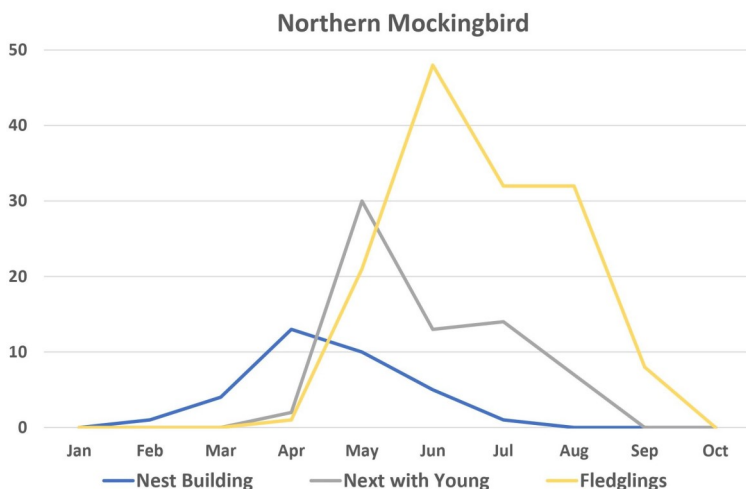


Figure 9. Number of observations for each breeding stage for the Northern Mockingbird by month.

extended through August and into September, again consistent with multiple broods or frequent re-nesting. The extended nesting period for the bluebird is consistent with multi-brooding, as expected for this species in this area (Guinan et al. 2008, D. Airola, pers. comm.)

The breeding season for Northern Mockingbirds (*Mimus polyglottos*) in our study (Figure 9) began earlier (March) and extended later (though August into September) than most published data (Table 1) reported. All three breeding stages with sufficient data to analyze were quite long, certainly long enough to support multiple brooding. Only birds in Florida (Farnsworth et al. 2011) showed phenology similar to ours, and that population may raise three or more broods per year.

The European Starling (*Sturnus vulgaris*) was the only species in our study to demonstrate a shorter breeding season than expected from published data (Table 1), with only a few observations of nest-building before March and no fledglings seen after July (Figure 10). The fact that nest-building peaked in April, nests with young peaked in May, and few fledglings were observed past June, suggests that few starlings would have had the opportunity to complete two full breeding cycles (40–45 days each). The other introduced bird in our study, the House Sparrow (*Passer domesticus*), showed the expected extended breeding season running from February into August (Figure 11). Broad peaks for each stage suggest that multiple broods were common.

Figure 10. Number of observations for each breeding stage for the European Starling by month.

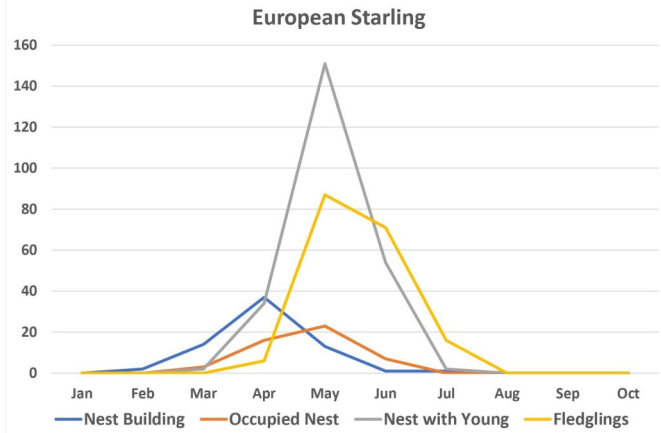


Figure 11. Number of observations for each breeding stage for the House Sparrow by month.

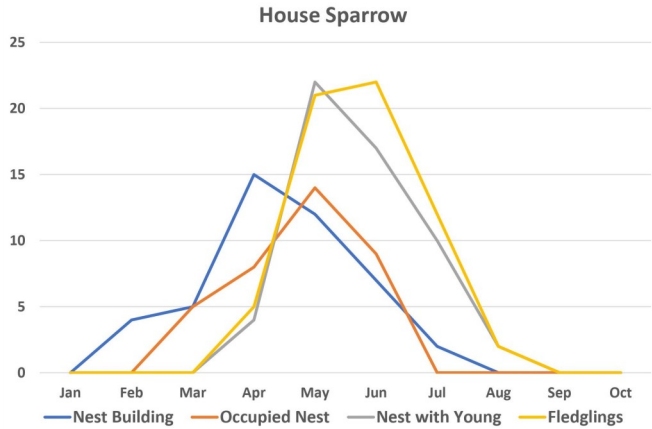
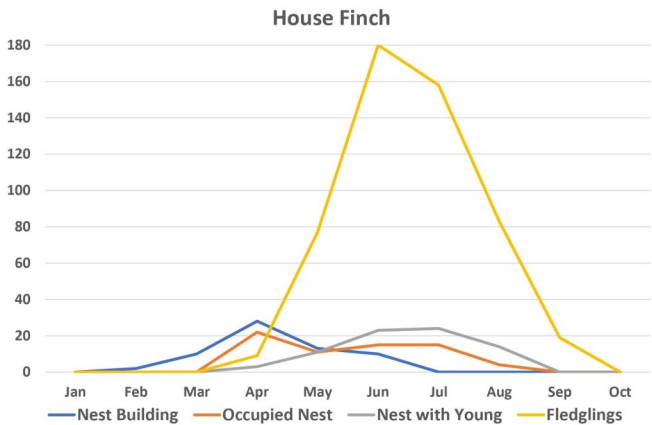


Figure 12. Number of observations for each breeding stage for the House Finch by month.



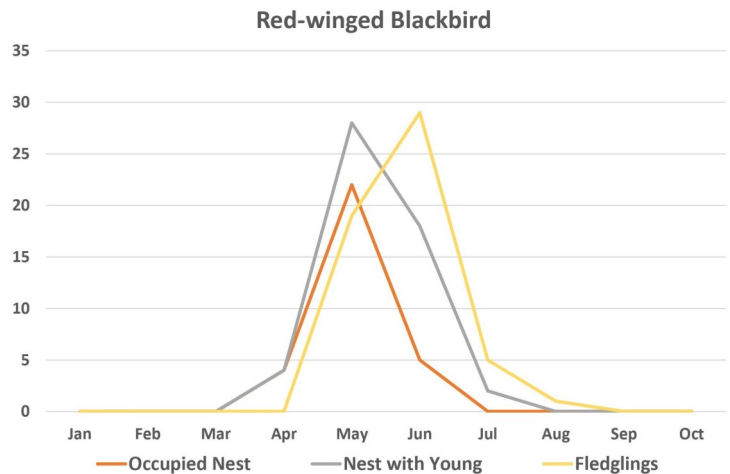
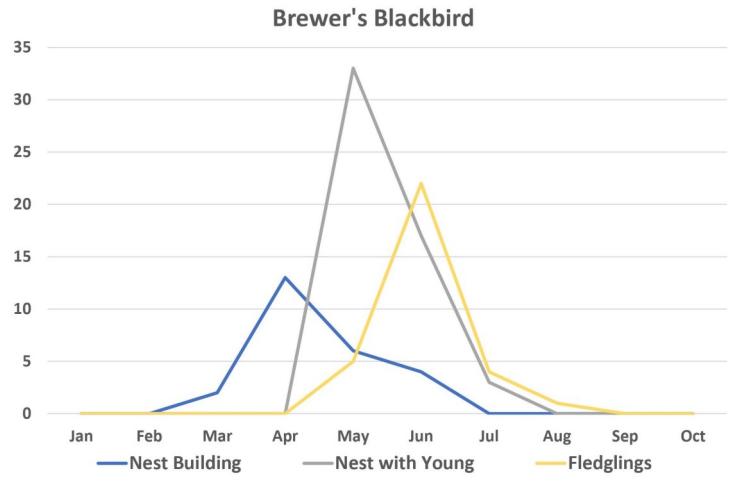


Figure 13. Number of observations for each breeding stage for two blackbird species by month.

The House Finch (*Haemorhous mexicanus*) was yet another species that had a more extended breeding season (Figure 12) than described in the literature (Table 1). Fledglings were observed from April well into September, a much longer season than in Woods' (1968) California observations. Multiple successful broods per season are common for the species (Badyaev et al. 2012), and our results allow ample time for raising two or more broods.

The breeding seasons for both the Brewer's Blackbird (*Euphagus cyanocephalus*) and Red-winged Blackbird (*Agelaius phoeniceus*) were relatively short (Figure 13), as expected for species that do not commonly produce more than one successful brood per year. The nest-building of

Brewer’s Blackbirds observed in May could be due to replacement nests following early failures. Williams (1952) observed some second broods in Monterey County, California but acknowledged that those could have been from replacement nests rather than the result of successful multiple broods.

Phenology of Urban vs. Non-urban Breeding Birds

We compared breeding phenology between birds nesting in highly urbanized blocks and less urbanized ones because nearly all published studies of breeding phenology were conducted in non-urban areas, and Sacramento County land cover includes a substantial proportion (>30%) of developed land (Yang et al. 2016). We used data from 14 species known to regularly breed in both urban and non-urban habitats and compared the median dates for each breeding stage for each species where sufficient data were available (Table 2).

Table 2. Difference in median date for each breeding stage between urban and non-urban breeders (negative numbers mean earlier date for urban, positive means a later date). Differences of greater than 10 days are in bold.

Species	Nest-building	Occupied Nest	Nest with Young	Fledglings
Mourning Dove	-35			
Red-shouldered Hawk	-2	1	1	
Black Phoebe		10	23	24
California Scrub-Jay	-13			16
Yellow-billed Magpie	2			
Cliff Swallow	10	-2		9
Oak Titmouse			2	1
House Wren	3		0	9
Western Bluebird			-1	18
American Robin	-3		-6	25
Northern Mockingbird			11	42
European Starling	2	-7	-4	-12
House Sparrow				-11
House Finch				27

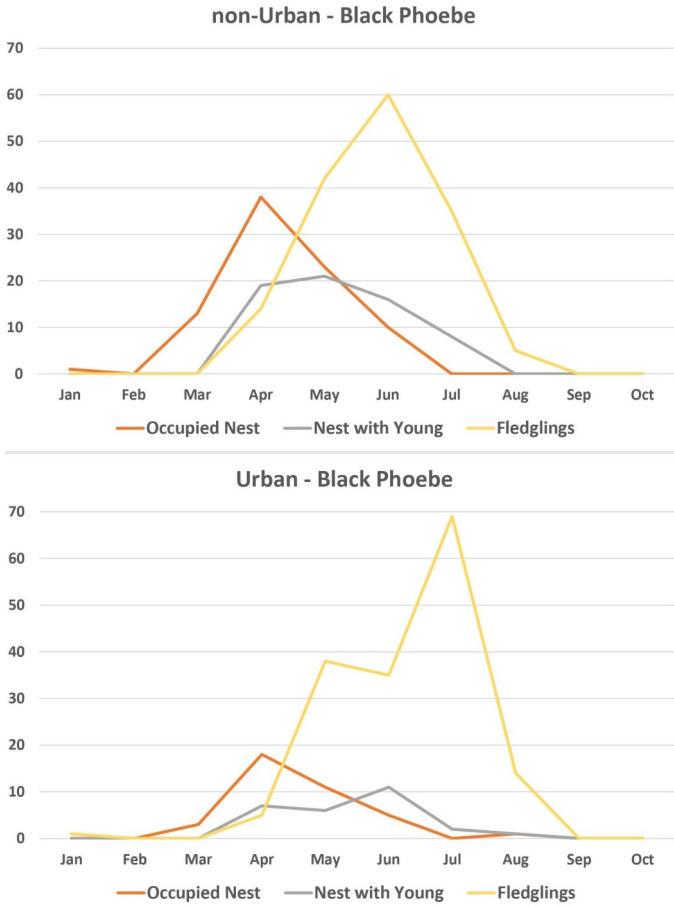


Figure 14. Comparison of non-urban vs. urban phenology for the Black Phoebe.

Five species (Red-shouldered Hawk, Yellow-billed Magpie, Cliff Swallow, Oak Titmouse, and House Wren) showed little difference in timing of breeding in urban and non-urban habitats. For five species (Black Phoebe, Western Bluebird, American Robin, Northern Mockingbird, and House Finch) median dates for one or more stages were substantially later for urban nesters. Only three species, the non-native European Starling and House Sparrow, and the Mourning Dove showed substantial shifts to earlier dates. The California Scrub-Jay showed a shift toward earlier nest-building but later fledging among the urban breeders, consistent with potential increased incidence of double-brooding in urban habitats.

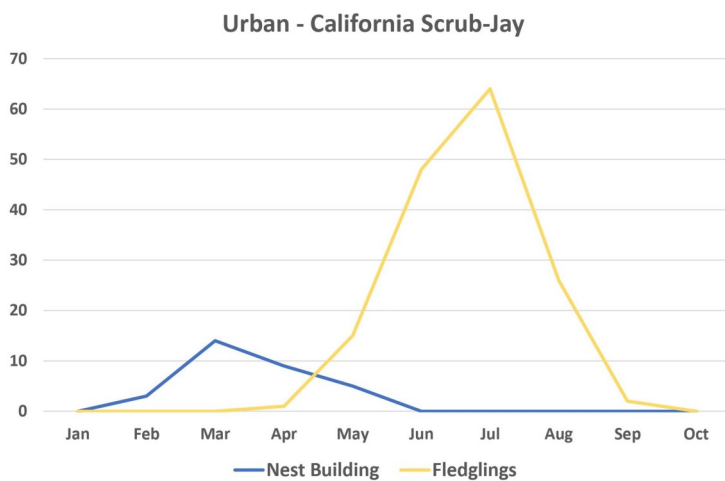
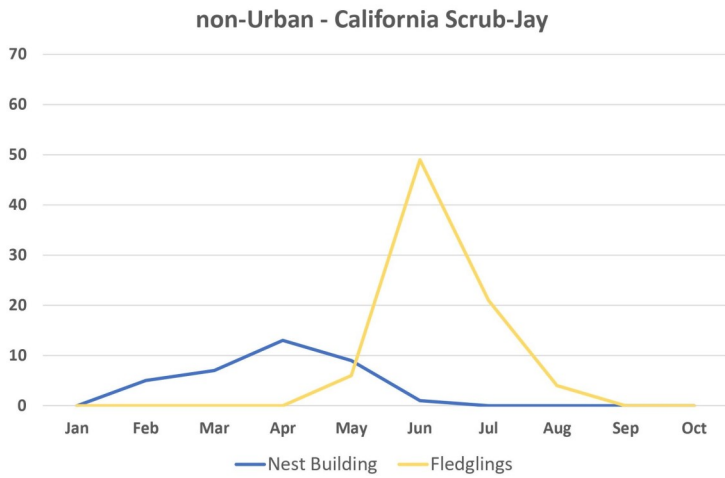


Figure 15. Comparison of non-urban vs. urban phenology for the California Scrub-Jay.

We also looked more closely at the overall patterns of phenology from urban and non-urban data for the eight species discussed above that showed substantial deviations from published results. The Black Phoebe’s pattern showed a later peak in fledgling observations (Figure 14) for urban-nesting birds (peak shifted from June to July). California Scrub-Jays began nest-building earlier and fledglings peaked later in urban blocks (Figure 15). We only had sufficient data to compare urban and non-urban nesting from the nest-building stage for the Yellow-billed Magpie, and the data looked very similar (Figure 16). Urban-nesting Cliff Swallows showed overall broader peaks for all three stages we examined (Figure 17), again suggestive of second replacement broods being more common in those blocks.

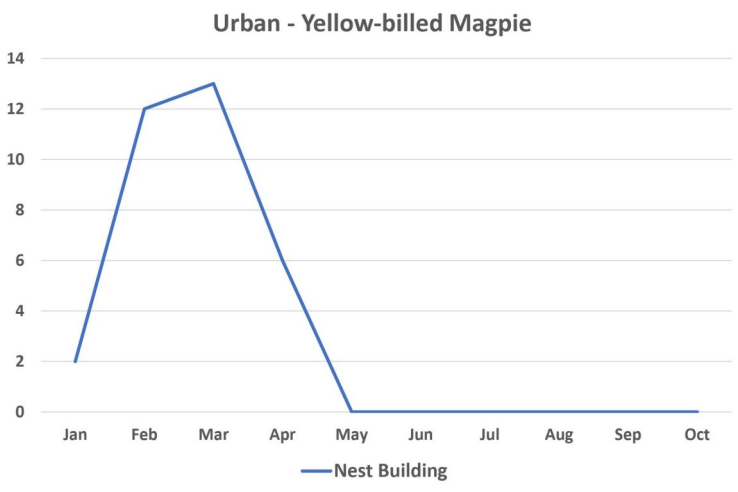
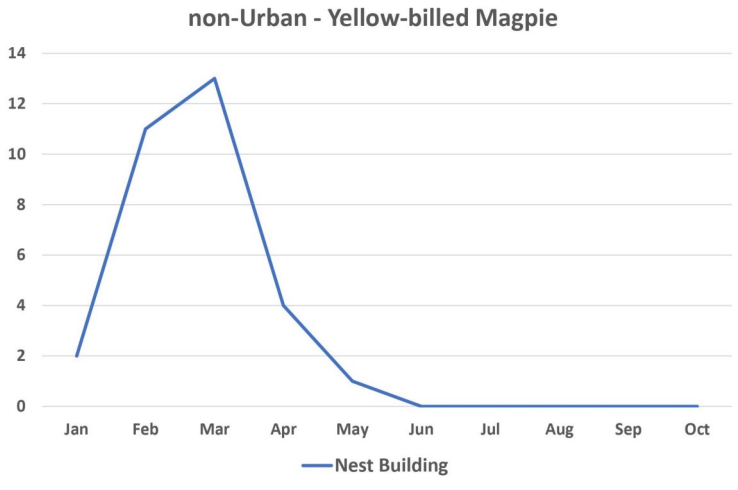


Figure 16. Comparison of non-urban vs. urban phenology for the Yellow-billed Magpie.

The American Robin also showed a decided shift toward later fledglings (Figure 18) with very few observed in August in non-urban areas compared to large numbers in urban blocks. Northern Mockingbirds showed the most dramatic shifts to later fledgling dates in urban sites (Figure 19), with non-urban fledglings peaking in June but urban ones peaking in August. The pattern of breeding observations for European Starlings (Figure 20) showed no obvious differences between urban and non-urban breeders except that there may have been more late fledglings in non-urban blocks. The only breeding stage for which we had sufficient data to compare for the House

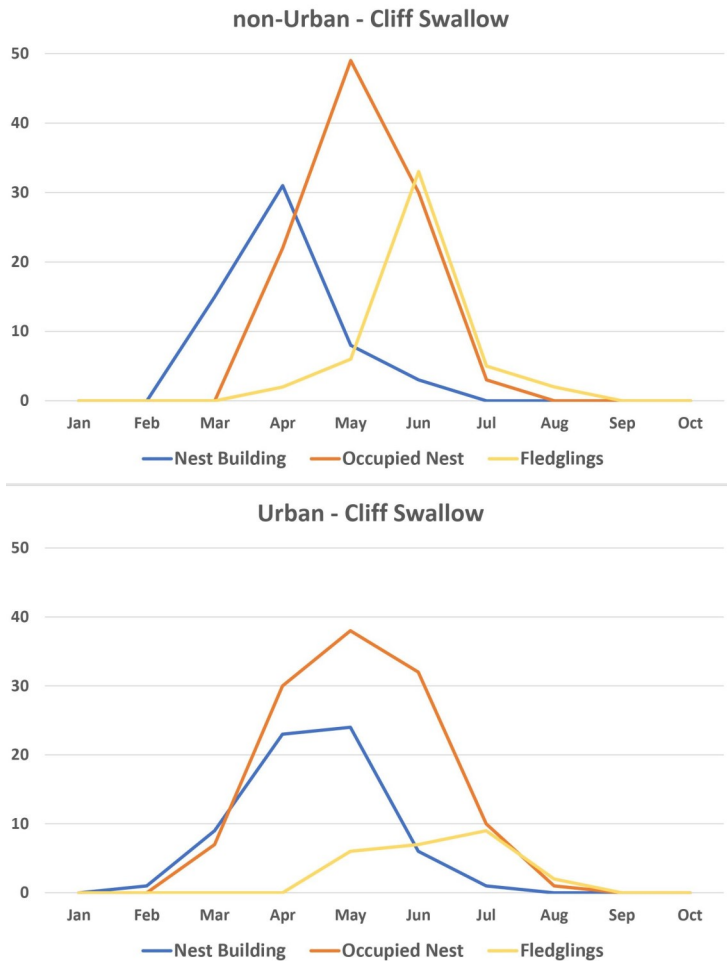


Figure 17. Comparison of non-urban vs. urban phenology for the Cliff Swallow.

Finch was fledglings, and those observations were generally later in urban-breeding birds (Figure 21) with peak numbers in May and June for non-urban nesters vs. June and July for urban breeders. House Finch fledglings were observed in September in urban areas, but not in non-urban blocks.

Implications and Testable Hypotheses

Even given the semi-quantitative nature of our data, it is striking that eight of the 23 species evaluated showed substantial deviations from published breeding phenology and that seven of those showed extended breeding season lengths. Only one of those species, the European Starling, showed a shorter breeding season than expected. In addition, two of those

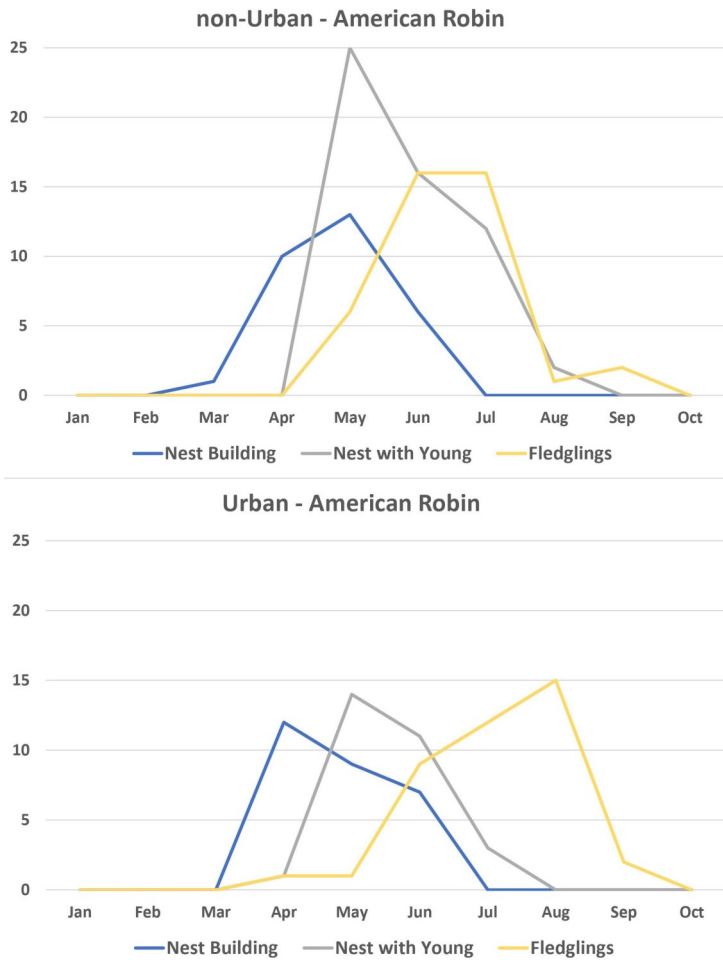


Figure 18. Comparison of non-urban vs. urban phenology for the American Robin.

species that do not commonly produce multiple successful broods per season (the California Scrub-Jay and Cliff Swallow), showed breeding seasons long enough to allow more than one successful brood. These breeding season extensions could be due to very frequent re-nesting after initial failure or the production of multiple successful broods, or a combination of the two.

It is possible that the unusually high degrees of plasticity we observed in the timing of breeding among local birds, may have resulted from variation in nest timing among individuals or year-to-year variation due to environmental factors such as weather. However, we compared our phenologies to those determined from studies that were conducted in a variety of locales and over

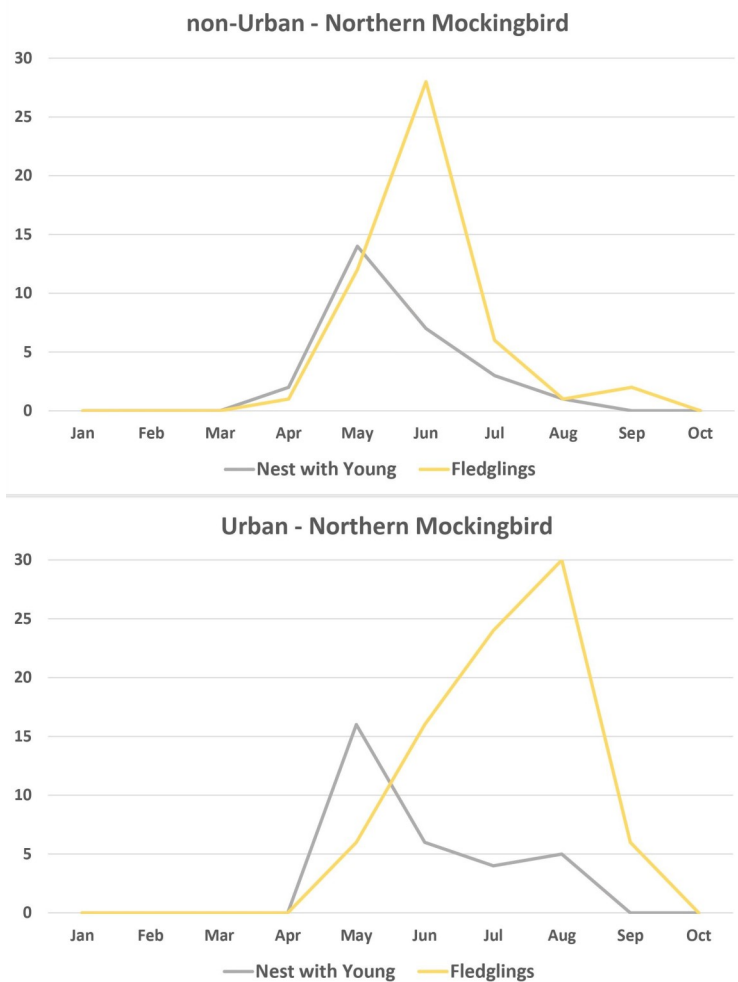


Figure 19. Comparison of non-urban vs. urban phenology for the Northern Mockingbird.

multi-year time frames (e.g., other California multi-year BBAs). Therefore, it is likely that the ranges from the literature to which we compared encompassed a similar set of factors that would have affected timing of nest stages. These similar conditions suggest that the greater plasticity exhibited of Sacramento species is a result of real changes in the timing of breeding behaviors. Pandolfino et al. (2021) reported results suggesting that early-season nesting birds in Sacramento County may have begun nesting earlier in recent years due to warmer winter and early spring temperatures in this area, and this may have influenced this increase plasticity.

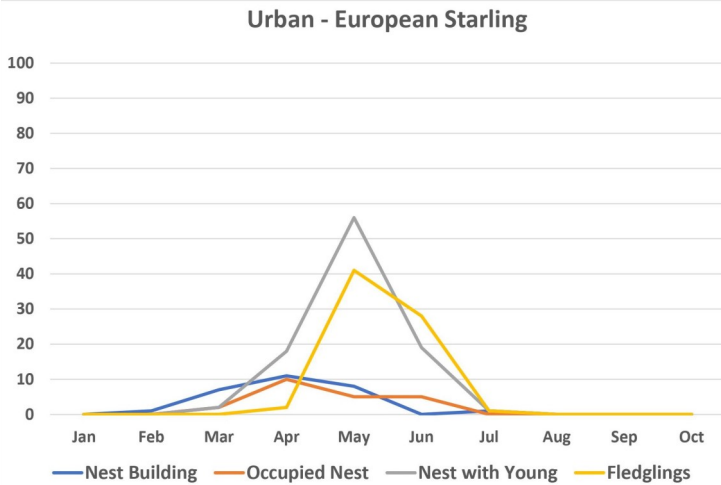
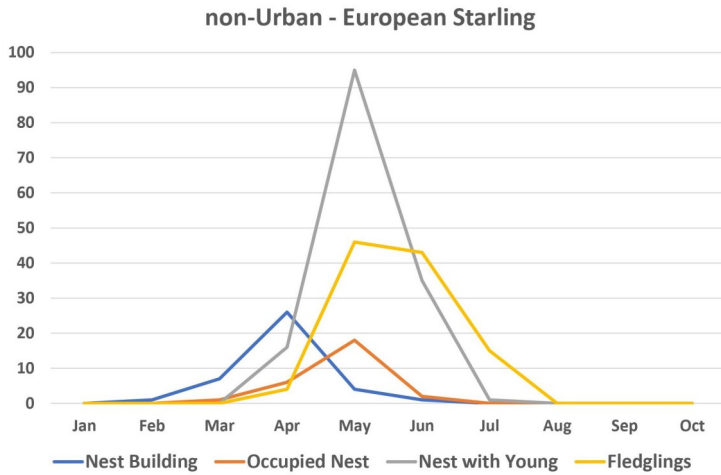


Figure 20. Comparison of non-urban vs. urban phenology for the European Starling.

Because most published data on breeding phenology were collected in non-urban settings and Sacramento County includes a large proportion of urban land cover, we also compared phenology of urban vs. non-urban breeders. The results for seven of the eight species with deviations from published data suggest that urban nesters account for many or all of those deviations.

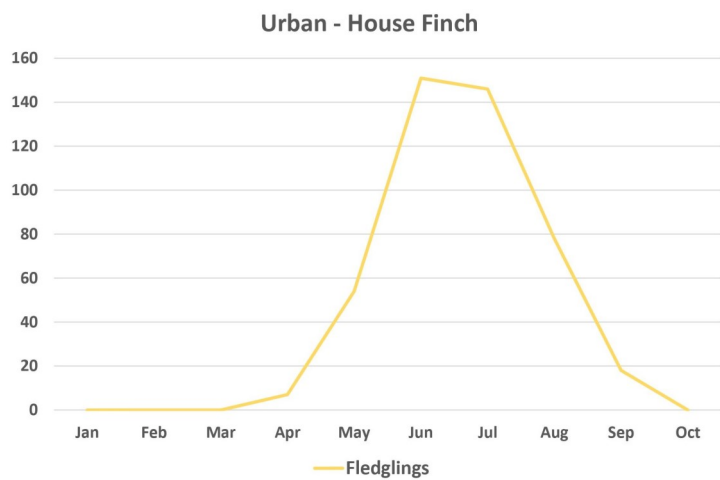
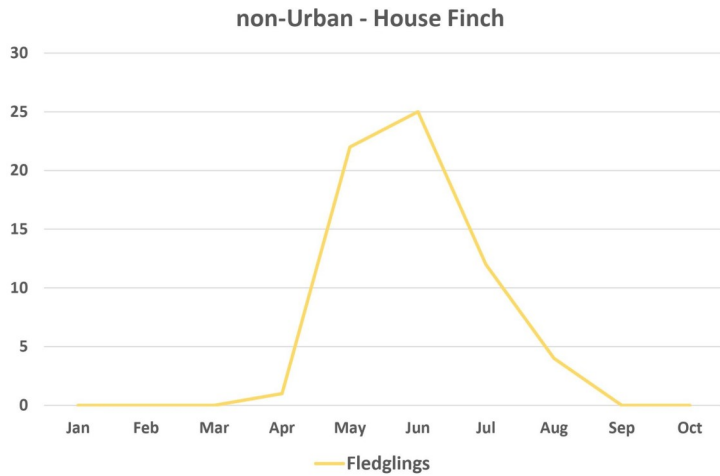


Figure 21. Comparison of non-urban vs. urban phenology for the House Finch (note that scales are not the same).

Taken together, these results suggest two possible hypotheses to explain the extended breeding seasons we observed for some species:

- Urban-nesting birds may be able to successfully raise more broods per season than non-urban nesters;
- Urban-nesting birds of these species may experience higher than normal rates of nest failure, and therefore produce a large number of replacement clutches.

These hypotheses could be tested with careful studies of breeding birds in both types of habitats in Sacramento County. In this regard, the recent work of Airola et al. (2021) on urban-nesting Yellow-billed Magpies in the county could provide a basis for comparison with non-urban populations for this species.

The long-neglected field of avian urban ecology now has a growing body of research comparing urban and non-urban breeding for many species (e.g., Gil and Brumm 2014). Those studies include examples that could support either of the two hypotheses above and reveal the complexity of factors that could be to the advantage or the detriment of urban nesters.

If food abundance and availability is greater in urban settings, this could improve nest success and make double-brooding more likely. Chace and Walsh (2006) and Amrhein (2014) found more food resources in urban settings due to factors such as wild bird feeding, exotic plantings, and scavenging sources, which could benefit granivores, frugivores, and omnivores. A recent review by Jones and Leather (2021) found that invertebrate abundance and diversity was generally lower in urbanized areas compared to non-urban ones, but Faeth et al. (2005) found contrary results in an arid location in Arizona, with available insect prey mass greater in urban areas. This result is likely due to the supplemental watering of urban landscapes. Sochat et al. (2006) suggested that food availability may be more reliable in urban settings where human activity creates more uniform and stable environmental conditions than in more natural non-urban areas. Given the seasonally arid nature of the Sacramento region and the impacts of occasional droughts, urban irrigation and other buffering effects could be important influences in this area.

Studies on effects of predation risk in urban habitats have produced some interesting paradoxes. For example, Fischer et al. (2012) found that, even in urban areas with higher predator abundance, predation of nesting birds was often reduced, perhaps due to better food availability or better adaptation to urban predators. Urban habitats may lack many of the predators common in non-urban habitats (Blumstein 2014), but urban sites include other predators such as domestic cats, considered the greatest source of bird mortality in the U.S. (Loss et al. 2013).

Human activity in the vicinity of nesting urban birds could also have contradictory effects. Disturbance near a nest can provoke nest abandonment or flushing when eggs or young need incubation or brooding. However, most urban studies show a high degree of habituation to human presence among urban birds (Blumstein 2014). Presence of humans may increase predation by causing birds to flush and fall victim to predators, or it may inhibit those predators if they are less habituated to humans (Blumstein 2014).

The literature provides some support for the hypothesis that favorable conditions in urban settings in our study led to more frequent multiple successful broods and an extended nesting season. The exhaustive review of breeding phenology of urban birds by Deviche and Davies (2014) found that, in most studies where urban and non-urban phenology were compared, urban-nesting birds showed earlier dates of nest-building, egg-laying, incubation, and hatching. The only two species that showed delayed breeding activity in urban settings were the European Starling and House Sparrow, both studied in their native European range. More recently, Marini et al. (2017) confirmed earlier nesting in Mountain Chickadees (*Poecile gambeli*) breeding in an urban setting than in a nearby non-urban site. Studies of several species confirmed that earlier nesting increased the frequency of double-brooding including Wrentit (*Chamaea fasciata*; Geupel and DeSante 1990), Western Bluebird (Jacobs et al. 2013), Black-throated Blue Warbler (*Setophaga caerulescens*; Townsend et al. 2013), Southern House Wren (*musculus* subspecies group; Carro et al. 2014), and European Hoopoe (*Upupa epops*; Hoffmann et al. 2015). Also, urban-nesting Great Tits (*Parus major*) had a higher frequency of double-brooding than birds nesting in forest habitats (Bukor et al. 2021).

Conclusion

Our results suggest that the breeding phenologies of several species in Sacramento County deviate substantially from published data and that much of that deviation may be due to extended breeding seasons of birds nesting in urbanized blocks. Whether those longer breeding seasons are due to more frequent re-nesting after failed attempts or more frequent successful double-brooding remains an open and fascinating question. Our review of studies comparing urban and non-urban nesting reveals factors that could permit raising of more successful broods per season (more abundant and reliable sources of food, longer breeding seasons, reduced predation by native predators), and factors that could lead to more frequent nest failure (increased human disturbance, predation by domestic predators). This question is amenable to testing with careful research by monitoring breeding of individuals in urban and non-urban settings in the county. Given the increasing encroachment of urban landscapes into previously non-urban habitats, understanding the effects of urbanization on breeding birds has important implications for conservation of these species.

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