CHAPTER THREE
CHANGES IN BREEDING PHENOLOGY BETWEEN THE TWO ATLASES

There is simply no further doubt that the earth's climate is changing. There is a rich and rapidly growing body of literature documenting the responses of plants and animals, including birds, to those changes (Forchhammer et al. 1998, Hughes 2000, Schneider and Root 2002, Walther et al. 2002, Crick 2004, Parmesan 2006, Møller et al. 2010, Charmantier and Gienapp 2013, Dunn and Møller 2014, Cohen et al. 2018, Scridel et al. 2018). Given that nearly three decades elapsed between these two atlases, we wanted to look at local climate differences between these two periods, and to see if any changes we see in breeding birds might be linked to those differences.

METHODOLOGY

Given that the primary purpose of any BBA is to assess the breeding status of all species in each block within the geographically chosen area, most atlases do not necessarily maintain careful records of the dates on which all breeding behaviors are observed (breeding phenology). However, during Atlas 1, TM was careful to maintain and compile phenology data. This gave us the opportunity to investigate any possible changes in the dates when breeding occurred between the two atlases. By collecting eBird data, and not having specific participants focus on specific blocks, we were able to collect these data for the full breeding season during Atlas 2. However, to compare the phenology data from Atlas 1 to Atlas 2, we needed to acknowledge how the difference in methods between the atlases might affect any comparison.

The primary issue is that, in a traditional BBA, once a species reaches the highest level of breeding confirmation in a given block, further data on that, or other (less confirmatory), breeding behavior is not routinely recorded for that species in that block. And, once a block reaches completion, participants generally move on to cover other blocks. Thus, in such a BBA (and in the case of Atlas 1), the dates recorded for breeding behaviors are strongly biased toward the earliest date those behaviors were observed. Therefore, we knew that comparing recorded phenology data from Atlas 1 to the full set of phenology data from Atlas 2 (which includes all behaviors throughout the season) would yield an inaccurate comparison. That is, data from Atlas 1 would contain an inherent bias for early dates, while data from Atlas 2 would include behaviors from the complete breeding season. Indeed, when we did a direct comparison of breeding phenology using all Atlas 2 data, we found that every breeding stage for every species appeared to occur later in the season in Atlas 2, undoubtedly due to this bias toward early dates in Atlas 1.

To address this, we filtered Atlas 2 breeding behavior to include only the first (earliest) occurrence of that behavior in each block. By doing this, we hoped to be able to approximate the way phenology data were collected in Atlas 1, and to make better comparisons between the two atlases.

Breeding Stages

For both atlases we divided the observations into four breeding stages: nest building, occupied nest, nest with young, and fledglings. The behaviors we assigned to each stage were:

- 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: feeding young or fledglings.

Species Compared

To limit our comparisons to species for which we had adequate data, we analyzed only those species which had at least 10 breeding stage observations for at least one of the four stages in both atlases. We compared median dates for each breeding stage for each species for which we had at least 10 observations of that breeding stage from each atlas. Thirty-five species met these criteria for at least one breeding stage. Prior to comparing phenology

Table 3-1. Species meeting our criteria for phenology comparisons between the atlases and group(s) to which we assigned them. Given that we have very limited data on movements of individual birds, our inclusion of species in the Sedentary group is based on our best assumption about these movements.

	Neotropical Migrant	Sedentary	Early Nester	Other
Mallard			X	
California Quail		X		
Pied-billed Grebe				X
Mourning Dove			X	
Killdeer			X	
White-tailed Kite		X		
Red-shouldered Hawk		X	X	
Red-tailed Hawk			X	
Great Horned Owl			X	
Nuttall's Woodpecker		X		
American Kestrel				X
Black Phoebe		X	X	
Western Kingbird	X			
Ash-throated Flycatcher	X			
American Crow			X	
California Scrub-Jay				X
Yellow-billed Magpie		X	X	
Cliff Swallow	X			
Barn Swallow	X			
Tree Swallow	X		X	
Northern Rough-winged Swallow	X			
Oak Titmouse		X	X	
Bushtit		X	X	
White-breasted Nuthatch		X		
American Robin				X
Northern Mockingbird		X		
European Starling			X	
House Sparrow		X	X	
House Finch				X
Western Meadowlark				X
Bullock's Oriole	X			
Red-winged Blackbird				X
Tricolored Blackbird				X
Brown-headed Cowbird				X
Brewer's Blackbird				X

data, we placed those species into four categories (Table 3-1): neotropical migrants, likely sedentary residents, early nesters, and other (uncategorized). Note that some species were placed into more than one category. While many of the species in the early nester and other categories are present in the county year-round, a subset (or perhaps all) of the local breeding individuals may make seasonal movements. Thus, we placed a species into the sedentary category only when we had a high degree of confidence that the breeding individuals remain in the area year-round.

Oak Titmouse by Tim Manolis

RESULTS

Given the differences in methods between the two atlases, and the relatively small number of observations, it is not possible to draw firm, statistically valid conclusions from our results. Nonetheless, the results do suggest some interesting patterns, especially when viewed in the context of local climate changes.

The neotropical migrant species we analyzed showed somewhat earlier dates during Atlas 2 for nest building and occupied nests; however, by the nestling and fledgling stages, there was little change from Atlas 1 (Figure 3-1). Likely sedentary residents showed earlier dates for occupied nests, but the nestling stage showed almost no change and fledglings may have appeared even later in Atlas 2 (Figure 3-2). Early nesting birds demonstrated the most consistent pattern (Figure 3-3), with each breeding stage earlier in Atlas 2. The other species (not assigned to any of the prior three categories) also showed consistently earlier dates, though the differences were smaller than for early nesters (Figure 3-4). The proportion of species nesting earlier in each stage showed a similar pattern (Figure 3-5), with only the early nesters and other categories having most species earlier in all four breeding stages.

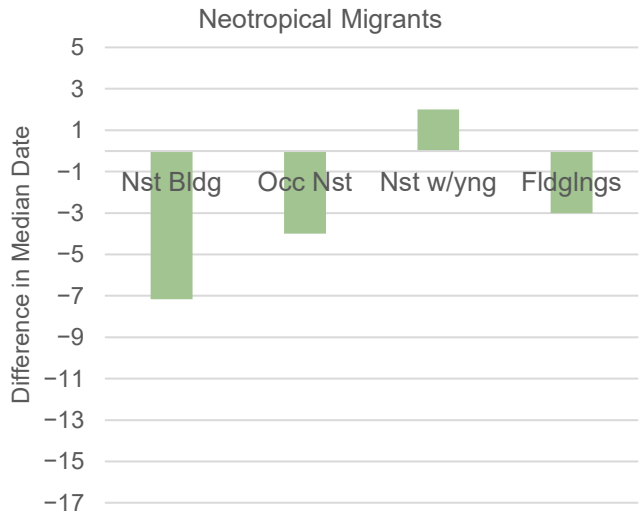

Figure 3-1. Difference (days) in median dates for each breeding stage between Atlas 2 and Atlas 1 for neotropical migrants (negative number = earlier dates in Atlas 2).

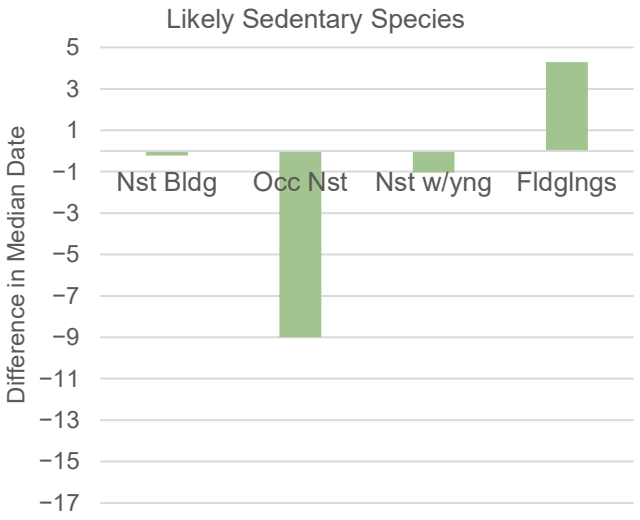

Figure 3-2. Difference (days) in median dates for each breeding stage between Atlas 2 and Atlas 1 for likely sedentary residents (negative number = earlier dates in Atlas 2).

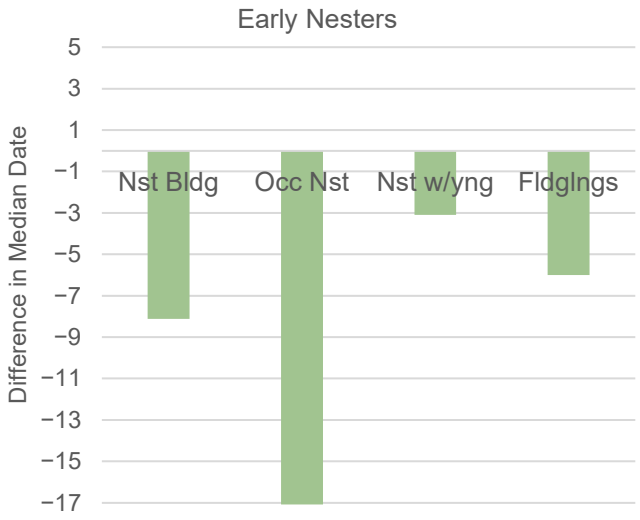

Figure 3-3. Difference (days) in median dates for each breeding stage between Atlas 2 and Atlas 1 for early nesting species (negative number = earlier dates in Atlas 2).

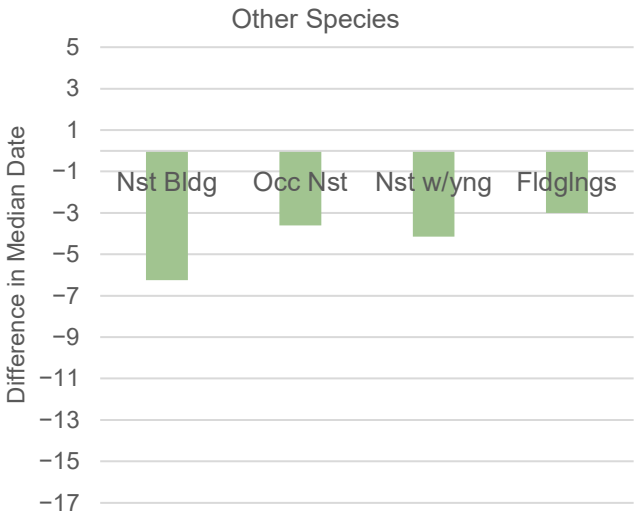

Figure 3-4. Difference (days) in median dates for each breeding stage between Atlas 2 and Atlas 1 for species that did not clearly fit into any of the other categories. (negative number = earlier dates in Atlas 2).

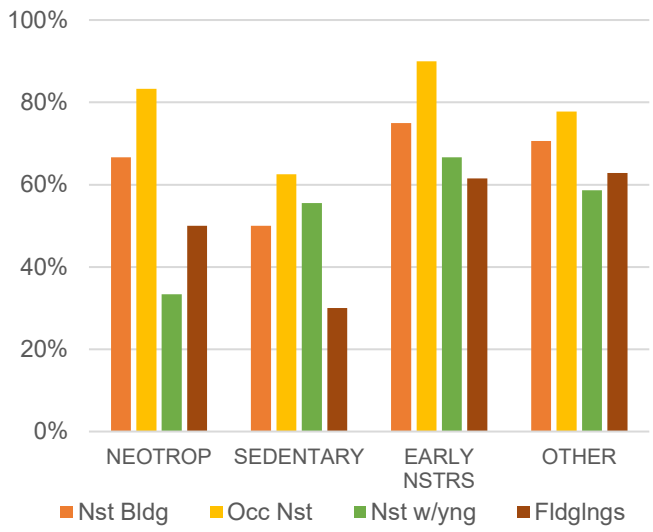

Figure 3-5. Percent of species breeding earlier in Atlas 2 by category and breeding stage.

Our confidence in the observed pattern of early nesting species showing a shift to earlier breeding is strengthened by seeing the impact of removing the early nesters from the neotropical or sedentary groups. When early nesters, Red-shouldered Hawk (*Buteo lineatus*), Black Phoebe (*Sayornis nigricans*), Yellow-billed Magpie (*Pica nuttalli*), Oak Titmouse (*Baeolophus inornatus*), Bushtit (*Psaltriparus minimus*), and House Sparrow (*Passer domesticus*), were removed from the sedentary category, the remaining species now showed slightly later breeding dates for each stage (Figure 3-6). When we removed the one early nester, Tree Swallow (*Tachycineta bicolor*), from the neotropical migrant group, nest building was still earlier, but the three subsequent stages showed little or no change (Figure 3-7).

DISCUSSION

As noted in Chapter Two, Sacramento winter temperatures were significantly warmer during Atlas 2 than during Atlas 1, consistent with long-term trends and previously noted by Hampton (2019), while spring-summer temperatures were essentially unchanged. Thus, our observation that early-nesting species appear to have advanced their breeding phenology may be due to these species taking advantage of those warmer temperatures. Perhaps the invertebrate prey that most of these species depend on for breeding have advanced their phenologies and are becoming available earlier. Extensive reviews and meta-analyses of patterns of breeding phenology change in response to climate have noted that resident species tend to show the largest changes, and migrants tend to show the smallest (Both et al. 2010, Halupka and Halupka 2017, Samplonius et al. 2018). It may be that resident species are able to respond much more quickly to local changes than migrants. Migrants would need to first advance their migration dates before showing a change in breeding phenology. Our findings are consistent with these observations. Indeed, the one early nester we included among the neotropical migrants, Tree Swallow, is a species found in our area in relatively small numbers throughout the winter. We do not know if those wintering individuals stay to breed, but if they do, that could explain their ability to respond to changes in local climate more easily than other migrants.

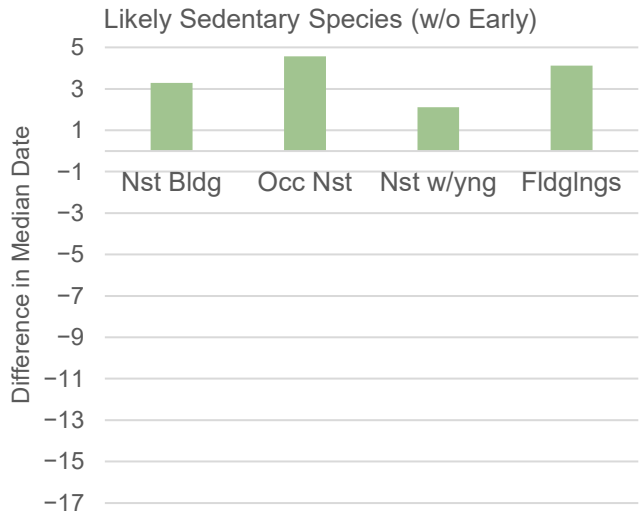

Figure 3-6. Difference (days) in median dates for each breeding stage between Atlas 2 and Atlas 1 for sedentary species after removing early nesters. (negative number = earlier dates in Atlas 2).

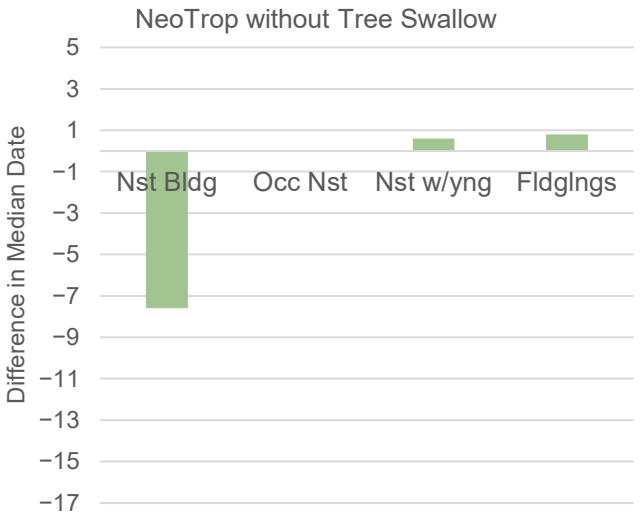

Figure 3-7. Difference (days) in median dates for each breeding stage between Atlas 2 and Atlas 1 for neotropical migrants after removing Tree Swallow. (negative number = earlier dates in Atlas 2).

Northern Harrier at nest by Barry Kent MacKay