American Kestrels (*Falco sparverius*) change nesting phenology amid a population decline: climate change or competition from European Starlings (*Sturnus vulgaris*) what results from 2015-2024 nest box study at the Ridgefield National Wildlife Refuge Indicate

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ABSTRACT

The decline of the American Kestrel population has been well-documented with resource competition and climate change proposed as potential causes. This study presents data from a ten-year monitoring project involving 14 nest boxes during the nesting season at the Ridgefield National Wildlife Refuge in Clark County, Washington. We observed a significant shift in nesting phenology, with kestrels nesting an average of 19.8 days earlier from 2020 to 2024 compared to 2015 to 2019 (p<0.01). During this latter period, the mean occupancy rate of American Kestrels rose from 22.5 ± 5.5% to 38.6 ± 6.5%, while the occupancy rate of their competitor, the European Starling, decreased from 64.0 ± 5.3% to 30.0 ± 9.6%. Importantly, no significant changes in climate were observed over the study period. The combination of stable climate conditions, changes in nesting phenology, and the narrowing gap in occupancy rates between American Kestrels and European Starlings suggests that this shift may be an adaptive response by American Kestrels to reduce competition for nesting cavities.

INTRODUCTION

The decline of the raptor populations has been extensively documented across several indicators (McClure *et al.* 2017, Goodrich *et al.* 2012, *Bystrak et al.* 2012). Data from the US Geological Survey's Breeding Bird Survey, National Audubon Society's Christmas Bird Count, nest box monitoring programs (Smallwood *et al.*2009), and Raptor Population Index (migration counts) (Hoffman and Smith 2003), collectively indicate long-term declines of American Kestrel populations in numerous regions of North America including the Pacific Northwest region (Figure 1).

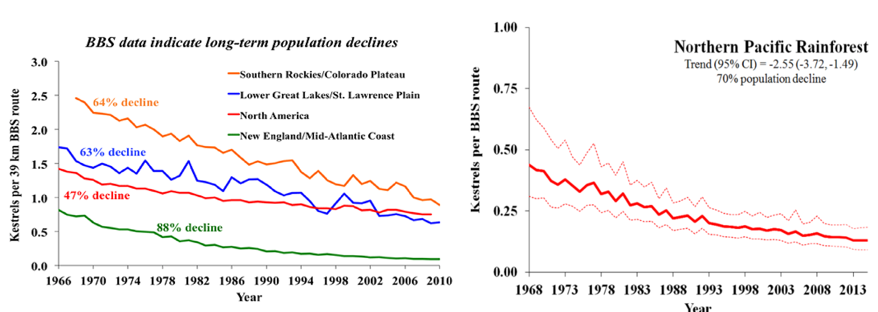

Figure 1. American Kestrel population declines as recorded from USGS banding data reported by region (1996-2010) and from the Northern Pacific Rainforest (1968-2013).

The American Kestrel (Falco sparverius) is the smallest falcon in North America and one of the most commonly observed raptors. As secondary cavity nesters, they typically nest in hollows created by other birds or mammals and often utilize nest boxes when natural cavities are scarce, primarily due to habitat loss and competition for nesting sites. Nest box programs have been implemented as a management tool to study kestrels and help increase their populations (Anderson *et al.* 2016, Strasser and Heath 2013, Katzer *et al.* 2005).

Several factors are proposed as potential causes for raptor population declines, particularly for American Kestrels: (1) habitat loss and fragmentation, (2) herbicide and pesticide use, (3) human disturbance (Stupik *et al.* 2015, Strasser and Heath 2013), (4) disease, (5) climate change (McClure et al. 2017), (6) biological changes specific to American Kestrels (Smith et al. 2017), (7) predation (Stupik *et al.* 2015, Smallwood *et al.* 2009), and (8) competition for nest cavities, notably with their primary competitor, the European Starling (Sturnus vulgaris) (McClure *et al*. 2015, Koenig 2003, Bechard and Bechard 1996). Each of these factors may contribute individually to the overall population declines.

We present data from a ten-year period of nest box monitoring conducted at the Ridgefield National Wildlife Refuge in Clark County, southwest Washington, USA.

STUDY GOAL

Our goal was to determine if climate change or competition for nesting sites was the cause of the nesting phenology shift and perhaps a factor for the population decline in our area.

STUDY SITE

Our study was conducted at the Ridgefield National Wildlife Refuge located in Ridgefield, Washington. The Ridgefield NWR is an area of marshes, wetlands, grasslands and riparian corridors as well as forests of Douglas fir and Oregon white oak that total 2,084 hectares, with the elevation ranging between 3 and 30m (Figure 2)(CCP 2010). Ridgefield NWR is made up of five units: the River "S", the Carty, Bachelor Island, Roth, and Ridgeport Dairy. The purpose of the refuge is to provide habitat for wintering waterfowl, except for the Carty and Roth units as they are managed as a natural floodplain. For this study nest boxes were set up in four of the five units of Ridgefield; River "S", Bachelor Island, Roth, and Ridgeport dairy. Ridgefield National Wildlife managers report no significant change in management practices or use of pesticides or herbicides within the refuge for the ten-year period of our study (personal communication).

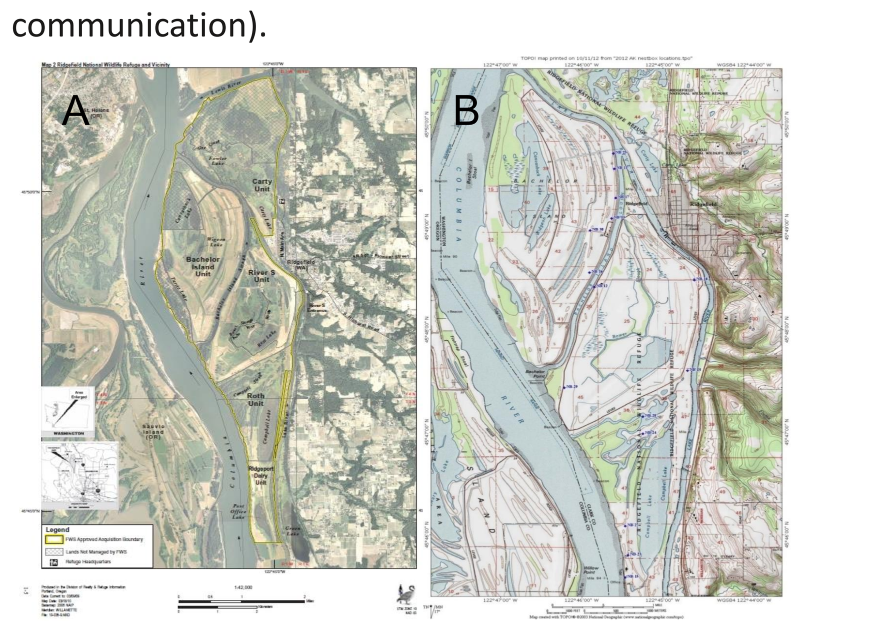

Figure 2. Aerial map(A) of the Ridgefield National Wildlife Refuge (WA) with units identified and 2024 American Kestrel nestbox locations (B) identified.

RESULTS

Nesting Phenology

American Kestrels are present year-round on the refuge and in the surrounding area, though some individuals may migrate. Over the course of our 10-year study, nest boxes were available for use 136 times. American Kestrels occupied these boxes 42 times, while European Starlings attempted to use them 63 times (Figure 3). We documented a significant shift in the nesting phenology of American Kestrels: from 2015-2019, the mean Julian Date for the first egg was 127.8 ±4.9, whereas from 2020-2024 it was 108 ±5.4, representing a shift in nesting of 19.8-days (p<0.01) (Figure 4). European Starlings laid their first eggs on a Julian date of 105.1 ±5.6. Consequently, the shift in nesting by American Kestrels during this period meant that the first eggs laid by European Starlings were only 2.9 days earlier than those of American Kestrels.

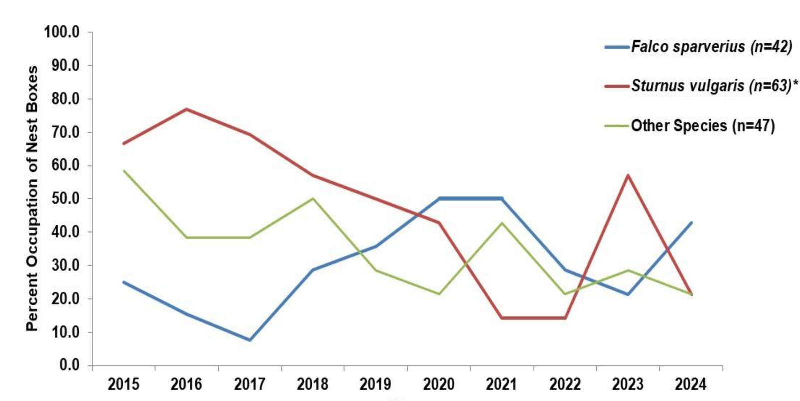

Figure 3. Percent occupation of nest boxes by American kestrels (Falco sparverius), European starlings (Sturnus vulgaris), and other species at Ridgefield National Wildlife Refuge (2015-2024).

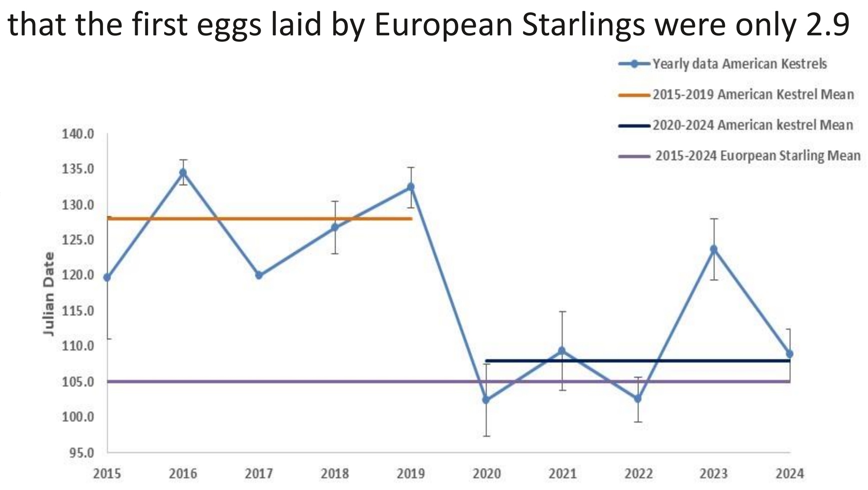

Figure 4. Julian date of egg laying for American kestrels with standard deviation by year from 2015-20204(n=42). Laying means from 2015-2019,2020-2020 and 2015-2024 for European starlings are also shown. There is a significant difference(p<0.01) between the means for American Kestrels 2015-2019 and 2020-2024.

Productivity

Of the 15 nesting attempts by American Kestrels, 13 were successful (78.3 ±10.9%) during the 2015-2019 period. From 2020-2024, 18 nesting attempts were successful out of the 27 total (69.0 ±9.6%). Furthermore, from 2015-2019, American Kestrels laid 4.5 ±0.64 eggs per clutch and the mean percentage of eggs to fledge young was 53.1.3 ±10.8%; the conversion rate of chicks to fledglings was 84.9 ±11.7 %. In contrast, from 2020-2024, American Kestrels produced 4.9 ±0.32 eggs per clutch and the mean percentage of eggs to fledge young was 56.5 ±10.3%; the conversion rate of chicks to fledglings was 73.0 ±7.3% (Figure 5). There was no significant difference in any productive measure between the two periods.

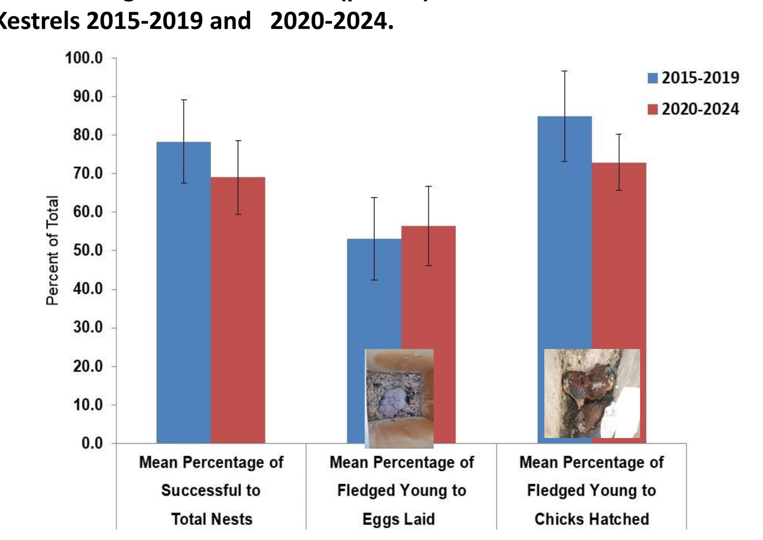

Figure 5. Comparison of mean percentage ratios for successful to total nests, fledged young to eggs laid, and fledged young to chicks hatched for American kestrels (Falco sparverius) at Ridgefield National Wildlife Refuge (2015-2019 vs. 2020-2024).

American Kestrel production was highest in 2019, when 5 pairs fledged 20 chicks. Production was lowest in 2017 when only 2 chicks were fledged. Two other native species used the nest boxes successfully: Purple Martins (*Progne subis*) and Tree Swallows (*Tachycineta bicolor*).

Climate Change

We also compared climatological data between the two 5-year periods including precipitation (Figure 5), mean monthly temperatures (Figure 6), and mean monthly low temperatures (Figure 7) to determine if there were any relevant differences, of which there were none.

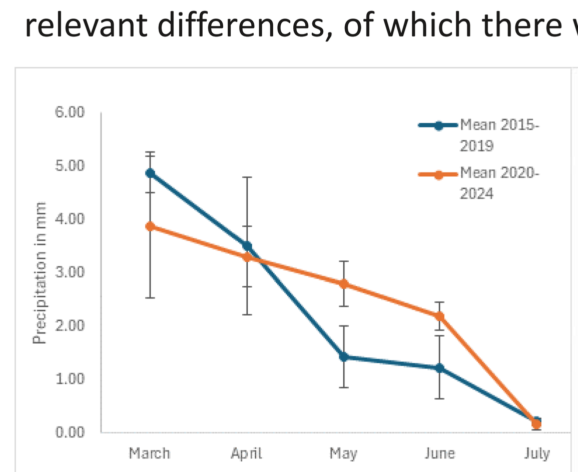

Figure 5. Comparison between the monthly mean precipitation (mm) in 2015-2019 and 2020-2024 from the NOAA station in Battleground, Washington.

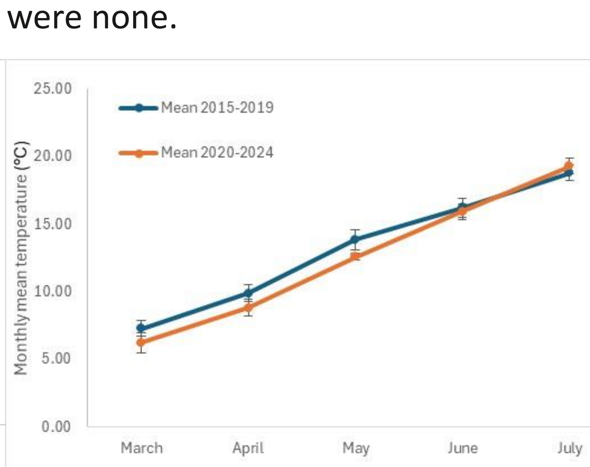

Figure 6. Comparison between the monthly mean temperature (°C) in 2015-2019 and 2020-2024 from the NOAA station in Battleground, Washington.

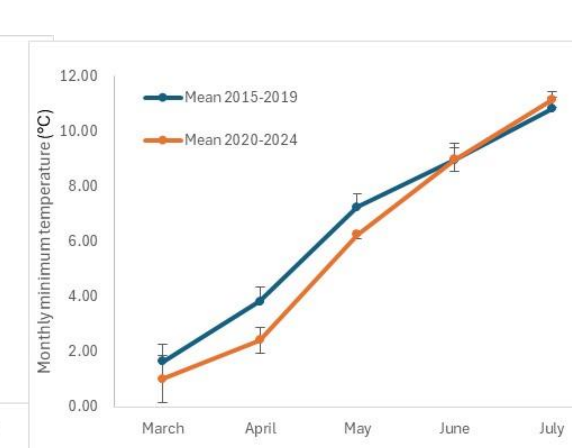

Figure 7. Comparison between the monthly minimum temperature (°C) in 2015-2019 and 2020-2024 from the NOAA station in Battleground, Washington.

Nesting Competition with European Starlings

We also compared the competition for nest boxes between American Kestrels and European Starlings on the refuge. From 2015-2019, American Kestrels had a total mean percent occupation of 22.5 ±5.5 (n=15) while European Starlings had a 64.0 ±5.3 total mean percent occupation. During 2020-2024, American Kestrels had a total mean percent occupation of 38.6 ±6.5 (n=27) while European Starlings had a 30.0 ±9.6 total mean percent occupation. European Starlings had a distinct decline in attempts that was statically significant (p=0.04). However, year to year occupation varied greatly for both time periods. American Kestrels attempted nesting in boxes 4 times after the removal of starling nests with eggs or nesting material during the 2015-2019 period but there were no post-starling occupation attempts during the 2020-2024 period.

METHODS

Nest boxes suitable for American Kestrels were placed at the Ridgefield National Wildlife Refuge (WA) in 2004; during subsequent years' additional nest boxes were added and others repaired and occasionally relocated (Fig 2 current locations). For the period of this study, we monitored 14 nest boxes. Nest boxes were cleaned, and 5-7 cm of new wood-shavings were added each March. All nest boxes were monitored weekly for occupation in the spring of each year. American Kestrel pairs were observed during the breeding season; records of nesting chronology and occupation of other species were recorded. European Starling nesting material and eggs, if present, were removed while native species were not otherwise disturbed. In 2016, we attached RFID chips to the leg bands of nesting adults. Adult birds were trapped via a bal-chatri trap or within the nest box; nestlings were sampled prior to fledging. The presence of eggs was recorded and converted to Julian days for both species, laying dates were estimated by clutch size on the day of first observation. All subjects were banded with USGS aluminum bands to allow for the identification of individual birds and standard morphometric data was collected for all individuals including age, sex, tarsus length, beak length and weight. All samples were collected in accordance with Guidelines to the use of wild birds in research (Fair 2010). We report productivity measures and reproductive output following Smallwood, 2009 and Katzner *et al.*,2005. All data are reported to USGS Bird banding laboratory and the American Kestrel Partnership. Annual climate data was retrieved from the NOAA reporting station located in Battle Ground, Washington approximately 19 kilometers from the refuge.

DISCUSSION

While there was no significant change in American Kestrel productivity, notable changes occurred in the mean Julian dates of the first egg laid and in nest box occupation. Beginning in 2020, American Kestrels started laying their first eggs 19.8 days earlier, which narrowed the gap between their first egg and that of European Starlings from 26.3 days to just 2.9 days. Additionally, the increase in the mean percentage of nest box occupation by American Kestrels contrasts with a significant decline in European Starling nesting attempts during the same period. This suggests that the kestrels' shift in nesting phenology may have effectively reduced starling occupancy and competition for nest boxes. Notably, in the 2020-2024 period, there were no attempts by Kestrels to occupy boxes after starlings, a change from the 2015-2019 period. American Kestrels are successfully minimizing competition for nesting sites with starlings nesting by shifting their nest phenology.

Despite the increase in nest box occupation and the shift in nesting timing, American Kestrels have not experienced a significant change in their overall productivity. While the Kestrels may be adapting their nesting strategies to mitigate competition with European Starlings it is not increasing productivity, and our productivity measures are similar those reported in the literature if slightly higher.

Our analysis of local climatological data—including precipitation, mean monthly temperatures, and mean monthly low temperatures—revealed no significant differences between the two study periods. This absence of climatic variability implies that the changes in nesting phenology and reproductive strategies are more likely driven by competitive interactions between American Kestrels and European Starlings than by environmental factors.

CONCLUSION

Given the significant decrease in the difference in mean Julian dates for the first egg laid between American Kestrels and European Starlings, coupled with the stable climate conditions from 2015-2019 to 2020-2024, we suggest that the shift in nesting phenology reflects an adaptive strategy by American Kestrels to reduce competition for nesting cavities. However, even with this adjustment, their productivity did not improve. Our study did not directly assess the potential impacts of disease and predation on the local American Kestrel or other factors proposed for the population decline.

While our findings provide insights into the reasons behind the shift in nesting phenology to reduce competition with European Starlings, further research is needed to understand why American Kestrel productivity did not improve alongside these changes, as well as to explore the possible effects of predation and disease on their population.

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LITERATURE CITED

ANDERSON, A. M., NOVAK, S. J., SMITH, J. F., STEENHOF, K. & HEATH, J. A. (2016). Nesting phenology, mate choice, and genetic divergence within a partially migratory population of American Kestrels. *Auk* **133,** 99-109.

BYSTRAK, D., NAKASH, E. & LUTMERDING, J. A. (2012). Summary of Raptor Banding Records at the Bird Banding Lab. *Journal of Raptor Research* **46,** 12-16.

Fair JM, Jones J. Guidelines to the use of wild birds in research. Ornithological Council; 2010.

GOODRICH, L. J., FARMER, C. J., BARBER, D. R. & BILDSTEIN, K. L. (2012). What Banding Tells Us About the Movement Ecology of Raptors. *Journal of Raptor Research* **46,** 27-35.

HOFFMAN, S. W. & SMITH, J. P. (2003). Population trends of migratory raptors in western North America, 1977-2001. *Condor* **105,** 397-419.

KATZNER, T., ROBERTSON, S., ROBERTSON, B., KLUCSARITS, J., MCCARTY, K. & BILDSTEIN, K. L. (2005). Results from a long-term nest-box program for American Kestrels: implications for improved population monitoring and conservation. *Journal of Field Ornithology* **76,** 217-226.

KOENIG, W. D. (2003). European Starlings and their effect on native cavity-nesting birds. *Conservation Biology* **17,** 1134-1140.

McClure CJWM, Sarah ES, Richard Van B, Benjamin PP, Julie AH. Commentary: Research Recommendations for Understanding the Decline of American Kestrels *(Falco sparverius*) Across Much of North America. Journal of Raptor Research 2017;**51**(4):455-464, 10.

Smallwood JA. Effects of Researcher-Induced Disturbance on American Kestrels Breeding in Nest Boxes in Northwestern New Jersey. Journal of Raptor Research 2016;**50**(1):54-59.

SMALLWOOD, J. A., CAUSEY, M. F., MOSSOP, D. H., KLUCSARITS, J. R., ROBERTSON, B., ROBERTSON, S., MASON, J., MAURER, M. J., MELVIN, R. J., DAWSON, R. D., BORTOLOTTI, G. R., PARRISH, J. W., JR., BREEN, T. F. & BOYD, K. (2009). Why Are American Kestrel (Falco sparverius) Populations Declining in North America? Evidence from Nest-Box Programs. *Journal of Raptor Research* **43,** 274-282.

STRASSER, E. H. & HEATH, J. A. (2013). Reproductive failure of a human-tolerant species, the American kestrel, is associated with stress and human disturbance. *Journal of Applied Ecology* **50,** 912-919.

STUPIK, A. E., SAYERS, T., HUANG, M., RITTENHOUSE, T. A. G. & RITTENHOUSE, C. D. (2015). Survival and Movements of Post-Fledging American Kestrels Hatched from Nest Boxes. *Northeastern Naturalist* **22,** 20-31.