*Thank you to the editor and reviewers for your thoughtful feedback on the manuscript. Editorial and reviewer feedback is in bold, responses are in normal text, and quotations from the manuscript are italicized.*

**Comments from the Associate Editor**

**Thank you for submitting your work to Ornithological Applications. I have now received two detailed reviews of the manuscript and have re-read the manuscript myself. While we all think there is value in evaluating whether telemetry data can be used to better understand the migration of American Woodcocks, both reviewers raised substantive concerns about the methodology. The reviewers felt, and I agree, that more justification or explanation was needed for several important assumptions made in the modeling process.  
  
Perhaps most importantly, both reviewers questioned whether it was reasonable to assume that all diurnal locations were on the ground and relatedly, assume that only “in flight” nocturnal locations can provide useful information about collision risk. As a result of these assumptions (and the choice of prior on the flight parameter), there were relatively few nocturnal locations used to inform estimated distributions of flight altitudes during migration.**

Please see our response to Reviewer 1’s concerns regarding the assumption that all diurnal locations are on the ground, and Reviewer 2’s interest in diurnal collision risk. In regard to sample size: we recognize that the dataset we use here is smaller than those used in many ornithological studies. Our small number of flight locations, especially relative to the >600 woodcock captured and tagged by the EWMRC since 2017, reflects the difficulty of capturing nocturnal migratory data from transmitters with limited battery life, when individuals are making migratory flights on only a few nights per year. Despite these limitations, we are able to leverage our much larger ground dataset to inform the error processes in the model and extract fairly precise estimates for the true flight altitude distribution (see credible intervals for Table 1 and Figure 2).

**There were also questions about assumed distributions for model parameters. In particular, it may not be reasonable to assume a normal distribution for altitude measurement errors.**

Please see our response to Reviewer 1’s concerns on this topic: we have switched to using a Student’s t-distribution for modeling measurement error as recommended in Péron et al. (2017).

**More information is also needed about the prior distribution used for the flight parameter (e.g., was this a beta distribution with mean = 0.33 and some unstated variance?). In the results, the authors report that 33% of nocturnal locations were classified as “in flight” (lines 203-205). Were there no data to inform the flight parameter since the mean value is exactly equal to the mean of the prior distribution?**

When revisiting the prior distribution for the flight parameter, we discovered that setting this informed prior was having more influence on the posterior distribution than we originally believed. We have made two changes to the model which have removed the need for an informed prior for

1. We have replaced the gamma distribution for flight altitudes with a log-normal distribution, which allows for a non-centered parameterization that samples more efficiently in Stan.
2. We have instituted a stricter definition for potential flight locations. In addition to requiring that potential flight locations be nocturnal locations recorded during migration, we now require that potential flight locations are preceded and followed by steps >6.68km (longer that 99% of stopover movements; Berigan 2024), increased from the former threshold of 1km. This removes a large portion of stopover locations from the dataset, where woodcock were making >1km transitory movements just after dusk and settling back on the ground before their locations were recorded at midnight. This has increased the proportion of true flight locations in the potential flight location dataset and made it easier for the model to correctly identify the flight altitude distribution.

As a consequence of these changes, the model now fits with a vague prior of Beta(2, 2) for , and vague priors for the log-normal distribution ( ~ N(0,1), ~ HN(0,1)).

**Finally, further discussion is needed about seasonal differences in migration altitudes given that more fatal collisions are documented in spring and yet their results suggest birds are flying at lower altitudes in fall.**

We have doubled the length of this section in the discussion, as shown below:

*p. 17*

*Woodcock collisions with buildings appear to occur more frequently during the spring rather than fall (Loss et al. 2019, Loss et al. 2020), which is notable as flight altitudes are generally higher during spring. This may be due to a mismatch between the data collection windows for bird collision studies and the fall migratory periods of woodcock (Loss et al. 2020). These building collisions may also be associated with the frequency of migratory stopovers: woodcock spend longer migrating during spring, and the increased number of stopovers may expose woodcock to a greater risk of building collision during crepuscular flights (Berigan 2024). Woodcock also conduct lengthy aerial displays during the spring, which may provide an additional opportunity for collision with buildings.*

**Comments from Reviewer 1**

**The manuscript describes flight height data from American woodcocks during spring and fall migration, demonstrating that this species flies lower on average and spends more time in the 'collision zone' than other migratory birds.**

**I appreciated that the error on the flight height data was corrected using ancillary information about when the birds were most likely to be flying (migration period at night). I would advise to highlight that aspect in the abstract. But unfortunately that information was ridden with errors. There was no way to 100% ascertain that the birds were flying or not. So I am not sure the approach was successful (some more details and consequences under point 4 below).  
  
I also appreciated that a mixture model was used to estimate the probability of flying during the migration period at night. Again, I advise emphasizing that in the abstract. Also again, that model was still fitted based the propagation of the error associated with the clearly false assumption that the birds never flew during the day and outside of the migration period.**

**All in all, I advise first to perform a sensibility analysis to the violation of the model assumptions (brief outline in point 4 below) and second to down-tone the conclusions and use the adverb "tentatively" more.**

Thank you for your comments; we have addressed them in detail below. We’ve also added the following sentence to the abstract to more closely reflect our methodology:

*p. 1*

*We implemented a Bayesian hierarchical mixture model to identify whether locations were recorded on the ground or during flight, isolate measurement error, and describe the distribution of flight altitudes.*

**Main comments  
1) From the abstract onwards the authors put too much emphasis on the average flight height, and not enough emphasis on the variance and overall variability. Both the mean and variance contribute to the probability to fly in the collision zone (Péron et al 2020 Animal Biotelemetry). For example, Table 1 absolutely needs to present the variance and maybe the skewness, not just the mean and median which are not informative enough in this context.**

We have added information on flight altitude variance to the abstract, and variance and skewness to Table 1 of the results. Our focus on mean flight altitudes is largely due to the utility of the mean for comparison to other studies, for which information on variance is often not available. We agree on the importance of variance for predicting collision risk, and incorporate variance into our methodology for determining exposure to airspace obstacles.

**2) The study locations are not provided. The text just says "across the eastern portion of their range". Please add the study locations.**

We have added the following sentence to the *Data collection and preprocessing* section of the methods:

*p. 5*

*We captured woodcock at 100 sites across the eastern portion of their range, including Alabama, Florida, Georgia, Louisiana, Maine, Maryland, New Jersey, New York, North Carolina, Nova Scotia, Ontario, Pennsylvania, Québec, Rhode Island, South Carolina, Vermont, Virginia, West Virginia, and Wisconsin.*

**3) Please explain how you determined whether "birds had a known migratory or non-migratory state". Does it mean that you removed the first few days and last few days of each migratory journey, as these would be the ones with the most uncertainty? In which case how much data was dropped? Please be specific.**

We’ve revised this section to state the following:

*p. 6*

*We subset these readings to include only locations in which birds had a known migratory or non-migratory state, based on the hidden Markov model delineations of migratory tracks derived in Berigan (2024).*

**4) "we assumed all diurnal and non-migratory points were known ground locations". This sounds like a very strong assumption. Please discuss the consequences of its violation for your inference. The birds are inevitably going to sometimes be flying when you don't want them to. Eg, circadian movement between roosts and foraging grounds outside of the migration period, disturbances etc. The estimated sampling error rate of the flight height is going to be inflated, thereby leading to a potentially large downward bias on the process variance in flight height, and associated bias on the estimated probability to fly in the collision zone. I would request some sensibility analysis. One approach would be to introduce a probability that the bird was flying when you initially considered it was not flying, and look at the change in the results when this probability varies.**

To simplify this assumption, we’ve modified the analysis to assume that only diurnal points (recorded at 1300–1500 hours Eastern Time) are known ground locations. Woodcock are somewhat unique among birds in that flight during diurnal hours is rare. Rabe et al. (1983) estimated that woodcock spend 2% of their diurnal time budget engaged in flight. Vander Haegen (1992) was more conservative, estimating that the true percentage was closer to 1%. When these flights do occur, they tend to be low altitude. Our personal observations suggest that woodcock typically make short flights a few meters above ground. When flushed they will occasionally climb to just above canopy height, after which they tend to maintain altitude (McAuley et al. 2020). Thus, we feel confident that 1) any flight locations which occur in the known ground subset of the data are rare, and 2) that these observations are of low altitude, and have limited capacity to bias the dataset. We have added a brief version of this clarifying information to the *Data collection and preprocessing* section of the methods.

As requested, we’ve also conducted a sensitivity analysis to determine the extent to which the presence of flight locations in the known ground subset of the dataset might bias our results. We randomly selected 2% of the data in this subset and added their preexisting altitude measurements (assumed to be attributable solely to measurement error; Equation 2) to a randomly generated diurnal flight altitude. We sampled these diurnal flight altitudes from a uniform distribution between 0 and 21.5m, with the upper limit determined by adding 5m to the average canopy height among all points in the dataset (extracted from LANDFIRE 2023). We then ran the model as normal and compared the new flight altitude metrics to those derived from our original model (Table R1).

Table R1. Flight altitude metrics derived from the original model, and a sensitivity analysis model in which 2% of known ground locations are actually recorded in flight.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Original model | | Sensitivity analysis | |
| Metric | Estimate | 95% Credible Interval | Estimate | 95% Credible Interval |
| Median flight altitude | 262m | 218–304m | 263m | 220–309m |
| Mean flight altitude | 379m | 320–447m | 380m | 318–449m |
| Standard deviation | 393m | 279–540m | 394m | 280–541m |
| Skewness | 3.95 | 2.64–6.53 | 3.96 | 2.62–6.49 |

**5) Eq. 1: from experience that distribution is in reality very far from Gaussian (Péron et al 2017 J Applied Ecology). Please provide empirical evidence from your data that the distribution of the error can be approximated with a Gaussian. Or maybe, also based on Péron et al 2017, suggest that correcting for non Gaussian features is not always necessary because the bias when not correcting was small in some cases.**

Thank you for pointing us towards Péron et al (2017). We conducted posterior predictive checks on our observation error using both Gaussian and Student’s t-distributions and found that the latter more accurately describes the heavy tails of the distribution. We have therefore switched our parameterization of observation error to use a Student’s t-distribution with similarly vague priors.

**6) Eq. 3. Again, please provide some justification for the Gamma distribution of true flight heights. It seems arbitrary to me.**

Please note our response to the Associate Editor’s comments, in which we detail our reasons for switching from a gamma to a log-normal distribution. We have added the following sentence to the methods:

*p. 7*

*We chose a log-normal distribution because it accommodated a heavy right tail, which is a common feature of bird altitude distributions (White et al. 2020).*

**Minor  
L89 I don't think you can make the case that woodcocks are less maneuverable. Indeed, round wings, lack of flocking reflex, comparatively slow flight and good night vision make them more maneuverable than other shorebirds and possibly passerines. And you don't need that argument.**

We have removed this text from the introduction.

**L94 "identified" -> suggested or proposed**

Changed to “suggested”.

**L102: What brought you to this hypothesis? If there is no reasoning or if it's a post-hoc hypothesis maybe say "postulated".**

Changed to “postulated”.

**L143: Can I ask that my paper is not put in the same basket as Poessel et al please? I know it's a bit out of line but I would appreciate.**

As this sentence is not essential to the manuscript, we have elected to remove the sentence entirely (including both citations).

**Comments from Reviewer 2**

**I read your paper with great interest. American Woodcocks are such a curious and interesting bird, and the chance to learn how its unusual morphology and flight ecology might combine to affect its susceptibility to collision with anthropogenic structures differentially by season, age, and sex intrigued me. I was initially concerned that your findings might lead to suggestions for mitigating the collision risk to this species that were at odds with those already recommended for nocturnally migrating passerines and near-passerines. I looked forward to your painting a picture of woodcock migration that was highly resolved thanks to the gigantic number of GPS positions you obtained.**

Thank you.

**I think that by using only the points you determined to be both nocturnal and representative of birds in flight to assess the importance of flight altitude, you may have missed a good opportunity to evaluate other important sources of collision risk, such as proximity to collision hazards for birds on the ground.**

We agree that discerning between diurnal and nocturnal collision risk is an important part of assessing collision vulnerability (see final paragraph of the discussion). We have an ongoing study that examines woodcock use of urban areas for stopovers during migration, including implications for their migratory survival, and will explore this topic further during that study.

**I generally think of birds colliding with objects while in active nocturnal migration as being associated with ALN and bad weather. During bad weather even the higher flying migrants are known to drop down in altitude and often become confused by ALN (artificial lights at night)--e.g., at lighthouses, tall skyscrapers, and even the 9-11 Memorial lights. Does the possibility that woodcocks fly lower on average than other nocturnal migrants put them at higher risk of collision caused mortality? I think that is the question you were trying to answer.**

We believe that our study provides evidence that low-flying migrants, such as woodcock, fly within the range of airspace obstacles even during good weather conditions. Other factors, such as ALN and bad weather, may exacerbate these issues, or interfere with woodcocks’ ability to avoid obstacles they encounter.

**I was intrigued by the possibility that intraspecific differences in flight altitude might be reflected in known demographics of salvaged specimens, and I think that would be an interesting avenue to pursue based on your current study. Given that female woodcocks are roughly 30% heavier than males, but have wings that are <10% larger than males, it might be interesting to know if females (and especially the lower flying immature females) in fact outnumber males in collision studies.**

This is certainly a topic of interest, and we’ve had discussions about partnering with a museum for a follow-up study based on the characteristics of salvaged specimens.

**I am left wondering if collision risk might be tied significantly to the geographic proximity to tall objects and buildings with reflective glass when woodcocks are on the ground, either immediately following or prior to their nocturnal migratory flights.**

We agree that woodcock are most likely to collide with buildings (especially low-rise buildings) during the takeoff and landing portions of their migratory flights. As above, we have an ongoing study that examines woodcock use of urban areas for migratory stopovers and will have the capacity to explore this issue in greater detail there.