Lack of evidence for discrete migration strategies in American Woodcock suggests potential for species' resilience

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Rationale and Research Questions

The American woodcock (*Scolopax minor*) is a migratory species experiencing long-term population decline due to habitat degradation (a). **Within-species diversity in behavior is important for resilience to climate and landscape change (b).**

Question 1. Does variation in migration strategy occur in discrete groups or along gradients, and what characteristics of migration are driving this?

Question 2. Are body condition, age/sex class, or location associated with strategy?

F1. American woodcock range map

Methods

F2. Map with gray circles showing capture locations

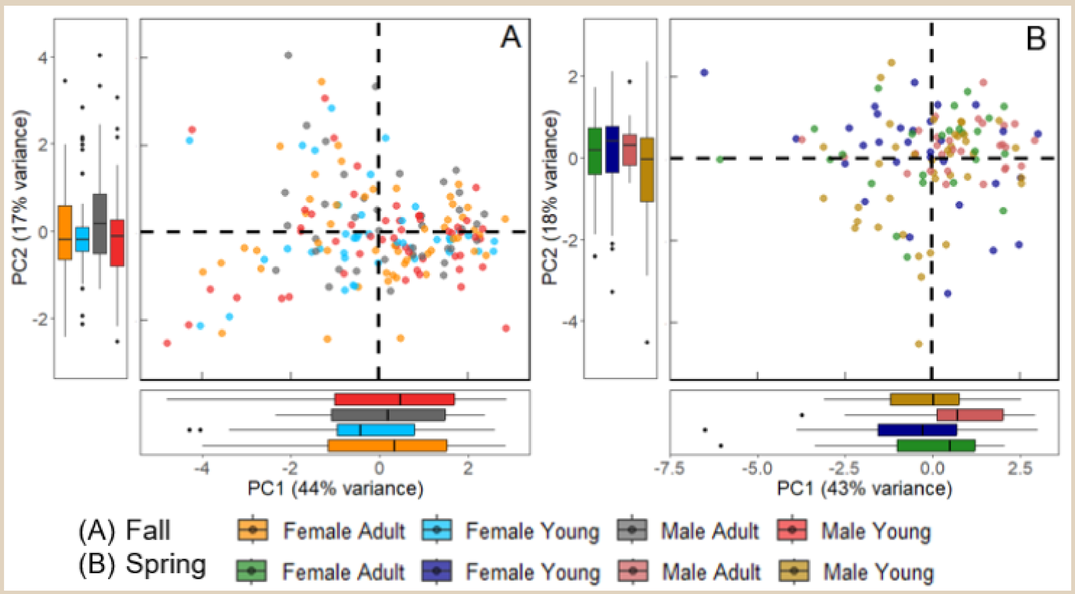
We used fall (southward, n=139) and spring (northward, n=132) GPS migration data collected between 2017 and 2022 across 17 US states and Canadian Provinces (F2) to calculate 7 migration metrics of ecological significance (T1).

Then, we used principal components analysis (PCA) to address question 1 and linear regressions with Principal Component (PC) score as a response and starting/ending location, body condition, and age/sex class as predictors to address question 2.

T1. Definitions of migration metrics calculated to characterize strategy

Migration Metric	Definition
Number of Stopping Events	Combined number of stops and stopovers
Proportion of Time in Stopover	Proportion of migration period spent in stopover
Migration Duration	Difference in time (days) between departure and arrival times
Mean Stopping Event Duration	Mean duration of all stopping events, including stops and stopovers
Mean Distance from Coast	Mean distance of migration GPS points from the nearest point on the Atlantic coastline
Migration Distance	Distance travelled along the bird's path from the last point of pre-migration to the first point of post-migration
Deviation from Straight Line Distance	Difference between straight migration distance and total migration distance
Departure Index	Relative departure date, correcting for location and bird characteristics (C)

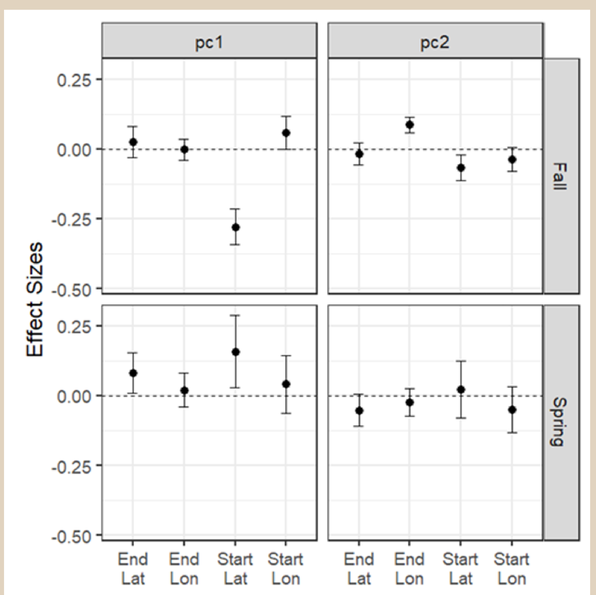
Results



F3. Scatterplots for (A) fall and (B) spring migration showing PC1 score on the X axis and PC2 score on the Y axis, with each point representing a bird. Boxplots along the x and y axes show the distribution of PC scores among age/sex classes. The dashed lines indicate a PC score of 0.

T2. PCA loadings for each migration metric. Terms with a loading of above 0.4, which we interpreted as substantial drivers of PC score (d), are bold

	Fall		Spring	
	PC1 (44%)	PC2 (17%)	PC1 (43%)	PC2 (18%)
Number of Stopping Events	**-0.46**	0.22	**-0.48**	0.19
Migration Duration	**-0.46**	**-0.40**	**-0.44**	**-0.35**
Mean Stop Duration	-0.17	**-0.44**	-0.06	**-0.72**
Migration Distance	**-0.51**	0.19	**-0.50**	0.17
Distance from Coast	-0.26	0.29	-0.29	0.05
Deviation from Straight Line	**-0.44**	0.23	**-0.47**	0.12
Departure Index	0.18	**0.65**	0.10	**0.52**



F4. Effect sizes for each spatial predictor in the principal components regression. Each panel represents one model. Points show mean effect sizes (β) and bars show 95% confidence intervals. The dashed line indicates 0 (i.e., no effect).

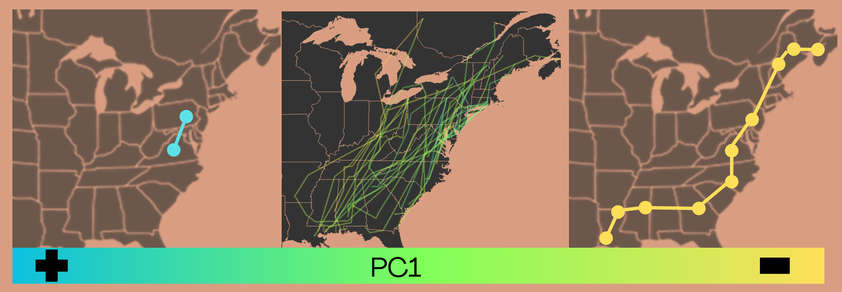
Variation in migration strategy occurs as gradients, not clusters, and PC scores were consistent across demographic groups (F3).

Migration characteristics related to distance and duration are primary drivers of variation in strategy (i.e., heavy loadings for PC1; T2).

Starting and ending location had significant ($p<0.05$) effects on PC score (F4), but body condition did not. Age/sex class did only for PC1 in the spring.

Discussion

Woodcock show gradients in migration strategy with similar patterns for fall and spring



F5. An illustration of a migration expected of a high (left) and low (right) PC1 score, with an example of 30 woodcock fall migration paths from our study colored according to PC1 score (center)

Migration distance drives variation in strategy, and this most substantially influenced by summer latitude, so decisions birds make in response to conditions at the start of fall and end of spring migration affect strategy.

The diversity and lack of discrete clusters in migration strategy indicate that woodcock as a species have plasticity in migratory behavior and are likely resilient to change.

References & Acknowledgements

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