*Low migratory flight altitudes may explain increased collision risk for American Woodcock*

Liam Berigan1\*, Sarah Clements1, Rachel Darling1, Alex Fish1, Amber Roth1,2, Greg Balkcom3, Bobbi Carpenter4, Gary Costanzo5, Jeffrey Duguay6, Kayleigh Filkins7, Clayton Graham8, William Harvey9, Michael Hook10, Douglas Howell11, Seth Maddox12, Scott McWilliams13, Shawn Meyer14, Theodore Nichols15, J. Bruce Pollard16, Christian Roy17, David Sausville18, Colby Slezak13, Josh Stiller19, Jacob Straub7, Mathieu Tetreault17, Dawn Washington20, Lisa Williams21, Erik Blomberg1.

1 Department of Wildlife, Fisheries, and Conservation Biology, University of Maine, Orono, Maine, USA.

2 School of Forest Resources, University of Maine, Orono, Maine, USA.

3 Georgia Department of Natural Resources, Wildlife Resources Division, Fort Valley, Georgia, USA.

4 Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Gainesville, Florida, USA.

5 Virginia Department of Wildlife Resources, Charles City, Virginia, USA.

6 Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana, USA.

7 Department of Environmental Science and Ecology, State University of New York-Brockport, Brockport, New York, USA.

8 Department of Natural Resources Science, University of Rhode Island, Kingston, Rhode Island, USA.

9 Wildlife and Heritage Service, Maryland Department of Natural Resources, Cambridge, Maryland, USA.

10 South Carolina Department of Natural Resources, Columbia, South Carolina, USA.

11 North Carolina Wildlife Resources Division, Wildlife Management Division, Edenton, North Carolina, USA.

12 Wildlife and Freshwater Fisheries Division, Alabama Department of Conservation and Natural Resources, Montgomery, Alabama, USA.

13 Department of Natural Resources Science, University of Rhode Island, Kingston, Rhode Island, USA.

14 Environment and Climate Change Canada, Ottawa, Ontario, Canada.

15 New Jersey Division of Fish and Wildlife, Woodbine, New Jersey, USA.

16 Environment and Climate Change Canada, Sackville, New Brunswick, Canada.

17 Environment and Climate Change Canada, Gatineau, Quebec, Canada.

18 Vermont Fish and Wildlife Department, Essex Junction, Vermont, USA.

19 New York State Department of Environmental Conservation, Division of Fish and Wildlife, Albany, New York, USA.

20 U.S. Fish and Wildlife Service, Davis, West Virginia, USA.

21 Pennsylvania Game Commission, Harrisburg, Pennsylvania, USA.

\*Corresponding author. Address: 506 Stone Gate Blvd, Elkton, MD, USA 21921. Email: liamaberigan@gmail.com.

**Acknowledgements**

We would like to thank the 43 collaborating organizations which have provided funding and logistic support since this project began in 2017, a full list of whom is available at woodcockmigration.org. Special thanks to C. Baranski, A. Bourgeois, R. Brown, L. Clark, T. Cooper, S. Heerkens, R. Masse, D. McAuley, G. Norman, T. Pitman, K. Sullivan, and H. Wallbridge for their significant contributions. J. Zydlewski, P. Rahimzadeh-Bajgiran, S. Morano, and M. Lewis provided comments which substantially improved this manuscript. P. Rahimzadeh-Bajgiran and K. Ongman provided invaluable methodological support.

*Funding statement*

Funding and logistic support was provided, in part, by the Alabama Department of Conservation and Natural Resources, American Woodcock Society, Association des Sauvaginiers du Saguenay-Lac-St-Jean, Canaan Valley National Wildlife Refuge, Cape May National Wildlife Refuge, Silvio O. Conte National Wildlife Refuge, Club des Bécassiers du Québec, Eastern Bird Banding Association, Environment and Climate Change Canada, Florida Fish and Wildlife Conservation Commission, Friends of the 500th, Georgia Department of Natural Resources, Louisiana Department of Wildlife and Fisheries, Maine Department of Inland Fisheries and Wildlife, Maryland Department of Natural Resources, Moosehorn National Wildlife Refuge, New Jersey Division of Fish and Wildlife, New York Department of Environmental Conservation, North Carolina Wildlife Resources Commission, Old Hemlock Foundation, Pennsylvania Game Commission, Penobscot Valley Chapter—Maine Audubon, Rhode Island Department of Environmental Management, Ruffed Grouse Society and American Woodcock Society, South Carolina Department of Natural Resources, The Nature Conservancy—New Jersey, The Nature Conservancy—Vermont, USFWS Webless Migratory Game Bird Program, USGS Patuxent Wildlife Research Center, University of Maine, University of Maine Canadian-American Center, University of Rhode Island, Vermont Fish and Wildlife Department, Virginia Department of Wildlife Resources, West Virginia Highlands Conservancy, Wildlife Management Institute, and the Woodcock Conservation Society. This project was supported by the USDA National Institute of Food and Agriculture, McIntire-Stennis project number ME0-21422 and ME0-42018 through the Maine Agricultural and Forest Experiment Station.

*Ethics statement*

All capture and handling was conducted in accordance with protocols approved by the University of Maine Institutional Animal Care and Use Committee (Protocols A2017-05-02 and A2020-07-01) as well as permits from the USGS Bird Banding Laboratory and Canadian Bird Banding Office.

*Conflict of interest statement*

The authors declare no conflicts of interest.

*Author contributions*

EJ, AR, and LB initially conceived of this paper, and LB conducted the analysis with support from SC. LB wrote the initial draft manuscript, and EJ and AR provided substantive feedback on subsequent drafts. EJ, AR, AF, RD, SC, and LB contributed to the collection and maintenance of the Eastern Woodcock Migration Research Cooperative dataset. GB, BC, GC, JD, KF, CG, WH, MH, DH, S Maddox, S McWilliams, S Meyer, TN, JP, CR, DS, CS, J Stiller, J Straub, MT, DW, and LW provided funding and/or logistic support for the acquisition and deployment of GPS transmitters on woodcock. All authors read and approved the final manuscript.

*Data availability*

The data underlying this article will be made available in the Dryad Digital Repository upon manuscript acceptance. Code used in these analyses is publicly available on Github at https://github.com/EWMRC/flight-altitude.