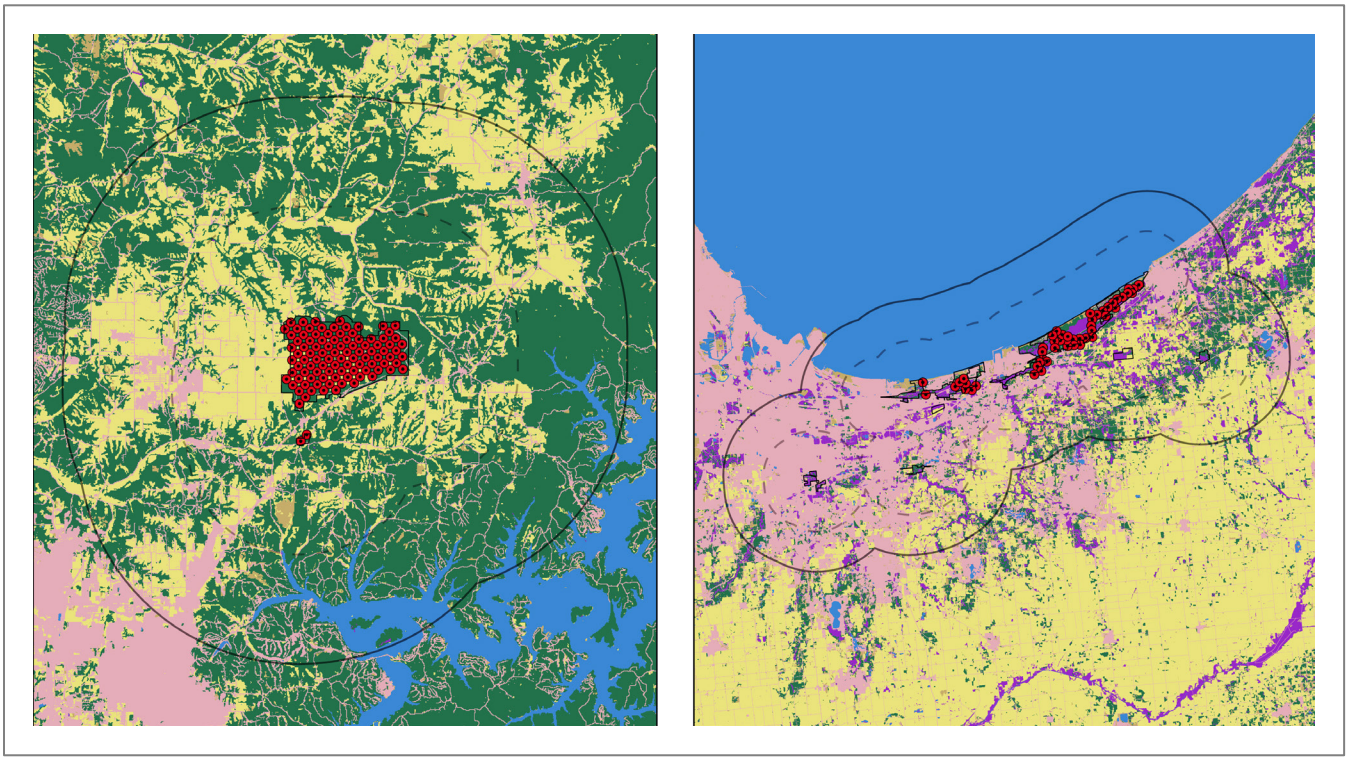
National Park Service
U.S. Department of the Interior

Science Report NPS/SR—2025/317
https://doi.org/10.36967/2312602

US National Park Units as Breeding Bird Habitat

A Comparison of Species Prevalence and Land Cover across the Midwestern and Central United States



Parks are sometimes islands of habitat within a larger urban, residential, or agricultural landscape.

MAPS CREATED BY THE NATIONAL PARK SERVICE USING INFORMATION FROM THE NATIONAL LAND COVER DATABASE (NLCD)

US national park units as breeding bird habitat: A comparison of species prevalence and land cover across the midwestern and central United States

Science Report NPS/SR—2025/317

Ryan C. Burner[1], Alan A. Kirschbaum[2], Ted Gostomski[2], David G. Peitz[3]

[1] US Geological Survey
Upper Midwest Environmental Sciences Center
2630 Fanta Reed Rd
La Crosse, WI 54601

[2] National Park Service
Great Lakes Inventory and Monitoring Network
2800 Lakeshore Drive East
Ashland, WI 54806

[3] National Park Service
Heartland I&M Network
Wilson's Creek National Battlefield
5242 S. State Hwy ZZ
Republic, MO 65738

Please cite this publication as:

Burner, R. C., A. A. Kirschbaum, T. Gostomski, and D. G. Peitz. 2025. US national park units as breeding bird habitat: A comparison of species prevalence and land cover across the midwestern and central United States. Science Report NPS/SR—2025/317. National Park Service, Fort Collins, Colorado. https://doi.org/10.36967/2312602

NPS 920/197253, June 2025

The National Park Service Science Report Series disseminates information, analysis, and results of scientific studies and related topics concerning resources and lands managed by the National Park Service. The series supports the advancement of science, informed decisions, and the achievement of the National Park Service mission.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible and technically accurate.

Views, statements, findings, conclusions, recommendations, and data in this report do not necessarily reflect views and policies of the National Park Service, US Department of the Interior. Mention of trade names or commercial products does not constitute endorsement or recommendation for use by the US Government.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

This report is available in digital format from the National Park Service DataStore and the Natural Resource Publications Management website. If you have difficulty accessing information in this publication, particularly if using assistive technology, please email irma@nps.gov.

Contents

Page

Figures v
Tables xii
Abstract xiii
List of Acronyms xiv
Acknowledgments xvi
Introduction 1
Bird Conservation Regions and Bird Monitoring 1
Park Landscapes 5
Methods 6
Landscape Habitat Assessment 6
Land Cover Trends Through Time 6
Monitoring Birds in the National Parks 7
Analyses 12
Results 13
Landscape Analyses 13
Bird Conservation Region Analyses 17
Prairie Potholes (BCR 11) 17
Boreal Hardwood Transition (BCR 12) 20
Badlands and Prairies (BCR 17) 23
Shortgrass Prairie (BCR 18) 26
Central Mixed Grass Prairie (BCR 19) 29
Eastern Tallgrass Prairie (BCR 22) 32
Prairie Hardwood Transition (BCR 23) 35
Central Hardwoods (BCR 24) 38
Mississippi Alluvial Valley (BCR 26) 41
Appalachian Mountains (BCR 28) 43
Summary 43
Discussion 44

Contents (continued)

Page

Literature Cited 46

Appendix A. Park-specific Results. 51

Appendix B. Detections of Species of Interest in Each Midwest Park Unit. 116

Figures

Page

Figure 1. National park units in the Midwest Region's three Inventory and Monitoring networks: Great Lakes Network (GLKN; blue dots), Heartland Network (HTLN; green dots), and Northern Great Plains Network (NGPN; orange dots). 3

Figure 2. Land cover proportions within each park (top row) and in a 5-km and 10-km buffer (middle and bottom rows, respectively) around 35 national park units in three Midwest Region Inventory and Monitoring networks. 4

Figure 3. Percentage of landscape models showing statistically significant change ($p<0.05$) in percent land cover, by analysis area (within the park, 5 km outside the park, and 10 km outside the park). 14

Figure 4. Percentage of landscape models showing statistically significant change ($p<0.05$) in percent of land cover, by Bird Conservation Region. 16

Figure 5. Proportion of predicted versus actual bird species detections on National Park Service (NPS) survey routes at two parks in Bird Conservation Region (BCR) 11: Missouri National Recreational River (MNRR) and Pipestone National Monument (PIPE). 18

Figure 6. Trends through time in land cover classes at National Park Service (NPS) units within Bird Conservation Region (BCR) 11: Missouri National Recreational River (MNRR) and Pipestone National Monument (PIPE). 19

Figure 7. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at seven parks in Bird Conservation Region (BCR) 12: Apostle Islands National Lakeshore (APIS), Grand Portage National Monument (GRPO), Isle Royale National Park (ISRO), Pictured Rocks National Lakeshore (PIRO), the northern half of the Saint Croix National Scenic Riverway (SACN), Sleeping Bear Dunes National Lakeshore (SLBE), and Voyageurs National Park (VOYA). 21

Figure 8. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 12: Apostle Islands National Lakeshore (APIS), Grand Portage National Monument (GRPO), Isle Royale National Park (ISRO), Pictured Rocks National Lakeshore (PIRO), the northern half of the Saint Croix National Scenic Riverway (SACN), Sleeping Bear Dunes National Lakeshore (SLBE), and Voyageurs National Park (VOYA). 22

Figures (continued)

Page

Figure 9. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at nine parks in Bird Conservation Region (BCR) 17: Badlands National Park (BADL), Devils Tower National Monument (DETO), Fort Laramie National Historic Site (FOLA), Jewel Cave National Monument (JECA), Knife River Indian Villages National Historic Site (KNRI), Mount Rushmore National Memorial (MORU), Niobrara National Scenic River (NIOB), Theodore Roosevelt National Park (THRO), and Wind Cave National Park (WICA). 24

Figure 10. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 17: Badlands National Park (BADL), Devils Tower National Monument (DETO), Fort Laramie National Historic Site (FOLA), Jewel Cave National Monument (JECA), Knife River Indian Villages National Historic Site (KNRI), Mount Rushmore National Memorial (MORU), Niobrara National Scenic River (NIOB), Theodore Roosevelt National Park (THRO), and Wind Cave National Park (WICA). 25

Figure 11. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at two parks in Bird Conservation Region (BCR) 18: Agate Fossil Beds National Monument (AGFO) and Scotts Bluff National Monument (SCBL). 27

Figure 12. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 18: Agate Fossil Beds National Monument (AGFO) and Scotts Bluff National Monument (SCBL). 28

Figure 13. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at Homestead National Historical Park (HOME) in Bird Conservation Region (BCR) 19. 30

Figure 14. Trends through time in land cover classes at Homestead National Historical Park (HOME) in Bird Conservation Region (BCR) 19. 31

Figure 15. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at three parks in Bird Conservation Region (BCR) 22: Herbert Hoover National Historical Site (HEHO), Hopewell Culture National Historical Park (HOCU), and Tallgrass Prairie National Preserve (TAPR). 33

Figure 16. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 22: Herbert Hoover National Historical Site (HEHO), Hopewell Culture National Historical Park (HOCU), and Tallgrass Prairie National Preserve (TAPR). 34

Figures (continued)

Page

Figure 17. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at four parks in Bird Conservation Region (BCR) 23: Effigy Mounds National Monument (EFMO), Indiana Dunes National Park (INDU), Mississippi National River and Recreation Area (MISS), and the southern half of the St. Croix National Scenic Riverway (SACN). 36

Figure 18. Trends through time in land cover classes at National Park Service (NPS) units in BCR 23: Effigy Mounds National Monument (EFMO), Indiana Dunes National Park (INDU), Mississippi National River and Recreation Area (MISS), and the southern half of the St. Croix National Scenic Riverway (SACN). 37

Figure 19. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at four parks in Bird Conservation Region (BCR) 24: George Washington Carver National Monument (GWCA), Lincoln Boyhood National Memorial (LIBO), Pea Ridge National Military Park (PERI), and Wilson's Creek National Battlefield (WICR). 39

Figure 20. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 24: George Washington Carver National Monument (GWCA), Lincoln Boyhood National Memorial (LIBO), Pea Ridge National Military Park (PERI), and Wilson's Creek National Battlefield (WICR). 40

Figure 21. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at Arkansas Post National Memorial (ARPO) in Bird Conservation Region (BCR) 26. 41

Figure 22. Trends through time in land cover classes at Arkansas Post National Memorial (ARPO) in Bird Conservation Region (BCR) 26. 42

Figure 23. Land cover classes at Agate Fossil Beds National Monument (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 52

Figure 24. Proportion of actual versus predicted bird species detections during surveys at Agate Fossil Beds National Monument (Nebraska). 53

Figure 25. Land cover classes at Apostle Islands National Lakeshore (Wisconsin) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 54

Figure 26. Proportion of actual versus predicted bird species detections during surveys at Apostle Islands National Lakeshore (Wisconsin). 55

Figure 27. Land cover classes at Arkansas Post National Memorial (Arkansas) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 56

Figures (continued)

Page

Figure 28. Proportion of actual versus predicted bird species detections during surveys at Arkansas Post National Memorial (Arkansas). 57

Figure 29. Land cover classes at Badlands National Park (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 58

Figure 30. Proportion of actual versus predicted bird species detections during surveys at Badlands National Park (South Dakota). 59

Figure 31. Land cover classes at Devil's Tower Beds National Monument (Wyoming) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 60

Figure 32. Proportion of actual versus predicted bird species detections during surveys at Devil's Tower Beds National Monument (Wyoming). 61

Figure 33. Land cover classes at Effigy Mounds National Monument (Iowa) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 62

Figure 34. Proportion of actual versus predicted bird species detections during surveys at Effigy Mounds National Monument (Iowa). 63

Figure 35. Land cover classes at Fort Laramie National Historical Site (Wyoming) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 64

Figure 36. Proportion of actual versus predicted bird species detections during surveys at Fort Laramie National Historical Site (Wyoming). 65

Figure 37. Land cover classes at George Washington Carver National Monument (Missouri) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 66

Figure 38. Proportion of actual versus predicted bird species detections during surveys at George Washington Carver National Monument (Missouri). 67

Figure 39. Land cover classes at Grand Portage National Monument (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 68

Figure 40. Proportion of actual versus predicted bird species detections during surveys at Grand Portage National Monument (Minnesota). 69

Figure 41. Land cover classes at Herbert Hoover National Historic Site (Iowa) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 70

Figure 42. Proportion of actual versus predicted bird species detections during surveys at Herbert Hoover National Historic Site (Iowa). 71

Figure 43. Land cover classes at Homestead National Historical Park (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 72

Figures (continued)

Page

Figure 44. Proportion of actual versus predicted bird species detections during surveys at Homestead National Historical Park (Nebraska). 73

Figure 45. Land cover classes at Hopewell Culture National Historical Park (Ohio) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 74

Figure 46. Proportion of actual versus predicted bird species detections during surveys at Hopewell Culture National Historical Park (Ohio) 75

Figure 47. Land cover classes at Indiana Dunes National Park (Indiana) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 76

Figure 48. Proportion of actual versus predicted bird species detections during surveys at Indiana Dunes National Park (Indiana). 77

Figure 49. Land cover classes at Isle Royale National Park (Michigan) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 78

Figure 50. Proportion of actual versus predicted bird species detections during surveys at Isle Royale National Park (Michigan). 79

Figure 51. Land cover classes at Jewel Cave National Monument (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 80

Figure 52. Proportion of actual versus predicted bird species detections during surveys at Jewel Cave National Monument (South Dakota). 81

Figure 53. Land cover classes at Knife River Indian Villages National Historic Site (North Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 82

Figure 54. Proportion of actual versus predicted bird species detections during surveys at Knife River Indian Villages National Historic Site (North Dakota). 83

Figure 55. Land cover classes at Lincoln Boyhood National Memorial (Indiana) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 84

Figure 56. Proportion of actual versus predicted bird species detections during surveys at Lincoln Boyhood National Memorial (Indiana). 85

Figure 57. Land cover classes at Mississippi National River and Recreation Area (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 86

Figure 58. Proportion of actual versus predicted bird species detections during surveys at Mississippi National River and Recreation Area (Minnesota). 87

Figures (continued)

Page

Figure 59. Land cover classes at Missouri National Recreational River (South Dakota/Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 88

Figure 60. Proportion of actual versus predicted bird species detections during surveys at Missouri National Recreational River (South Dakota/Nebraska). 89

Figure 61. Land cover classes at Mount Rushmore National Memorial (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 90

Figure 62. Proportion of actual versus predicted bird species detections during surveys at Mount Rushmore National Memorial (South Dakota). 91

Figure 63. Land cover classes at Niobrara National Scenic River (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 92

Figure 64. Proportion of actual versus predicted bird species detections during surveys at Niobrara National Scenic River (Nebraska). 93

Figure 65. Land cover classes at Pea Ridge National Military Park (Arkansas) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 94

Figure 66. Proportion of actual versus predicted bird species detections during surveys at Pea Ridge National Military Park (Arkansas) 95

Figure 67. Land cover classes at Pictured Rocks National Lakeshore (Michigan) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 96

Figure 68. Proportion of actual versus predicted bird species detections during surveys at Pictured Rocks National Lakeshore (Michigan). 97

Figure 69. Land cover classes at Pipestone National Monument (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 98

Figure 70. Proportion of actual versus predicted bird species detections during surveys at Pipestone National Monument (Minnesota). 99

Figure 71. Land cover classes at St. Croix National Scenic Riverway (Wisconsin/Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 100

Figure 72. Proportion of actual versus predicted bird species detections during surveys at St. Croix National Scenic Riverway (Wisconsin/Minnesota). 101

Figure 73. Land cover classes at Scotts Bluff National Monument (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 102

Figures (continued)

Page

Figure 74. Proportion of actual versus predicted bird species detections during surveys at Scotts Bluff National Monument (Nebraska). 103

Figure 75. Land cover classes at Sleeping Bear Dunes National Lakeshore (Michigan) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 104

Figure 76. Proportion of actual versus predicted bird species detections during surveys at Sleeping Bear Dunes National Lakeshore (Michigan). 105

Figure 77. Land cover classes at Tallgrass Prairie National Preserve (Kansas) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 106

Figure 78. Proportion of actual versus predicted bird species detections during surveys at Tallgrass Prairie National Preserve (Kansas)..... 107

Figure 79. Land cover classes at Theodore Roosevelt National Park (North Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 108

Figure 80. Proportion of actual versus predicted bird species detections during surveys at Theodore Roosevelt National Park (North Dakota). 109

Figure 81. Land cover classes at Voyageurs National Park (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 110

Figure 82. Proportion of actual versus predicted bird species detections during surveys at Voyageurs National Park (Minnesota)..... 111

Figure 83. Land cover classes at Wilson's Creek National Battlefield (Missouri) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 112

Figure 84. Proportion of actual versus predicted bird species detections during surveys at Wilson's Creek National Battlefield (Missouri). 113

Figure 85. Land cover classes at Wind Cave National Park (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023). 114

Figure 86. Proportion of actual versus predicted bird species detections during surveys at Wind Cave National Park (South Dakota). 115

Tables

Page

Table 1. Bird Conservation Regions (BCRs) in the Midwest Region inventory and monitoring networks and the number of park units where songbird monitoring is conducted. 2

Table 2. National Land Cover Database (NLCD) cover classes grouped into covariates for analyzing bird count data using Bayesian hierarchical models. 6

Table 3. National Land Cover Database (NLCD) cover class groupings for trend analysis of land cover in U.S. national parks in the Midwest Region. 6

Table 4. National park units included in this study, arranged by Inventory and Monitoring (I&M) network, with locations by State and Bird Conservation Region (BCR) shown. 8

Table 5. Species of concern by Bird Conservation Region (BCR). 10

Table 6. Number of models showing statistically significant change ($p<0.05$) in percent land cover, grouped by analysis area (within the park, 5 km outside the park, and 10 km outside the park). 15

Table 7. Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. 116

Abstract

The value of national parks as bird habitat depends not only on local conditions within the parks, but also on the landscape habitat matrices in which they are located. However, the influences of local and landscape habitat matrices on birds vary by species and have not been quantified. Similarly, the trends of land cover types through time have not been systematically quantified for Midwest Region national parks and the landscapes around them, despite evidence of ongoing habitat loss exacerbated by climate change and human population growth. Managers and policy makers can use this information to understand and sustain the contribution of parks to our Nation's avifauna.

We developed models using North American Breeding Bird Survey (BBS) data collected on routes from across the central United States. The models were used to predict occupancy of bird species of concern in 32 national park units across nine Bird Conservation Regions in the Midwest based on land cover in and around those parks. We then compared these predictions with data collected through National Park Service (NPS) bird surveys at each park to determine if bird species of concern were more or less prevalent than expected.

In each park, the mean difference between observed species detections and mean predicted detections indicates that most species are less frequently detected in the parks than predicted. However, when the range of uncertainty of predictions is considered, only 21% of park-bird combinations showed strong evidence (95%) of differing from expectation. Of these, species were less common than expected in the park in all but two cases.

These results indicate that some bird species of concern occupy sites in Midwest Region national park units at a rate roughly comparable to sites with similar land cover in the Bird Conservation Region (BCR) in which they occur. However, for one in five species-park combinations, parks appear to be less occupied than comparable sites elsewhere.

List of Acronyms

AGFO: Agate Fossil Beds National Monument

APIS: Apostle Islands National Lakeshore

ARPO: Arkansas Post National Memorial

BADL: Badlands National Park

BCR: Bird Conservation Region

DETO: Devils Tower National Monument

EFMO: Effigy Mounds National Monument

FOLA: Fort Laramie National Historic Site

GLKN: Great Lakes Inventory and Monitoring Network

GRPO: Grand Portage National Monument

GWCA: George Washington Carver National Monument

HEHO: Herbert Hoover National Historic Site

HOCU: Hopewell Culture National Historical Park

HOME: Homestead National Historical Park

HTLN: Heartland Inventory and Monitoring Network

I&M: Inventory and Monitoring

INDU: Indiana Dunes National Park

ISRO: Isle Royale National Park

JECA: Jewel Cave National Monument

KNRI: Knife River Indian Villages National Historic Site

LIBO: Lincoln Boyhood National Memorial

MCMC: Markov chain Monte Carlo

MISS: Mississippi National River and Recreation Area

MNRR: Missouri National Recreational River

MORU: Mount Rushmore National Memorial

BBS: North American Breeding Bird Survey

NGPN: Northern Great Plains Inventory and Monitoring Network

NIOB: Niobrara National Scenic River

PERI: Pea Ridge National Military Park

PIPE: Pipestone National Monument

PIRO: Pictured Rocks National Lakeshore

SACN: Saint Croix National Scenic Riverway

SCBL: Scotts Bluff National Monument

SLBE: Sleeping Bear Dunes National Lakeshore

TAPR: Tallgrass Prairie National Preserve

THRO: Theodore Roosevelt National Park

VOYA: Voyageurs National Park

WICA: Wind Cave National Park

WICR: Wilson's Creek National Battlefield

Acknowledgments

Thanks to the many volunteers, contractors, and park staff who complete the bird surveys for NPS and the North American Breeding Bird Survey every year. We thank the U.S. Geological Survey Natural Resource Preservation Program (USGS NRPP) for the funding that allowed us to complete this analysis. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Introduction

Breeding songbirds in North America have declined in abundance over the past 50 years, and grassland- and forest-dependent species are among those most affected (Rosenberg et al. 2019). Grassland birds have declined by more than 50% overall, with 74% of species declining (Rosenberg et al. 2019). Forest birds have fared only slightly better, with overall rates of decreasing abundance ranging from 18% to 30% and more than half of all species declining (Rosenberg et al. 2019). Habitat fragmentation and loss are responsible for many of these declines (Rosenberg et al. 2019), and altered climatic conditions will bring additional new challenges and exacerbate existing ones (Matthews et al. 2004, Wu et al. 2018).

Fulfilling part of the National Park Service's (NPS) fundamental role to "conserve the scenery and the natural and historic objects and the wild life therein" (NPS 1916), parks provide grassland and forest habitats in their natural states, even as these habitats are becoming increasingly fragmented across the broader landscape. Such landscape-scale effects of habitat fragmentation and loss outside the parks may overwhelm the benefits provided by protected habitats (Hamilton et al. 2013), causing parks to become less valuable for birds. Furthermore, the effects of landscape-scale habitat loss may exhibit abrupt response "tipping points" (Baker and King 2010), beyond which local breeding bird populations decline or are extirpated.

The value of national parks as bird habitat depends not only on local conditions within the parks, but also on the landscape habitat matrices in which they are located (Beck et al. 2016, Gimmi et al. 2011, Scholtz et al. 2017). However, the influences of landscape habitat matrices on birds vary by species, and the amount of forest and grassland habitat, and the degree of fragmentation in each, have not been systematically quantified for national park units in the Midwest Region.

For purposes of this report, "Midwest Region" refers to the National Park Service/Department of the Interior administrative boundary (also referred to as "Regions 3, 4, 5") that includes 64 national park units across 13 States: North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Arkansas, Wisconsin, Illinois, Michigan, Indiana, and Ohio. However, two parks in the Northern Great Plains Network in Wyoming, which is outside the Midwest Region, are also included.

Bird Conservation Regions and Bird Monitoring

Bird Conservation Regions (BCRs) are ecologically distinct regions in North America with similar bird communities, habitats, and resource management issues (BSC/NABCI 2014). There are 66 BCRs across Canada, the United States, and Mexico. The three Midwest Region Inventory and Monitoring (I&M) networks span 13 BCRs, with four in the Great Lakes Network, eight in the Heartland Network, and four in the Northern Great Plains Network (Table 1, Figure 1). Not all Midwest BCRs have national park units in them, and some parks span two BCRs.

Table 1. Bird Conservation Regions (BCRs) in the Midwest Region inventory and monitoring networks and the number of park units where songbird monitoring is conducted.

Bird Conservation Region Designator	BCR Name	Number of Park Units in the BCR [A]
11	Prairie Potholes	2
12	Boreal Hardwood Transition	7
17	Badlands and Prairies	8
18	Shortgrass Prairie	3
19	Central Mixed Grass Prairie	2
22	Eastern Tallgrass Prairie	3
23	Prairie Hardwood Transition	4
24	Central Hardwoods	4
26	Mississippi Alluvial Valley	1
28 [B]	Appalachian Mountains [B]	1

[A] Number of parks is greater than 32 because some parks overlap two different BCRs with bird survey points in both.

[B] BCR not included due to insufficient Breeding Bird Survey routes in our study area for modeling.

The U.S. Fish and Wildlife Service initiated the North American Breeding Bird Survey (BBS) in 1966 as a means of monitoring change in breeding bird populations (Sauer et al. 2017). At that time, point count surveys were conducted along 600 roadside routes in the eastern United States and eastern Canada. Today, coordinated jointly by the U.S. Geological Survey (USGS), Environment and Climate Change Canada and the Canadian Wildlife Service, and the Mexican National Commission for the Knowledge and Use of Biodiversity, approximately 3,300 routes of 50 survey points each are sampled annually, providing range-wide population data for hundreds of bird species in the United States, Canada, and portions of northern Mexico (USGS/CWS 2020).

Breeding bird monitoring has been conducted in some national park units for many years prior to the formation of the NPS Inventory and Monitoring Division. As a result, songbird populations were identified by many parks as a critical natural resource and part of a larger suite of "vital signs" for which long-term monitoring programs were established (Oakley et al. 2003, NPS 1992). Since the early 2000s, songbird monitoring in many midwestern parks has been coordinated by the region's three I&M networks, which encompass 37 national park units in 15 States: the Great Lakes Network (nine parks), Heartland Network (15 parks), and Northern Great Plains Network (13 parks) (Figure 1). These parks vary considerably in their surrounding land cover (Figure 2).

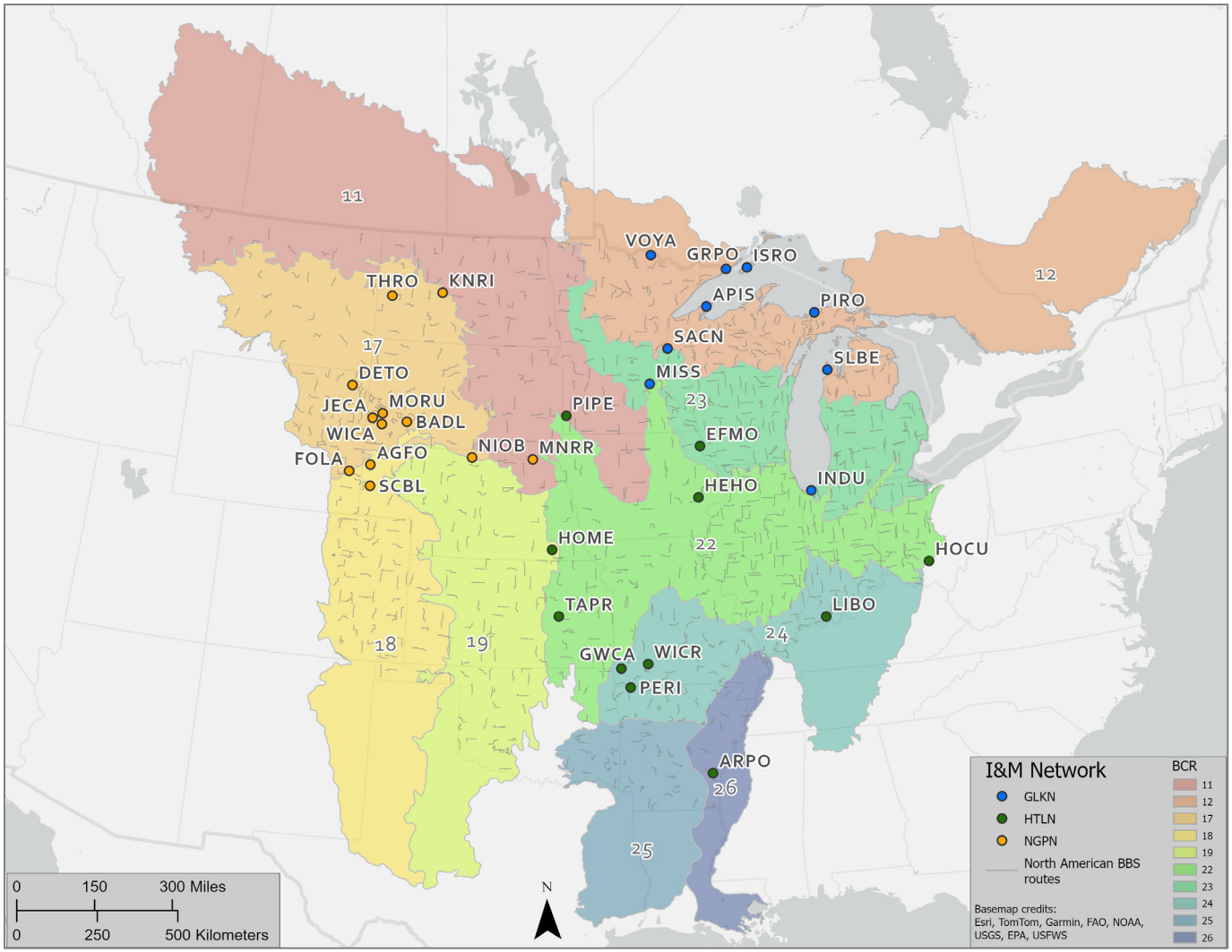


Figure 1. National park units in the Midwest Region's three Inventory and Monitoring networks: Great Lakes Network (GLKN; blue dots), Heartland Network (HTLN; green dots), and Northern Great Plains Network (NGPN; orange dots). Gray lines indicate North American Breeding Bird Survey (BBS) routes. Colored and numbered polygons indicate Bird Conservation Regions (BCRs). All maps in report created in Esri ArcGIS Pro 3.3.1.

NPS

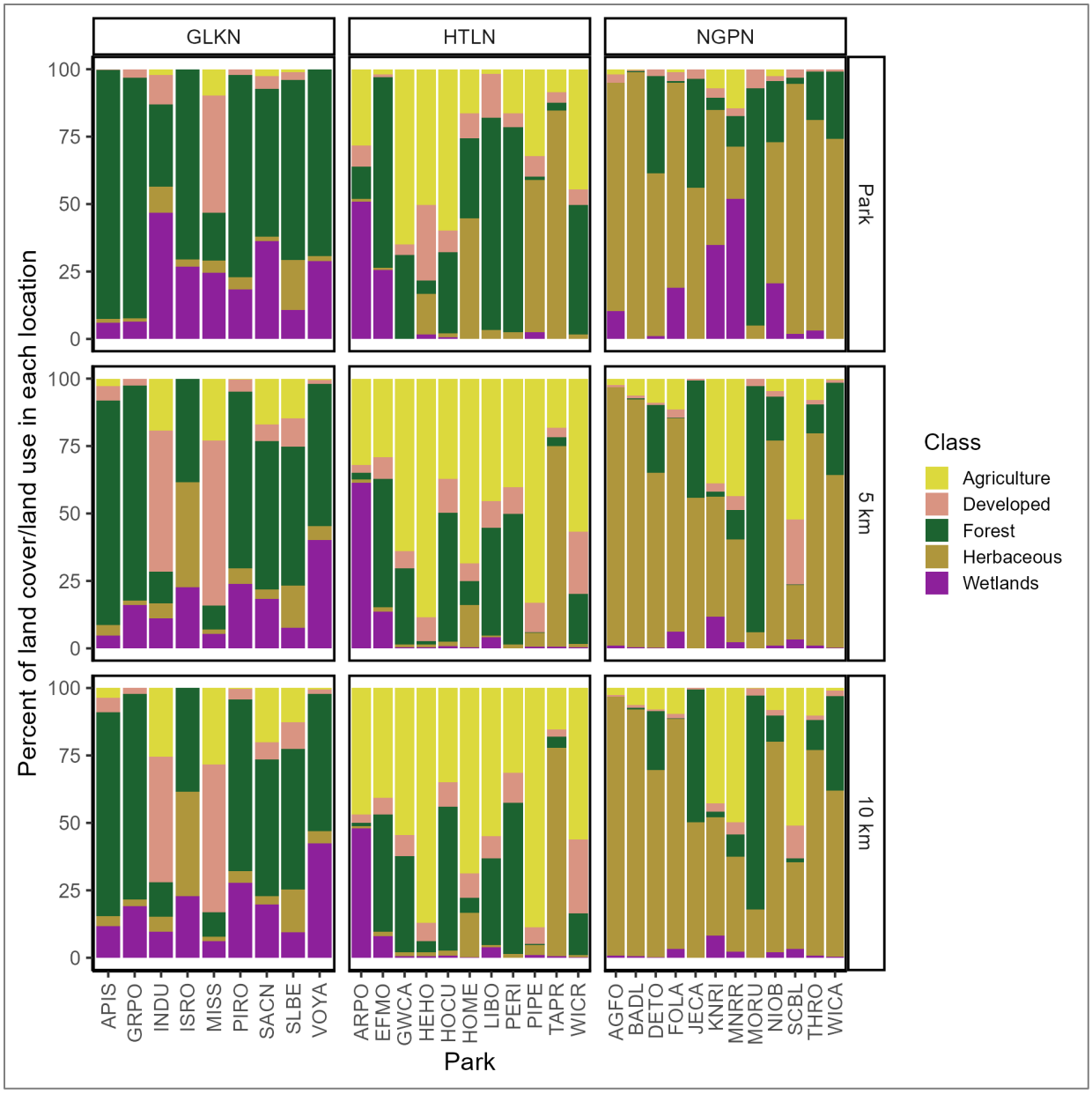


Figure 2. Land cover proportions within each park (top row) and in a 5-km and 10-km buffer (middle and bottom rows, respectively) around 35 national park units in three Midwest Region Inventory and Monitoring networks. Values are based on the 2019 U.S. Geological Survey National Land Cover Database (Dewitz 2023) and were calculated in ArcGIS. GLKN = Great Lakes Network, HTLN = Heartland Network, and NGPN = Northern Great Plains Network.

NPS

Park Landscapes

Landscape matrices in which these parks are located vary widely. Some are embedded in intact grasslands and forests, while others are surrounded by suburban sprawl (Figure 2). Substantial proportions of the Great Lakes Network (GLKN) park landscapes are open water or forested, with only two parks (Indiana Dunes National Park [INDU] and Mississippi National River and Recreation Area [MISS]) located in heavily urbanized areas. The Heartland Network (HTLN) parks are nestled within an agricultural landscape but contain a substantial amount of forest and scattered urban areas, particularly at Cuyahoga Valley National Park (CUVA). Parks in the Northern Great Plains Network (NGPN) are primarily in grasslands, with scattered areas of agriculture and forest. NGPN has the least amount of development among the three networks.

Our objectives were to:

1. Conduct a landscape habitat assessment and test for statistically significant trends in land cover classes from 2001 to 2021 within midwestern and central U.S. national park units and at buffers of 5 km and 10 km outside each park.
2. Predict the presence of bird species in national park units using models (Burner et al. 2024a) trained on BBS data and compare our predictions to the actual presence of species as documented by NPS monitoring.

Methods

Landscape Habitat Assessment

We used information from the U.S. Geological Survey (USGS) National Land Cover Database (NLCD; Dewitz 2023) to assess landscape-scale habitat availability. Details of the process can be found in Burner et al. (2024a). Briefly, we calculated the proportion of land cover (30-m NLCD cells of a given cover class) within a 400-m radius for each of our merged cover classes (Table 2). We did this for each NPS breeding bird survey point in our analysis area (Figure 1 and Appendix A maps) in each corresponding NLCD year (2001, 2004, 2006, 2008, 2011, 2013, 2016, 2019) using the focal statistics tool in ArcGIS Pro 3.3.1 (Esri 2024).

Table 2. National Land Cover Database (NLCD) cover classes grouped into covariates for analyzing bird count data using Bayesian hierarchical models.

Covariate	NLCD Cover Classes
Forest	Deciduous Forest, Evergreen Forest, Mixed Forest, Wood Wetlands
Grass/hay	Grassland/Herbaceous, Pasture/Hay, Sedge/Herbaceous
Development	Developed, Open Space; Developed, Low Intensity; Developed, Medium Intensity; Developed, High Intensity
[Not included]	Open Water, Barren Land, Cultivated Crops, Shrub/Scrub, Emergent Herbaceous Wetlands

Land Cover Trends Through Time

To test for trends in land cover change through time in and around parks, we grouped the NLCD classes into five categories (Table 3). Classes were chosen to represent those of interest within the analysis area (refer to Figure 1). We used R 4.4.1 (R Core Team 2024) and the Mann-Kendall test within the trend package (Pohlert 2023) to determine if there was a monotonic trend ($p<0.05$) in the timeseries. We chose to test for trends at three spatial scales of interest (within park, 5 km around park boundary, 10 km around park boundary) and included all NLCD years currently available (2001, 2004, 2006, 2008, 2011, 2013, 2016, 2019, 2021).

Table 3. National Land Cover Database (NLCD) cover class groupings for trend analysis of land cover in U.S. national parks in the Midwest Region.

Grouped Class	NLCD Cover Class
Developed	Developed, Open Space; Developed, Low Intensity; Developed, Medium Intensity; Developed, High Intensity
Herbaceous	Barren Land, Shrub/Scrub, Grassland/Herbaceous
Agriculture	Pasture/Hay, Cultivated Crops
Forest	Deciduous Forest, Evergreen Forest, Mixed Forest
Wetlands	Emergent Herbaceous Wetlands, Woody Wetlands
(not included)	Water

Monitoring Birds in the National Parks

Each network has its own songbird monitoring protocol (Beaupré et al. 2013, Gostomski et al. 2010, HTLN 2023) that specifies the methods used to conduct surveys. The Great Lakes and Heartland networks use variable circular plot count methods (Fancy 1997, Ralph et al. 1995, Reynolds et al. 1980), while the Northern Great Plains Network uses a point-transect survey method (Nelson and Fancy 1999, Buckland et al. 2001). Depending on the park, surveys are conducted by a combination of NPS staff, paid contractors, and volunteers.

Count duration in NPS surveys ranges from 3 to 10 minutes, depending on the park, which is longer than the 3-minute counts used for BBS surveys, and NPS counts are usually conducted far from roads (in contrast to the roadside surveys conducted by the BBS). Otherwise, NPS survey methods were generally similar to those used in the BBS, and day and time covariates helped to account for covariate-dependent differences in detection.

Data from the BBS form the baseline for our comparisons with songbird monitoring in the national parks. Using landscape-scale habitat information along with extensive data collected from across the entire region for the BBS (Ziolkowski et al. 2022), we modeled the responses of grassland and forest bird species of interest to these habitat covariates using stop-level BBS data, which are important for management-relevant inferences at these spatial scales (Niemuth et al. 2017, Veech et al. 2017).

We used models from Burner et al. (2024a) based on Burner et al. (2024b) and trained on BBS route data from nine BCRs to predict expected bird communities in NPS units given the land cover in and around these units. We then looked for generalizable patterns across NPS units in each BCR to determine if NPS units in some areas are consistently supporting more or fewer priority bird species than nearby land cover would predict.

Our analyses included songbird monitoring data from 32 national park units in the Midwest Region's three Inventory and Monitoring networks: Great Lakes, Heartland, and Northern Great Plains (Table 4). Bird species of interest for each BCR were selected based on conservation priority status (USFWS 2021, Northern Forest Birds Network/Upper Mississippi Great Lakes Joint Venture 2021, Rosenberg et al. 2016) (Table 5). Species of interest included grassland specialists such as Bobolink (*Dolichonyx oryzivorus*), Henslow's Sparrow (*Centronyx henslowii*), and Chestnut-collared Longspur (*Calcarius ornatus*), and forest specialists such as Cerulean Warbler (*Setophaga cerulea*; threatened), Black-throated Blue Warbler (*Setophaga caerulescens*), Canada Warbler (*Cardellina canadensis*), and Canada Jay (*Perisoreus canadensis*). Several dozen more common species (exact number varied by model) were also included to inform model estimates of land cover (Burner et al. 2024a). Inventory and monitoring bird data are available from Gostomski and Key (2020) for GLKN, from Peitz (2021, 2023) for HTLN, and from Bird Conservancy of the Rockies (2020) for NGPN.

Table 4. National park units included in this study, arranged by Inventory and Monitoring (I&M) network, with locations by State and Bird Conservation Region (BCR) shown. National Park Service (NPS) I&M networks are Great Lakes (GLKN), Heartland (HTLN), and Northern Great Plains (NGPN). Songbird monitoring is conducted at 11 of the 15 parks in the Heartland Network.

Unit Code	NPS Unit Name	NPS I&M Network	U.S. State	Total area (km^2)	Bird Conservation Region (BCR)	BCR Designator
APIS	Apostle Islands National Lakeshore	GLKN	WI	168.3	Boreal Hardwood Transition	12
GRPO	Grand Portage National Monument	GLKN	MN	2.9	Boreal Hardwood Transition	12
INDU	Indiana Dunes National Park	GLKN	IN	64.5	Prairie Hardwood Transition	23
ISRO	Isle Royale National Park	GLKN	MI	570.9	Boreal Hardwood Transition	12
MISS	Mississippi National River and Recreation Area	GLKN	MN	217.8	Prairie Hardwood Transition	23
PIRO	Pictured Rocks National Lakeshore	GLKN	MI	298.1	Boreal Hardwood Transition	12
SACN	Saint Croix National Scenic Riverway	GLKN	WI	331.6	Boreal Hardwood Transition, Prairie Hardwood Transition	12, 23
SLBE	Sleeping Bear Dunes National Lakeshore	GLKN	MI	285.9	Boreal Hardwood Transition	12
VOYA	Voyageurs National Park	GLKN	MN	828.4	Boreal Hardwood Transition	12
ARPO	Arkansas Post National Memorial	HTLN	AR	3.1	Mississippi Alluvial Valley	26
EFMO	Effigy Mounds National Monument	HTLN	IA	10.1	Prairie Hardwood Transition	23
GWCA	George Washington Carver National Monument	HTLN	MO	1.0	Central Hardwoods	24
HEHO	Herbert Hoover National Historic Site	HTLN	IA	0.8	Eastern Tallgrass Prairie	22
HOCU	Hopewell Culture National Historical Park	HTLN	OH	7.2	Eastern Tallgrass Prairie, Appalachian Mountains	22 [A]
HOME	Homestead National Historical Park	HTLN	NE	0.9	Central Mixed Grass Prairie	19
LIBO	Lincoln Boyhood National Memorial	HTLN	IN	0.8	Central Hardwoods	24
PERI	Pea Ridge National Military Park	HTLN	AR	17.3	Central Hardwoods	24
PIPE	Pipestone National Monument	HTLN	MN	1.2	Prairie Potholes	11
TAPR	Tallgrass Prairie National Preserve	HTLN	KS	44.1	Eastern Tallgrass Prairie	22

[A] HOCU falls on the line between BCRs 22 and 28, but for this study, all of HOCU's bird survey data are treated as BCR 22.

[B] DETO and FOLA are in the NPS Intermountain Region, but they are still part of the Northern Great Plains I&M Network (Midwest Region).

[C] FOLA and NIOB fall on the line between two BCRs, but only one (FOLA) or a few (NIOB) bird survey points are in the neighboring BCR. For this study, all bird survey data from these two parks are considered part of BCR 17.

Table 4 (continued). National park units included in this study, arranged by Inventory and Monitoring (I&M) network, with locations by State and Bird Conservation Region (BCR) shown. National Park Service (NPS) I&M networks are Great Lakes (GLKN), Heartland (HTLN), and Northern Great Plains (NGPN). Songbird monitoring is conducted at 11 of the 15 parks in the Heartland Network.

Unit Code	NPS Unit Name	NPS I&M Network	U.S. State	Total area (km^2)	Bird Conservation Region (BCR)	BCR Designator
WICR	Wilson's Creek National Battlefield	HTLN	MO	9.9	Central Hardwoods	24
AGFO	Agate Fossil Beds National Monument	NGPN	NE	12.3	Shortgrass Prairie	18
BADL	Badlands National Park	NGPN	SD	982.3	Badlands and Prairies	17
DETO	Devils Tower National Monument B	NGPN	WY	5.5	Badlands and Prairies	17
FOLA	Fort Laramie National Historic Site [B]	NGPN	WY	3.6	Badlands and Prairies	17 [C]
JECA	Jewel Cave National Monument	NGPN	SD	5.2	Badlands and Prairies	17
KNRI	Knife River Indian Villages National Historic Site	NGPN	ND	7.2	Badlands and Prairies	17
MNRR	Missouri National Recreational River	NGPN	NE/SD	276.7	Prairie Potholes	11
MORU	Mount Rushmore National Memorial	NGPN	SD	5.2	Badlands and Prairies	17
NIOB	Niobrara National Scenic River	NGPN	NE	117.6	Badlands and Prairies	17 [C]
SCBL	Scotts Bluff National Monument	NGPN	NE	13.0	Shortgrass Prairie	18
THRO	Theodore Roosevelt National Park	NGPN	ND	285.1	Badlands and Prairies	17
WICA	Wind Cave National Park	NGPN	SD	137.3	Badlands and Prairies	17

[A] HOCU falls on the line between BCRs 22 and 28, but for this study, all of HOCU's bird survey data are treated as BCR 22.

[B] DETO and FOLA are in the NPS Intermountain Region, but they are still part of the Northern Great Plains I&M Network (Midwest Region).

[C] FOLA and NIOB fall on the line between two BCRs, but only one (FOLA) or a few (NIOB) bird survey points are in the neighboring BCR. For this study, all bird survey data from these two parks are considered part of BCR 17.

Table 5. Species of concern by Bird Conservation Region (BCR). Taxonomy follows Chesser et al. (2024). AOS = American Ornithological Society. An "X" indicates presence.

English Name	Scientific Name	AOS Code	Bird Conservation Region (BCR)									
			11	12	17	18	19	22	23	24	25	26
Baird's Sparrow	*Centronyx bairdii*	BAIS	X	–	X	–	–	–	–	–	–	–
Bewick's Wren	*Thryomanes bewickii*	BEWR	–	–	–	–	–	–	–	X	X	–
Black-billed Cuckoo	*Coccyzus erythropthalmus*	BBCU	X	X	X	–	X	X	X	X	–	–
Blackburnian Warbler	*Setophaga fusca*	BLBW	–	X	–	–	–	–	–	–	–	–
Black-throated Blue Warbler	*Setophaga caerulescens*	BTBW	–	X	–	–	–	–	–	–	–	–
Black-throated Green Warbler	*Setophaga virens*	BTNW	–	X	–	–	–	–	–	–	–	–
Bobolink	*Dolichonyx oryzivorus*	BOBO	X	X	X	–	X	X	X	–	–	–
Brewer's Blackbird	*Euphagus cyanocephalus*	BRBL	X	–	X	–	–	–	–	–	–	–
Brown-headed Nuthatch	*Sitta pusilla*	BHNU	–	–	–	–	–	–	–	X	X	–
Canada Jay	*Perisoreus canadensis*	CAJA	–	X	–	–	–	–	–	–	–	–
Canada Warbler	*Cardellina canadensis*	CAWA	–	X	–	–	–	–	X	–	–	–
Cerulean Warbler	*Setophaga cerulea*	CERW	–	–	–	–	–	–	–	X	–	X
Chestnut-collared Longspur	*Calcarius ornatus*	CCLO	X	–	X	X	–	–	–	–	–	–
Chestnut-sided Warbler	*Setophaga pensylvanica*	CSWA	–	X	–	–	–	–	–	–	–	–
Common Grackle	*Quiscalus quiscula*	COGR	X	–	–	X	X	–	–	–	–	–
Connecticut Warbler	*Oporornis agilis*	CONW	–	X	–	–	–	–	–	–	–	–
Eastern Meadowlark	*Sturnella magna*	EAME	–	–	–	X	X	–	–	–	–	–
Evening Grosbeak	*Coccothraustes vespertinus*	EVGR	–	X	–	–	–	–	–	–	–	–
Field Sparrow	*Spizella pusilla*	FISP	–	–	–	–	–	–	–	X	–	–
Golden-winged Warbler	*Vermivora chrysoptera*	GWWA	–	X	–	–	–	–	X	–	–	–
Grasshopper Sparrow	*Ammodramus savannarum*	GRSP	X	–	X	X	X	X	X	X	–	–
Greater Prairie-Chicken	*Tympanuchus cupido*	GRPC	X	–	–	X	X	–	–	–	–	–
Henslow's Sparrow	*Centronyx henslowii*	HESP	–	–	–	–	–	X	X	X	–	–
Horned Lark	*Eremophila alpestris*	HOLA	X	–	X	X	X	–	–	–	–	–

Table 5 (continued). Species of concern by Bird Conservation Region (BCR). Taxonomy follows Chesser et al. (2024). AOS = American Ornithological Society. An "X" indicates presence.

English Name	Scientific Name	AOS Code	Bird Conservation Region (BCR)									
			11	12	17	18	19	22	23	24	25	26
Kentucky Warbler	*Geothlypis formosa*	KEWA	–	–	–	–	–	X	–	X	X	X
Lark Bunting	*Calamospiza melanocorys*	LARB	X	–	X	X	X	X	–	–	–	–
Least Flycatcher	*Empidonax minimus*	LEFL	X	X	–	–	–	–	–	–	–	–
LeConte's Sparrow	*Ammospiza leconteii*	LCSP	X	X	–	X	–	–	X	–	–	–
Loggerhead Shrike	*Lanius ludovicianus*	LOSH	–	–	X	–	X	X	–	–	–	–
Nashville Warbler	*Leiothlypis ruficapilla*	NAWA	–	X	–	–	–	–	–	–	–	–
Northern Bobwhite	*Colinus virginianus*	NOBO	–	–	–	X	X	–	–	–	–	–
Olive-sided Flycatcher	*Contopus cooperi*	OSFL	–	X	–	–	–	–	–	–	–	–
Ovenbird	*Seiurus aurocapilla*	OVEN	–	X	–	–	–	–	–	–	–	–
Prairie Warbler	*Setophaga discolor*	PRAW	–	–	–	–	–	–	–	X	X	X
Prothonotary Warbler	*Protonotaria citrea*	PROW	–	–	–	–	–	X	–	X	X	X
Red-headed Woodpecker	*Melanerpes erythrocephalus*	RHWO	X	–	X	X	X	X	X	X	X	X
Scaled Quail	*Callipepla squamata*	SCQU	–	–	–	X	–	–	–	–	–	–
Sprague's Pipit	*Anthus spragueii*	SPPI	X	–	X	–	–	–	–	–	–	–
Swainson's Thrush	*Catharus ustulatus*	SWTH	–	X	–	–	–	–	–	–	–	–
Thick-billed Longspur	*Rhynchophanes mccownii*	TBLO	X	–	X	X	–	–	–	–	–	–
Veery	*Catharus fuscescens*	VEER	–	X	–	–	–	–	–	–	–	–
Winter Wren	*Troglodytes hiemalis*	WIWR	–	X	–	–	–	–	–	–	–	–
Wood Thrush	*Hylocichla mustelina*	WOTH	–	X	–	–	–	X	X	X	X	X
Yellow-bellied Sapsucker	*Sphyrapicus varius*	YBSA		X								
Yellow-billed Cuckoo	*Coccyzus americanus*	YBCU	–	–	–	–	X	–	–	–	–	–

Not all BCRs that occur in the Midwest Region are represented by a park where songbird monitoring is conducted. Also, in cases where a park occupies more than one BCR (HOCU, FOLA, NIOB), that park was typically assigned to the BCR in which most of its survey points are located. One BCR (28: Appalachian Mountains) was not included in our analyses because the number of BBS routes in our study area was insufficient to use in modeling. Therefore, NPS survey points in BCR 28 were analyzed in the context of the neighboring BCR (BCR 22).

Analyses

We used Bayesian hierarchical models in NIMBLE (de Valpine et al. 2023) in R 4.4.1 (R Core Team 2024) developed by Burner et al. (2024). This allowed us to account for the nested and spatial nature of BBS data (surveys within routes within regions within years) and to account for spatial uncertainty inherent in stop-level BBS analyses (Burner et al. 2024a). We fit four presence-absence models, each covering a portion of the full study area and including BBS routes in BCRs corresponding to the relevant NPS units. Models included the linear and quadratic effects of forest, grass/hay, and development land cover (400-m radius), latitude and longitude, and several covariates influencing detection (day of year and time of day). An intercept was estimated for each species on each route, nested in the appropriate BCR, and for each observer.

For each species, the model was trained only using those BBS routes with start points located within that species' breeding range, as defined by Strimas-Mackey et al. (2022). Each model was used to predict bird detections for all NPS monitoring surveys, resulting in one set of predictions for each of 100 Markov chain Monte Carlo (MCMC) samples from the model-fitted process.

For each NPS unit, model predictions were made only for those species whose breeding ranges overlapped with one or more survey points in that park. Thus, model predictions represent the expected bird detections in NPS units based on their geographic location, BCR, and land cover. We then compared the predictions to presence-absence data collected from NPS surveys to determine whether NPS units hosted more (or fewer) species than predicted.

Results are presented as boxplots showing the proportion of predicted versus actual bird species detections on NPS survey routes at parks in a given BCR (*actual detections from NPS surveys − model-predicted proportion of species detections on NPS surveys*). The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Our model did not make predictions for out-of-range species.

We chose to present results by BCR instead of by network because grouping by BCR provides a more ecologically meaningful group and because species of concern are defined by BCR. Park-specific results are presented in Appendix A.

Results

Landscape Analyses

Statistically significant change ($p<0.05$) in percentage of land cover is occurring more often outside the parks than inside (Figure 3). Developed land showed the largest number of significant trends, followed by agriculture, forest, herbaceous, and wetlands (Table 6). Changes were most numerous in Badlands and Prairies (BCR 17; 69 significant models) and the Boreal Hardwood Transition (BCR 12; 44 significant models), together accounting for 48% of the total number of significant models (Figure 4).

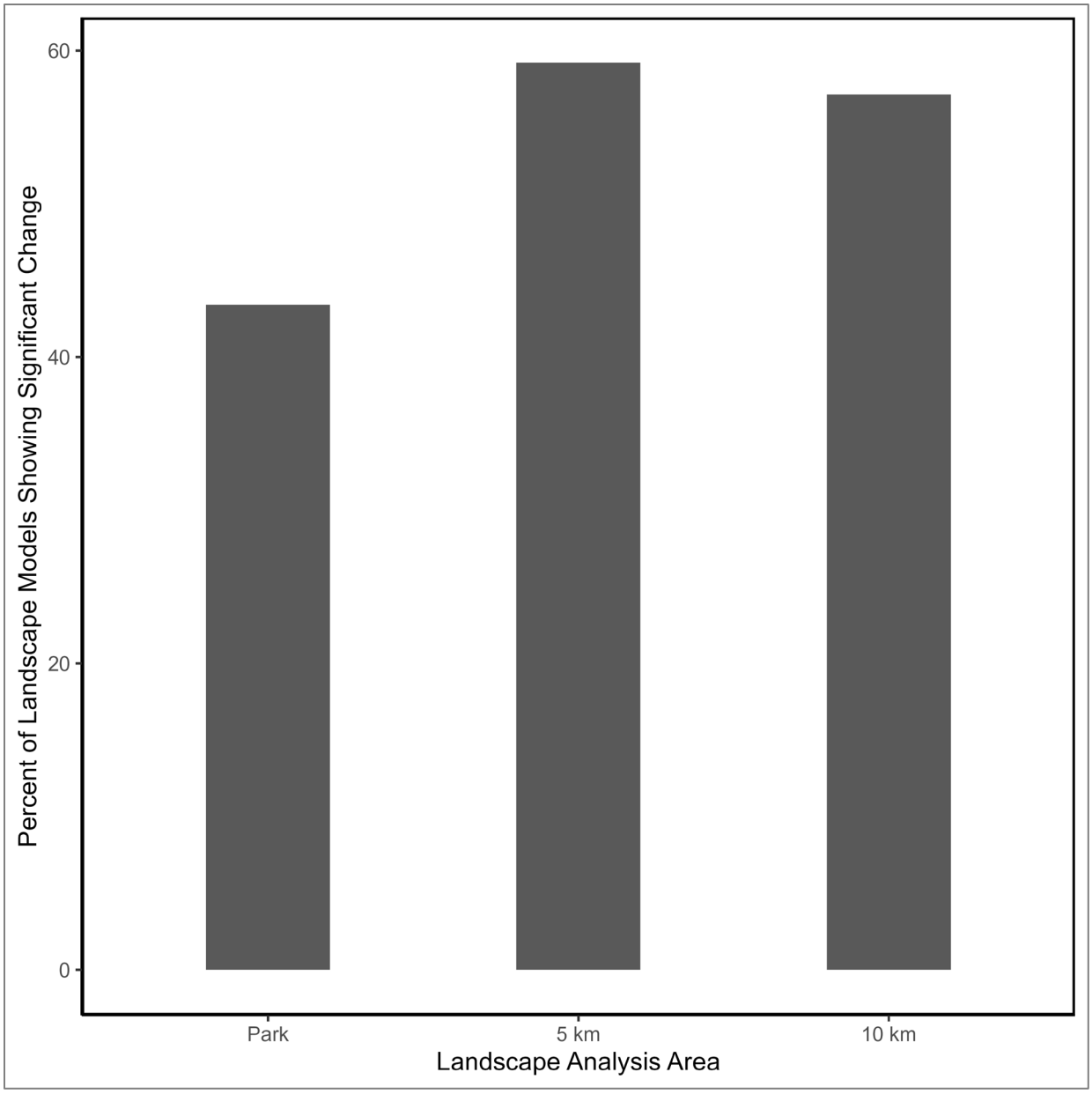


Figure 3. Percentage of landscape models showing statistically significant change ($p<0.05$) in percent land cover, by analysis area (within the park, 5 km outside the park, and 10 km outside the park).

NPS

Table 6. Number of models showing statistically significant change ($p<0.05$) in percent land cover, grouped by analysis area (within the park, 5 km outside the park, and 10 km outside the park).

		Land Cover Class				
BCR	**Analysis Area**	**Agriculture**	**Developed**	**Forest**	**Herbaceous**	**Wetlands**
11	Within Park	0	1	1	0	0
12	Within Park	3	6	2	2	1
17	Within Park	4	5	3	2	1
18	Within Park	1	0	0	0	0
19	Within Park	1	0	0	1	0
22	Within Park	1	2	1	1	0
23	Within Park	2	3	2	0	1
24	Within Park	3	2	1	0	1
26	Within Park	0	1	1	0	0
11	5 km	2	2	0	1	0
12	5 km	5	6	2	1	1
17	5 km	5	9	5	7	0
18	5 km	2	2	1	2	0
19	5 km	1	1	1	1	0
22	5 km	3	3	1	1	2
23	5 km	3	3	3	2	0
24	5 km	4	4	0	1	1
26	5 km	1	1	0	0	0
11	10 km	1	2	0	1	0
12	10 km	4	6	4	0	1
17	10 km	6	9	4	6	3
18	10 km	1	2	0	1	1
19	10 km	1	1	1	1	0
22	10 km	1	3	1	1	1
23	10 km	3	3	3	2	0
24	10 km	4	4	2	3	1
26	10 km	1	1	1	0	0
TOTALS	**–**	**63**	**82**	**40**	**37**	**15**

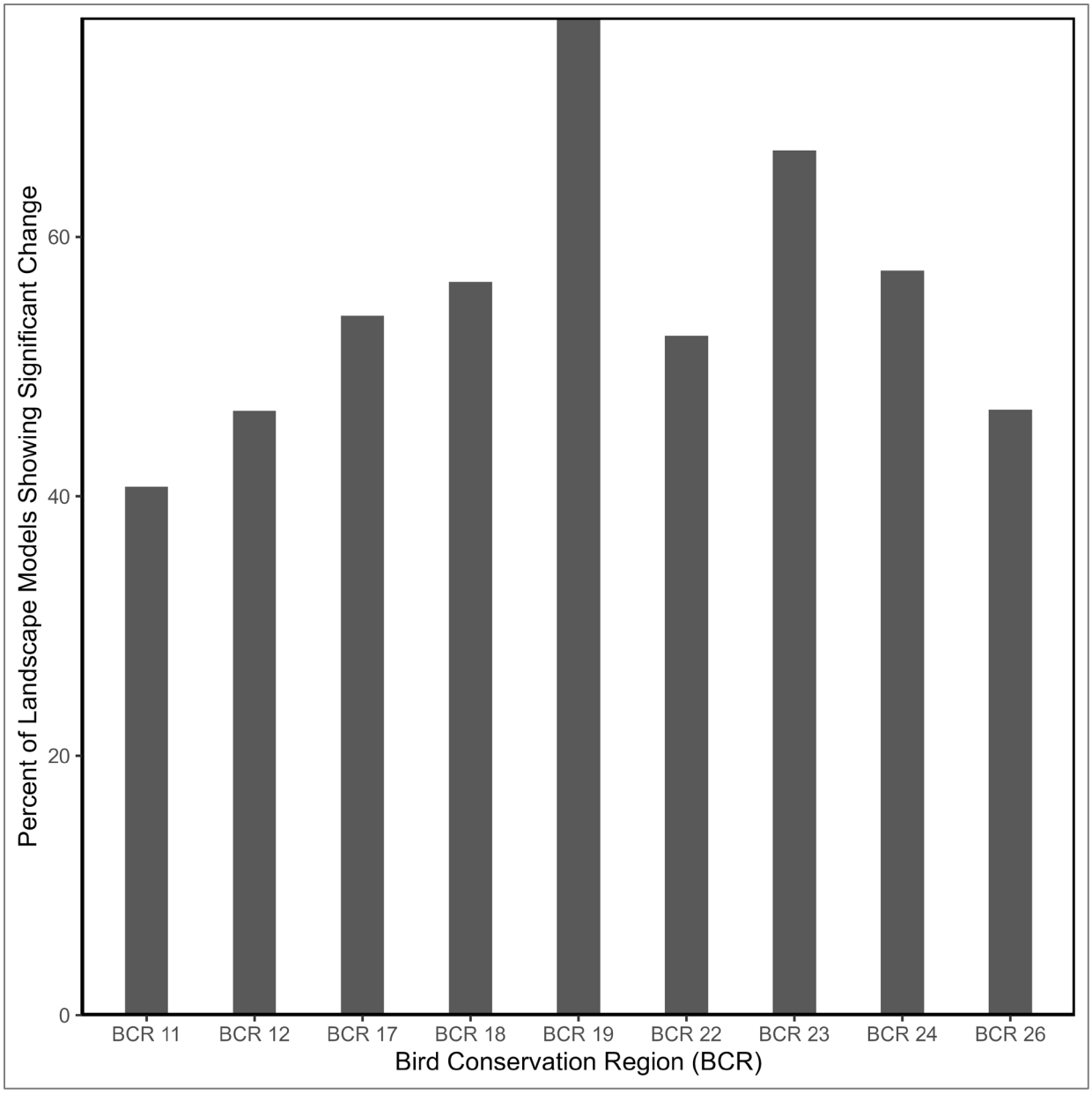


Figure 4. Percentage of landscape models showing statistically significant change ($p<0.05$) in percent of land cover, by Bird Conservation Region. Refer to Table 1 for BCR names.

NPS

Bird Conservation Region Analyses

The following summaries are presented by BCR, with representative parks noted in each. Hopewell Culture National Historical Park (HOCU) is on the line between the Appalachian Mountains and Eastern Tallgrass Prairie BCRs. The number of BBS routes in our study area was insufficient to use in modeling for the Appalachian Mountains BCR, so all HOCU's points were analyzed as part of BCR 22 (Eastern Tallgrass Prairie). More detailed results for each park are presented in Appendix A.

Prairie Potholes (BCR 11)

Represented by Missouri National Recreational River (MNRR) and Pipestone National Monument (PIPE).

Parks in BCR 11 had lower occupancy than BBS routes with similar land cover for some species of concern, but PIPE had higher occupancy than predicted for Grasshopper Sparrow, Common Grackle, and Bobolink (Figure 5).

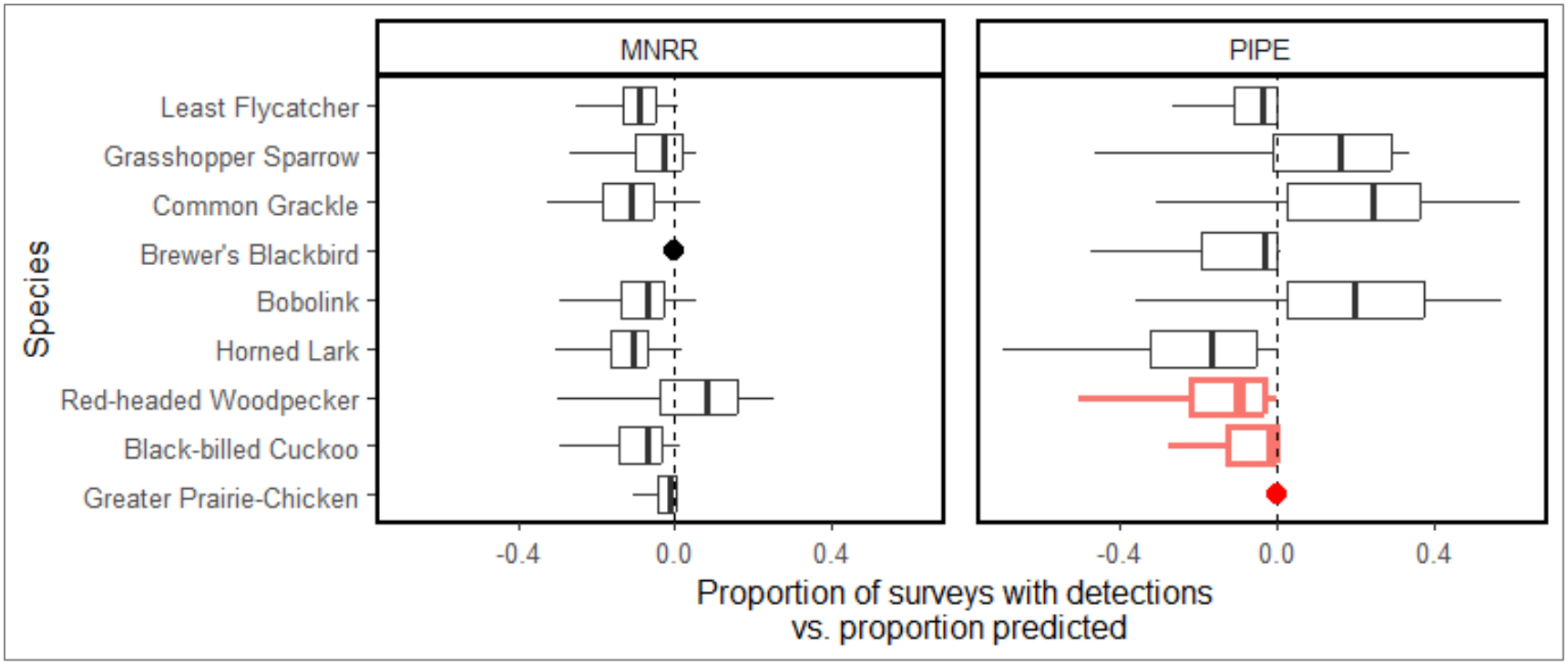


Figure 5. Proportion of predicted versus actual bird species detections on National Park Service (NPS) survey routes at two parks in Bird Conservation Region (BCR) 11: Missouri National Recreational River (MNRR) and Pipestone National Monument (PIPE). Boxplots are shown for species of concern in this BCR whose breeding range encompasses at least one of the parks or who was detected in at least one of the parks. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. Positive boxplot values thus indicate a species that was more commonly detected than it was predicted to be, and negative values indicate the opposite. The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Dots are shown in place of boxplots for out-of-range species detected (black) or not detected (red) in the park. Refer to Table 5 for species' scientific names.

USGS

We found several more significant trends in landscape change at MNRR than PIPE (Figure 6). The developed class showed significant positive trends at all three scales at MNRR and two (5 and 10 km) at PIPE. At MNRR we also found trends in agriculture, forest, and herbaceous at various scales. However, at PIPE the only other class that had significant trends was agriculture at the 5-km buffer.

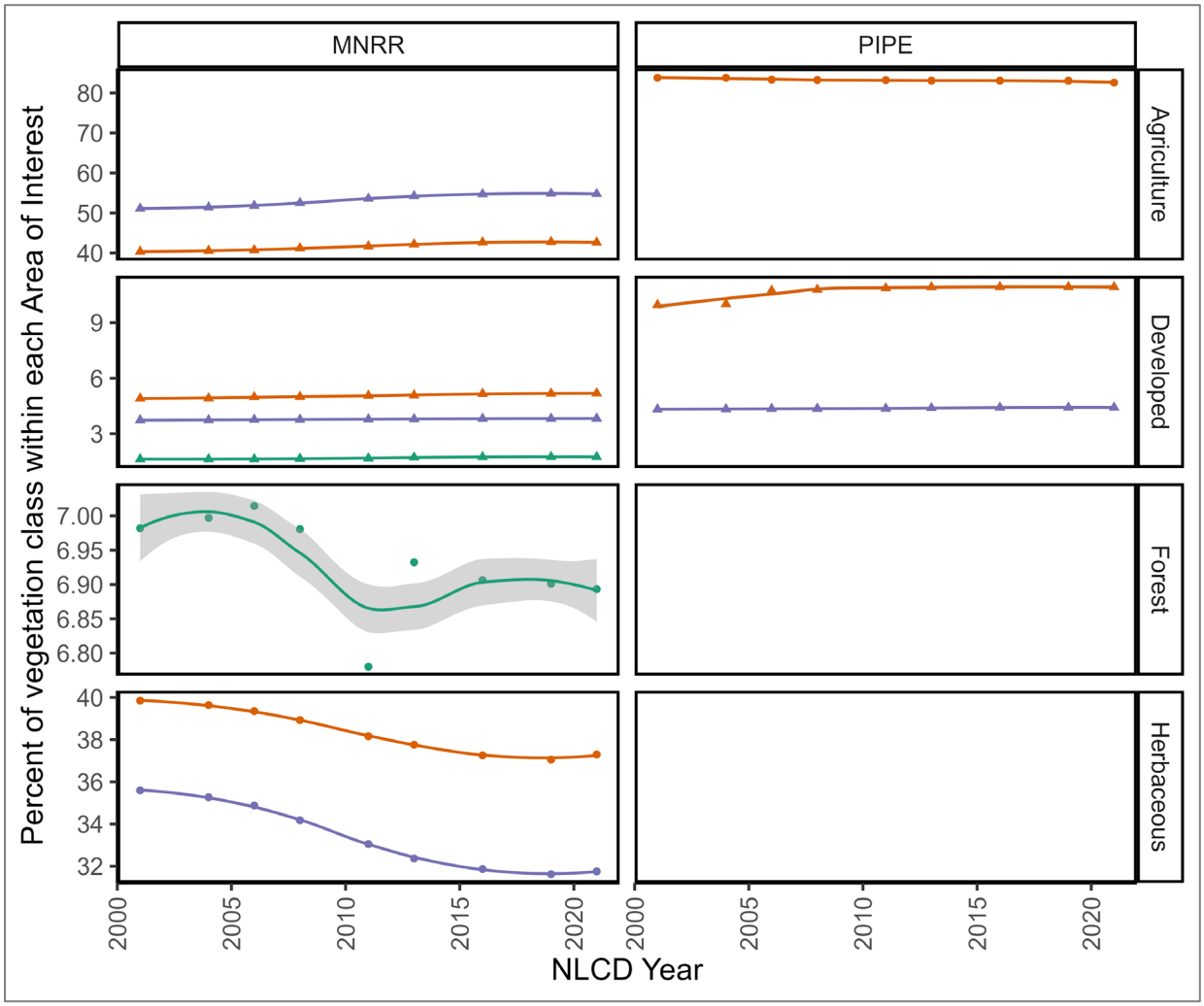


Figure 6. Trends through time in land cover classes at National Park Service (NPS) units within Bird Conservation Region (BCR) 11: Missouri National Recreational River (MNRR) and Pipestone National Monument (PIPE). Triangles represent a positive trend (slope; $p<0.05$), and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Boreal Hardwood Transition (BCR 12)

Represented by Apostle Islands National Lakeshore (APIS), Grand Portage National Monument (GRPO), Isle Royale National Park (ISRO), Pictured Rocks National Lakeshore (PIRO), Sleeping Bear Dunes National Lakeshore (SLBE), Voyageurs National Park (VOYA), and the northern half of the Saint Croix National Scenic Riverway (SACN).

Parks in BCR 12 had occupancy that was comparable to BBS routes with similar land cover for many species of concern (Figure 7).

All parks within the BCR had significant trends in agriculture and developed at various scales (Figure 8). The remaining classes had varying levels of significant trends. The only other noteworthy result was at VOYA, where the wetlands class had a significant positive trend at all analysis scales.

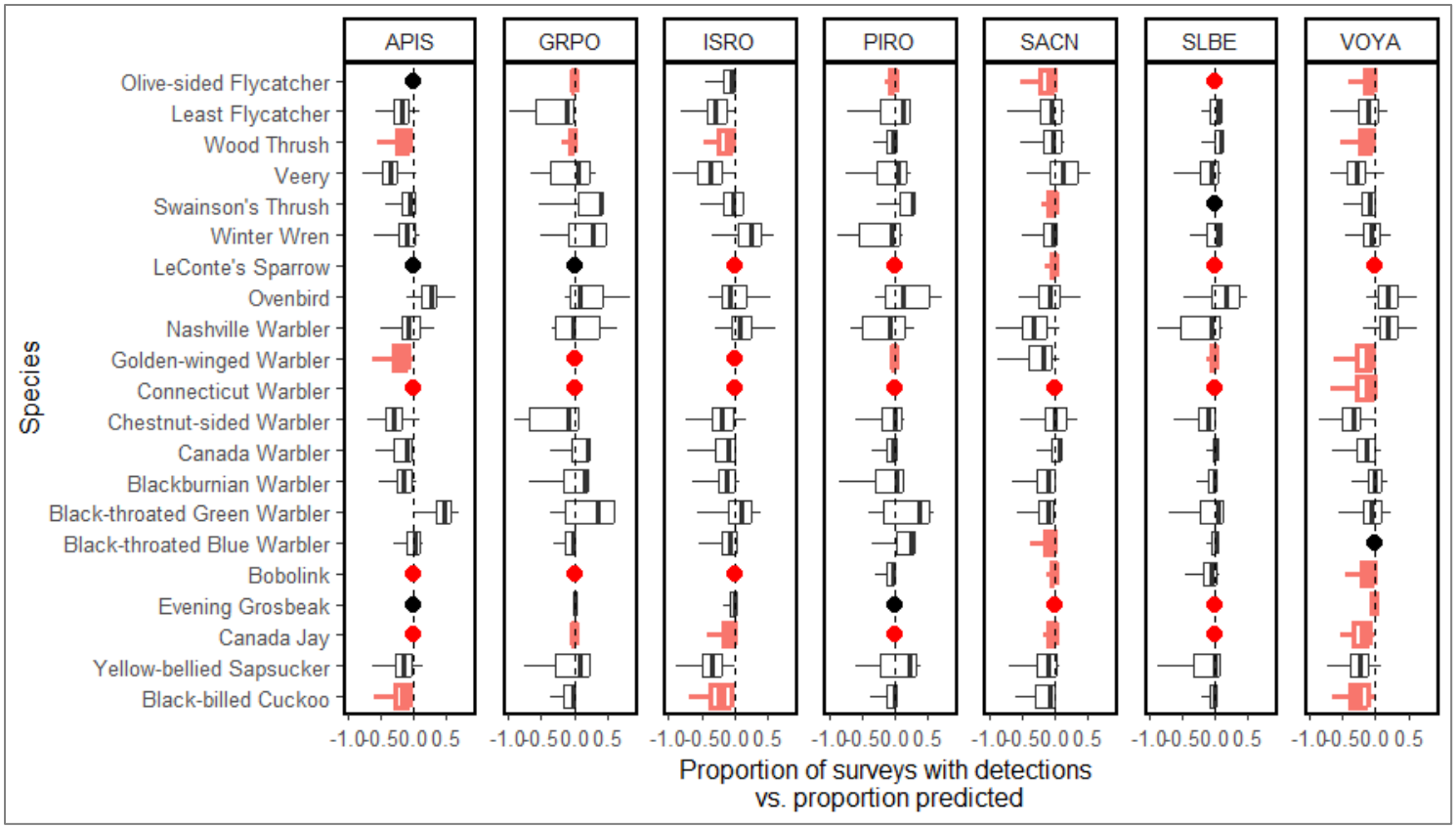


Figure 7. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at seven parks in Bird Conservation Region (BCR) 12: Apostle Islands National Lakeshore (APIS), Grand Portage National Monument (GRPO), Isle Royale National Park (ISRO), Pictured Rocks National Lakeshore (PIRO), the northern half of the Saint Croix National Scenic Riverway (SACN), Sleeping Bear Dunes National Lakeshore (SLBE), and Voyageurs National Park (VOYA). Boxplots are shown for species of concern in this BCR whose breeding range encompasses at least one of the parks or who was detected in at least one of the parks. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Dots are shown in place of boxplots for out-of-range species detected in (black) or absent from (red) a given park. Refer to Table 5 for species' scientific names.

USGS

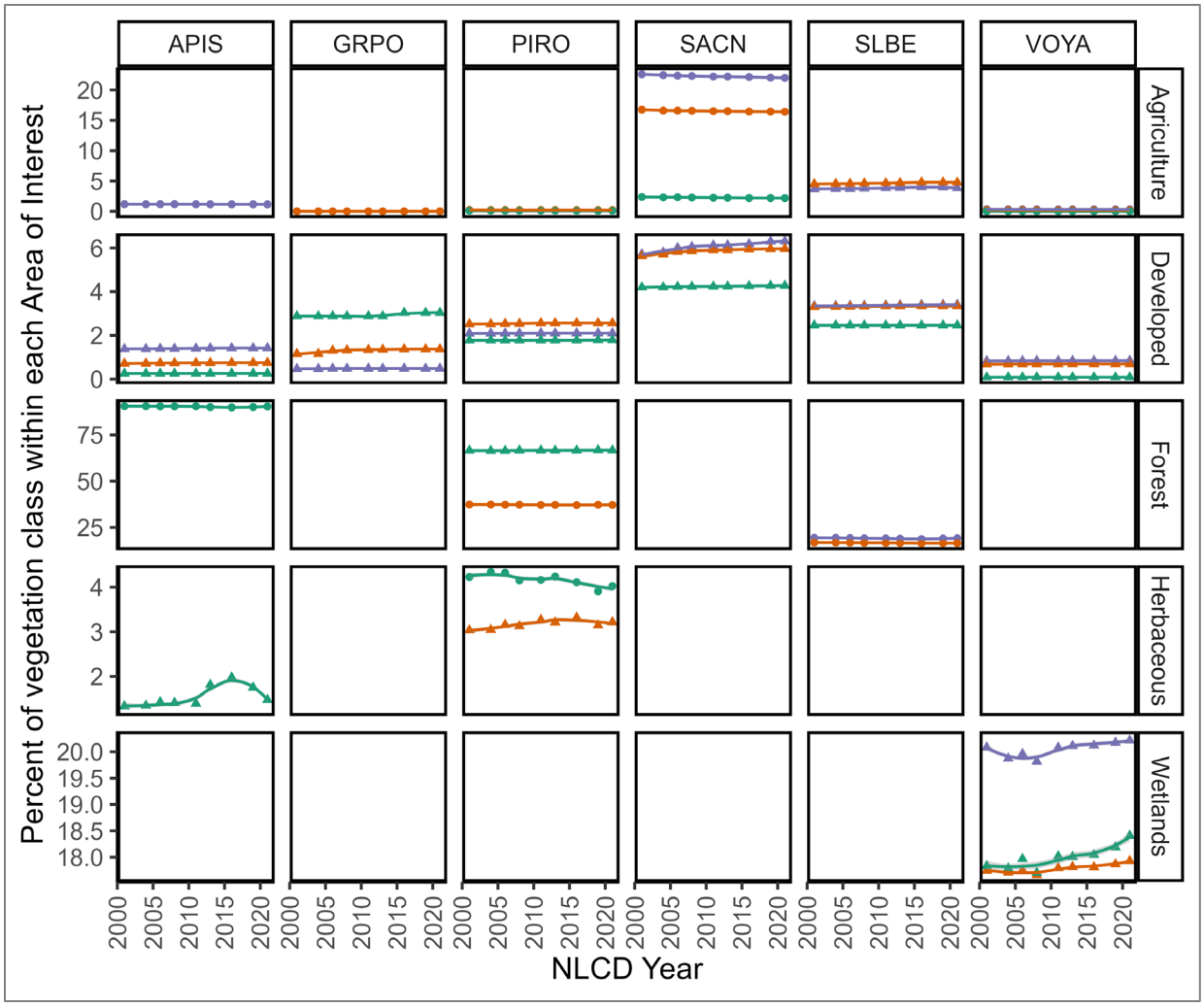


Figure 8. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 12: Apostle Islands National Lakeshore (APIS), Grand Portage National Monument (GRPO), Isle Royale National Park (ISRO), Pictured Rocks National Lakeshore (PIRO), the northern half of the Saint Croix National Scenic Riverway (SACN), Sleeping Bear Dunes National Lakeshore (SLBE), and Voyageurs National Park (VOYA). Triangles represent a positive trend (slope; $p<0.05$), and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Badlands and Prairies (BCR 17)

Represented by Badlands National Park (BADL), Devils Tower National Monument (DETO), Fort Laramie National Historic Site (FOLA), Jewel Cave National Monument (JECA), Knife River Indian Villages National Historic Site (KNRI), Mount Rushmore National Memorial (MORU), Niobrara National Scenic River (NIOB), Theodore Roosevelt National Park (THRO), and Wind Cave National Park (WICA).

Parks in BCR 17 had lower occupancy than BBS routes with similar land cover for many species of concern. However, most species in KNRI were similar to expectations, and Grasshopper Sparrow was more prevalent than expected in several parks (Figure 9). MORU is outside the range of most priority species (8 of 11), and only one species (Red-headed Woodpecker) was detected inside the park. Similarly, JECA is out of range for 8 of 11 priority species, and only two were detected in the park.

Parks in this BCR are characterized largely by herbaceous and forest land cover classes and low amounts of developed areas and wetlands. Most parks had significant trends in agriculture, developed, forest, and herbaceous classes (Figure 10). One park (JECA) only had significant trends in one land cover class (developed).

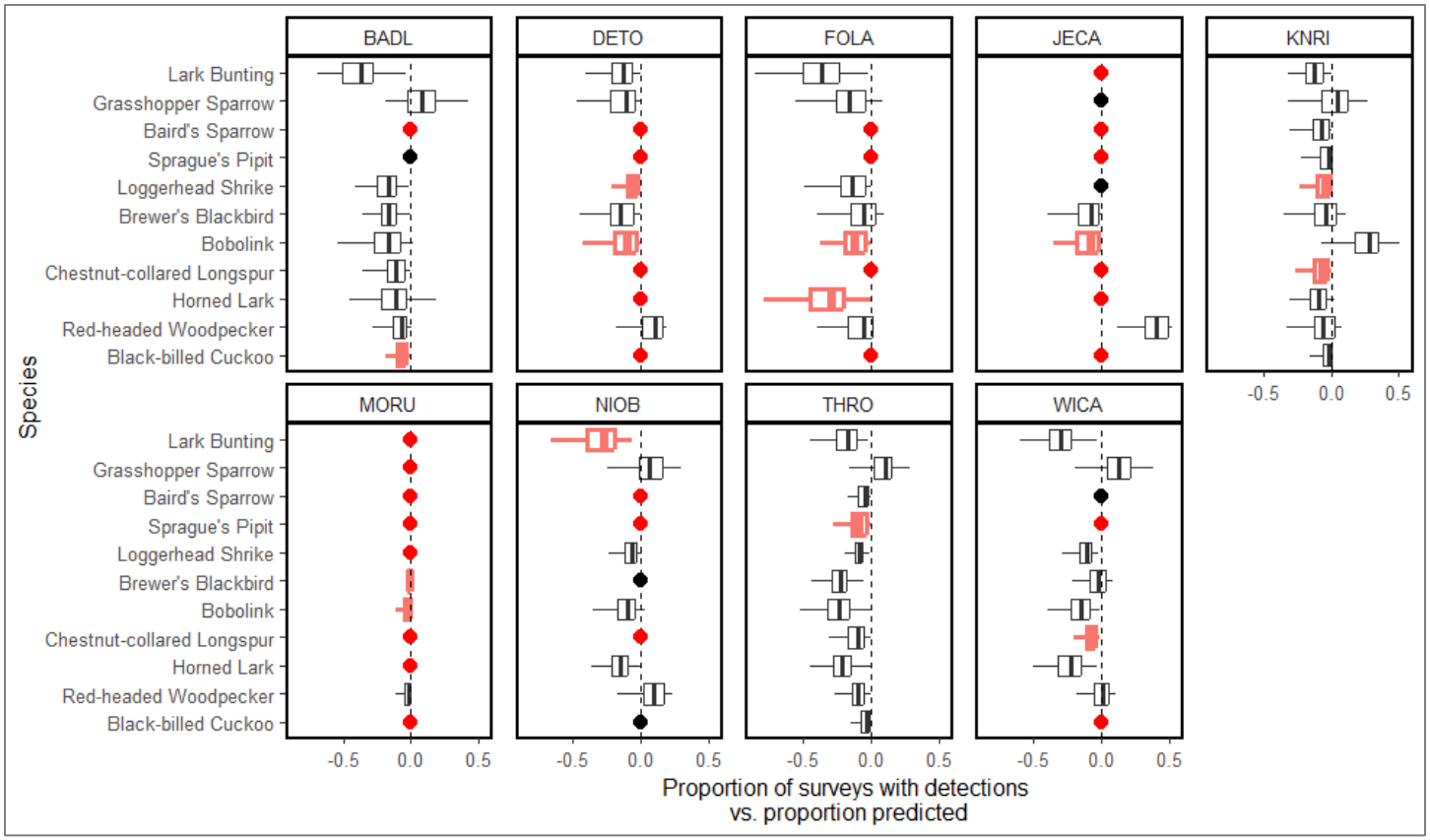


Figure 9. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at nine parks in Bird Conservation Region (BCR) 17: Badlands National Park (BADL), Devils Tower National Monument (DETO), Fort Laramie National Historic Site (FOLA), Jewel Cave National Monument (JECA), Knife River Indian Villages National Historic Site (KNRI), Mount Rushmore National Memorial (MORU), Niobrara National Scenic River (NIOB), Theodore Roosevelt National Park (THRO), and Wind Cave National Park (WICA). Boxplots are shown for species of concern in this BCR whose breeding range encompasses at least one of the parks or who was detected in at least one of the parks. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Dots are shown in place of boxplots for out-of-range species detected in (black) or absent from (red) a given park. Refer to Table 5 for species' scientific names.

USGS

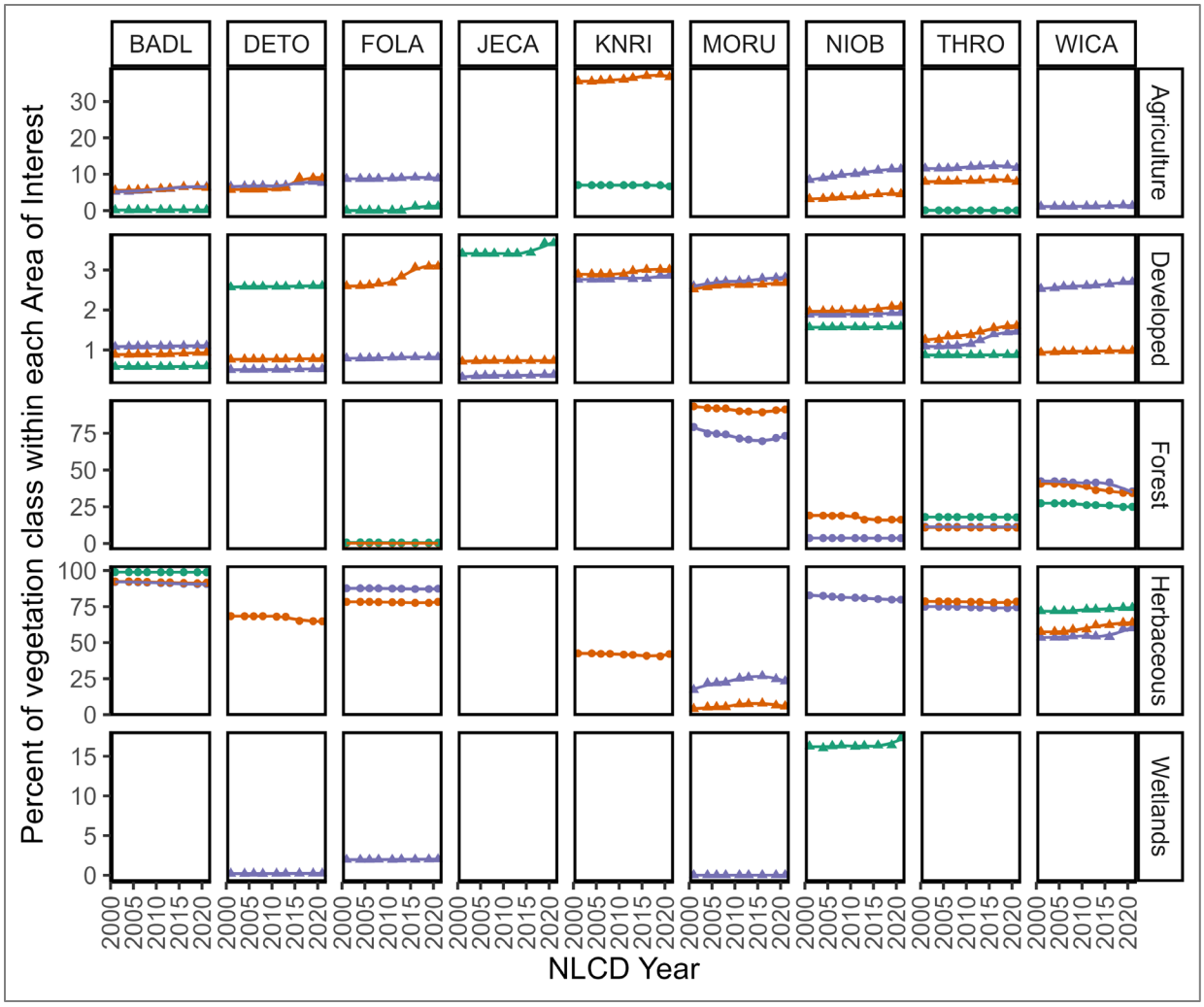


Figure 10. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 17: Badlands National Park (BADL), Devils Tower National Monument (DETO), Fort Laramie National Historic Site (FOLA), Jewel Cave National Monument (JECA), Knife River Indian Villages National Historic Site (KNRI), Mount Rushmore National Memorial (MORU), Niobrara National Scenic River (NIOB), Theodore Roosevelt National Park (THRO), and Wind Cave National Park (WICA). Triangles represent a positive trend (slope; $p<0.05$) and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Shortgrass Prairie (BCR 18)

Represented by Agate Fossil Beds National Monument (AGFO) and Scotts Bluff National Monument (SCBL). Only one of Fort Laramie's (FOLA) survey points falls within this BCR, so FOLA data were analyzed in the context of BCR 17.

Each of the parks in BCR 18 had occupancy that was lower than BBS routes with similar land cover for many species of concern (Figure 11).

Parks in this BCR are largely composed of herbaceous and agriculture land cover classes. SCBL had some significant trends at the 5- and 10-km buffers in all land cover classes (Figure 12). There was a slight downward trend in forest and a slight upward trend in wetlands at SCBL.

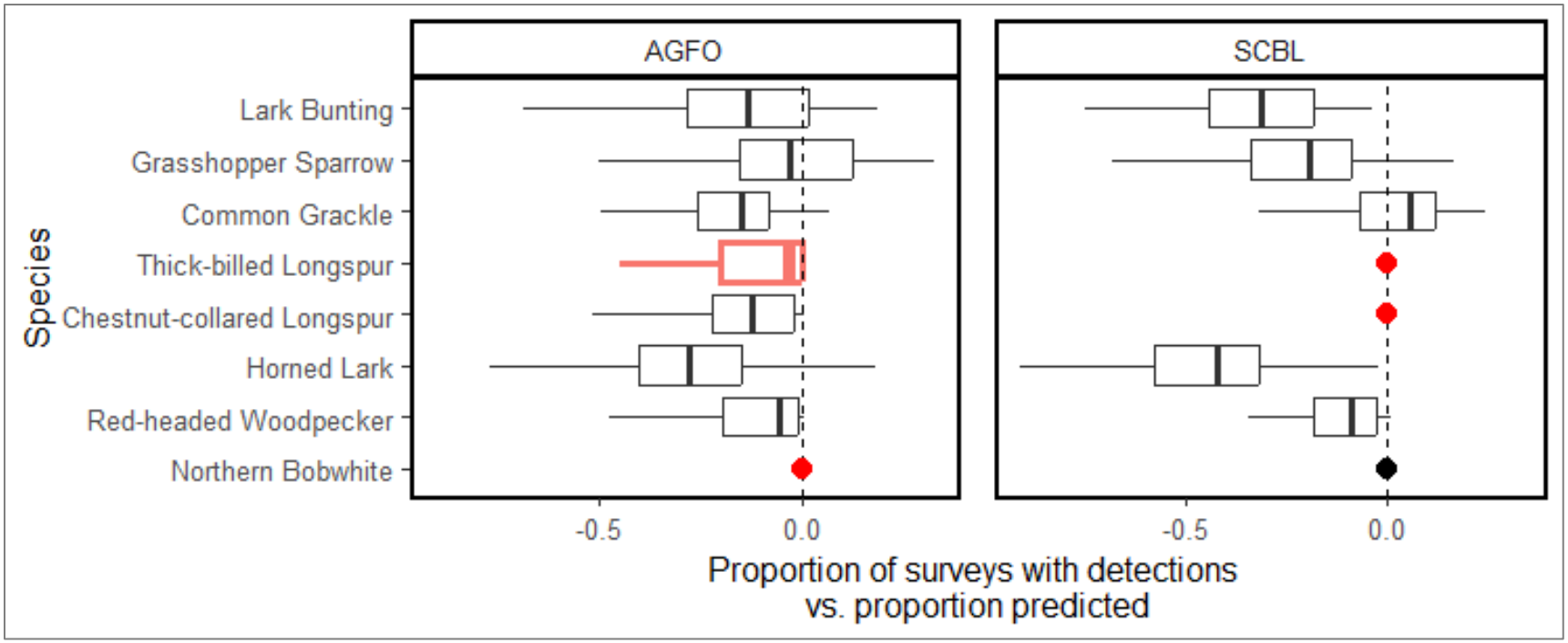


Figure 11. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at two parks in Bird Conservation Region (BCR) 18: Agate Fossil Beds National Monument (AGFO) and Scotts Bluff National Monument (SCBL). Boxplots are shown for species of concern in this BCR whose breeding range encompasses at least one of the parks or who was detected in at least one of the parks. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Dots are shown in place of boxplots for out-of-range species detected in (black) or absent from (red) a given park. Refer to Table 5 for species' scientific names.

USGS

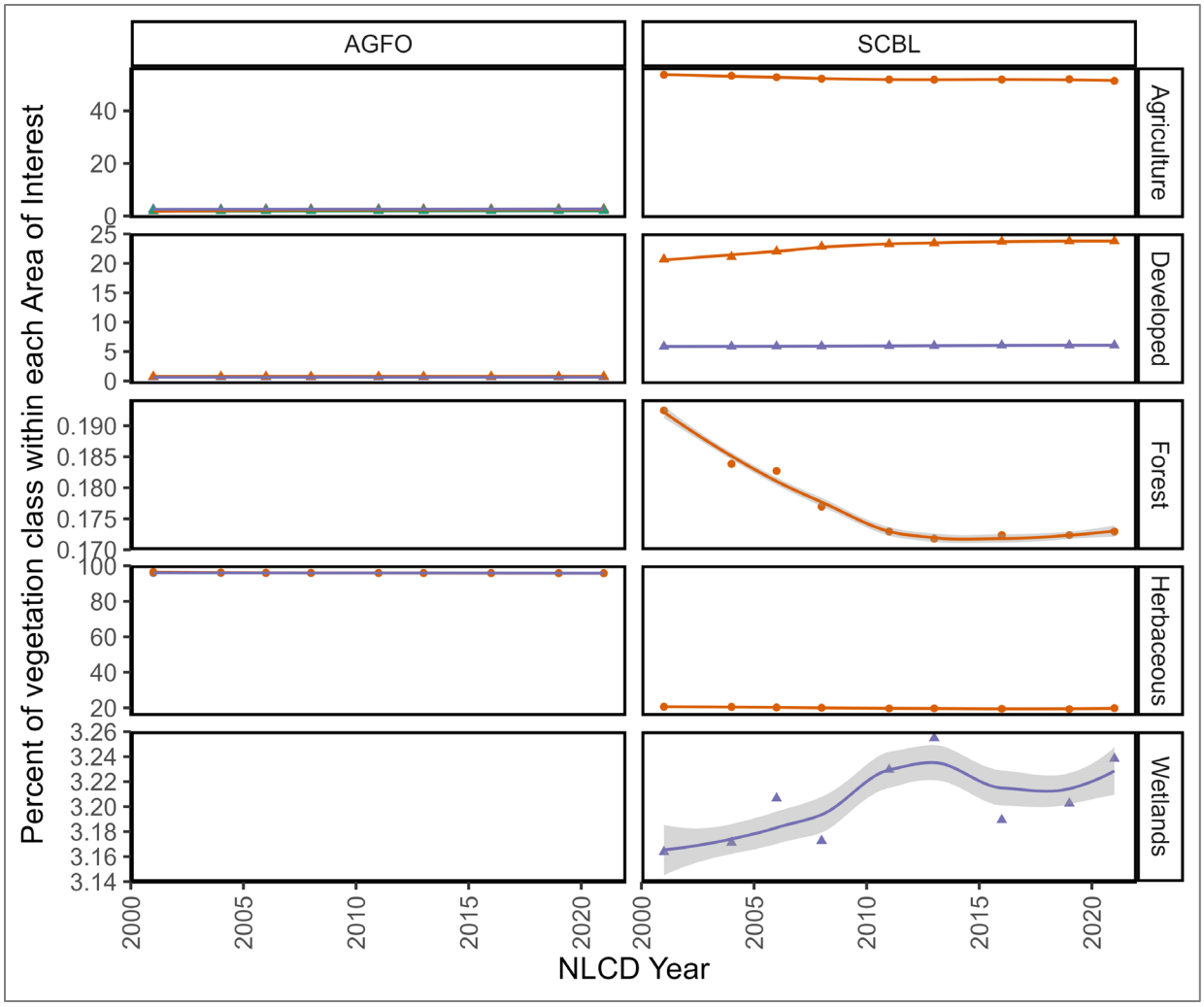


Figure 12. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 18: Agate Fossil Beds National Monument (AGFO) and Scotts Bluff National Monument (SCBL). Triangles represent a positive trend (slope; $p<0.05$) and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5 km buffer (orange), and within a 10 km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Central Mixed Grass Prairie (BCR 19)

Homestead National Historical Park (HOME) and Niobrara National Scenic River (NIOB) both occupy this BCR, but most of NIOB's points fall within BCR 17. NIOB data were analyzed in the context of BCR 17.

Occupancy at HOME was comparable to BBS routes with similar land cover for a few species of concern, but several species exhibited lower occupancy (Figure 13).

HOME is largely dominated by agriculture and herbaceous cover classes. There was a significant upward trend in developed area outside the park at the 5- and 10-km spatial scales (Figure 14).

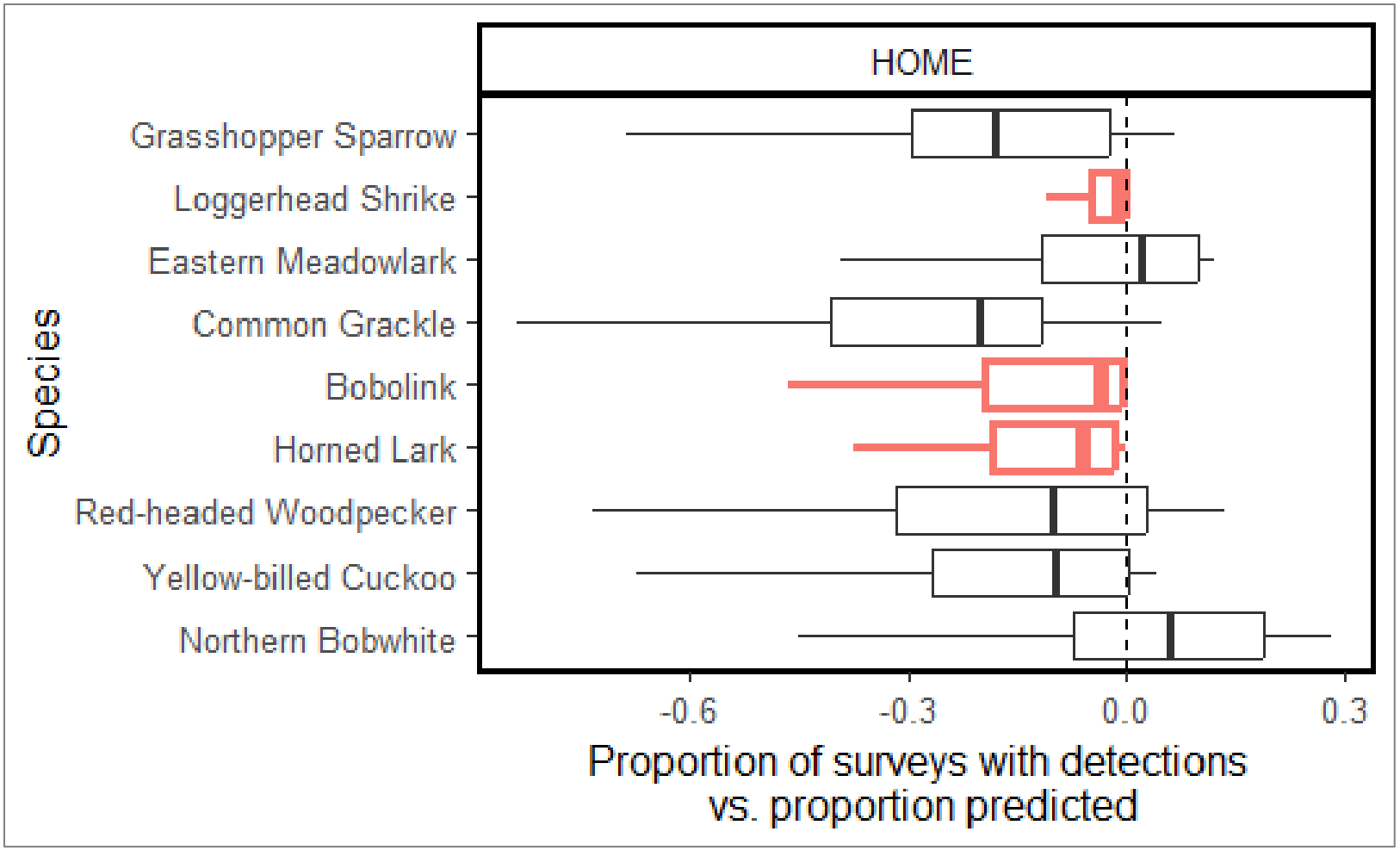


Figure 13. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at Homestead National Historical Park (HOME) in Bird Conservation Region (BCR) 19. Boxplots are shown for species of concern in this BCR whose breeding range encompasses or who was detected in the park. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Refer to Table 5 for species' scientific names.

USGS

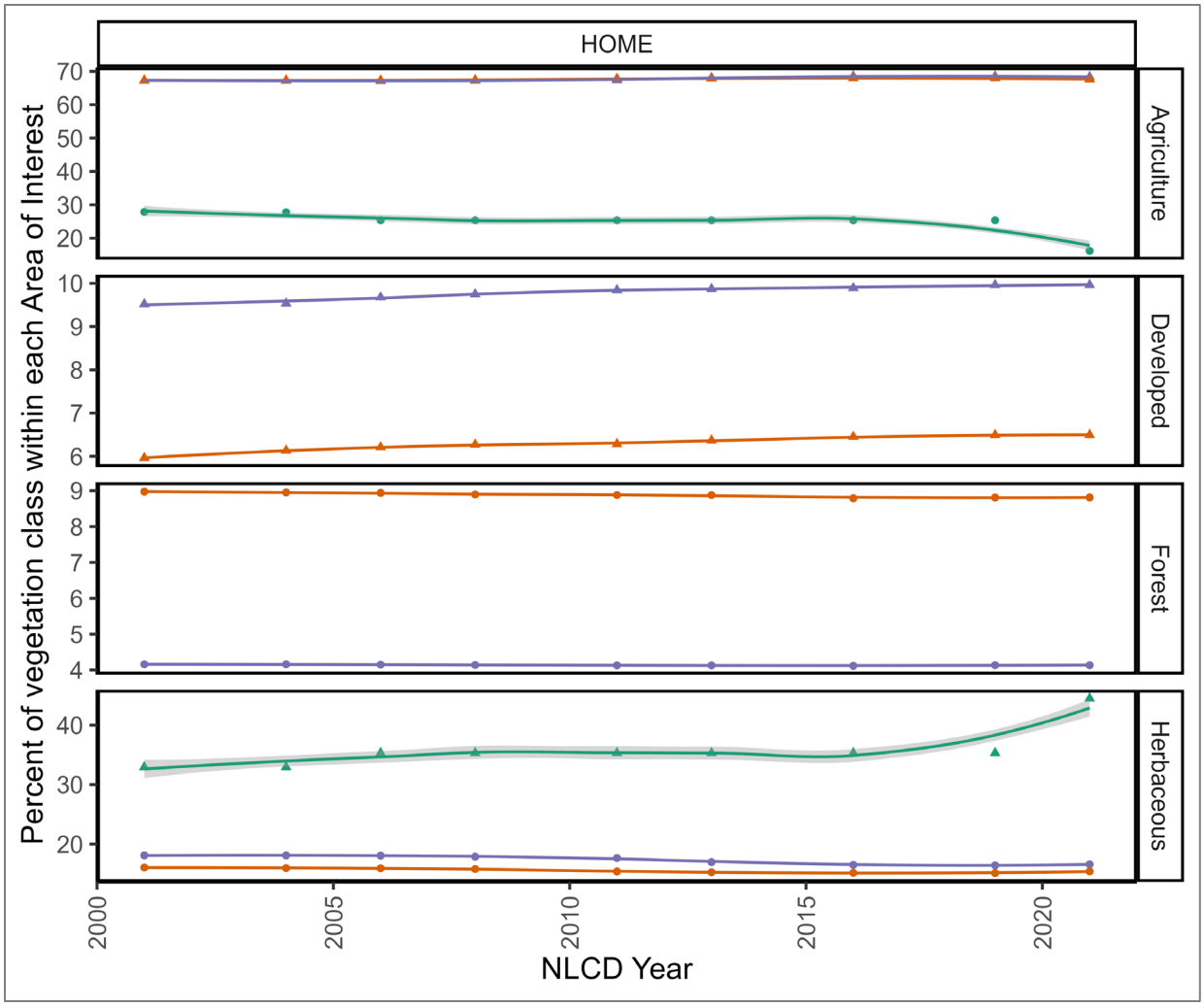


Figure 14. Trends through time in land cover classes at Homestead National Historical Park (HOME) in Bird Conservation Region (BCR) 19. Triangles represent a positive trend (slope; $p<0.05$), and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Eastern Tallgrass Prairie (BCR 22)

Herbert Hoover National Historical Site (HEHO) and Tallgrass Prairie National Preserve (TAPR) are in the Eastern Tallgrass Prairie BCR. Hopewell Culture National Historical Park (HOCU) is on the line between the Appalachian Mountains BCR and Eastern Tallgrass Prairie (BCR 22). The number of BBS routes in our study area was insufficient to use in modeling for the Appalachian Mountain BCR, so all of HOCU's points were analyzed as part of BCR 22.

Parks in BCR 22 had occupancy that was comparable to or somewhat below BBS routes with similar land cover for most species of concern (Figure 15). However, Grasshopper Sparrow was more prevalent than expected in two of three parks, and Henslow's Sparrow was more prevalent in one park.

The landscape around the parks in this BCR is composed of agriculture and herbaceous cover types. Trends were significant for agriculture and developed land classes at all three parks in this BCR (Figure 16). At HOCU, trends also were significant in wetlands at the 5- and 10-km buffers.

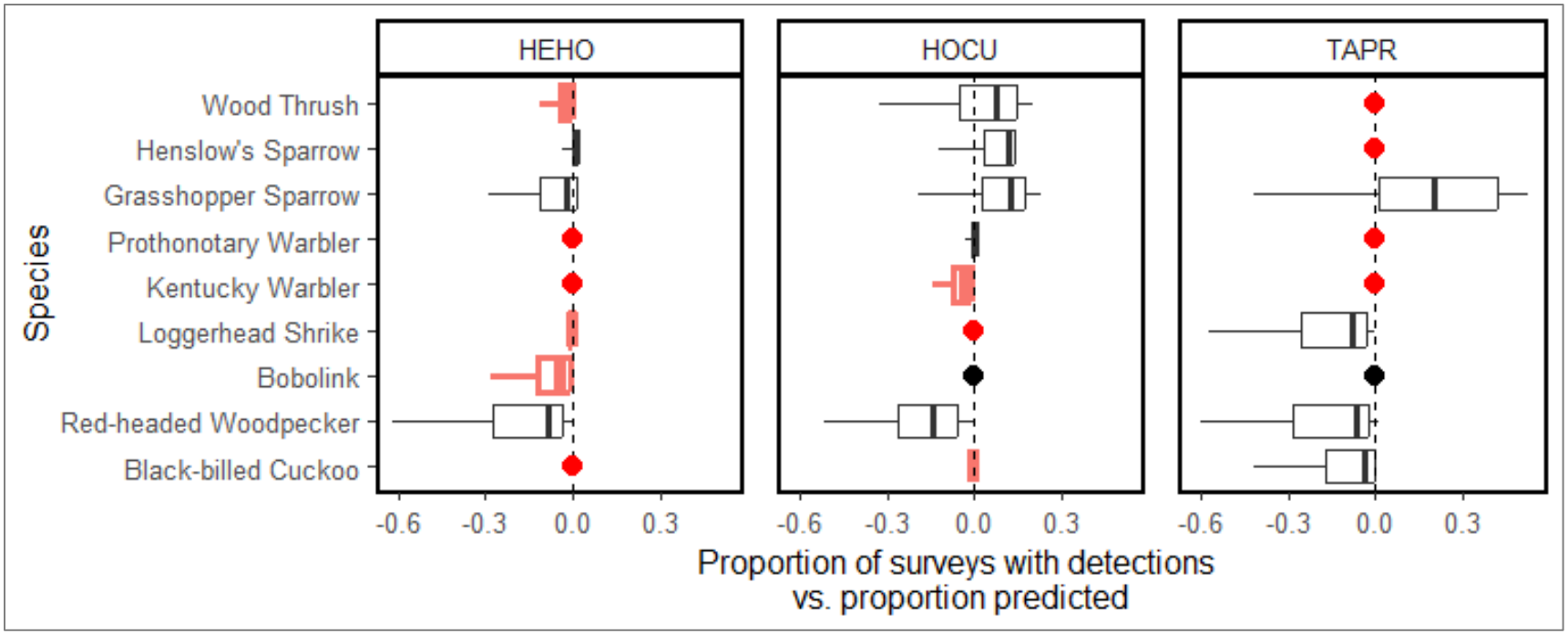


Figure 15. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at three parks in Bird Conservation Region (BCR) 22: Herbert Hoover National Historical Site (HEHO), Hopewell Culture National Historical Park (HOCU), and Tallgrass Prairie National Preserve (TAPR). Boxplots are shown for species of concern in this BCR whose breeding range encompasses at least one of the parks or who was detected in at least one of the parks. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Dots are shown in place of boxplots for out-of-range species detected in (black) or absent from (red) a given park. Refer to Table 5 for species' scientific names.

USGS

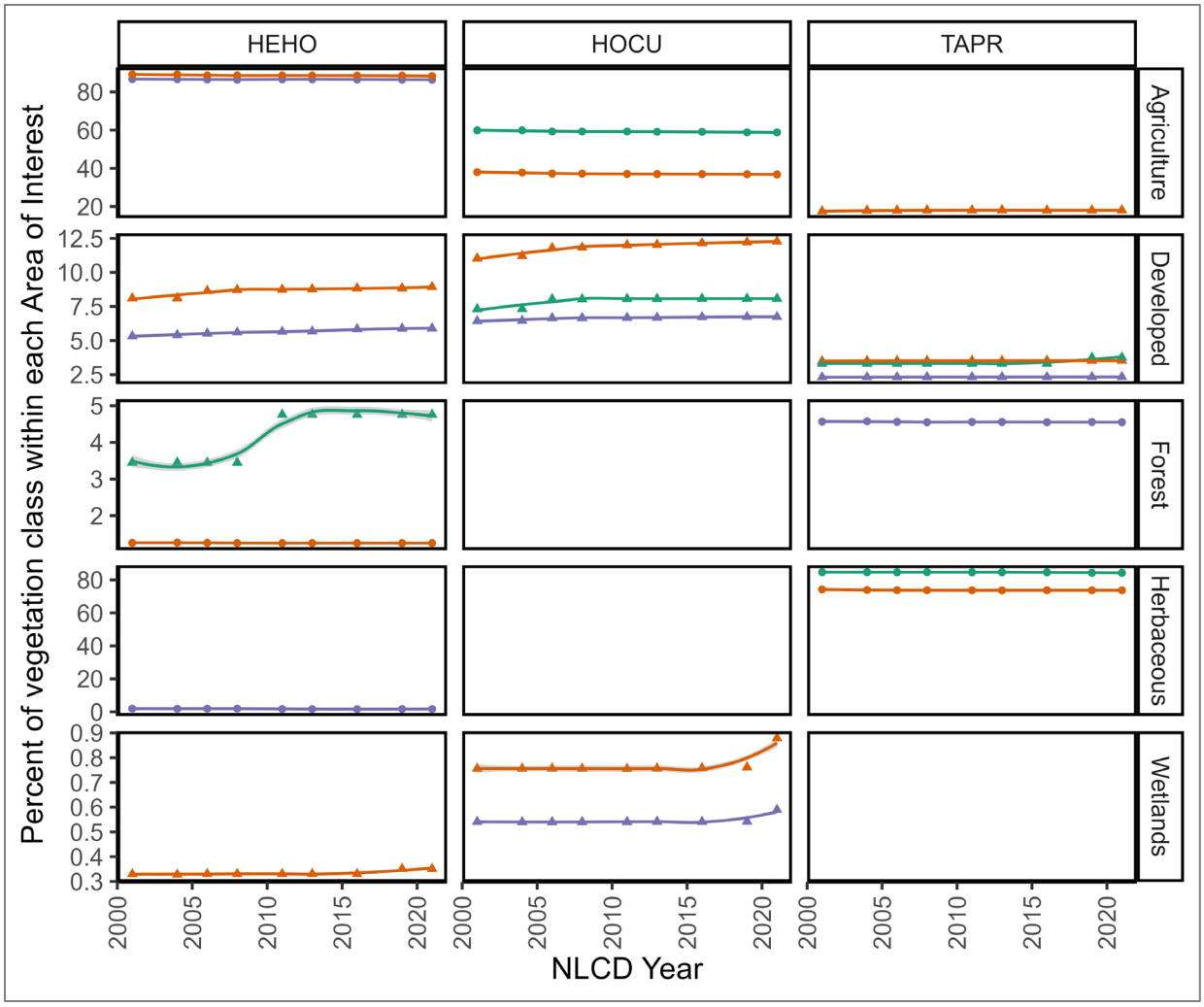


Figure 16. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 22: Herbert Hoover National Historical Site (HEHO), Hopewell Culture National Historical Park (HOCU), and Tallgrass Prairie National Preserve (TAPR). Triangles represent a positive trend (slope; $p<0.05$), and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Prairie Hardwood Transition (BCR 23)

Represented by Effigy Mounds National Monument (EFMO), Indiana Dunes National Park (INDU), Mississippi National River and Recreation Area (MISS), and the southern half of the St. Croix National Scenic Riverway (SACN).

Parks in BCR 23 had occupancy that was comparable to BBS routes with similar land cover for many species of concern (Figure 17). Only two of the nine priority species were detected at INDU (Wood Thrush and Red-headed Woodpecker).

The parks in this BCR lie within a matrix of agriculture, developed, and forest land cover types, and all parks in the BCR experienced significant changes at varying scales in all three cover types (Figure 18).

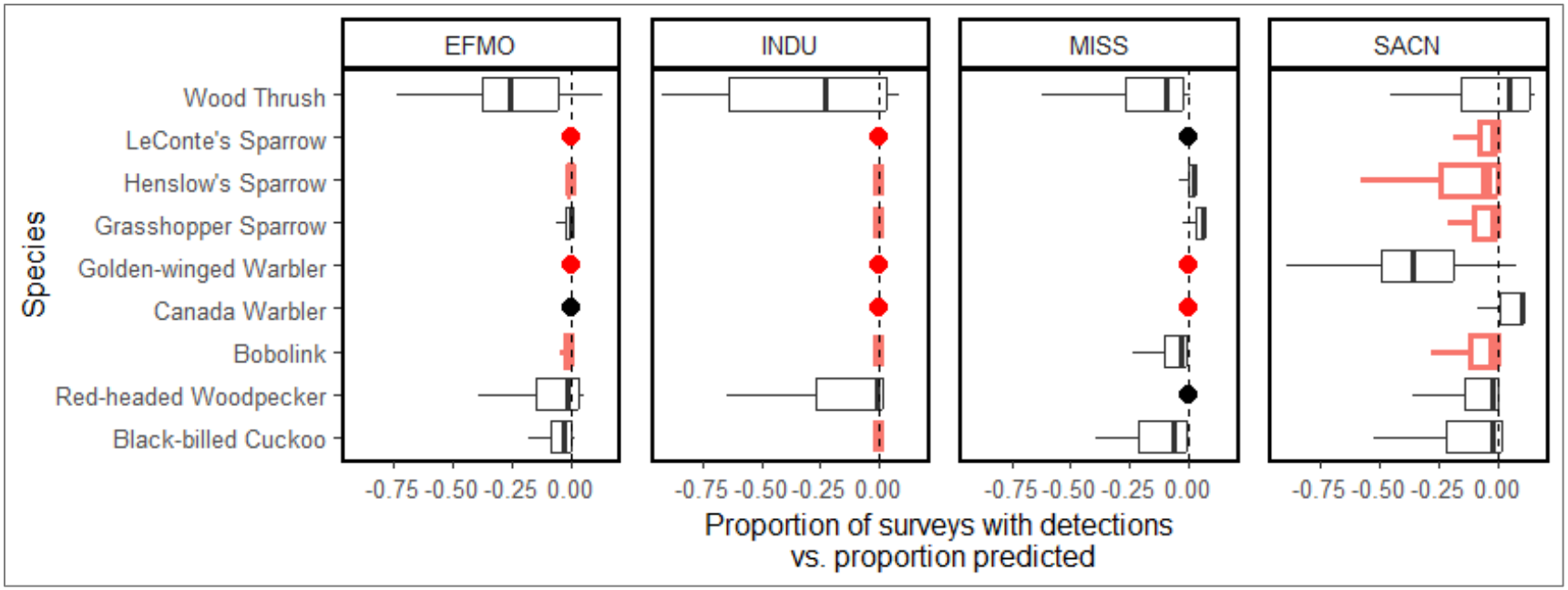


Figure 17. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at four parks in Bird Conservation Region (BCR) 23: Effigy Mounds National Monument (EFMO), Indiana Dunes National Park (INDU), Mississippi National River and Recreation Area (MISS), and the southern half of the St. Croix National Scenic Riverway (SACN). Boxplots are shown for species of concern in this BCR whose breeding range encompasses at least one of the parks or who was detected in at least one of the parks. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Dots are shown in place of boxplots for out-of-range species detected in (black) or absent from (red) a given park. Refer to Table 5 for species' scientific names.

USGS

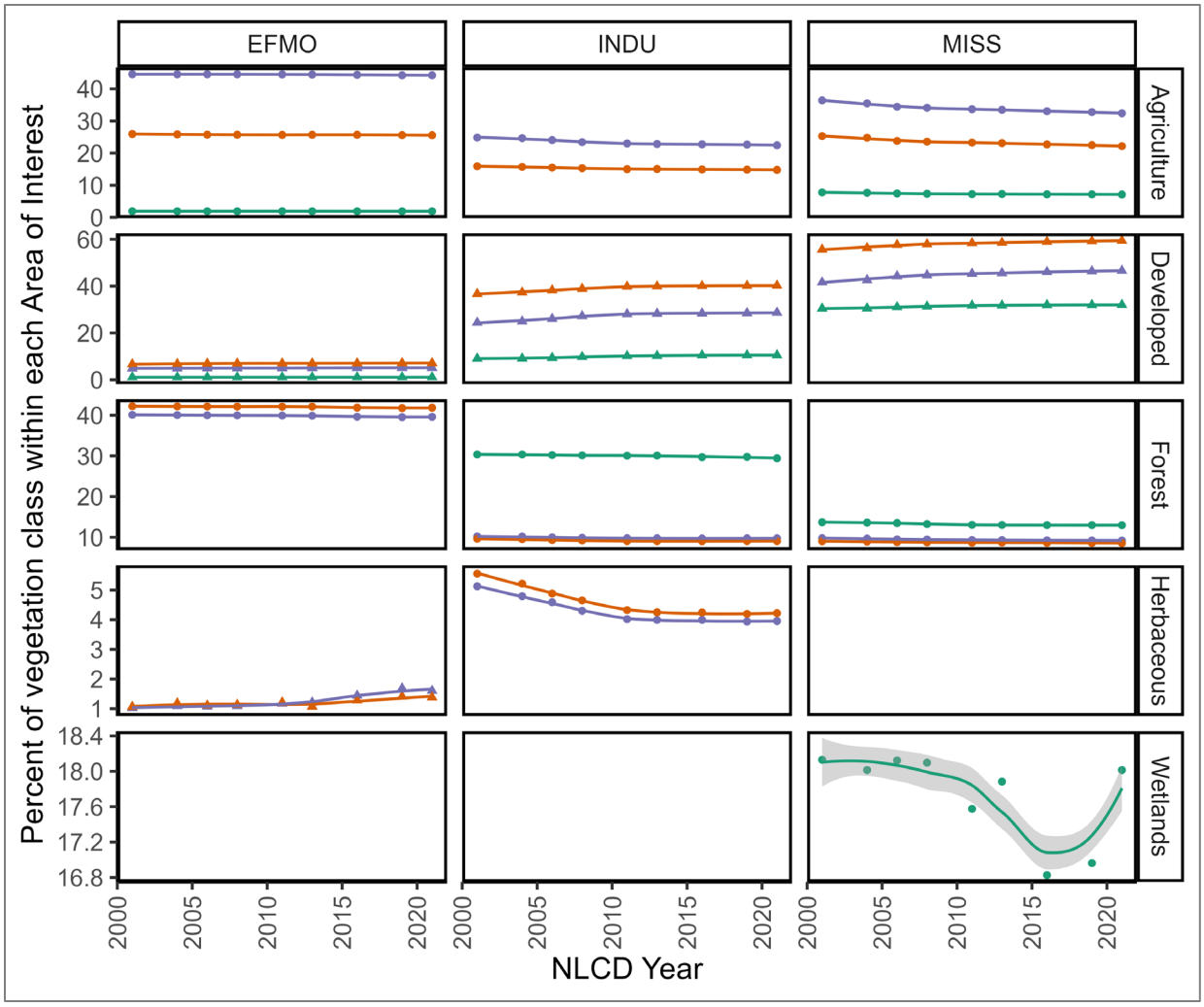


Figure 18. Trends through time in land cover classes at National Park Service (NPS) units in BCR 23: Effigy Mounds National Monument (EFMO), Indiana Dunes National Park (INDU), Mississippi National River and Recreation Area (MISS), and the southern half of the St. Croix National Scenic Riverway (SACN). Triangles represent a positive trend (slope; $p<0.05$) ,and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Central Hardwoods (BCR 24)

Represented by George Washington Carver National Monument (GWCA), Lincoln Boyhood National Memorial (LIBO), Pea Ridge National Military Park (PERI), and Wilson's Creek National Battlefield (WICR).

Parks in BCR 24 had occupancy that was comparable to BBS routes with similar land cover for many species of concern (Figure 19). However, the occupancy of Red-headed Woodpecker and Field Sparrow was lower than expected in nearly all parks.

Parks in this BCR are characterized by agriculture and forest, with one park (WICR) having a large proportion of developed area outside the park. All parks in the BCR experienced significant trends in agriculture and developed classes at multiple scales (Figure 20).

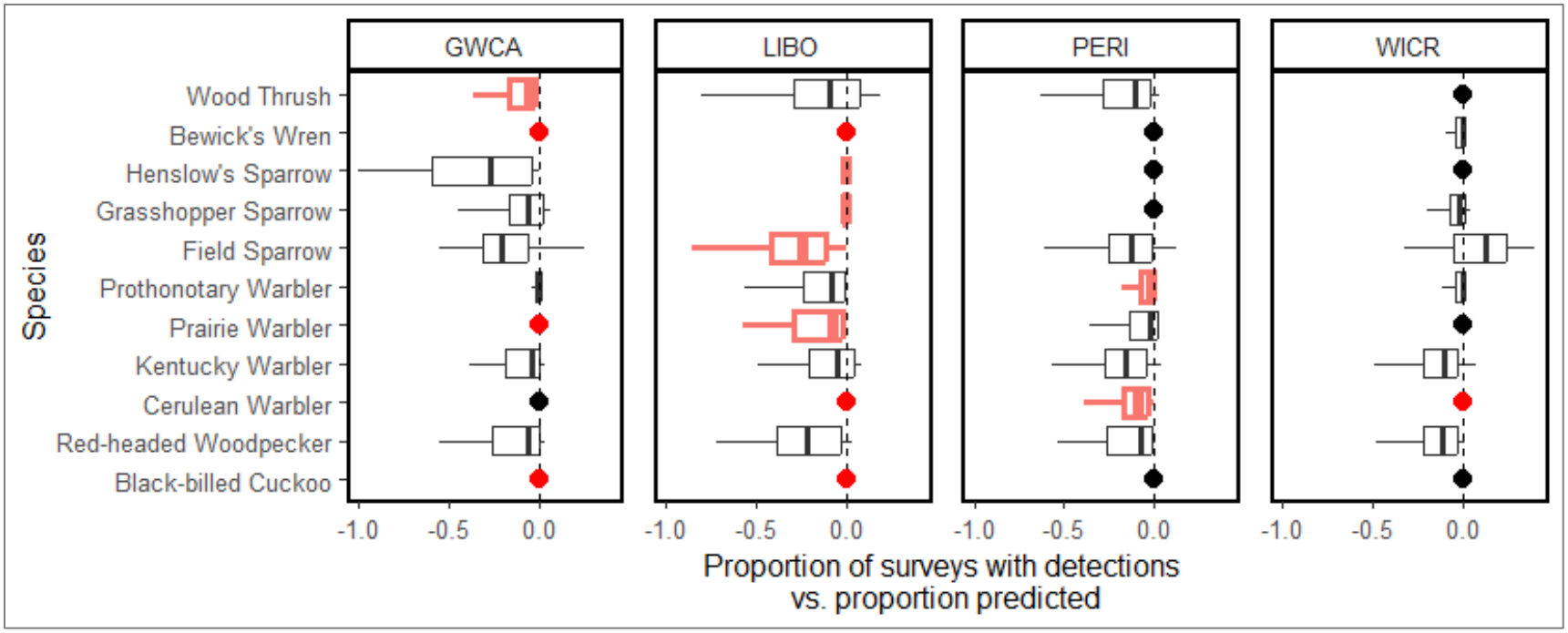


Figure 19. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at four parks in Bird Conservation Region (BCR) 24: George Washington Carver National Monument (GWCA), Lincoln Boyhood National Memorial (LIBO), Pea Ridge National Military Park (PERI), and Wilson's Creek National Battlefield (WICR). Boxplots are shown for species of concern in this BCR whose breeding range encompasses at least one of the parks or who was detected in at least one of the parks. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Red boxplots indicate a species that was not detected in any park surveys. Dots are shown in place of boxplots for out-of-range species detected in (black) or absent from (red) a given park. Refer to Table 5 for species' scientific names.

USGS

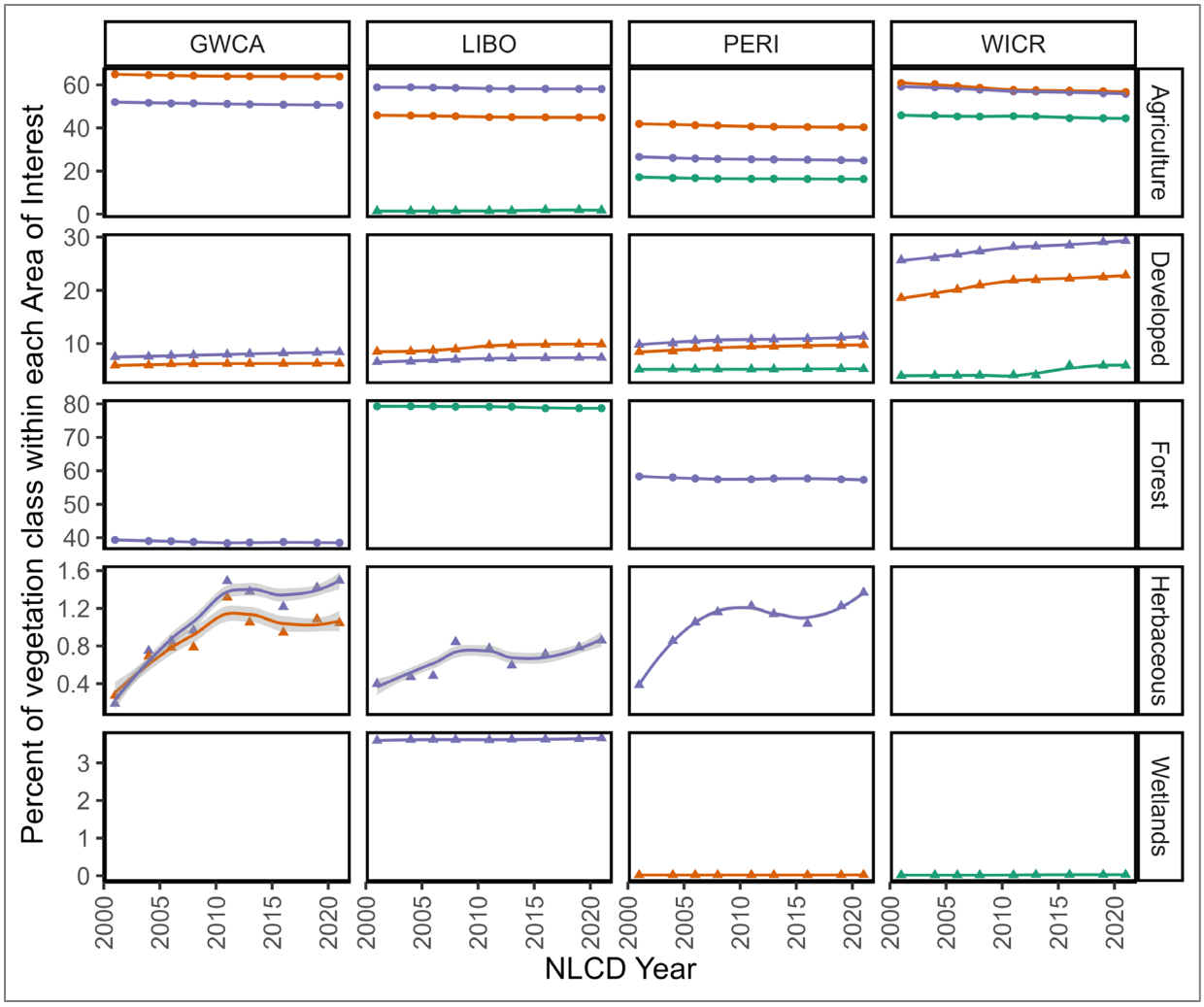


Figure 20. Trends through time in land cover classes at National Park Service (NPS) units in Bird Conservation Region (BCR) 24: George Washington Carver National Monument (GWCA), Lincoln Boyhood National Memorial (LIBO), Pea Ridge National Military Park (PERI), and Wilson's Creek National Battlefield (WICR). Triangles represent a positive trend (slope; $p<0.05$) and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Mississippi Alluvial Valley (BCR 26)

Only Arkansas Post National Memorial (ARPO) is located in this BCR.

Occupancy of species of concern in ARPO was comparable to or slightly below expectations when compared to BBS routes with similar land cover (Figure 21).

Agriculture, developed, and forest land cover types in this BCR showed significant trends, with most of the trends occurring within the 10-km buffer (Figure 22).

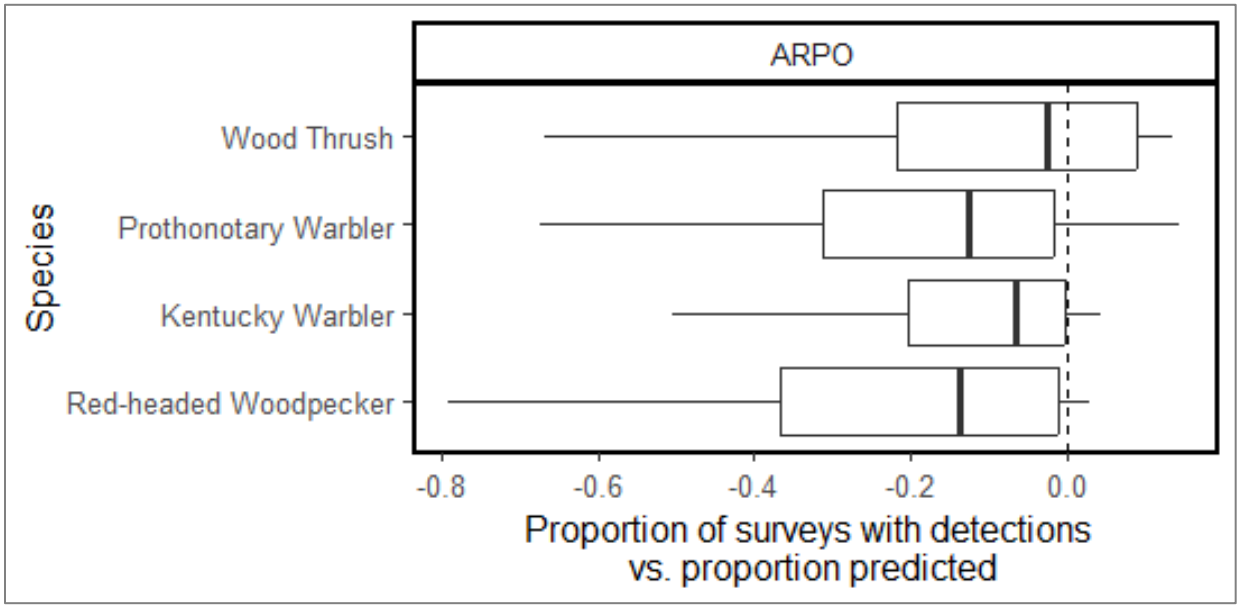


Figure 21. Proportion of predicted versus actual species detections on National Park Service (NPS) survey routes at Arkansas Post National Memorial (ARPO) in Bird Conservation Region (BCR) 26. Boxplots are shown for species of concern in this BCR whose breeding range encompasses or who was detected in the park. Boxplots represent the proportion of actual detections from NPS surveys minus model-predicted proportion of species detections on NPS surveys. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Refer to Table 5 for species' scientific names.

USGS

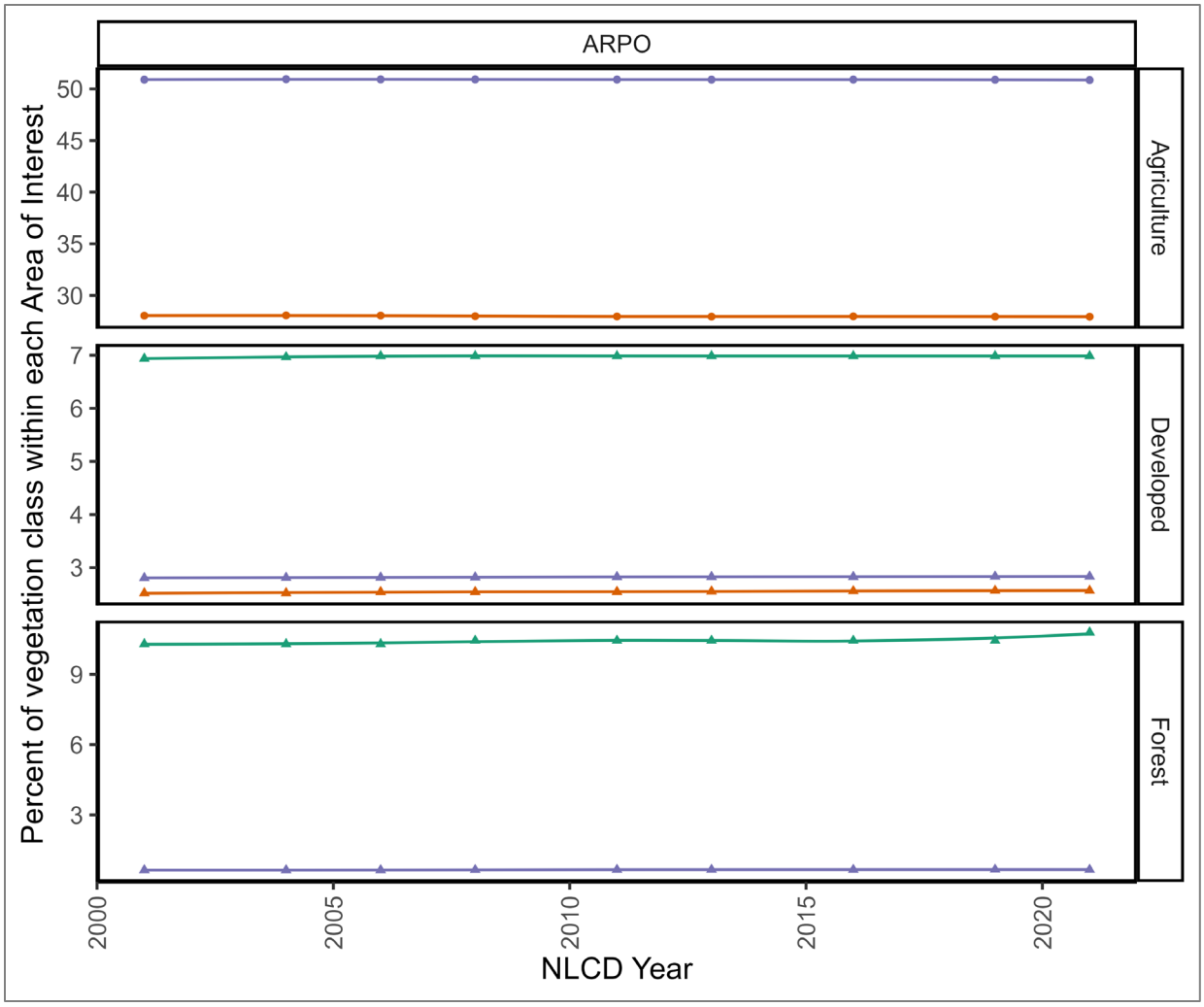


Figure 22. Trends through time in land cover classes at Arkansas Post National Memorial (ARPO) in Bird Conservation Region (BCR) 26. Triangles represent a positive trend (slope; $p<0.05$), and circles represent a negative trend (slope). Points and lines represent data within the park (teal), within a 5-km buffer (orange), and within a 10-km buffer (purple). No line is shown when the trend was non-significant. A Mann-Kendall test was used to test for a monotonic trend in each timeseries. Lines were generated using the loess smoothing function. Note that y axes are truncated to better show variation through time. NLCD is National Land Cover Database (Dewitz 2023).

NPS

Appalachian Mountains (BCR 28)

Hopewell Culture National Historical Park (HOCU) is on the line between the Appalachian Mountains and Eastern Tallgrass Prairie BCRs. The number of BBS routes was insufficient for use in modeling, so all of HOCU's points were analyzed as part of BCR 22 (Eastern Tallgrass Prairie).

Summary

The mean difference between observed and mean expected proportion of surveys detected across *all species* was negative in each park, indicating that species are on average less commonly detected in parks than expected. The exception to this was Jewel Cave (JECA), which had only a few species of concern (refer to Figure 9).

The mean difference between observed and mean expected detections across *all parks* was negative for all but three species: Northern Bobwhite, Ovenbird, and Black-throated Green Warbler. However, there were only 60 out of a total of 289 (21%) park-bird species combinations for which the observed proportion of detections differed from the predicted proportion with >95% probability (one-sided; refer to Appendix B). This included only two cases where observed exceeded expected with high probability: Black-throated Green Warbler in the Apostle Islands (APIS) (Figure 7) and Red-headed Woodpecker at Jewel Cave (JECA) (Figure 9). The 63 park-bird combinations in which species were less commonly detected than expected included 19 total species of concern (44%) in at least one park and at least one species in 17 of 32 (53%) of parks.

Discussion

Overall, parks appeared to have lower occupancy of bird species of concern than did areas with similar land cover elsewhere in the same BCR. In each park, the mean difference between species detections and mean predicted detections indicates that most species are less frequently detected in parks than expected. This is despite the longer point count duration used in most parks relative to the BBS. However, when the range of uncertainty of predictions is considered, only 21% of park-bird combinations showed strong evidence (95%) of differing from expectation. Of these, species were less common in the park than expected in all but two cases: Black-throated Green Warbler in the Apostle Islands (APIS) and Red-headed Woodpecker at Jewel Cave (JECA).

The variation or uncertainty in our model predictions likely results from species that have weak or variable responses to land cover covariates. Species that are difficult to detect can also add noise and thus uncertainty to models. This uncertainty makes it more challenging to detect differences in occupancy between parks and the surrounding BCR. Nevertheless, the general tendency for mean detection values to be lower than predicted in parks likely represents a real pattern, even if the confidence in this result for any given species is lower many common statistical thresholds (e.g., 95%).

It is somewhat unexpected to find that parks do not appear to be providing superior habitat for bird species of concern in their BCRs. This may be due in part to the nature of national parks in the Midwest Region. In a study of two Great Lakes region national park units, Gimmi et al. (2011) found that creating a national park helped to improve habitat within the park by reducing and stopping development, but increased amenity levels following park establishment led to enhanced development around both parks. Development rates of change immediately adjacent to a park were much higher than in the broader landscape. Wood et al. (2015) found that housing density at the boundary of protected areas tended to have a strong negative influence on abundance and richness of bird species of greatest conservation concern and land cover affiliates (species associated with natural land cover such as forest breeding birds). This is not unexpected, given the known negative response of forest and grassland birds to habitat fragmentation (Beck et al. 2016, Gnass Giese et al. 2015).

Our analyses do not directly address the factors determining park habitat quality and quantity, but the relatively small size of parks in this region could result in patches of habitat that are often smaller than in the broader landscape, and this combined with increased development around these parks could reduce habitat quality and patch connectivity. Many parks in this region were also established for cultural and historic reasons rather than primarily to protect habitat, so these parks would not necessarily be expected to contain (or occur within landscapes containing) the highest quality habitat.

In terms of land cover change, the “developed” land cover class increased the most through time around most parks. As public lands, and more precisely national parks, continue to draw people closer to them, they could expect to experience increased development in the future. Understanding the possible repercussions of the public’s draw to these areas will be increasingly important. In

addition, as land cover datasets change due to the increasing spatial and temporal resolution in satellite data, we expect that finer scale analyses will be possible.

Clearly habitat outside of parks is important for breeding birds in the Midwest, both because parks are small and because they do not include the best habitat for many species. Nonetheless, parks are important and are likely to increasingly represent islands of habitat in more developed landscapes. Parks are also locations on the landscape where direct targeted habitat improvement projects can be implemented, such as controlled burns to increase grassland habitat quality.

Our study is limited by the relatively coarse nature of land cover data relative to the habitat requirements of bird species. We did not distinguish, for example, among forest types (e.g., coniferous vs. deciduous) and did not explicitly consider the size of land cover patches but rather only the total area within a given radius. Nevertheless, NLCD land cover classes have been shown to be good predictors of bird species richness and abundance (Farwell et al. 2020). As land cover data improve, increasingly fine-scale models and analyses will be possible. Survey times also differ among our datasets, with NPS surveys often having longer duration than BBS. This potential bias, however, would tend to result in higher detection rates in parks, the opposite of our findings, and so we are confident that our results are robust to this difference.

Literature Cited

Baker, M. E., and R. S. King. 2010. A new method for detecting and interpreting biodiversity and ecological community thresholds. Methods in Ecology and Evolution 1(1): 25–37. Available at: https://doi.org/10.1111/j.2041-210X.2009.00007.x

Beaupré, K., R. E. Bennetts, J. A. Blakesley, K Gallo, D. Hanni, A. Hubbard, R. Lock, B. F. Powell, H. Sosinski, P. Valentine-Darby, C. White and M. Wilson. 2013. Landbird monitoring protocol and standard operating procedures for the Chihuahuan Desert, Northern Great Plains, Sonoran Desert, and Southern Plains Networks: Version 1.00. Natural Resource Report NPS/SOPN/NRR—2013/729. National Park Service, Fort Collins, Colorado. Available at: https://irma.nps.gov/DataStore/DownloadFile/484922

Beck, J. J., M. J. McKone, and O. W. McMurtrey. 2016. Edge effects and avian community structure in a restored tallgrass prairie. Natural Areas Journal 36(3): 328–333. Available at: https://doi.org/10.3375/043.036.0313

BSC/NABCI (Bird Studies Canada and North American Bird Conservation Initiative). 2014. Bird Conservation Regions. Maps published by Bird Studies Canada on behalf of the North American Bird Conservation Initiative. Available at: https://www.birdscanada.org/bird-science/nabci-bird-conservation-regions

Bird Conservancy of the Rockies. 2020. NGPN landbird monitoring tabular data. National Park Service, Northern Great Plains Network, Rapid City, South Dakota. Available at: https://irma.nps.gov/DataStore/Reference/Profile/2285415

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press, United Kingdom.

Burner, R. C., A. Kirschbaum, J. A. Hostetler, D. J. Ziolkowski, Jr, N. M. Anich, D. Turek, E. D. Striegel, and N. D. Niemuth. 2024a. Informative priors can account for location uncertainty in stop-level analyses of the North American Breeding Bird Survey (BBS), allowing fine-scale ecological analyses. Ornithological Applications 126:duae041. Available at: https://doi.org/10.1093/ornithapp/duae041

Burner, R. C., A. Kirschbaum, N. M. Anich, N. D. Niemuth, E. D. Striegel, and W. E. Thogmartin. 2024b. Location and land cover uncertainty associated with stop-level data from the North American Breeding Bird Survey (BBS). U.S. Geological Survey data release. Available at: https://doi.org/10.5066/P1CLSQED

Chesser, R. T., S. M. Billerman, K. J. Burns, C. Cicero, J. L. Dunn, B. E. Hernández-Baños, R. A. Jiménez, O. Johnson, A. W. Kratter, N. A. Mason, and P. C. Rasmussen. 2024. Check-list of North American birds (online). American Ornithological Society. Available at: https://checklist.americanornithology.org/

de Valpine, P., C. J. Paciorek, D. Turek, N. Michaud, C. Anderson-Bergman, E. Obermaier, C. Wehrhahn Cortes, A. S. L. Rodrigues, D. Temple Lang, and S. Paganin. 2023. NIMBLE: MCMC, particle filtering, and programmable hierarchical modeling. R package version 1.0.1. Available at: https://cran.r-project.org/package=nimble and https://doi.org/10.5281/zenodo.1211190

Dewitz, J. 2023. National Land Cover Database (NLCD) 2021 products. U.S. Geological Survey data release. Available at: https://doi.org/10.5066/P9JZ7AO3

Esri. 2024. ArcGIS Pro 3.3.1. Environmental Systems Research Institute, Redlands, California, USA.

Fancy, S. G. 1997. A new approach for analyzing bird densities from variable circular plot counts. Pacific Science 51: 107–114.

Farwell, L. S., P. R. Elsen, E. Razenkova, A. M. Pidgeon, and V. C. Radeloff. 2020. Habitat heterogeneity captured by 30-m resolution satellite image texture predicts bird richness across the United States. Ecological Applications 30: e02157. Available at: https://doi.org/10.1002/eap.2157

Gimmi, U., S. L. Schmidt, T. J. Hawbaker, C. Alcántara, U. Gafvert, and V. C. Radeloff. 2011. Increasing development in the surroundings of U.S. National Park Service holdings jeopardizes park effectiveness. Journal of Environmental Management 92: 229–239. Available at: https://doi.org/10.1016/j.jenvman.2010.09.006

Gnass Giese, E. E., R. W. Howe, A. T. Wolf, N. A. Miller, and N. G. Walton. 2015. Sensitivity of breeding birds to the “human footprint” in western Great Lakes forest landscapes. Ecosphere 6: 1–22. Available at: https://doi.org/10.1890/ES14-00414.1

Gostomski, T., M. Knutson, N. P. Danz, B. Route, and T. W. Sutherland. 2010. Landbird monitoring protocol: Great Lakes Inventory and Monitoring Network. Natural Resource Report NPS/GLKN/NRR—2010/225. National Park Service. Fort Collins, Colorado. Available at: https://irma.nps.gov/DataStore/DownloadFile/376378

Gostomski T., and R. Key. 2020. GLKN landbird monitoring: Certified data, 2014–2020. National Park Service, Great Lakes Inventory and Monitoring Network, Ashland, Wisconsin. Available at: https://irma.nps.gov/DataStore/Reference/Profile/2283665

Hamilton, C. M., S. Martinuzzi, A. J. Plantinga, V. C. Radeloff, D. J. Lewis, W. E. Thogmartin, P. J. Heglund, and A. M. Pidgeon. 2013. Current and future land use around a nationwide protected area network. PLoS ONE 8(1): e55737. Available at: doi:10.1371/journal.pone.0055737

HTLN (Heartland Inventory and Monitoring Network). 2023. Breeding bird monitoring protocol for the Heartland Inventory and Monitoring Network: Narrative, version 3.0 (revised September 2023). Natural Resource Report NPS/HTLN/NRR—2023/2609. National Park Service, Fort Collins, Colorado. Available at: https://doi.org/10.36967/2301758

Matthews, S. N., R. J. O'Connor, L. R. Iverson, and A. M. Prasad. 2004. Atlas of climate change effects in 150 bird species of the eastern United States. General Technical Report NE-318. USDA Forest Service, Northeast Research Station, Newtown Square, Pennsylvania. Available at: https://doi.org/10.2737/NE-GTR-318

Nelson, J. T., and S. G. Fancy. 1999. A test of the variable circular-plot method when exact density of a bird population was known. Pacific Conservation Biology 5: 139–143.

Niemuth, N. D., M. E. Estey, S. P. Fields, B. Wangler, A. A. Bishop, P. J. Moore, R. C. Grosse, and A. J. Ryba. 2017. Developing spatial models to guide conservation of grassland birds in the U.S. Northern Great Plains. The Condor: Ornithological Applications 119: 506–525. Available at: https://doi.org/10.1650/CONDOR-17-14.1

Northern Forest Birds Network/Upper Mississippi Great Lakes Joint Venture. 2021. Priority forest bird species-habitat matrix. Available at: https://umgljv.org/partnerships/northern-forest-birds-network/ or download directly at https://umgljv.org/NFBN/Priority-Forest-Bird-Species-Habitat-Matrix-FINAL.xlsx

NPS (National Park Service). 1916. An act to establish a National Park Service, and for other purposes (Organic Act). U.S. Code, Title 16, Section 1. Available at: https://www.govinfo.gov/content/pkg/USCODE-2010-title16/html/USCODE-2010-title16-chap1-subchapI-sec1.htm

NPS (National Park Service). 1992. Natural resources inventory and monitoring. NPS-75. National Park Service, Natural Resource Stewardship and Science, Washington, D.C. Available at: https://irma.nps.gov/DataStore/DownloadFile/449556

Oakley, K. L., L. P. Thomas, and S. G. Fancy. 2003. Guidelines for long-term monitoring protocols. Wildlife Society Bulletin 31(4): 1000–1003.

Peitz, D. G. 2021. Breeding bird monitoring dataset for the Heartland Network Inventory and Monitoring Program. Heartland I&M Network, National Park Service. Available at: https://irma.nps.gov/DataStore/Reference/Profile/2240627

Peitz, D. G. 2023. Heartland Inventory and Monitoring Network breeding bird data package. National Park Service. Fort Collins, Colorado. Available at: https://doi.org/10.57830/2300777

Pohlert, T. 2023. trend: Non-parametric trend tests and change-point detection. R package version 1.1.6. Available at: https://CRAN.R-project.org/package=trend

R Core Team. 2024. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Version 4.4.1. Available at: www.R-project.org

Ralph, C. J., S. Droege, and J. R. Sauer, editors. 1995. Monitoring bird populations by point counts. General Technical Report PSW-GTR-149. USDA Forest Service, Albany, California.

Reynolds, R. T., J. M. Scott, and R. A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. Condor 82: 309–313.

Rosenberg, K. V., A. M. Dokter, P. J. Blancher, J. R. Sauer, A. C. Smith, P. A. Smith, J. C. Stanton, A. Panjabi, L. Helft, M. Parr, and P. P. Marra. 2019. Decline of the North American avifauna. Science 366: 120–124. Available at: www.science.org/doi/pdf/10.1126/science.aaw1313

Rosenberg, K. V., J. A. Kennedy, R. Dettmers, R. P. Ford, D. Reynolds, J. D. Alexander, C. J. Beardmore, P. J. Blancher, R. E. Bogart, G. S. Butcher, A. F. Camfield, A. Couturier, D. W. Demarest, W. E. Easton, J. J. Giocomo, R. H. Keller, A. E. Mini, A. O. Panjabi, D. N. Pashley, T. D. Rich, J. M. Ruth, H. Stabins, J. Stanton, and T. Will. 2016. Partners in Flight landbird conservation plan: 2016 revision for Canada and continental United States. Partners in Flight Science Committee. Available at: www.partnersinflight.org/resources/the-plan/

Sauer, J. R., K. L. Pardieck, D. J. Ziolkowski, Jr., A. C. Smith, M-A. R. Hudson, V. Rodriguez, H. Berlanga, D. K. Niven, and W. A. Link. 2017. The first 50 years of the North American Breeding Bird Survey. The Condor: Ornithological Applications 119: 576–593. Available at: http://doi.org/10.1650/CONDOR-17-83.1

Scholtz, R., J. A. Polo, S. D. Fuhlendorf, and G. D. Duckworth. 2017. Land cover dynamics influence distribution of breeding birds in the Great Plains, USA. Biological Conservation 209: 323–331. Available at: https://doi.org/10.1016/j.biocon.2017.02.028

Strimas-Mackey, M., S. Ligocki, T. Auer, and D. Fink. 2022. ebirdst: Tools for loading, plotting, mapping and analysis of eBird status and trends data products. R package version 2.2021.1. Available at: https://ebird.github.io/ebirdst/

USFWS (U.S. Fish and Wildlife Service). 2021. Birds of conservation concern 2021. United States Department of the Interior, U.S. Fish and Wildlife Service, Migratory Birds, Falls Church, Virginia. Available at: https://www.fws.gov/media/birds-conservation-concern-2021

USGS/CWS (U.S. Geological Survey and Canadian Wildlife Service). 2020. Strategic plan for the North American Breeding Bird Survey, 2020–30. U.S. Geological Survey Circular 1466 [supersedes USGS Circular 1307]. U.S. Geological Survey, Reston, Virginia. Available at https://doi.org/10.3133/cir1466

Veech, J. A., K. L. Pardieck, and D. J. Ziolkowski. 2017. How well do route survey areas represent landscapes at larger spatial extents? An analysis of land cover composition along Breeding Bird Survey routes. The Condor: Ornithological Applications 119: 607–615. Available at: https://doi.org/10.1650/CONDOR-17-15.1

Wood, E. M., A. M. Pidgeon, V. C. Radeloff, D. P. Helmers, P. D. Culbert, N. S. Keuler, and C. H. Flather. 2015. Long-term avian community response to housing development at the boundary of US protected areas: Effect size increases with time. Journal of Applied Ecology 52(5): 1227–1236. https://doi.org/10.1111/1365-2664.12492

Wu, J. X., C. B. Wilsey, L. Taylor, and G. W. Schuurman. 2018. Projected avifaunal responses to climate change across the U.S. National Park System. PLoS ONE 13(3): e0190557. Available at: https://doi.org/10.1371/journal.pone.0190557

Ziolkowski, D., M. Lutmerding, V. I. Aponte, and M-A. R. Hudson. 2022. 2022 release—North American Breeding Bird Survey dataset (1966–2021). U.S. Geological Survey, Eastern Ecological Science Center at the Leetown Research Laboratory. Available at: https://doi.org/10.5066/P97WAZE5

Appendix A. Park-specific Results.

The following figures show land cover classes in and around (within 5 and 10 km) each of the national park units included in this analysis. Figures also indicate the locations of bird survey points in each park.

Agate Fossil Beds National Monument (AGFO), Nebraska

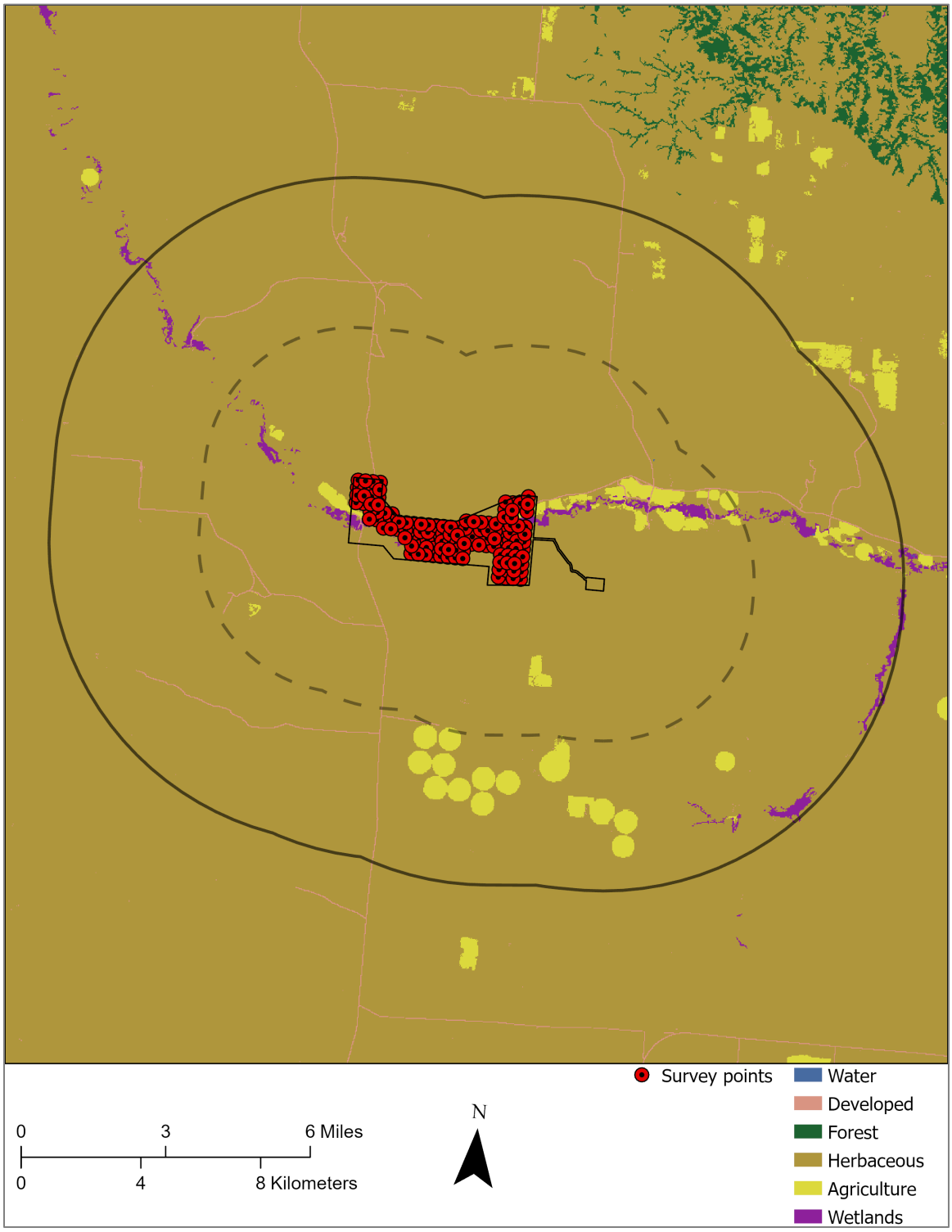


Figure 23. Land cover classes at Agate Fossil Beds National Monument (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

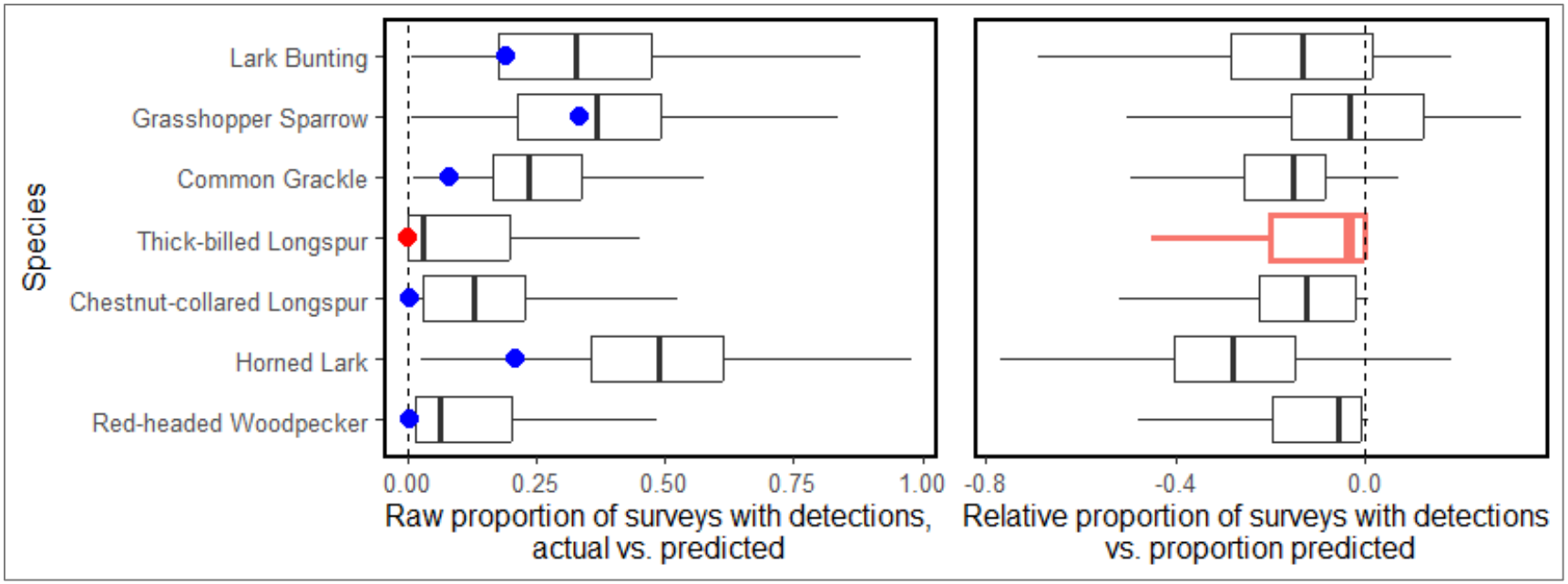


Figure 24. Proportion of actual versus predicted bird species detections during surveys at Agate Fossil Beds National Monument (Nebraska). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Apostle Islands National Lakeshore (APIS), Wisconsin

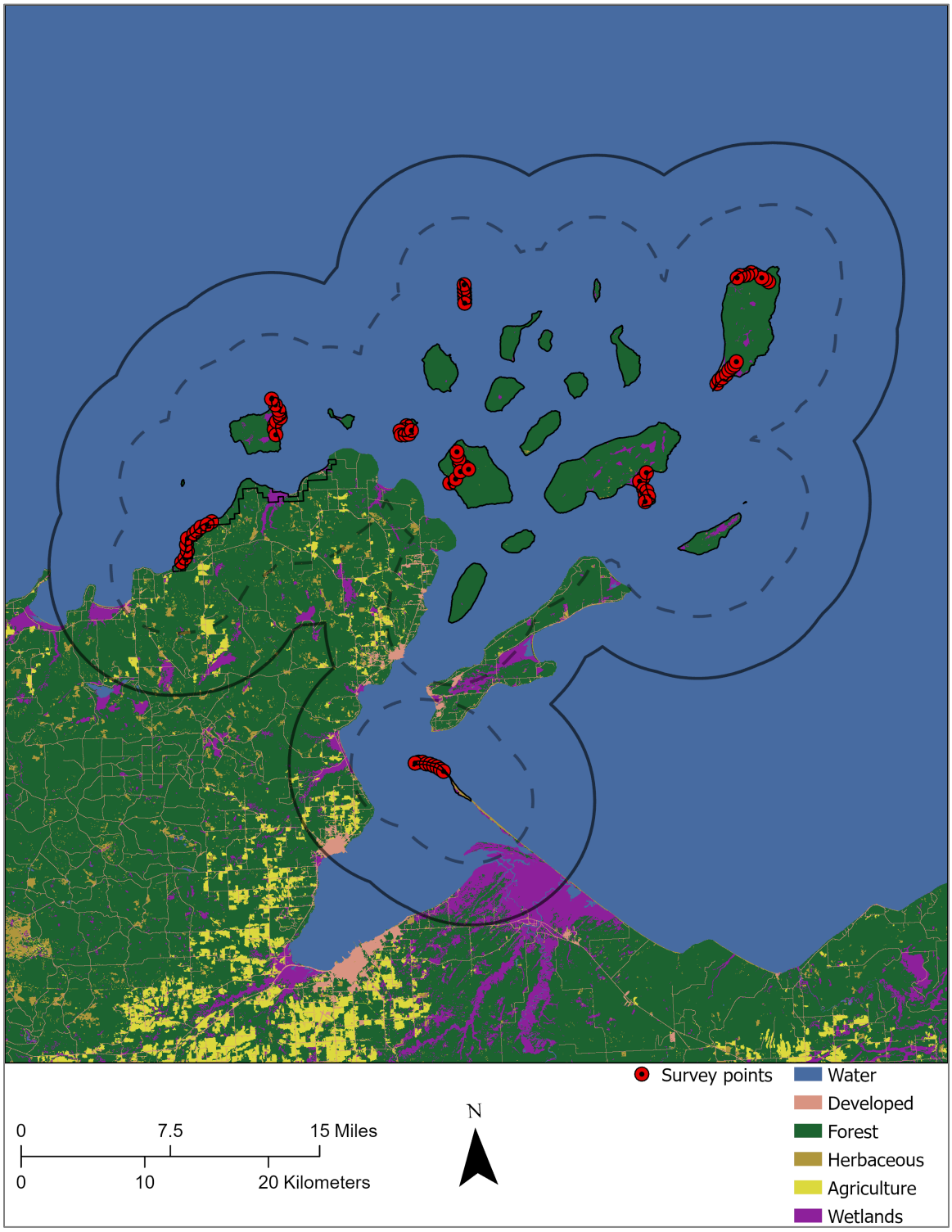


Figure 25. Land cover classes at Apostle Islands National Lakeshore (Wisconsin) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

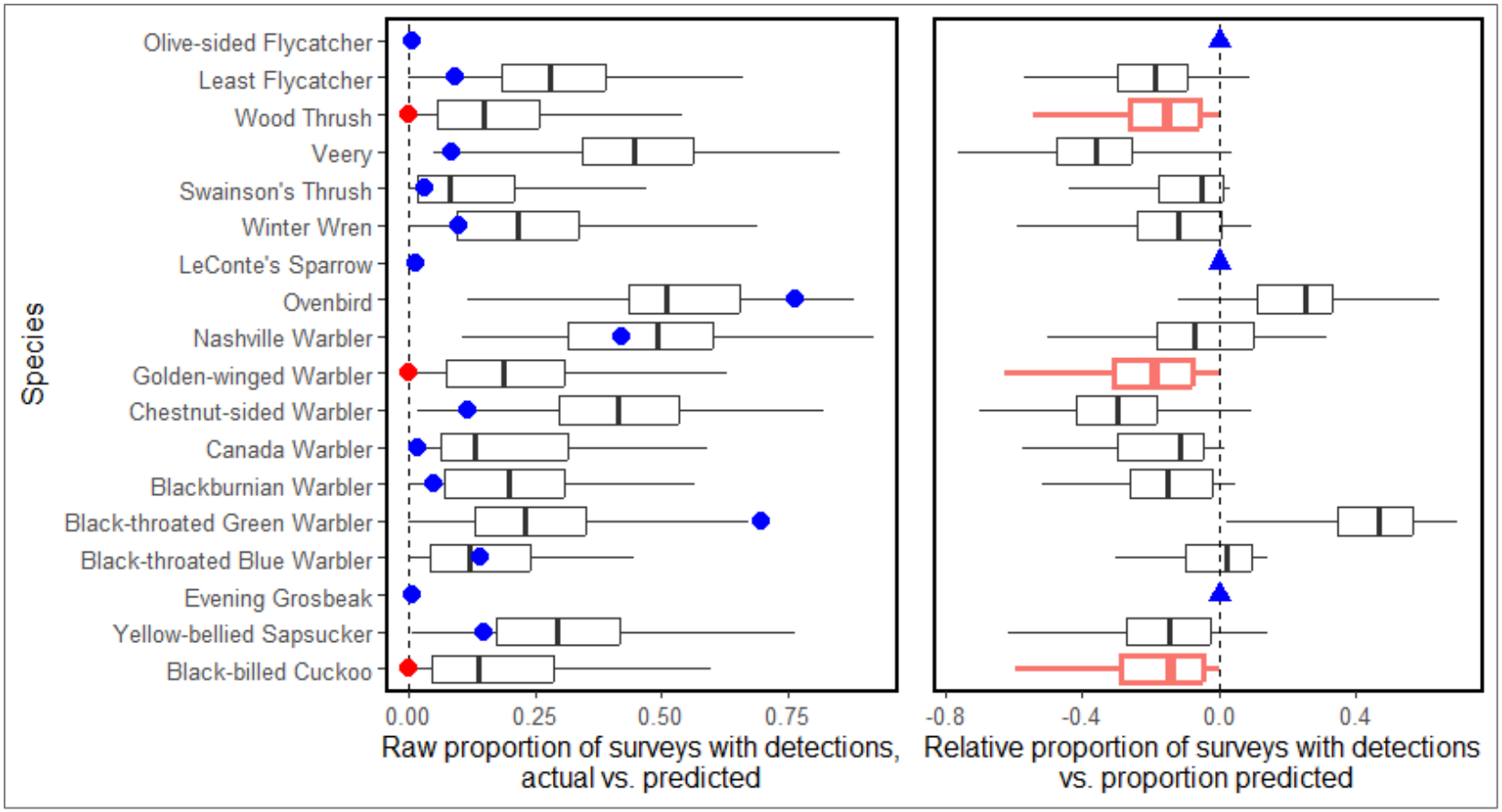


Figure 26. Proportion of actual versus predicted bird species detections during surveys at Apostle Islands National Lakeshore (Wisconsin). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names. *USGS*

Arkansas Post National Memorial (ARPO), Arkansas

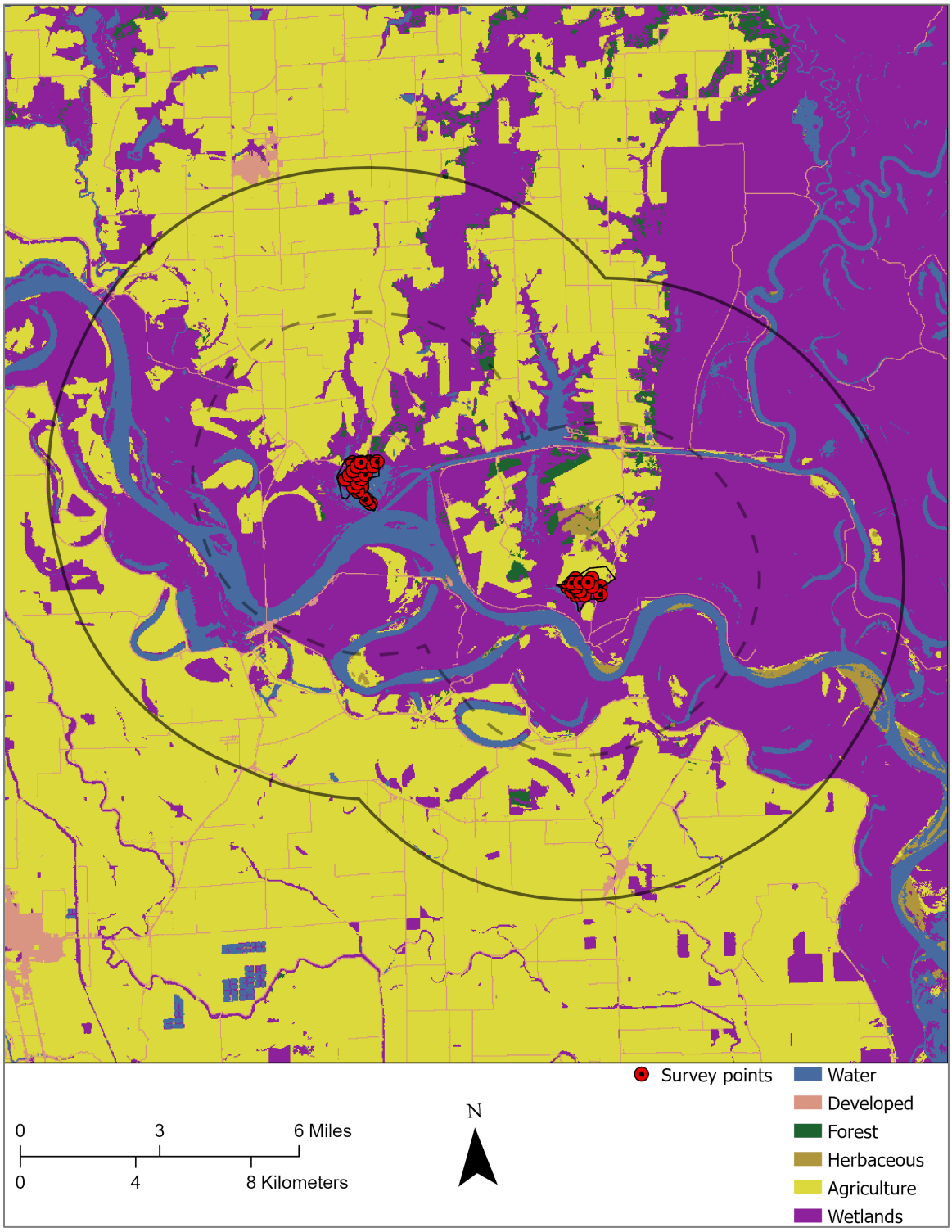


Figure 27. Land cover classes at Arkansas Post National Memorial (Arkansas) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

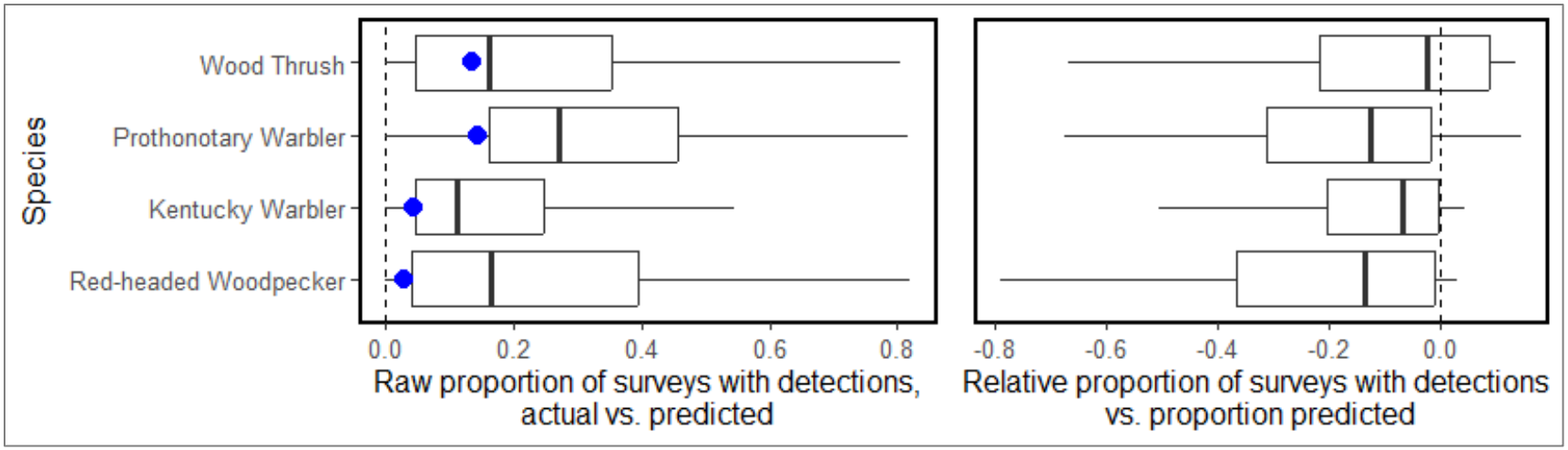


Figure 28. Proportion of actual versus predicted bird species detections during surveys at Arkansas Post National Memorial (Arkansas). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of NPS surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from National Park Service (NPS) surveys minus the model-predicted proportion of species detections on NPS surveys. Refer to Table 5 for species' scientific names.

USGS

Badlands National Park (BADL), South Dakota

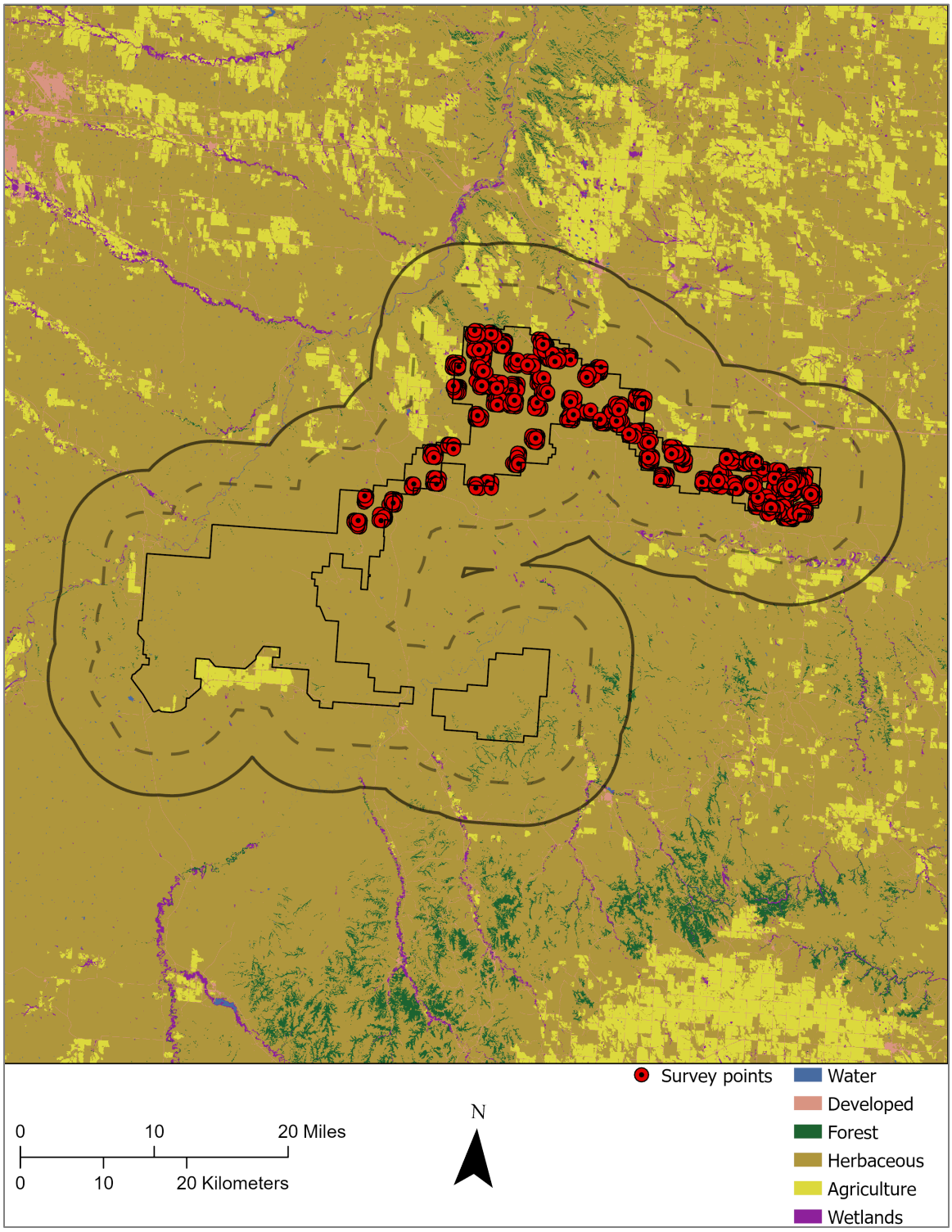


Figure 29. Land cover classes at Badlands National Park (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

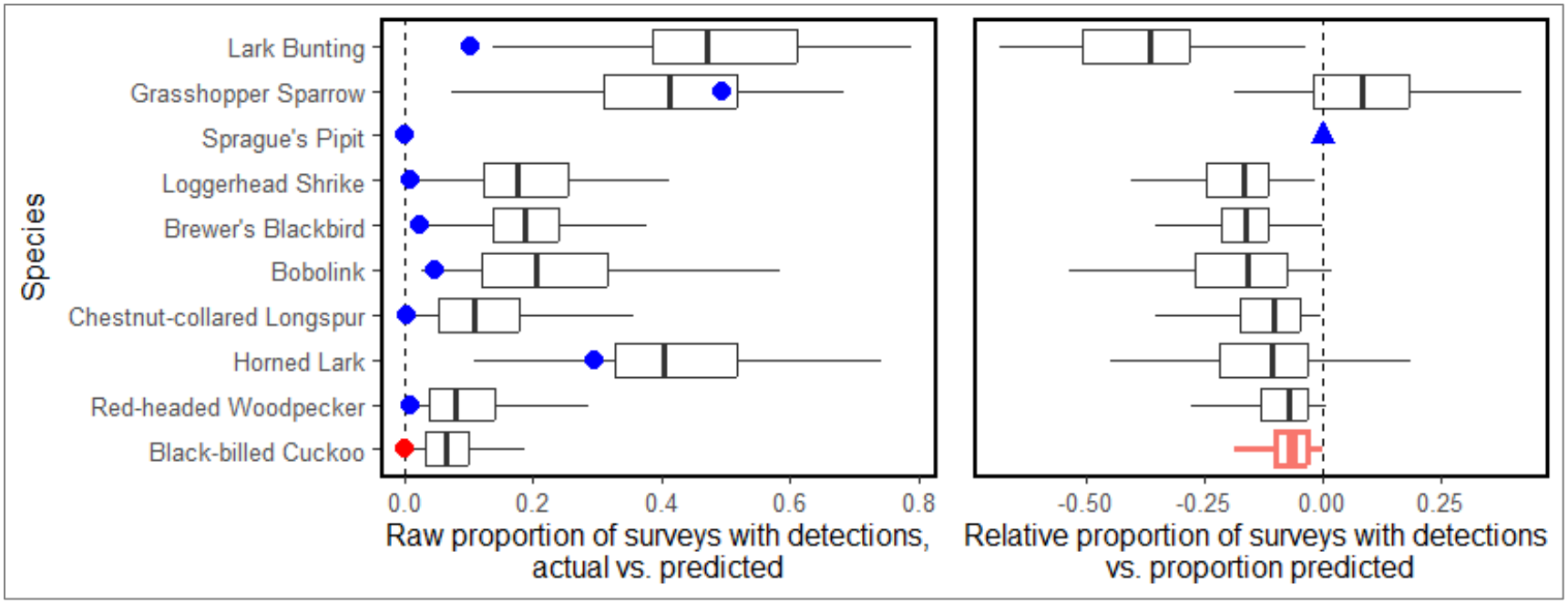


Figure 30. Proportion of actual versus predicted bird species detections during surveys at Badlands National Park (South Dakota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.
USGS

Devils Tower National Monument (DETO), Wyoming

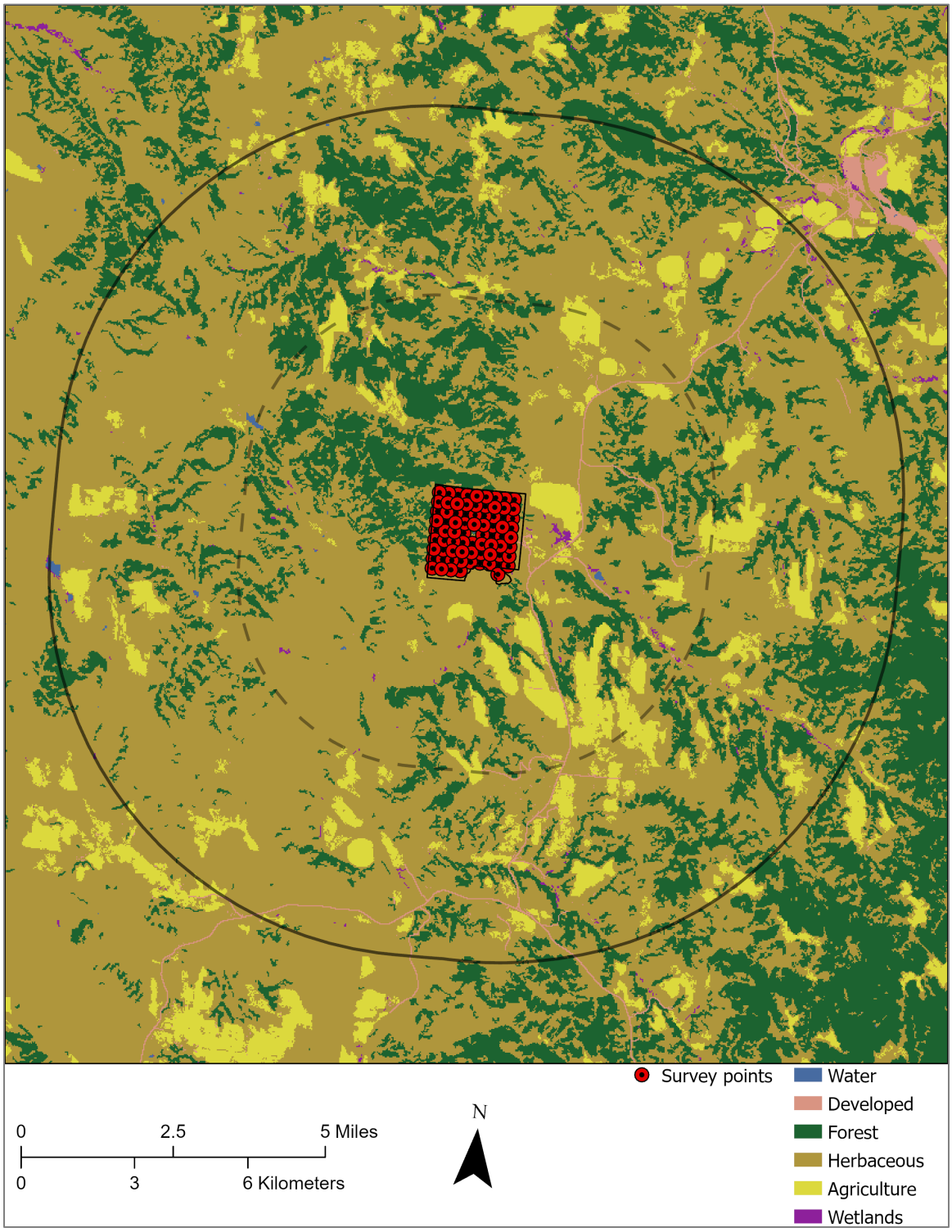


Figure 31. Land cover classes at Devil's Tower Beds National Monument (Wyoming) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

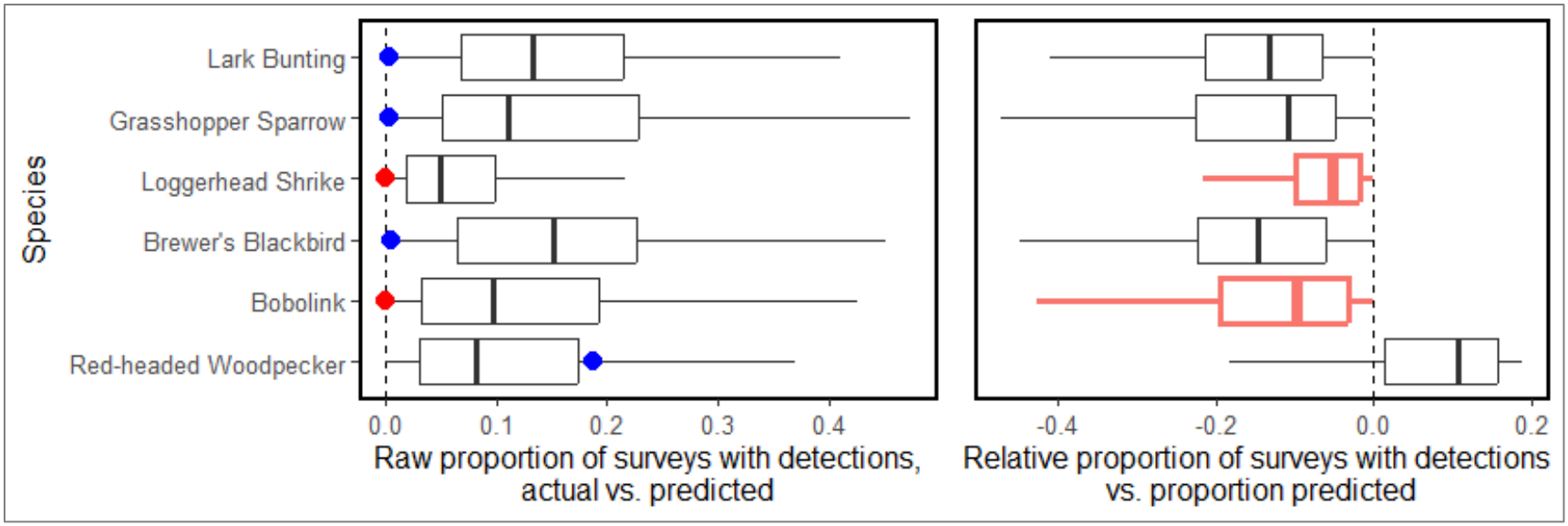


Figure 32. Proportion of actual versus predicted bird species detections during surveys at Devil's Tower Beds National Monument (Wyoming). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Effigy Mounds National Monument (EFMO), Iowa

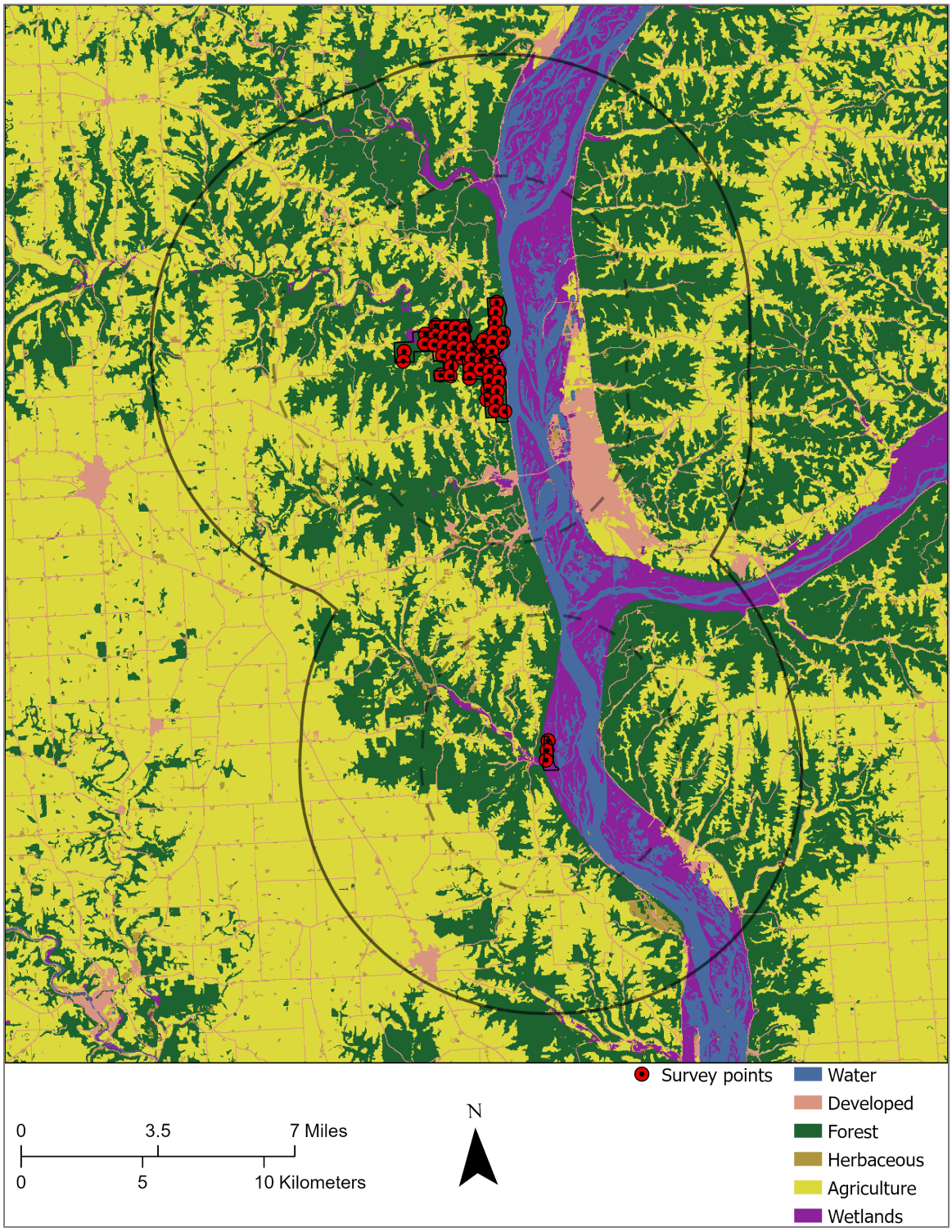


Figure 33. Land cover classes at Effigy Mounds National Monument (Iowa) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

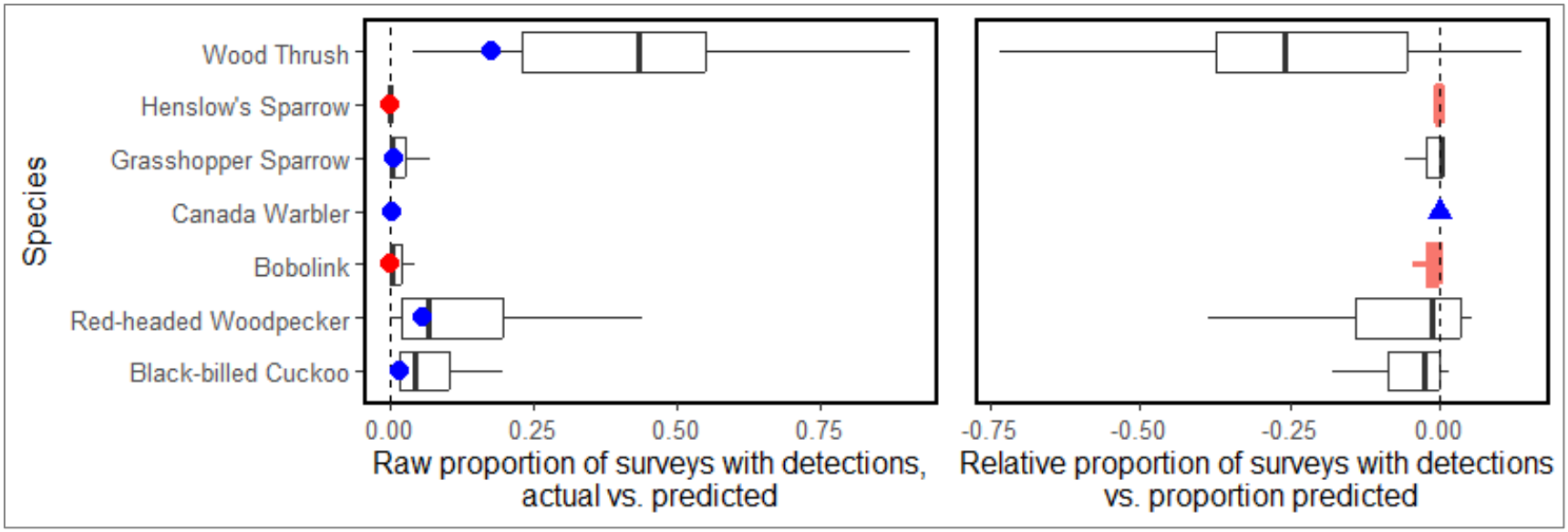


Figure 34. Proportion of actual versus predicted bird species detections during surveys at Effigy Mounds National Monument (Iowa). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.
USGS

Fort Laramie National Historic Site (FOLA), Wyoming

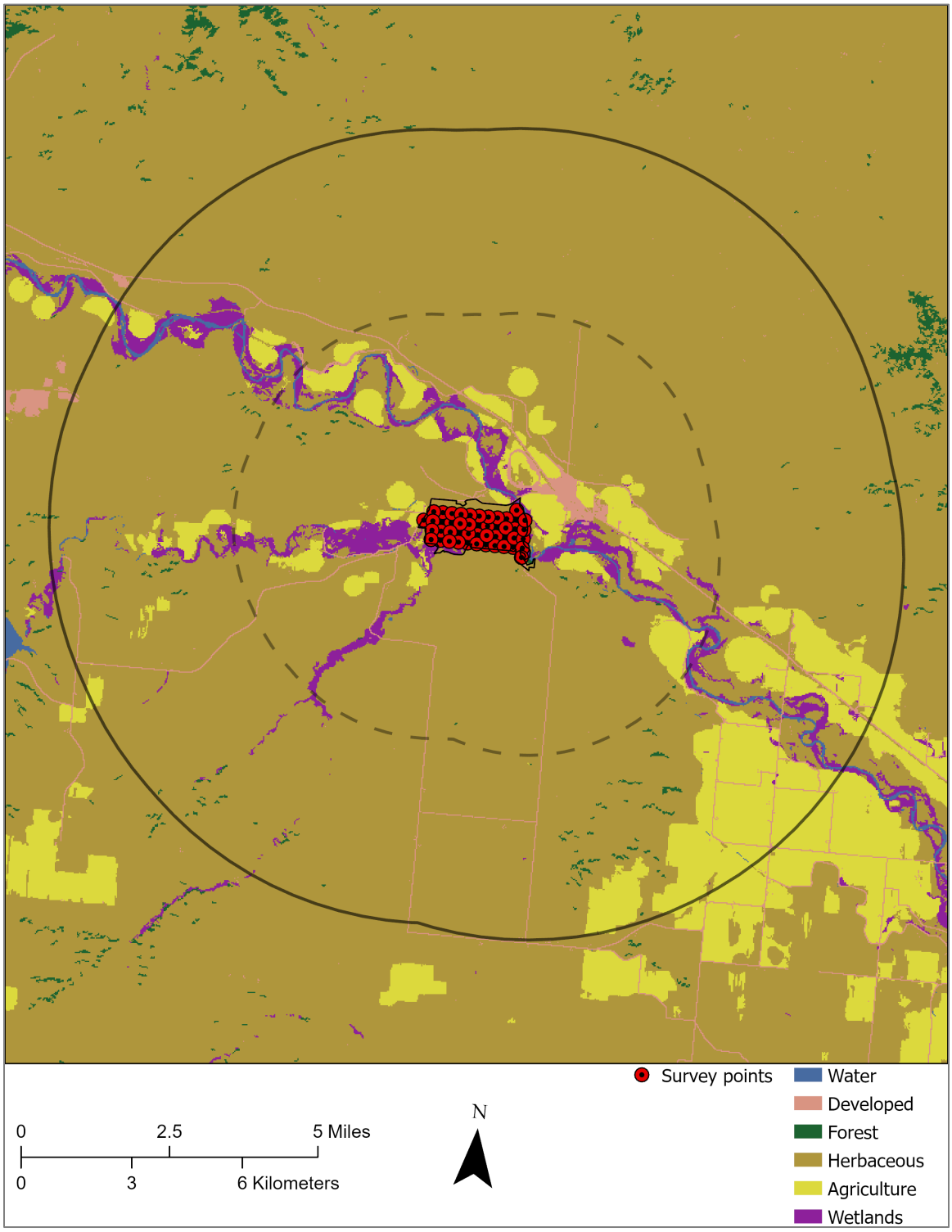


Figure 35. Land cover classes at Fort Laramie National Historical Site (Wyoming) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

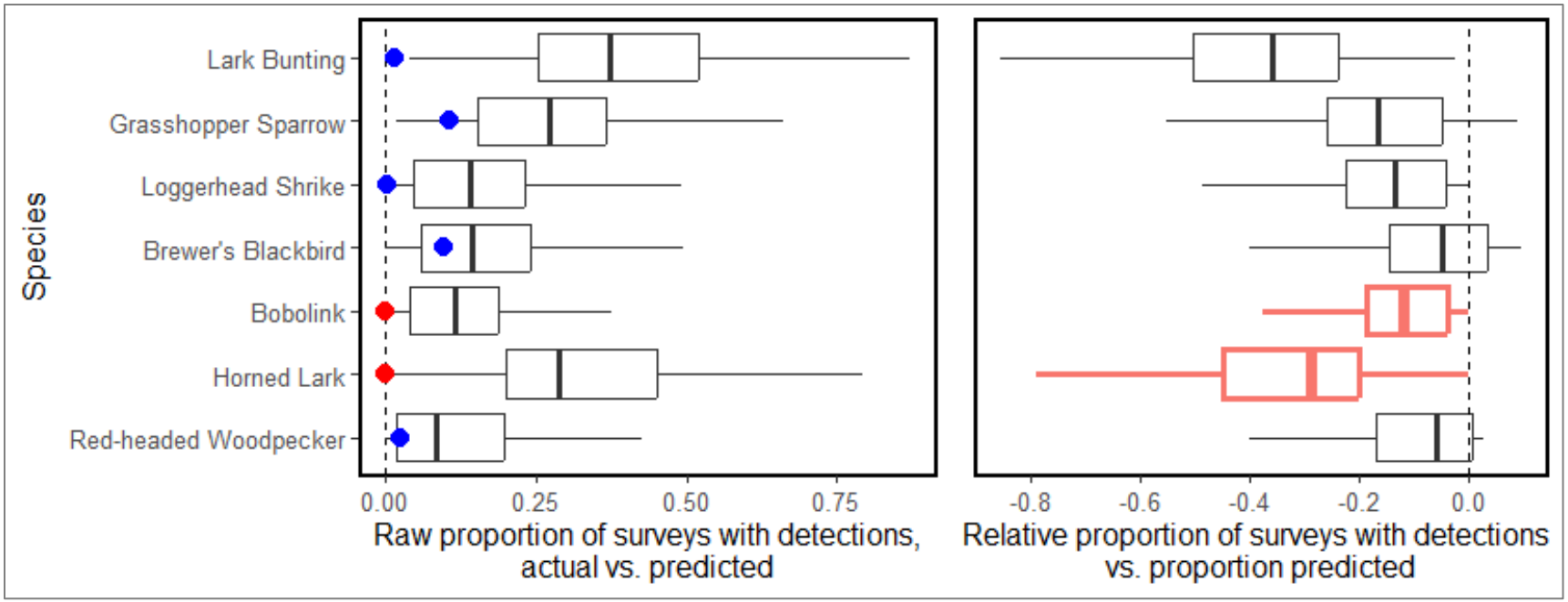


Figure 36. Proportion of actual versus predicted bird species detections during surveys at Fort Laramie National Historical Site (Wyoming). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

George Washington Carver National Monument (GWCA), Missouri

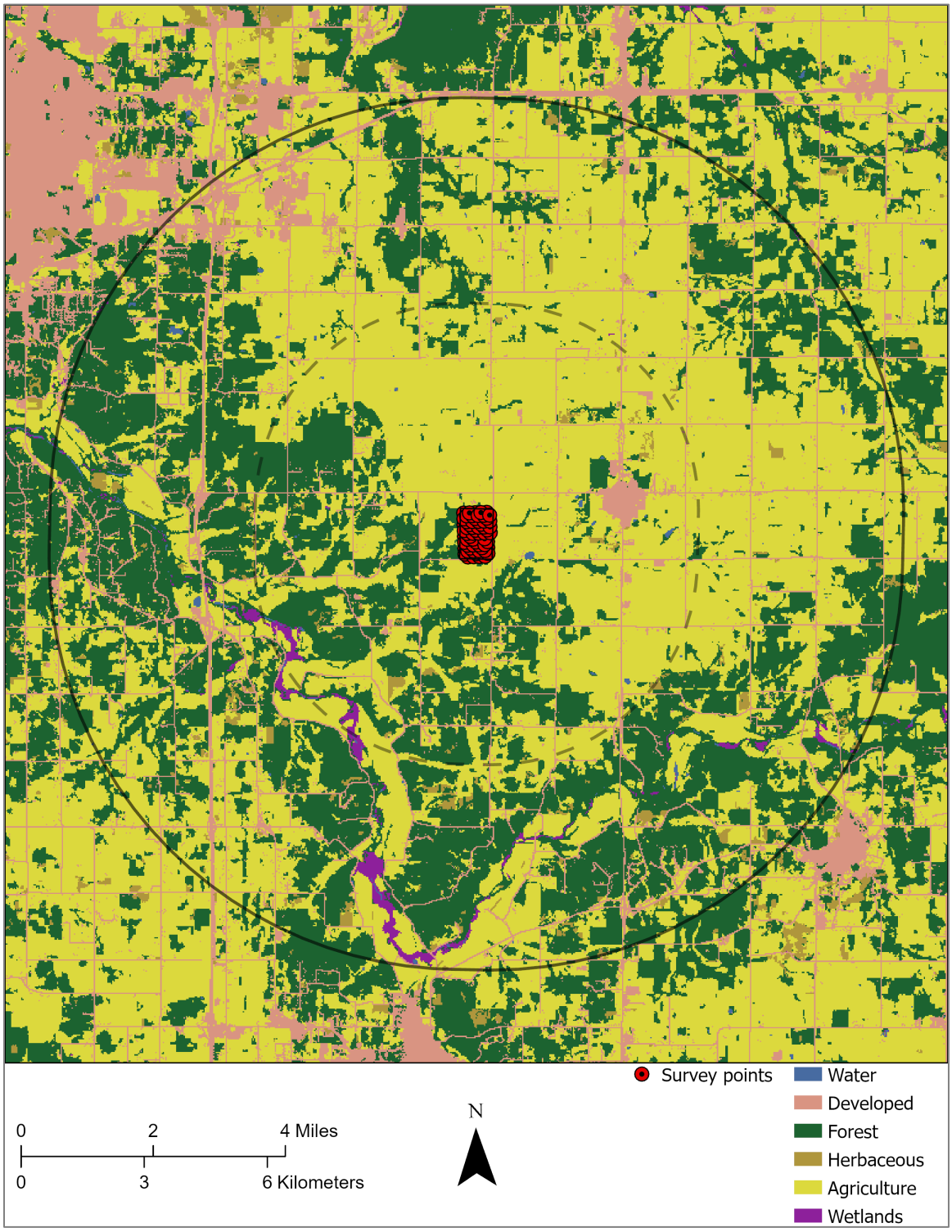


Figure 37. Land cover classes at George Washington Carver National Monument (Missouri) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

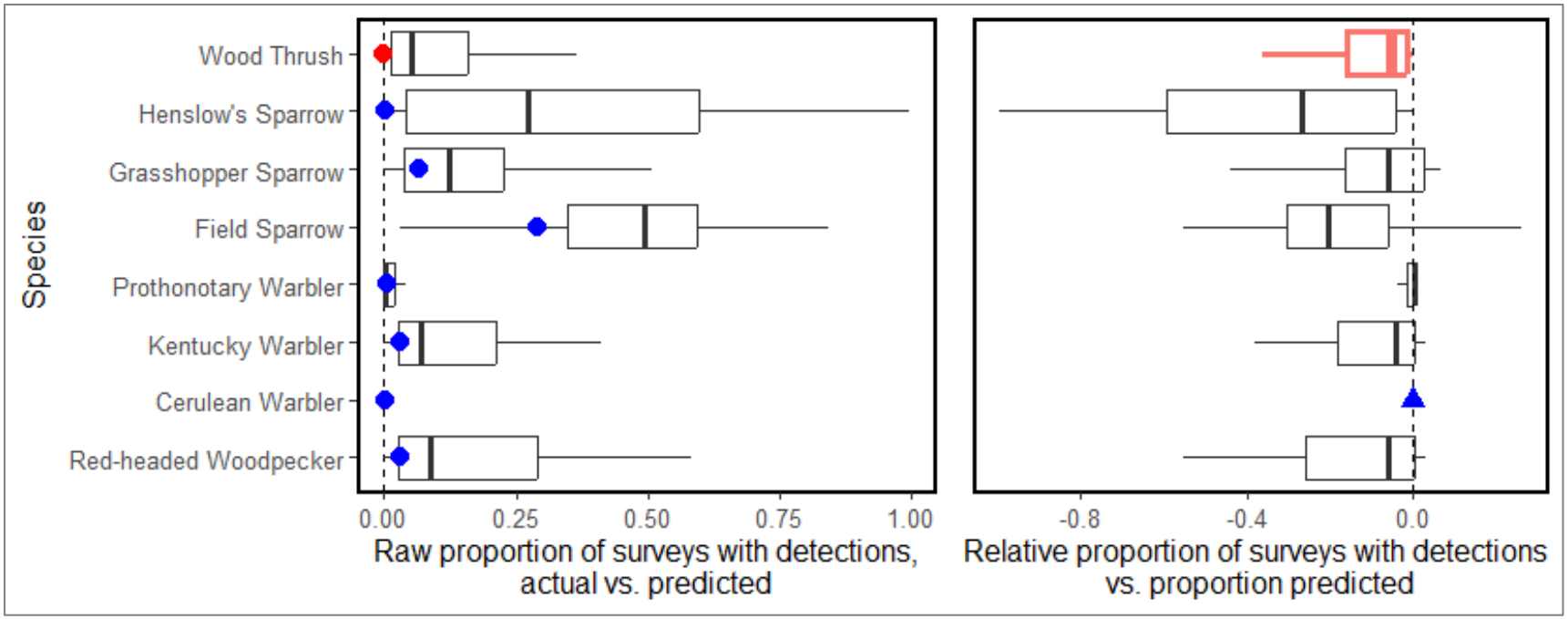


Figure 38. Proportion of actual versus predicted bird species detections during surveys at George Washington Carver National Monument (Missouri). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.

USGS

Grand Portage National Monument (GRPO), Minnesota

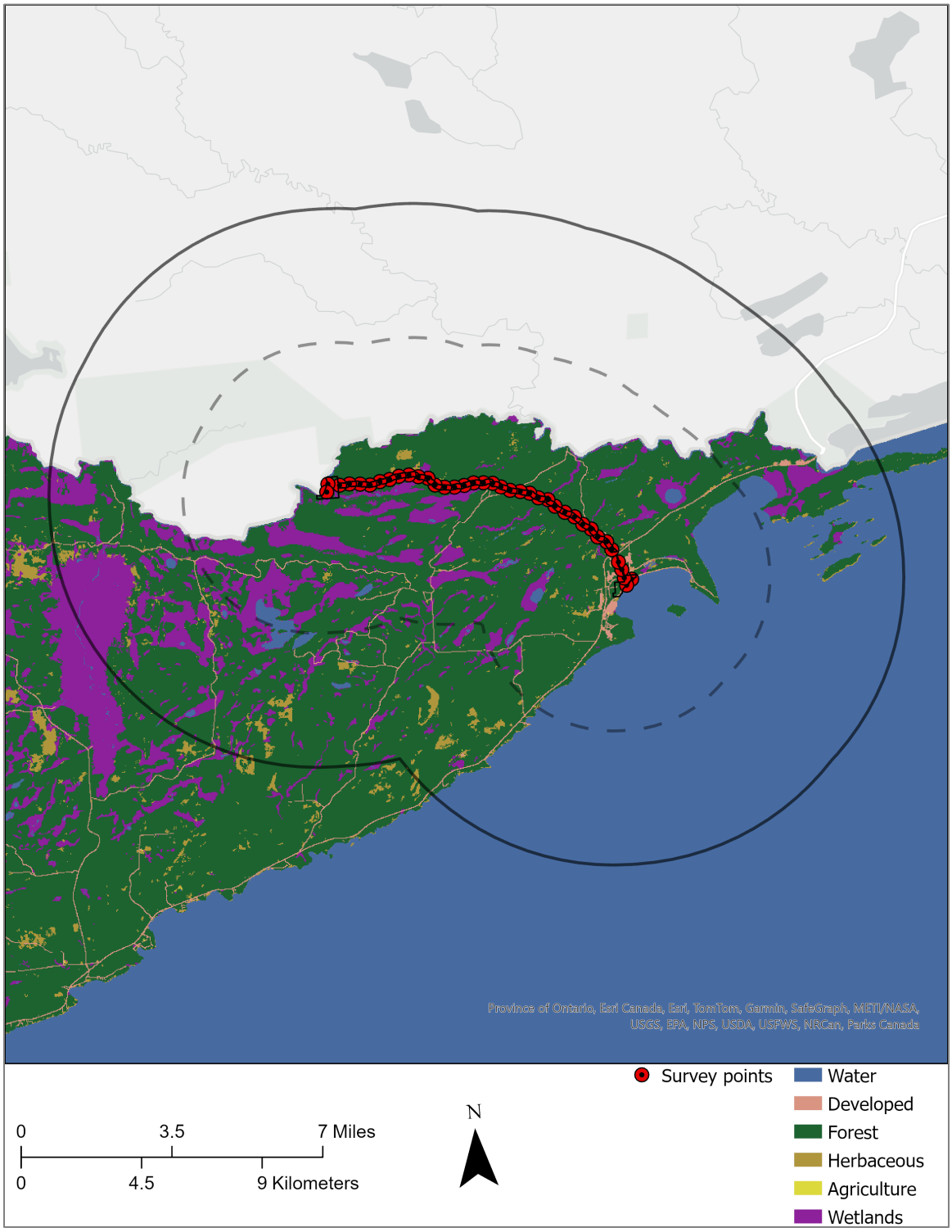


Figure 39. Land cover classes at Grand Portage National Monument (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

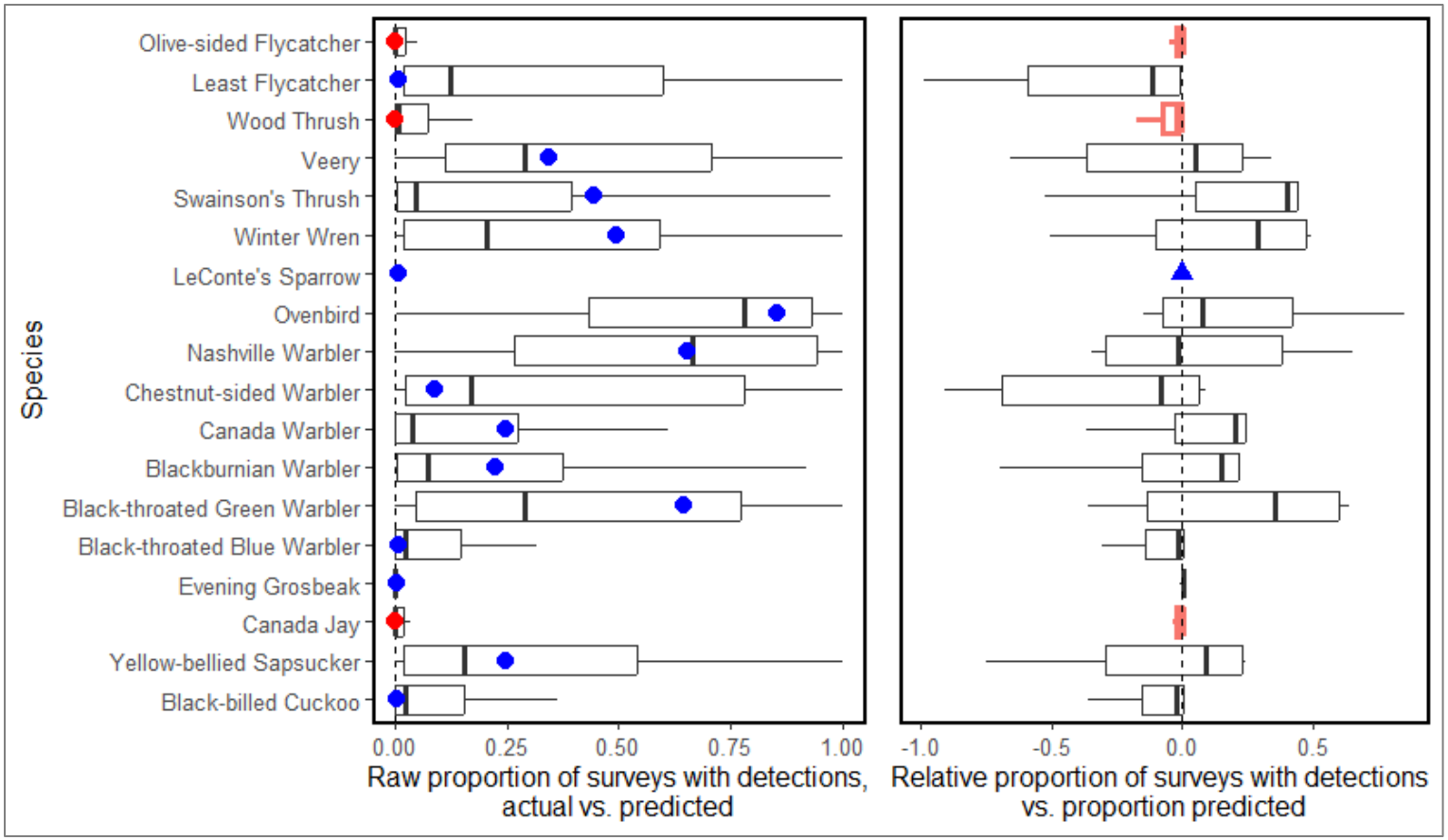


Figure 40. Proportion of actual versus predicted bird species detections during surveys at Grand Portage National Monument (Minnesota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of NPS surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from National Park Service (NPS) surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names. *USGS*

Herbert Hoover National Historic Site (HEHO), Iowa

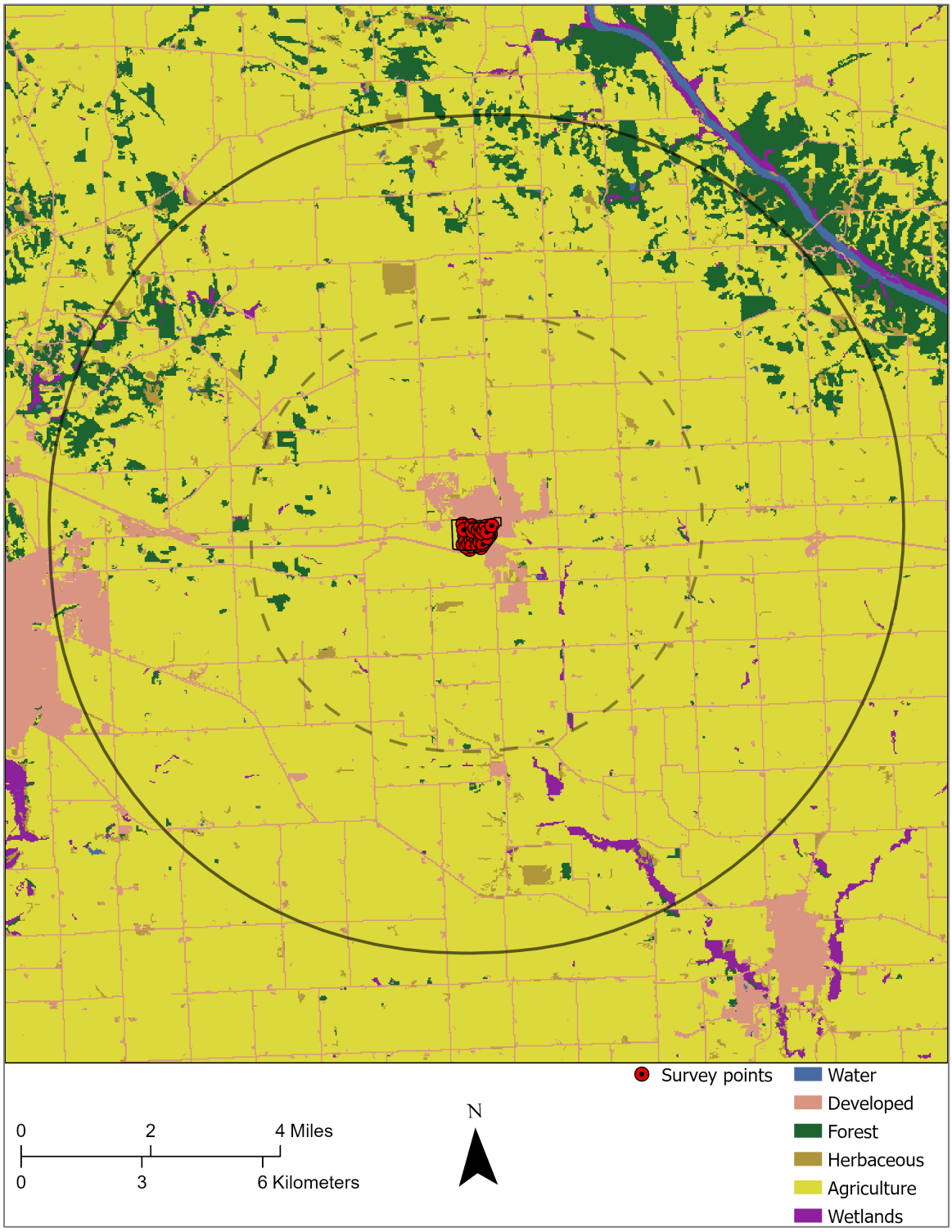


Figure 41. Land cover classes at Herbert Hoover National Historic Site (Iowa) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

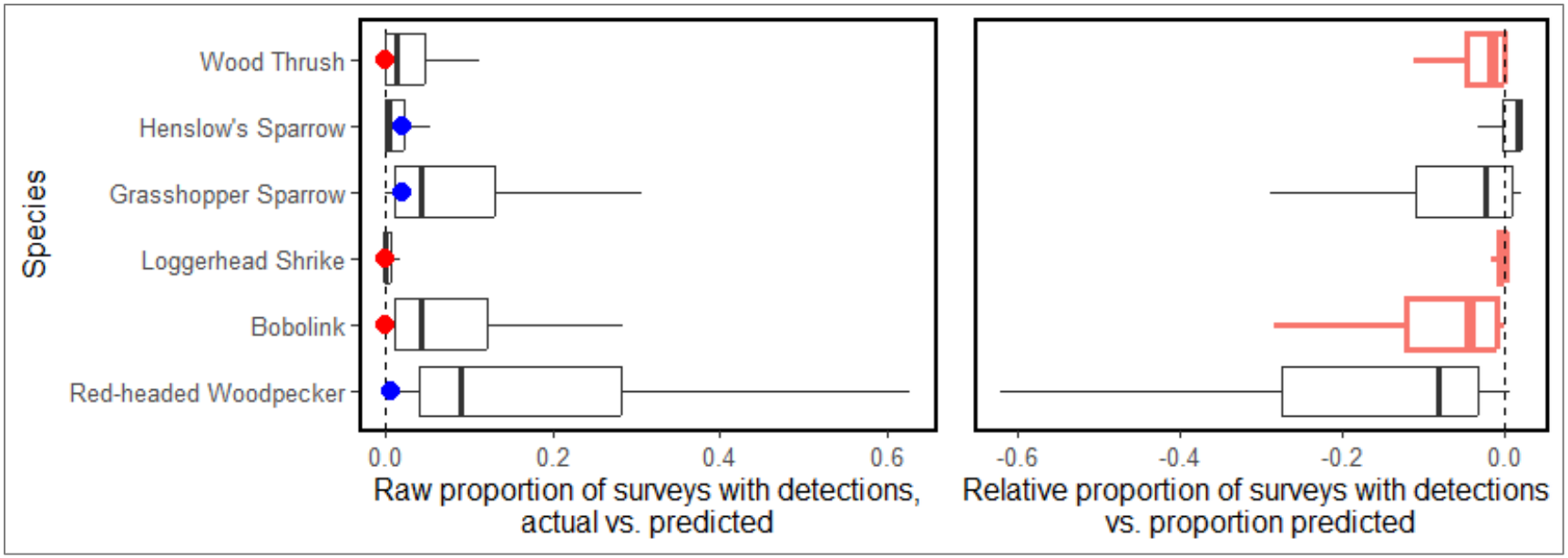


Figure 42. Proportion of actual versus predicted bird species detections during surveys at Herbert Hoover National Historic Site (Iowa). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Homestead National Historical Park (HOME), Nebraska

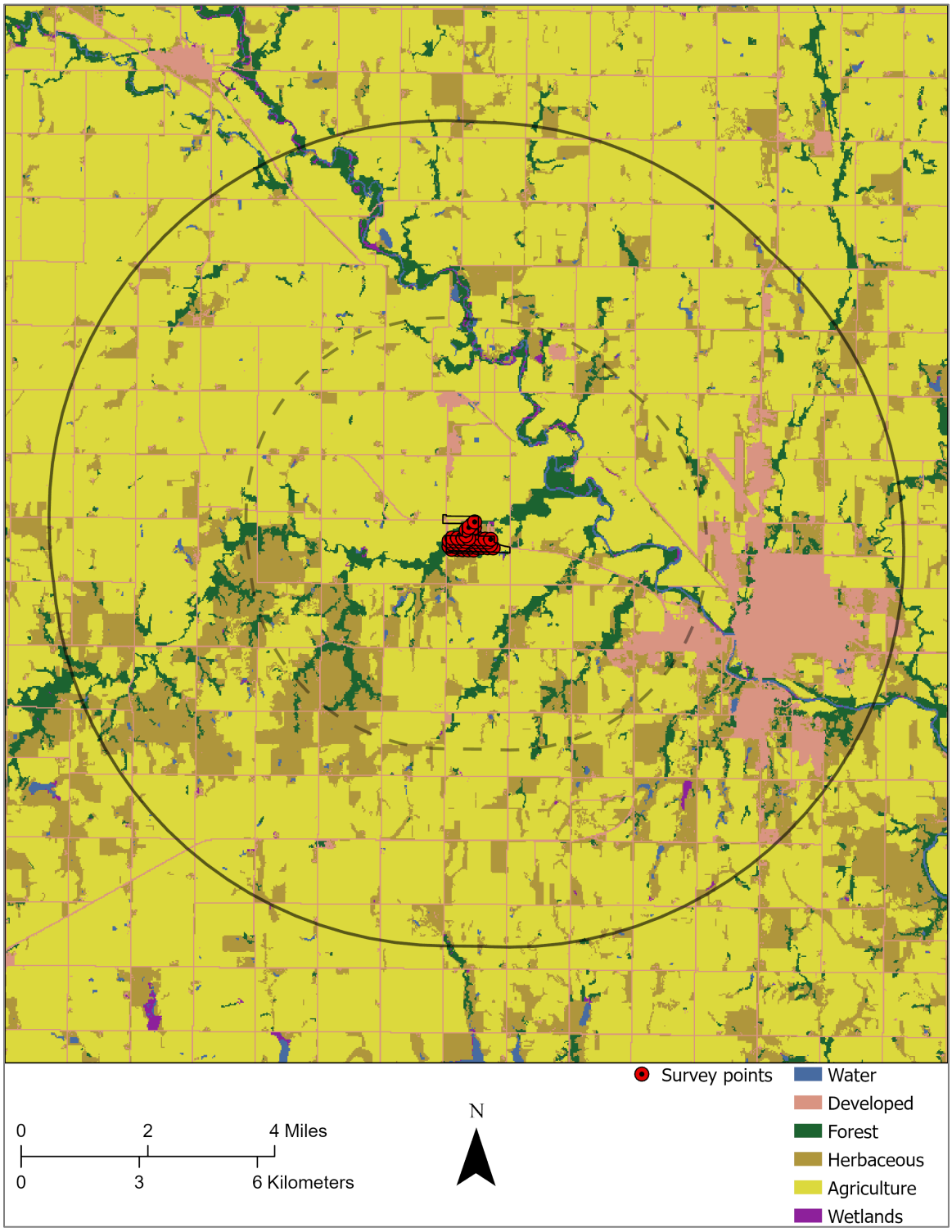


Figure 43. Land cover classes at Homestead National Historical Park (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

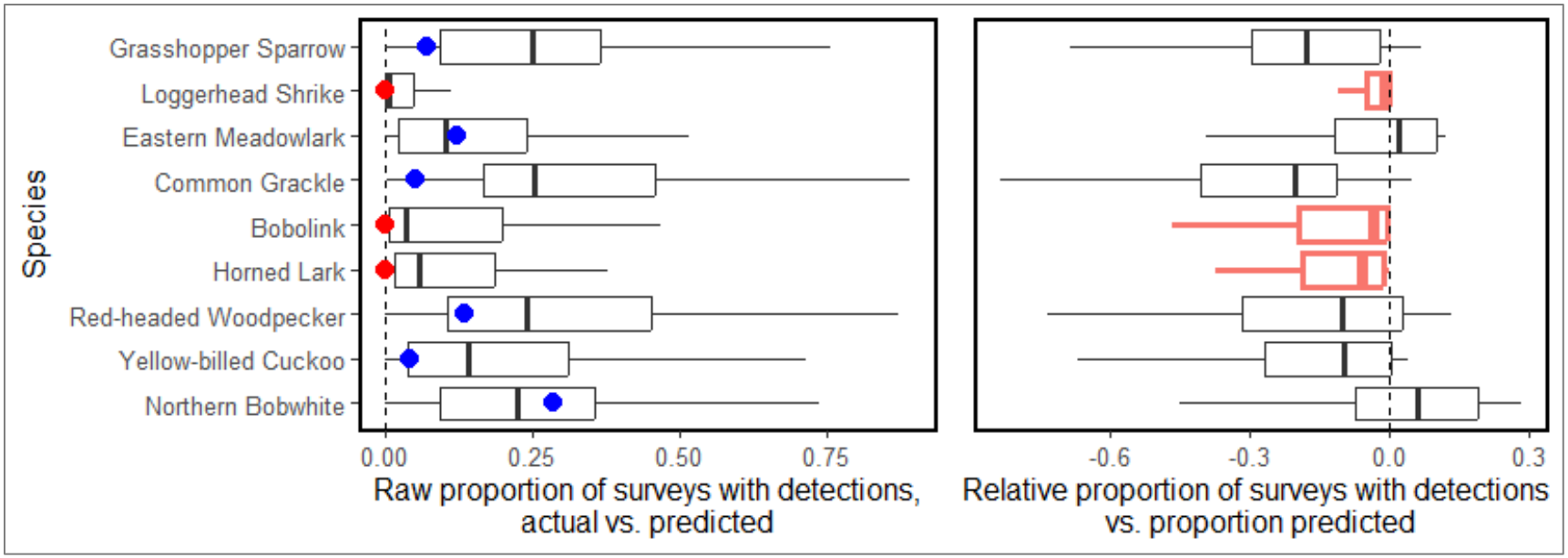


Figure 44. Proportion of actual versus predicted bird species detections during surveys at Homestead National Historical Park (Nebraska). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Hopewell Culture National Historical Park (HOCU), Ohio

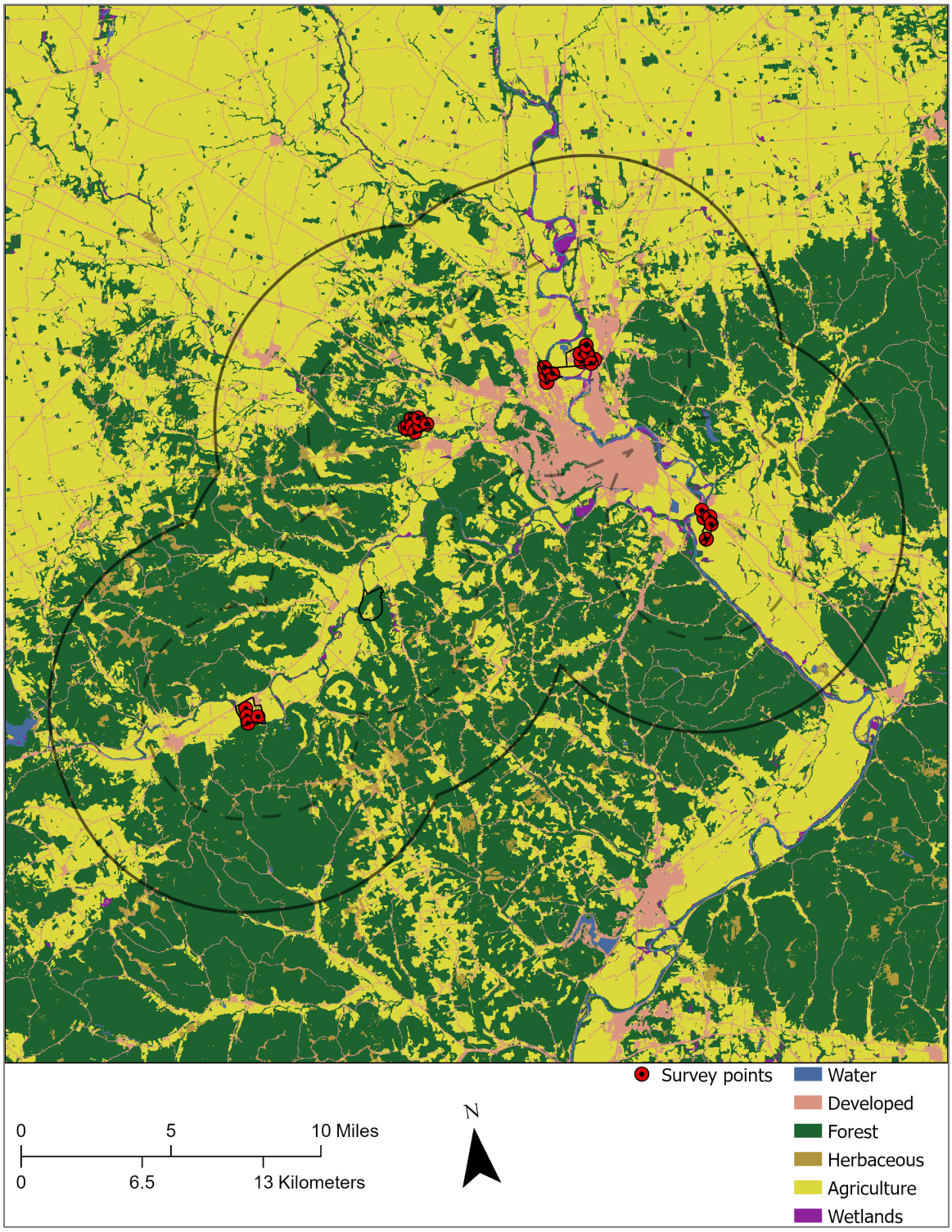


Figure 45. Land cover classes at Hopewell Culture National Historical Park (Ohio) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

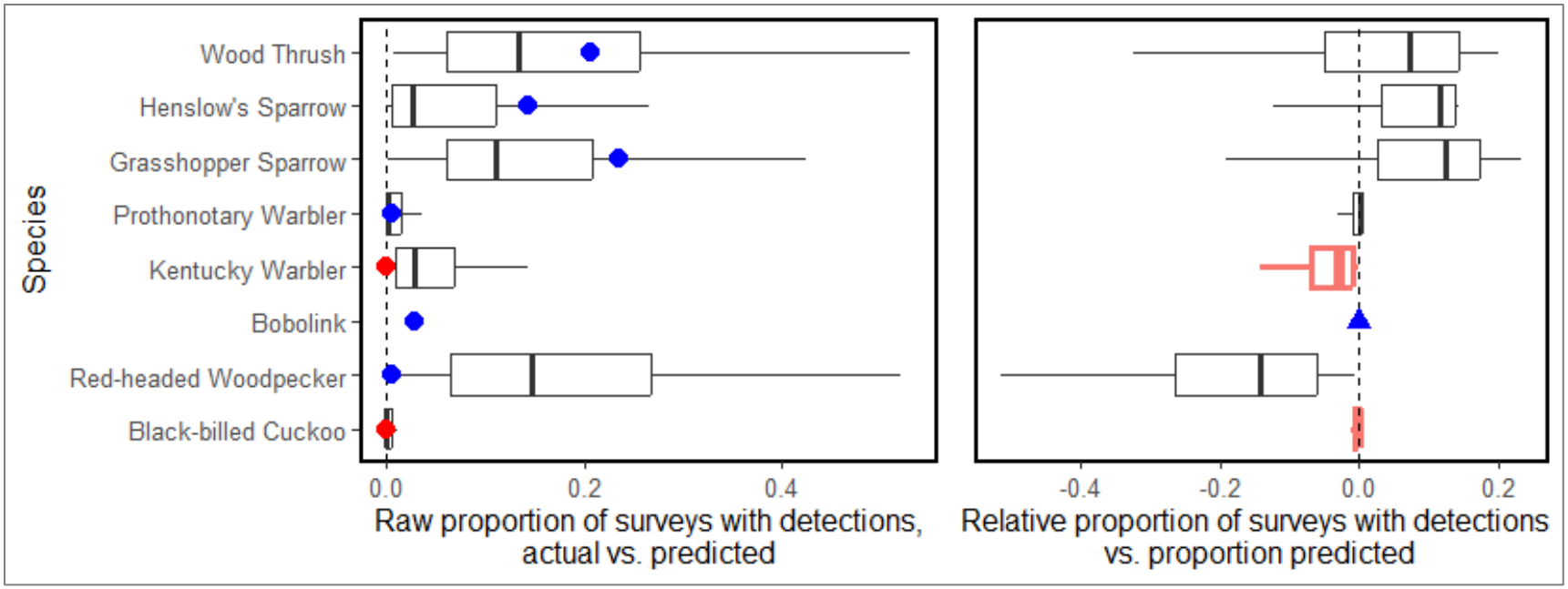


Figure 46. Proportion of actual versus predicted bird species detections during surveys at Hopewell Culture National Historical Park (Ohio). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and redwas detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.

USGS

Indiana Dunes National Park (INDU), Indiana

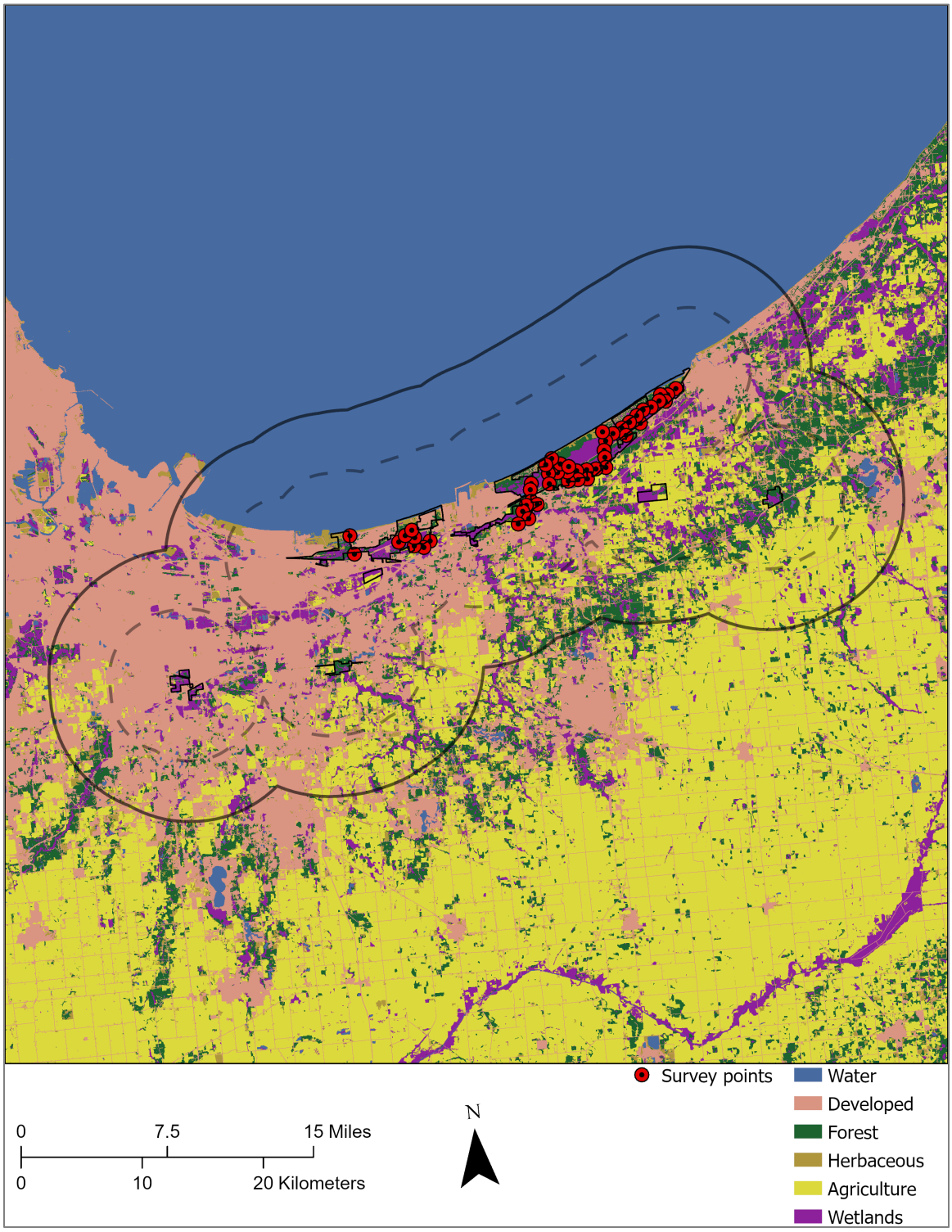


Figure 47. Land cover classes at Indiana Dunes National Park (Indiana) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

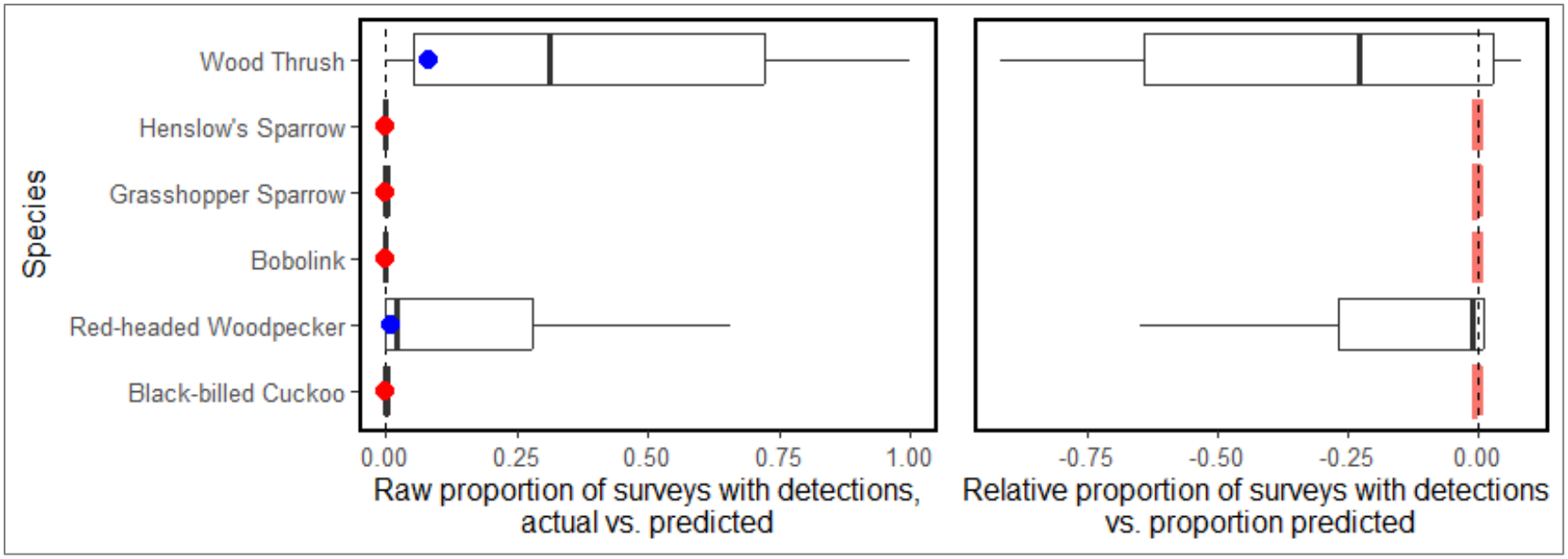


Figure 48. Proportion of actual versus predicted bird species detections during surveys at Indiana Dunes National Park (Indiana). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Isle Royale National Park (ISRO), Michigan

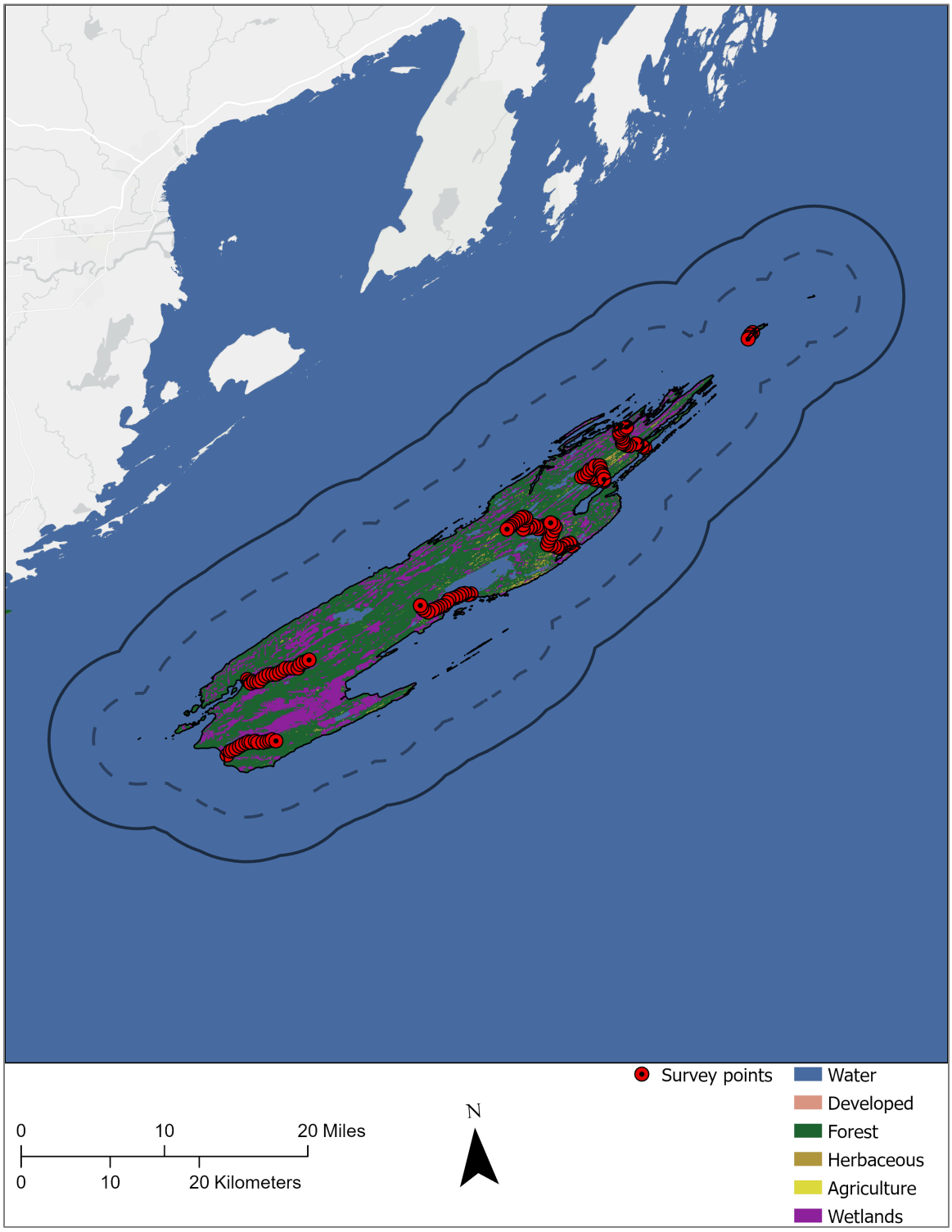


Figure 49. Land cover classes at Isle Royale National Park (Michigan) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

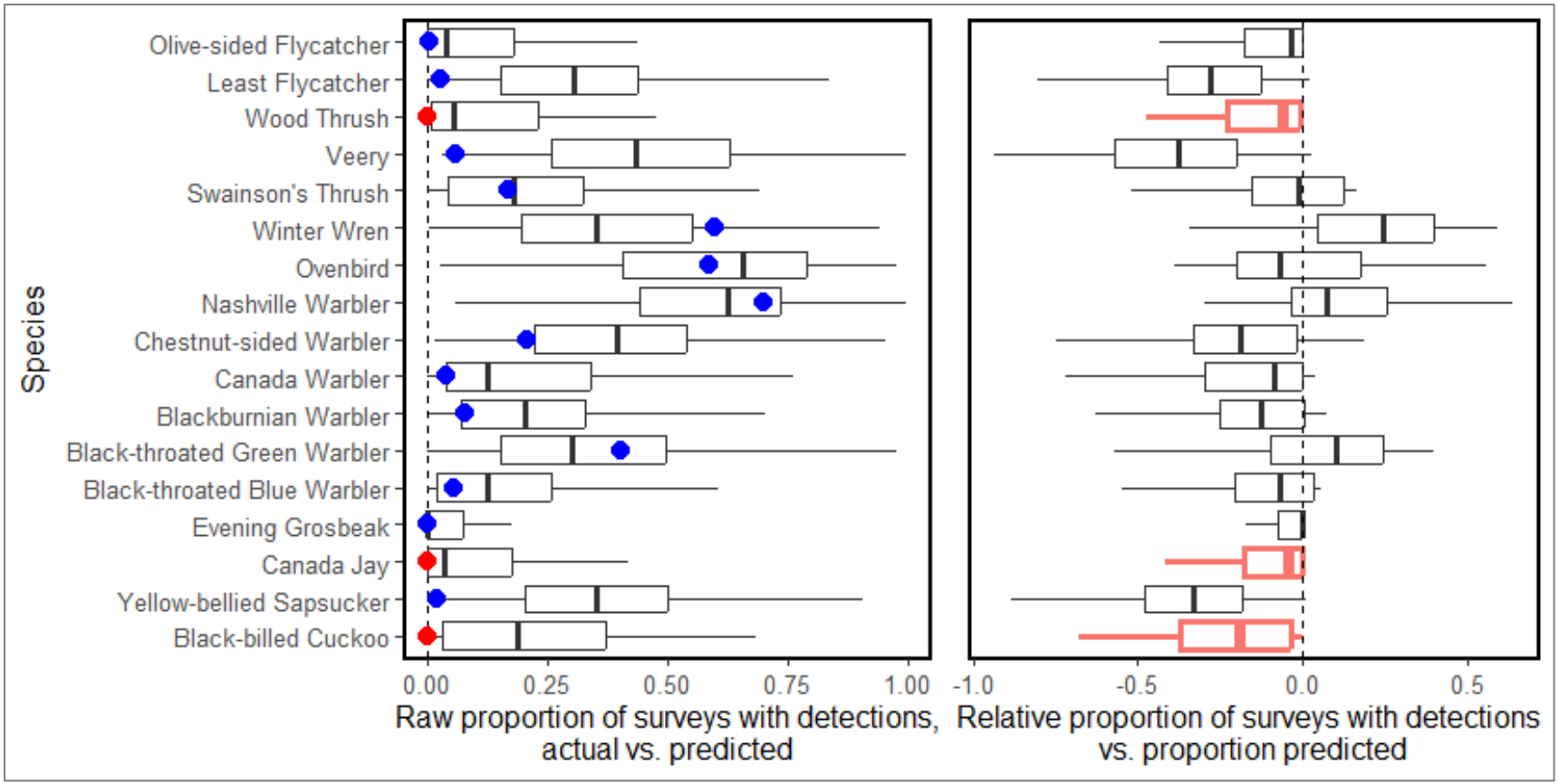


Figure 50. Proportion of actual versus predicted bird species detections during surveys at Isle Royale National Park (Michigan). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Jewel Cave National Monument (JECA), South Dakota

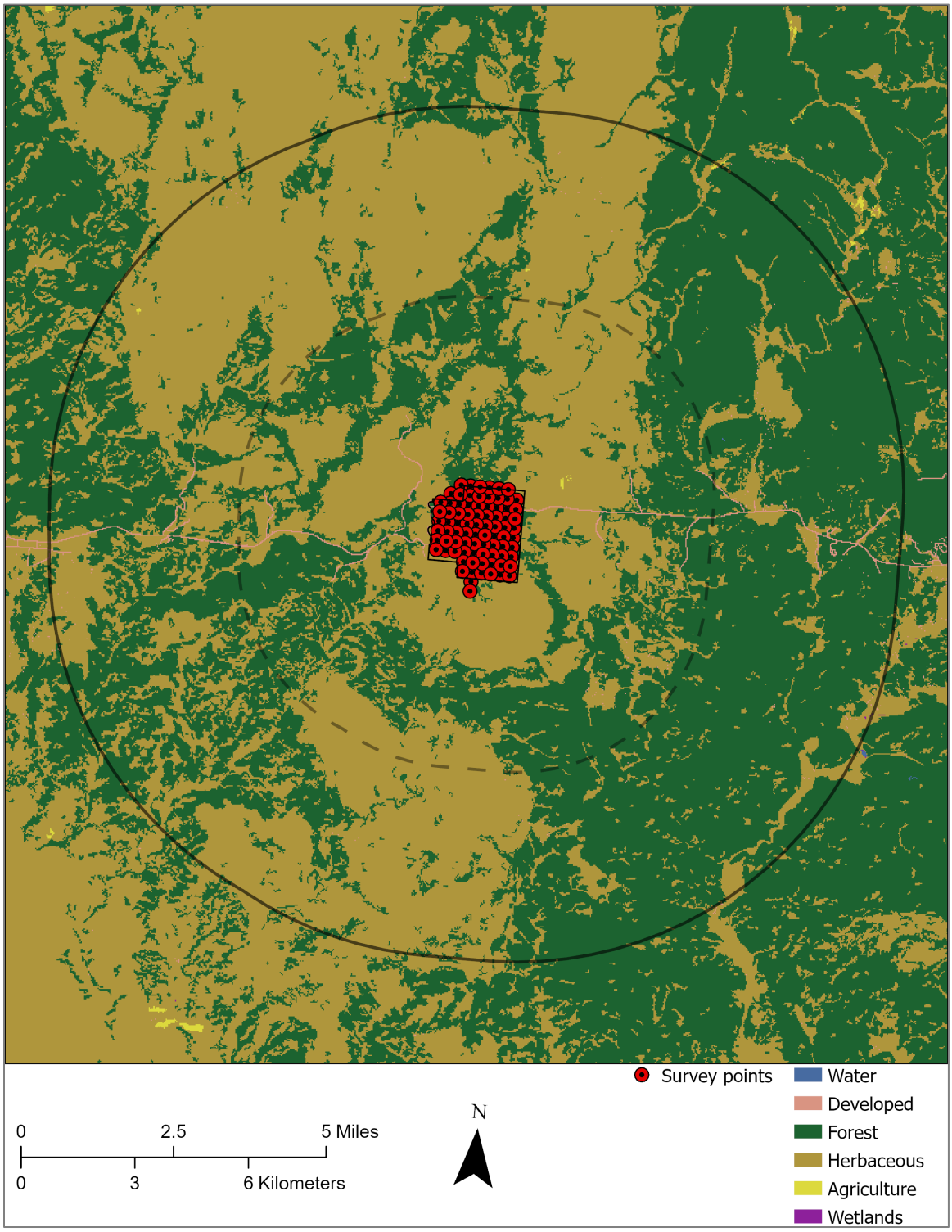


Figure 51. Land cover classes at Jewel Cave National Monument (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

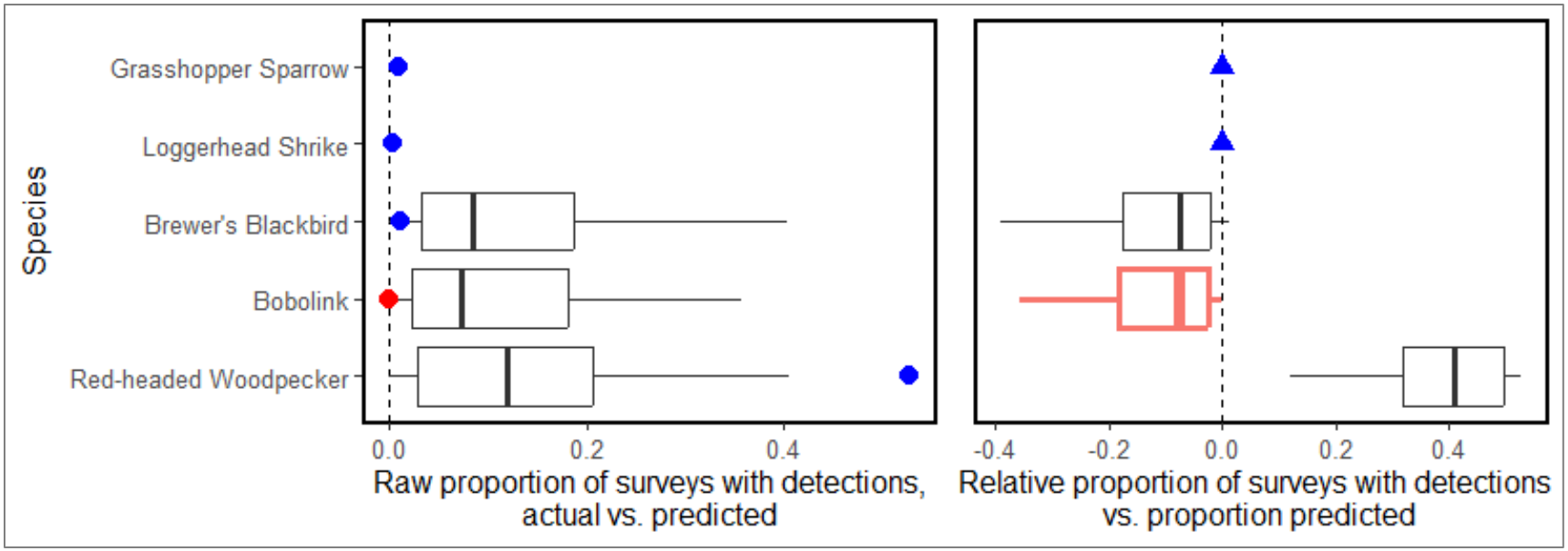


Figure 52. Proportion of actual versus predicted bird species detections during surveys at Jewel Cave National Monument (South Dakota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names. *USGS*

Knife River Indian Villages National Historic Site (KNRI), North Dakota

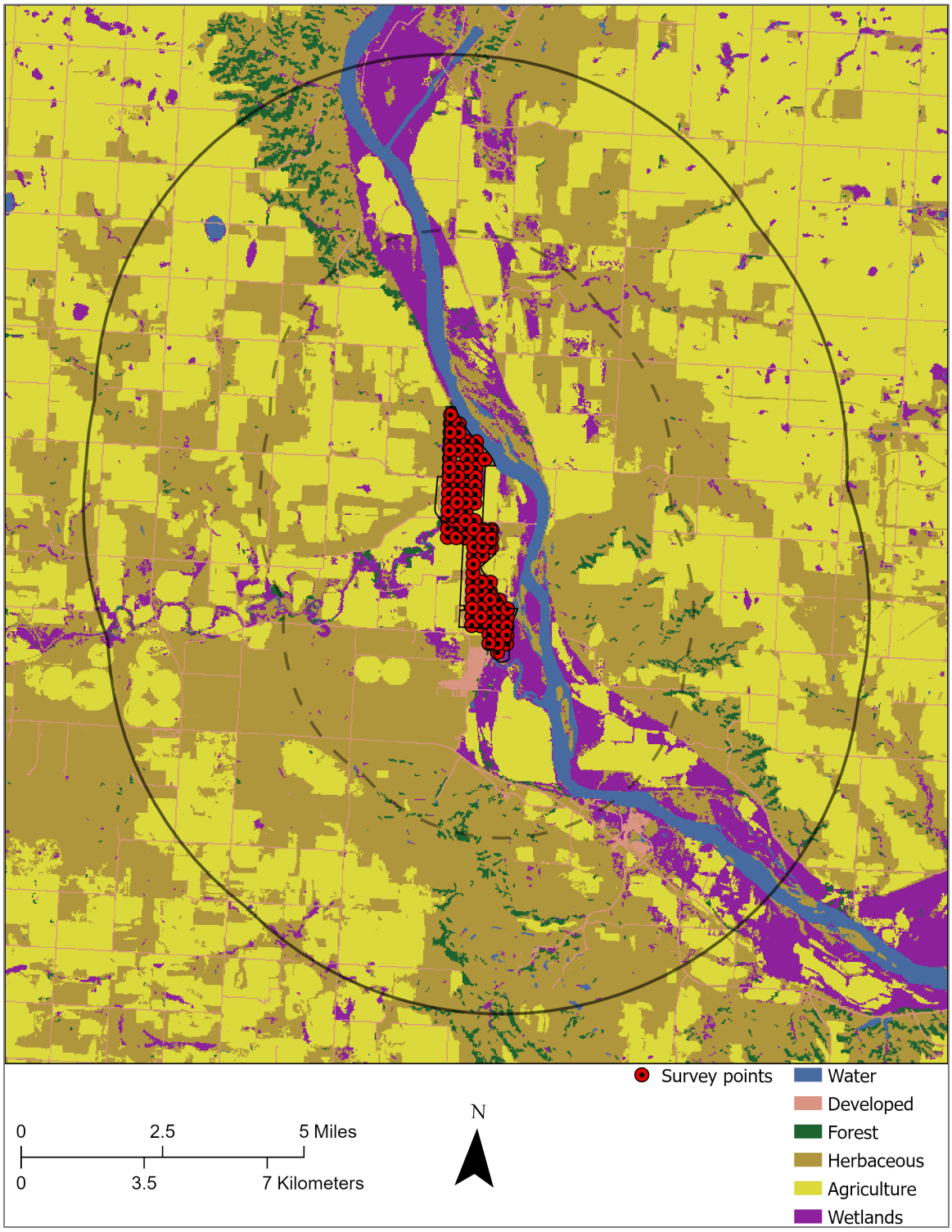


Figure 53. Land cover classes at Knife River Indian Villages National Historic Site (North Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

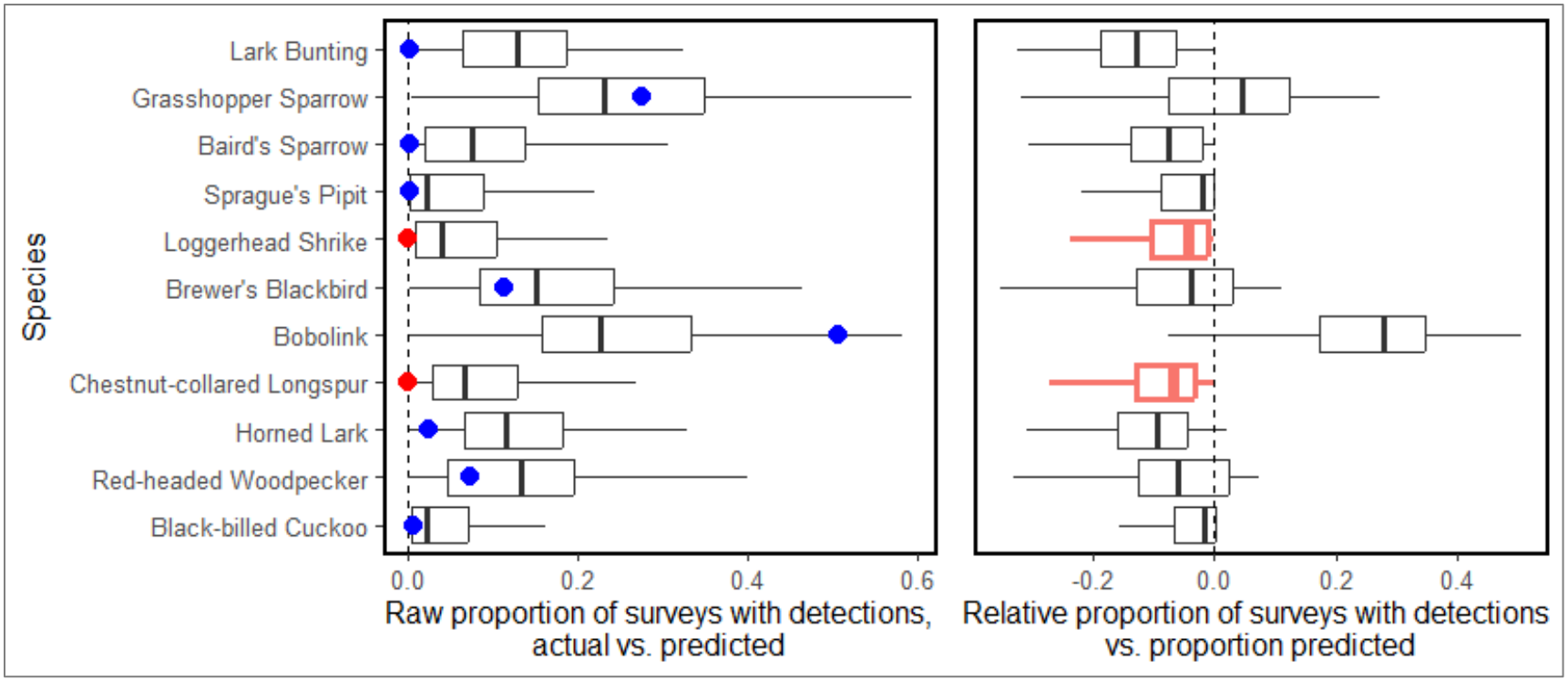


Figure 54. Proportion of actual versus predicted bird species detections during surveys at Knife River Indian Villages National Historic Site (North Dakota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Lincoln Boyhood National Memorial (LIBO), Indiana

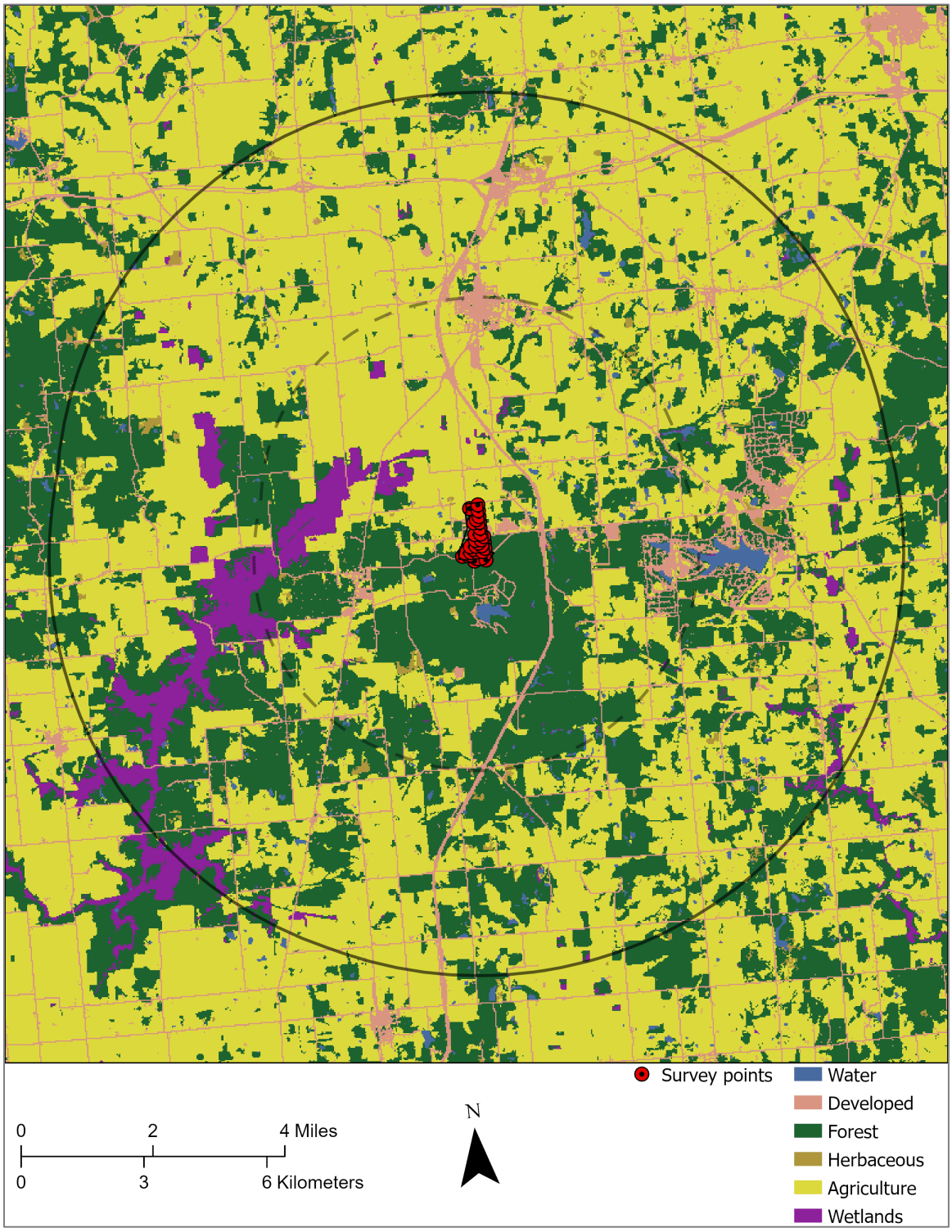


Figure 55. Land cover classes at Lincoln Boyhood National Memorial (Indiana) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

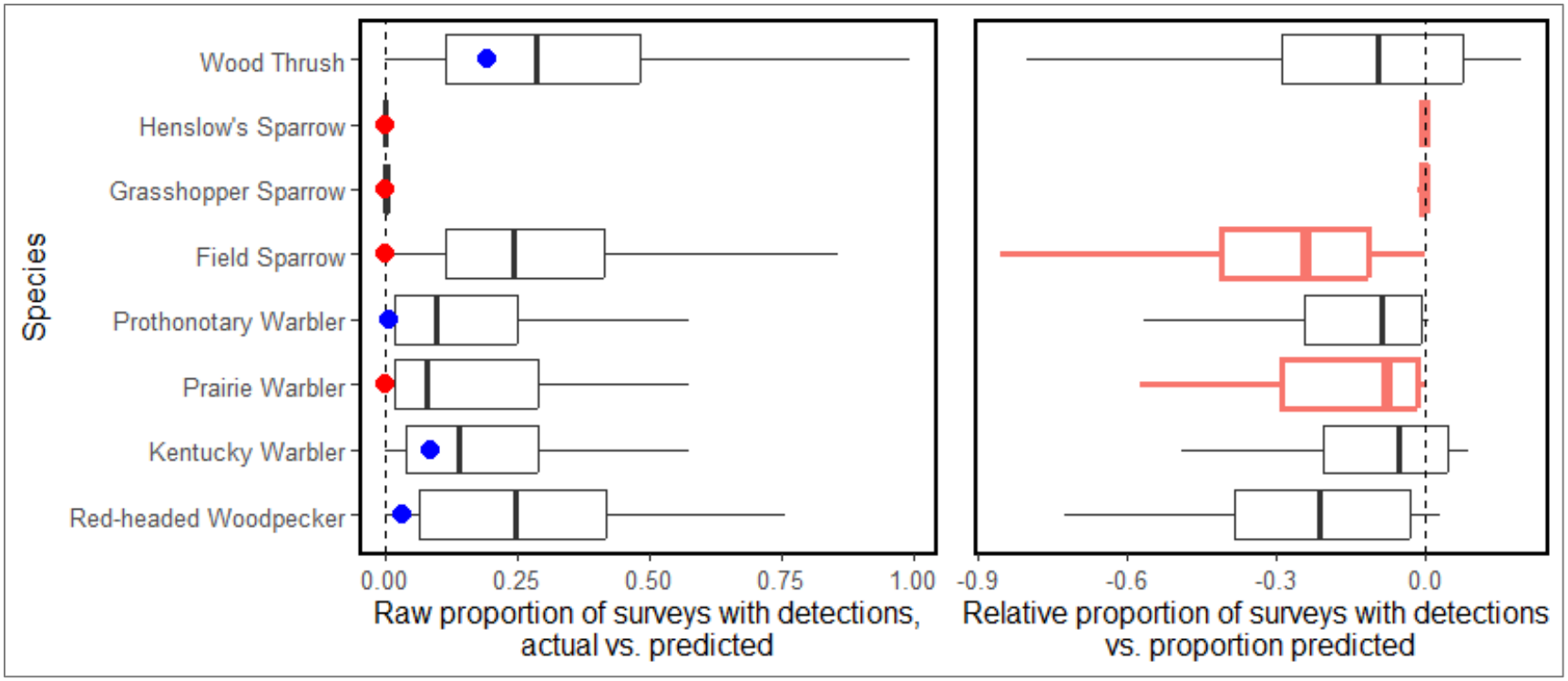


Figure 56. Proportion of actual versus predicted bird species detections during surveys at Lincoln Boyhood National Memorial (Indiana). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Mississippi National River and Recreation Area (MISS), Minnesota

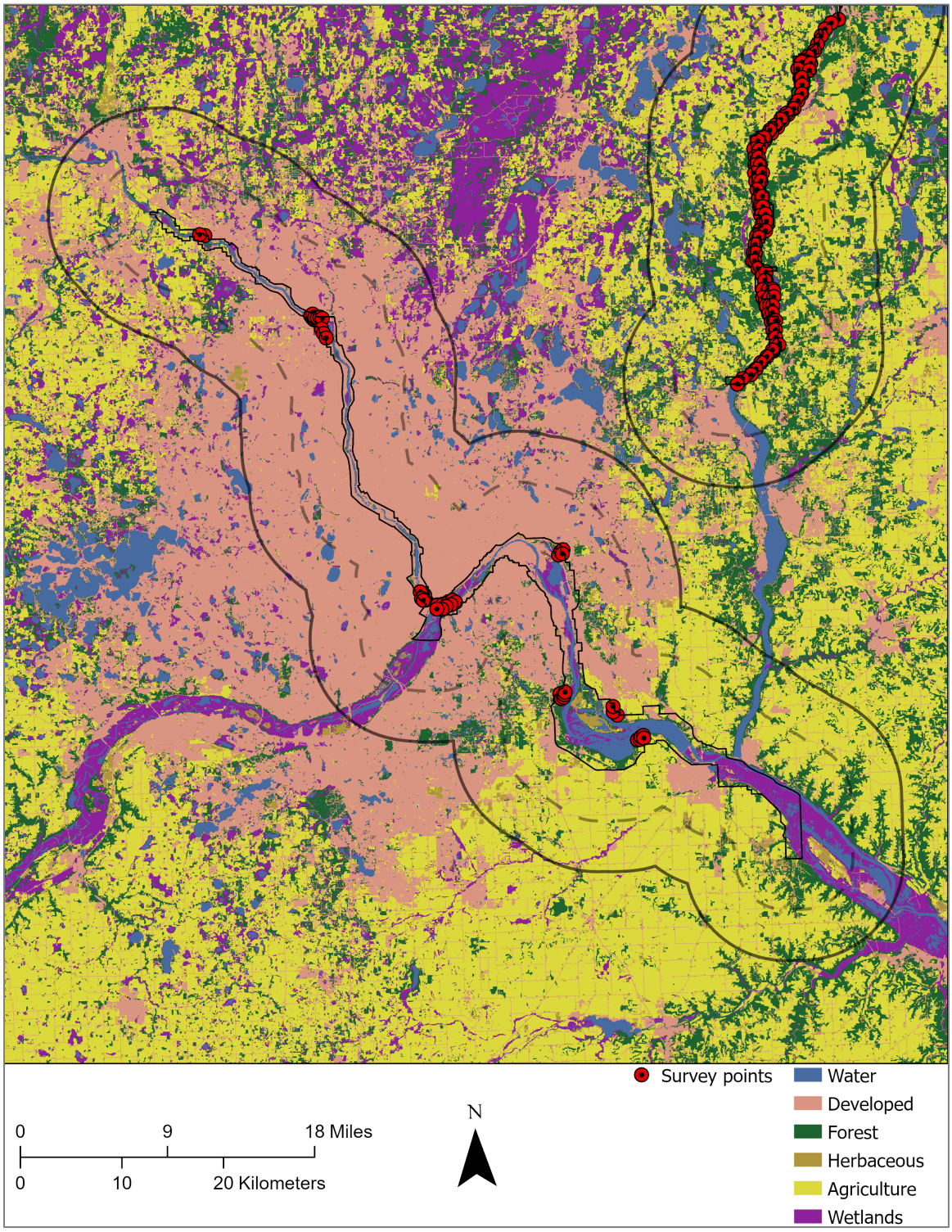


Figure 57. Land cover classes at Mississippi National River and Recreation Area (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

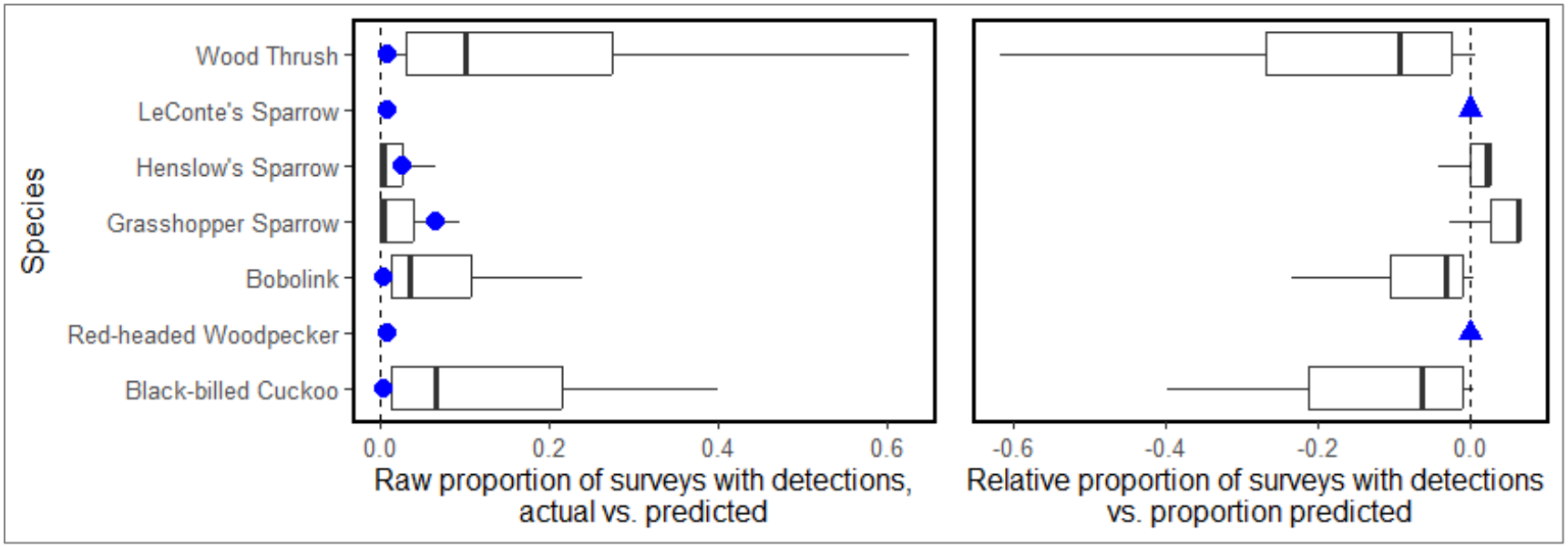


Figure 58. Proportion of actual versus predicted bird species detections during surveys at Mississippi National River and Recreation Area (Minnesota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Survey (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.

USGS

Missouri National Recreational River (MNRR), Nebraska/South Dakota

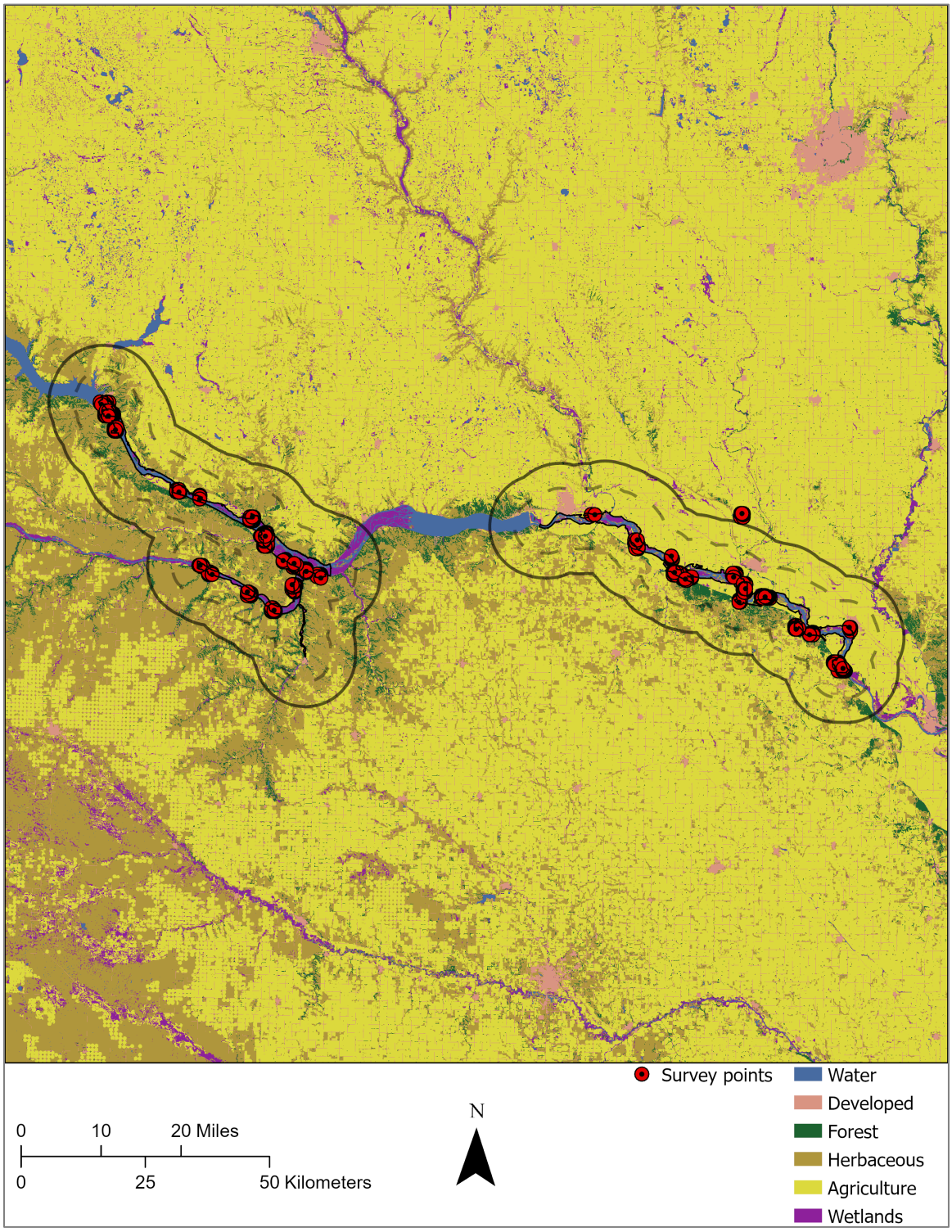


Figure 59. Land cover classes at Missouri National Recreational River (South Dakota/Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

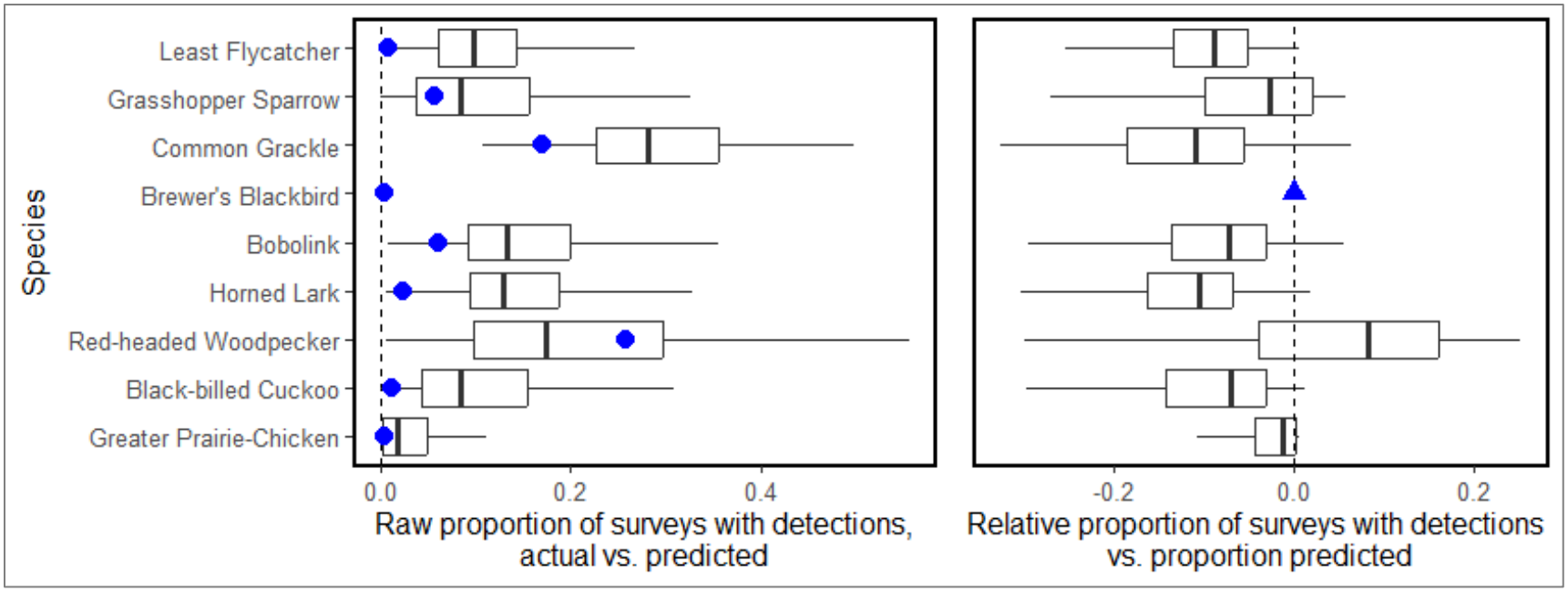


Figure 60. Proportion of actual versus predicted bird species detections during surveys at Missouri National Recreational River (South Dakota/Nebraska). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.

USGS

Mount Rushmore National Memorial (MORU), South Dakota

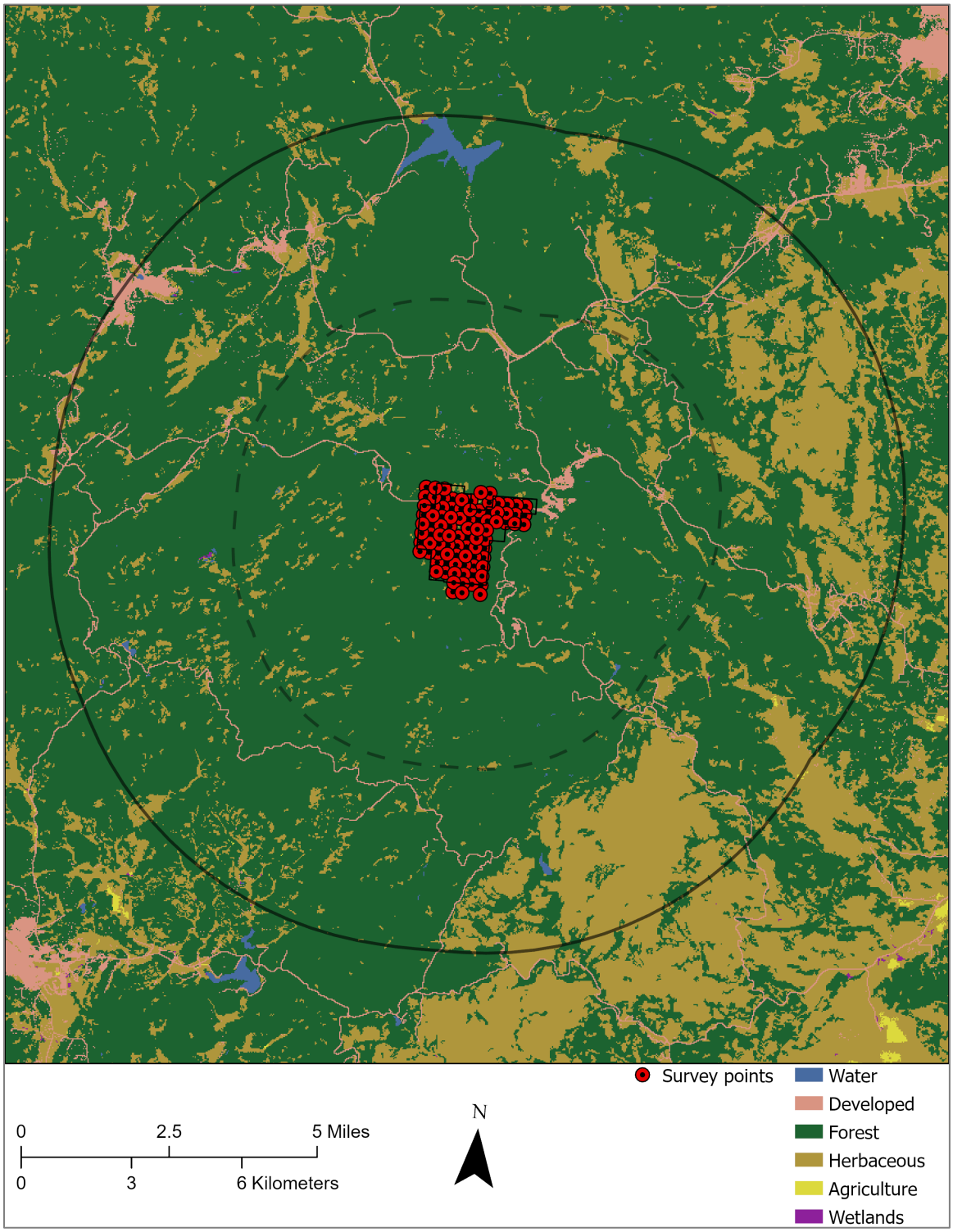


Figure 61. Land cover classes at Mount Rushmore National Memorial (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

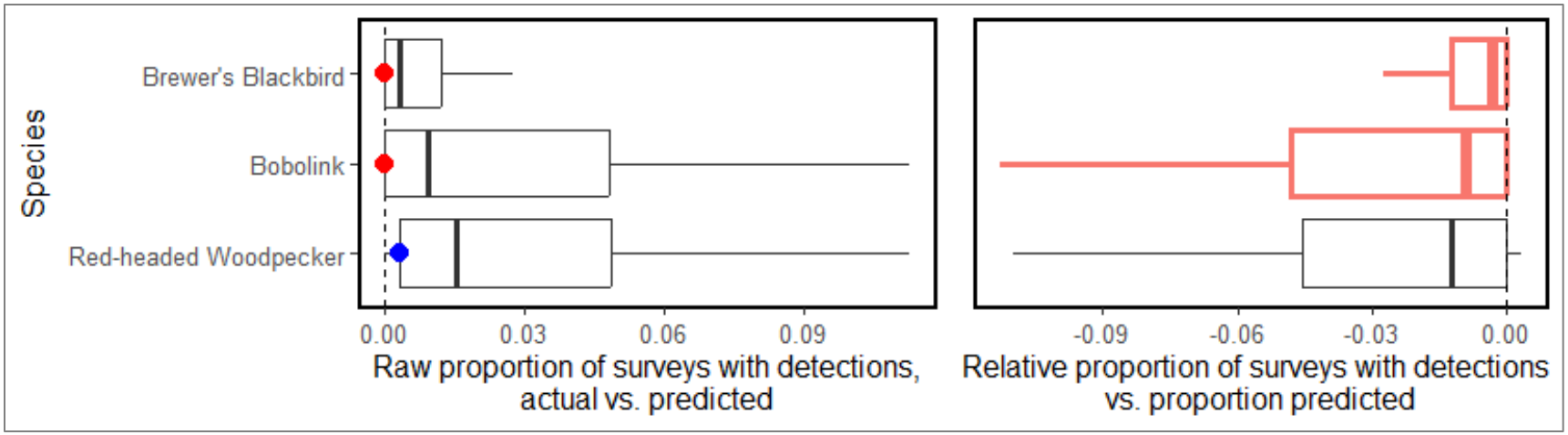


Figure 62. Proportion of actual versus predicted bird species detections during surveys at Mount Rushmore National Memorial (South Dakota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Niobrara National Scenic River (NIOB), Nebraska

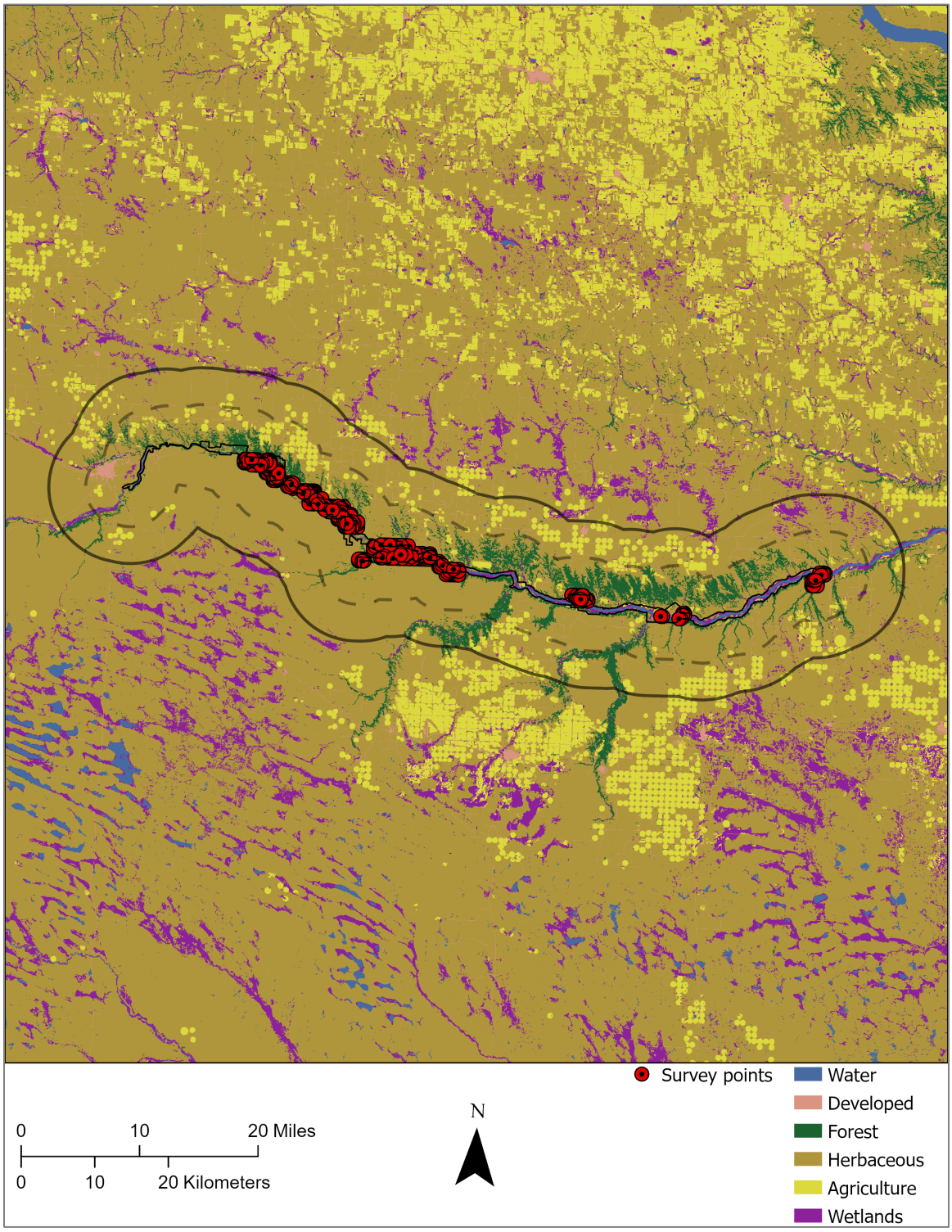


Figure 63. Land cover classes at Niobrara National Scenic River (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

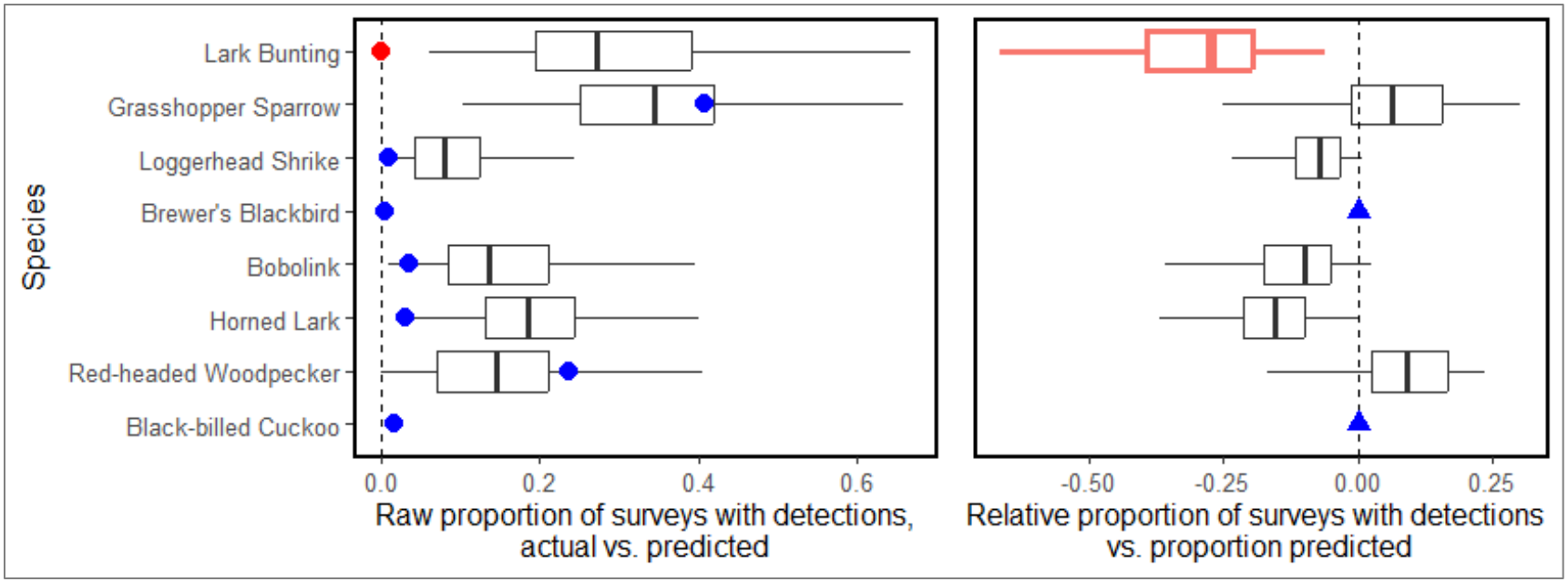


Figure 64. Proportion of actual versus predicted bird species detections during surveys at Niobrara National Scenic River (Nebraska). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.
USGS

Pea Ridge National Military Park (PERI), Arkansas

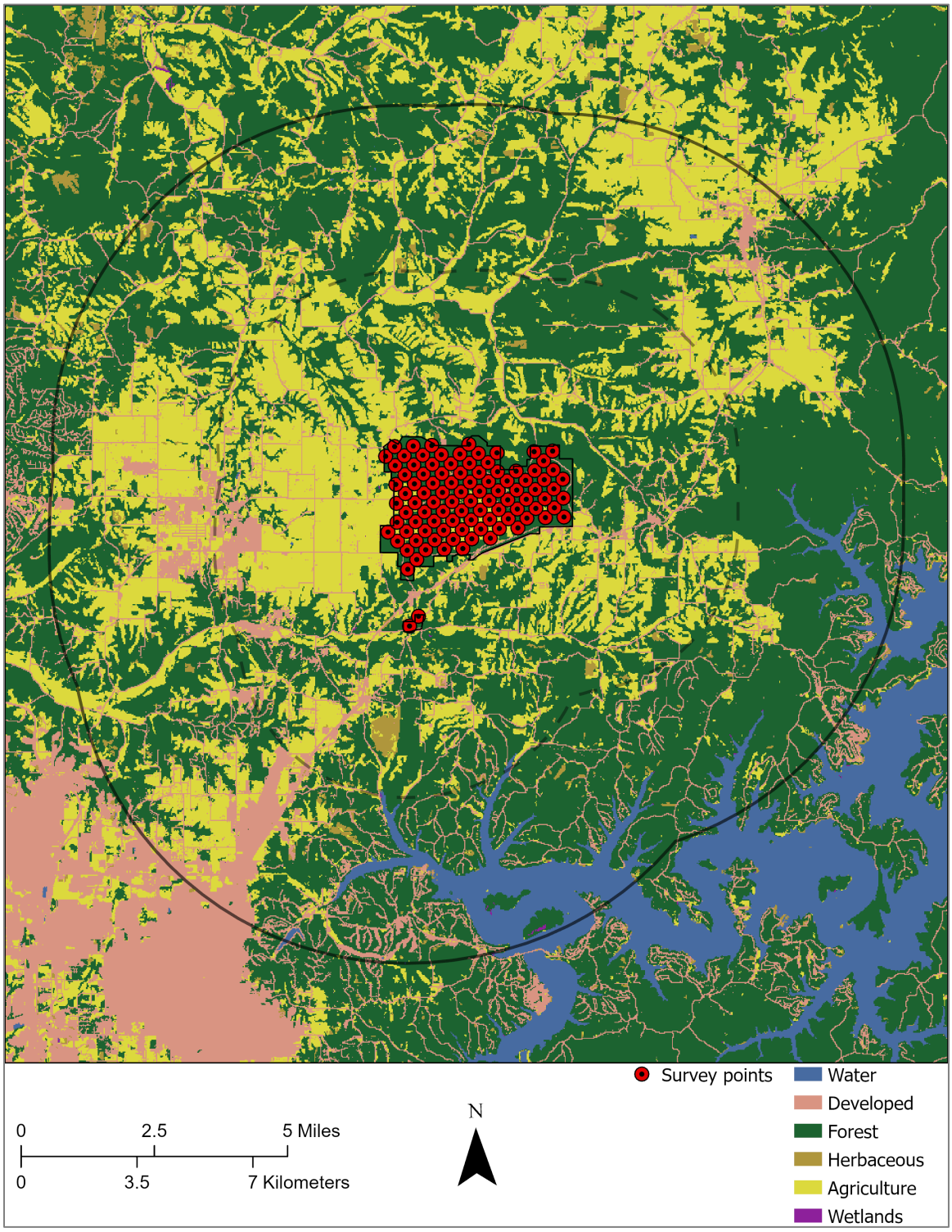


Figure 65. Land cover classes at Pea Ridge National Military Park (Arkansas) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

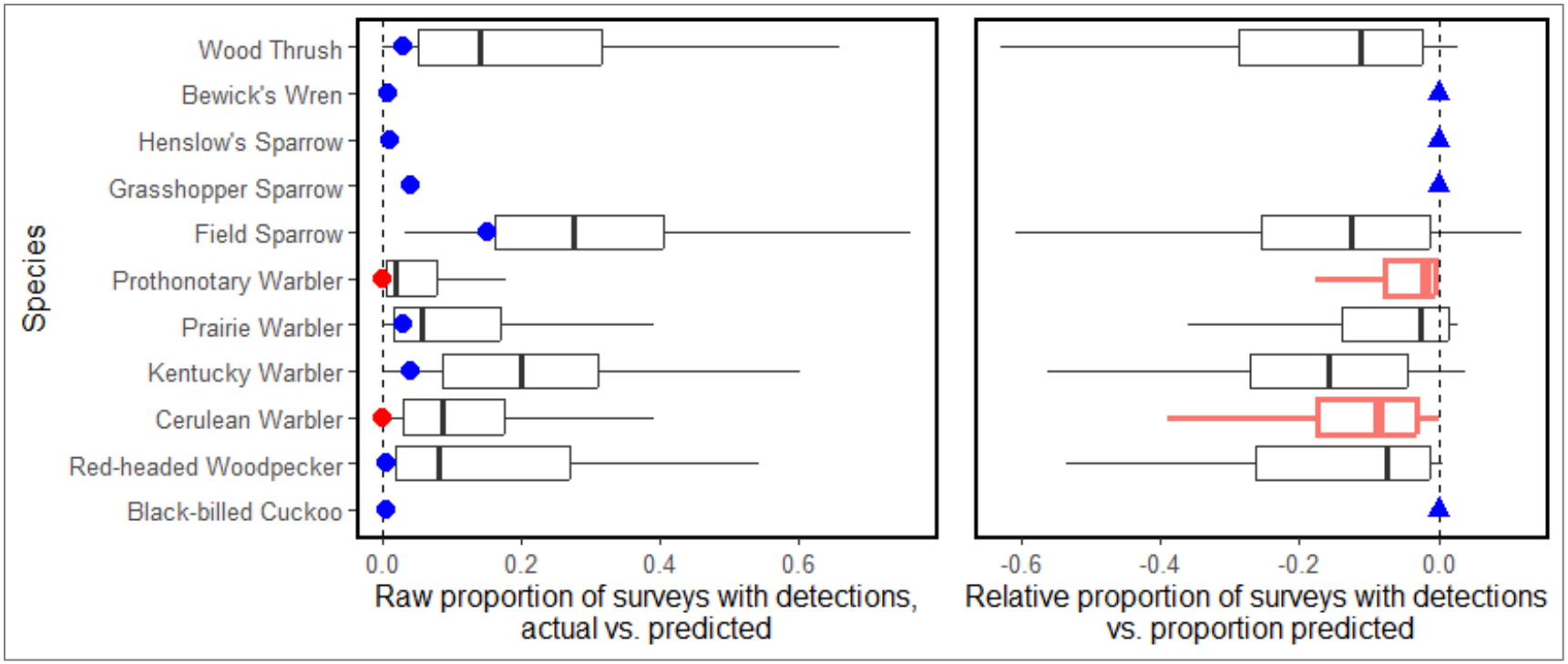


Figure 66. Proportion of actual versus predicted bird species detections during surveys at Pea Ridge National Military Park (Arkansas). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.
USGS

Pictured Rocks National Lakeshore (PIRO), Michigan

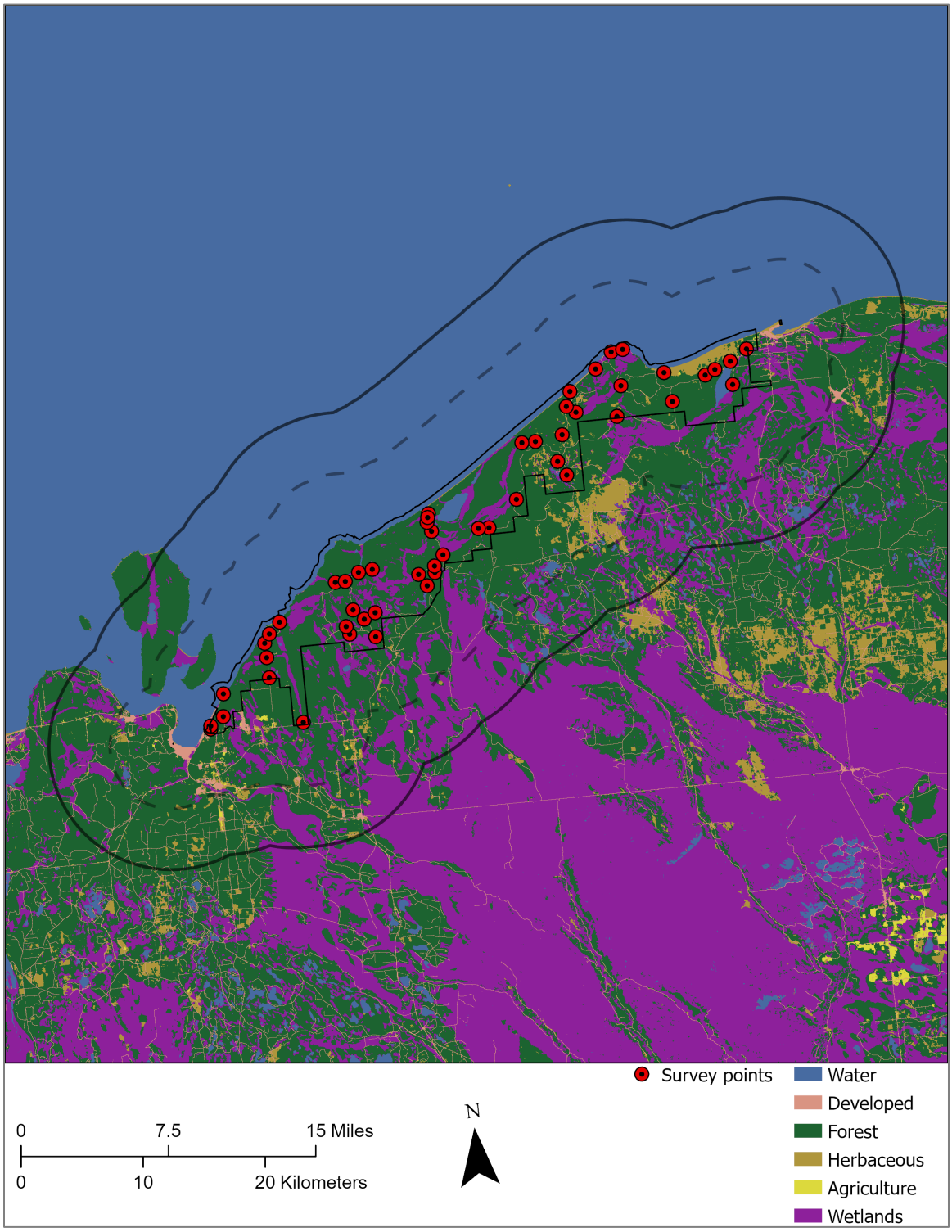


Figure 67. Land cover classes at Pictured Rocks National Lakeshore (Michigan) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

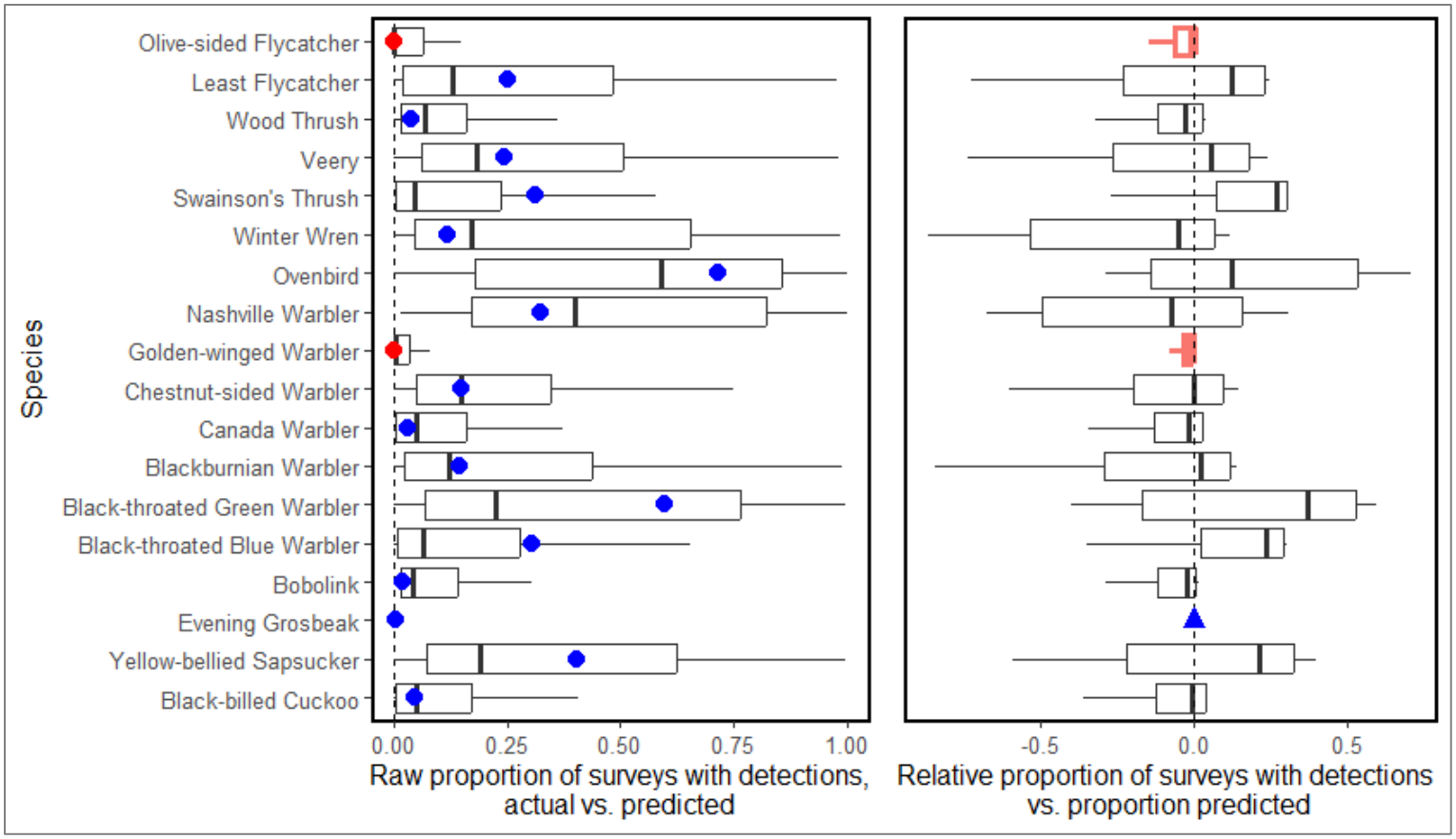


Figure 68. Proportion of actual versus predicted bird species detections during surveys at Pictured Rocks National Lakeshore (Michigan). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names. *USGS*

Pipestone National Monument (PIPE), Minnesota

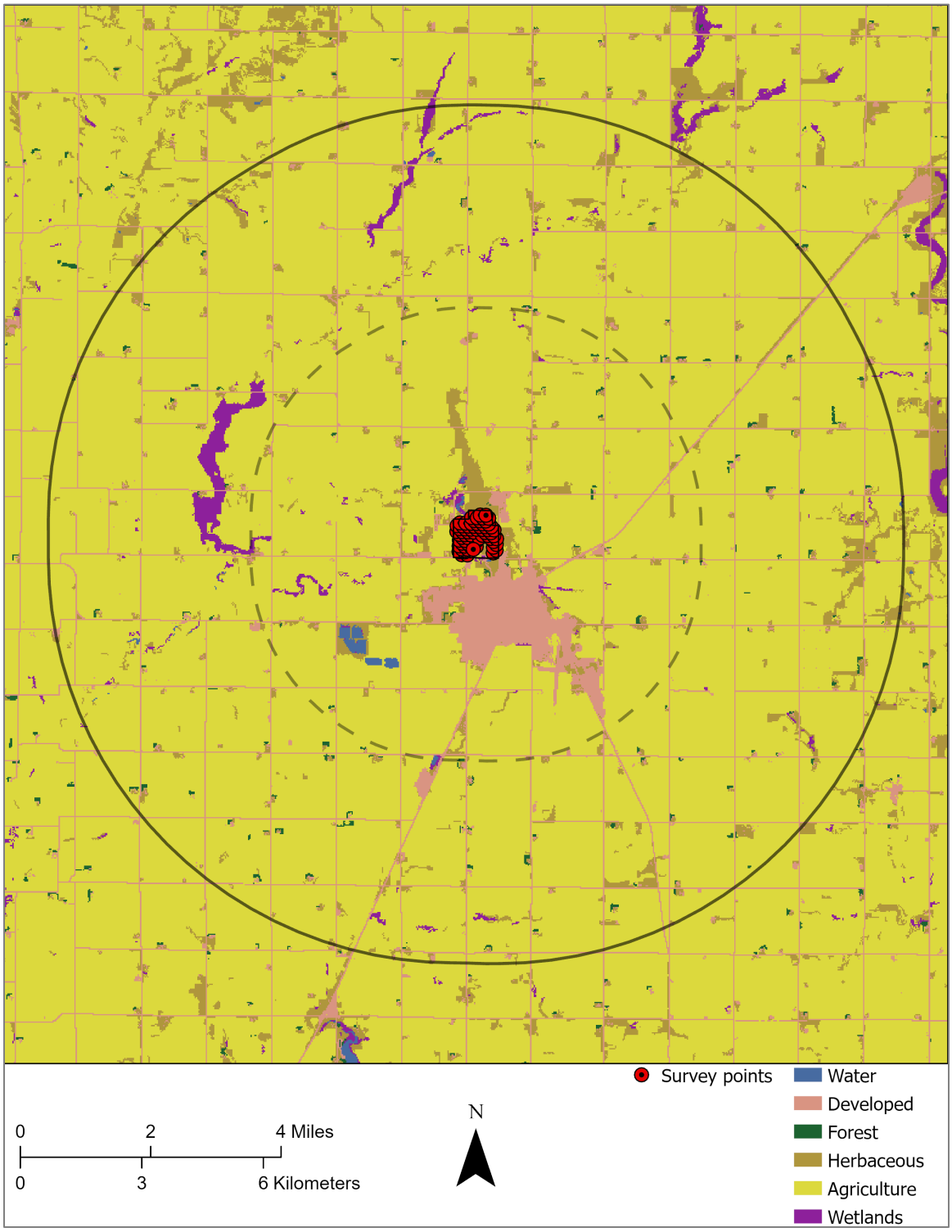


Figure 69. Land cover classes at Pipestone National Monument (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

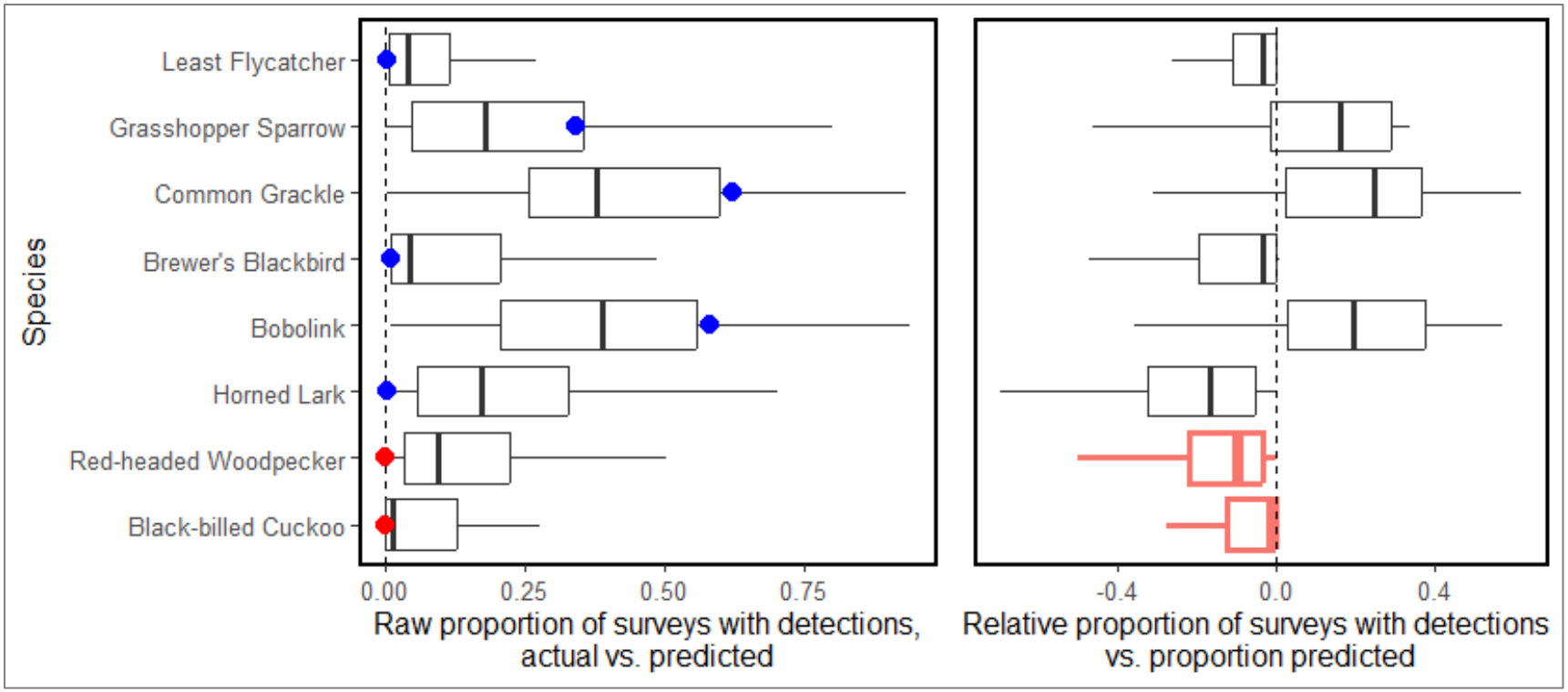


Figure 70. Proportion of actual versus predicted bird species detections during surveys at Pipestone National Monument (Minnesota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Saint Croix National Scenic Riverway (SACN), Wisconsin/Minnesota

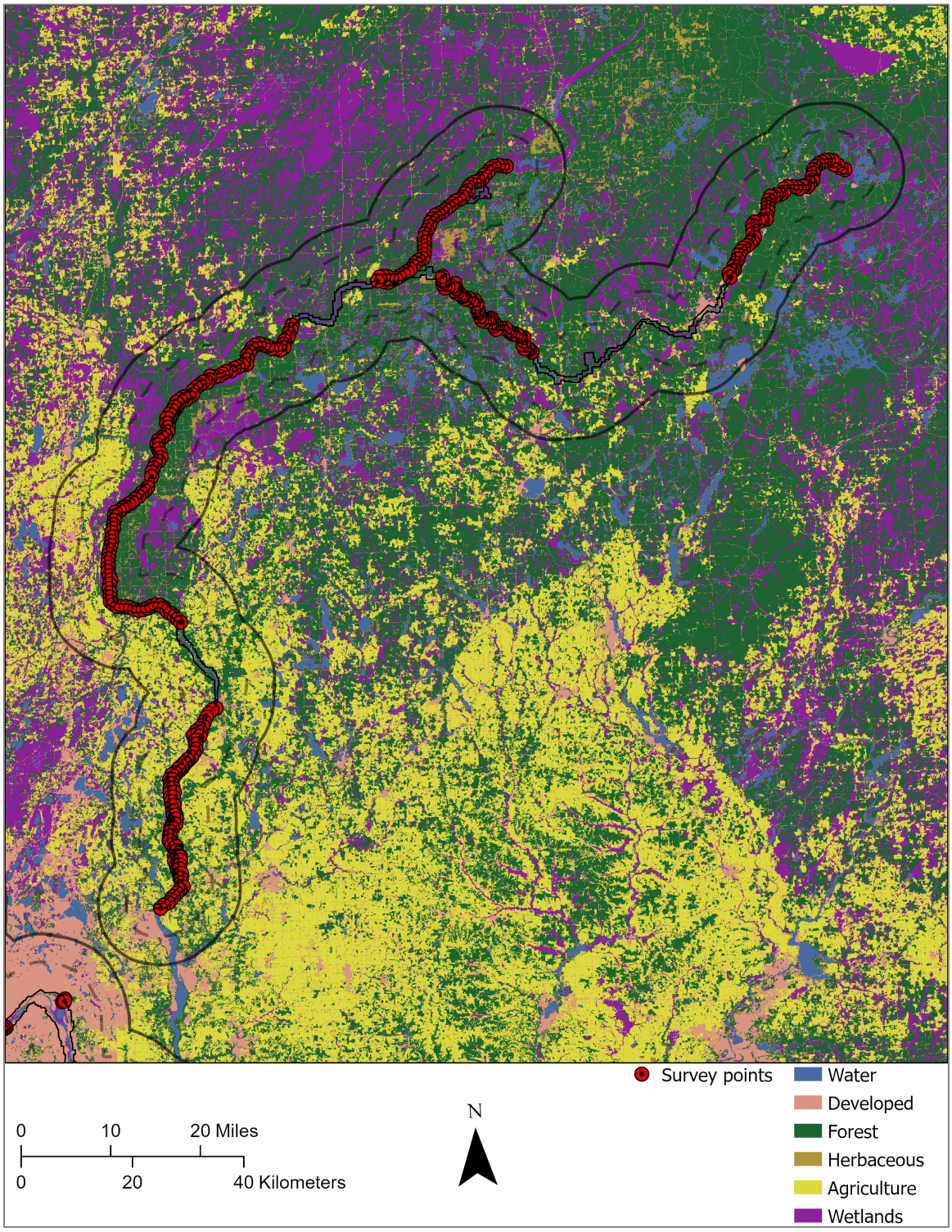


Figure 71. Land cover classes at St. Croix National Scenic Riverway (Wisconsin/Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

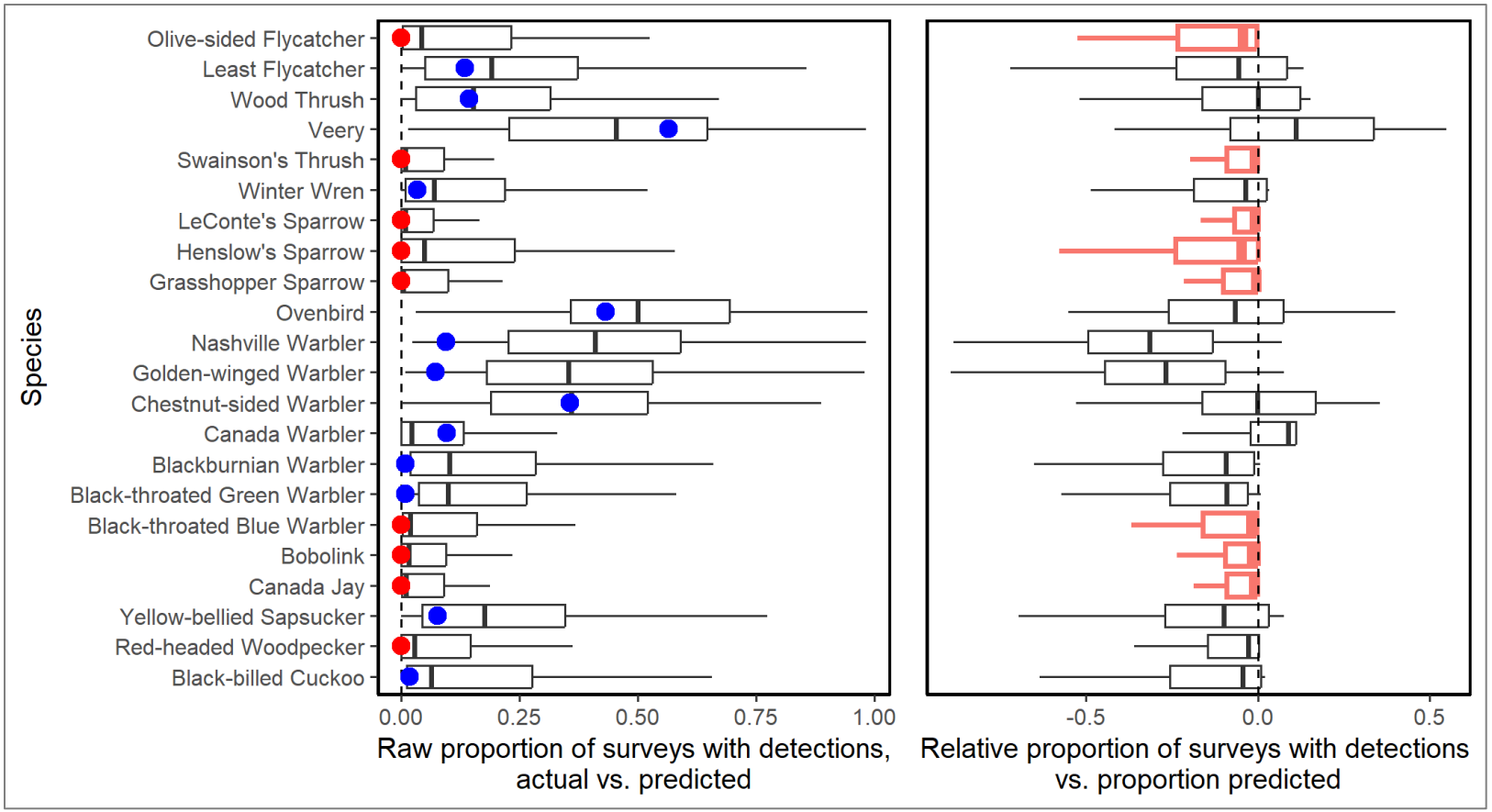


Figure 72. Proportion of actual versus predicted bird species detections during surveys at St. Croix National Scenic Riverway (Wisconsin/Minnesota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park.

USGS

Scotts Bluff National Monument (SCBL), Nebraska

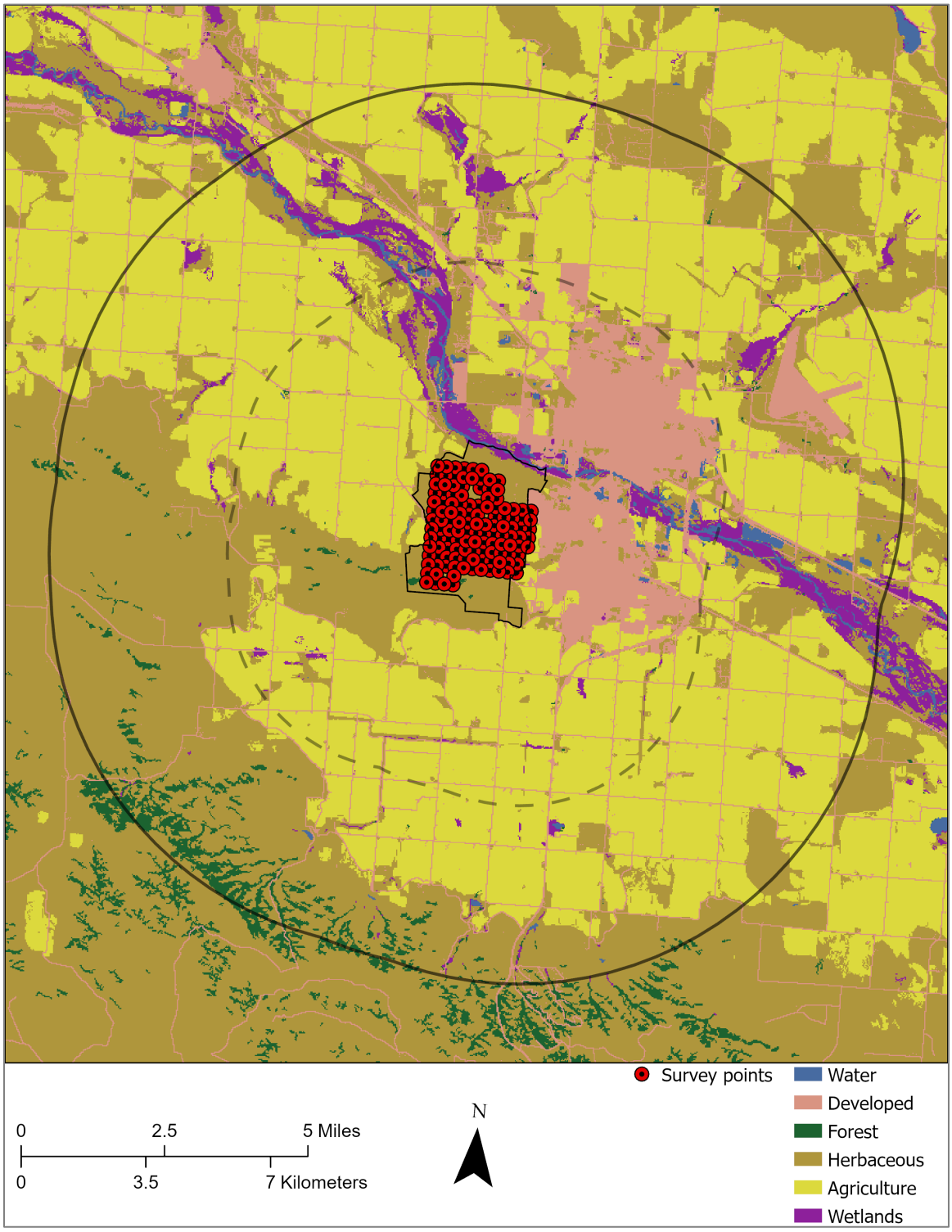


Figure 73. Land cover classes at Scotts Bluff National Monument (Nebraska) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

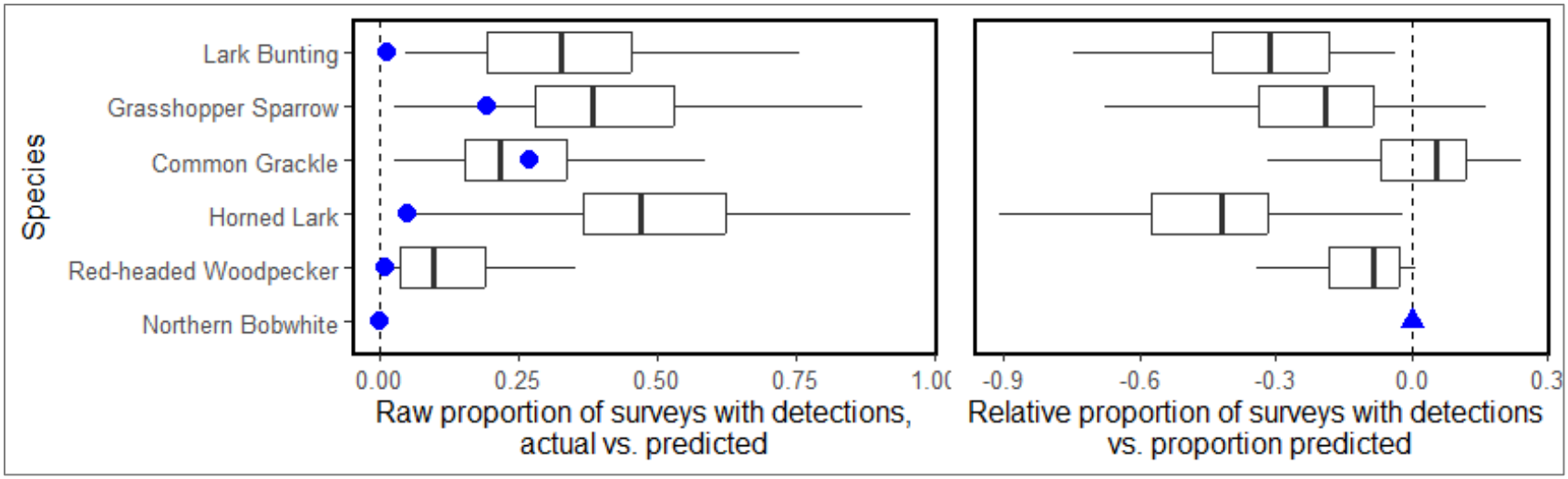


Figure 74. Proportion of actual versus predicted bird species detections during surveys at Scotts Bluff National Monument (Nebraska). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.

USGS

Sleeping Bear Dunes National Lakeshore (SLBE), Michigan

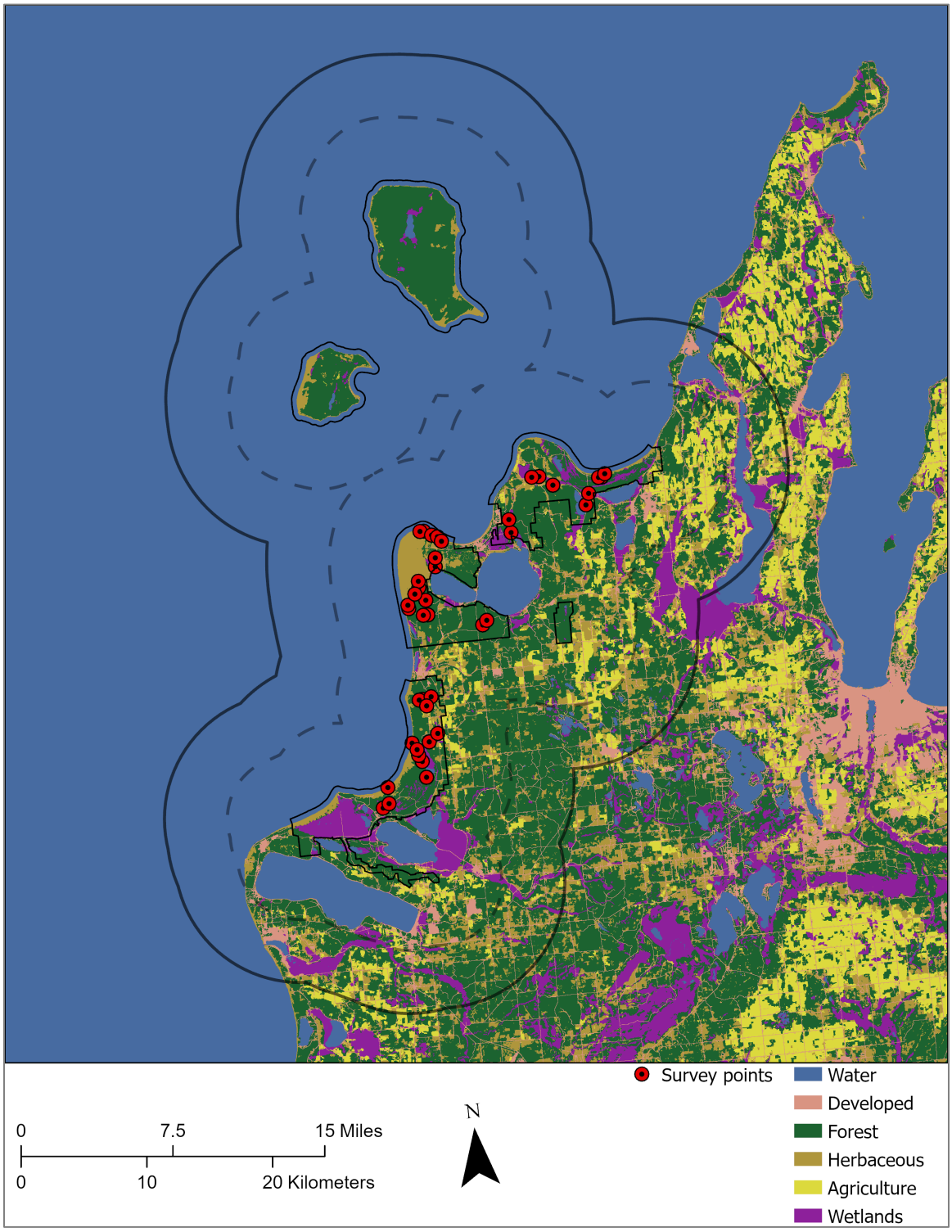


Figure 75. Land cover classes at Sleeping Bear Dunes National Lakeshore (Michigan) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

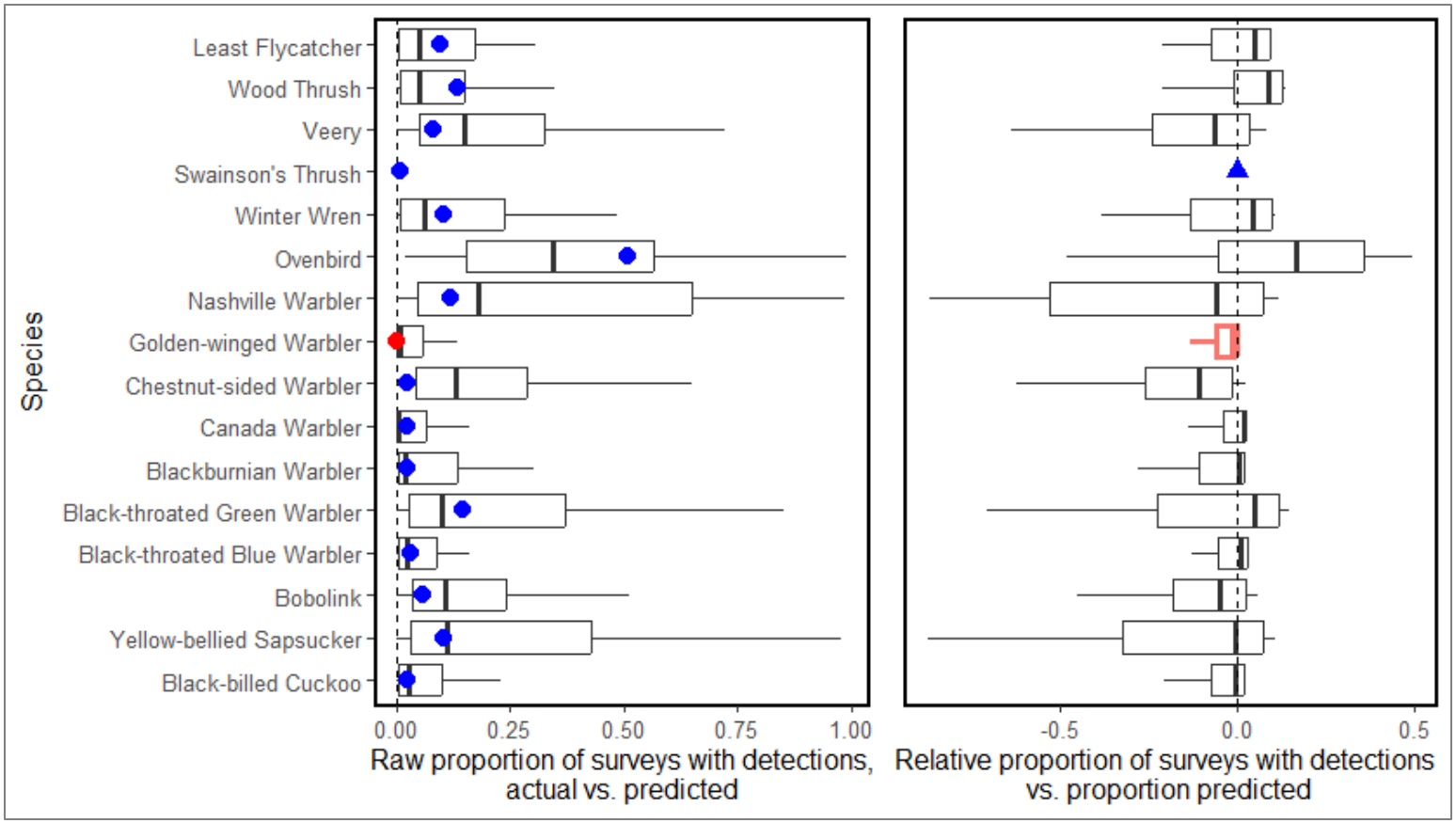


Figure 76. Proportion of actual versus predicted bird species detections during surveys at Sleeping Bear Dunes National Lakeshore (Michigan). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service NPS surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.
USGS

Tallgrass Prairie National Preserve (TAPR), Kansas

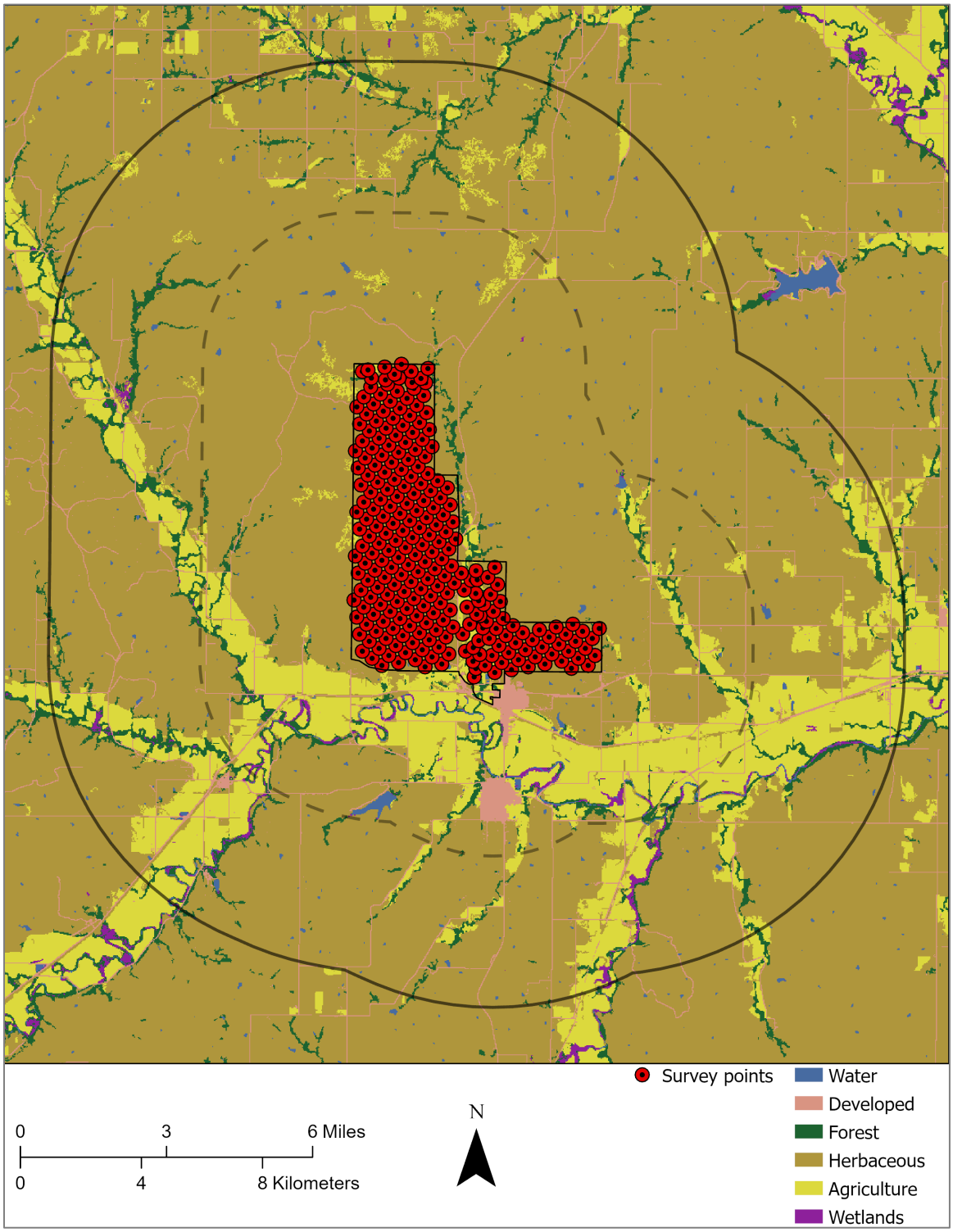


Figure 77. Land cover classes at Tallgrass Prairie National Preserve (Kansas) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

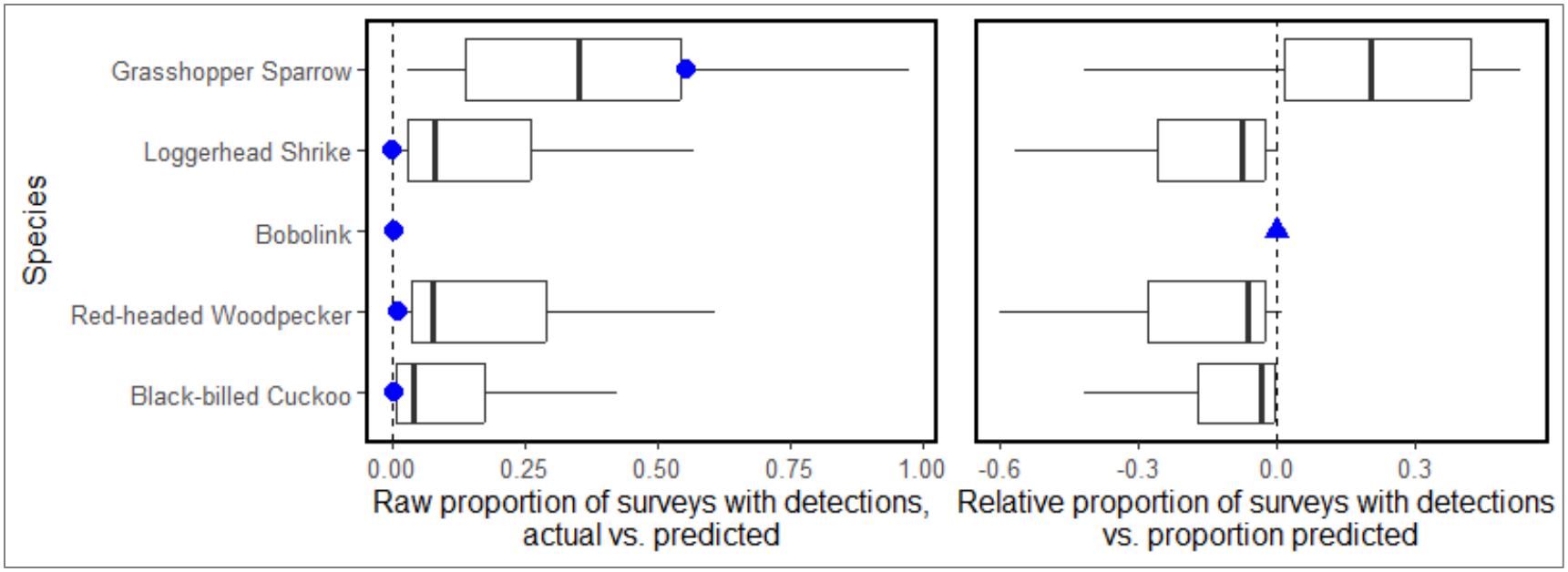


Figure 78. Proportion of actual versus predicted bird species detections during surveys at Tallgrass Prairie National Preserve (Kansas). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.

USGS

Theodore Roosevelt National Park (THRO), North Dakota

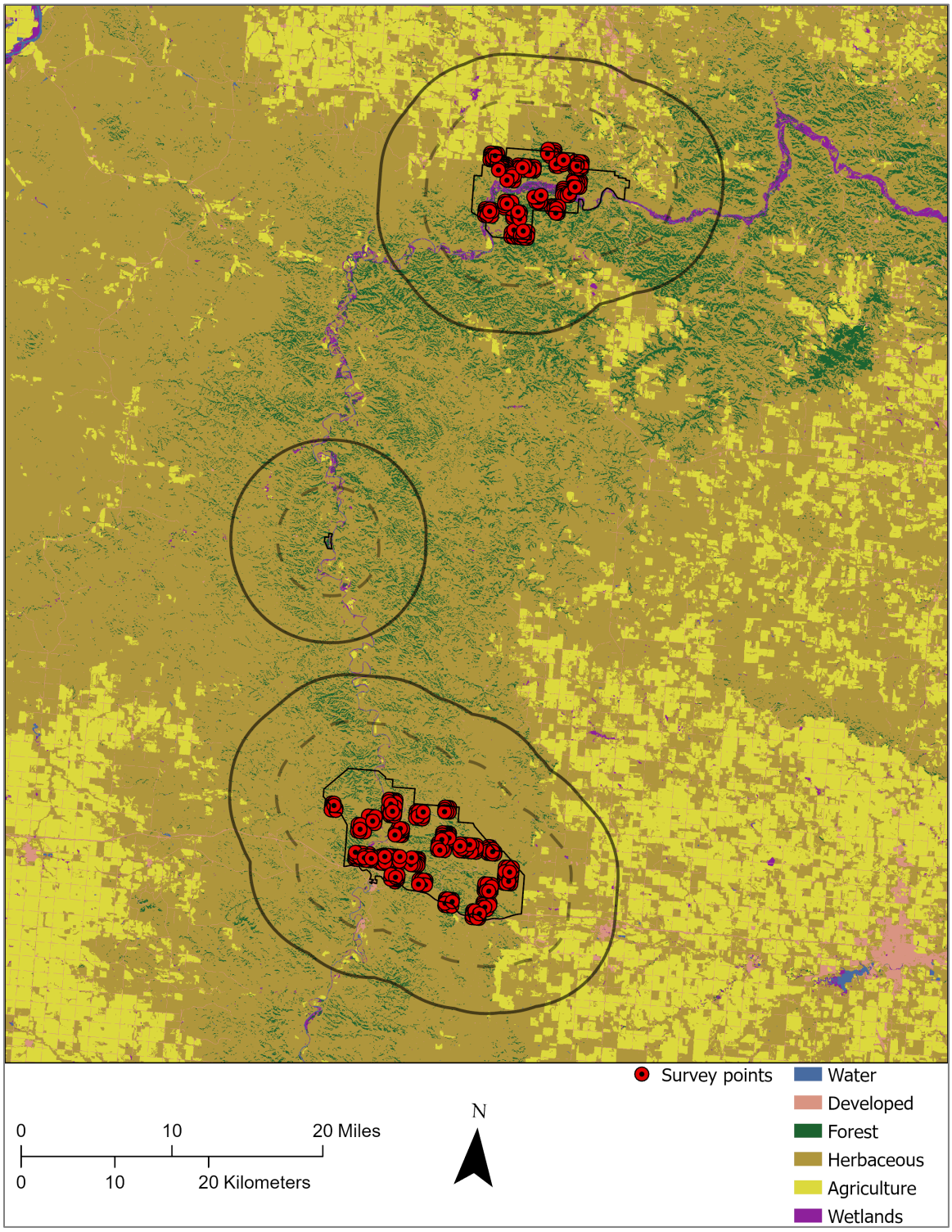


Figure 79. Land cover classes at Theodore Roosevelt National Park (North Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

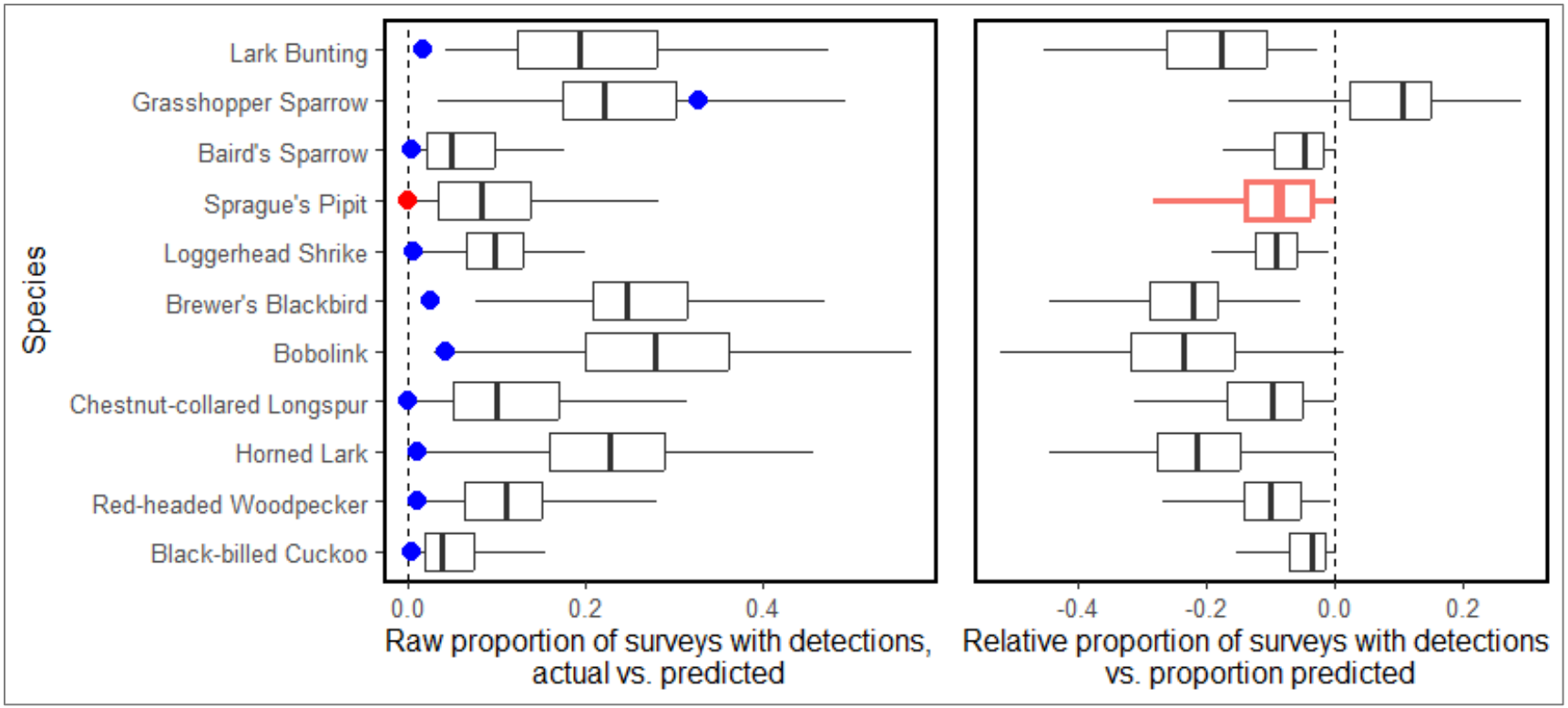


Figure 80. Proportion of actual versus predicted bird species detections during surveys at Theodore Roosevelt National Park (North Dakota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Refer to Table 5 for species' scientific names.

USGS

Voyageurs National Park (VOYA), Minnesota

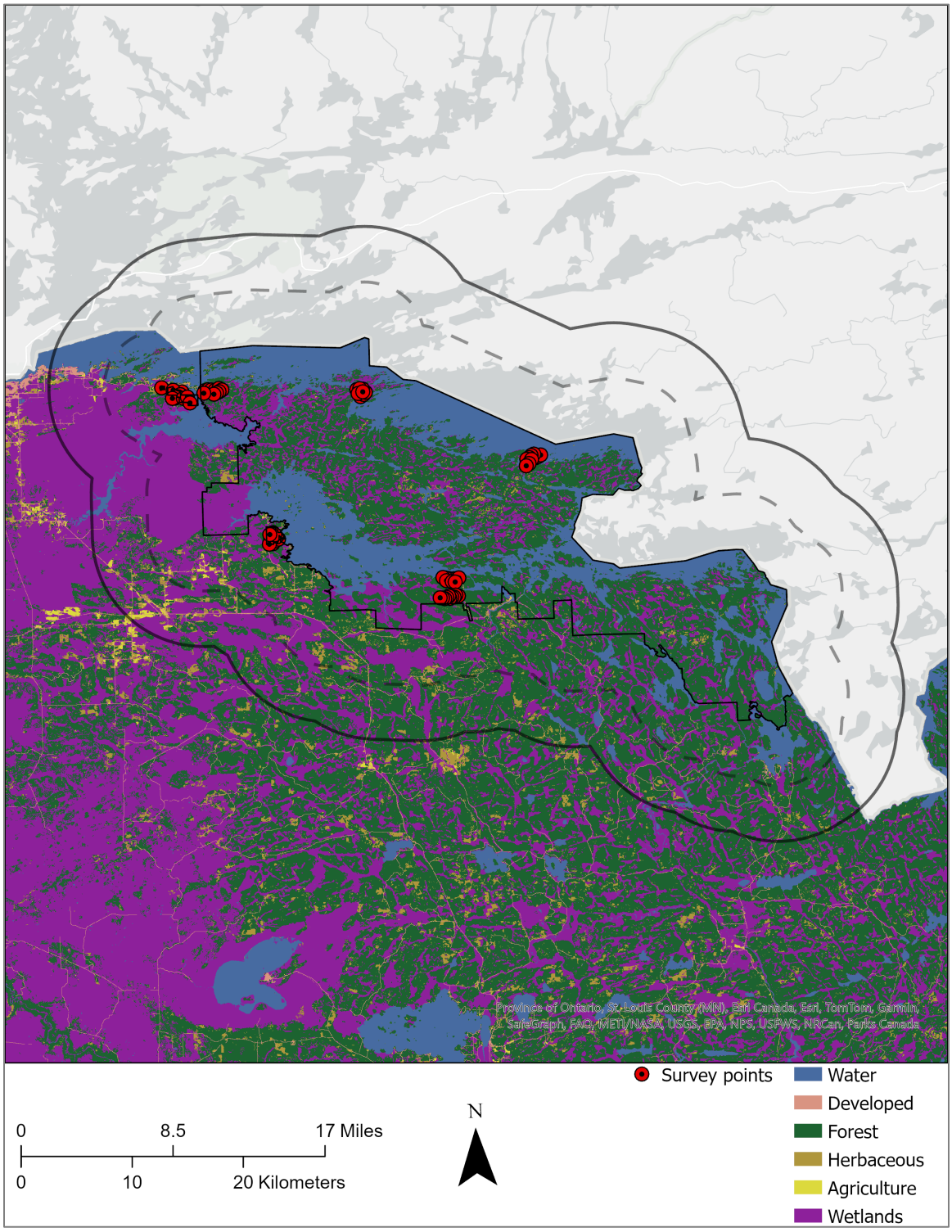


Figure 81. Land cover classes at Voyageurs National Park (Minnesota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

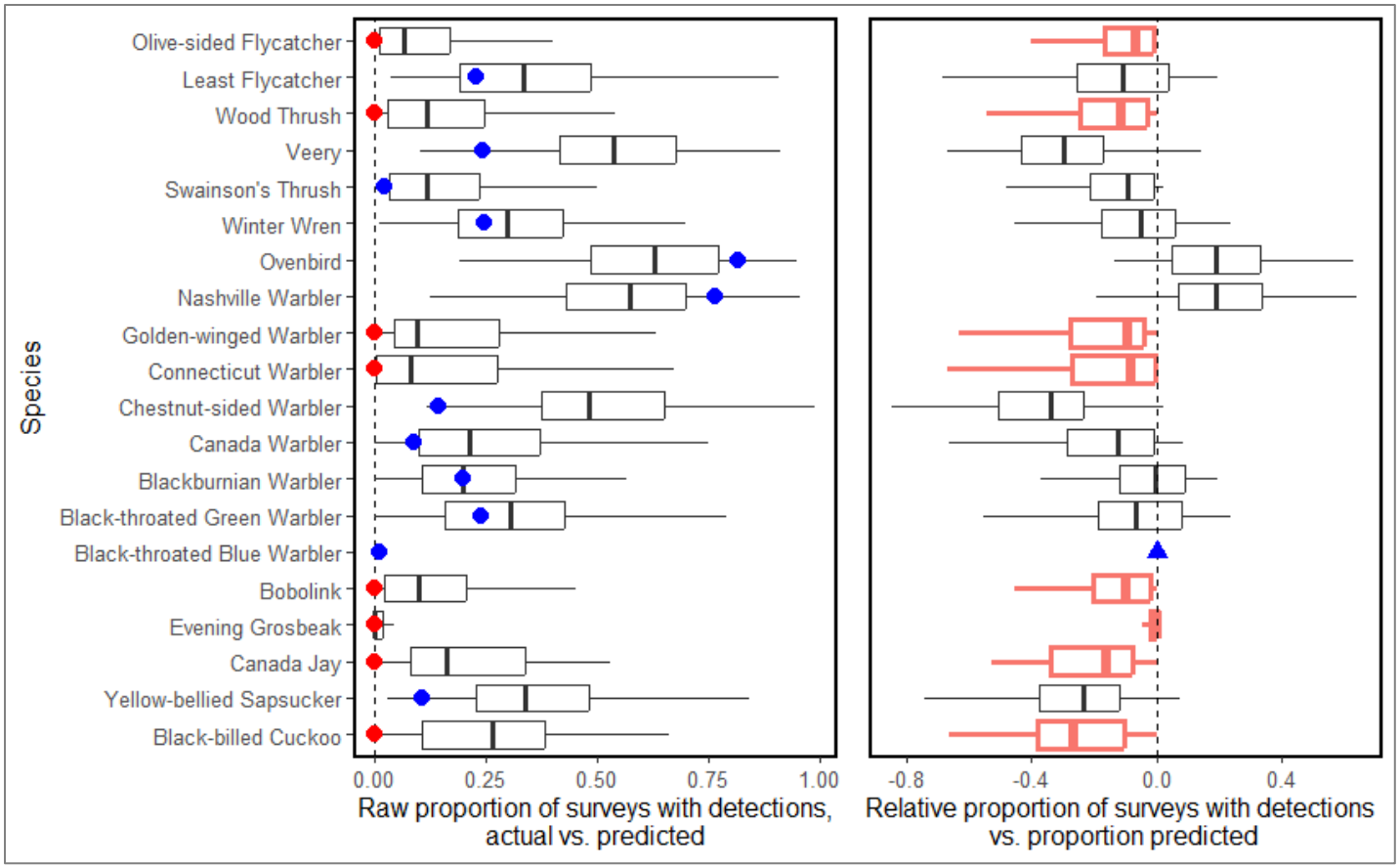


Figure 82. Proportion of actual versus predicted bird species detections during surveys at Voyageurs National Park (Minnesota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.
USGS

Wilson's Creek National Battlefield (WICR), Missouri

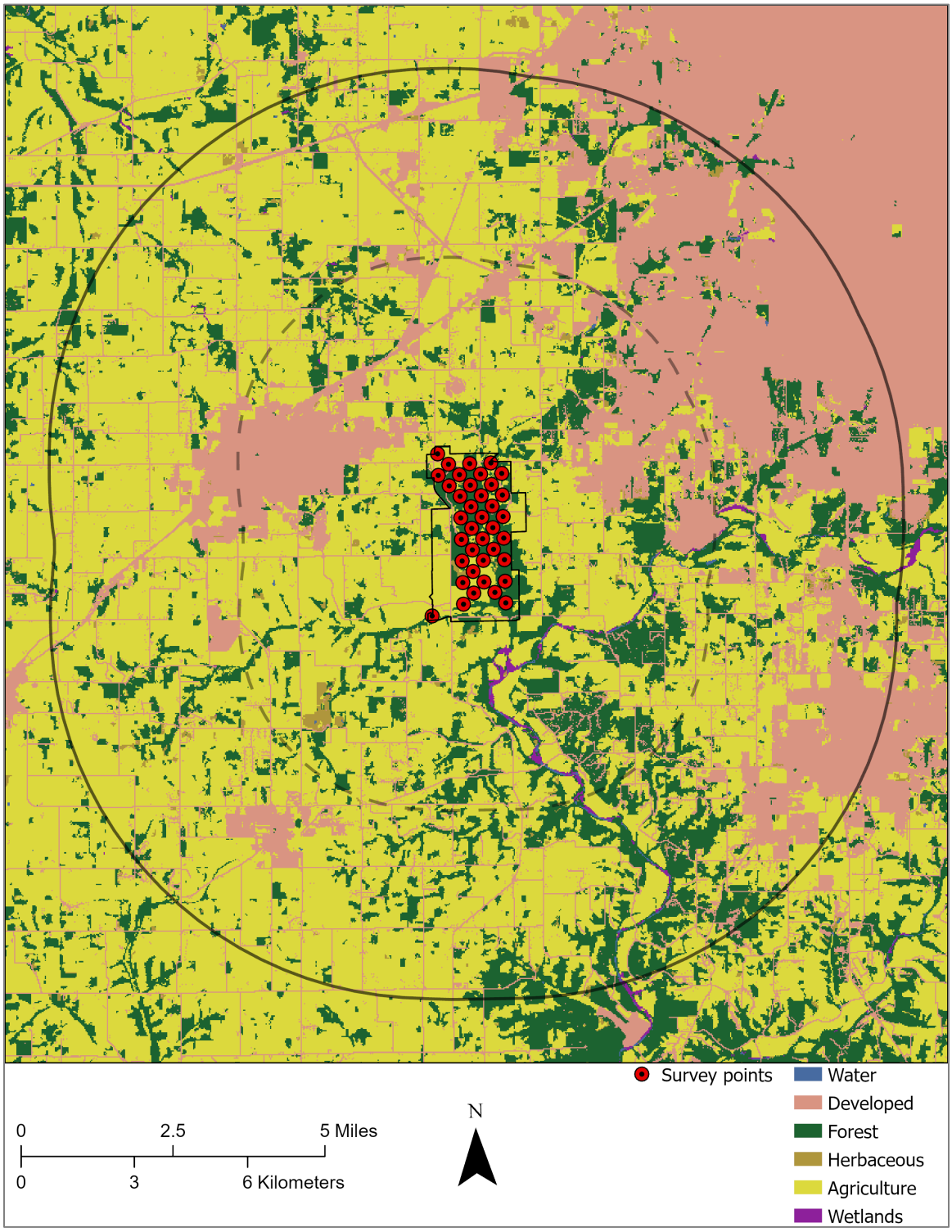


Figure 83. Land cover classes at Wilson's Creek National Battlefield (Missouri) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

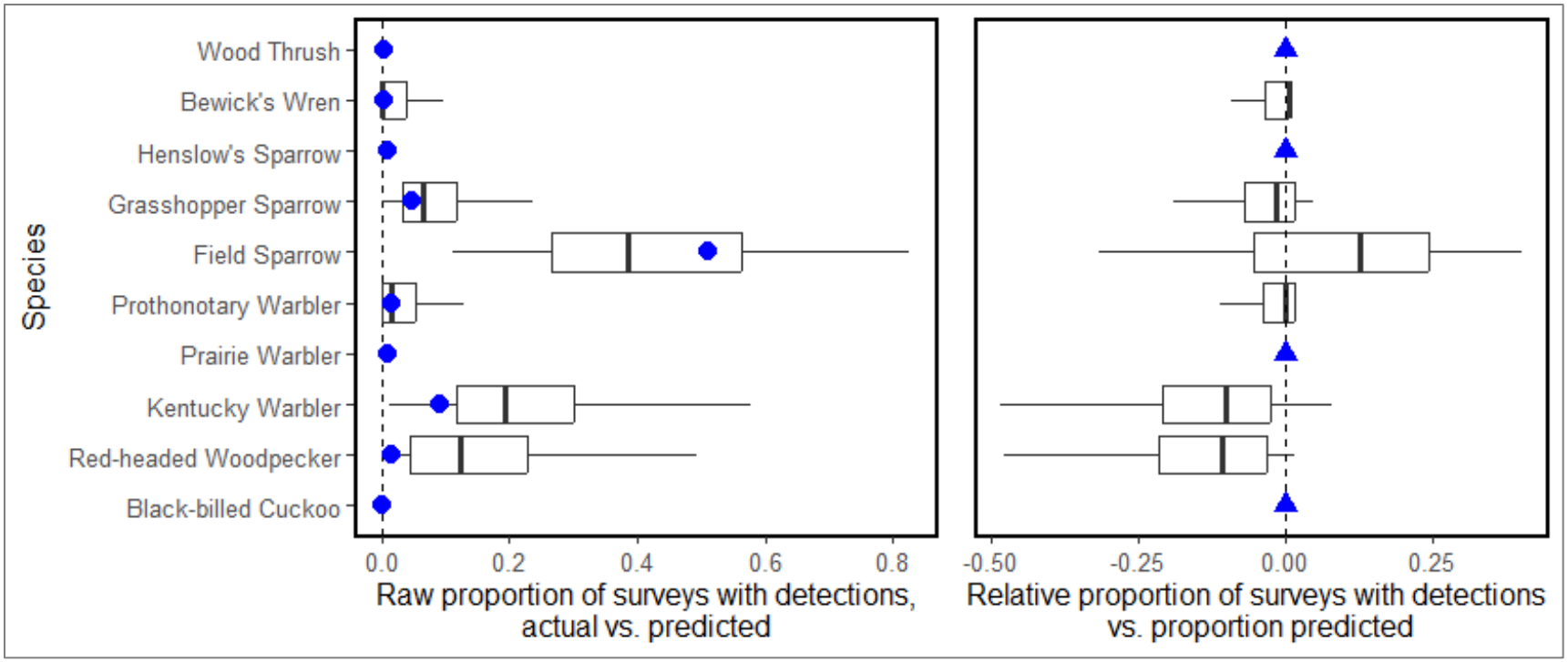


Figure 84. Proportion of actual versus predicted bird species detections during surveys at Wilson's Creek National Battlefield (Missouri). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25th and 75th percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of National Park Service (NPS) surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from NPS surveys minus the model-predicted proportion of species detections on NPS surveys. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.

USGS

Wind Cave National Park (WICA), South Dakota

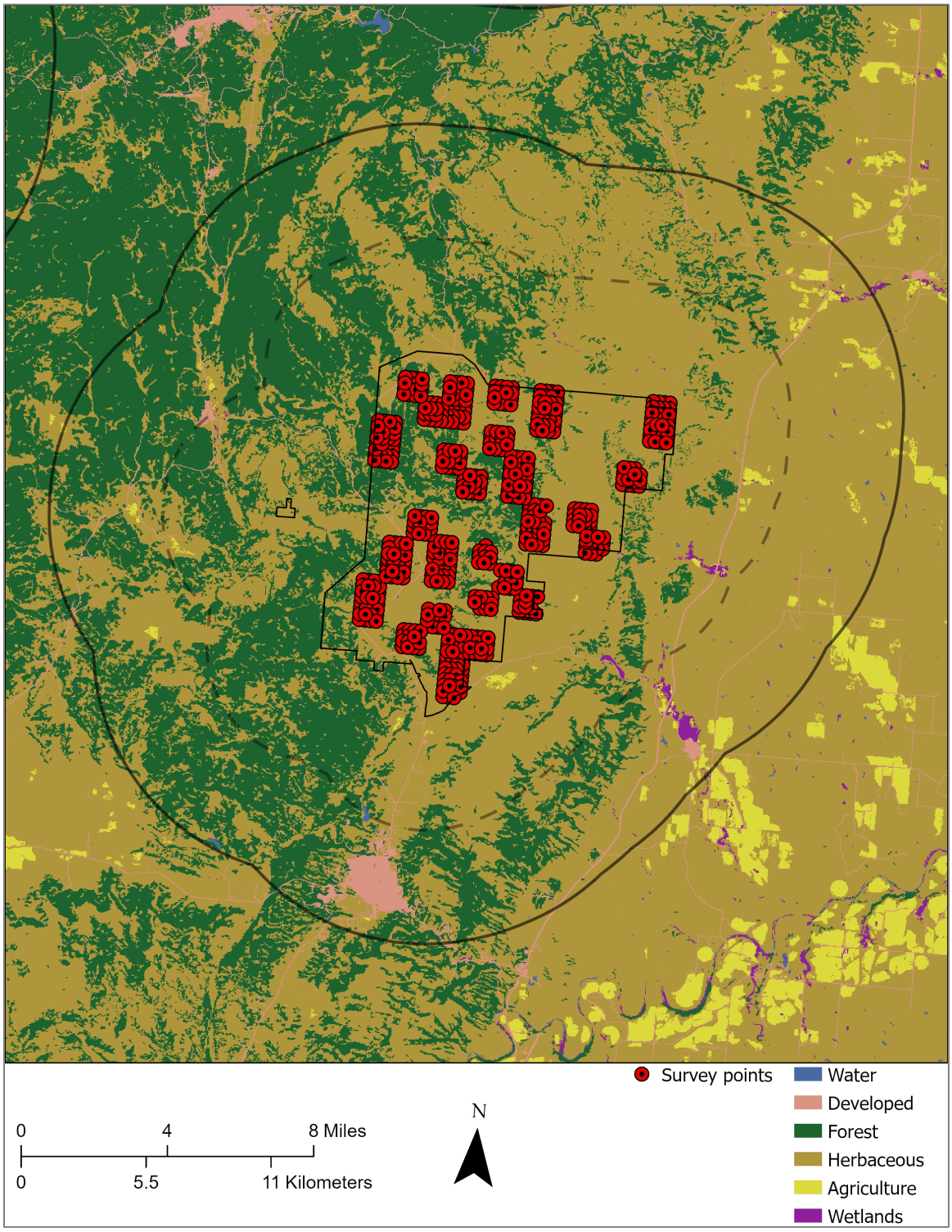


Figure 85. Land cover classes at Wind Cave National Park (South Dakota) and within 5 and 10 km of the park (from National Land Cover Database; Dewitz 2023).

NPS

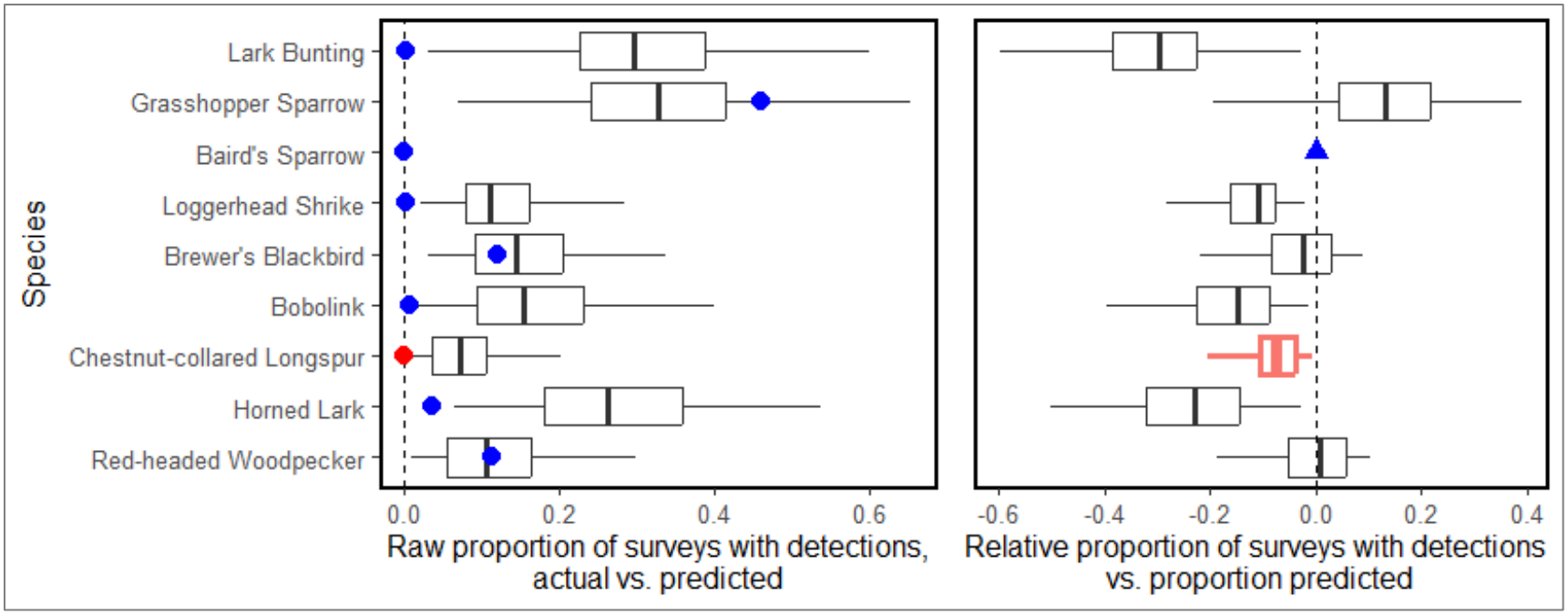


Figure 86. Proportion of actual versus predicted bird species detections during surveys at Wind Cave National Park (South Dakota). Boxplots are shown for species of concern in this Bird Conservation Region (BCR) that either were detected in or whose breeding range encompasses the park. **LEFT PANEL:** Boxplots show predicted proportion of surveys in which each species would be detected based on models trained on data from Breeding Bird Survey (BBS) routes in the BCR. The upper and lower boxplot edges indicate the first and third quartiles (25^{th} and 75^{th} percentiles). The whiskers extend to the largest and smallest values no farther than 1.5 × IQR (inter-quartile range) from the boxplot edge. Outliers are not shown. Blue dots indicate the actual proportion of NPS surveys in which a species was detected, and red dots indicate that a species was not detected. **RIGHT PANEL:** Boxplots show the proportion of actual detections from National Park Service (NPS) surveys minus the model-predicted proportion of species detections on NPS surveys. Red boxplots indicate a species that was not detected in any NPS survey at the park. Blue triangles in the right panel indicate detection(s) of out-of-range species in the park. Refer to Table 5 for species' scientific names.
USGS

Appendix B. Detections of Species of Interest in Each Midwest Park Unit.

The proportion of surveys on which each species of interest was detected are shown in each species-park combination in Table 7.

Table 7. Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
AGFO	Chestnut-collared Longspur	0.005	0.882	0.088
AGFO	Common Grackle	0.082	0.863	0.137
AGFO	Grasshopper Sparrow	0.336	0.549	0.451
AGFO	Horned Lark	0.208	0.922	0.078
AGFO	Lark Bunting	0.192	0.725	0.265
AGFO	Red-headed Woodpecker	0.005	0.833	0.147
AGFO	Thick-billed Longspur	0	0.765	0
APIS	Black-billed Cuckoo	0	0.951	0
APIS	Blackburnian Warbler	0.049	0.824	0.147
APIS	Black-throated Blue Warbler	0.142	0.412	0.588
APIS	Black-throated Green Warbler	0.698	0.010	0.990
APIS	Canada Warbler	0.019	0.873	0.078
APIS	Chestnut-sided Warbler	0.117	0.971	0.029
APIS	Golden-winged Warbler	0	0.941	0
APIS	Least Flycatcher	0.093	0.882	0.088
APIS	Nashville Warbler	0.420	0.608	0.382
APIS	Ovenbird	0.765	0.069	0.931
APIS	Swainson's Thrush	0.031	0.608	0.333
APIS	Veery	0.086	0.961	0.029
APIS	Winter Wren	0.099	0.735	0.255
APIS	Wood Thrush	0	0.941	0

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
APIS	Yellow-bellied Sapsucker	0.148	0.804	0.176
ARPO	Kentucky Warbler	0.042	0.755	0.245
ARPO	Prothonotary Warbler	0.143	0.784	0.216
ARPO	Red-headed Woodpecker	0.029	0.765	0.216
ARPO	Wood Thrush	0.135	0.520	0.480
BADL	Black-billed Cuckoo	0	1	0
BADL	Bobolink	0.045	0.961	0.039
BADL	Brewer's Blackbird	0.023	0.990	0.010
BADL	Chestnut-collared Longspur	0.002	1	0
BADL	Grasshopper Sparrow	0.495	0.373	0.627
BADL	Horned Lark	0.295	0.824	0.176
BADL	Lark Bunting	0.102	1	0
BADL	Loggerhead Shrike	0.008	1	0
BADL	Red-headed Woodpecker	0.008	0.980	0.020
DETO	Bobolink	0	0.971	0
DETO	Brewer's Blackbird	0.005	0.971	0.029
DETO	Grasshopper Sparrow	0.002	0.980	0
DETO	Lark Bunting	0.002	0.980	0
DETO	Loggerhead Shrike	0	0.980	0
DETO	Red-headed Woodpecker	0.187	0.225	0.755
EFMO	Black-billed Cuckoo	0.017	0.725	0.245
EFMO	Bobolink	0	0.647	0
EFMO	Grasshopper Sparrow	0.006	0.392	0.569
EFMO	Henslow's Sparrow	0	0.294	0
EFMO	Red-headed Woodpecker	0.056	0.539	0.451
EFMO	Wood Thrush	0.176	0.833	0.167
FOLA	Bobolink	0	0.971	0

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
FOLA	Brewer's Blackbird	0.095	0.647	0.353
FOLA	Grasshopper Sparrow	0.106	0.863	0.137
FOLA	Horned Lark	0	0.980	0
FOLA	Lark Bunting	0.015	1	0
FOLA	Loggerhead Shrike	0.004	0.912	0.029
FOLA	Red-headed Woodpecker	0.026	0.706	0.284
GRPO	Black-billed Cuckoo	0.005	0.618	0.304
GRPO	Blackburnian Warbler	0.225	0.333	0.667
GRPO	Black-throated Blue Warbler	0.009	0.598	0.373
GRPO	Black-throated Green Warbler	0.644	0.314	0.686
GRPO	Canada Jay	0	0.480	0
GRPO	Canada Warbler	0.248	0.275	0.725
GRPO	Chestnut-sided Warbler	0.090	0.627	0.373
GRPO	Evening Grosbeak	0.005	0.216	0.735
GRPO	Least Flycatcher	0.009	0.775	0.196
GRPO	Nashville Warbler	0.653	0.500	0.490
GRPO	Olive-sided Flycatcher	0	0.441	0
GRPO	Ovenbird	0.856	0.324	0.676
GRPO	Swainson's Thrush	0.446	0.225	0.775
GRPO	Veery	0.342	0.451	0.549
GRPO	Winter Wren	0.495	0.294	0.706
GRPO	Wood Thrush	0	0.706	0
GRPO	Yellow-bellied Sapsucker	0.248	0.412	0.578
GWCA	Field Sparrow	0.290	0.843	0.157
GWCA	Grasshopper Sparrow	0.065	0.647	0.333
GWCA	Henslow's Sparrow	0.003	0.853	0.118
GWCA	Kentucky Warbler	0.030	0.696	0.275

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
GWCA	Prothonotary Warbler	0.005	0.431	0.500
GWCA	Red-headed Woodpecker	0.030	0.725	0.275
GWCA	Wood Thrush	0	0.931	0
HEHO	Bobolink	0	0.902	0
HEHO	Grasshopper Sparrow	0.020	0.657	0.324
HEHO	Henslow's Sparrow	0.020	0.255	0.735
HEHO	Loggerhead Shrike	0	0.412	0
HEHO	Red-headed Woodpecker	0.007	0.990	0.010
HEHO	Wood Thrush	0	0.735	0
HOCU	Black-billed Cuckoo	0	0.422	0
HOCU	Grasshopper Sparrow	0.235	0.206	0.794
HOCU	Henslow's Sparrow	0.143	0.137	0.843
HOCU	Kentucky Warbler	0	0.961	0
HOCU	Prothonotary Warbler	0.005	0.353	0.569
HOCU	Red-headed Woodpecker	0.005	1	0
HOCU	Wood Thrush	0.207	0.333	0.657
HOME	Bobolink	0	0.853	0
HOME	Common Grackle	0.052	0.941	0.049
HOME	Eastern Meadowlark	0.121	0.431	0.569
HOME	Grasshopper Sparrow	0.069	0.775	0.225
HOME	Horned Lark	0	0.853	0
HOME	Loggerhead Shrike	0	0.676	0
HOME	Northern Bobwhite	0.283	0.402	0.598
HOME	Red-headed Woodpecker	0.134	0.686	0.304
HOME	Yellow-billed Cuckoo	0.041	0.735	0.265
INDU	Black-billed Cuckoo	0	0.333	0
INDU	Bobolink	0	0.147	0

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
INDU	Grasshopper Sparrow	0	0.265	0
INDU	Henslow's Sparrow	0	0.088	0
INDU	Red-headed Woodpecker	0.010	0.520	0.412
INDU	Wood Thrush	0.083	0.725	0.275
ISRO	Black-billed Cuckoo	0	0.980	0
ISRO	Blackburnian Warbler	0.078	0.716	0.284
ISRO	Black-throated Blue Warbler	0.054	0.686	0.314
ISRO	Black-throated Green Warbler	0.402	0.333	0.667
ISRO	Canada Jay	0	0.902	0
ISRO	Canada Warbler	0.040	0.765	0.225
ISRO	Chestnut-sided Warbler	0.206	0.784	0.216
ISRO	Evening Grosbeak	0.003	0.382	0.618
ISRO	Least Flycatcher	0.027	0.941	0.059
ISRO	Nashville Warbler	0.698	0.343	0.647
ISRO	Olive-sided Flycatcher	0.005	0.696	0.284
ISRO	Ovenbird	0.586	0.559	0.441
ISRO	Swainson's Thrush	0.168	0.520	0.480
ISRO	Veery	0.058	0.941	0.039
ISRO	Winter Wren	0.597	0.206	0.794
ISRO	Wood Thrush	0	0.971	0
ISRO	Yellow-bellied Sapsucker	0.021	0.980	0.020
JECA	Bobolink	0	0.922	0
JECA	Brewer's Blackbird	0.012	0.853	0.118
JECA	Red-headed Woodpecker	0.528	0.010	0.990
KNRI	Baird's Sparrow	0.002	0.941	0.010
KNRI	Black-billed Cuckoo	0.006	0.667	0.284
KNRI	Bobolink	0.506	0.088	0.912

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
KNRI	Brewer's Blackbird	0.114	0.647	0.353
KNRI	Chestnut-collared Longspur	0	0.990	0
KNRI	Grasshopper Sparrow	0.276	0.382	0.618
KNRI	Horned Lark	0.024	0.922	0.069
KNRI	Lark Bunting	0.002	0.990	0
KNRI	Loggerhead Shrike	0	0.951	0
KNRI	Red-headed Woodpecker	0.073	0.637	0.353
KNRI	Sprague's Pipit	0.002	0.735	0.235
LIBO	Field Sparrow	0	0.990	0
LIBO	Grasshopper Sparrow	0	0.314	0
LIBO	Henslow's Sparrow	0	0.186	0
LIBO	Kentucky Warbler	0.084	0.627	0.363
LIBO	Prairie Warbler	0	0.843	0
LIBO	Prothonotary Warbler	0.008	0.784	0.167
LIBO	Red-headed Woodpecker	0.031	0.833	0.157
LIBO	Wood Thrush	0.191	0.676	0.304
MISS	Black-billed Cuckoo	0.005	0.794	0.147
MISS	Bobolink	0.005	0.794	0.108
MISS	Grasshopper Sparrow	0.068	0.137	0.853
MISS	Henslow's Sparrow	0.027	0.206	0.735
MISS	Wood Thrush	0.009	0.912	0.059
MNRR	Black-billed Cuckoo	0.012	0.922	0.078
MNRR	Bobolink	0.062	0.863	0.137
MNRR	Common Grackle	0.171	0.843	0.157
MNRR	Grasshopper Sparrow	0.057	0.657	0.333
MNRR	Greater Prairie-Chicken	0.005	0.716	0.265
MNRR	Horned Lark	0.025	0.980	0.020

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
MNRR	Least Flycatcher	0.009	0.990	0.010
MNRR	Red-headed Woodpecker	0.258	0.324	0.667
MORU	Bobolink	0	0.637	0
MORU	Brewer's Blackbird	0	0.520	0
MORU	Red-headed Woodpecker	0.003	0.696	0.225
NIOB	Bobolink	0.036	0.931	0.059
NIOB	Grasshopper Sparrow	0.408	0.284	0.716
NIOB	Horned Lark	0.031	0.990	0.010
NIOB	Lark Bunting	0	1	0
NIOB	Loggerhead Shrike	0.009	0.931	0.059
NIOB	Red-headed Woodpecker	0.237	0.167	0.824
PERI	Cerulean Warbler	0	0.931	0
PERI	Field Sparrow	0.150	0.755	0.235
PERI	Kentucky Warbler	0.040	0.882	0.108
PERI	Prairie Warbler	0.029	0.608	0.363
PERI	Prothonotary Warbler	0	0.863	0
PERI	Red-headed Woodpecker	0.005	0.931	0.039
PERI	Wood Thrush	0.027	0.873	0.108
PIPE	Black-billed Cuckoo	0	0.716	0
PIPE	Bobolink	0.581	0.206	0.794
PIPE	Brewer's Blackbird	0.010	0.745	0.225
PIPE	Common Grackle	0.622	0.206	0.794
PIPE	Grasshopper Sparrow	0.339	0.255	0.745
PIPE	Horned Lark	0.002	0.980	0.010
PIPE	Least Flycatcher	0.004	0.765	0.157
PIPE	Red-headed Woodpecker	0	0.961	0
PIRO	Black-billed Cuckoo	0.043	0.510	0.490

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
PIRO	Blackburnian Warbler	0.143	0.451	0.549
PIRO	Black-throated Blue Warbler	0.303	0.235	0.765
PIRO	Black-throated Green Warbler	0.597	0.314	0.686
PIRO	Bobolink	0.017	0.676	0.294
PIRO	Canada Warbler	0.030	0.578	0.422
PIRO	Chestnut-sided Warbler	0.147	0.490	0.490
PIRO	Golden-winged Warbler	0	0.539	0
PIRO	Least Flycatcher	0.251	0.333	0.667
PIRO	Nashville Warbler	0.325	0.539	0.461
PIRO	Olive-sided Flycatcher	0	0.451	0
PIRO	Ovenbird	0.714	0.363	0.637
PIRO	Swainson's Thrush	0.312	0.186	0.814
PIRO	Veery	0.242	0.441	0.559
PIRO	Winter Wren	0.117	0.627	0.363
PIRO	Wood Thrush	0.039	0.520	0.461
PIRO	Yellow-bellied Sapsucker	0.403	0.343	0.657
SACN	Black-billed Cuckoo	0.018	0.637	0.358
SACN	Blackburnian Warbler	0.009	0.863	0.127
SACN	Black-throated Blue Warbler	0	0.912	0
SACN	Black-throated Green Warbler	0.009	0.912	0.069
SACN	Bobolink	0	0.721	0
SACN	Canada Jay	0	0.843	0
SACN	Canada Warbler	0.097	0.279	0.721
SACN	Chestnut-sided Warbler	0.358	0.500	0.500
SACN	Golden-winged Warbler	0.073	0.868	0.132
SACN	Grasshopper Sparrow	0	0.500	0
SACN	Henslow's Sparrow	0	0.637	0

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
SACN	Least Flycatcher	0.136	0.637	0.363
SACN	LeConte's Sparrow	0	0.618	0
SACN	Nashville Warbler	0.095	0.922	0.078
SACN	Olive-sided Flycatcher	0	0.873	0
SACN	Ovenbird	0.433	0.637	0.363
SACN	Red-headed Woodpecker	0	0.735	0.265
SACN	Swainson's Thrush	0	0.745	0
SACN	Veery	0.565	0.343	0.657
SACN	Winter Wren	0.034	0.549	0.451
SACN	Wood Thrush	0.144	0.495	0.500
SACN	Yellow-bellied Sapsucker	0.077	0.676	0.324
SCBL	Common Grackle	0.271	0.353	0.647
SCBL	Grasshopper Sparrow	0.194	0.853	0.147
SCBL	Horned Lark	0.049	1	0
SCBL	Lark Bunting	0.013	1	0
SCBL	Red-headed Woodpecker	0.011	0.873	0.118
SLBE	Black-billed Cuckoo	0.023	0.500	0.490
SLBE	Blackburnian Warbler	0.023	0.480	0.510
SLBE	Black-throated Blue Warbler	0.032	0.402	0.559
SLBE	Black-throated Green Warbler	0.144	0.373	0.627
SLBE	Bobolink	0.059	0.637	0.353
SLBE	Canada Warbler	0.023	0.373	0.618
SLBE	Chestnut-sided Warbler	0.023	0.784	0.196
SLBE	Golden-winged Warbler	0	0.637	0
SLBE	Least Flycatcher	0.095	0.402	0.598
SLBE	Nashville Warbler	0.117	0.559	0.431
SLBE	Ovenbird	0.509	0.304	0.686

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
SLBE	Veery	0.081	0.637	0.324
SLBE	Winter Wren	0.104	0.422	0.559
SLBE	Wood Thrush	0.135	0.265	0.716
SLBE	Yellow-bellied Sapsucker	0.104	0.510	0.490
TAPR	Black-billed Cuckoo	0.004	0.843	0.157
TAPR	Grasshopper Sparrow	0.555	0.245	0.755
TAPR	Loggerhead Shrike	0.002	0.990	0.010
TAPR	Red-headed Woodpecker	0.010	0.882	0.108
THRO	Baird's Sparrow	0.004	0.951	0.039
THRO	Black-billed Cuckoo	0.004	0.912	0.069
THRO	Bobolink	0.044	0.980	0.020
THRO	Brewer's Blackbird	0.025	1	0
THRO	Chestnut-collared Longspur	0.001	0.990	0
THRO	Grasshopper Sparrow	0.326	0.186	0.814
THRO	Horned Lark	0.011	0.990	0
THRO	Lark Bunting	0.018	1	0
THRO	Loggerhead Shrike	0.007	1	0
THRO	Red-headed Woodpecker	0.010	1	0
THRO	Sprague's Pipit	0	0.922	0
VOYA	Black-billed Cuckoo	0	0.971	0
VOYA	Blackburnian Warbler	0.196	0.510	0.490
VOYA	Black-throated Green Warbler	0.236	0.578	0.422
VOYA	Bobolink	0	0.971	0
VOYA	Canada Jay	0	0.961	0
VOYA	Canada Warbler	0.086	0.755	0.245
VOYA	Chestnut-sided Warbler	0.141	0.990	0.010
VOYA	Connecticut Warbler	0	0.765	0

Table 7 (continued). Observed proportion of surveys in which species of interest were detected in each park and the probabilities of those observations being less than and greater than predicted. Very high values of "Probability Observed < Predicted" represent strong evidence that the species is less prevalent in the park than on Breeding Bird Survey (BBS) routes with similar land cover in the surrounding Bird Conservation Region (BCR), and very high values of "Probability Observed > Predicted" represent strong evidence of the opposite. The probability observed versus expected columns sum to 1 in many rows; when they sum to <1, this indicates that in the remaining proportion of cases (1-sum), both the observed and the expected were exactly equal (usually zero). Includes all species-park combinations for which the park overlaps with the species' breeding range and for which the species is a species of concern in the park's primary BCR. For scientific names and American Ornithological Society (AOS) species codes, refer to Table 5. NPS is National Park Service.

NPS Unit Code	English Name	Proportion of Surveys Detected	Probability Observed < Predicted	Probability Observed > Predicted
VOYA	Evening Grosbeak	0	0.422	0
VOYA	Golden-winged Warbler	0	0.961	0
VOYA	Least Flycatcher	0.228	0.676	0.324
VOYA	Nashville Warbler	0.767	0.147	0.853
VOYA	Olive-sided Flycatcher	0	0.873	0
VOYA	Ovenbird	0.818	0.118	0.882
VOYA	Swainson's Thrush	0.020	0.765	0.235
VOYA	Veery	0.242	0.951	0.049
VOYA	Winter Wren	0.245	0.627	0.373
VOYA	Wood Thrush	0	0.951	0
VOYA	Yellow-bellied Sapsucker	0.104	0.951	0.049
WICA	Bobolink	0.006	1	0
WICA	Brewer's Blackbird	0.120	0.637	0.363
WICA	Chestnut-collared Longspur	0	1	0
WICA	Grasshopper Sparrow	0.459	0.127	0.873
WICA	Horned Lark	0.037	1	0
WICA	Lark Bunting	0.002	1	0
WICA	Loggerhead Shrike	0.002	1	0
WICA	Red-headed Woodpecker	0.113	0.431	0.559
WICR	Bewick's Wren	0.005	0.431	0.559
WICR	Field Sparrow	0.510	0.324	0.676
WICR	Grasshopper Sparrow	0.048	0.637	0.353
WICR	Kentucky Warbler	0.091	0.882	0.108
WICR	Prothonotary Warbler	0.017	0.471	0.480
WICR	Red-headed Woodpecker	0.014	0.873	0.108

National Park Service
U.S. Department of the Interior

Science Report NPS/SR—2025/317
https://doi.org/10.36967/2312602



Natural Resource Stewardship and Science
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

NPS 920/197253, June 2025