Long-term Avian Research and Monitoring on Mt. Mansfield, Vermont

2016 Report to the Forest Ecosystem Monitoring Cooperative

Part I. Demographic Monitoring of Montane Forest Birds on Mt. Mansfield

Part II. Forest Bird Surveys on Mt. Mansfield and Lye Brook Wilderness Area

Installing an Automated Recording Device for capturing daily bird vocalizations in order to determine the date of their arrival.

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Part I. Demographic Monitoring of Montane Forest Birds on Mt. Mansfield

Introduction

In 2016, we continued demographic monitoring of Bicknell's Thrush *(Catharus bicknelli)*, Swainson's Thrush *(C. ustulatus)*, Blackpoll Warbler *(Setophaga striata)*, Yellow-rumped (Myrtle) Warbler *(S. coronata coronata)*, White-throated Sparrow *(Zonotrichia albicollis)*, and other songbirds, completing our 25th consecutive field season on the Mt. Mansfield ridgeline. This report presents a brief summary of data collected.

We also initiated a complementary study to monitor potential phenological mismatching between insectivorous songbirds and other trophic groups. Climate change is expected to increase the risk of extinction for many species, yet the mechanisms through which climate affects populations of plants and animals remain unclear. One prominent explanation is the phenological-mismatch hypothesis, which argues that a warming climate advances the seasonal timing of key life-history events at lower trophic levels but not at higher trophic levels, leading to maladaptive phenologies. Birds, especially long-distance migrants, have been argued to suffer especially from this phenomenon. Their primary prey, arthropods, reach peak abundance earlier in warm years, whereas the annual cycle of birds is endogenously regulated in response to photoperiod, which is unaffected by climate change. Birds thus return from wintering grounds relatively late, miss the peak abundance of key prey species, and can raise fewer young. Evidence that phenological mismatches are becoming widespread, however, is meager. In 2016, we began to examine several key assumptions of this hypothesis on the Mount Mansfield ridgeline. We attempted to document the phenology of a mountain ecosystem at three trophic levels — plants, arthropods, and insectivorous birds — and to document how phenology is affected by local weather conditions, which we assume will provide insight into the link between climate and phenology. By tracking weather-driven variation in phenology, we seek to (1) test the assumption that phenology at lower trophic levels closely tracks local weather, especially temperature; (2) examine whether birds adjust the timing of reproduction accordingly; and (3) examine whether bird species with different life-history strategies respond differently. In particular, we seek to understand whether long-distance migrants like Bicknell's Thrush and Blackpoll Warbler, which are thought to have relatively rigid phenological schedules that respond primarily to photoperiod, respond differently to interannual variation in spring weather than do short-distance migrants like White-throated Sparrow and Yellow-rumped (Myrtle) Warbler, which may have greater flexibility in timing of arrival to the breeding grounds and subsequent initiation of reproductive activities (Knudsen et al. 2011). Despite many studies investigating the phenology of avian reproduction, very few have simultaneously tracked changes in phenology of prey species (Visser et al. 2011)

Methods

For the 25th consecutive breeding season, we used mist-netting and banding to monitor breeding bird species on an established study plot on the Mt. Mansfield ridgeline between c. 1155-1190 m (3800-3900 ft) elevation. As in previous years, we focused our efforts on five common target species: Bicknell's Thrush, Swainson's Thrush, Blackpoll Warbler, Yellow-rumped (Myrtle) Warbler, and White-throated Sparrow. Since 2012, as a means to more broadly assess population changes and the potential impacts of climatic warming, our efforts have encompassed the entire avian community.

We netted birds on 20 days between 19 May and 14 September 2016, using 10-30 nylon mist nets (12 x 2.5-m and 6 x 2.5-m, 36-mm mesh) placed at sites that have been used annually since 1992, primarily on the Amherst, Lakeview, and Long trails. Nets were generally opened from late afternoon until dusk and from dawn until late morning on the following day. Bicknell's Thrushes were captured both passively and through the use of vocal lures (recorded playbacks of conspecific vocalizations), while other species were passively captured. Each individual was fitted with a uniquely-numbered U.S. Fish and Wildlife Service (USFWS) leg band. We recorded data on age, sex, breeding condition, fat class, ectoparasites, flight feather wear, and net site of capture. Standard metrics included wing chord, tail length, weight, tarsal length, culmen length, bill length from mid-nares, bill width, and bill depth. Additionally, a small blood sample was obtained from Bicknell's and Swainson's thrushes for long-term monitoring of mercury burdens. We collected 30–50 ul of blood in a 75 ul heparinized capillary tube by puncturing the cutaneous ulnar (brachial) vein with a 27.5 gauge needle. Capillary tubes were sealed on both ends with Critocaps and placed in a labeled glass 7 cc vacutainer and frozen within 24 hours.

To begin a planned long-term study of avian phenology, we collected data to examine correlations between local weather and time-series that describe leaf-out, abundance of arthropods, and phenology of reproduction in insectivorous birds. We tracked leaf-out using time-lapse cameras that captured repeated photographs of deciduous trees. These cameras also captured the timing of loss of snowpack. We sampled arthropods weekly, beginning as soon as the ground was mostly free of snow, and continued through mid-July, at which point most birds had fledged young. We sampled the density and estimated biomass of ground- and foliage-dwelling arthropods at randomly selected points along the ridgeline. We generally sampled 10 different points per week during the 6-week survey period. We conducted visual ground surveys in a 0.5 m X 0.5 m plot at each point (Strong et al. 2004). Arthropods were either collected and stored for later analysis or were identified to morphospecies in the field and measured to the nearest mm. We used the same groups identified in Strong et al. (2004): ants (Formicidae); Coleoptera; Diptera; Hymenoptera; Homoptera; Hemiptera; holometabolous larvae, primarily Lepidoptera and Hymenoptera; and spiders. Each survey lasted for 5 minutes. We then randomly selected one branch (hardwood, spruce, or fir) in each of the cardinal directions around the survey point on which to conduct surveys for foliage-dwelling arthropods. The survey began with a rapid visual inspection of the branch, primarily to identify large, flying insects. These individuals were collected or identified and measured. Once the visual survey was complete, the bag of a collecting net was placed over the branch and shaken vigorously to dislodge as many arthropods as possible. The contents of the bag were transferred to a storage container and frozen for later sorting and analysis. After the survey was complete, we recorded the length and maximum width of the portion of the branch surveyed. For spruce or fir branches, which tend to have complicated shapes, we used regression analysis on collected branches to determine the relationship between the area of foliage surveyed and our measurements of length and width. For the purposes of comparison with our visual ground surveys, each week we used pitfall traps to sample ground-dwelling arthropods at randomly located points along the ridgeline. At each point, we established an array of four pitfall traps. Traps were filled with soapy water, opened at sunrise, and closed 6 hours later. All arthropods collected were sorted into the groups identified above and measured to the nearest mm.

We monitored arrival times of all breeding birds using automated recording devices (ARD) to record vocalizations. We positioned 10 ARD throughout the study site and set them to record for 2 hours around sunrise and 2 hours around sunset, times when birds in this ecosystem vocalize most frequently. We deployed the ARDs on 28 April, a date that typically precedes the return of most breeding birds to this high-elevation site (ground is typically snow-covered through the first week of May). After field work concluded, we reviewed recordings to determine first arrival date and to characterize the distribution of arrival dates for Bicknell's Thrush. Similar analyses of other bird species are underway. We tracked the phenology of breeding using standardized classifications of gonad development taken from captured individuals of each species. For males, we classified cloacal protuberance development into 4 classes, and we measured maximum width of the protuberance to the nearest 0.01 mm. For females, we classified brood-patch development into one of 5 standard categories. Both of these traits vary seasonally as a function of reproductive state and thus serve as a useful measure of breeding phenology.

Results and Discussion

We accumulated 2,172 net-hours in 2016 (Table 1.1), with a mean of 108.6 ±60 SD net-hours per day (range = 30–174). We had 512 bird captures comprising 392 individuals of 30 species were captured and banded (Table S1), for a capture rate of 18 new birds/100 net-hours. We recaptured 45 individuals that had been banded in a previous year (Table S1).

As usual, Bicknell's Thrush had the highest rate of return captures (37%), similar as previous years. High site fidelity combined with intensive use of playback lures likely plays a role in Bicknell's Thrush recapture rates. We have captured 316 adult Bicknell's Thrushes since 1992 (Table S2), 113 of these individuals in multiple years (1 in seven years, 7 in six years, 6 in five years, 9 in four years, 30 in three years, 60 in two years, and 203 in just a single year). The oldest known thrushes were a male and female, both aged as after-second-year when captured, making them at least 10 years old when last recaptured (Table S2).

We reconfirmed the male-biased sex ratio of adult mist-netted Bicknell's Thrush that we have consistently documented over the 25 years of this study, with a 2.2:1 male:female ratio in 2016. Our complementary research on the species' Hispaniolan wintering grounds suggests that sexual habitat segregation may limit survivorship of females (Townsend et al. 2011), and we have focused on conserving female-dominated habitats on the wintering grounds. Of the 52 Bicknell's Thrush captured, 16 were after second-year (ASY) males, 9 were second-year (SY) males, 5 were ASY females, 6 were SY females, 1 was AHY bird of unknown sex, and 16 were HY individuals of unknown sex (Table S1).

We collected blood samples from 59 Bicknell's Thrush, 30 Swainson's Thrush, 1 Hermit Thrush, 1 American Robin, and 1 Sharp-shinned Hawk as part of our long-term monitoring of avian mercury burdens on Mount Mansfield. Anthropogenic input of mercury into the environment has elevated risk to fish and wildlife, particularly in northeastern North America. We previously documented MeHg availability in a terrestrial montane ecosystem by examining a suite of insectivorous passerines and other trophic levels (Rimmer et al. 2005, 2009). Our recent sampling (2014-2016) will enable us to investigate changes in blood mercury burdens in thrushes over an approximately 20-year period.

A video report featuring the phenology equipment, protocols and early results can be viewed at https://vtecostudies.org/blog/the-mount-mansfield-phenology-project. Phenocams showed the last full cover of snowpack was on 29 April, indicating the warm, early spring that was noted across the Northeast. However, the last measurable snowfall occurred on 4 May and lasted for 8 days. Heart-leaved Paper Birch (*Betula cordifolia*) leaves broke bud on 24 May, and leaf out was on 29 May. Mountain Wood Fern (*Dryopteris campyloptera*) burst from the ground on 30 May, and full leaf out was on 6 June in the understory.

The first Bicknell's Thrush vocalization captured by the ARDs occurred on 19 May, just after the last measurable snowfall (Fig 1.1). It is possible that some thrushes may have arrived earlier and remained silent, but this is our best estimate of first arrival date. Previously, the earliest records for spring returns to the breeding grounds by Bicknell's Thrush were 17 May 1995 on Belvidere Mountain in northeastern Vermont and 16 May on Stratton Mountain in southern Vermont. Analyses of Bicknell's Thrush geolocator data that are underway will yield estimates of arrival dates that are not reliant on vocalizations, but may be less precise than these. We are currently retrieving return dates for other bird species from the ARD recordings.

Breeding condition of female Bicknell's Thrushes was highly synchronous, with nearly all individuals with full brood patches by 20 June (Fig. 1.2). Male breeding condition also peaked in mid June, but many males were in breeding condition for longer periods of time (Fig. 1.2). The earliest confirmed nest building on Mt. Mansfield from our previous work was 1 June. Other extrapolated nest initiation dates ranged from 2-4 June from Wallace's (1939) studies on the ridgeline, with known fledging dates between 3 Jul–3 Aug (70% by 14 Jul) in Vermont (n = 53; Wallace 1939, Townsend et al. 2015). Estimated biomass of ground- and foliage-dwelling arthropods at randomly selected points sampled weekly on the Mt. Mansfield ridgeline in 2016 generally peaked during the average nestling and fledgling period for thrushes (Fig. 1.3), a period when songbirds are provisioning both their young and themselves.

Monitoring both long-distance migrants, such as Bicknell's Thrush, and short-distance migrants, such as White-throated Sparrow, will allow us to monitor and detect phenological mismatches in the future. The phenology mismatch hypothesis predicts that long-distance migrant birds that experience greater changes on their breeding verses winter grounds, may not arrive on migration to the breeding grounds at an earlier date and consequently may miss the peak emergence of arthropods for provisioning young. This could lead to declines in productivity and eventually affect population-level changes. Only detailed phenological monitoring such as this will enable the elucidation of ecological changes in these different, but related trophic levels, and the potential effects of a changing climate in causing them.

New Publications and Open Data During this Report Period

Peer-reviewed Publications:

- Townsend, J., K.P. McFarland, C.C. Rimmer, W.G. Ellison and J.E. Goetz. 2015. Bicknell's Thrush (*Catharus bicknelli*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America. doi:10.2173/bna.592
- DeLuca, W.V., B.K. Woodworth, C.C. Rimmer, P.P. Marra, P.D. Taylor, K.P. McFarland, S.A. MacKenzie, and D.R. Norris. 2015. Transoceanic migration by a 12 g songbird. Biology Letters 11:20141045. (Abstract)

Open Data:

- DeLuca W.V., Woodworth B.K., Rimmer C.C., Marra P.P., Taylor P.D., McFarland K.P., Mackenzie S.A., Norris D.R. 2016. Data from: Transoceanic migration by a 12 g songbird. Movebank Data Repository. doi:10.5441/001/1.jb182ng4
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- Vermont Center for Ecostudies, J. D. Lambert, and J. Hart. 2015. Mountain Birdwatch 1.0. KNB Data Repository. doi:10.5063/F1DN430G
- Vermont Center for Ecostudies. Mountain Birdwatch 2.0: 2010-2016. KNB Data Repository. doi:10.5063/F15M63MS

Work Planned in 2017

- QA/QC banding database and submit for archival at FEMC.
- Collect blood samples to examine temporal trends in mercury concentrations in Bicknell's Thrush and Swainson's Thrush from 2014 through 2017 on the Mt. Mansfield ridgeline.
- Complete banding sessions for the 26th consecutive year during the 2017 breeding season.

- Deploy ARDs to monitor spring arrival of migratory songbirds.
- Analyze survivorship of Bicknell's Thrush using mark-recapture data.

Acknowledgements

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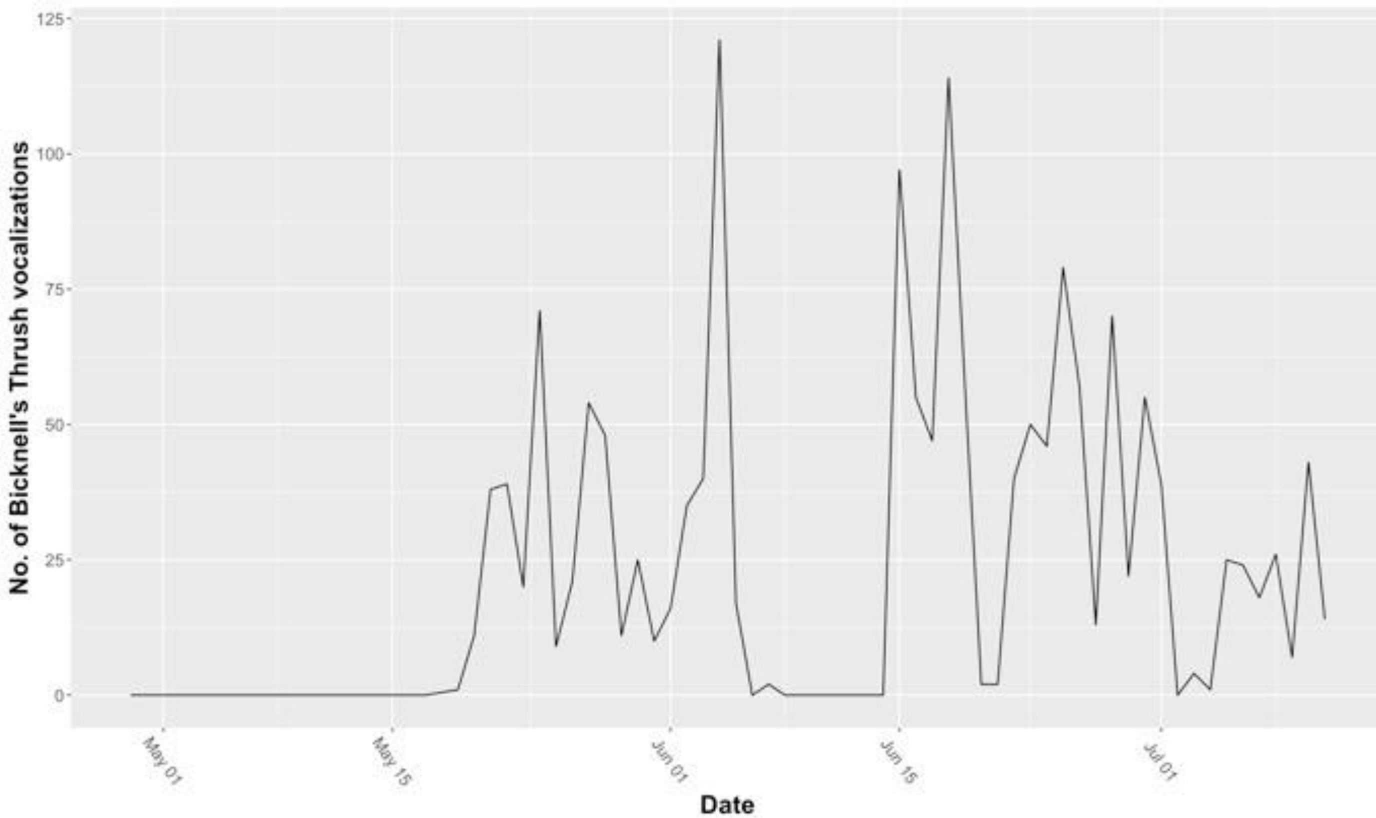
Table 1.1. Daily net hours (hours per 12 m net) in 2016.

Date	**Net Hours (hrs/12m net)**
5/19/16	30.0
5/20/16	103.0
5/31/16	51.5
6/1/16	127.5
6/14/16	92.3
6/15/16	189.0
6/22/16	63.9
6/23/16	173.3
6/29/16	55.0
6/30/16	175.0
7/6/16	72.0
7/7/16	201.5
7/13/16	68.5
7/14/16	173.8
7/20/16	60.0
7/21/16	180.0
7/27/16	75.5
7/28/16	182.0
9/13/16	35.0
9/14/16	63.0
Total	2171.6

Table 1.2. Numbers of birds banded on Mt. Mansfield in 2016, ranked by species abundance.

Species	No. Individuals Captured	Status
Blackpoll Warbler	70	Breeding
Myrtle Warbler	67	Breeding
White-throated Sparrow	56	Breeding
Bicknell's Thrush	52	Breeding
Dark-eyed Junco	41	Breeding
Swainson's Thrush	23	Breeding
American Robin	16	Breeding
Red-breasted Nuthatch	8	Breeding
Yellow-bellied Flycatcher	8	Breeding
Purple Finch	7	Breeding
Black-throated Blue Warbler	6	Transient
Pine Siskin	5	Breeding
Tennessee Warbler	4	Transient
Hermit Thrush	3	Transient
Magnolia Warbler	3	Breeding
Ovenbird	3	Transient
Black and White Warbler	2	Transient
Blackburnian Warbler	2	Transient
Hairy Woodpecker	2	Transient
Ruby-crowned Kinglet	2	Breeding
Sharp-shinned Hawk	2	Transient
Black-capped Chickadee	1	Transient
Downy Woodpecker	1	Transient
Indigo Bunting	1	Transient
Least Flycatcher	1	Transient
Lincoln Sparrow	1	Transient
Northern Saw-whet Owl	1	uncertain
Red-eyed Vireo	1	Transient
Song Sparrow	1	Transient
White-breasted Nuthatch	1	Transient
Winter Wren	1	Breeding

Figure 1.1. The daily number of Bicknell's Thrush vocalizations captured by 10 ARDs on the Mt. Mansfield ridgeline in 2016. The period of silence from June 4 to 14 was likely the result of inclement weather.



No. of Bicknell's Thrush vocalizations
125
100
75
50
25
0
May 01
May 15
Jun 01
Jun 15
Jul 01
Date

Figure 1.2. Phenology of reproductive condition of captured females (top) and males (bottom) on the Mt. Mansfield ridgeline in 2016.

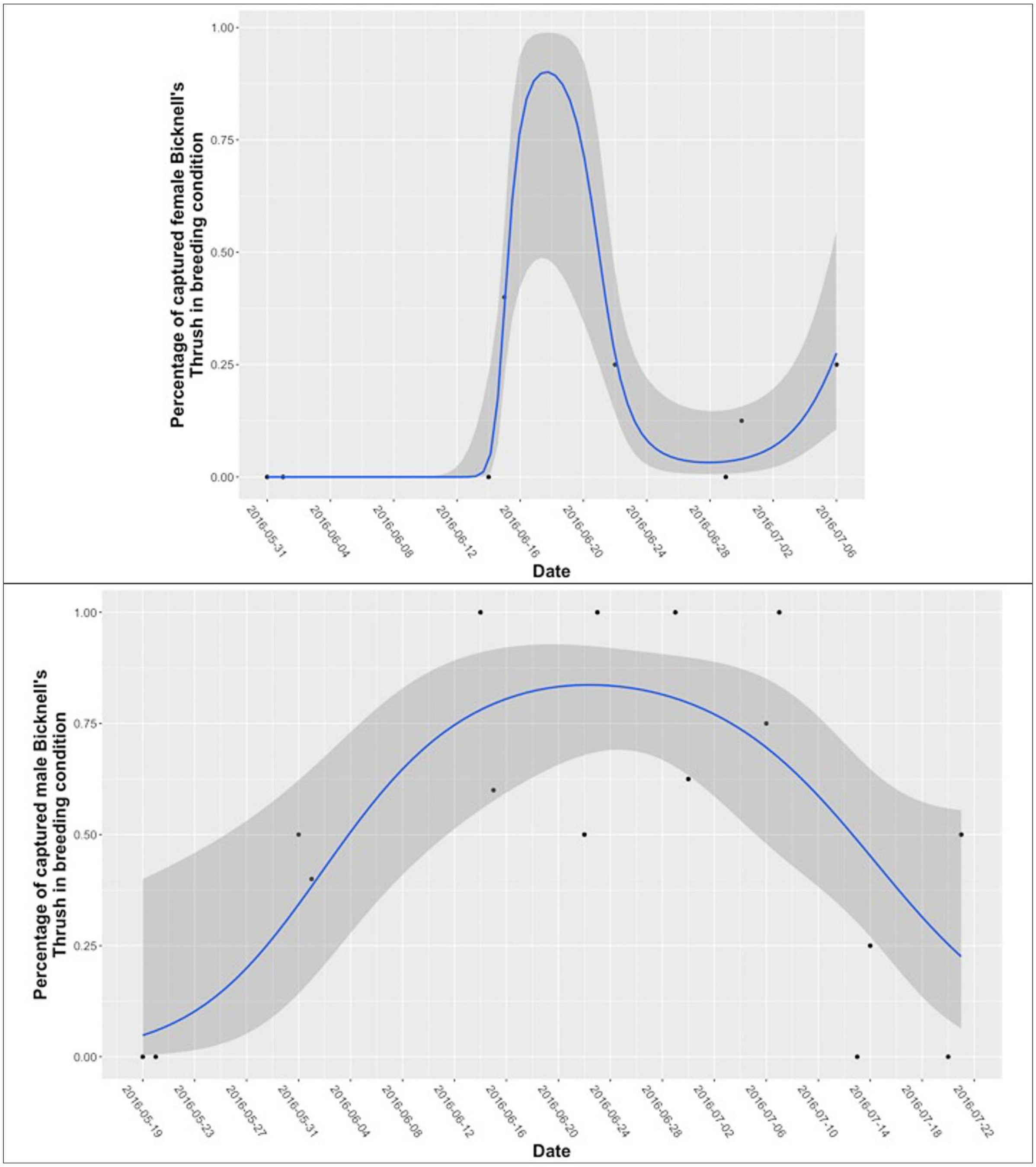
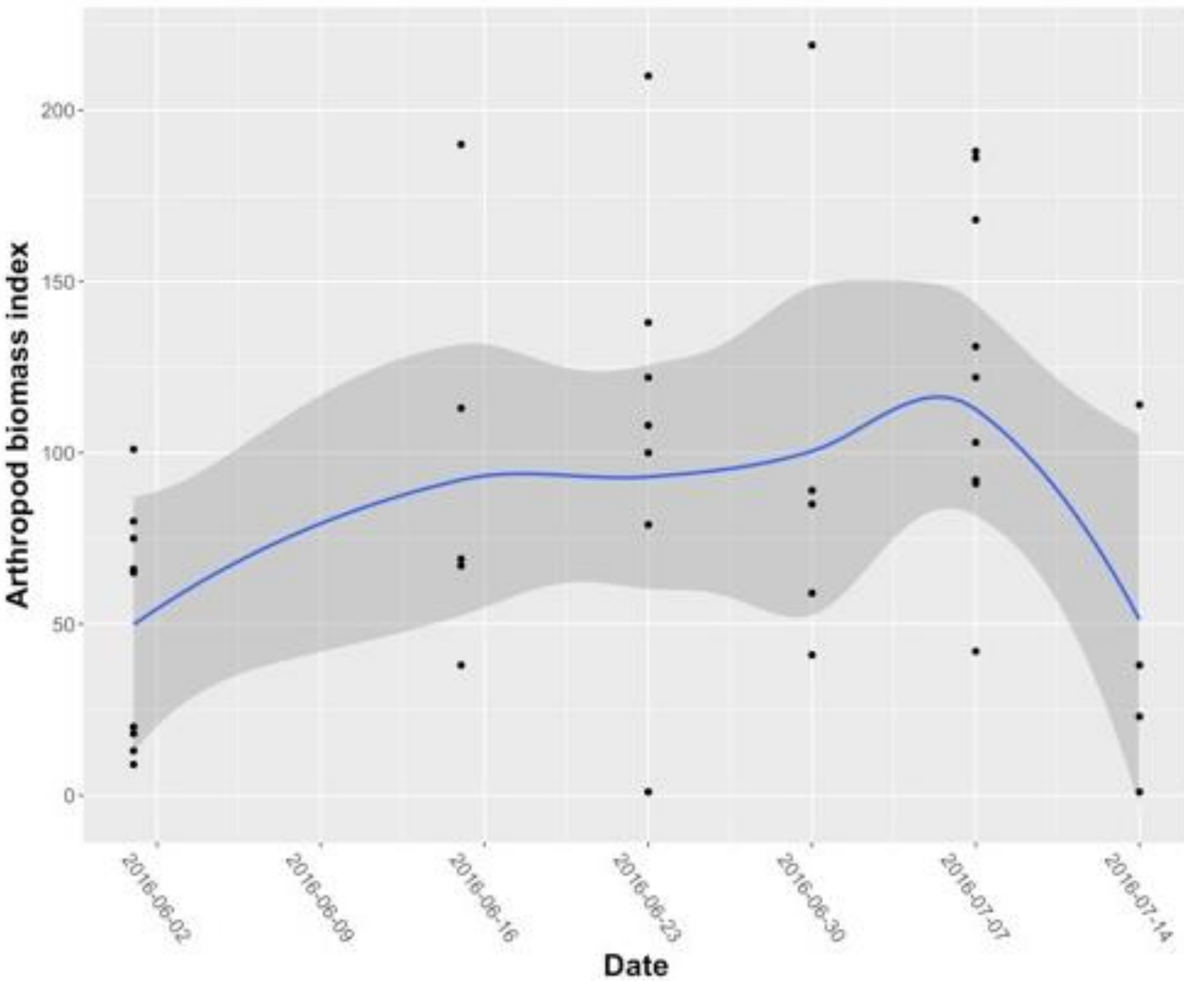


Figure 1.3. Estimated biomass of ground- and foliage-dwelling arthropods at randomly selected points sampled weekly on the Mt. Mansfield ridgeline.



Part II. Forest Bird Surveys on Mt. Mansfield and Lye Brook Wilderness Area

Introduction

Woodlands cover three out of every four acres in Vermont, making it the fourth most forested state in the U.S. Forests contribute tremendous value to Vermont's economy, providing raw materials, jobs, and recreational opportunities. In addition, forests deliver a variety of ecosystem services, including erosion control, flood protection, and mitigation of climate change through carbon sequestration. They also provide critical wildlife habitat, and among forest-dwelling wildlife there is no group more captivating than songbirds, whose vibrant colors and dynamic voices animate a largely green and quiet landscape. And while it's clear that forest birds need forests, there is a growing body of evidence to show that forests also need birds for the critical roles they play, ranging from pollination and pest control, to seed dispersal and nutrient cycling (Whelan et al. 2015). Monitoring bird populations is therefore key to gaining a broader understanding of forest ecology and health. This is especially crucial at a time when our woodlands are on the threshold of dramatic change due to myriad threats that range from fragmentation and parcelization (Fidel 2007), to an ever-growing array of invasive species and a warming climate. Regular monitoring is essential to assess trends in species presence, species richness, population trends and demographics. Such information is critical to the conservation of sensitive species.

Methods

Breeding bird surveys were conducted at permanent study sites located on the west slope of Mt. Mansfield in Underhill State Park (UNSP) and at the Lye Brook Wilderness Area (LBWA). These two study sites are part of VCE's long-term Forest Bird Monitoring Program (FBMP), which was initiated in 1989 with the primary goals of conducting habitat-specific monitoring of forest interior breeding bird populations in Vermont and tracking long-term changes (Faccio et al. 1998, Faccio et al. 2017).

Each study site contains five point count stations. Survey methods include unlimited distance point counts, based on the approach described by Blondel et al. (1981) and used in Ontario (Welsh 1995). Counts begin shortly after dawn on days where weather conditions are unlikely to reduce count numbers. Observers record all birds seen and heard during a 10-min sampling period, divided into 2-, 3-, and 5-min intervals. Surveys during 2016 represented the 25th year of data collection at UNSP and the 15th at LBWA, exclusive of years when no surveys were conducted (2003, 2005, and 2012 at UNSP, and 2012 and 2015 at LBWA).

Results

Surveys at the mid-elevation, northern hardwood study sites at Underhill State Park and Lye Brook Wilderness showed similar species composition, with a total of 50 and 48 species, respectively. The number of individual birds detected at UNSP in 2016 increased to above the 25-year average, and while species richness also increased, it remained slightly below average. At Lye Brook, both species richness and the number of individual birds detected increased to the second highest recorded in the count's 15-year history. Despite these increases, the long-term trends for both number of individuals and species richness have declined slightly at both sites (Fig. 2.1).

Long-term Trends

Underhill State Park – Total number of individuals and species richness increased from 2015, with 57 individuals of 20 species recorded, including a Ruby-crowned Kinglet and Yellow-bellied Flycatcher, both new for the survey. Among the nine most common species, only four were above the 25-year mean, and five were below. Overall, counts of Ovenbird and Black-throated Green Warbler increased, while the long-term trend for Hermit Thrush, the Vermont State bird, remained relatively flat (Fig. 2.2). These results echo the broader, 25-year trends observed for these three species in the statewide Vermont FBMP dataset, in which both Black-throated Green Warbler and Ovenbird significantly increased, while Hermit Thrush showed no trend (Faccio et al. 2017). A single Canada Warbler was detected in 2016, the first since 2013; this species is declining at a rate of 4.36% annually (r^2=0.668), representing the sharpest decline among the nine most commonly detected species.

Lye Brook Wilderness Area – Both relative abundance (n=74) and species richness (n=19) increased to the second highest in the survey's history, and were both well above the 15-year means of 62.4 and 16.1, respectively. Among the eight most common species, all but Pileated Woodpecker were above the 15-year average; however, only Red-eyed Vireo, Yellow-bellied Sapsucker, and Black-throated Green Warbler exhibited increasing population trends. While numbers of Black-throated Blue Warbler increased for the second straight year from a record low of just three individuals in 2013, the species' long-term trend showed a moderate decline of -2.25% per year (r^2 = 0.227) (Fig. 2.3). Counts of Red-eyed Vireo showed a strong upward trend (Fig. 2.3), increasing by 8.76% annually (r^2 = 0.358), mirroring the significant statewide trend exhibited by VCE's 25-year study (Faccio et al. 2017).

Discussion

Long-term trends of forest birds at both UNSP and LBWA suggest that the relative abundance of the total number of birds detected has declined slightly over the survey period. However, it should be noted that site-specific trend estimates must be interpreted with caution, as these data are from a limited geographic sample and can be greatly influenced by years with extreme high or low counts. Also, year-to-year changes in survey counts may simply reflect natural fluctuations in abundance, differences in detection rates of observers and/or species, variability of singing rates due to nesting stage, and/or a variety of dynamic factors, such as predator or prey abundance, overwinter survival, effects of diseases such as West Nile Virus, and local habitat change.

Not surprisingly, most of the strongest population trends observed at both study sites—including the increasing trends of Black-throated Green Warbler at UNSP and Red-eyed Vireo at LBWA, and the declining trend of Canada Warbler at UNSP—reflect the broader state-wide trends for these species during the 25-year study of the Vermont Forest Bird Monitoring Program (Faccio et al. 2017).

It is unknown which of the many anthropogenic stressors (e.g., habitat degradation and loss due to development, land use change, acid precipitation and other atmospheric pollutants, or changing climatic conditions) may be contributing to these population trends, but it is likely all have had impacts. In addition, migratory species, whether short-distance or long-distance Neotropical migrants, have declined across Vermont forests, while year-round residents showed no trend (Faccio et al. 2017). This suggests that migratory species face additional limiting factors, both on their wintering grounds and during migratory stopover that could be impacting populations. Continued data collection and comparison with survey data from other ecologically similar sites will be necessary to fully elucidate population trends of various species at these sites.

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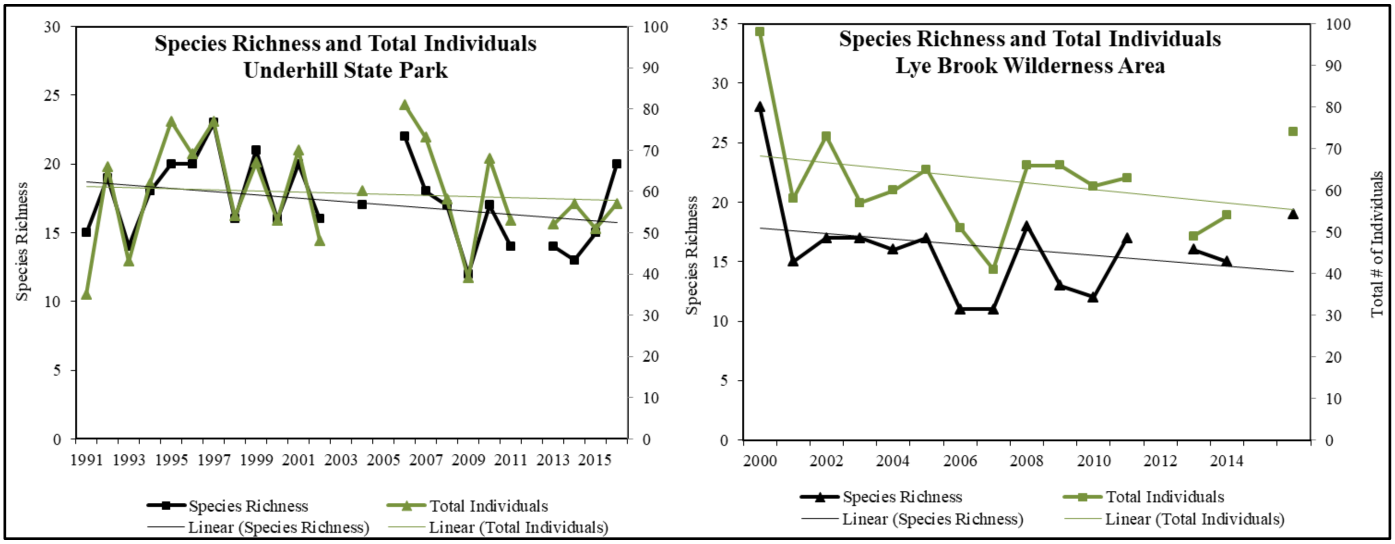

Figure 2.1. Annual totals and trends for species richness and total number of individuals detected at Underhill State Park, 1991-2016, and Lye Brook Wilderness Area, 2000-2016.

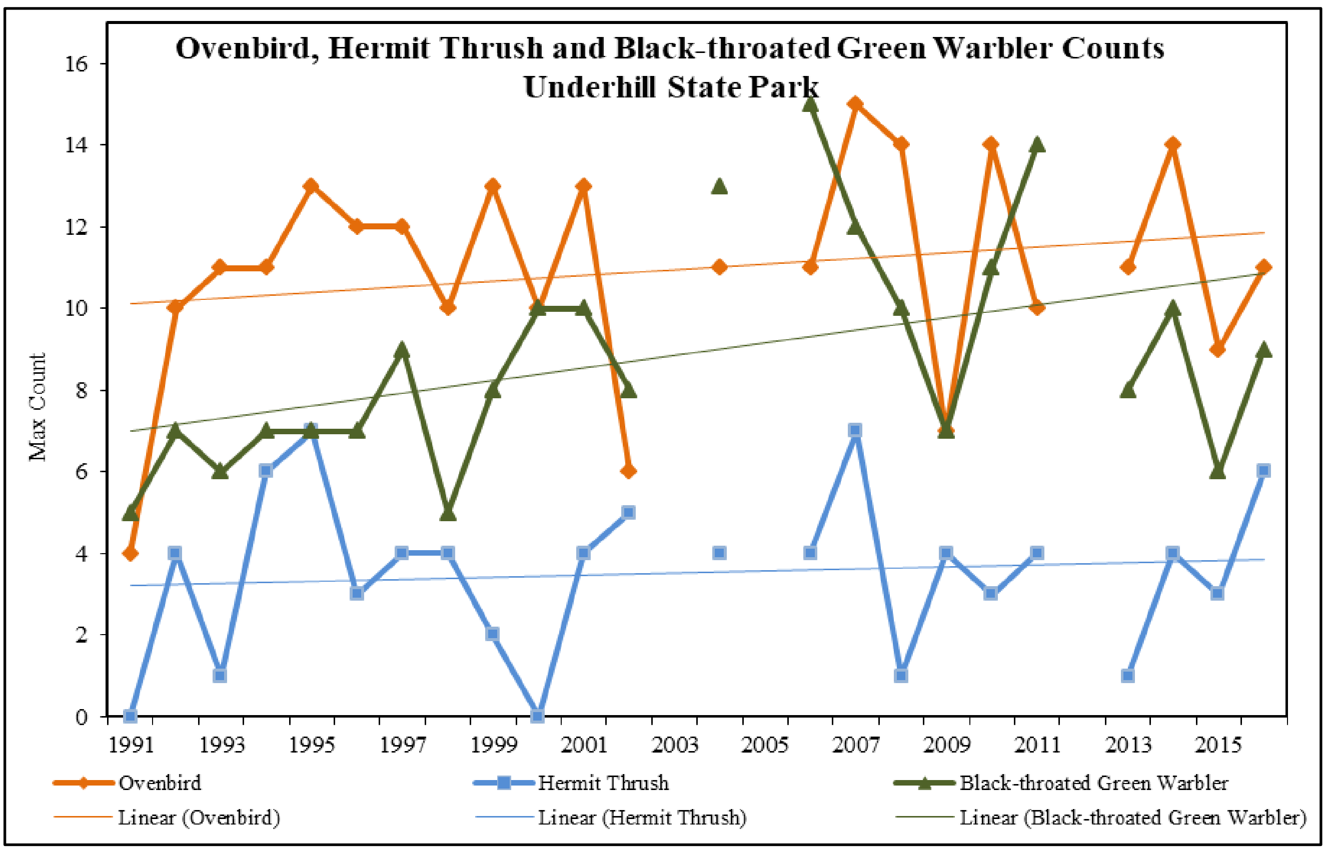

Figure 2.2. Twenty-five year data and trends for Ovenbird, Hermit Thrush, and Black-throated Green Warbler from annual surveys conducted at Underhill State Park, 1991-2016.

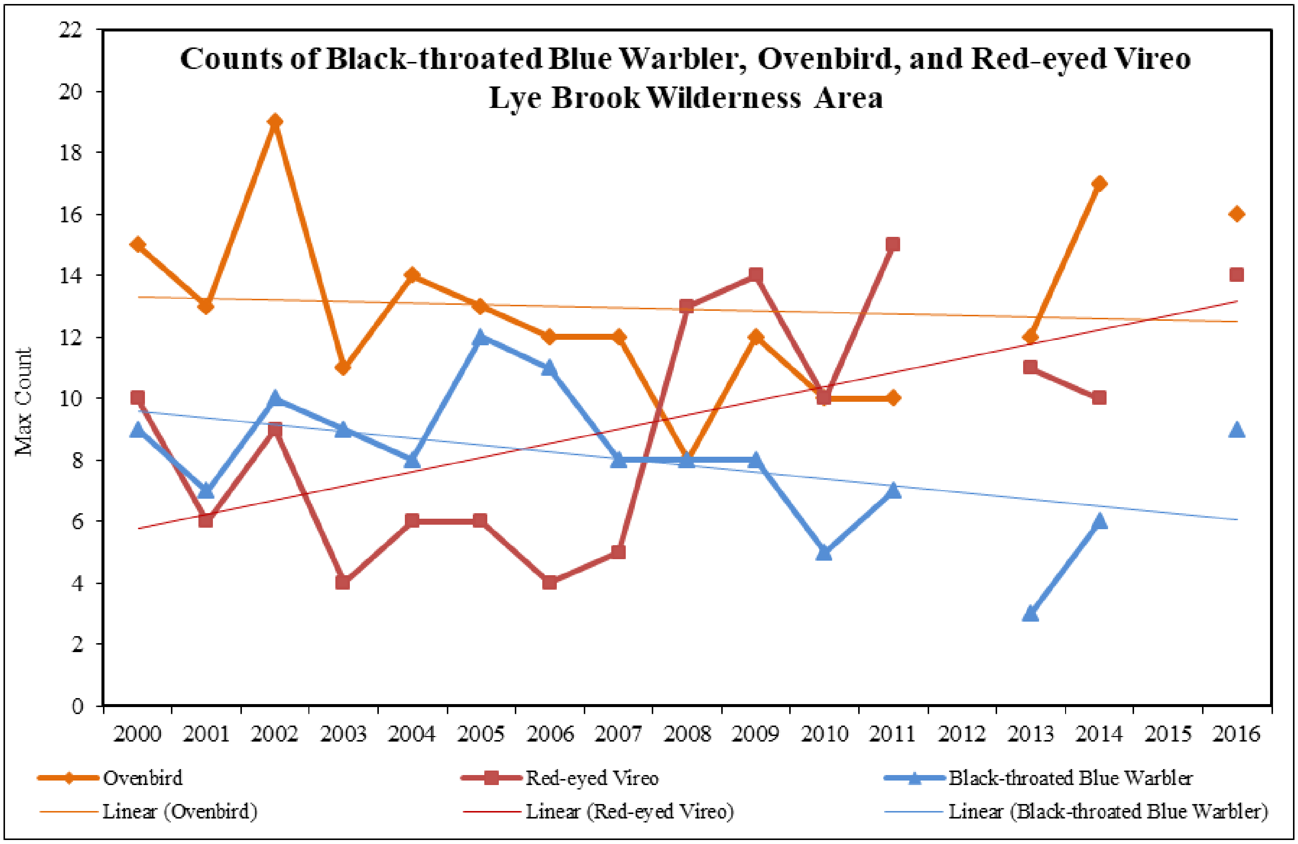

Figure 2.3. Twenty-five year data and trends for Black-throated Blue Warbler, Ovenbird, and Red-eyed Vireo from annual surveys conducted at Lye Brook Wilderness Area, 2000-2016.