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Investigating the distribution, population status, and habitat requirements of the Wayne's Black-throated Green Warbler in the northern south Atlantic Coastal Plain

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INVESTIGATING THE DISTRIBUTION, POPULATION STATUS, AND HABITAT REQUIREMENTS OF THE WAYNE'S BLACK-THROATED GREEN WARBLER IN THE NORTHERN SOUTH ATLANTIC COASTAL PLAIN

Center for Conservation Biology

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EXECUTIVE SUMMARY

The Wayne's Warbler (*Dendroica virens waynei*) is a unique, disjunct subspecies of the Black-throated Green Warbler that is restricted to the South Atlantic Coastal Plain from southeastern Virginia to South Carolina. The nominate form (*D. v. virens*) breeds in coniferous forests across the northern latitudes of North America and through the higher elevations of the Appalachians. The Wayne's population is 500 km east of the nearest Appalachian population and 1,200 m lower in elevation. The Wayne's form is smaller than the nominate race and has a distinctly smaller bill. The factors that lead to the isolation of the Wayne's form from the nominate race are not known. It is possible that this subspecies was originally associated with the extensive stands of Atlantic white cedar (*Chamaecyparis thyoides*) within the region. For all practical purposes, these forests were harvested prior to the description of the Wayne's form to science. No recent attempts have been made to assess the status, distribution and habitat associations of this subspecies. The two primary objectives of this field project were 1) to assess the general status and distribution of the Wayne's Warbler within the northern portion of the South Atlantic Coastal Plain (particularly focused on FWS refuge lands) and 2) to determine if there are habitat elements that may help to explain distribution patterns.

A network of 265 fixed-radius point counts was used to examine seasonal occurrence, spatial distribution, and patterns of habitat use by Black-throated Green Warblers. Survey plots were chosen to represent the full gradient of forest types within Great Dismal Swamp, NWR, Pocosin Lakes, NWR, and Alligator River, NWR. Plots were surveyed 7 times between early April and mid June, 2001. Detection patterns were used to develop a protocol for classifying plots as to occupation by breeding birds. Approximately one half of all plots were selected for vegetation measurements. Plots used for sub-sampling vegetation spanned the forest gradient and were evenly split between plots classified as breeding sites and plots classified as unoccupied.

The Wayne's Warbler is one of the earliest arriving and breeding neotropical migrants within the region. Detections of Black-throated Green Warblers began in early April, increased to a peak in late April and then declined throughout May and early June. Birds were detected during 251 (13.5%) of 1,862 point counts conducted. Detections were widespread and included 114 of 266 (52.6%) survey plots. During late April, birds were detected within 23% of all survey plots on Alligator River, NWR. Plots classified as breeding sites were highly clustered within Alligator River, NWR and were not identified within either the Great Dismal Swamp or Pocosin Lakes, NWR. Alligator River, NWR may support one of the highest breeding densities of this sub-species throughout its restricted breeding range.

Forest composition had a significant influence on the distribution of breeding sites. The frequency of plots classified as breeding sites was higher than expected for plots containing loblolly pine (*Pinus taeda*), Atlantic white cedar, and bald cypress (*Taxodium distichum*). The density of these tree species within survey plots was significantly higher for plots classified as breeding sites compared to plots classified as unoccupied. This response was particularly significant when all three tree species were combined.

BACKGROUND

Context

The Wayne's Warbler (*Dendroica virens waynei*) is a unique, disjunct subspecies of the Black-throated Green Warbler (Bangs 1918, A.O.U. 1957). The nominate race (*D. v. virens*) breeds in coniferous forests across the northern latitudes of North America and through the higher elevations of the Appalachians (Morse 1993). The Wayne's form is smaller than the nominate race and has a distinctly smaller bill. Wayne's has a much smaller breeding range and is restricted to the South Atlantic Coastal Plain from southeastern Virginia to South Carolina. Along much of this range, the population is confined to a fairly narrow band within the outer coastal plain (Sprunt 1953). This population is 500 km east of the Appalachian population and 1,200 m lower in elevation.

The factors that lead to the isolation of the Wayne's form from the nominate race are not known. It is possible that this subspecies was originally associated with the extensive stands of Atlantic white cedar (*Chamaecyparis thyoides*) that were once an important component of the region's plant community. These stands were similar in form to the coniferous forests where *D. v. virens* currently breeds. Wayne's appears to reach its highest density from southeastern Virginia through northeastern North Carolina. This was the former location of the most extensive tracts of white cedar (Ashe 1894). More than 100,000 acres of this habitat were harvested in the area in the late 1800's and early 1900's for the shingle industry. This event virtually eliminated this unique plant community from the region. The vegetation that has reclaimed many of the historic sites after harvest is dominated by hardwoods rather than white cedar (Frost 1987).

Most of the extensive stands of Atlantic white cedar were harvested prior to the description of the Wayne's form to science. How much the current pattern of habitat use (and our perceptions of habitat requirements) is influenced by the absence of white cedar is unknown. In the latter half of the twentieth century, the Wayne's subspecies has been suggested to utilize the entire gradient of forest types from Atlantic white cedar to bald cypress to mixed deciduous forest (Sprunt 1953, Meanley 1977, Potter Unpublished report). The population has also been suggested to have a close association with non-alluvial cypress swamps.

No recent attempts have been made to determine the status and distribution of Wayne's Warblers within the core of their breeding range (i.e. southeastern Virginia, coastal North Carolina). Once suggested to be a fairly common breeding species within the Dismal Swamp (Meanley 1977), researchers now suggest that over the past 10-15 years they have disappeared from the northern portion and have declined substantially in the southern portion (Meanley and Schwab, pers. comm.). No attempts have been made to clarify the influence of forest composition on distribution.

Objectives

As deliberations continue about the benefits and risks associated with restoring Atlantic white cedar and the appropriate techniques needed to manage coastal forests, information is needed on the status and requirements of this unique subspecies. The two primary objectives of this field project were 1) to assess the general status and distribution of the Wayne’s Warbler within the northern portion of the South Atlantic Coastal Plain (particularly focused on FWS refuge lands) and 2) to determine if there are habitat elements that may help to explain distribution patterns.

METHODS

Study Area

This study was conducted within the Alligator River, NWR, Pocosin Lakes, NWR, and Dismal Swamp, NWR (Figures 1, 2, and 3). These properties are located within the coastal plain of southeastern Virginia and northeastern North Carolina. Alligator River and Pocosin Lakes, NWRs are located on the peninsula of land bounded to the north by the Albemarle Sound and to the south by the Pamlico River. The Great Dismal Swamp is located east of the Suffolk scarp and west of U.S. Route 17. The Great Dismal Swamp is located within the city of Suffolk in Virginia and within Gates, Camden, and Pasquotank counties North Carolina. Pocosin Lakes, NWR is located within Washington, Tyrell, and Hyde counties North Carolina. Alligator River, NWR is located within Dare county North Carolina.

Site Selection

A network of 265 survey plots was established throughout the broad study area. The network included 154 plots on or within the vicinity of Alligator River, NWR, 83 plots on or within the vicinity of Great Dismal Swamp, NWR, and 29 plots on Pocosin Lakes, NWR. Survey plots were clustered in “mini-routes” (groups of 20-30 points) to maximize survey efficiency. An assessment of potential field sites was conducted during March of 2001. Information was collected through a combination of road surveys, aerial photographs, and meetings with refuge personnel. During this phase, an attempt was made to 1) determine the distribution of forest types targeted within the study, and 2) evaluate survey efficiency of various field options (i.e. assess roadway condition and access and evaluate site clustering). Sites were chosen in late March that were accessible and could support a cluster of 20-30 point count locations.

Final selection of study plots within larger areas was based on forest type. Target forest types represented the full forest gradient within refuge lands. Categories included 1) PPP – pond pine (*Pinus serotina*) pocosin, 2) HDWD - hardwood dominated, 3) MIX – pine/hardwood mix, 4) PIN - pine dominated, 5) CED - white cedar component, and 6) CYP - bald cypress (*Taxodium distichum*) component. Tall pocosins with pond pine form

over relatively shallow peat deposits and are characterized by high above-ground plant biomass. Characteristic plant species include sweet gum (*Liquidambar styraciflua*), red maple (*Acer rubrum*), gallberry (*Ilex glabra*), fetter bush (*Leucothoe racemosa*), and wax myrtle (*Myrica cerifera*). Hardwood-dominated plots were those where an estimated 75% or more of the canopy-forming stems were hardwood. Most abundant trees included red maple and sweet gum. Mixed pine/hardwood plots had relatively even numbers of loblolly pine and hardwood stems. Pine-dominated plots were those where an estimated 75% or more of the canopy-forming stems were loblolly pine. White cedar plots were those that contained at least a minor component of white cedar trees. Bald cypress plots were those containing at least a minor component of bald cypress. It was not possible to locate an adequate sample of plots that were dominated by either white cedar or bald cypress. Initial selection of forest types for plot placement was done by visual inspection of forest composition. The number of spatial replicates for each forest type is given in Table 1. Due to the unique character of the three refuge properties, balance of forest types by geographic area was not possible (Table 1). Survey plots were established in late March and early April. Plots were positioned along roadways and separated by at least 0.5 km.

Bird Surveys

A fixed-radius point count technique was used to measure bird density and frequency of occurrence. A survey plot (point count) consisted of a 50-m radius circle with a wire flag located at its center. All surveys were conducted along roadways with the plot centers positioned at the road edge. The plot was split in half along the road axis. Birds detected within the 50-m radius plots were recorded as within the focal half or within the remainder. Birds detected within the focal half were used in habitat comparisons.

Bird surveys were conducted by a single observer standing at the plot center and counting all birds seen or heard within a 5-min period. Birds detected were stratified according to time period and location. The count period was subdivided into an initial 3-min period and a subsequent 2-min period. Birds were recorded as either within or beyond the 50-m radius. Surveys of plots were conducted in 11-d time blocks where all points within the network were surveyed within each block. Seven survey rounds were completed between 8 April and 12 June 2001. Plots covered by individual observers were rotated between time blocks to disperse any observer bias. The order of surveys within “mini-routes” was alternated between time blocks to reduce the impact of time-of-day effects. Surveys were conducted between 0.5 and 4.5 hrs after sunrise on days with no precipitation and wind speeds of less than 24 kph (15 mph).

Vegetation Sampling

Vegetation structure/composition was measured within a sub-sample of “occupied” and “unoccupied” (with respect to breeding Black-throated Green Warblers see below) survey plots. Selection of survey plots for sampling was based on occupation, habitat type, and geographic area. An attempt was made to balance samples between habitats and

Table 1. Distribution of survey plots by habitat type and geographic area.

Habitat Type	Pocosin Lakes	Alligator River	Great Dismal	Total
Pond Pine Pocosin	27	5	0	**32**
Hardwood Dominated	2	18	31	**51**
Pine/Hardwood Mix	0	49	12	**61**
Pine Dominated	0	31	9	**40**
Cedar Component	0	28	21	**49**
Cypress Component	0	23	10	**33**
Total	**29**	**154**	**83**	**266**

refuges (Table 2). All habitats were included in the selection except pond pine pocosin. No birds were detected within this habitat type during the course of the study. Since this habitat type was concentrated within Pocosin Lakes, NWR, no samples were taken from this property. Vegetation was measured between 27 June and 26 July 2001.

Table 2. Distribution of vegetation samples by habitat type and geographic area.

Habitat Type	Pocosin Lakes	Alligator River	Great Dismal	Total
Pond Pine Pocosin	0	0	0	**0**
Hardwood Dominated	0	15	11	**26**
Pine/Hardwood Mix	0	24	4	**28**
Pine Dominated	0	19	8	**27**
Cedar Component	0	20	12	**32**
Cypress Component	0	18	5	**23**
Total	**0**	**96**	**40**	**136**

Vegetation was sub-sampled within two plots established within each 50-m radius survey plot. Each of these subplots was stratified to include a 5 m-radius plot embedded within a larger 11.4 m-radius plot. Vegetation samples were taken from the focal half of the survey plot. The center of each vegetation plot was positioned 30 m from the center of the point count in two different directions (each > 90° apart). The initial direction for the first vegetation plot was chosen randomly from the center of the point count.

Vegetation data was collected on two different levels within circular plots. Counts of all large woody plants (>8 cm dbh) and dead standing stems (snags) by species and stem diameter class (diameter classes included 8-22, 23-38, and >38 cm dbh), and estimates of canopy cover and canopy height were collected over the entire 11.4-m radius plot. Canopy cover was measured as a percent cover using a convex densiometer and canopy height was measured using a clinometer. Data on understory vegetation was collected within the 5-m radius plot. Counts of understory vegetation were stratified to include stems, shrubs, and saplings > 0.5 m in height and < 8 cm dbh.

Data Analysis

Breeding sites - Identification of breeding sites for Wayne's Warblers using point count data alone was complicated by several opposing factors. The first of these is the potential for overlap between the two subspecies (*D. v. virens* and *D. v. waynei*) within the study area. The Wayne's subspecies is one of the earliest arriving neotropical migrants within the region. Within the study areas, individuals begin to arrive on breeding territories in late March to early April (Meanley 1977, Potter unpublished report). At this time, most *D. v. virens* individuals are believed to be still on winter territories (Sprunt 1953, Morse 1993). *D. v. virens* does not migrate through comparable latitudes until mid-April. There remains confusion as to whether or not and the extent to which *D. v. virens* migrates through the breeding range of *D. v. waynei*. Some authors suggest that *D. v. virens* winters primarily within Central America between Mexico and Panama and that most individuals migrate north via a land route through Mexico and Texas and continue on an inland track to the Appalachians and northern breeding areas (Stevenson 1957, Oberholser 1974, Morse 1993). This route suggests that the probability of contact between these two subspecies in the spring would be low. If true, virtually all of the individuals encountered within the study areas would be *D. v. waynei*. This view is supported by Sprunt (1953) who indicates that records of *D. v. virens* are completely absent from the south Atlantic Coast and suggests that *D. v. waynei* likely winters in a distinct location that is in closer proximity to the breeding grounds. It has been suggested that *D. v. waynei* winters in western Cuba (A.O.U. 1957). However, other authors (Potter unpublished report) that have worked within the study area suggest that *D. v. virens* does move through the area although there is no suggestion as to the winter origin or breeding destination of such individuals. The primary differences between *D. v. virens* and *D. v. waynei* are bill and body size. There are no song or appearance differences that would allow for separation in the field. At present, there is no way to determine the subspecies designation of birds detected within the area between mid-April and early May. Birds detected from late March through mid-April may clearly be assigned to *D. v. waynei* due to subspecific differences in the timing of migration. Birds detected after the first week of May may also be assigned to *D. v. waynei* because *D. v. virens* is on the breeding grounds.

A second complicating factor is the early breeding season of *D. v. waynei* and the rapid diminution of singing. The Wayne's subspecies is one of the earliest nesting neotropical migrants within the region. Nests with eggs have been documented within the Great Dismal Swamp as early as 4 April (Meanley 1977). Potter (unpublished report) observed a marked decline in singing apparently related to the hatching of eggs. Singing is not common after mid-May. This pattern suggests that there is a considerable reduction in detection probability through the month of May. The implication is that although birds detected in May could be definitively assigned to *D. v. waynei*, the probability of detecting breeding birds is much reduced.

In light of the factors outlined above, an attempt was made to develop rules for assigning occupancy status to survey plots based on point counts. An analysis of detection patterns was conducted to facilitate this process. Three occupancy classes were delineated including 1) breeding location (occupied), 2) potential breeding location, and 3) no breeding location (unoccupied). Sites were considered to be breeding locations if birds were detected after mid-May or where birds were detected during 3 out of the 7 survey rounds. Analysis of detection patterns illustrated that these conditions were related. Virtually all points having at least 3 separate detections also had detections after mid-May. This level of consistency supports the contention that these represent breeding locations. Potential breeding locations were plots where birds were detected fewer than 3 times with all detections prior to mid-May. Plots that were classified as unoccupied were those where birds were never detected during any of the 7 rounds.

Vegetation parameters - Several parameters describing vegetational structure were derived from vegetation sub-samples. These included mean canopy height (CANH), % canopy cover (CANC), canopy tree density (CAND), sub-canopy tree density (SUBD), sapling density (SAPD), and understory density (UND) (see Table 3 for parameter descriptions). Floristic information was generally not included in the analysis with the exception of canopy composition. Parameters were derived separately for the density of hardwood, pine, white cedar, and bald cypress stems that were > 22 dbh. Only plots where vegetation was sub-sampled and that were classified as breeding sites or unoccupied sites were included as samples. Sites that were sub-sampled but later classified as “potential breeding sites” were excluded from the sample. The exclusion of these sites reduced the overall sample size available for analysis (see Table 4 for final sample sizes).

Analysis – Due to the relatively small plot size, variation in breeding density recorded was very low. Incidences where more than one individual was detected within a single plot were rare. For this reason, temporal and geographic patterns were assessed using frequency of occurrence where survey plots were the statistical units. Frequency statistics were used to assess geographic patterns where the expected distribution was based on the number of survey plots within each area. Associations with vegetation characteristics were assessed by comparing mean values using occupancy as the grouping parameter. Potential breeding sites were omitted from this analysis. A Kilmogorov-Smirnov test was used to compare distributions relative to normality for each vegetation parameter. All non-normal parameters were transformed using three standard functions (including 1) log(X = 1), $(X)^{1/2}$, and arcsine (X)) and retested. Significance between occupied and unoccupied survey plots was evaluated using an F-test for all parametric variables and Mann-Whitney U test for all nonparametric variables.

Table 3. Description of structural vegetation parameters measured within survey plots within Alligator River, NWR and Great Dismal Swamp, NWR (June-July 2001).

Parameter	Description
Understory Density (UND)	Density (N/ha) of woody stems and shrubs >0.5 m in height and < 8 cm dbh. Estimate from 2 5-m radius plots.
Sapling Density (SAPD)	Density (N/ha) of tree stems >0.5 m in height and < 8 cm dbh. Estimate from 2 5-m radius plots.
Sub-canopy Density (SUBD)	Density (N/ha) of tree stems between 8 and 22 cm dbh. Estimate from 2 11.4-m radius plots.
Canopy Density (CAND)	Density (N/ha) of tree stems > 22 cm dbh. Estimate from 2 11.4-m radius plots.
Canopy Height (CANH)	Average height (m) of canopy-forming stems. Estimate from 4 samples measured with clinometer within survey plot.
Canopy Cover (CANC)	Average canopy cover (%) measured at 4 cardinal directions with convex densiometer. Estimates taken within 2 11.4-m plots.
Hardwood Density (HDWD)	Density (N/ha) of hardwooe stems > 22 cm dbh. Estimate from 2 11.4-m radius plots.
Pine Density (PIND)	Density (N/ha) of pine stems > 22 cm dbh. Estimate from 2 11.4-m radius plots.
White Cedar Density (CEDD)	Density (N/ha) of white cedar stems > 22 cm dbh. Estimate from 2 11.4-m radius plots.
Bald Cypress Density (CYPD)	Density (N/ha) of bald cypress stems > 22 cm dbh. Estimate from 2 11.4-m radius plots.
Conifer Density (COND)	Density (N/ha) of conifer stems > 22 cm dbh. Estimate from 2 11.4-m radius plots.

RESULTS

Bird Patterns

Throughout the study period, a total of 335 encounters were recorded with Black-throated Green Warblers during point counts. Birds were detected during 251 (13.5%) of 1,862 point counts conducted. Detections were widespread and included 114 of 266 (52.6%) survey plots.

Temporal – Detections of Black-throated Green Warblers were not evenly distributed among survey rounds (Figure 4). A substantial number of detections were made in the first survey round indicating that earliest arrivals were prior to the beginning or during the first round. Work within the area leading up to the first surveys and discussions with the local bird-watching community suggests that birds began to arrive approximately 2 days prior to the initiation of the first round. Detections increased during the month of April reaching a peak in late April to early May. At this time, birds were detected within 23% of all survey plots on Alligator River, NWR. It remains unclear if this peak represents the continued arrival or increased activity of *D. v. waynei* or the passage of *D. v. virens*. Detections steadily declined throughout the month of May. This decline may represent a diminution of singing on the part of breeding residents, the passage of *D. v. virens* moving toward breeding locations to the north or both.

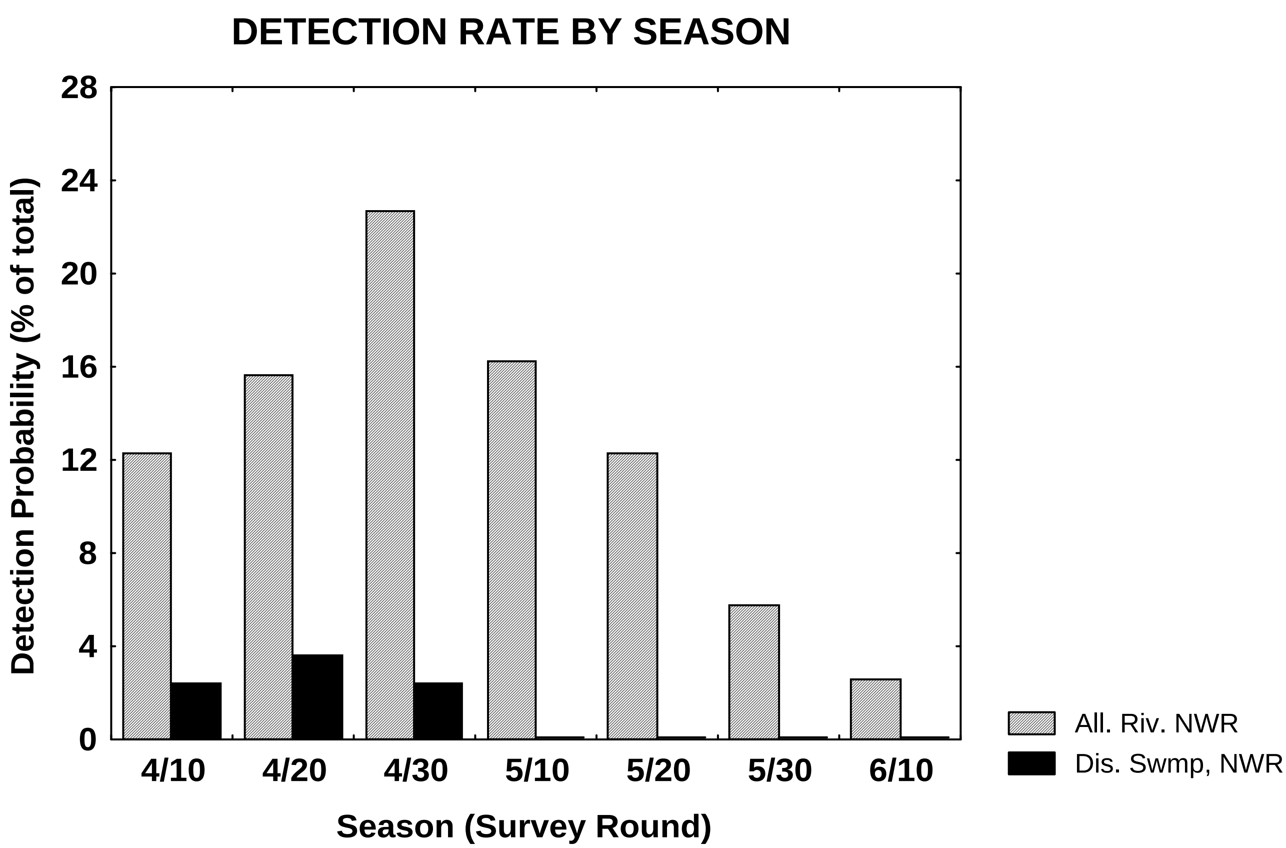

Figure 4. *Temporal pattern in detection probabilities for Black-throated Green Warblers within Alligator River, NWR and Great Dismal Swamp, NWR. No birds were detected within Pocosin Lakes, NWR.*

<u>Geographic</u> - Detections of Black-throated Green Warblers were not distributed among refuge lands as expected based on the number of survey plots established (Figure 5). Plots that were classified as both breeding sites and potential breeding sites were located within the Alligator River, NWR more often than either of the other two refuge properties (Table 5) ($\times^2 = 47.6$, df = 2, $p < 0.001$). No birds were detected during any round within Pocosin Lakes, NWR (Figure 6). Birds detected within Great Dismal Swamp, NWR were observed during the first three survey rounds only. These detections were widely distributed but inconsistent such that none of the survey plots were classified as breeding sites (Figure 7). All of the survey plots classified as breeding sites were located on or near Alligator River, NWR. More than 95% of all Black-throated Green detections were associated with this property. Within Alligator River, NWR plots classified as breeding sites or potential breeding sites were highly clustered (Figure 8) likely reflecting the distribution of habitat types.

Table 5. Summary of survey plots according to occupancy class and geographic area.

Geographic Area	Breeding Site	Potential Breeding Site	Unoccupied	Total
Pocosin Lakes, NWR	0	0	29	**29**
Alligator River, NWR	62	40	52	**154**
Great Dismal Swamp, NWR	0	12	71	**83**
Total	**62**	**52**	**152**	**266**

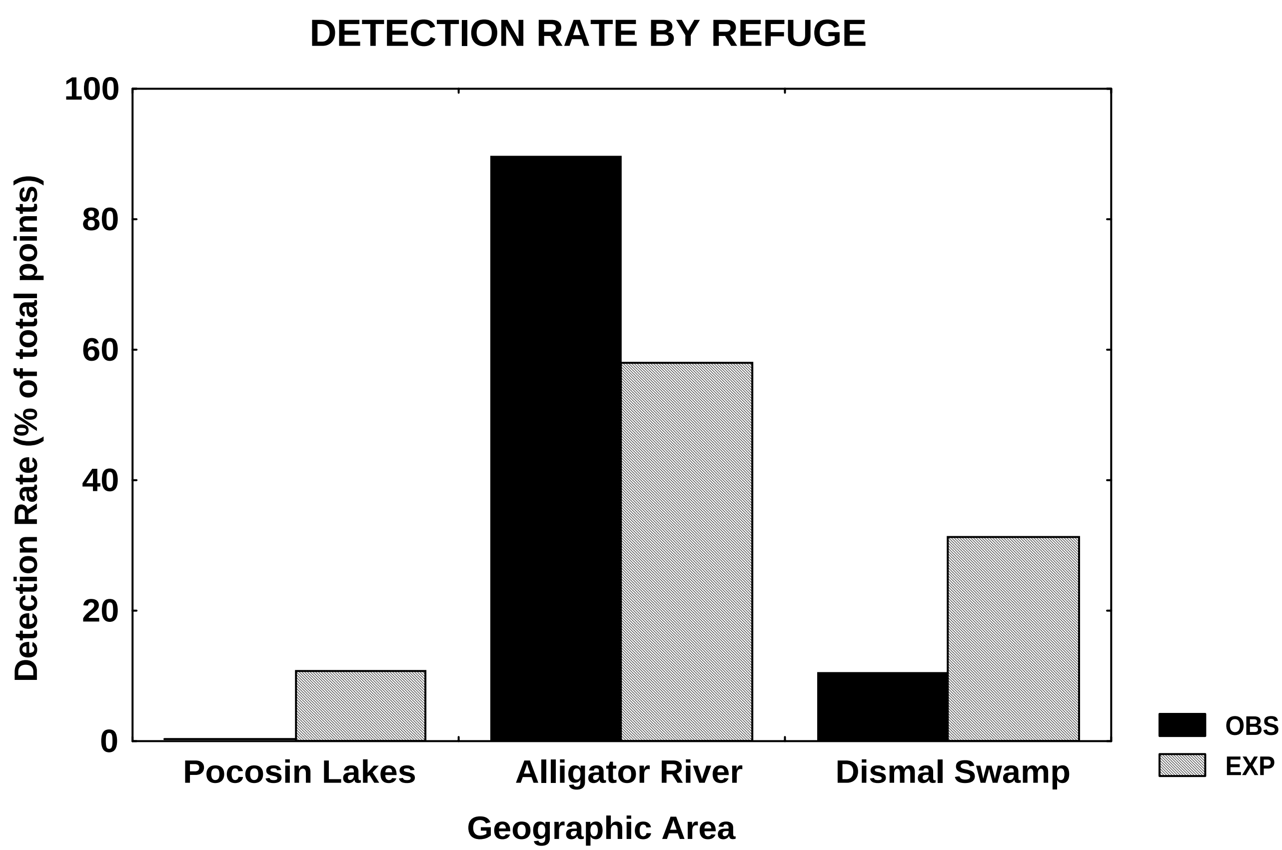

Figure 5. *Detection rates of Black-throated Green Warblers by refuge. Black bars indicate observed rate calculated as number of plots with at least one detection divided by the total number of points. Gray bars indicate expected detection rates based on the number of plots surveyed.*

Habitat Use

Black-throated Green Warblers did not use survey plots of different habitat types according to their availability (Figure 9) ($\times^2 = 31.7$, df = 5, $p < 0.05$). Birds were detected within pond pine pocosin and hardwood-dominated plots less than expected and plots with white cedar and bald cypress more than expected. Geography may have played a role in observed habitat-use patterns. However, the lack of balance between refuges made the potential impact of geography on observed habitat patterns difficult to isolate.

Occupied and unoccupied survey plots differed with respect to both vegetation structure and canopy composition (Table 6). Occupied plots had significantly higher canopy cover and lower understory density. These two factors are negatively correlated suggesting the obvious relationship that the shading of higher canopy cover leads to a reduction in understory vegetation. The influence of forest type on the distribution of breeding sites is suggested by the difference between occupied and unoccupied survey plots in the amount of conifers in the canopy. For example, the difference between occupied and unoccupied plots in the density of large pines was nearly significant ($p = 0.055$). The difference in the density of large cedar and cypress stems in the canopy was significant ($p < 0.05$). When pines, cedar, and cypress stems are combined, the resulting parameter (COND) was highly different ($p < 0.001$) between occupied and unoccupied plots (Table 6).

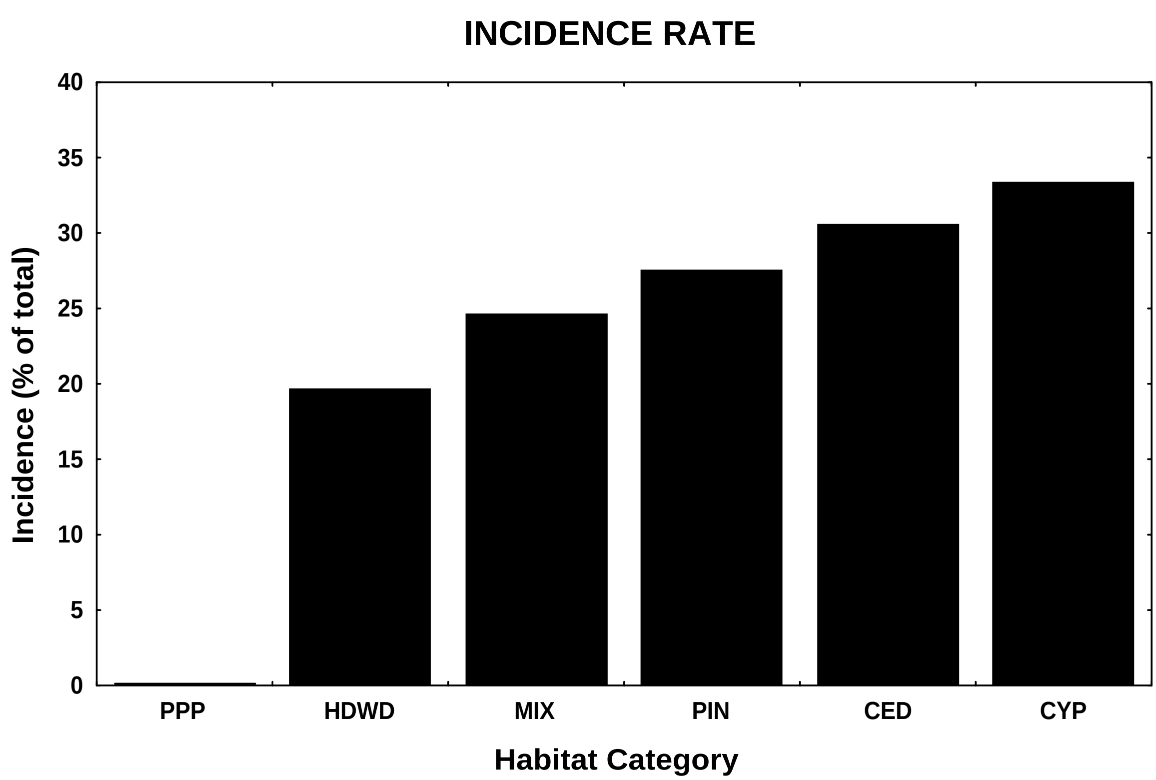

Figure 9. *Pattern of incidence of Black-throated Green Warbler by habitat type.*

Table 6. Comparisons of vegetation parameters between occupied and unoccupied survey plots (see methods for parameter abbreviations. Statistics are F-values unless otherwise specified. Mean values presented are individuals/ha.

Parameter	Occupied Mean ± SE N = 54	Unoccupied Mean ± SE N = 67	Statistic	p-value
Structural				
UND	15456 ± 896.6	19820 ± 1201.8	7.8	<0.05
SAPD	2025 ± 441.4	1409 ± 178.6	1.9	NS
SUBD	732.9 ± 66.47	620.9 ± 48.32	1.9	NS
CAND	192.7 ± 11.02	173.5 ± 8.01	2.1	NS
CANH	17.2 ± 0.51	19.1 ± 0.55	6.0	<0.05
CANC	84.3 ± 1.14	79.1 ± 1.58	6.6	<0.05
Composition				
HDWD	108.4 ± 13.11	105.4 ± 8.45	0.1	NS
PIND	69.1 ± 10.01	43.0 ± 7.59	1452.5[a]	0.055
CEDD	28.0 ± 10.10	8.6 ± 4.40	1569.5[a]	<0.05
CYPD	9.5 ± 3.05	2.7 ± 1.24	1533.0[a]	<0.05
COND	106.7 ± 12.00	54.3 ± 8.16	13.8	<0.05

[a]Mann-Whitney U statistic

DISCUSSION

The Wayne's subspecies of the Black-throated Green Warbler currently breeds from southeastern Virginia along the coast south to approximately Charleston South Carolina. Throughout much of this range the species breeds in very low densities. An exception to this pattern is the Great Dismal Swamp where the species was reported to be a fairly common breeder from the 1950's through 1970's (Meanley 1977) and Dare County within the Albemarle-Pamlico peninsula where high breeding densities were recorded in the early 1980's (Potter unpublished report). Results from this study support recent suggestions (Meanley and Schwab, pers. comm.) that the population within the Great Dismal Swamp has declined. Although the species does continue to breed within the swamp (Watts pers. obs.), none of the 83 points surveyed were classified as breeding sites based on criteria developed here. In contrast, the breeding population within the Alligator River, NWR and Dare Bombing Range was found to be similar to that reported in the early 1980's (Potter unpublished report). This location may support one of the highest breeding densities of any area within the subspecies range.

No Black-throated Green Warblers were detected within Pocosin Lakes, NWR. Nearly all of the survey plots established within the refuge were pond pine pocosin habitat. This species is known to utilize this habitat within the Albemarle-Pamlico peninsula (Potter unpublished report). In addition, the species is documented to occur well west of the study area (Wilson and Watts 2000). It is possible that the lack of use reflects the fragmented nature of these patches or their condition (e.g. tree density, stand age).

Birds began to arrive within study areas during the first week of April. This timing is consistent with other accounts that have listed arrival dates within the southern portion of the breeding range in mid to late March (Wayne 1910, Sprunt 1953) and within the northern portion of the breeding range at the end of March or early April (Meanley 1977, Potter unpublished report). Detection rates increased throughout April and then began to decline through May and into early June. This pattern is also consistent with previous authors who state that the species does not become common within the region until mid to late April (Sprunt 1953, Meanley 1977). Singing rates have been suggested to diminish rapidly after chicks hatch which may partially account for the decline in detection rates through May. In support of this, Potter (unpublished report) states “in late May and early June, full song was rarely heard after 0900 EDT”.

The peak in birds in late April may represent the passage of the nominate subspecies *D. v. virens* through the region. The timing of this peak would be consistent with breeding times reported for populations to the north in New England. Potter (unpublished report) indicates that birds were detected in numerous locations in coastal North Carolina in mid-April where no birds were detected at later dates suggesting the presence of transients. Sprunt (1953) points to the dearth of records of Black-throated Green within the extreme southeast in spring and suggest that *D. v. virens* does not likely pass through the range of *D. v. waynei*. *D. v. virens* winters primarily within Central America between Mexico and Panama and most individuals apparently migrate north via a land route through Mexico and Texas and continue on an inland track to the Appalachians and northern breeding areas (Stevenson 1957). However, Black-throated Green Warblers do winter throughout the Caribbean and south Florida in low numbers (e.g. Emlen 1977, Morse 1993). *D. v. Waynei* has been suggested to winter in western Cuba (A.O.U. 1957). The taxonomic origin of other populations that winter in the Caribbean has not been clearly documented. Confusion remains about the level and timing of overlap between these subspecies. For example, does *D. v. virens* winter within the Caribbean? Are *D. v. virens* and *D. v. waynei* geographically isolated on the winter grounds? What is the geographic range of *D. v. waynei* on the winter grounds? Because *D. v. waynei* is a small, unique population that is geographically isolated on the breeding grounds, understanding the risks that it faces within the winter range has conservation significance.

Black-throated Green Warblers occurred across the full gradient of habitat types from hardwood-dominated sites to sites supporting a bald cypress component. However, birds were not detected with the same frequency across all habitat types. Within this gradient, there was a lower frequency of occurrence within hardwood-dominated sites. In addition, survey plots classified as breeding sites had significantly higher densities of conifers including loblolly pines, Atlantic white cedar, and bald cypress. These results are consistent with impressions expressed by other observers. In South Carolina, Wayne's are suggested to be associated with non-alluvial patches of bald cypress (Sprunt 1953, Curson et al. 1994). Potter indicates that a common trait among territories that she observed in coastal North Carolina was the presence of pines and or bald cypress. She emphasizes the occurrence of mature trees, a characteristic that is common to other accounts (Sprunt 1953).

The unique complex of habitats within the outer coastal plain from southeastern Virginia through the Carolinas supports a number of unique avian forms. Like the Wayne's Black-throated Green Warbler, these forms include endemic subspecies and disjunct populations. For example, an isolated population of Cerulean Warblers (*Dendroica cerulea*) occurs along the lower Roanoke River and Chowan Basin (Lynch 1981). A distinct form of the Prairie Warbler (*Dendroica discolor*) that breeds within tall pocosin and forested habitats occurs in coastal Virginia and North Carolina (Meanley 1977, Nolan et al. 1999). An unusually dense population of Worm-eating Warbler breeds in distinctly different habitat than elsewhere in the species Range (Watts and Wilson, In review). Bachman's Warbler (*Vermivora bachmanii*) has been suggested to have a close association with cane (*Arundinaria gigantea*) thickets within the region (Remsen 1986). Virtually all of these forms appear to winter exclusively in the Caribbean. As with other species of conservation concern (e.g. Kirtlands Warbler (*Dendroica kirtlandii*), Bicknell's Thrush (*Catharus bicknelli*)), populations that winter exclusively on small isolated islands are subject to dramatic declines if land use changes are not in their favor. From a conservation perspective, it is important to determine the risks that the Wayne's form of the Black-throated Green Warbler faces on both the breeding and winter grounds. Efforts should be made to examine available museum materials to better refine winter distribution.

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