LANDBIRD MIGRATION ON BLOCK ISLAND: COMMUNITY COMPOSITION AND CONSERVATION IMPLICATIONS FOR AN ISLAND STOPOVER HABITAT

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Abstract: We trapped landbird migrants in mist nets in shrub/scrub habitats at the Block Island Banding Station, Rhode Island, from 1970 through 1994. During the 25-year study period, we captured 109 species (15,046 individuals) during spring migration (1 April–31 May) and 113 species (52,775 individuals) in the fall (15 Aug–15 Nov); 103 species were captured at least once in both seasons. Gray Catbird (*Dumetella carolinensis*; 17.1% of total spring captures), Common Yellowthroat (*Geothlypis trichas*; 13.7%), Yellow-rumped Warbler (*Dendroica coronata*; 10.7%), and White-throated Sparrow (*Zonotrichia albicollis*; 6.6%) dominated the spring captures, whereas Yellow-rumped Warbler (35.1% of total fall captures), Gray Catbird (13.2%), Golden-crowned Kinglet (*Regulus satrapa*; 4.5%), and Red-eyed Vireo (*Vireo olivaceous*; 4.1%) were the most common species in the fall. Warblers, mimic-thrushes, and New World sparrows were the three most abundant taxa in both seasons (warblers: 51% spring, 47% fall; mimic-thrushes: 17% spring, 14% fall; New World sparrows: 13% spring, 10% fall). Species that winter both in the southeastern United States and Central America/Caribbean were the most abundant migrants on the Island, accounting for 42% and 51% of spring and fall captures, respectively. Thirty-four percent of spring captures were species that winter exclusively in the Neotropics, versus 29% of fall captures. Thirty-eight percent of spring captures and 21% of fall captures were species that breed on Block Island. To establish an index of interannual variation in abundance by species, coefficient of variation (CV) values were calculated using the annual mean number of birds captured/1,000 net-hours over 25 years. CV values in spring (mean = 168) were nearly double the fall CV values (mean = 89). We suggest that this difference relates to the greater regularity of frontal systems in the fall. Hatching-year birds accounted for a greater percentage of captures during fall migration at Block Island (mean = 93.9%) than at any other coastal or inland site in northeastern North America. We present a detailed review of the processes that bring migrants to Block Island, most of which are traveling well to the east of their principal migration routes. Finally, we summarize recent research on the foraging and stopover ecology of these migrants, in order to develop potential conservation initiatives to protect and enhance habitat for landbird migrants on Block Island.

Introduction

In October of 1956, ornithologist James Baird visited Block Island with members of the Audubon Society of Rhode Island, and "was immediately successful in netting over 200 birds in less than 50 net hours—a far larger number than could have been caught in the same netting period on the mainland" (Baird and Nisbet 1960, p 123). Though Baird's brief mist-netting experiment hardly constituted a scientific study, it was convincing evidence of the large concentrations of migratory songbirds that occur, with conducive weather conditions, on islands located off the southern New England coast. During his visit, Baird documented the northerly directed morning flights of migrants across, and eventually off, the Island toward the Rhode Island mainland. This phenomenon was later explored in depth by Able (1977) during his 1975 visit to Block Island. They (Baird and Nisbet 1960; Able 1977) concluded that these northerly movements represented reoriented flights of migrants compensating for easterly wind-drift incurred during the previous night's migration. Baird observed that as the morning flight progressed, birds became concentrated at the Island's north end. It is within this habitat corridor that migrants have been intercepted by the mist nets at the Block Island (Lapham) Banding Station (BIBS) each spring and fall from 1970 to the present.

Able (1977), who used birds captured at BIBS in cage-orientation experiments, was impressed by the preponderance of hatch-year birds among fall captures at Block Island. Ralph (1981) further explored this relationship in New England by using data from banding stations and tower kills at various distances from the coast. Ralph (1975, 1981) demonstrated a clear spatial age gradient for most species migrating through New England in the fall.

Sampling stations closer to the coast had a higher percentage of hatch-year birds than did stations farther inland. Ralph (1975, 1981) termed this trend the "coastal effect."

While a host of observational, banding, and radar studies published by Baird, Ian Nisbet, and their colleagues substantially furthered our understanding of migratory bird movements in New England (Baird et al. 1958, 1959; Baird and Nisbet 1960; Drury and Keith 1962; Drury and Nisbet 1964; Murray 1966; Nisbet and Drury 1967), only one published study, to our knowledge, has provided basic quantitative data on landbird community structure at a coastal stopover location in southern New England. Hagan et al. (1992) published detailed statistics from a long-term fall banding station near Plymouth, Massachusetts. We found no published studies presenting landbird community data for offshore islands in New England in the fall, or from mainland or island capture sites in the spring.

Further, Ralph (1981) has clearly demonstrated a relatively high proportion of hatch-year fall migrants at coastal versus inland banding stations on the continent, but nothing has been published on age ratios from banding stations located on offshore islands. In addition, the magnitude of the coastal effect among sites near the coast has not been explored.

In this paper, we used 25 consecutive years (1970–1994) of spring and fall landbird-migration capture data from BIBS to: (1) quantify landbird community composition during spring and fall migration, including species composition, capture rates (i.e., birds per 1,000 net-hours [nh]), and annual variation in capture rates for each species; (2) compare the fall migrant community at BIBS to a coastal mainland site near Plymouth; and (3) test the hypothesis that age ratios during fall migration on Block Island are different from those at mainland sites near the coast.

We also draw on the wealth of published data on migratory landbird movements in the northeast to describe the processes by which landbirds reach, and venture from, Block Island in their migratory travels. Finally, we use recent data on the foraging ecology of Block Island landbird migrants (Parrish 1997, 2000; McWilliams 2000; Wilson and McWilliams 2000) and aspects of migrant stopover biology and habitat conservation (Moore et al. 1995; Moore 2000a) to suggest conservation initiatives for landbird migrant habitats on Block Island.

Methods

Study Area

Block Island is a 25.1-km² (6,202-acre) island, 22 km (13.6 mi) east of the eastern end of Long Island, New York and 15.1 km (9.4 mi) south of the coast of Rhode Island (41°12'N, 71°35'W) in southern New England (see Rosenzweig et al., this volume, for a complete description of the Island). The Island is 9.7 km (6 mi) long from north to south, and narrows abruptly from its greatest width of 5.8 km (3.6 mi) at its southern end to a 1.9-km (1.2-mi) wide strip at its north end (Figure 1). BIBS is situated among privately owned woody habitats in the Clay Head sanctuary 2.5 km (1.6 mi) from the Island's northernmost point. At the initiation of the banding efforts in 1967, the area was dominated by herbaceous habitats < 1 m tall. The habitats of the banding station are presently composed of 2- to 3-m tall shrub communities dominated by Northern Bayberry (*Myrica pensylvanica*), Northern Arrowwood (*Viburnum dentatum* var. *lucidum*), Multiflora Rose (*Rosa multiflora*), field rose (*Rosa* spp.), Shadbush (*Amelanchier canadensis*), Pokeweed (*Phytolacca americana*), and Poison Ivy (*Toxicodendron radicans*). Nine kettle ponds, with a total area of 1.4 ha (3.5 acres), are scattered throughout the Clay Head sanctuary. Several stands of mature Japanese Black Pine (*Pinus thunbergiana*) were planted in the early 1970s and are now within 200 m (218 yards) of the banding station.

Banding Station Operations

Elise Lapham (EL) established BIBS in 1967 on her property in the northeast corner of Block Island. Here we report on capture data for the period 1970–1994 because (1) skull ossification was not employed routinely in aging fall captures until 1970, and (2) we have used this 25-year

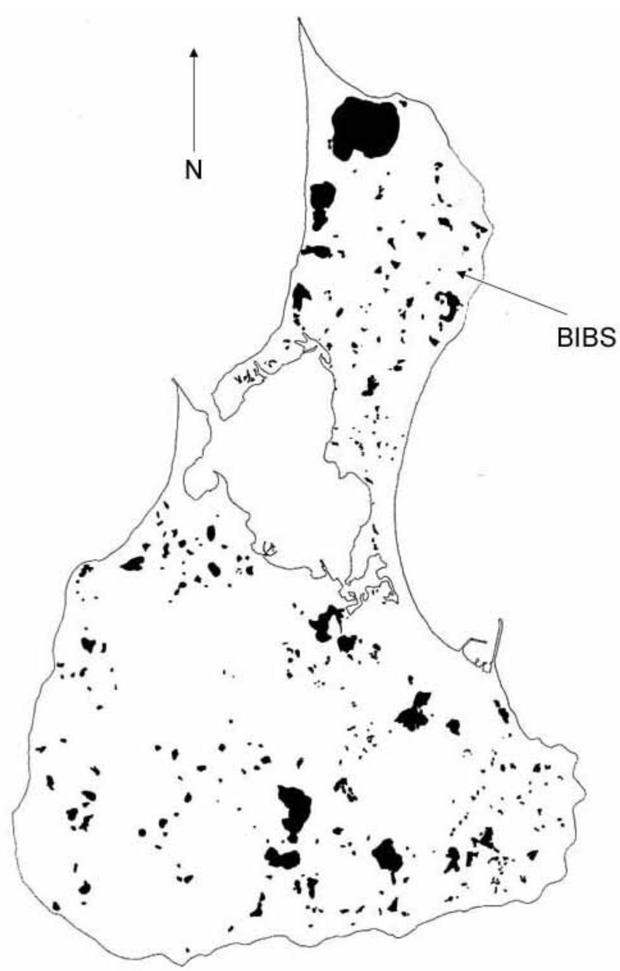

Figure 1. *Location of the Block Island Banding Station (BIBS) and freshwater ponds on Block Island, Rhode Island.*

period in other studies and therefore employed it here for consistency. Five to 13, 12-m long mist nets were operated each year during spring (1 April–30 May, mean net-activity days [number of days nets were set] = 26.0 ± 6.0, range = 6–36), and fall (15 August–15 November, mean net-activity days = 46.7 ± 11.4, range = 32–75). EL and her team of volunteers operated nets in two clusters 50 m (55 yards) apart during the first decade of effort. In 1976, a third cluster of nets was established 50 m from the closest existing nets on a mowed lawn between shrub habitats and a row of Japanese Black Pines. In 1976, ca. 0.6 ha (1.5 acres) of shrub habitat surrounding the central net cluster was mowed to < 1 m in height. Otherwise, succession of vegetation along the net lanes has progressed naturally since 1967. Staff checked nets every 30–60 min, placed each bird captured in a cloth bag, and transported the birds to a central lab where a federally issued aluminum band was placed on the right leg. Banding staff recorded the time of capture, natural wing cord, and weight to the nearest gram. Banding team members routinely used skull ossification to age birds in the fall and, when possible, available plumage and morphological criteria were used to determine gender (e.g., Pyle 1987, 1997). Staff also recorded molt progression. The taxonomy we present follows that of the American Ornithologist's Union (AOU 1998). We pooled captures of Gray-cheeked Thrush (*Catharus minimus*) and Bicknell's Thrush (*C. bicknelli*) into a single taxon called Gray-cheeked Thrush, because Bicknell's Thrush was only recently recognized as a distinct species (AOU 1998). Thirty-five captured hummingbirds (all *Archilochus colubris*) were released without banding or processing. During days of extremely high capture rates, selected individuals of three other species were released without banding or processing: Yellow-rumped Warbler (*Dendroica coronata*), 7,760 total released; Gray Catbird (*Dumetella carolinensis*), 29 total released; Golden-crowned Kinglet (*Regulus satrapa*), 96 total released. For the years 1967–1976, EL also set seed-baited ground traps to capture relatively small numbers of seed-eating birds, principally White-throated Sparrows (*Zonotrichia albicollis*). Total yearly net-hours ranged from 2,857 (1972) to 9,652 (1976); net-hours per year averaged 5,776 (SD = 1,901; see Appendix A for a summary of annual net-hours).

Statistical Analysis

We included all Yellow-rumped Warblers, Gray Catbirds, and Golden-crowned Kinglets in summary statistics, even those that were not banded. In addition, we included in all analyses the small numbers of seed-eating birds captured in baited ground traps, as they could not be separated from the mist-net captures. For all analyses, we used only the initial capture record for each individual; no data on recaptured individuals were included in this paper.

We calculated the percentage of hatch-year (HY) birds by using only individuals of known age. We also present lower and upper bounds around age ratio estimates by recalculating the percentage including all birds of unknown age as either after-hatch-year (AHY) or HY, respectively.

We used the "diel index" of Ralph (1981, p 174) to quantify interspecific variation in the "nocturnalness" of migration. This index was calculated as the ratio between the number of birds (natural logarithms) killed during nocturnal flights at a lighthouse at the Long Point Bird Observatory, Ontario, and the number of birds captured during netting and trapping operations conducted the following day. Thus, the higher the diel index, the greater the probability that the species migrates only at night. We classified migrants into five groups based on their wintering ranges (Hagan et al. 1992; Rappole et al. 1995): northeastern North America = 1, southeastern North America = 2, southeastern North America/Central America/Caribbean = 3, Central America/Caribbean = 4, and South America = 5.

We used the independent samples *t*-test to compare species richness between spring and fall. We used paired *t*-tests and Pearson product-moment correlations to assess age ratios at Block Island compared to data presented in Hagan et al. (1992) and Ralph (1981). Because variables measuring bird abundance were skewed positively by years of extraordinary numbers, we used the Wilcoxon matched-pairs signed-ranks test and Spearman rank correlations to assess differences in species abundance between the spring and fall. We quantified interannual variation for each of the 50 most-abundant migrant species by calculating the coefficient of variation (CV) of the annual mean number of birds captured per 1,000 net-hours over the 25-year study period. We used $P < 0.05$ as the cutoff for statistical significance with two-tailed comparisons. We present mean ± 1 standard deviation (SD) throughout the paper. Statistical analyses were performed using Stata v. 6.0 (College Station, Texas).

Results

During the 25-year study period, we captured a total of 15,046 landbirds during spring (annual mean = 602 ± 301, range = 86–1,435), and 52,775 birds during fall (annual mean = 2,111 ± 1,274, range = 915–5,400). We captured significantly fewer migrants annually during spring migration compared to fall (spring mean yearly rate = 290 birds per 1,000 nh ± 172, range = 98–747, versus fall mean yearly rate = 1,101 birds per 1,000 nh ± 828, range = 354–3,262; sign-rank $z = -4.37$, $n = 25$, $P < 0.00001$). We also captured significantly fewer species annually in the spring than in the fall (spring annual mean = 54.6 ± 12.2, cumulative total of 109 species, versus fall annual mean = 71.0 ± 8.0; cumulative total of 113 species; $t = -6.20$, $n = 25$, $P = < 0.0001$; see Appendix A for a summary of species richness for each year); 103 species were captured at least once in both the spring and fall.

Five species accounted for 52% of total captures during spring, Gray Catbird (17.1% of total spring captures), Common Yellowthroat (*Geothlypis trichas*; 13.7%), Yellow-rumped Warbler (10.7%), White-throated Sparrow (6.6%) and Magnolia Warbler (*Dendroica magnolia*; 4.2%) (Table 1). The five most abundant species in fall (60% of total captures) were Yellow-rumped Warbler (35.1%), Gray Catbird (13.2%), Golden-crowned Kinglet (4.5%), Red-eyed Vireo (*Vireo olivaceus*), and White-throated Sparrow (3.1%). Landbird community structure was similar between spring and fall, based on the proportion of captures (r_s = 0.59, n = 103, $P < 0.0001$) and the percentage of net-activity days that a species was captured (r_s = 0.62, n = 103, $P < 0.0001$; Appendix B). Warblers, mimic-thrushes, and New World sparrows were the dominant avian families in both spring (50.8%, 17.4%, and 12.7%, respectively) and fall (46.7%, 13.5%, and 10.4%, respectively) (Table 2).

The two species captured most often in the spring, Gray Catbird and Common Yellowthroat (Table 1), ranked third and second in abundance, respectively, among the breeding species on Block Island (Table 4; data from 1990 point counts [n = 104] of R. Enser, Rhode Island Natural Heritage Program, and C. Raithel, RI Department of Environmental Management [DEM], Division of Fish and Wildlife), while the Song Sparrow (*Melospiza melodia*), the most abundant Block Island breeding species, ranked 15th in abundance for spring captures. Four of the dominant fall migrants, Gray Catbird, Common Yellowthroat, Song Sparrow, and American Robin (*Turdus migratorius*; Table 1), were among the six most abundant Block Island breeding species (Table 4). We detected a positive correlation between spring capture rates (percent of total spring captures) of individual species and the number of breeding pairs per plot (r_s = 0.28, n = 108, P = 0.004); there was no such correlation between the percent of fall captures and breeding pairs per plot (r_s = 0.09, n = 113, P = 0.36).

Table 1. *Relative abundance of the 50 most abundant landbirds captured at the Block Island Banding Station during spring and fall migration from 1970 to 1994.*

	% of total captures		Abundance rank		CV[a]	
Species	Spring	Fall	Spring	Fall	Spring	Fall
Northern Flicker	0.1	0.8	76	23	173.0	155.2
Eastern Phoebe	0.0	0.7	80	26	215.1	80.3
White-eyed Vireo	0.5	0.2	29	55	108.3	88.8
Blue-headed Vireo	0.3	0.4	41	31	81.1	62.5
Red-eyed Vireo	1.0	4.1	21	4	96.2	103.4
Blue Jay	3.5	0.1	6	70	179.1	168.1
Black-capped Chickadee	0.3	0.3	45	38	122.3	55.4
Red-breasted Nuthatch	0.3	0.8	43	22	201.9	123.4
Brown Creeper	0.3	1.6	49	14	139.2	65.4
House Wren	0.3	0.6	42	28	98.3	99.8
Winter Wren	0.1	0.6	69	29	203.8	112.4
Golden-crowned Kinglet	0.4	4.5	38	3	360.7	94.7
Ruby-crowned Kinglet	1.4	2.2	14	7	117.5	100.2
Veery	0.9	1.4	23	15	73.7	101.8
Gray-cheeked Thrush[b]	0.3	0.9	48	21	125.2	179.2
Swainson's Thrush	1.2	2.0	18	9	120.3	137.5
Hermit Thrush	0.5	2.1	28	8	107.8	95.8
Wood Thrush	0.7	0.2	25	54	102.9	118.3
American Robin	0.6	1.8	27	12	81.9	83.3
Gray Catbird	17.1	13.2	1	2	40.9	52.7
Brown Thrasher	0.3	0.3	44	37	145.8	181.7
Cedar Waxwing	0.0	1.0	83	20	256.0	109.5
Tennessee Warbler	0.4	0.2	36	43	178.0	122.4
Northern Parula	2.1	0.2	10	41	118.6	112.5
Yellow Warbler	1.2	0.0	17	98	67.5	40.3
Magnolia Warbler	4.2	0.4	5	33	83.3	95.1
Cape May Warbler	0.1	0.5	65	30	244.5	131.5
Black-throated Blue Warbler	0.4	1.2	34	16	118.0	67.7
Yellow-rumped Warbler	10.7	35.1	3	1	149.4	95.4
Bay-breasted Warbler	0.5	0.2	31	56	146.7	63.2
Blackpoll Warbler	3.4	1.0	7	19	115.9	110.0
Black-and-White Warbler	3.2	0.7	8	24	75.8	52.7
American Redstart	1.8	1.7	12	13	111.7	78.6
Ovenbird	2.9	0.7	9	27	84.7	63.7
Northern Waterthrush	2.0	0.7	11	25	71.3	116.5
Common Yellowthroat	13.7	2.4	2	6	43.4	80.8
Wilson's Warbler	0.6	0.1	26	65	148.5	97.9
Canada Warbler	1.6	0.2	13	52	121.2	90.5
Scarlet Tanager	0.2	0.4	56	32	119.9	119.4
Eastern Towhee	1.3	1.1	16	18	106.7	65.0
Song Sparrow	1.4	2.0	15	11	68.1	122.8
Swamp Sparrow	1.2	1.2	19	17	123.5	106.3
White-throated Sparrow	6.6	3.1	4	5	89.3	88.0
Dark-eyed Junco	0.1	2.0	60	10	172.0	74.1
Northern Cardinal	0.4	0.3	39	36	102.0	70.6
Rose-breasted Grosbeak	0.9	0.2	22	47	100.3	106.2
Red-winged Blackbird	0.7	0.0	24	87	239.3	34.7
Baltimore Oriole	0.5	0.2	30	45	180.3	131.6
House Finch	0.5	0.1	32	62	194.1	81.6
American Goldfinch	1.2	0.1	20	66	93.4	63.7

[a]Coefficient of variation calculated using annual mean number of birds captured/1,000 net-hours over 25 years.

[b]Includes both Gray-cheeked and Bicknell's Thrush.

There was considerably more interannual variation in capture rates at BIBS during spring migration compared to fall migration. The median CV values for spring and fall were 168 (range = 41–500) and 89 (range = 22–200), respectively (sign-rank z = -3.71, n = 50, P = 0.0002; Table 1). The CVs of nine species—Eastern Phoebe (*Sayornis phoebe*), Black-capped Chickadee (*Poecile atricapillus*), Brown Creeper (*Certhia americana*), Golden-crowned Kinglet, Cedar Waxwing (*Bombycilla cedrorum*), Bay-breasted Warbler (*Dendroica castanea*), Dark-eyed Junco (*Junco hyemalis*), House Finch (*Carpodacus mexicanus*), and Red-winged

Table 2. *Seasonal variation in the types of landbirds that were captured at the Block Island Banding Station from 1970–1994.*

Group	% of captures	
	Spring	Fall
Cuckoos	0.0	0.1
Woodpeckers	0.1	1.3
Flycatchers	0.9	1.3
Vireos	2.0	4.9
Corvids	3.5	0.1
Swallows	0.2	<0.1
Chickadees	0.3	0.3
Creepers	0.3	1.6
Nuthatches	0.3	0.9
Wrens	0.7	1.4
Kinglets	1.9	6.7
Thrushes	4.2	8.4
Mimic-thrushes	17.4	13.5
Starlings	0.1	<0.1
Waxwings	<0.1	1.0
Warblers	50.8	46.7
Tanagers	0.2	0.4
New World Sparrows	12.7	10.4
Cardinals	0.4	0.3
Blackbirds	1.9	0.3
Finches	2.0	0.4

Blackbird (*Agelaius phoeniceus*)—were 2 or more times greater in spring than in fall, and for an additional 10 species, were 1.5 or more times greater in spring (Table 1). The fall CV values of only three species—Northern Waterthrush, Common Yellowthroat, and Song Sparrow—were as great as 1.5 times their respective spring values (Table 3).

Based on captures at BIBS only, the abundance of certain species tended to fluctuate dramatically among years, while populations of other species tended be somewhat stable. That is, the interannual CV values between spring and fall captures were positively correlated ($r_s = 0.32$, $n = 50$, $P = 0.02$). The CVs for the spring migration period fluctuated inversely with the percent of total spring captures ($r_s = -0.58$, $n = 50$, $P < 0.0001$); there was no such relationship in the fall ($r_s = 0.02$, $n = 50$, $P = 0.90$).

We summarized for each species the age ratio (percent HY birds) of birds captured at BIBS in fall and the coastal (C) and coastal plain (CP) sites of Ralph (1981; Ralph used skull ossification, as did we, in determining the age of fall migrants) (Table 5). The mean percent HY values for these sites (including only the 50 most abundant species at Block Island), were 93.9 (± 5.72), 88.6 (± 9.27), and 69.7 (± 14.0), respectively, and the mean at BIBS was significantly greater than that of both the coastal and coastal plain stations (BI:C $t = 4.03$, $n = 40$, $P < 0.0001$; BI:CP $t = 10.77$, $n = 38$, $P < 0.0001$). Block Island percent HY values were greater than those of coastal sites for 34 (85%) of 40 species, and greater than those of coastal plain sites for 33 (87%) of 38 species. The by-species percent HY values between BIBS and the other sites were not correlated (BI:C $r = 0.14$, $n = 40$, $P = 0.04$; BI:CP $r = 0.04$, $n = 38$, $P = 0.82$).

Table 3. *Seasonal variation (% of total captures) in wintering destinations of landbirds banded at the Block Island Banding Station from 1970–1994.*

Wintering region	Spring %	Fall %
Northeast US	6.4	2.1
Southeast US	17.8	26.8
Southeast US/Central America/Caribbean	41.5	50.7
Central America/Caribbean	26.3	11.2
South America	8.0	9.2

Table 4. *Relative abundance of breeding landbirds and birds captured during migration on Block Island. Breeding bird surveys were point counts conducted in 1990*[a]*, while abundance during migration is based on birds banded at the Block Island Banding Station from 1970–1994.*

Species	Nesting pairs/plot	% of total captures	
		Spring	Fall
Song Sparrow	3.1	1.4	2.0
Common Yellowthroat	2.9	13.7	2.4
Gray Catbird	1.9	17.1	13.2
Eastern Towhee	1.3	1.3	1.1
Carolina Wren	1.2	0.3	0.2
American Robin	1.0	0.6	1.8
Red-winged Blackbird	0.7	0.7	0.0
Bank Swallow	0.6	0.1	0.0
Common Grackle	0.6	0.1	0.1
Yellow Warbler	0.5	1.2	0.0
Northern Cardinal	0.4	0.4	0.3
European Starling	0.2	0.1	0.0
American Goldfinch	0.2	1.2	0.1
House Finch	0.2	0.5	0.1
Savannah Sparrow	0.2	0.0	0.0
Eastern Kingbird	0.2	0.1	0.0
Brown-headed Cowbird	0.1	0.4	0.0
Tree Swallow	0.1	0.1	0.0
Black-capped Chickadee	0.1	0.3	0.3
Totals	15.5	39.6	21.6

[a]Data from 104 point counts by R. Enser and C. Raithel.

We documented a strong positive correlation ($r_s = 0.73$, $n = 61$, $P < 0.0001$) between the DI of Ralph (1981) and the ranked index of distance to the wintering grounds: mean DI of northeast-US migrants 0.0, southeast-US migrants 0.45 (± 0.24), southeast-US/Central America/Caribbean migrants 0.78 (± 0.20), Central America/Caribbean migrants 0.78 (± 0.17), and South America migrants 0.86 (± 0.11).

Discussion

Origins of Block Island Migrants

Birds captured on Block Island during spring and fall represent a sample of myriad eastern landbirds which undertake migratory travels to and from their Nearctic breeding grounds each year. Dominant flight paths through the eastern United States are directed northeasterly in the spring and southwesterly in fall (e.g., Drury and Keith 1962; Moore et al. 1995), and distances traveled range from flights within the northeastern United States to the

Table 5. *Age ratios (% hatch-year) of the 50 most abundant fall migrants at Block Island Banding Station from 1970–1994 (BI) and at Coastal and Coastal Plain (CP) sites of Ralph (1981)*[a].

		% hatch-year birds		
Species	BI *n*	BI[b]	Coastal	CP
Yellow-bellied Sapsucker	165	97.5 (95.1, 97.5)		
Downy Woodpecker	108	70.0 (58.3, 75.0)		
Northern Flicker	398	89.3 (67.5, 91.9)		
Yellow-bellied Flycatcher	102	88.2 (81.3, 89.2)	95.5	
Eastern Phoebe	375	88.1 (51.4, 93.0)	100.0	72.8
Blue-headed Vireo	209	97.3 (87.5, 97.6)	93.2	100.0
Philadelphia Vireo	120	97.4 (95.0, 97.5)		
Red-eyed Vireo	2,157	98.7 (98.5, 98.7)	93.0	68.0
Black-capped Chickadee	139	85.8 (52.5, 91.3)	94.6	92.3
Red-breasted Nuthatch	442	85.4 (76.9, 86.8)	71.8	93.7
Brown Creeper	849	98.4 (87.5, 98.5)	81.9	62.0
Carolina Wren	122	83.0 (76.2, 84.4)		
House Wren	317	96.6 (92.1, 96.8)	98.5	92.9
Winter Wren	306	99.6 (94.4, 99.6)		
Golden-crowned Kinglet	2,360	99.8 (76.3, 99.8)	87.0	77.2
Ruby-crowned Kinglet	1,167	98.4 (49.7, 99.2)	53.3	57.5
Veery	733	96.0 (95.7, 96.0)	84.3	59.1
Gray-cheeked Thrush	476	97.4 (96.8, 97.4)	91.6	44.3
Swainson's Thrush	1,078	96.5 (95.7, 96.5)	93.5	55.5
Hermit Thrush	1,132	98.2 (97.9, 98.2)	94.2	75.1
American Robin	934	90.3 (86.5, 90.7)	92.6	52.4
Gray Catbird	6,956	96.5 (96.3, 96.5)	94.0	77.4
Brown Thrasher	146	87.6 (72.6, 89.7)	78.6	51.6
Cedar Waxwing	522	95.3 (94.4, 95.4)		
Tennessee Warbler	108	95.3 (95.3, 95.3)	66.0	73.2
Nashville Warbler	94	97.8 (95.7, 97.8)	97.3	89.6
Northern Parula	119	97.3 (93.2, 97.4)	80.7	60.0
Magnolia Warbler	203	96.4 (94.5, 96.5)	91.9	67.4
Cape May Warbler	290	99.6 (98.9, 99.6)	93.7	92.8
Black-throated Blue Warbler	630	96.9 (95.0, 96.9)	93.3	80.2
Yellow-rumped Warbler	18,538	98.5 (96.5, 98.5)	92.4	66.2
Western Palm Warbler	187	98.3 (96.2, 98.3)		
Blackpoll Warbler	551	90.0 (88.3, 90.1)	79.8	60.7
Black-and-White Warbler	385	94.4 (92.7, 94.5)	86.8	62.1
American Redstart	911	95.3 (94.0, 95.3)	96.8	65.3
Ovenbird	357	93.6 (91.5, 93.8)	92.5	77.3
Northern Waterthrush	377	94.0 (92.0, 94.1)	84.4	43.0
Common Yellowthroat	1,276	88.4 (86.3, 88.7)	78.2	53.3
Scarlet Tanager	205	95.0 (93.1, 95.1)	93.8	70.2
Eastern Towhee	558	92.7 (92.2, 92.8)	91.0	70.9
Field Sparrow	94	98.8 (91.4, 98.9)	91.8	70.3
Song Sparrow	1,050	95.3 (85.0, 95.8)	86.1	82.5
Lincoln's Sparrow	88	98.7 (92.0, 98.8)	93.8	97.3
Swamp Sparrow	608	96.2 (92.1, 96.3)	94.0	61.3
White-throated Sparrow	1,650	97.9 (93.0, 98.0)	91.6	64.5
White-crowned Sparrow	96	94.7 (93.7, 94.7)	91.8	
Dark-eyed Junco	1,065	98.2 (96.9, 98.3)	97.1	74.7
Northern Cardinal	165	82.4 (62.4, 86.6)		
Rose-breasted Grosbeak	102	93.7 (73.5, 95.0)	89.9	58.9
Baltimore Oriole	105	94.4 (64.7, 96.1)		
Purple Finch	106	87.5 (72.6, 89.6)	85	70.7

[a]Coastal sites include Sudbury, Massachusetts east to Monomy Island, Massachusetts, and Coastal Plain sites include Rector, Pennsylvania east to Littleton, Massachusetts.
[b]The interval in parentheses represents calculations with all birds of unknown age classified as after-hatch-year or hatch-year birds, respectively.

intercontinental routes traveled by the Nearctic-Neotropical migrants. Using radar data, Drury and Keith (1962) estimated that several million landbirds pass through southern New England during a typical night of fall migration. Fewer birds fill the skies in spring: at Block Island, fall capture totals more than tripled spring totals. This inequity probably results from (1) the greater number of birds traveling in fall following the recruitment of first-year birds into the population, and (2) the general clockwise flow of migration produced by prevailing continental wind patterns that bias bird movements easterly in the fall and westerly in the spring (Scholander 1955; Drury and Keith 1962; Nisbet and Drury 1967; Moore et al. 1995).

Banding studies from the Manomet Center for Conservation Sciences (MCCS) in Plymouth establish clear associations of spring (Atwood 1992) and fall (Hagan et al. 1992) migration captures with birds nesting in the eastern forests of the United States and Canada. Birds from those populations no doubt constitute the majority of the migrants captured at Block Island. However, the breeding ranges of many eastern Nearctic-Neotropical migrant species extend well into central Canada (Moore et al. 1995; Rappole et al. 1995), and those more western populations are represented, to a lesser extent, in the movements of birds through southeastern New England (Moore et al. 1995).

Age Ratios and Relative Numbers of Over-Water Migrants: The Coastal Effect

Migrant landbirds banded on Block Island during the fall are predominately immature birds, having fledged only 1–4 months prior to their capture date. Nearly 97% of the total fall captures reported in this study were of hatch-year birds, and the mean percent of immatures for the dominant 50 species of fall migrants was 93.9%. Hatch-year birds dominate coastal banding stations in the northeastern United States, where they typically exceed 90% of all fall captures (Drury and Keith 1962; Murray 1966; Able 1977; Ralph 1975, 1981; Hagan et al. 1992). Adults tend to be much more common at inland sampling sites within the region (Drury and Keith 1962; Ralph 1975, 1981), with higher proportions of immature birds captured near the coast, which led Ralph (1981) to coin the term "coastal effect" to describe this age gradient. His study was based on capture data from autumn banding stations and tower-kill samples from a continuum of points from Rector, Pennsylvania east to Monomy Island, Massachusetts at the elbow of Cape Cod. He found higher proportions of young on the coast than at the nearest inland location for 52 of 59 species examined, and that the difference was significantly greater ($P \leq 0.05$) for 40 of those 52 species. Based on those findings, and on the relative abundance of species at his study sites, Ralph (1981) concluded that immature birds dominating coastal flights in the northeast were individuals traveling on the eastern periphery of the main migration route of their respective species. He also classified 61 species according to their principal fall migration routes through the northeastern United States, and found that only one species, the Red-breasted Nuthatch (*Sitta carolinensis*), clearly fit a coastal flyway pattern.

Consistent with these findings, radar analysis (Drury and Keith 1962) suggested that 10–150 times as many birds move over Boston as over Cape Cod and points easterly during a typical flow of night migration during spring or fall, and in a later radar study, Drury and Nisbet (1964) concluded that relative to inland volumes, "only a meager fringe of the movement passes near the Cape [Cod] and Nantucket…."

As our data from Block Island represent a population of fall migrants farther offshore than those from the accumulated coastal sites (Monomy Island, Manomet, and Boston, Massachusetts; Island Beach, New Jersey) of Ralph (1981), we predicted, consistent with Ralph's conclusions, that the proportion of hatch-year birds on Block Island would be even greater than at those sites. Indeed, Block Island hatch-year percents exceeded those of Ralph's aggregated coastal sites for 34 of the 40 species for which data was available for both samples (Table 5), and the mean percent of hatch-year birds, across species, was significantly greater for the Block Island sample (94%) than for the aggregated coastal sample of Ralph (89%). Also consistent with Ralph's (1981) findings, the only species determined by his criteria to have a coastal flyway as its principal route, Red-breasted Nuthatch, had a relatively low hatch-year value (85%) at Block Island (Table 5).

Morris et al. (1994), working on Appledore Island, Maine 10 km offshore of the New Hampshire/Maine border, presented evidence of a spring coastal effect in warblers. Ninety-four percent of their spring captures in 1990 and 1991 were of second-year birds (that is, birds born the previous calendar year). They followed Ralph's (1981) rationale in suggesting that these young birds were traveling to the east of the principal spring migration corridors of their respective species. We classified only 16% of our spring-captured warblers as second-year, and were unable to distinguish second-year birds from older birds (i.e., classified as "after-hatch-year") in 81% of our spring warbler sample. Therefore, we believe that this marked discrepancy represents a difference in aging methods and/or criteria between the Block Island and Appledore Island sites, rather than a true difference in the age-class structure of these migratory populations.

Over-Water Movement Patterns of Offshore Migrants

Explanations for the coastal effect combine the inherent disorientation of immature migrants with the ability of the adults to avoid the coast (Drury and Keith 1962; Richardson 1978; Ralph 1981). Later experimental evidence indicates that inexperience, as well as endogenously determined errors in orientation, play a role in the misguided travels of first-year migrants (Moore 1984). Data from Block Island are consistent with the learning hypothesis: we have banded over 50,000 migrants (non-breeders) on Block Island in 33 years, and not one has been recaptured in a subsequent season or year. Thus, immature fall migrants that survive coastal flights through southeastern New England follow inland routes during later migrations, and/or the low survival rate of immature migrants following coastal routes in their first fall results in few recaptures.

Regardless of the mechanisms that lead immature birds to travel coastal routes, few such migrants would be subjected to the hazards of offshore flights were it not for the drifting effects from the prevailing northwesterly winds of the autumn season on their tracks during nocturnal passages. A multitude of radar, banding, and observational studies has documented a strong association between northwesterly winds, typically associated with the passage of autumnal cold fronts, and large numbers of nocturnal migrants moving over, and east of, the Atlantic shoreline (e.g., Baird et al. 1958, 1959; Baird and Nisbet 1960; Drury and Keith 1964; Able 1977; Williams et al. 1977; Richardson 1978, 1990). Large concentrations of fall migrants occur on offshore islands and along the coast on the mornings following nights of strong northwestern wind, and indeed, active days of banding at our Block Island station can be readily predicted with such weather patterns. In contrast, days with low capture rates at BIBS can be predicted based on the prevalence of nights with winds out of the east-southeast.

Not all migrants traveling coastal flyways are drifted easterly over the Atlantic. Radar data have documented that many coastal migrants in both spring (Nisbet and Drury 1967) and fall (Drury and Nisbet 1964) gradually adjust their headings during the night to compensate for drift, and that such corrections maintain their flights on tracks that place them near or over the mainland at dawn. Most landbirds captured at Block Island (excluding individuals that nest there) are among those migrants that failed to adequately compensate for drift during the night, and thus by early morning were aloft over the western Atlantic. Investigators employing radar (Richardson 1978) and data from ground observations at offshore-island and coastal concentration points (Stone 1937; Baird and Nisbet 1960; Murray 1976; Able 1977; Wiedner et al. 1992; Moore et al. 1995) have documented that during the hours surrounding dawn, such offshore fall migrants make an abrupt change of heading to a northwest track leading to the nearest land. Despite this corrective reorientation, on a given night many thousands of migrants may have been drifted so far out to sea as to be unable to regain land in the morning, and thus perish (Scholander 1955; Ralph 1978). Many more, however, such as the birds banded at Block Island, will have retained sufficient energy reserves to carry them to a safe landfall at the coast.

Daytime Movements of Block Island Migrants: The Morning Flight

Migrants reaching Block Island following nocturnal flights continue movements on the Island for several hours after dawn, a phenomenon that has been termed the "morning flight" (Baird and Nisbet 1960; Able 1977). Morning flight along the New England coast often involves large concentrations of migrants moving at low altitudes, and because of its resultant high visibility has received much attention by researchers who have attempted to explain its function (Dennis and Whitles 1955; Baird and Nisbet 1960; Murray 1966; Able 1977; Gauthreaux 1978; Wiedner et al. 1992; Provencher 1993; Moore et al. 1995). Investigators of this phenomenon during fall migration at Block Island (Baird and Nisbet 1960; Able 1977) documented a northward movement of migrants over the Island, resulting in a concentration of birds at the north end. Indeed, it is birds following such routes that are captured at BIBS. Baird and Nisbet (1960) and Able (1977) reported that upon reaching the northern extremity of the Island, many birds continued their morning flight northerly over Block Island Sound toward the mainland. These flights were attributed to a compensatory action for the previous night's easterly wind-drift; this explanation for morning flight is also offered by investigators studying it elsewhere (Murray 1966; Wiedner et al. 1992; Moore 1990; Moore et al. 1995). Moore (1990) drew a distinction between the "reoriented" movements of birds in flight, such as those over the western Atlantic, and the "redetermined" movements of migrants that correct their course after landing, such as those partaking of morning flight on Block Island. Recent papers (Wiedner et al. 1992; Moore et al. 1995; Moore and Aborn 2000) suggest that, among the migrants participating in morning flights, some may be seeking habitat favorable for resting and foraging. Evidence for this explanation is provided for Block Island migrants by Parrish (1997), who analyzed recapture data from our records for the years 1969–1995 for 18 species of Nearctic-Neotropical migrants. His analysis revealed that 6.5% of the migrants captured at our station were recaptured during the same season, and that 28.3% of banded Northern Waterthrushes were recaptured. From experiments conducted with captured fall migrants, Parrish (1997) further demonstrated that many species are capable of mass-gain during stopover at Block Island. Thus, while most participants in morning flight on Block Island may have their destinations on the mainland as compensation for the previous night's wind-drift, other migrants are clearly seeking habitats on the Island for purposes of foraging and resting.

Community Composition of Block Island Migrants during Spring and Fall Migration

Four species—the Yellow-rumped Warbler, Gray Catbird, Common Yellowthroat, and White-throated Sparrow—dominated spring and fall capture at BIBS. These species were the four most abundant migrants in spring, totaling 48% of captures, and were among the six most abundant species in fall, totaling 54% of captures; the Yellow-rumped Warbler alone accounted for 35% of total captures in the fall. The two most abundant spring migrants, Gray Catbird and Common Yellowthroat, are among the three most abundant breeding birds on the Island, and overall, 38.1% of total spring captures were of the Island's 12 dominant (> 3.5 pairs per plot) breeding species (R. Enser, C. Raithel, *personal communication*). The relative abundance of spring migrant species was positively correlated with the number of nesting pairs per plot; however, this correlation did not exist in fall, when only 21.1% of total captures were Island-breeding species. It was noteworthy that Common Yellowthroats, which accounted for 14% of spring captures, initiated migratory movements off Block Island in late summer prior to fall banding activity at our station: Yellowthroats accounted for only 2% of fall captures.

Although the CV values calculated for each species were positively correlated between spring and fall migrations, spring CVs were consistently higher than those in fall (see Table 1), and the median difference across species was statistically significant. This greater interannual variation in abundance among our spring samples is likely a result of differences in weather patterns between spring and fall. Cold fronts and associated northwest winds that are so strongly associated with fall migratory flights occur with more regularity than do the warm-air systems associated with southwest winds in the spring (Drury and Keith 1962; Moore 1995). Indeed, in our experience some springs have very few evenings with southwest winds, resulting in relatively small numbers of birds captured. Spring CV values correlated negatively with relative abundance, suggesting that uncommon birds occur with less annual regularity than do more abundant species; this relationship did not exist in our fall sample, when migrant species, in general, occurred in greater numbers.

The proportion of Nearctic-Neotropical migrants at a stopover site could have implications for conservation initiatives, as long-distance migrants encounter greater ecological barriers in their migratory travels than do species that complete their life cycles in North America (Moore 1995). Our classification of wintering ranges is clouded by three of Block Island's dominant migratory species: Gray Catbird, Yellow-rumped Warbler, and Common Yellowthroat. These three species have broad winter ranges, extending throughout the southeastern United States (north of the tropics) and the islands of the Caribbean (tropical; Rappole et al. 1995). Because we did not know the wintering destinations for individuals in this dominant group of birds, we can only state with certainty that the true percentages of Nearctic-Neotropical migrants in our spring and fall samples range from 34% to 76% and 20% to 71%, respectively (see Table 3).

Despite the volume of literature on landbird migration in New England, particularly during fall, there exist few quantitative descriptions of avian community composition at stopover sites in the northeast. Only fall migration data from MCCS (Hagan et al. 1992) provides a multi-year sample of relative abundance data for the entire landbird community over the entire fall migration period. Hagan et al. (1992) presented capture data for 52 species of relatively abundant fall landbird migrants for 1970–1988, using the period 15 August–15 September, as did we, to define the fall migration. Yellow-rumped Warbler, Gray Catbird, Red-eyed Vireo, White-throated Sparrow, Golden-crowned Kinglet, and Dark-eyed Junco were among the 10 most abundant fall migrants at both BIBS and MCCS, and there was a strong positive correlation of the ranked species abundance between the sites. However, there exist substantial and predictable differences between these fall migrant communities.

The MCCS site is situated on the coastal mainland, whereas BIBS is on an island 15 km offshore. We predicted that the MCCS sample would contain a higher proportion of diurnal migrants, as such species would be better able to avoid offshore wind-drift than nocturnal migrants which lose visual contact with the landscape. Consistent with this theory, the dominant fall migrant at MCCS was the Black-capped Chickadee, which accounted for 20.7% of fall captures. Black-capped Chickadees were assigned a DI of 0.00 by Ralph (1981), a value indicative of a daytime-only migrant. Two other diurnally migrating species ranking among the top 10 in abundance at MCCS were American Robin (5.3% of captures, DI = 0.32), and Tufted Titmouse (2.3% of captures, DI not available). At BIBS, chickadees and robins ranked 38th (0.3% of captures) and 12th (1.8% of captures) in abundance in the fall, respectively, and in 25 years, we never captured a single Tufted Titmouse. Additionally, the mean DI was significantly greater for the Block Island fall migrant community (0.71) compared to the MCCS community (0.51). Thus, while diurnal migrants constitute a large proportion of a coastal-mainland fall migration community, landbird migration on Block Island is weighted heavily toward nocturnal species. These species are apparently wind-drifted to sea, far to the east of their desired migratory route, after losing visual contact with the coast during nocturnal migration.

The DI was strongly correlated with a ranked index of distance to the wintering grounds: i.e., the smaller the DI, the shorter the distance to the wintering grounds. Thus, it is not surprising that the proportion of migrants that winter in the northeast was much higher at MCCS during fall migration (26.0%) than at BIBS (2.1%). However, the prevalence of Yellow-rumped Warblers at BIBS strongly inflates the proportion of southeast-US/Central America/Caribbean migrants in that sample (50.7% BIBS, 30.5% MCCS), and the probability of capturing a bird that winters only in the Neotropics was nearly identical at BIBS and MCCS: Central America/Caribbean, 11.2% at BIBS and 11.4% at MCCS; South America, 9.2% at BIBS and 9.4% at MCCS).

Conservation of Block Island Migrants

Although reports of continental declines of Nearctic-Neotropical migrants in recent decades may have been exaggerated (Moore 2000b), there is substantial evidence that many species of this group are indeed in decline, and that this downward trend is more pronounced since 1978 (Sauer and Droege 1992; Robbins et al. 1992; Hagan et al. 1992). Analyses of fall migration capture data from MCCS (Hagan et al. 1992) and BIBS (Reinert and Lapham 1999) suggest recent declines in breeding-bird populations sampled at these southeastern New England banding stations. At MCCS, 36 (69%) of 52 landbird species assessed showed declines in the years 1980–1988 relative to the period 1970–1979. Those declines were statistically significant for 11 species: three Nearctic-Neotropical migrants, six southeastern-US migrants, and two species that winter in both regions. Twenty-two (55%) of the 40 species assessed at BIBS were significantly less abundant in the years 1980–1995 than in the years 1968–1979: 10 Nearctic-Neotropical migrants, 10 southeastern-US migrants, and two species that winter in both regions. Clearly, the populations of many migratory species that nest in northeastern North America are threatened, and many of the affected species are Nearctic-Neotropical migrants that merit special consideration. Hagan et al. (1992, p 128) emphasized that "…we should not overlook conservation problems facing short-distance migrants with both winter and summer ranges restricted to North America. These species should be monitored as closely as Neotropical-wintering species."

Moore et al. (1995) reported that, in developing strategies for the conservation of Nearctic-Neotropical migrants, the importance of habitat for birds during the migratory period ("en route," see Moore 2000b), i.e., stopover habitats, had been largely overlooked. Conservation measures targeting temperate breeding grounds or Neotropical wintering areas would be compromised unless the habitat requirements of the migratory period were also addressed. Because of the long distances traveled between wintering and breeding grounds by Nearctic-Neotropical landbird migrants, stopovers are required in habitats along the way for resting and foraging to fuel the next leg of the migratory journey. Thus, the conservation of habitats that provide these en route requirements is critical to the survival of migratory bird populations (Moore et al. 1995). Block Island provides stopover habitat for tens of thousands of spring and fall migrants each year; and for several reasons related to its geographical position, the Island represents an especially critical link in the migratory pathways of many individual birds traveling coastal routes.

The Importance of Block Island as a Migratory-Bird Stopover Site

Because of its position in the Atlantic Ocean, Block Island provides critical resting and foraging habitats for migrants, particularly in the fall after the birds have encountered strong northwest winds. Many migrants that are blown out to sea may have exhausted their energy reserves during their return flights, and were it not for such offshore habitats, these young landbirds would perish. The importance of en route habitats adjacent to ecological barriers, such as those provided on Block Island, was repeatedly emphasized in a recently published series of papers on landbird migrant stopover biology (Moore 2000a), which strongly urged readers to take measures to protect the habitats, and thus the large concentrations of migrants they attract (Barrow et al. 2000; Hutto 2000; Petit 2000; Woodrey 2000). Further augmenting the importance of Block Island habitats for migrants is the high proportion of first-year birds in the spring and fall landbird communities. The perils of migration are magnified for such immature birds, which are inexperienced in travel and en route foraging strategies, yet the health of migratory species is heavily dependent on the recruitment of young into their populations (Moore et al. 1995; Parrish 1997; Woodrey 2000; McWilliams 2000). The lean condition of immature migrants reaching Block Island after over-water flights dictates their need for more lengthy stopover periods for adequate refueling (Moore et al. 1995; Morris 1996), and habitat of sufficient quality and quantity is required to meet such energy demands (Moore et al. 1995; Moore and Aborn 2000; McWilliams 2000).

Thus, Block Island represents a critically important link in a chain of stopover habitats traditionally used by large numbers of first-year migrants traveling through the northeastern United States. This link is threatened, however, by the unrelenting development pressures in coastal areas throughout the United States (e.g., Moore et al. 1995; Mabey and Watts 2000; Parrish 2000) and on Block Island. Aggressive conservation strategies aimed at protecting stopover habitats must be enacted in coastal areas if migratory bird populations are to be maintained at current levels.

Stopover Habitats of High Priority on Block Island

Researchers have shown that the habitats used by landbird migrants during stopover may be substantially different from the habitats utilized by the same species during the breeding and wintering seasons (Moore et al. 1995; Parrish 1997, 2000; Petit 2000). Therefore, information on the resource requirements of migrants during stopover periods is required for the development of effective conservation strategies for en route habitats (Moore et al. 1995; Barrow et al. 2000; McWilliams 2000; Moore 2000b; Petit 2000). Due to recent intensive field research on the stopover ecology of fall landbird migrants on Block Island, such data is available to us, and we are able to suggest land conservation initiatives specifically tailored for Block Island.

During the fall seasons of 1993–1995, Parrish (1997) studied the diets of Nearctic-Neotropical landbird migrants on Block Island in the shrub habitats at the Island's north end, approximately 2 km north of BIBS. His analysis of the diets of migrants, all of which are insectivorous during the breeding season, revealed that many species expanded their diets en route to include fruit; frugivory was extensive within individual migrants, and widespread among the species sampled. Parrish found that species consuming relatively high proportions of fruit gained more mass during stopover than did those that maintained highly insectivorous diets. He suggested that the dietary plasticity exhibited by migrants represented an adaptation to the energetic demands of migration, and that the preservation of fruit-bearing shrublands in coastal regions represented a critical element in the development of conservation strategies for Nearctic-Neotropical landbird migrants. In a later paper (Parrish 2000, p 65), he specified that "protection of existing maritime shrubland habitats and stewardship efforts aimed at managing for successional stages typified by an abundance of fruiting plants are encouraged given the importance of fruit in the diets and behaviors of many [landbird migrant] species." Moore et al. (1995) underscored the importance of coastal shrub communities as providers of critical food resources for immature migrants returning to land following disoriented nocturnal flights over the western Atlantic.

Among the plant species providing fruit-food resources, only three were found in 20% or more of the fecal samples acquired from Parrish's captured migrants: Northern Arrowwood (*Viburnum dentatum* var. *lucidum*), Northern Bayberry (*Myrica pensylvanica*), and Pokeweed (*Phytolacca americana*). Northern Arrowwood was found in 66.5% of all fecal samples, and was the most-used fruit of thrushes, vireos, Emberizine sparrows, and most warblers. The waxy berries of Northern Bayberry were found in 97.5% of the fecal samples of Yellow-rumped Warblers. Although no other species foraged on *Myrica* fruit as often as Yellow-rumped Warblers, the dominance of this species in fall at BIBS (35% of captures) underscores the importance of bayberry patches as a stopover habitat. *Viburnum* and *Myrica* are among the most abundant shrub species on Block Island, and this likely contributed to their high use by migrants. However, recent experiments with captive Red-eyed Vireos by Wilson and McWilliams (2000) suggest that migrants select foods based in part on their fatty acid composition; thus, birds in the wild may select fruit-types based in part on their energy value. The high use of *Viburnum* is consistent with this notion, as Arrowwood berries are high in lipid and energy content (Parrish 1997).

Suggested Conservation Initiatives for Landbird Stopover Habitats on Block Island

Within the state of Rhode Island, Block Island is acclaimed as a site of unparalleled natural beauty and rare and endangered flora and fauna (see Littlefield et al., this volume). The recognition of these values has spawned land acquisition/protection efforts by international (e.g., The Nature Conservancy [TNC]), national (e.g., the US Fish and Wildlife Service), state (e.g., the Audubon Society of Rhode Island, the Rhode Island DEM), and local (e.g., the Block Island Conservancy [BIC], the Block Island Land Trust [BILT], the Town of New Shoreham) organizations, resulting in the current protection of 7.6 km^2, or a remarkable 26.2% of the Island's total land area (C. Baker, *personal communication*; see also Rosenzweig Figure 7, this volume). In managing conservation properties, these organizations have formed an informal, yet highly effective partnership that leverages the biological expertise inherent in each entity. The management objectives developed by this partnership include, among numerous Natural Heritage elements, protecting the Island's spring and fall landbird migrations (Block Island Bio-reserve Plan, TNC 1990). Drawing on these elements, and on recent literature on the conservation of en route habitats, we here offer eight suggestions to the partnership organizations for the continuance, or initiation, of conservation actions related to the maintenance and enhancement of landbird migrant stopover habitats on Block Island. These suggestions embody a current philosophy of managing the southwest portion of the Island for grassland ecosystems and the north end of the Island for migratory bird habitat (Raithel 1994; S. Comings, *personal communication*).

1. Incorporate the value of Block Island's landbird migration in the Town's comprehensive plan (see Mabey and Watts 2000).
2. Consolidate and publish comprehensive, ecosystem-scaled, land-use philosophies and management objectives for Block Island.
3. Continue to monitor fruit production of shrub habitats in the Island's north end, and be prepared to manage habitats as necessary to optimize fruit production. Also consider (a) the importance of Northern Arrowwood, Northern Bayberry, and the herbaceous Pokeweed in the diets of fall migrants on Block Island as documented by Parrish (1997, see above; Barrow et al. 2000); and (b) the importance of freshwater bodies adjacent to vegetative cover, as water deprivation may be the factor forcing stopover for individual migrants (Moore et al. 1995).
4. Continue management practices that maintain grassland systems in the southwest part of the Island. Attempt to enhance the area of existing fields by suggesting grassland management schema to the owners of private lands adjacent to existing grassland tracts. Such practices maintain ecosystem diversity and provide critically important habitat for grassland nesting birds and migrants (see Raithel 1994; Petit 2000; Vickery and Herkert 2001), and are also consistent with habitat enhancement for the indigenous American Burying Beetle (*Nicrophorus americanus*; Kozol 1995; Scott 1998).
5. Continue to promote the use of "management agreements" among partnership organizations and private landowners for special management/preservation concerns (e.g., TNC's agreement with Block Island Airport for rare-plant protection; see also Mabey and Watts 2000).
6. As a supplement to the extensive public education efforts of TNC and partners, develop a "landowner's guide" designed to educate citizens about the natural values of their properties, and to instruct them in land-use practices that will benefit landbird migrants and other wildlife populations (see Mabey and Watts 2000). Important elements include: (a) recommendations for landscape plantings and management of existing shrub habitats (see item 3 above); (b) the importance of maintaining vegetative cover adjacent to freshwater bodies, regardless of size (see item 3 above); and (c) recommended schedules for mowing grassland habitats (see item 4 above). The guide should include contacts for further advice on all land-use practices.
7. Develop incentives for the development and/or restoration of landbird migrant habitats on private properties (see Mabey and Watts 2000). Include information on such incentives in the landowner's guide suggested in item 6.
8. Consolidate, among conservation partnership organizations, a list of privately owned lands of high priority for acquisition and/or protection. Develop additional mechanisms to (a) quickly evaluate properties that come on the market as to their value as migratory bird habitat, and (b) initiate acquisition/protection efforts where appropriate.

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Dedication

This chapter is dedicated to the memory of Helen Lapham (1939–1997), who enriched the lives of so many in sharing her passion for, and knowledge of, natural history, and who dedicated much of her life to the implementation and successful operation of the Block Island Banding Station.

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