

Stopover Ecology of Neotropical Migrants in Central Veracruz, México¹

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Abstract

Available information on the ecology of neotropical migrants during the winter season and especially during migration is far behind the existing knowledge of birds during the breeding season. This paper presents a stopover ecology case study. We document the occurrence of species, outline the prevailing weather patterns during spring and fall migration seasons, and present an analysis of the landscape and land use indices from central Veracruz, México, to better understand the relationship between birds and some of the variables that model their migration strategies.

The central Veracruz region has a large altitudinal gradient and habitat types vary from coastal to alpine. Forty-four localities of central Veracruz were extensively surveyed between 1991-2003, using field techniques such as migration counts, mist nets, and fixed-radius point counts. Prevailing weather during migration seasons consists of fronts called 'Nortes' in the fall and 'Suradas' in the spring.

The area has a high diversity of neotropical migrants with 239 species recorded, representing over 44 percent of the regional avifauna. Migrant bird species decrease in both quantity and relative proportion of local avifaunas as elevation increases. Lowland habitats are of conservation concern, while highland habitats are better preserved. Migrants seem to first occupy lowland habitats and then spread out to locations with a more specific habitat type and altitude. The relative importance of habitat patches in this fragmented landscape is believed to be influenced by weather regimes and vary temporally. We make specific recommendations on future stopover ecology research with immediate

applications and recommendations for conservation measures.

Key words: neotropical migrant birds, stopover ecology, Veracruz, México.

Introduction

During the spring of 1992, the senior author was attending a tropical ornithology course in southern México taught by instructors from the Point Reyes Bird Observatory. There, Steve N. G. Howell used the term "White Map Syndrome" to explain how the lack of information on tropical birds, and that of neotropical migrants outside their breeding range, was reflected in many distributional works by leaving the section of the map corresponding to México (or any other area outside the United States and Canada) colored in white (*fig. 1*). This syndrome continues to be present in many recent publications, although our understanding of the winter ecology of neotropical migrants – and more recently of the conservation issues of wintering areas and stopover sites – has improved significantly within the last 25 years (e.g. Keast and Morton 1980, Rappole et al. 1983, Hagan and Johnston 1992, Finch and Stangel 1992).

The original interest in neotropical migrant ecology outside the breeding season, was primarily focused on habitat relationships and species distribution on their non-breeding range (e.g. Lowery and Dalquest 1951; Andrie 1966; Greenberg 1980; Lynch 1989, 1995; López-Ornat and Greenberg 1990; Hutto 1992; Greenberg et al. 1997, 2001). More recently, the ecology of migrants at stopover sites has been recognized by the scientific and conservation community as a period of critical importance (Moore 2000, Yong and Finch 2002). However, information on neotropical migrants continues to be lacking outside the breeding period.

Researchers and conservationists are recognizing the need to look at a larger scale than individual species, such as the physiographic regions described in the Partners in Flight Bird Conservation Plans (Rich et al. 2004). Recently, conservationists have turned their

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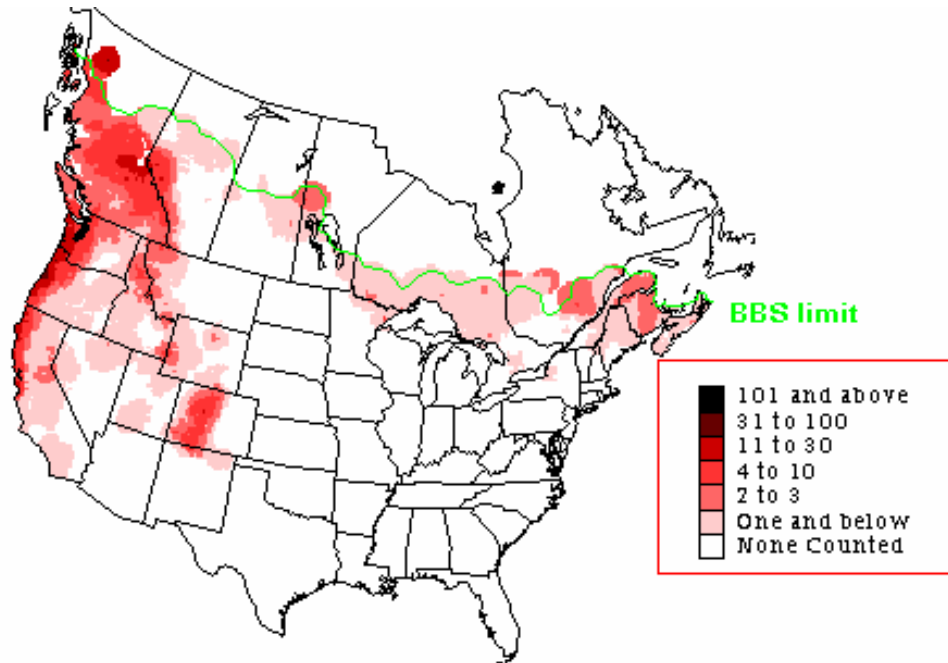


Figure 1— The White Map Syndrome. The lack of information about the status of migrant birds outside the well-studied area of the United States and Canada is frequently depicted in maps as a white area. Winter distribution of Neotropical migrants is roughly understood, but the level of information is far from parallel to the one available on the breeding season. Stopover areas information is only recently being explored. Source: Breeding Bird Survey data for the Wilson's Warbler (*Wilsonia pusilla*) (Sauer et al. 2003 [on-line]).

attention to the identification and protection of important sites for en-route migrants, reviewing existing bird conservation and land protection plans, and adding stopover areas not encompassed in current conservation initiatives (e.g. Duncan et al. 2002). However, the interface between bird migration strategies, geography, and climate is a complicated topic, and even basic criteria to define what makes a stopover site a conservation priority are still debated.

This paper provides a descriptive account of (1) the species of neotropical migrant birds present in central Veracruz, their seasonal occurrence, and altitudinal distribution; (2) the effect of weather regimes on bird migrations during spring and fall migration seasons; and (3) the landscape features, habitats, and regional land use practices of importance to neotropical migrants. We also identify key issues for ecological research and provide a list of local conservation priorities.

Methods

Study area

Central Veracruz, México, lies at the intersection of the Central Volcanic Belt and the Sierra Madre Oriental. The lowlands of the wide Gulf coastal plain narrow to its minimum at around 19° 30' of North latitude, and

this geographic feature constrains the width of the migration front for many species (fig. 2). We arbitrarily selected field work localities within a rectangle of 1 degree of latitude by 1.5 degrees of longitude (19 to 20°N, and 96 to 97°30'W), an area of roughly 10,059 square kilometers (table 1, fig. 2). Within that geographic area, the variation in altitude ranges from sea level to 5,747 meters above sea level (mASL) at the summit of the Pico de Orizaba volcano. All the observations were made in localities below 3,500 mASL and most were below 2,400 mASL (table 1).

As suggested by the altitudinal variation, the vegetation of the area is diverse. Gómez-Pompa (1973) has described 15 major vegetation associations for this region, from coastal scrub to alpine meadows. The most representative vegetation types are (in approximate order of regional coverage) tropical deciduous forest, tropical evergreen forest, cloud forest, oak forest, pine-oak forest, pine forest, and fir forest.

Very few of these habitats remain in a pristine condition and natural communities continue to be under strong anthropogenic pressure. Many different agricultural practices have largely replaced natural habitats (Hoffman and Velázquez 1995). This mosaic of variation in altitude, vegetation types, and location in the transition area between the nearctic and the neotropic has resulted in a high regional bird diversity

Table 1— *List of localities of study of neotropical migrants in central Veracruz, México, 1991-2003 and survey techniques used.*

	Locality	Coordinates	Elevation (mASL) ¹	Survey technique(s) used ²
1	Acajete	19°35'N 97°07'W	2,010	MICT, NSYO
2	Actopan	19°30'N 96°37'W	380	MICT, NSYO
3	Antigua	19°17'N 96°17'W	10	MICT, NSYO
4	Cardel	19°22'N 96°22'W	29	MICT, MSNT, PTCT, BNDS (El Palmar), NSYO
5	Cerro Gordo	19°26'N 96°42'W	660	MICT, MSNT, NSYO
6	Chachalacas	19°25'N 96°19'W	10	MICT, NSYO
7	Chichicaxtle	19°21'N 96°28'W	120	MICT, MSNT, NSYO
8	Coatepec	19°27'N 96°57'W	1,225	MSNT, NSYO
9	Cumbre del Español	18°29'N 97°08'W	1,990	PTCT
10	El Aserradero	18°31'N 97°07'W	3,100	PTCT, NSYO
11	El Castillo	19°35'N 96°52'W	1,180	NSYO
12	El Rincón	18°34'N 97°04'W	1,415	PTCT
13	Fortín (El Corazón)	18°54'N 97°01'W	700	PTCT, MSNT, NSYO
14	Jilotepec	19°36'N 96°57'W	1,380	NSYO
15	La Joya	19°36'N 97°02'W	2,230	MSNT, PTCT, NSYO
16	La Mancha	19°35'N 96°23'W	10	MICT, MSNT, BNDS, NSYO
17	Las Torres	18°54'N 97°01'W	815	PTCT, NSYO
18	Las Vigas	19°38'N 97°06'W	2,485	MSNT, PTCT, NSYO
19	Macuil Acatl	18°29'N 97°03'W	2,350	PTCT
20	Matalarga	18°52'N 96°58'W	700	PTCT, MSNT, NSYO
21	Metlac Primero	18°28'N 97°03'W	1,960	PTCT, NSYO
22	Miradores	19°28'N 96°47'W	925	MICT, MSNT, NSYO
23	Monte Blanco	18°57'N 97°00'W	1,300	PTCT, MSNT, NSYO
24	Monte Salas	18°55'N 97°01'W	1,020	PTCT, MSNT, NSYO
25	Naolinco	19°39'N 96°52'W	1,605	MICT, MSNT, NSYO
26	Palma Sola	19°46'N 96°26'W	90	MICT, NSYO
27	Peña Blanca	18°03'N 97°07'W	1,825	PTCT, NSYO
28	Perote	19°34'N 97°15'W	2,420	NSYO
29	Plan de las Hayas	19°45'N 96°40'W	1,080	MICT, NSYO
30	Playa Juan Angel	19°30'N 96°20'W	10	NSYO
31	Potrero Nuevo	18°34'N 97°05'W	3,490	PTCT
32	Rinconada	19°21'N 96°34'W	254	MICT, NSYO
33	Rio Escondido	19°20'N 96°32'W	160	MICT, MSNT, NSYO
34	San Julián	19°14'N 96°15'W	45	NSYO
35	Teocelo	19°23'N 96°58'W	1,240	MSNT, NSYO
36	Tetla	18°59'N 97°03'W	1,400	PTCT, NSYO
37	Tocuila	18°31'N 96°54'W	1,310	PTCT, NSYO
38	Totalco	19°30'N 97°21'W	2,380	NSYO
39	Veracruz City	19°13'N 96°08'W	20	NSYO
40	Villa Rica	19°41'N 96°24'W	25	NSYO
41	Xalapa	19°32'N 96°55'W	1,440	MICT, MSNT, PTCT, NSYO
42	Xocotla	18°32'N 97°05'W	1,950	PTCT, NSYO
43	Xometla	18°31'N 97°31'W	2,550	PTCT, NSYO
44	Zapoapan	18°50'N 97°58'W	700	PTCT, NSYO

¹mASL: meters above the sea level.²Codes for survey techniques: PTCT: point counts; MSNT: mist net survey; BNDS: banding station; MICT: counts of migrants; NSYO: non-systematic observations.

of over 500 species (Ruelas and Montejo 1999, R. Straub unpubl. data, E. Ruelas I. unpubl. data).

Each fall, a series of fronts move across the central Veracruz area from the north. Between the period of mid-August and mid-November each year (the height of the migration season) between 11 and 15 fronts, locally called 'Nortes', modify the seasonal rhythm of the migration. Nortes last between 2 and 7 days, the first day usually has the strongest winds (as strong as 75 kph) that decrease as the front passes through. For a day or two following a Norte, the winds have a reduced and southerly component. Precipitation ranges from 550 to 715 mm during the period 20 August through 20 November of each year (SEMARNAT 2004).

During spring migration, the weather is similar, but southerly winds of lesser speeds dominate the region and alternate with fewer days of winds of a northerly component. These fronts, locally called 'Suradas', are more diffuse and about 8 to 12 of these fronts are reported between the 1 March and 15 May of each year (Servicio Meteorológico Nacional 2004) (*fig. 3*).

Bird Surveys

Our inventory of neotropical migrants is the result of several studies carried on between 1991 and fall 2003 in 44 localities. Four main field methodologies were used in these surveys:

- (1) *Fixed-radius point counts of winter residents.* We used 10 min, 25-m radius point counts spaced at 200 m (Hutto et al. 1986, Ralph et al. 1995) to survey winter residents during the fall of 1993 in the lowlands around Cardel and La Antigua, and around Fortín and Coscomatepec in 1995 (N = 21 localities) (López-Portillo et al. 1993, Ruelas 1995, E. Ruelas I. unpubl. data).
- (2) *Mist nets.* An array of five to ten 2.5-m by 12-m, 25-mm mesh mist nets were used in 16 localities to survey local avifaunas (*sensu* Ralph and Scott 1981, Ralph et al. 1993). Mist nets were used during breeding and non-breeding season.
- (3) *Operation of banding stations.* Migrant species records have also been obtained during the operation of banding stations for raptors in El Palmar and La Mancha (Ruelas 1993, Scheuermann and Ruelas 2003) and for passerines (E. Martínez L. pers. comm., R. Straub pers. comm.).

- (4) *Diurnal counts of migrants.* Counts have been performed in 16 localities following standard procedures described by Kerlinger (1989:30) and HMANA (2004). The protocol locally in use is focused on raptors, vultures, and wading birds, but includes any other species recorded.

In addition to the four methods outlined above, we also included daily observations collected as part of non-systematic field work at 39 locations (*table 1*).

Landscape Feature Analysis

Rather than attempting a thorough analysis of the 42 different land use categories that can be differentiated in satellite imagery available, we calculated a series of landscape indices (O'Neill et al. 1988) to understand general patterns of land use. The landscape analysis was done using a commercially available satellite image from 1994 and a 1:250,000 spatio-map with pixels of 30-m resolution (INEGI 2004a). The 1x1.5 degree study area was divided into three arbitrary altitudinal categories we considered to be a good representation of altitudinal variation of the local distribution of bird species (*fig. 4*). Bird species records were assigned to the altitudinal category where they had been collected to determine relative importance of different altitudinal categories.

Landscape indices were obtained using the raster version of Fragstats 2.0 (McGarical and Marks 1994). The landscape metrics obtained are typically used to characterize the geometric and spatial properties of fragments in a map (Fortin 1999), and include: (1) the proportion of non-forested grid cells; (2) the proportion of forested grid cells; (3) dominance or the extent to which one or several similar land uses dominate the region (low values = few land uses); (4) a measure of the complexity of shapes in the landscape, an index that incorporates perimeter-area information (low values = low variation in fragment shapes, e.g. mechanized agriculture which uses square-shaped fields; and (5) mean patch size which is the average size of fragments over 0.81 hectares (three by three grid cells).

Results

We recorded 239 species of neotropical migrants (39 families) (*Appendix 1*). These represent ~44 percent of all the species of birds recorded in the area to date (Ruelas and Montejo 1999, E. Ruelas I. unpubl. data, R. Straub unpubl. data) (*table 2*). Most species of migrants (N = 146) have overwintering populations, while relatively fewer species have both wintering and resident populations, or are purely transient (*fig. 5*).

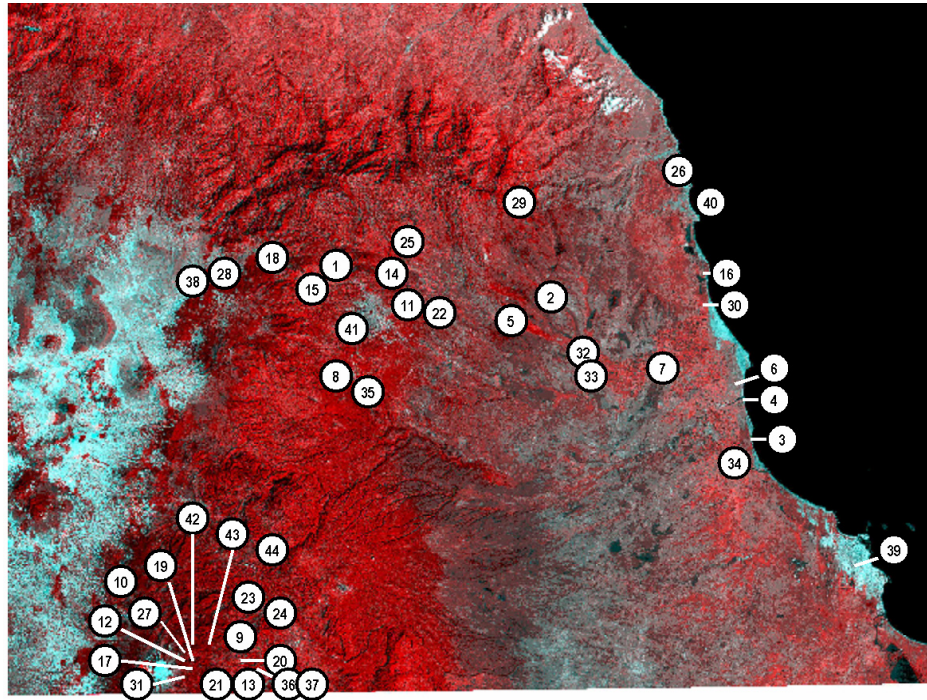


Figure 2— Topographic and land use features of the central Veracruz landscape. Source: INEGI spatio-map scale 1:250,000 (INEGI 2004a) from a 1994 satellite image. Localities of field work are numbered as in *table 1*.

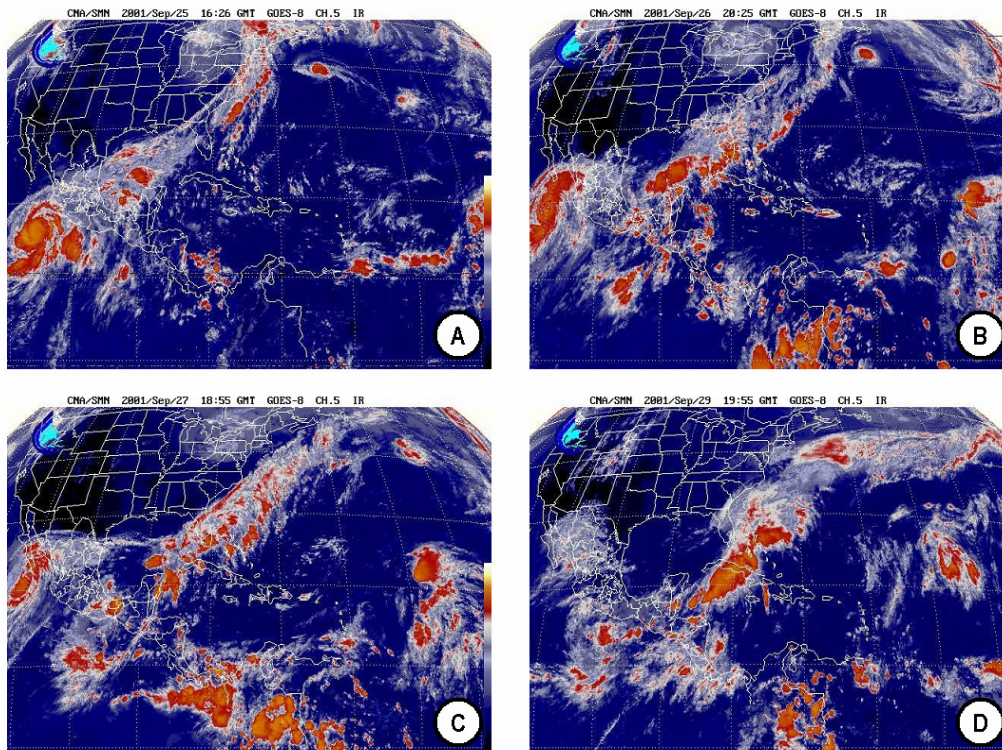


Figure 3— The typical sequence of a Norte during the fall migration season in central Veracruz, México. (A) A clearly defined Norte with winds of 55 kilometers per hour is recorded from northern Tamaulipas to Veracruz. (B) A Norte finds opposition as it encounters a low pressure system with eastern and southern winds. Winds reduce their speed to 35 kilometers per hour in central Veracruz. (C) Mean wind speed for the day is 12 kilometers per hour in central Veracruz, from the northeast and shifting to the east around 1700 CST. (D) The prevailing winds are east in the morning hours. Low wind speed (6 kilometers per hour) from the southeast is recorded in the afternoon hours in central Veracruz. Source: satellite GOES 10 and GOES 12 images of the Servicio Meteorológico Nacional (2004).

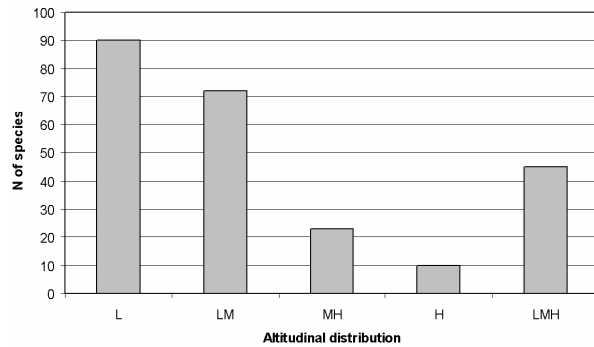


Figure 4— Altitudinal distribution of neotropical migrants recorded in central Veracruz, México. Excluding the nearly 18 percent of the species with altitudinally widespread distributions, the number of species decreases dramatically as altitude increases. Key to altitudinal distribution codes: (L) lowlands below 500 mASL; (LM) lowlands-mid-elevations between 0-1,500 mASL; (MH) mid-elevations-highlands, between 500 and 1,500 mASL; (H) highlands above 1,500 mASL; and (LMH) altitudinally widespread migrants.

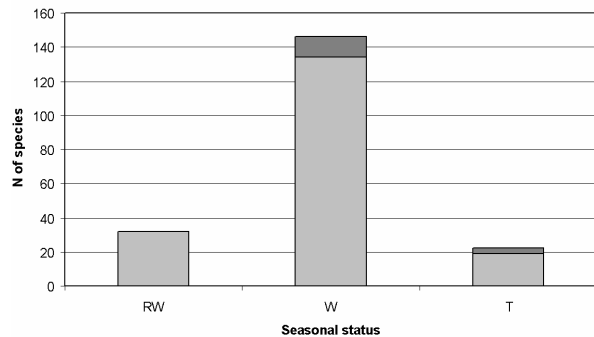


Figure 5— Seasonal status of neotropical migrants recorded in central Veracruz, México. Key to seasonality codes: (RW) species with year-round resident and wintering populations; (W) species with only wintering populations (light gray), and wintering species with accidental records in the area (dark gray); (T) species with transient populations (light gray), which includes (t) species of transient species that might have wintering populations (dark gray), and three records of accidental transient migrants.

Altitudinal distribution

The flux of incoming migrants appears to occur first in the lowlands and spread across the study area at a later time. This idea is supported by the fact that most species ($N = 162$) can be found in the lowlands throughout the northern winter season, where it is frequent to find species of mid-elevation and highland birds [e.g. Black-throated Green Warbler (*Dendroica virens*), Hermit Warbler (*D. occidentalis*), and Townsend's Warblers (*D. townsendi*)] that settle in higher altitudinal habitats as the winter season advances (fig. 4).

Except for the 45 species of altitudinally-widespread migrants, migrant birds are overall more abundant and encompass a larger proportion of the local avifauna in

lowland elevations. Migrant species decrease both in quantity and total proportion of the avifauna as altitude increase ($r^2 = 0.947$, $P < 0.01$, $df = 3$) (fig. 4), despite the relatively better condition of forest habitats in the highlands (table 3).

Weather and Migration

During fall migration, diurnal migrants (e.g. vultures, hawks, storks, ibises) cease their flights during the start of the fronts, when wind speed can reach up to 75 kph. In the days after the beginning of a Norte, winds slow down and the migration continues its pace for periods of two to five days until the front is followed by a few days of winds with a southerly component. The number of birds recorded daily at a migration count site varies and it is highly weather-dependent (i.e. high numbers with Nortes and low numbers with Suradas).

It is unclear what the effect of Nortes might be on nocturnal migrants, but we suspect that they respond in a similar way to the diurnal migrants, since large numbers of passerine migrants often are found foraging in all habitats following the start of Nortes. When fronts are very strong, events of moderate mortality are not infrequent. Nortes provoke overcast, windy weather in the lowlands and days with heavy precipitation in the highlands, possibly reducing foraging or making adequate shelter for migrants harder to locate.

Table 2— Neotropical migrants present in central Veracruz, México, by ecological/taxonomic groups. The base inventory of birds is taken from Ruelas and Montejo (1999) and R. Straub and E. Ruelas I. (unpubl. data).

Ecological / taxonomic group	Total N of species	Species of neotropical migrants
Waterbirds (Grebes to Ducks, Rails to Cranes)	60	44
Shorebirds (Plovers to Gulls)	51	46
Non-passerine landbirds (New World Vultures to Falcons, Pigeons to Woodpeckers)	64	40
Suboscine passerines (Flycatchers to Swallows)	45	25
Oscine passerines (Wrens to Orioles)	176	84
Total	528	239

Table 3— *Indices of landscape use for central Veracruz, México. These include: (P1) the percentage of non-forested grid cells; (P2) the percentage of forested grid cells, including primary vegetation types and second growth; (D1) dominance (high values= one land use type dominates others); (D3) complexity of shapes in the landscape (high values= higher variation of shapes in the landscape); and (MPS) mean patch size, average area of forested habitat patches over 0.81 hectares.*

Elevational category	Index				
	P1	P2	D1	D3	MPS (ha)
Lowlands (0 to 500 mASL)	89	11	1.25	0.84	6.5
Mid-elevation (500 to 1,500 mASL)	62	38	0.80	1.16	27.8
Highlands (>1500 mASL)	42	58	0.65	1.11	33.5

The system observed in spring migration is similar, although the alternating Suradas are not as strong as Nortes and Suradas usually last fewer days and show a less marked effect on the seasonal timing of migration. Hurricanes are infrequent in this area because of the protection of the Yucatán Peninsula that blocks their trajectory.

Landscape Attributes and Migration

The lowlands of central Veracruz have lost more of the original habitat cover than the mid-elevation and highland localities. Land uses in lowlands below 500 mASL include primarily sugar cane plantations and cattle pastures and the remaining forested area is highly fragmented (mean patch size < 6.5 ha) and restricted to short riparian corridors and inaccessible terrain (table 3).

Non-forested, mid-elevation landscapes (500 to 1,500 mASL) are utilized mainly for cattle pastures and shade coffee plantations, among many other crop types. Average patch size is over four times that found in the lowlands (table 3). Land use systems of mid-elevations are more dynamic than lowland and highland landscapes, and land use can change dramatically within a few years resulting in a heterogeneous mosaic of land uses.

The highlands are the best preserved altitudinal zone, with less than half of the original landscape converted into agricultural production. Cattle production is the dominant use in this landscape, although corn, wheat, potatoes, and other high elevation crops are found as well. Second-growth forest is abundant despite long-term forestry practices for lumber and charcoal. The lower human population densities may be responsible for the overall better preserved landscape (table 3). Forested patches have the largest average size of any in the region.

Discussion

Relative Importance

The large number of migrant species recorded wintering in central Veracruz represents nearly two-thirds of the species involved in the nearctic-neotropical avian migration system (Partners in Flight 2004). To our knowledge, this is the highest diversity of neotropical migrant species recorded for a given area (Rappole et al. 1983, Yong and Finch 2002).

Distribution by Altitude and Habitat

The altitudinal distribution patterns of migrants support the idea of a hierarchical mode for habitat selection in Veracruz. Migrants appear to be more plastic and to select a wider variety of habitats and altitudinal ranges early in the migration season. Habitats may be selected first by landscape attributes, e.g. forested vs. non-forested habitats, and as the winter season advances the migrants seem to confine themselves to more specific habitats, supporting the observations of Hutto (1985) for western México and the scale-dependent model of Moore et al. (this volume).

Some species of migrants requiring high quality or very specific habitats, such as Marsh Wrens (*Cistothorus palustris*), Hooded Warblers (*Wilsonia citrina*), and Worm-eating Warblers (*Helmitheros vermivorus*), have been recorded in Veracruz in the past (Sclater 1857, 1859; Chapman 1897; Davis 1945). Despite extensive field work, they appear to either occur in low numbers or be absent as over-wintering migrants. Because most of the pristine or well-preserved habitats in the lowlands have largely vanished, local and regional bird distributions seen today are principally a human-influenced phenomenon. Habitat use patterns observed for residents and migrants must be interpreted within these constraints.

Weather and its Influence in Selection of Habitat and Altitude

Bird migrations are largely modeled by prevailing wind conditions and habitat availability (Berthold 2003). The

local weather regimes described here, with alternating front systems, affects bird abundance and results in selection of different habitat patches. These patches may have a different relative importance as stopover habitat in years with different weather regimes (Moore 2000).

Between-year variation of precipitation and distribution of fronts is relatively high (coefficient of variation 25-36 percent, Servicio Meteorológico Nacional 2004) and habitat use in small fragments of vegetation can not be considered 'traditional' due to the patchy nature of its distribution. Large expanses of forest are consistently used by migrants, such as those in the Sierra de Manuel Díaz and the higher-elevation Sierra de Misantla (parallel to the 19° 30'N line). The conservation of stopover habitats in such a region needs to be considered a dynamic process with ample spatial and temporal flexibility. We suggest that a classification of stopover habitats which assign a fixed label of relative importance in such highly-fragmented areas should be discouraged.

Role of Land Use in Regional Bird Distribution and Seasonality

Lowland habitats have historically had a much higher human population density than mid-elevation and highland areas and land uses have remained relatively unchanged for many years (Hoffman and Velázquez 1995). Mid-elevation habitats, formerly dedicated to agriculture are reverting to habitats more suitable for birds through secondary succession. The areas around large cities such as Xalapa, Córdoba, Fortín, Huatusco, and Orizaba have shifted large proportions of their human population from primary production to industrial and commercial activities within the last 20 years resulting in a net increase in forested area in recent years (INEGI 2004b).

Solving the White Map Syndrome: Further Avenues of Research and Conservation

Recommendations for further work in the region can be classified in two types: research directions, and conservation priorities. Since the base for most conservation suggestions rests on further knowledge of migration ecology, we will start outlining what we consider the most important research topics for the region:

Research Priorities

- (1) Determine species and populations involved in migrations; conduct an assessment of the

geographic origin and the relative importance of the region for each species' populations;

- (2) Define species-specific patterns of the timing of migration and geographic distribution;
- (3) Identify stopover and wintering areas. Once identified, determine migrant use of stopover habitat, length of stopover, relative importance of available vegetation types, and survivorship and health of migrants using habitat fragments as stopover and wintering sites;
- (4) Determine the influence of weather on the timing, geographic distribution and habitat use by migrants; and
- (5) Investigate diet and food resources used by neotropical migrants.

Conservation Issues

- (1) Identify of populations, species, and habitats that need critical conservation attention;
- (2) Assess and rank human activities influencing (positively, negatively) migratory birds;
- (3) Identify conflicts with agricultural and other human activities and generate possible solutions;
- (4) Evaluate the role of preserving habitat versus promotion of land use practices that have little or no conflict with habitat use by migrants (e.g., shade coffee) or recovery of altered habitats;
- (5) Increase funding available for neotropical migratory bird research, public outreach, and habitat conservation in Veracruz; and
- (6) Develop local capable, sustainable human resources to implement research and conservation priorities.

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Literature Cited

- Andrle, R. F. 1966. **North American migrants in the Sierra de Tuxtla of southern Veracruz, México.** *Condor* 68: 177-184.
- Berthold, P., editor. 2003. **Avian migration.** New York, NY and London, UK: Springer Verlag.
- Chapman, F. M. 1898. **Notes on the birds observed at Jalapa and Las Vigas, Vera Cruz, México.** *Bulletin of the American Museum of Natural History* X: 15-43.
- Davis, W. B. 1945. **Notes on Veracruz birds.** *Auk* 62: 272-286.
- Duncan, C. D., B. Abel, D. Ewert, M. L. Ford, S. Mabey, D. Mehlman, P. Patterson, R. Sutter, and M. Woodrey. 2002. **The Nature Conservancy, Arlington, VA.** Available at <http://www.conserveonline.org>. Accessed 9 April 2004.
- Finch, D. M. and P. W. Stangel, eds. 1993. **Status and management of neotropical migratory birds.** Gen. Tech. Rep. RM-GTR-229. Fort Collins, CO: Service Rocky Mountain Forest Range Experiment Station, Forest Service, U.S. Department of Agriculture.
- Fortin, M.-J. 1999. **Spatial statistics in landscape ecology.** In J. M. Klopatek and R. H. Gardner, eds. *Landscape ecological analysis - Issues and applications.* New York: Springer-Verlag; 253-279.
- Gómez-Pompa, A. 1973. **Ecology of the vegetation of Veracruz.** In A. Graham, ed. *Vegetation and vegetational history in northern Latin America.* Amsterdam, Netherlands: Elsevier Publishers; 73-148.
- Greenberg, R. 1990. **Southern México: crossroads for migratory birds.** Washington, DC: Smithsonian Migratory Bird Center.
- Greenberg, R., P. Bichier, and J. Sterling. 1997. **Acacia, cattle, and migratory birds in southeastern México.** *Biological Conservation* 80: 235-247.
- Greenberg, R., C. E. Gonzáles, P. Bichier, and R. Reitsma. 2001. **Nonbreeding habitat selection and foraging behavior of the Black-throated Green Warbler complex in southeastern México.** *Condor* 103(1): 31-37.
- Hagan III, J. M., and D. W. Johnston, editors. **Ecology and conservation of neotropical migratory birds.** Washington, DC: Smithsonian Institution Press.
- Howell, S. N. G., and S. Webb. 1995. **A guide to the birds of México and northern Central America.** Oxford, UK: Oxford University Press.
- Hoffman, O., and E. Velázquez. 1995. **Las llanuras costeras de Veracruz, la lenta construcción de regiones.** Xalapa, Veracruz, México: L'Institut Français de Recherche Scientifique por le Developpement en Coopération - Universidad Veracruzana.
- Hutto, R. L. 1985. **Habitat selection by nonbreeding, migratory land birds.** In M. L. Cody, ed. *Habitat selection in birds.* New York: Academic Press; 455-76.
- Hutto, R. L. 1992. **Habitat distributions of migratory landbird species in western México.** In J. M. Hagan III and D. W. Johnston, eds. *Ecology and conservation of neotropical migratory birds.* Washington, DC: Smithsonian Institution Press; 221-239.
- Hutto, R. L., S. M. Pletschet, and P. Hendricks. 1986. **A fixed-radius point count method for nonbreeding and breeding season use.** *Auk* 103: 593-602.
- Instituto Nacional de Estadística, Geografía e Informática (INEGI). 2004a. **Spatiomaps scale 1:250,000 from 1994 satellite images.** http://mapserver.inegi.gob.mx/geografia/espanol/prodyserv/prods-eograficos/espacio_virtual/nuevo.cfm (Accessed 9 April 2004).
- INEGI. 2004b. **National population and housing census, 1980-2000.** <http://www.inegi.gob.mx/est/default.asp?c=2343> (Accessed 9 April 2004).
- Keast, A., and E. S. Morton, editors. 1980. **Migrant birds in the neotropics: Ecology, behavior, distribution, and conservation.** Washington, DC: Smithsonian Institution Press.
- Kerlinger, P. 1989. **Flight strategies of migrating hawks.** Chicago, IL and London, UK: University of Chicago Press.
- López-Omat, A., and R. Greenberg. 1990. **Sexual segregation by habitat in migratory warblers of Quintana Roo, México.** *Auk* 107: 539-543.
- López-Portillo, J., M. T. Pulido, G. Vásquez, P. Moreno-Casasola, P. Zamora C., F. González-G., and E. Ruelas I. 1993. **Impacto ambiental de la ampliación de la carretera Cardel - Veracruz.** Technical report for the Government of Veracruz. Veracruz, México: Instituto de Ecología A.C. Xalapa.
- Lowery, G. H., Jr., and W. W. Dalquest. 1951. **Birds from the state of Veracruz, México.** *University of Kansas Publications of the Museum of Natural History* 3: 531-649.
- Lynch, J. F. 1989. **Distribution of overwintering nearctic migrants in the Yucatan peninsula I: General patterns of occurrence.** *Condor* 91: 515-544.
- Lynch, J. F. 1995. **Effects of point count duration, time of the day, and aural stimuli on detectability of migratory and resident bird species in Quintana Roo, México.** In C. J. Ralph, J. R. Sauer, and S. Droege, tech. eds. *Monitoring bird populations by point counts.* Gen. Tech. Rep. PSW-GTR-149. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 1-6.
- McGarigal, K., and B. J. Marks. 1994. **Fragstats version 2.0. Spatial pattern analysis program for quantifying landscape structure.** Corvallis, OR: Oregon State University, Forest Science Department.

- Moore, F. R., editor. 2000. **Stopover ecology of nearctic-neotropical landbird migrants: Habitat relations and conservation implications.** Studies in Avian Biology No. 20. Cooper Ornithological Society.
- Moore, F. R., M. S. Woodrey, J. J. Buler, and S. Woltmann. This volume. **Understanding the stopover of migratory birds: A scale dependent approach.**
- O'Neill, R. V., J. R. Krummel, R. H. Gardner, G. Sugihara, B. Jackson, D. L. DeAngelis, B. T. Milne, M. G. Turner, B. Zygmunt, S. W. Christensen, V. H. Dale, and R. L. Graham. 1988. **Indices of landscape pattern.** Landscape Ecology 1: 153-162.
- Partners in Flight (2004). **List of neotropical migratory birds.** http://birdhabitat.fws.gov/NMBCA/eng_birdlist.htm. Accessed 9 April 2004.
- Ralph, C. J. and J. M. Scott, editors. 1981. **Estimating numbers of terrestrial birds.** Studies in Avian Biology No. 6. Cooper Ornithological Society.
- Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. **Handbook of field methods for monitoring landbirds.** Gen. Tech. Rep. PSW-GTR-144. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.
- Ralph, C. J., S. R. Sauer, and S. Droege, technical editors. 1995. **Monitoring bird populations by point counts.** Gen. Tech. Rep. PSW-GTR-149. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.
- Rappole, J. H., E. S. Morton, T. E. Lovejoy, III and J. L. Ruos. 1983. **Nearctic avian migrants in the neotropics.** Washington, DC: U.S. Fish and Wildlife Service.
- Rich, T. R., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. **Partners in Flight North American landbird conservation plan.** Ithaca, NY: Cornell Lab of Ornithology.
- Ruelas I., E. 1993. **Estación de marcaje de aves rapaces migratorias Veracruz, México.** Reporte Técnico. Centro de Estudios para la Conservación de los Recursos Naturales. San Cristóbal de Las Casas, Chiapas, México.
- Ruelas I., E. 1995. **Distribution and abundance of endemic and neotropical migratory birds in forest remnants, second growth vegetation, and agroecosystems in the Metlac River basin, Veracruz, México.** Final report of project 93-174 to the National Fish and Wildlife Foundation. Córdoba, Veracruz, México: Pronatura Veracruz.
- Ruelas I., E., and J. E. Montejó D. 1999. **An incomplete checklist to the birds of central Veracruz. Second edition.** In-house publication sponsored by the National Fish and Wildlife Foundation. Xalapa, Veracruz, México: Pronatura Veracruz.
- Sauer, J. R., J. E. Hines, and J. Fallon. 2003. **The North American Breeding Bird Survey, results and analysis 1966 - 2002. Version 2003.1.0.** Laurel, MD: USGS Patuxent Wildlife Research Center.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2004. **Metadata, climate, and precipitation.** <http://infoteca.semarnat.gob.mx/Metadato.asp> (Accessed 9 April 2004).
- Scheuermann, K. L. and E. Ruelas I. 2003. **Five years of raptor banding in Veracruz, México.** Paper presented at the Hawk Migration Association of North America 2003 Conference. Corpus Christi, TX.
- Sclater, P. L. 1857. **List of additional species of Mexican birds obtained by M. August Sall, from the environs of Jalapa and S. Andres Tuxtla.** Proceedings of the Zoological Society (London) 1857: 201-207.
- Sclater, P. L. 1859. **On a series of birds collected in the vicinity of Jalapa, in southern México.** Proceedings of the Zoological Society (London) 1859: 362-393.
- Servicio Meteorológico Nacional. 2004. **GOES 12 and GOES 10 satellite images.** <http://smn.cna.gob.mx/> (Accessed 9 April 2004).
- Yong, W., and D. M. Finch. 2002. **Stopover ecology of landbirds migrating along the middle Rio Grande valley in spring and fall.** Gen. Tech. Rep. RMRS-GTR-99. Ogden, UT: Rocky Mountain Forest Station, Forest Service, U.S. Department of Agriculture.

Appendix 1— A list of the neotropical migrants of central Veracruz, México. Taxonomy and nomenclature follows Howell and Webb (1995). Key to seasonal status codes: (RW) a species with resident and wintering populations; (W) a species with wintering populations only (includes WA, accidental in the area); (T) a species with transient populations [includes (t), species with transient populations which could have unconfirmed (W) populations, and (tA), accidental in the area]. Elevation records codes: (L) lowlands between 0-500 mASL; (M) mid-elevation, 500-1,500 mASL; and (H) highlands, >1,500 mASL.

Species		Seasonal status	Elevation records
Grebes (Podicipedidae 2)			
Pied-billed Grebe	<i>Podilymbus podiceps</i>	RW	LM
Eared Grebe	<i>Podiceps nigricollis</i>	t	L
Boobies and gannets (Sulidae 1)			
Northern Gannet	<i>Morus bassanus</i>	W?A	L
Pelicans (Pelecanidae 1)			
American White Pelican	<i>Pelecanus erythrorhynchos</i>	t	LM
Cormorants (Phalacrocoracidae 2)			
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	W	L
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i>	RW	LM
Anhingas (Anhingidae 1)			
Anhinga	<i>Anhinga anhinga</i>	RW	LM
Herons (Ardeidae 8)			
American Bittern	<i>Botaurus lentiginosus</i>	W	L
Least Bittern	<i>Ixobrychus exilis</i>	t	L
Great Blue Heron	<i>Ardea herodias</i>	W	LMH
Great Egret	<i>Egretta alba</i>	RW	LMH
Snowy Egret	<i>Egretta thula</i>	RW	LM
Little Blue Heron	<i>Egretta caerulea</i>	W	LM
Tricolored Heron	<i>Egretta tricolor</i>	W	L
Reddish Egret	<i>Egretta rufescens</i>	R?W	L
Ibises and spoonbills (Threskiornithidae 3)			
White Ibis	<i>Eudocimus albus</i>	W	L
White-faced Ibis	<i>Plegadis chihi</i>	W	L
Roseate Spoonbill	<i>Platalea ajaja</i>	W	L
Storks (Ciconiidae 2)			
Jabiru	<i>Jabiru mycteria</i>	tA	L
Wood Stork	<i>Mycteria americana</i>	t	L
Geese and ducks (Anatidae 18)			
White-fronted Goose	<i>Anser albifrons</i>	W	L
Snow Goose	<i>Anser caerulescens</i>	W	L
Canada Goose	<i>Branta canadensis</i>	WA	L
Wood Duck	<i>Aix sponsa</i>	WA	L
Green-winged Teal	<i>Anas crecca</i>	W	LMH
Mallard	<i>Anas platyrhynchos</i>	WA	L
Northern Pintail	<i>Anas acuta</i>	W	L
Blue-winged Teal	<i>Anas discors</i>	W	LM
Cinnamon Teal	<i>Anas cyanoptera</i>	W	LM
Northern Shoveler	<i>Anas clypeata</i>	W	L
Gadwall	<i>Anas strepera</i>	W	L
American Wigeon	<i>Anas americana</i>	W	L
Canvasback	<i>Aythya valisineria</i>	W	L
Redhead	<i>Aythya americana</i>	W	L
Lesser Scaup	<i>Aythya affinis</i>	W	LMH
Hooded Merganser	<i>Mergus cucullatus</i>	t?A	LM
Red-breasted Merganser	<i>Mergus serrator</i>	WA	L
Ruddy Duck	<i>Oxyura jamaicensis</i>	t?	L

Appendix 1. continued.

Species		Seasonal status	Elevation records
New world vultures (Cathartidae 1)			
Turkey Vulture	<i>Cathartes aura</i>	RW	LM
Kites, hawks, eagles, and allies (Accipitridae 18)			
Osprey	<i>Pandion haliaetus</i>	W	LMH
Hook-billed Kite	<i>Chondrohierax uncinatus</i>	W	LM
Swallow-tailed Kite	<i>Elanoides forficatus</i>	T	LM
Mississippi Kite	<i>Ictinia mississippiensis</i>	T	LM
Plumbeous Kite	<i>Ictinia plumbea</i>	T	L
Bald Eagle	<i>Haliaetus leucocephalus</i>	WA	L
Northern Harrier	<i>Circus cyaneus</i>	W	LMH
Sharp-shinned Hawk	<i>Accipiter striatus</i>	W	LMH
Cooper's Hawk	<i>Accipiter cooperii</i>	RW	LMH
Common Black Hawk	<i>Buteogallus anthracinus</i>	RW	L
Harris's Hawk	<i>Parabuteo unicinctus</i>	W	LM
Grey Hawk	<i>Buteo nitidus</i>	RW	L
Red-shouldered Hawk	<i>Buteo lineatus</i>	W	L
Ferruginous Hawk	<i>Buteo regalis</i>	WA	LM?H
Broad-winged Hawk	<i>Buteo platypterus</i>	t	LMH
Swainson's Hawk	<i>Buteo swainsoni</i>	T	LMH
Zone-tailed Hawk	<i>Buteo albonotatus</i>	W	LM
Red-tailed Hawk	<i>Buteo jamaicensis</i>	W	LMH
Golden Eagle	<i>Aquila chrysaetos</i>	WA	L
Falcons and allies (Falconidae 3)			
American Kestrel	<i>Falco sparverius</i>	W	LMH
Merlin	<i>Falco columbarius</i>	W	LM
Peregrine Falcon	<i>Falco peregrinus</i>	W	LMH
Rails, gallinules, and allies (Rallidae 5)			
Virginia Rail	<i>Rallus limicola</i>	W	L
Sora	<i>Porzana carolina</i>	W	L
Purple Gallinule	<i>Porphyryula martinica</i>	RW	L
Common Moorhen	<i>Gallinula chloropus</i>	RW	L
American Coot	<i>Fulica americana</i>	RW	LMH
Cranes (Gruidae 1)			
Sandhill Crane	<i>Grus canadensis</i>	WA	L
Plovers (Charadriidae 7)			
Black-bellied Plover	<i>Pluvialis squatarola</i>	W	L
American Golden Plover	<i>Pluvialis dominica</i>	T	L
Snowy Plover	<i>Charadrius alexandrinus</i>	W	L
Wilson's Plover	<i>Charadrius wilsonia</i>	W	L
Semipalmated Plover	<i>Charadrius semipalmatus</i>	W	L
Piping Plover	<i>Charadrius melodus</i>	W	L
Killdeer	<i>Charadrius vociferus</i>	RW	LMH
Oystercatchers (Haematopodidae 1)			
American Oystercatcher	<i>Haematopus palliatus</i>	W	L
Stilts and avocets (Recurvirostridae 2)			
Black-necked Stilt	<i>Himantopus mexicanus</i>	RW	LM
American Avocet	<i>Recurvirostra americana</i>	W	LM
Sandpipers and allies (Scolopacidae 24)			
Greater Yellowlegs	<i>Tringa melanoleuca</i>	W	L
Lesser Yellowlegs	<i>Tringa flavipes</i>	W	LM
Solitary Sandpiper	<i>Tringa solitaria</i>	W	L
Willet	<i>Catoptrophorus semipalmatus</i>	W	L
Spotted Sandpiper	<i>Actitis macularia</i>	W	LMH
Upland Sandpiper	<i>Bartramia longicauda</i>	T	L

Appendix 1. continued.

Species		Seasonal status	Elevation records
Sandpipers and allies (Scolopacidae 24) (contd.)			
Whimbrel	<i>Numenius phaeopus</i>	W	L
Long-billed Curlew	<i>Numenius americanus</i>	W	L
Marbled Godwit	<i>Limosa fedoa</i>	W	L
Ruddy Turnstone	<i>Arenaria interpres</i>	W	L
Red Knot	<i>Calidris canutus</i>	W	L
Sanderling	<i>Calidris alba</i>	W	L
Semipalmated Sandpiper	<i>Calidris pusilla</i>	T	L
Western Sandpiper	<i>Calidris mauri</i>	W	L
Least Sandpiper	<i>Calidris minutilla</i>	W	L
White-rumped Sandpiper	<i>Calidris fuscicollis</i>	T	L
Baird's Sandpiper	<i>Calidris bairdii</i>	T	L
Pectoral Sandpiper	<i>Calidris melanotos</i>	T	L
Stilt Sandpiper	<i>Calidris himantopus</i>	W	L
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>	T	L
Short-billed Dowitcher	<i>Limnodromus griseus</i>	W	L
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	W	L
Common Snipe	<i>Gallinago gallinago</i>	W	LM
Wilson's Phalarope	<i>Steganopus tricolor</i>	T	L
Gulls, terns, and skimmers (Laridae 12)			
Laughing Gull	<i>Larus atricilla</i>	RW	LM
Franklin's Gull	<i>Larus pipixcan</i>	T	LM
Ring-billed Gull	<i>Larus delawarensis</i>	W	L
Herring Gull	<i>Larus argentatus</i>	W	L
Gull-billed Tern	<i>Sterna nilotica</i>	R?W	L
Caspian Tern	<i>Sterna caspia</i>	W	L
Royal Tern	<i>Sterna maxima</i>	W	L
Sandwich Tern	<i>Sterna sandvicensis</i>	W	L
Forster's Tern	<i>Sterna forsteri</i>	W	L
Least Tern	<i>Sterna antillarum</i>	RW	L
Black Tern	<i>Chlidonias niger</i>	t	L
Black Skimmer	<i>Rynchops niger</i>	W	L
Pigeons and doves (Columbidae 2)			
White-winged Dove	<i>Zenaida asiatica</i>	W	LMH
Mourning Dove	<i>Zenaida macroura</i>	W	LM
Cuckoos (Cuculidae 2)			
Black-billed Cuckoo	<i>Coccyzus erythrophthalmus</i>	T	LM
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	T	LM
Owls (Strigidae 2)			
Burrowing Owl	<i>Athene cunicularia</i>	W	LMH
Short-eared Owl	<i>Asio flammeus</i>	W	LM
Nighthawks and nightjars (Caprimulgidae 4)			
Lesser Nighthawk	<i>Chordeiles acutipennis</i>	W	LM
Common Nighthawk	<i>Chordeiles minor</i>	RW	LM
Chuck-Will's-Widow	<i>Caprimulgus carolinensis</i>	W	L
Northern Whip-poor-will	<i>Caprimulgus vociferus</i>	W	LM
Swifts (Apodidae 2)			
Chimney Swift	<i>Chaetura pelagica</i>	T	LM
Vaux's Swift	<i>Chaetura vauxi</i>	R?W?	MH?
Hummingbirds (Trochilidae 4)			
Ruby-throated Hummingbird	<i>Archilochus colubris</i>	t	MH
Black-chinned Hummingbird	<i>Archilocus alexandri</i>	t	MH
Broad-tailed Hummingbird	<i>Selasphorus platycercus</i>	W?	MH
Rufous Hummingbird	<i>Selasphorus rufus</i>	t?	LMH

Appendix 1. continued.

Species		Seasonal status	Elevation records
Kingfishers (Alcedinidae 1)			
Belted Kingfisher	<i>Ceryle alcyon</i>	W	LM
Woodpeckers (Picidae 1)			
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	W	MH
Flycatchers (Tyrannidae 15)			
Olive-sided Flycatcher	<i>Contopus borealis</i>	t	MH
Eastern Pewee	<i>Contopus virens</i>	T	LM
Yellow-bellied Flycatcher	<i>Empidonax flaviventris</i>	t?	LM
Acadian Flycatcher	<i>Empidonax virescens</i>	T	LM
Alder Flycatcher	<i>Empidonax alnorum</i>	T	L
Willow Flycatcher	<i>Empidonax trailli</i>	T	LM?H?
White-throated Flycatcher	<i>Empidonax albigularis</i>	W	LM
Least Flycatcher	<i>Empidonax minimus</i>	W	LM
Hammond's Flycatcher	<i>Empidonax hammondi</i>	W	MH
Buff-breasted Flycatcher	<i>Empidonax fulvifrons</i>	R?W?	H
Eastern Phoebe	<i>Sayornis phoebe</i>	W	LMH
Say's Phoebe	<i>Sayornis saya</i>	RW	H
Vermillion Flycatcher	<i>Pyrocephalus rubinus</i>	W	LMH
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	W	LM
Great Crested Flycatcher	<i>Myiarchus crinitus</i>	tA	LM
Brown-crested Flycatcher	<i>Myiarchus tyrannulus</i>	RW	LM
Western Kingbird	<i>Tyrannus verticalis</i>	tA	L?M
Eastern Kingbird	<i>Tyrannus tyrannus</i>	T	L
Scissor-tailed Flycatcher	<i>Tyrannus forficatus</i>	t	L
Swallows (Hirundinidae 6)			
Purple Martin	<i>Progne subis</i>	T	L
Tree Swallow	<i>Tachycineta bicolor</i>	W	LM
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	RW	LMH
Bank Swallow	<i>Riparia riparia</i>	T	L
Cliff Swallow	<i>Hirundo pyrrhonota</i>	T	LM
Barn Swallow	<i>Hirundo rustica</i>	T	LMH
Wrens (Troglodytidae 2)			
Northern House Wren	<i>Troglodytes aedon</i>	W	L?
Marsh Wren	<i>Cistothorus palustris</i>	W	MH
Kinglets and gnatcatchers (Sylviidae 2)			
Ruby-crowned Kinglet	<i>Regulus calendula</i>	W	LMH
Blue-grey Gnatcatcher	<i>Poliophtila caerulea</i>	W	LM
Thrushes and allies (Turdidae 4)			
Veery	<i>Catharus fuscescens</i>	T	L
Swainson's Thrush	<i>Catharus ustulatus</i>	t?	LM
Wood Thrush	<i>Catharus mustelinus</i>	W	LM
American Robin	<i>Turdus migratorius</i>	RW	MH
Mockingbirds, thrashers, and allies (Mimidae 2)			
Grey Catbird	<i>Dumetella carolinensis</i>	W	LM
Northern Mockingbird	<i>Mimus polyglottos</i>	RW	LMH?
Wagtails and Pipits (Motacillidae 1)			
American Pipit	<i>Anthus rubescens</i>	W	LMH
Waxwings (Bombycillidae 1)			
Cedar Waxwing	<i>Bombycilla cedrorum</i>	W	MH
Shrikes (Laniidae 1)			
Loggerhead Shrike	<i>Lanius ludovicianus</i>	W	LMH
Vireos (Vireonidae 9)			
White-eyed Vireo	<i>Vireo griseus</i>	W	LMH
Bell's Vireo	<i>Vireo belli</i>	T	LMH

Appendix 1. continued.

Species		Seasonal status	Elevation records
Vireos (Vireonidae 9) (contd.)			
Blue-headed Vireo	<i>Vireo solitarius</i>	W	LMH?
Cassin's Vireo	<i>Vireo cassinii</i>	W	H
Plumbeous Vireo	<i>Vireo plumbeus</i>	RW	H
Yellow-throated Vireo	<i>Vireo flavifrons</i>	W	MH
Warbling Vireo	<i>Vireo gilvus</i>	t?	LM
Philadelphia Vireo	<i>Vireo philadelphicus</i>	T	LM
Red-eyed Vireo	<i>Vireo olivaceus</i>	T	LM
Emberizidae			
Wood warblers (Parulinae 39)			
Blue-winged Warbler	<i>Vermivora pinus</i>	W	MH
Golden-winged Warbler	<i>Vermivora chrysoptera</i>	T	LM
Tennessee Warbler	<i>Vermivora peregrina</i>	W	MH
Orange-crowned Warbler	<i>Vermivora celata</i>	W	LMH
Nashville Warbler	<i>Vermivora ruficapilla</i>	W	LMH
Northern Parula	<i>Parula americana</i>	W	LM
Yellow Warbler	<i>Dendroica petechia</i>	W	LM
Chestnut-sided Warbler	<i>Dendroica pennsylvanica</i>	T	LM
Magnolia Warbler	<i>Dendroica magnolia</i>	W	LM
Yellow-rumped Warbler	<i>Dendroica coronata</i>	W	LMH
Black-throated Blue Warbler	<i>Dendroica caerulescens</i>	WA	M
Black-throated Grey Warbler	<i>Dendroica nigrescens</i>	W	MH
Townsend's Warbler	<i>Dendroica townsendi</i>	W	MH
Hermit Warbler	<i>Dendroica occidentalis</i>	W	MH
Black-throated Green Warbler	<i>Dendroica virens</i>	W	LMH
Golden-cheeked Warbler	<i>Dendroica chrysoparia</i>	t	M
Blackburnian Warbler	<i>Dendroica fusca</i>	T	LM
Yellow-throated Warbler	<i>Dendroica dominica</i>	W	L
Grace's Warbler	<i>Dendroica graciae</i>	RW?	H
Palm Warbler	<i>Dendroica palmarum</i>	WA	M
Bay-breasted Warbler	<i>Dendroica castanea</i>	T	LM
Cerulean Warbler	<i>Dendroica cerulea</i>	T	LM
Black-and-white Warbler	<i>Mniotilta varia</i>	W	LMH
American Redstart	<i>Setophaga ruticilla</i>	W	LM
Prothonotary Warbler	<i>Protonotaria citrea</i>	T	LM
Worm-eating Warbler	<i>Helminthos vermivorus</i>	t	LM
Swainson's Warbler	<i>Helminthos swainsoni</i>	T	LM
Ovenbird	<i>Seiurus aurocapillus</i>	W	LM
Northern Waterthrush	<i>Seiurus noveboracensis</i>	W	LMH?
Louisiana Waterthrush	<i>Seiurus motacilla</i>	W	LM
Kentucky Warbler	<i>Oporornis formosus</i>	W	LM
Mourning Warbler	<i>Oporornis philadelphia</i>	T	LM
MacGillivray's Warbler	<i>Oporornis tolmiei</i>	W	MH
Common Yellowthroat	<i>Geothlypis trichas</i>	W	LMH
Hooded Warbler	<i>Wilsonia citrina</i>	t	LM
Wilson's Warbler	<i>Wilsonia pusilla</i>	W	LMH
Canada Warbler	<i>Wilsonia canadensis</i>	T	LM
Red-faced Warbler	<i>Cardellina rubrifrons</i>	W	H
Yellow-breasted Chat	<i>Icteria virens</i>	W	LM
Tanagers (Thraupinae 3)			
Summer Tanager	<i>Piranga rubra</i>	W	LMH
Scarlet Tanager	<i>Piranga olivacea</i>	T	LM
Western Tanager	<i>Piranga ludoviciana</i>	W	MH

Appendix 1. continued.

Species		Seasonal status	Elevation records
Grosbeaks and buntings (Cardinalinae 7)			
Rose-breasted Grosbeak	<i>Pheucticus ludovicianus</i>	W	LM
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	W	MH
Blue Grosbeak	<i>Passerina caerulea</i>	W	LMH?
Indigo Bunting	<i>Passerina cyanea</i>	W	LM
Varied Bunting	<i>Passerina versicolor</i>	W	LM
Painted Bunting	<i>Passerina ciris</i>	W	LM
Dickcissel	<i>Spiza americana</i>	t	L
Brushfinches, seedeaters, sparrows, and allies (Emberizinae 7)			
Chipping Sparrow	<i>Spizella passerina</i>	RW	MH
Clay-colored Sparrow	<i>Spizella pallida</i>	W	H
Vesper Sparrow	<i>Poocetes gramineus</i>	W	H
Lark Sparrow	<i>Chondestes grammacus</i>	W	H
Grasshopper Sparrow	<i>Ammodramus savenarum</i>	W	LMH
Savannah Sparrow	<i>Ammodramus sandwichensis</i>	R?W	MH
Lincoln's Sparrow	<i>Melospiza lincolnii</i>	W	MH
Blackbirds and orioles (Icteridae 7)			
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	RW	LMH
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	WA	H
Brewer's Blackbird	<i>Euphagus cyanocephalus</i>	W	L
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	RW	L
Orchard Oriole	<i>Icterus spurius</i>	W	LM
Hooded Oriole	<i>Icterus cucullatus</i>	RW	L
Baltimore Oriole	<i>Icterus galbula</i>	W	LM
Bullock's Oriole	<i>Icterus bullockii</i>	W	LMH?