Progress Report: Resource Dynamics and Early Spring Arrival of Nearctic-Neotropical Landbirds Along the Northern Lake Huron Shoreline.

Date: 2 December, 2000

As a continuation of our data collection efforts in 1999, we monitored insect abundance, collected foraging behavior on American Redstarts (*Setophaga ruticilla*) in order to determine how early arriving birds utilized resources, and collected data to determine the influence emergent aquatic insects have on fitness for both passage and breeding birds within the study area. Our research is a combination of insect sampling, mist-netting birds to assess condition, colorbanding individuals and nest monitoring. Progress towards specific goals is described below.

General.

We captured 2381 individuals of 63 species, logged 14,398.5 net hours and had an overall capture rate of 0.17 birds/net hour. This rate was down a bit from the 1999 field season, in which we captured 0.23 birds/net hour. Once again, the most abundant species captured was American Redstart followed by Yellow-rumped Warbler, Magnolia Warbler, Black-throated Green Warbler, and Black-and-white Warbler (see Appendix A).

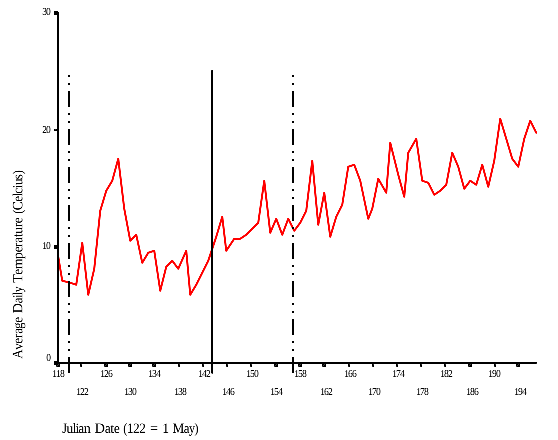

Figure 1. Average daily temperatures relative to median capture date (day 143) for all landbird migrants captured at Pontchartrain Shores, Michigan, 2000 (lines encompass 95% of all first captures).

Both daily temperature sampling (Figure 1) and monitoring the temporal progression of leaf-out in quaking aspen (*Populus tremuloides*) (Figure 2) indicated that onset of spring was similar to 1998 and 1999 (and a good deal different from 1997, which had a cold, delayed spring).

A result of these warmer temperatures (relative to seasons like 1997) was advancement in the progression of leaf-out, which was complete by the time many long distance migrants arrived/passed through the study site (see Figure 2). We have previously demonstrated a significant correlation between stage of leaf-out and numbers of nonflying arthropods, such as caterpillars (r=0.620, p=0.0001; R. Smith and F. Moore, unpublished). Thus, relative to years such as 1997, birds arriving along the north shore of Lake Huron experienced a generally better food situation. It is, however, important to point out that migrants did begin to arrive as early as 29 April (Julian Day 119), well before leaf-out was complete. Hence, many birds, even in this relatively good year, faced a situation with depressed food upon arrival. We feel that during this early arrival period midges are a critical food source (see below) whose importance is especially magnified during cold late springs such as we saw in 1997.

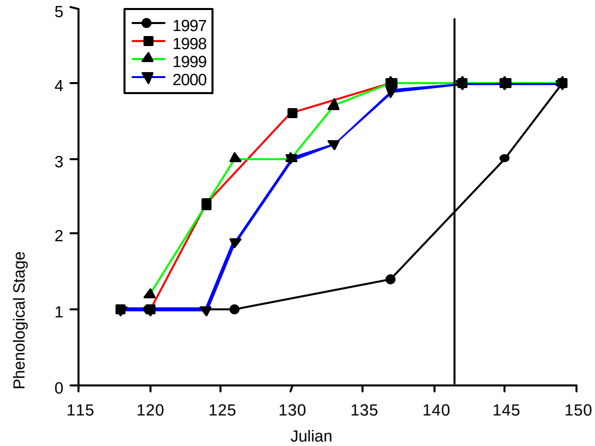

Figure 2. This graph tracks the advancement of leafout for Quaking at Pontchartrain Shores, Michigan. A phenological score of 1 leaves still in bud and a score of 4 represents leaves completely Scores are subjective and based on an average of 10 trees of each for each date observed. Leafout was delayed by some 10 days in 1997 to 2000 (solid line represents median arrival date for the 2000 field

Spring Migratory Period.

We use a combination of sampling techniques aimed at collecting both flying and non-flying insects. Both methodologies work well and we feel they provide a good representation of insect abundance at the study site.

Even as the environmental situation may have been relatively better in 2000 than in some past years (notably 1997), many migrants still arrived at our study site prior to the annual pulse of terrestrial arthropods (Figures 3 and 4). Our results suggest that early spring midge hatches are a critical food source to migrants arriving/passing through our site during much of the migratory period. For instance, capture data indicate that a number of bird species gain mass during early spring when midges are abundant yet prior to the terrestrial arthropod pulse mentioned above (outside of spiders, see Table 1, Figure 3). Additionally, data collected in 2000 on foraging American Redstarts indicate that birds in shoreline habitat performed more foraging maneuvers per minute, suggesting more food was available in these areas (Shoreline rate = 2.60, Inland rate = 1.43; t = 2.91, df = 31, p = 0.007). This result coincides with Seefeldt (1997. Attack rates of Black-throated Green Warblers (*Dendroica virens*) and American Redstarts (*Setophaga ruticilla*) along the shoreline of northern Lake Huron. Master's Thesis, Department of Biology. Mt. Pleasant, Michigan, Central Michigan University), who identified higher foraging rates for American Redstarts in shoreline habitats and attributed these differences to early season midge hatches.

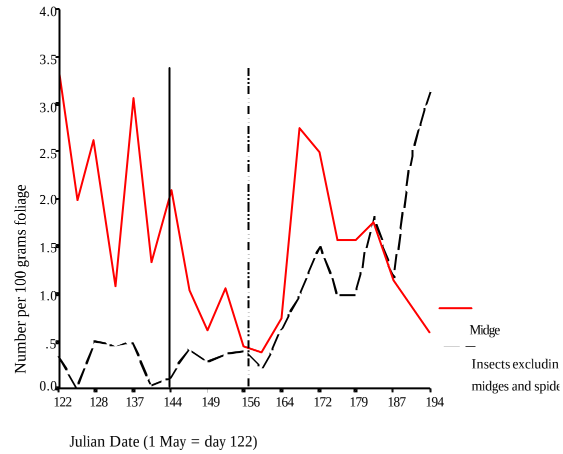

Figure 3. Median capture date (Julian day 144 = 24 May) relative to insect abundance, excluding spiders, at Pontchartrain Shores, Michigan, 2000. Ninety five percent of all first captures occurred from day 121 through day 156.

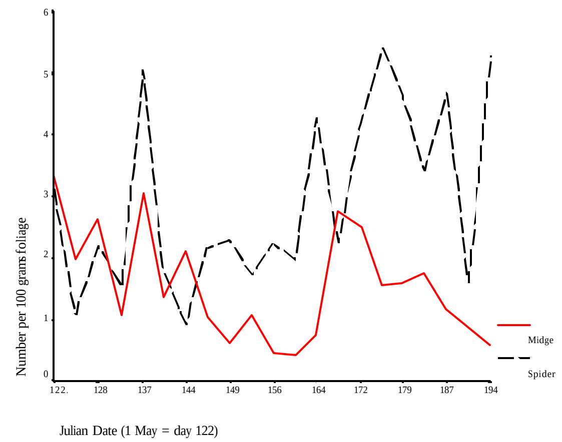

Figure 4. Midge and spider abundance at Pontchartrain Shores, Michigan, 2000. During the spring migratory period (prior to Julian day 153 - 1 June) there is a significant correlation between midge and spider abundance, Spearman's r = 0.277 p < 0.001 n = 106.

We think that the midge/bird relationship is actually more complex in that not only do early arrivals benefit directly by feeding on midges, but they also benefit indirectly by feeding on spiders, which in turn have been feeding on midges. A number of lines of evidence support this, though more work is clearly necessary. For one, there is a significant correlation (Spearman's r = 0.361, p < 0.001, n = 216; see Figure 4) between midge and spider abundance in shoreline habitats, suggesting a numerical response by spiders to abundant midges. Further, we have identified significant differences in spider abundance between shoreline and inland areas of similar vegetation composition. Spiders are more numerous in shoreline habitats through the end of May (Mann-Whitney Z = 4.813, P < 0.001; shoreline $\bar{x}$ = 2.24 spiders/100 grams foliage, inland $\bar{x}$ = 0.37 spiders/100 grams foliage). Finally, we have a number of anecdotal observations of birds feeding on midges, spiders feeding on midges, and birds feeding on spiders.

We plan to add to our sampling regime next year in order to more closely examine the midge/spider/bird relationship. We hope to sample bird behavior and insect abundance at inland sites with no midges. If spider abundance in shoreline habitat is related to midge abundance, then we expect to see fewer spiders immediately inland where there are no midges. Further, differences in bird foraging behavior between the two areas will support our contention that the midge/spider interaction in shoreline habitat is of significant importance to early season migrants.

Species	Significance Level	Estimated Mass Increase per Day	Estimated Gain per Day as a Percentage of Total Body Mass
American Redstart	**P < 0.001**	0.33 g	4.3 %
Black-and-white Warbler	**P = 0.01**	0.56 g	5.7 %
Blackburnian Warbler	**P = 0.15**	----	----
Black-throated Green Warbler	**P = 0.02**	0.25 g	2.9 %
Canada Warbler	**P = 0.02**	0.95 g	9.2 %
Common Yellowthroat	**P = 0.02**	1.08 g	10.4 %
Magnolia Warbler	P = 0.07	----	----
Yellow-rumped Warbler	P = 0.60	----	----
Nashville Warbler	P = 0.24	----	----
Northern Parula	P = 0.67	----	----
Swainson's Thrush	**P = 0.02**	4.80 g	15.2 %
Ruby-crowned Kinglet	P = 0.36	----	----

Table 1. Insectivorous landbirds captured prior to 1 June for which there were sufficient captures to perform statistical analyses. Multiple regression was used to check for increases, decreases, or no change in mass by regressing mass against capture time, controlling for capture date and body size. Estimated mass gain is based on an average mass calculated for each species captured at our study site prior to 1 June. Note that **none** of the species analyzed showed significant declines in mass.

Breeding Season.

We have also been monitoring American Redstart nests at our study site. This work has lead to a number of interesting relationships in need of further examination. In addition to providing a basic description of nest location (most of the nests we have found to date have been located in northern white cedar [*Thuja occidentalis*], a species of tree not generally thought to be as important a nesting site as deciduous species such as paper birch [*Betula papyrifera*] eg., Sherry, T.W. and R. T. Holmes. 1997. American Redstart (*Setophaga ruticilla*). *In* The Birds of North America, No. 277 (A. Poole and F. Gill eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, D.C.). timing of clutch initiation, number of eggs laid, number of young hatched, fledged etc., we have identified a number of interesting and novel relationships between arrival condition and reproductive performance. For instance, females that arrive at our site in better condition (as indicated by the amount of visible fat in the clavicular region and on the abdomen) lay more eggs (Kendall's $t = 0.3152$, one-tailed $p = 0.05$, $n = 24$) as well as heavier eggs (Spearman's $r = 0.711$, one-tailed $p = 0.01$, $n = 24$). Egg size has been linked to hatchling survivability in that chicks from larger eggs survive better (see Smith, H.G., Bruun, M. 1998. The effect of egg size and habitat on starling nestling growth and survival Oecologia 115:59-63).

We have also identified an intriguing relationship between male arrival condition and both egg mass ($r = 0.521$, one-tailed $p = 0.028$, $n = 14$) and egg volume ($r = 0.592$, one-tailed $p = 0.013$, $n = 14$). Also, fatter males tend to have more young than lean males during the nestling stage ($r=0.427$, one-tailed $p=0.056$, $n = 15$). Sample sizes are quite small in a number of these correlations, hence the fact that we are seeing relationships with these small sample sizes is encouraging. We feel that these relationships are real and will be sorted out more definatively by increasing sample size.

Another finding from last season's work is that mayflies (Ephemeridae) appear extremely important as a food source for nestlings. During the course of our nest monitoring activities, we observed, on numerous occasions, adult birds feeding nestlings newly emerged mayflies. While mayfly abundance is not completely reflected in our sampling (mayflies appear even more restricted to shoreline habitat and we necessarily sampled areas away from the immediate lakeshore in order to characterize our entire site), our sampling indicates mayflies become abundant around 27 June (Julian Day 179), which was when many birds were feeding nestlings (this peak agrees with anecdotal observations of the highest densities of mayflies occurring during the week of 25 June). For instance, median hatch day for American Redstarts was 22 June (Julian Day 174). American Redstart young generally stay in the nest for 8-9 days at our study site, which places the period of highest energetic demand for adults feeding nestlings during the period that mayflies are abundant (see Figure 5).

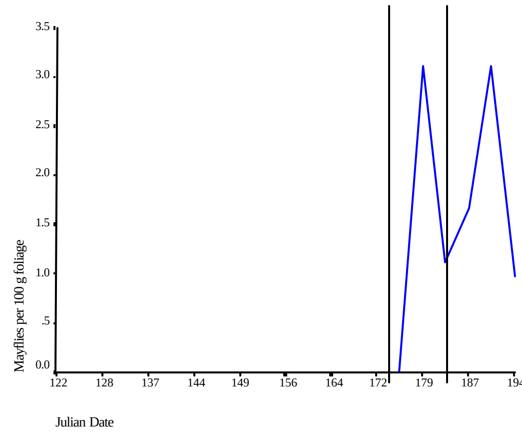

Figure 5. Plot of mayfly abundance, Pontchartain Shores, Michigan 2000. Lines indicate median hatch and fledge dates for American Redstart nestlings.

We feel this finding is especially intriguing and worthy of more direct examination. We are hoping to collaborate with a graduate student from Central Michigan University (a student of Dr. Michael Hamas) who will focus on the significance of mayflies to nesting birds.

Finally, we have previously demonstrated a distance effect in abundance of both midges and mayflies (both decrease with increasing distance from the lakeshore). In an effort to examine the influence of these aquatic insects on nesting parameters, we began marking the location of nests using a Global Positioning Unit and will subsequently load these points into a Geographic Information System. This will allow us to estimate distance from each nest to the lakeshore. We spent last season working out details of this procedure in addition to collecting locational data on some nests. It appears that this methodology will work though we have yet to perform analyses.

Initial work in the eastern Upper Peninsula (1993, 1994) suggested that midges were an important resource to early arriving birds (e.g., Ewert and Hamas, unpublished). Our continued research in the area, relating temporal and spatial changes in arthropod abundance and diversity, in conjunction with our mist-netting and behavioral observations, is more definitively answering questions relating significance of early season aquatic insects as an important food resource for birds. Further, our work has brought to light a number of relationships previously unknown at the beginning of our investigations (e.g. the early season abundance of spiders, the influence of mayflies, the relationship between arrival condition and reproductive performance etc.).

Our work has important conservation implications, especially as it relates to the importance of managing/conserving habitats for birds and other wildlife. The input of energy, by way of midges and mayflies, into terrestrial habitats magnifies the importance of conserving lakeshore areas - areas highly desired by humans for the placement of secondary vacation homes. Our research is bringing to light the importance of conserving both terrestrial and aquatic habitats for birds (and other wildlife). Hence, conservation efforts in coastal areas such as the north shore of Lake Huron must take on added dimensions as we continue to add to our understanding of the interrelationships between aquatic and terrestrial systems.

Appendix 1. Birds Captured at Pontchartrain Shores, Michigan, April - July, 2000. Note that Total captures include both first captures and all recaptures, hence the larger numbers.

SPECIES	New Captures	Returns from Previous Year	Total Captures
Sharp-shinned Hawk	5		7
Broad-winged Hawk	1		1
Killdeer	1		1
Yellow-bellied Sapsucker	2		2
Downy Woodpecker	9		9
Hairy Woodpecker	1		1
Yellow-shafted Flicker	5		6
Pileated Woodpecker	1		1
Alder Flycatcher	2		2
Willow Flycatcher	1		1
Yellow-bellied Flycatcher	5		5
Least Flycatcher	4		4
Great-crested Flycatcher	1		1
Blue-headed Vireo	3		3
Red-eyed Vireo	18	2	23
Blue Jay	1		1
Black-capped Chickadee	31	5	54
Red-breasted Nuthatch	8		11
Brown Creeper	22		44
Winter Wren	4		7
Golden-crowned Kinglet	45		70
Ruby-crowned Kinglet	18		18
Veery	29	7	73
Swainson's Thrush	24	3	42
Hermit Thrush	22		31
Gray-cheeked Thrush	3		3
Wood Thrush	1		1
American Robin	12	5	23
Gray Catbird	2		2
Brown Thrasher	1		1
Cedar Waxwing	47		52
Tennessee Warbler	1		1
Nashville Warbler	22		30
Northern Parula	22	8	52
Yellow Warbler	1		1
Chestnut-sided Warbler	4		4
Magnolia Warbler	79	9	153
Black-throated Blue Warbler	3		3
Yellow-rumped Warbler	116	16	246
Black-throated Green Warbler	89	1	148
Blackburnian Warbler	31	1	54
Palm Warbler	5		5
Bay-breasted Warbler	1		1
Black-and-white Warbler	63	2	91
Yellow-warbler	6		6
American Redstart	430	41	801
Ovenbird	29	3	43
Northern Waterthrush	3		3
Mourning Warbler	6		8
Common Yellowthroat	13		26
Connecticut Warbler	1		1
Wilson's Warbler	5		5
Hooded Warbler	1		4
Canada Warbler	23	2	26
American Tree Sparrow	2		2
Chipping Sparrow	10	1	13
Savanna Sparrow	2		2
Song Sparrow	30	1	43
Swamp Sparrow	2		2
Lincoln Sparrow	3		3
White-throated Sparrow	37	6	87
Northern Junco	7		7
Brown-headed Cowbird	1		1
Purple Finch	1		1
TOTAL	**1370**	**113**	**2381**