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

Date: 29 December, 1999

As a continuation of our data collection efforts in 1998, 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, mistnetting birds to assess condition, colorbanding individuals and nest monitoring. Progress towards specific goals is described below.

General - We captured 2356 individuals of 55 species, logged 10265.25 net hours and had an overall capture rate of 0.23 birds/net hour. Once again, the most abundant species captured was American Redstart followed by Magnolia Warbler, Yellow-rumped Warbler, White-throated Sparrow and Black-and-white Warbler (see Appendix A). Relative to 1998, we increased our total number of captures by 49% (1150 captures in 1998, 2356 in 1999). This was principally accomplished by relocating 3 nets and netting through the middle of July, some 2 weeks longer than in 1998 (our bander, Brian Johnson, also netted at the site for a couple of days in early August and has generously contributed these captures to our data set). We plan to add on the order of 5 nets in 2000.

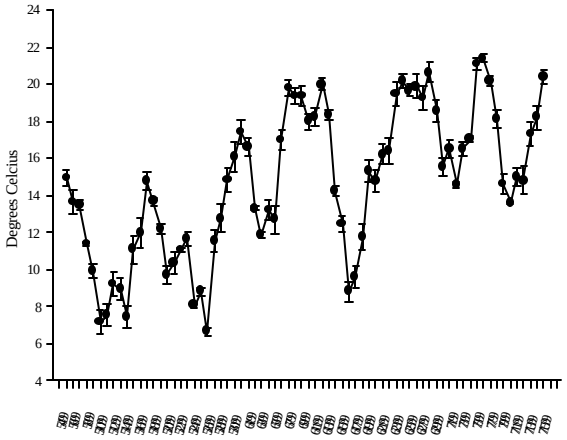

Figure 1. Average daily temperature (±SE) at Pontchartrain Shores, 1999.

Both daily temperature sampling and monitoring temporal changes in leaf-out of white birch (*Betula papyrifera*) and quaking aspen (*Populus tremuloides*) indicate that onset of spring was advanced for the eastern upper peninsula, this relative to work done in 1993, 1994 and 1997 (though not in 1998, in which spring was also advanced). For instance, comparisons of average daily temperatures for 1999 to a 10 year average (1986-1996; data from the St. Ignace weather station approx. 10 miles to the southwest) indicate that onset of spring occurred earlier, with average daily temperatures exceeding 10 C^o as early as 4 May. Typically, average daily temperatures do not exceed 10 C^o until around 15 May.

A result of these warmer temperatures in 1999 was advancement in the progression of leaf-out, which was complete by the time most of the long distance migrants arrived/passed through the study site. In 1997, which was a late spring, leaf-out was not complete until 9 June, whereas in 1998 it was complete by 13 May and in 1999 was complete by 12 May. 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 better food situation.

Objective: Describe how resources and resource abundance change temporally

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. As in 1998, migrants encountered a generally better food situation than in previous years in the eastern Upper Peninsula (R. Smith and F. Moore, unpublished). This quite likely was in response to the advanced spring.

As evidenced by Figs. 2 and 3, midges and spiders were initially very abundant, and basically the dominant arthropods during early spring. Both midge and spider populations underwent a general decline throughout the duration of our field work, until around 18 July, when there appeared to be another spike in spider abundance. As we discontinued sampling after 18 July, we are unable to characterize this peak. We can say that during this period many birds, especially those with early or failed nests, were beginning to molt, which entails an extreme energetic cost. This peak in spiders undoubtedly provided an important energy source.

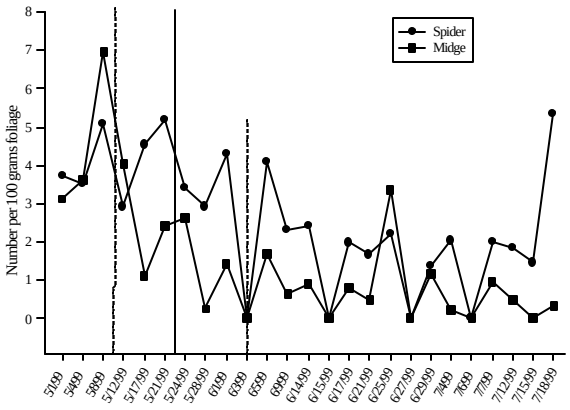

Figure 2. Median capture date (dashed lines encompass 95% of all first captures) for insectivorous migrants relative to midge and spider abundance, Pontchartrain Shores, Michigan, 1999.

Anecdotal observations indicate that both midges and spiders appear to be of significant importance to early arriving birds. We observed, on numerous occasions, spider webs full of midges along with spiders in shoreline habitat feeding on midges. Further, we watched birds feeding on midges and spiders during this early period; we even watched birds taking midges out of spider webs.

The correlation between midge abundance and spider abundance (Spearman's $r=0.361$, $p<0.001$, $n=216$) suggests that spiders were exhibiting a numerical response to midges, i.e., enhanced numbers of spiders in shoreline habitats as a result of a superabundant food source - midges. We plan to add to our sampling regime next year in order to more closely examine the midge/spider/bird relationship. We will 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.

<u>Objective: Examine the influence of emergent aquatic insects on fitness</u>

Data collected during the 1999 field season suggest that birds are deriving fitness benefits from the early season midge hatches, either by foraging directly on midges or by foraging on spiders. Our insect sampling demonstrates that many migrants arrived at our study site prior to the spring flush of terrestrial arthropods (outside of spiders) and that during this period birds gained mass. Multiple regression analyses on birds captured prior to 25 May (before this date our insect sampling indicates that arthropods, outside of midges and spiders, were depauperate, see Figs. 1 and 2) indicate that a number of species significantly increased body condition (i.e., demonstrated a positive mass gain after statistically controlling for capture date and body size; Table 1).

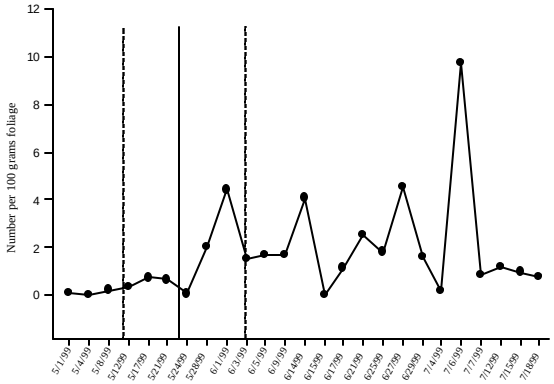

Figure 3. Median capture date (dashed lines encompass 95% of all first captures) for insectivorous migrants relative to nonflying insect abundance, excluding spiders, Pontchartrain Shores, Michigan, 1999.

SPECIES	SIGNIFICANCE LEVEL	ESTIMATED MASS INCREASE PER DAY	ESTIMATED GAIN PER DAY AS A PERCENTAGE OF TOTAL BODY MASS
American Redstart *Setophaga ruticilla*	**P = 0.03**	0.17 g	2.2 %
Black-and-white Warbler *Mniotilta varia*	P = 0.42	----	----
Black-throated Green Warbler *Dendroica virens*	**P = 0.01**	0.57 g	6.5 %
Magnolia Warbler *Dendroica magnolia*	**P = 0.05**	0.27 g	3.2 %
Yellow-rumped Warbler *Dendroica coronata*	**P = 0.006**	0.97 g	8.3 %
Nashville Warbler *Vermivora ruficapilla*	P = 0.40	----	----
Ovenbird *Seiurus aurocapillus*	P = 0.89	----	----
Ruby-crowned Kinglet *Regulus calendula*	**P = 0.02**	0.51 g	7.8 %

Table 1. Insectivorous landbirds captured prior to 25 May 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 25 May. Note that **none** of the species analyzed showed significant declines in mass.

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 a peak around 25 June, 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 19 June. 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 4).

We feel this finding is especially intriguing and worthy of more direct examination. We are hoping to bring in an additional graduate student, either from Central Michigan University or the University of Southern Mississippi, to focus directly on the significance of mayflies to nesting birds.

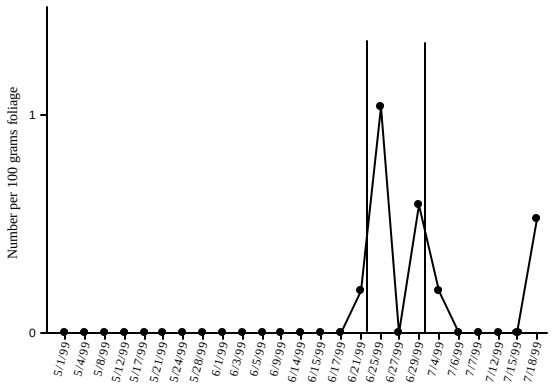

Figure 4. Plot of mayfly abundance, Pontchartrain Shores, Michigan, 1999. Lines indicate median hatch and fledge dates for American Redstart nestlings from first clutches.

Objective: Determine how birds are using resources during spring migration

Analyses on foraging behavior in American Redstarts suggest that birds foraged on midges in addition to spiders during early spring. For instance, male American Redstarts increased their use of sallystrikes, a foraging maneuver directed at a flying prey item, with time of day ($r=0.270$, $p=0.039$). Sallystrike rate did not correlate with temperature ($r=-0.027$, $p=0.859$) suggesting that the increase was not related to temperature effects on the birds themselves, and instead was in response to changes in behavior and/or type of prey. As midges were the dominant flying insect at this time, the observed bird behavior quite likely is reflective of midge behavior - midges swarm in warmer temperatures (R. Smith and F. Moore, unpublished) and birds are using more aerial maneuvers latter in the day when temperatures are warmer.

Previous work, where we directly compared foraging behavior of American Redstarts and Black-throated Green Warblers in shoreline habitats vs. inland habitats, suggests that, in addition to midges, birds are foraging on spiders during early spring. For instance, we have shown both birds species to differ significantly in their use of foraging maneuvers (AMREs $G=12.29$, $df=2$, $P<0.010$; BTNWs $G=6.32$, $df=2$, $P=0.04$) dependent upon whether they are in shoreline or inland habitats. Both used gleaning manuvers more in shoreline habitats during spring, suggesting the importance of spiders in addition to midges (Dallman et al. unpublished; Smith, R. Hamas, M, Dallman M and D. Ewert. 1998. Spatial variation in foraging of the Black-throated Green Warbler along the shoreline of northern Lake Huron. Condor 100:474-484).

The additional sampling that we have planned to more closely examine the midge/spider/bird relationship will also provide us with a more direct focus on the question of mayflies as an important food source for nesting birds. Because, as with midges, mayflies are tightly tied to shoreline habitat, comparisons of behavior between shoreline and inland areas will be illustrative in helping to determine the extent in which birds forage on mayflies. Further, combining insect sampling with nest monitoring will allow us to make comparisons of reproductive performance between shoreline and inland areas. For instance, if midges and/or mayflies are an important component in the diet of these birds, then we would expect to see differences in egg size, number of eggs per clutch, time of egg laying, hatching, fledging etc.

<u>Objective: Reproductive performance of American Redstarts nesting in shoreline habitat</u>

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 ($r=0.428$, $p=0.024$) as well as possibly heavier eggs ($r=0.375$, $p=0.093$). 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 ($r=0.521$, $p=0.028$) and egg volume ($r=0.592$, $p=0.013$). Also, fatter males tend to have more young than lean males during the nestling stage ($r=0.427$, $p=0.056$). Sample sizes are quite small in a number of these correlations (e.g., on the order of 15). The fact that we are seeing relationships with these small sample sizes is encouraging and we feel that these relationships are real and will be sorted out more definatively by increasing sample size.

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 definatively 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 (eg. 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 <u>both</u> 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, 1999. Note that Total captures include both first captures and all recaptures, hence the larger numbers. After Hatch Year (AHY) birds are birds that have undergone at least one complete migration. Hatch Year (HY) birds are birds hatched this year and have not yet undergone a migration.

SPECIES	New Captures	Returns from Previous Year	Total Captures	Date of First Capture	Date of Last Capture	Number of Days Captured	Peak Captures and Date of Peak	After Hatch Year (AHY)	Hatch Year (HY)
Sharp-shinned Hawk	2		3	5/15/99	8/6/99	3	1 each day	1	1
Merlin	1		1			1	1 on 6/14/99	1	0
American Woodcock	1		1			1	1 on 7/13/99	1	0
Mourning Dove	1		1			1	1 on 5/27/99	1	0
Yellow-bellied Sapsucker	1		1			1	1 on 5/12/99	1	0
Downy Woodpecker	5		5	6/20/99	7/23/99	5	1 each day	3	2
Hairy Woodpecker	4		4	6/8/99	7/21/99	4	1 each day	3	1
Yellow-shafted Flicker	7		8	5/11/99	7/14/99	8	1 each day	4	3
Yellow-bellied Flycatcher	2		2	5/23/99	6/10/99	2	1 each day	2	0
Least Flycatcher	2		2	6/9/99	7/21/99	2	1 each day	2	0
Eastern Phoebe	1		1			1	1 on 5/27/99	1	0
Red-eyed Vireo	27	2	34	5/20/99	7/14/99	19	7 on 5/31/99	29	0
Blue Jay	1		1			1	1 on 6/12/99	1	0
Black-capped Chickadee	26	3	60	4/30/99	8/7/99	29	7 on 7/23/99	19	10
Red-breasted Nuthatch	25		28	5/18/99	7/14/99	14	5 on 6/22/99	9	16
Brown Creeper	8		18	4/30/99	7/15/99	15	2 on three days	7	1
Winter Wren	4		6	5/3/99	7/22/99	6	1 each day	3	1
Golden-crowned Kinglet	6		7	5/2/99	8/7/99	6	2 on 5/2/99	4	2
Ruby-crowned Kinglet	18		18	4/30/99	5/20/99	12	5 on 5/10/99	18	0
Veery	24	3	36	5/12/99	7/15/99	25	4 on 7/8/99	24	3
Swainson's Thrush	18	2	31	5/19/99	7/14/99	22	3 on 6/27/99	19	1
Hermit Thrush	19		32	5/13/99	7/22/99	22	3 on three days	4	15
Wood Thrush	1		1			1	1 on 5/22/99	1	0
American Robin	34		37	5/10/99	7/22/99	21	8 on 7/22/99	26	8
Gray Catbird	1		1			1	1 on 5/15/99	1	0
Cedar Waxwing	22		22	5/31/99	7/15/99	10	4 on 6/16 and 6/21	21	1
Orange-crowned Warbler	1		1			1	1 on 5/10/99	1	0
Nashville Warbler	41		51	5/4/99	7/15/99	32	4 on 5/11/99	38	3
Northern Parula	21	6	49	5/6/99	8/7/99	31	3 on three days	24	3
Yellow Warbler	1		1			1	1 on 6/16/99	1	0
Chestnut-sided Warbler	2		2	5/12/99	5/16/99	2	1 each day	2	0
Magnolia Warbler	106	6	263	5/5/99	8/7/99	62	18 on 5/22/99	102	10
Black-throated Blue Warbler	1		1			1	1 on 5/16/99	1	0
Myrtle Warbler	75	8	151	5/3/99	8/7/99	59	6 on five days	65	18
Black-throated Green Warbler	65	1	95	5/5/99	8/7/99	51	8 on 5/18/99	57	9
Blackburnian Warbler	28	3	66	5/16/99	8/7/99	39	6 on 5/30/99	22	9
Palm Warbler	3		3	5/11/99	5/19/99	3	1 each day	3	0
Bay-breasted Warbler	2		2	5/18/99	5/19/99	2	1 each day	2	0
Black-and-white Warbler	82	2	124	5/4/99	8/7/99	52	9 on 5/16/99	73	11
American Redstart	428	16	832	5/6/99	8/7/99	64	43 on 5/29/99	423	21
Ovenbird	44	1	57	5/10/99	7/23/99	33	4 on 5/20/99	45	0
Northern Waterthrush	5		5	5/14/99	7/14/99	5	1 each day	3	2
Mourning Warbler	2		3	5/19/99	5/29/99	3	1 each day	2	0
Common Yellowthroat	4	1	7	5/24/99	8/8/99	5	1 on 5/24 and 5/26	4	1
Wilson's Warbler	4		6	5/22/99	5/28/99	4	2 on 5/22 and 5/24	4	0
Canada Warbler	36	2	46	5/18/99	8/7/99	29	5 on 5/31/99	37	1
American Tree Sparrow	1		1			1	1 on 4/30/99	1	0
Chipping Sparrow	3		7	5/12/99	6/8/99	6	1 on 6/2/99	3	0
Song Sparrow	12	1	18	5/5/99	8/8/99	14	2 on four days	6	7
Lincoln Sparrow	2		3	5/12/99	5/19/99	3	1 each day	2	0
White-throated Sparrow	56	6	131	5/2/99	7/21/99	51	9 on 5/12/99	55	7
White-crowned Sparrow	2		2	5/19/99	5/22/99	2	1 each day	2	0
Purple Finch	3		3	5/6/99	6/16/99	2	2 on 5/6/99	3	0
Pine Siskin	50		62	4/30/99	6/2/99	22	10 on 5/20/99	20	28
American Goldfinch	3		3	6/9/99	6/16/99	2	2 on 6/16/99	3	0
TOTAL	1344	63	2356	4/30/99	8/8/99	73	78 on 5/18/99	1210	195