Conservation Biology Research Grants Program
Natural Heritage & Nongame Research Program
Division of Ecological Services
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BIODIVERSITY OF SOUTHEASTERN MINNESOTA FORESTED STREAMS:

RELATIONSHIPS BETWEEN TROUT HABITAT IMPROVEMENT PRACTICES, RIPARIAN COMMUNITIES AND THE LOUISIANA WATERTHRUSH

REPORT TO:

NATURAL HERITAGE AND NONGAME WILDLIFE PROGRAM

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ABSRACT

Forested streams in southeastern Minnesota have a limited distribution and are managed to meet a variety of consumptive and non-consumptive objectives. One fisheries management technique is trout habitat improvement (HI). Trout HI can include substrate and bank modifications, narrowing of streams, removal of understory and canopy trees, and planting of grass. This study was conduced in Winona, Wabasha, Fillmore, Houston, and Olmsted counties in Minnesota in May through July of 1996 and 1997. The study describes avian riparian communities, aquatic invertebrates, their associations with a riparian obligate species, Louisiana Waterthrush (*Seiurus motacilla*), and possible impacts of trout habitat improvement projects n these species and communities. In Minnesota, Louisiana Waterthrushes are a Species of Special Concern. Point counts and nest searching techniques were used to assess the avian community and determine Louisiana Waterthrush reproductive success in May and June of each year. Concurrently, benthic aquatic invertebrates were collected using a Surber sampler, and assessed in the lab. Physical habitat assessments of the stream and stream banks were visually quantified in July of each year. The study include 20 sites in 1996, and 22 sites in 1997, covering 31.6 km of 1st - 3rd order streams. Randomization tests showed significant differences m avian communities between sites with and without trout habitat improvement and/or Louisiana Waterthrushes. Emergence of grassland and edge associated species and communities, including Brown headed Cowbirds, within areas of habitat improvement suggest loss of continuity in the forested riparian corridor. Aquatic invertebrates display greater variation in diversity and lower HBI scores (<%chironomids, >EPT) among streams with HI compared to those without. Among streams with HI Significant differences in stream physical habitats and riparian communities suggest trout habitat improvement may locally eliminate availability of several features required for Louisiana Waterthrush nesting, although no significant differences between HI and non HI sites were detected in reproductive success. Minimizing disturbance and protecting the riparian zones adjoining ephemeral 3rd order forested streams is a priority for conservation of Louisiana Waterthrushes and associated riparian communities in southeastern Minnesota.

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CHAPTER 1. Louisiana Waterthrush Ecology in Southeastern Minnesota

Introduction

The Louisiana Waterthrush (*Seiurus motacilla*) is a relatively large neotropical migrant wood warbler (Parulidae) (American Ornithologists' Union 1998). This ground nesting riparian obligate of eastern North America forages and breeds along flowing streams within mature forest. Although Breeding Bird Survey (BBS) data indicate Louisiana. Waterthrush populations have exhibited a nationwide 1.2% per year decline from 1980-1996 (Sauer et al. 1997), the species is not considered in immediate jeopardy (Robinson 1995).

In Minnesota, Louisiana Waterthrushes reach the northwestern limit of their breeding range. Historically, Roberts (1932) reported Louisiana Waterthrushes as not common but regularly breeding, including reported sightings dating to 1883. More recently, both Janssen (1987) and Eckert (1994) described the species as local or uncommon and occurring primarily in southeastern Minnesota. Louisiana Waterthrushes have been listed in Minnesota as a Species of Special Concern since 1984 (Coffin and Pfanmuller 1988, Natural Heritage and Nongame Research Program 1996) because of both limited range and documented population declines. Surveys for this species by the Minnesota County Biological Survey (MCBS) between 1988 -1993 documented territorial individuals ranging along the St. Croix River in Washington and Chisago counties and Houston and Winona counties in southeastern Minnesota (Eliason and Fall 1989, Minnesota Natural Heritage Database). In 1994, a brief breeding season study was conducted at Beaver Creek Valley State Park, Houston County, to further assess the

extent of the Louisiana Waterthrush population (Surdick 1996); five to six pairs were documented in the park along East Beaver Creek.

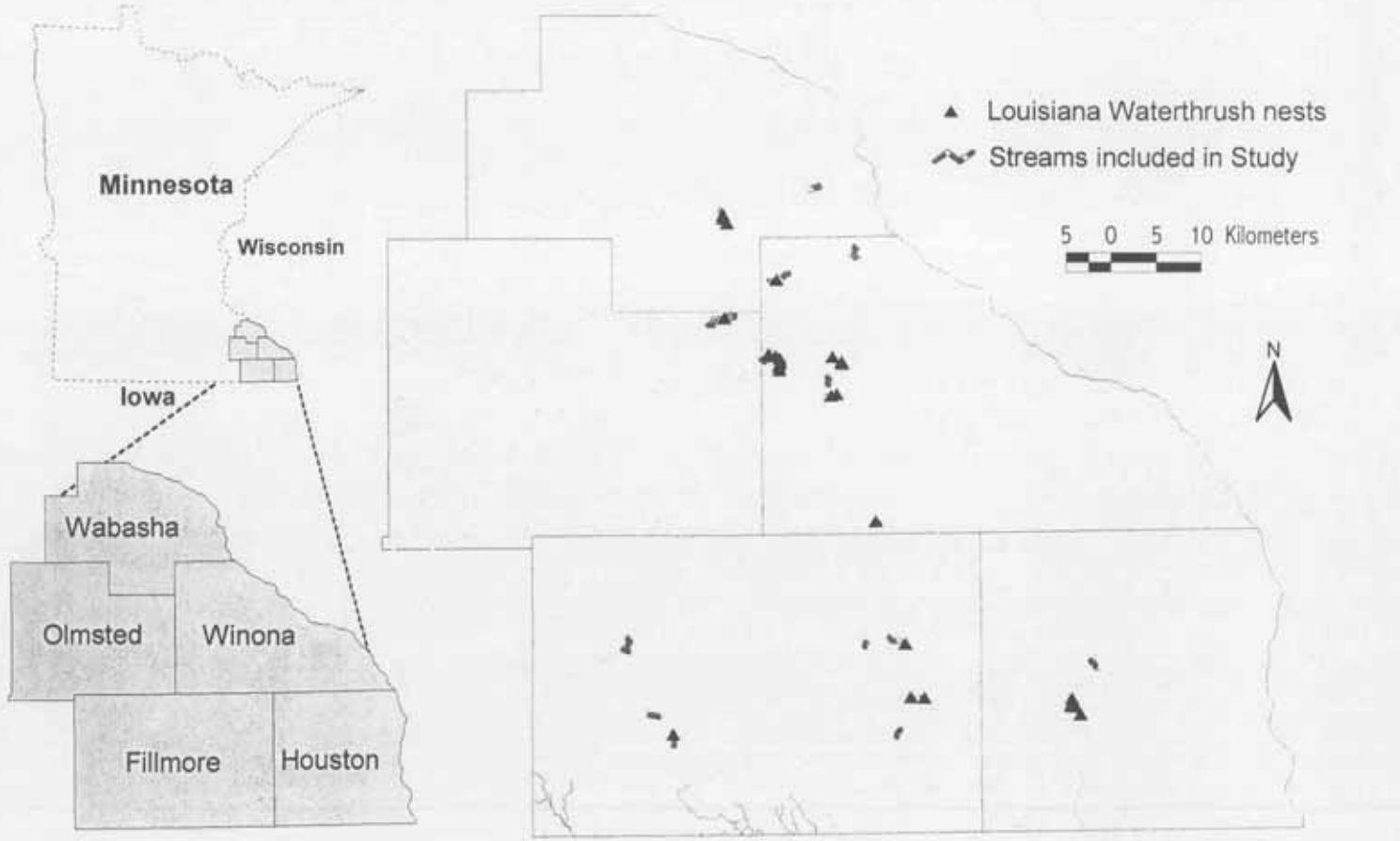
The present study commenced in 1996, as a broader investigation into the natural history and community ecology of Louisiana Waterthrushes in southeastern Minnesota. Objectives of this study fall into two categories:

1. Study Louisiana Waterthrush breeding biology in southeastern Minnesota, with a focus on annual reproduction and nest site characteristics.
2. Compare the avian and aquatic invertebrate assemblages, and riparian habitats where Louisiana Waterthrushes do and do not breed to identify what groups or species are most or least likely to co-occur.

Study Area

The study area was located in the unglaciated or Driftless Area Ecoregion (Omernik and Gallant 1988) of the state in southeastern Minnesota (Figure 1). The region is characterized by high bluffs dissected by steep valleys. Three major river systems, the Root, Whitewater and Zumbro, dominate the landscape and ultimately drain into the Mississippi River. Forest cover in this region is primarily restricted to steep slopes and narrow valleys. Native plant communities grade from predominantly maple-basswood forest *(Acer* spp. and *Tilia americana)* along the upper valley slopes and small streams on north facing slopes, to drier oak forest *(Quercus* spp.) on south facing slopes and bluff tops. Lowland hardwood forest occurs in valley bottoms, with occasional small black ash *(Fraxinus nigra)* swamps. Several rare plant communities found in the study areas include algific talus slopes and northern hardwood-conifer forest habitats (Minnesota County Biological Survey 1996a,b, and 1997a,b,c). Historically, native plant

Figure 1. Streams studied in south-eastern Minnesota and associated Lousiana Waterthrush nests.



communities on the bluff-tops were largely prairie and oak savanna. However, most of the native vegetation has been converted to row crops (primarily corn and soybeans) or pasture.

Twenty-two stream segments covering a five county area were included in the study (Table 1). Twelve of the study sites had breeding Louisiana Waterthrushes, and ten had none. Most streams were State designated trout streams *(Salmo trutta, S. gairdneri, Salvelinus fontinalis)* ranging from 1st to 3rd order and were surrounded by approximately 90% forest cover. Only two streams, South Branch Whitewater tributary (trout present, but not a designated trout stream) and the South Fork of the Root River (50% forest cover) deviated from these criteria. A minimum distance of 1 km separated study sites on the same stream (South and Middle Branches Whitewater). Diamond and Hemmingway creeks included ~100 m of pasture on one side of the stream.

Methods -

Point Counts To provide a measure of the breeding season avian community and aid in identifying streams used by Louisiana Waterthrushes, point count surveys were used at each study site during May and June of 1995 and 1996 (Bibby, Burgess and Hill 1992). Point counts were conducted after the dawn chorus (in May after 0625H, in June after 0545H) and under suitable weather conditions (no rain, little wind, and temperature >0°C). Each point count lasted seven minutes, and either I (1996 and 1997) or an assistant (1997) recorded all birds seen or heard as either inside or outside of a 50 m radius, sex, and how detected. Care was taken not to double count individuals within or across point counts. Point counts were established 10 m from the nearest stream, at least

Table 1. Study area counties, streams, sample sizes, and years.

County and Stream	Drainage	Point Counts	Aquatic Samples	Years
Wabasha County				
West Indian Creek	Zumbro	9	3	1996 - 1997
Snake Creek	Mississippi	5	2	1996 - 1997
Winona County				
South Branch Whitewater I	Whitewater	10	3	1996 - 1997
South Branch Whitewater II	Whitewater	6	3	1997
South Branch Whitewater tributary	Whitewater	5	2	1996 - 1997
Middle Branch Whitewater I	Whitewater	9	3	1996 - 1997
Middle Branch Whitewater II	Whitewater	6	2	1996 - 1997
Trout Run Creek	Whitewater	9	3	1996 - 1997
Trout Creek	Whitewater	6	2	1996 - 1997
Beaver Creek	Whitewater	10	3	1996 - 1997
Hemmingway Creek	Root	3	1	1996 - 1997
Olmsted County				
Logan Branch	Whitewater	10	3	1996 - 1997
North Branch Whitewater	Whitewater	5	2	1996 - 1997
Fillmore County				
Canfield Creek	Root	9	3	1996 - 1997
Forestville Creek	Root	6	2	1996 - 1997
Spring Valley Creek	Root	7	2	1996 - 1997
Diamond Creek	Root	9	3	1996 - 1997
Gribben Creek	Root	4	1	1997
Shattuck/Nepstad Creek	Root	10	3	1996 - 1997
South Fork Root	Root	5	2	1996 - 1997
Houston County				
East Beaver Creek	Root	10	3	1996 - 1997
Badger Creek	Root	5	2	1996 – 1997

50 m from the nearest edge (e.g. forest/grassland, or forest/crop fields), and at 200 m intervals along a given stream. I maximized the number of point counts along a given stream as habitat permitted, with up to ten point counts per study site (Table 1). At the conclusion of each point count, two minutes of Louisiana Waterthrush taped playback were used to solicit responses; three territorial calls (~15 seconds), followed by silence (~45 seconds), and then repeated. All responses, and extent of responses were noted as such and separated from standard point count data. The taped calls were not audible beyond 50 m.

For analyses, I included only males within the 50 m radius. In the case of nonsexually dimorphic species (e.g. Black-capped Chickadee, Blue Jay) half the individuals counted were included. Point counts were summarized for a given site and corrected for area which resulted in an average number of males detected per point count per site. Categorizations of habitat, and breeding and migration status were assigned from Green (1991 and 1995); forest use designations were taken from Freemark and Collins (1989). For single species comparisons, only southeastern Minnesota breeding species detected ten or more times were used.

Nest Searching Point count and playback information formed the basis of nest searching, augmented with additional visual observation of pairs and taped call playback. Louisiana Waterthrush pairs were tracked throughout the season, including territory establishment, pairing, nesting, and fledging. I located nests by observing males and females, and actively searching within their territories for nest locations. Once a nest was found, I recorded nesting stage and evidence of Brown-headed Cowbird *(Molothrus ater)* parasitism. Checks were made every 5-7 days to determine the fate of the nest. During nest searching and subsequent visits, every effort

was made to limit impacts of observers in the vicinity of the nest. All observers wore rubber boots (either knee-high or hip-waders) and made their approach by water. No nests were touched until either the nestlings fledged or the nest was destroyed.

Nest. Measurements Information on the physical characteristics of Louisiana Waterthrush nests was recorded after fledging or nest destruction. For each nest I used a meter tape and compass to measure vertical height (m) and horizontal distance (m) from the stream, bank slope (°), slope aspect (°), and direction of stream flow (°). Nest construction materials and the number and species of leaves included in the nest were also noted.

Aquatic Invertebrates I collected aquatic benthic invertebrates using a Surber sampler (30.5 cm x 30.5 cm x 5 cm) to compare the invertebrate assemblages between streams with and without Louisiana Waterthrushes. I collected benthic invertebrates at the riffle closest to every third point count (600 m intervals) starting with the second point count. At each sampled riffle, three random locations were selected and subsampled. Samples were collected in May and June of 1996 and 1997 and coincided with point count surveys: 20 streams were sampled in 1996 and 22 streams in 1997 (Table 1). Each subsample was stored in Khale's solution in 1996 and 70% EtOH in 1997. In the lab, samples were pooled for a given date and riffle. One hundred randomly selected invertebrates were identificated using a 10 x 10 grid (Hilsenhoff 1982) from each rifle. Resource specialists from the Minnesota Department of Natural Resources identified the invertebrates to species or the finest level of taxonomy possible. The Hilsenhoff Biotic (HBI) and Family Biotic (FBI) Indices (Hilsenhoff 1987 and 1988), Simpson and Brillouin diversity

indices (Peet 1975), species richness, Ephemeroptera - Plecoptera - Trichoptera (EPT dominance) and Chironomid dominance, and three indices of invertebrates eaten by Louisiana Waterthrushes (Eaton 1958, Craig 1987, Robinson 1995) were evaluated. The Waterthrush-Eaton Index is based on invertebrate species identified from stomach content analyses of Louisiana Waterthrushes, including Trichopterans, Ephemeropterans, Plecopterans, Coleopterans, Hemipterans, Neuropterans, and Diplopods (Eaton 1958). The Waterthrush-Craig Index contains invertebrates species consumed during enclosure experiments including Trichoperans, Epherneropterans, Dipterans, Ofgochaetes, and Isopods (Craig 1987). The waterthrush-total index includes the taxa listed in both Craig and Eaton, in addition to benthic aquatic invertebrates species reported elsewhere: odonate larvae, dytiscid larvae, crustaceans, and earthworms (Robinson 1995).

Stream and Streambank Habitat Quantified estimates and measurements of stream and stream bank habitats were collected during July 1996-7. At each study stream, the length of riffle, run, and pool components was measured. Definitions of these components are made by Platts, Megahan and Minshall (1983). Several estimates were made at each riffle, run, or pool including rock-July, rock-April, stream edge, and bank surface composition. Rock-July is the amount of rock exposed as a percentage of the stream surface in July. The rock-April is the amount of rock exposed as a percentage of the stream surface in April, estimated as 15 cm of additional flow. Stream edge is the percentage of streambank/stream interface with a slope less than 90° (vertical). Lastly, in each section the percentage of exposed bank, and vegetation types (moss/lichen, herbaceous, woody material) on the streambanks was estimated. Each of the

estimated percentages was converted into a quantity for each area and averaged for the entire stream. Measurements on twenty streams were obtained in 1996, and two in 1997. Reassessment of streams measured during 1996 showed little change in 1997. Therefore 1996 evaluations were employed both years.

Statistics - Natural history observations are described or presented as means and standard deviations. Comparisons among aquatic invertebrate and avian communities, and physical habitats were made for areas with and without breeding Louisiana Waterthrushes. A randomization tests with 10,000 iterations (MacAnova V4.1) evaluated differences in both means and variances of both weighted and unweighted samples (Oehlert and Bingham 1999). P-values were considered significant at $p \leq 0.05$.

Results-

Natural History Male Louisiana Waterthrush arrival in spring began about 15 April in both 1996 and 1997 and they immediately established territories (Table 2). Females were observed in territories about seven days after male arrival. Territory length for Louisiana Waterthrushes averaged about 460 m ± 110 m (n=46) along streams during 1996-7. Copulation and nest building were observed during the last week of April through late May; the first nests had complete clutches by May 3. Hatching ranged from 17 May through 28 June; incubation averaged 12-13 days. From incubation on, male territorial song became less and less frequent, even in response to taped songs. Fledging from the nest occurred between 28 May to 8 July, with observations of parental feeding continuing through July for the last pairs.

Louisiana Waterthrush nests were typically situated 1.3 m above the water, and 1.4 m in horizontal distance from the water (Figure 2). These nests were both tucked into earthen depressions and attached to exposed roots on the surface of exposed banks. Banks with nests were relatively steep, with an average of 69° slope (Figure 3). The nest entrances faced on average 94°±90 (n=23), with 13 nests facing between 0-85° and nine nests facing 100-285°; no nests were observed facing from 286-359°. The nest base was constructed of decaying leaves carried from the stream and surrounding area. Of leaves present in the analyzed nest bases (n-24), sugar maple leaves predominated with 59% presence among leaves (Figure 4). The red oak - white oak complex *(Quercus rubra* & *Q. ellipsoidalis, Q. alba* & *Q. macrocarpa)* were the second most abundant groups, occurring 9.1% and 9.6% respectively. The remaining 23% of leaves identified in nests were composed of elm *(Ulmus* spp.), willow *(Salix* spp.), black locust

Table 2. Louisiana Waterthrush locations during 1996-1997.

	1996			1997		
	individuals*	**territories**	**breeding**	**individuals***	**territories**	**breeding**
West Indian Creek	1	1	yes		2	yes
South Branch Whitewater I	1	2	yes	1	1	yes
South Branch Whitewater II	n/a	n/a		1		no
South Branch Whitewater tributary		2	yes		2	yes
Middle Branch Whitewater I		2	yes		2	yes
Trout Run Creek		2	yes		2	yes
Beaver Creek		1	yes	1		no
Hemmingway Creek		1	yes	1		no
Logan Branch		1	yes		1	yes
CanfieldCreek	1	1	yes		1	yes
Forestville Creek				1		no
Spring Valley Creek	1	1	yes	1		
Diamond Creek		2	yes		2	yes
Shattuck/Nepstad Creek		2	yes	1	2	yes
East Beaver Creek		4	yes		4	yes
Badger Creek	1		no	1		no

* Individuals were solitary transient birds neither holding a territory nor seen repeatedly over the season, with no evidence of breeding.

Figure 2. Height and distance ranges for Louisiana Waterthrush nests in southeastern Minnesota during 1996-1997.

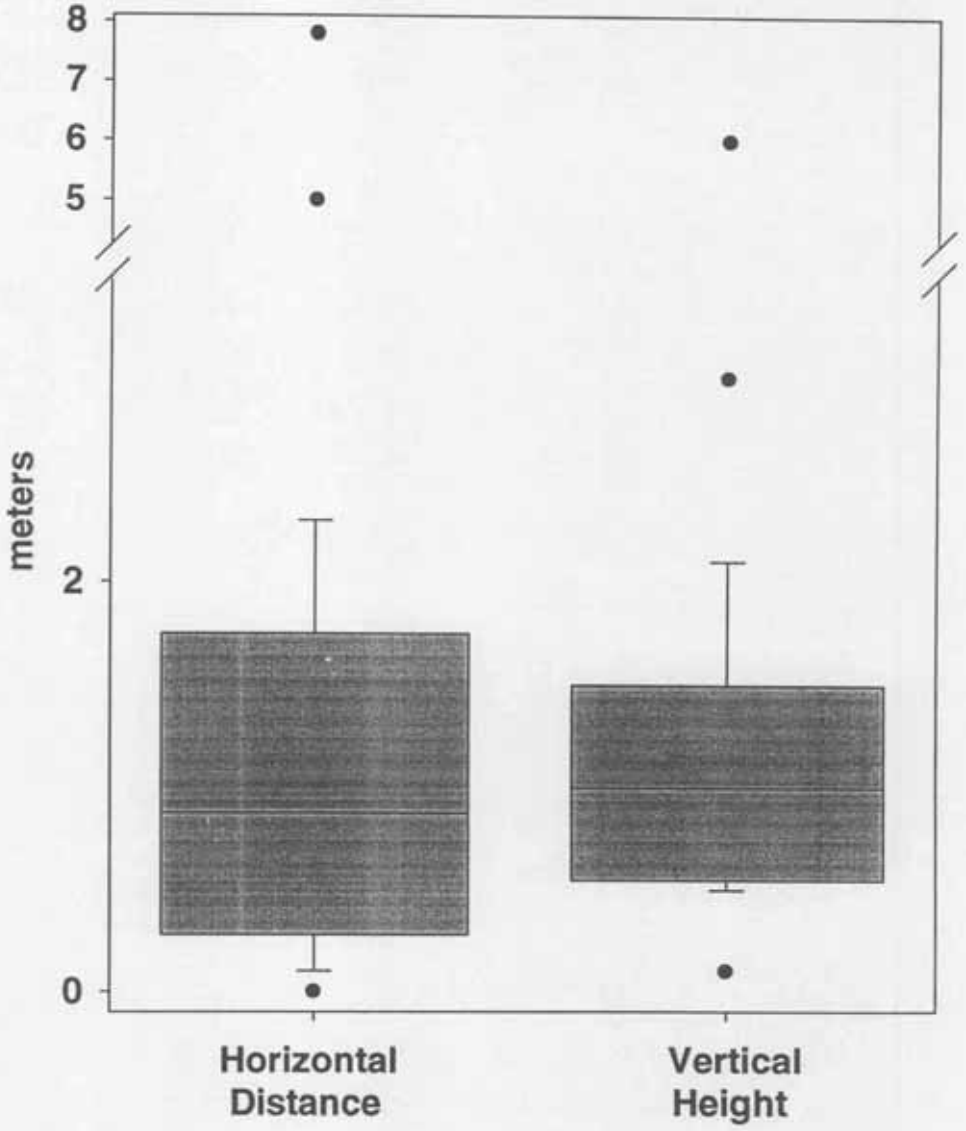


Figure 3. Bank angle and nest faces angle for Louisiana Waterthrushes in southeastern Minnesota during 1996-1997.

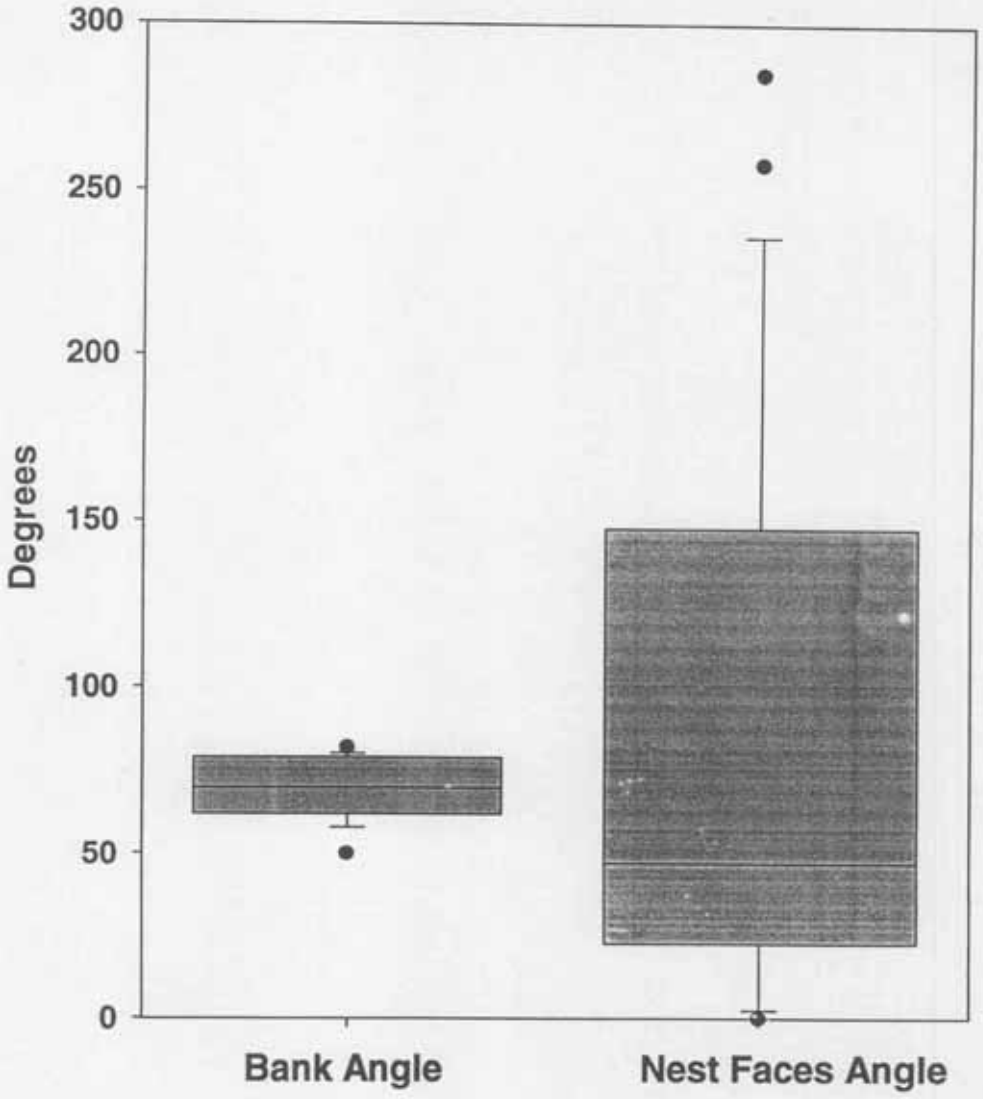
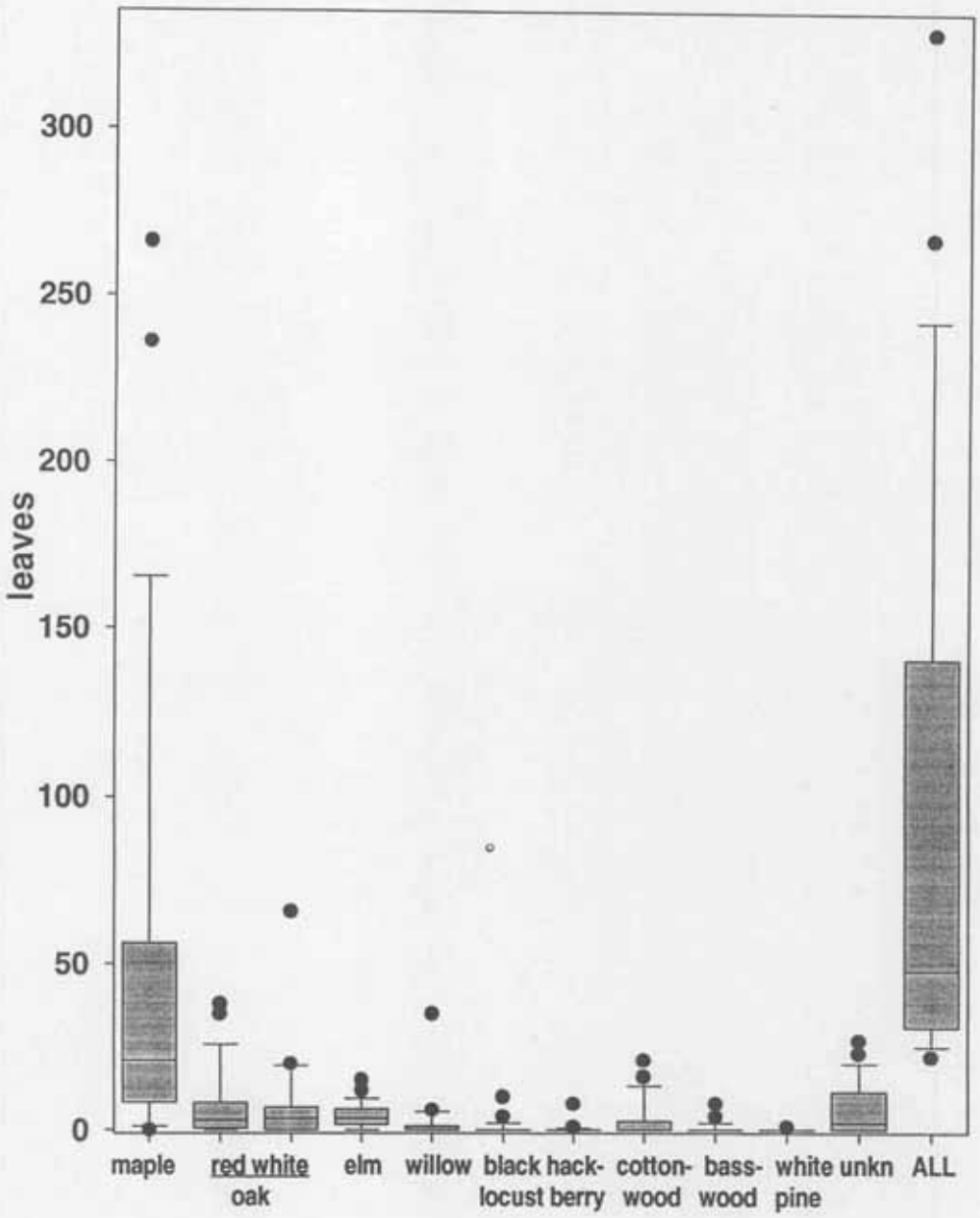


Figure 4. Leaves found in Louisiana Waterthrush nest bases in southeastern Minnesota during 1996-1997.



Reproductive Success Of 47 Louisiana Waterthrush territories established in 1996 and 1997, I collected reproductive information from 39 pairs and 24 nests. Twenty-three pairs successfully reared one or more chicks to fledging, with 15 of those pairs producing two to four fledglings. Eight pairs lost nests due to depredation (3), abandonment (2), and nest destruction (3) due to bank slumping. Renesting was documented in two of the three pairs that were depredated. Predators .were not identified, but one was suspected to be a Blue Jay *(Cyanocitta cristata).*

Minimum clutch size for Louisiana Waterthrushes in southeastern Minnesota ranged from one to five eggs, with a minimum average of 2.4 ±l .2 eggs/nest (Figure 5). The maximum hatching rate was 81%, or 1.8 ±1.4 chicks per nest. The maximum recorded fledging rate for all Louisiana Waterthrush nests was 1.5 ±1.3 fledglings per nest (79%) in southeastern Minnesota.

Brown-headed Cowbird brood parasitism of Louisiana Waterthrush nests occurred in a minimum of 15 nests (32%), and averaged 1.3 ± l .3 eggs per nest, ranging from zero to five eggs (Figure 6). A minimum of 86% of Brown-headed Cowbird chicks fledged during 1996 and 1997. Brown-headed Cowbirds removed waterthrush eggs, and crushed Louisiana Waterthrush chicks in the nest. One observation was also made of a Louisiana Waterthrush nest defense strategy: a Brown-headed Cowbird egg was buried in the base of a nest, with a new nest built on top.

Among Louisiana Waterthrush nests, where no Brown-headed Cowbird eggs, chicks or fledglings were observed, the success rate was 2.3 ± 0.8 fledglings per nest (n=15). Conversely, in cowbird parasitized nests, the success rate declined to 0.8 ± 0.7 fledglings per nest (n=12).

Figure 5. Louisiana Waterthrush eggs, chicks, fledglings and nonviable eggs per nest in southeastern Minnesota during 1996-1997.

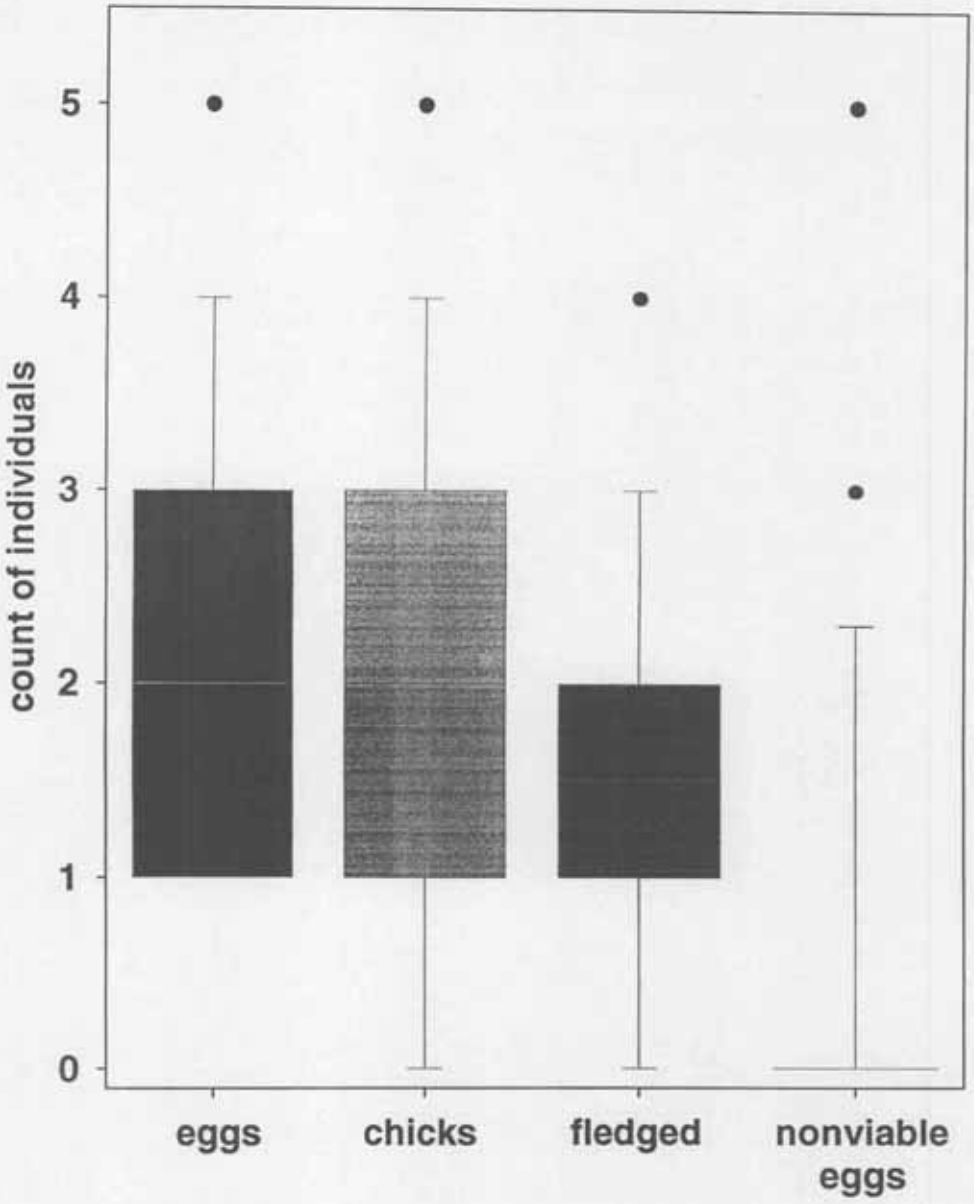
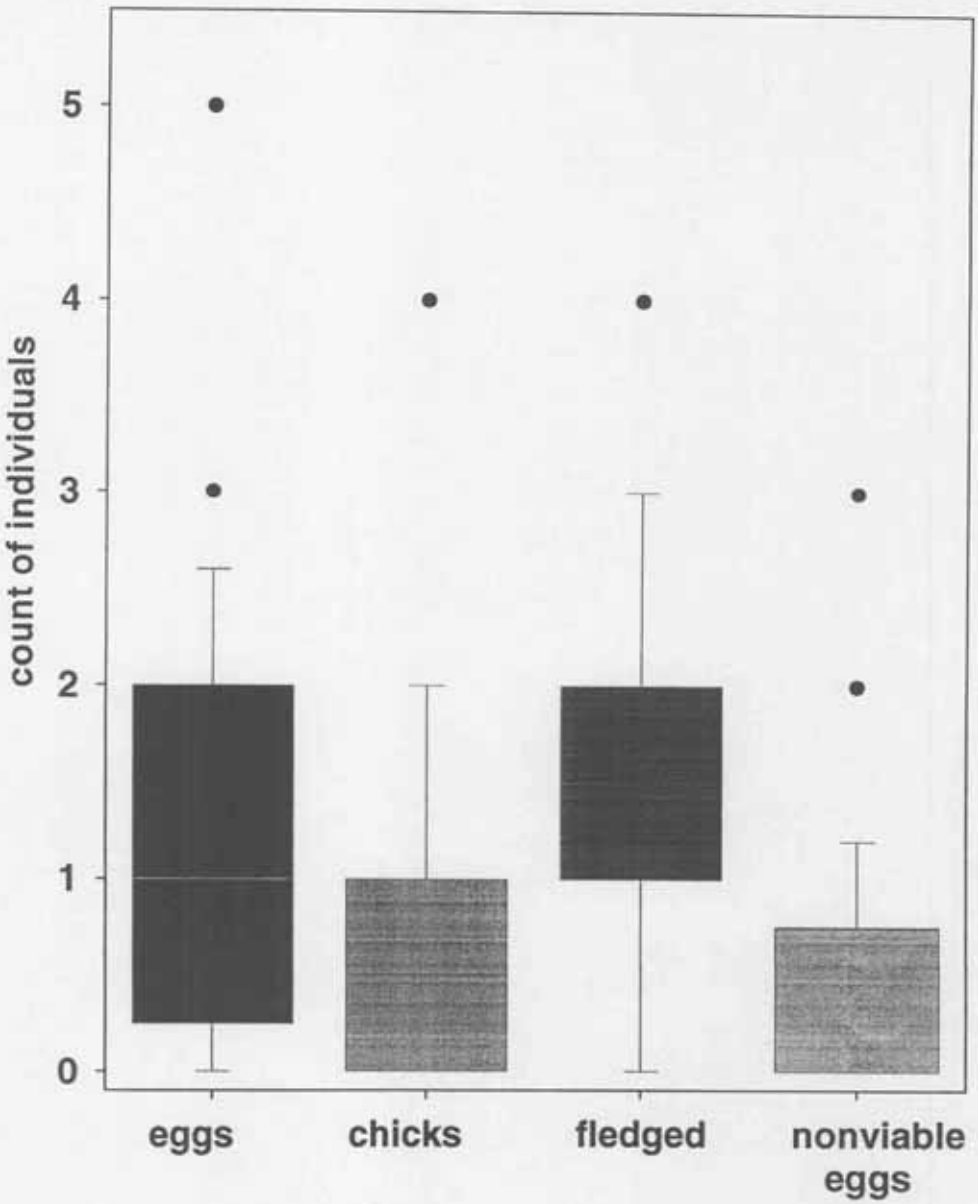


Figure 6. Brown-headed Cowbird eggs, chicks, fledglings and nonviable eggs per Louisiana Waterthrush nest in southeastern Minnesota during 1996-1997.



Point Counts and Bird Communities Ninety-five species were detected during the 508 point counts (Appendix A). Of those 95 species, 70 bred in southeastern Minnesota with 51 meeting the requirements for a single species analysis of their coincidence with Louisiana Waterthrushes. Twenty-nine community groups based on breeding status, migration and habitat types were also analyzed for their association with Louisiana Waterthrushes.

Five species and four bird community measures show significantly higher means among breeding areas with Louisiana Waterthrushes (Figures 7 and 8), including Acadian Flycatchers, Black-capped Chickadees, Eastern Wood-Pewees, Louisiana Waterthrushes, Veerys, and Swamp Sparrows. The variance in the detection of Veerys, Swamp Sparrows and Great Crested Flycatchers (Figures 7 and 8) was also significantly greater in areas with Louisiana Waterthrushes. Mean differences in four bird community measures included increased detection of permanent residents, breeding permanent residents of disturbed habitat, breeding continental migrants of contiguous forests, and species richness (Figures 9, 10, 11). Breeding permanent residents of disturbed habitat (Figure 9 showed significantly more variance in their mean detection among areas with Louisiana Waterthrushes.

Figure 7. Average number of Acadian Flycatchers, Veerys, and Louisiana Waterthrushes detected along streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).

Acadian Flycatcher: p(mean III) = 0.0288, p(mean I) = 0.0358
Veery: p(mean III) = 0.0084, p(mean I) = 0.0080
p(variance) < 0.0001
Louisiana Waterthrush: p(mean III) < 0.0001, p(mean I) < 0.0001
p(variance) = 0.0012

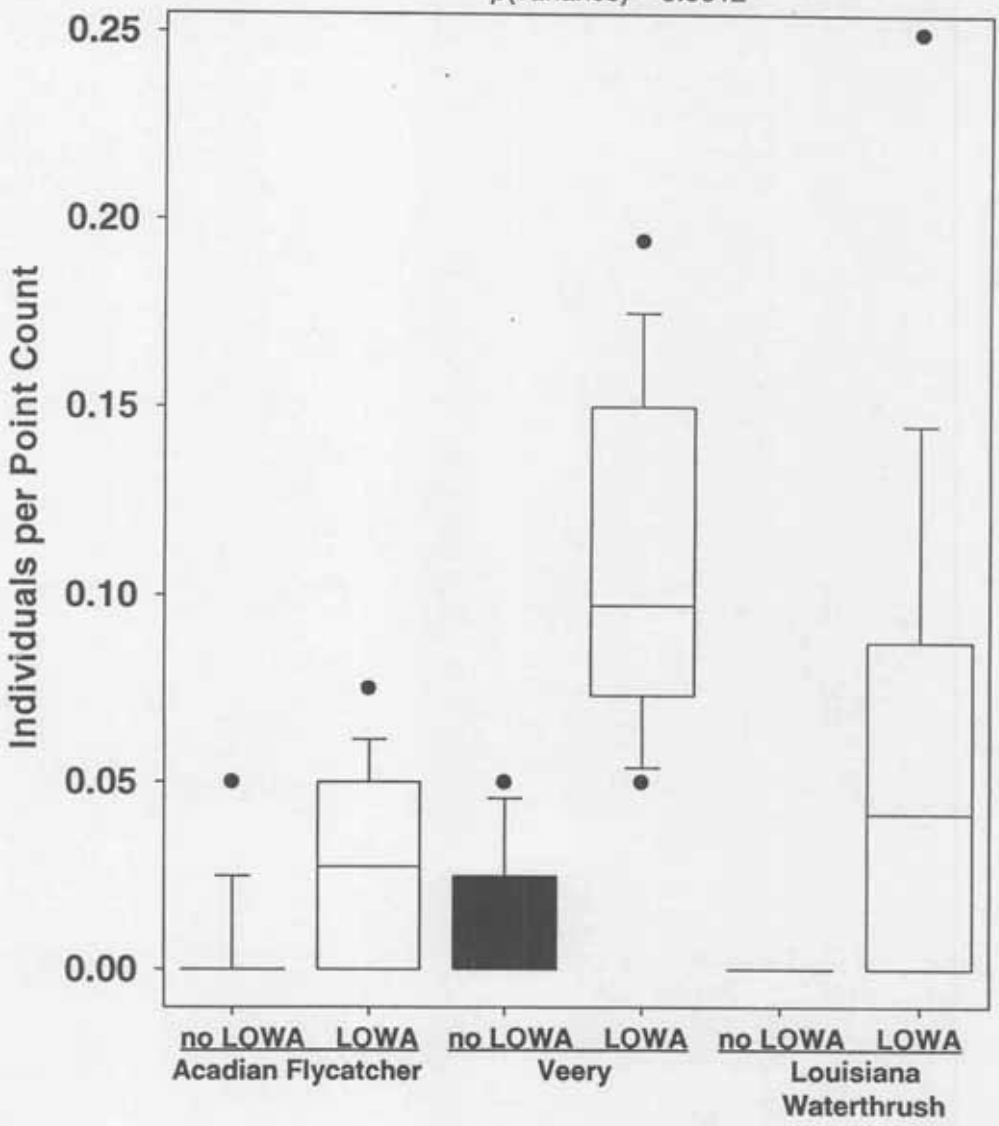
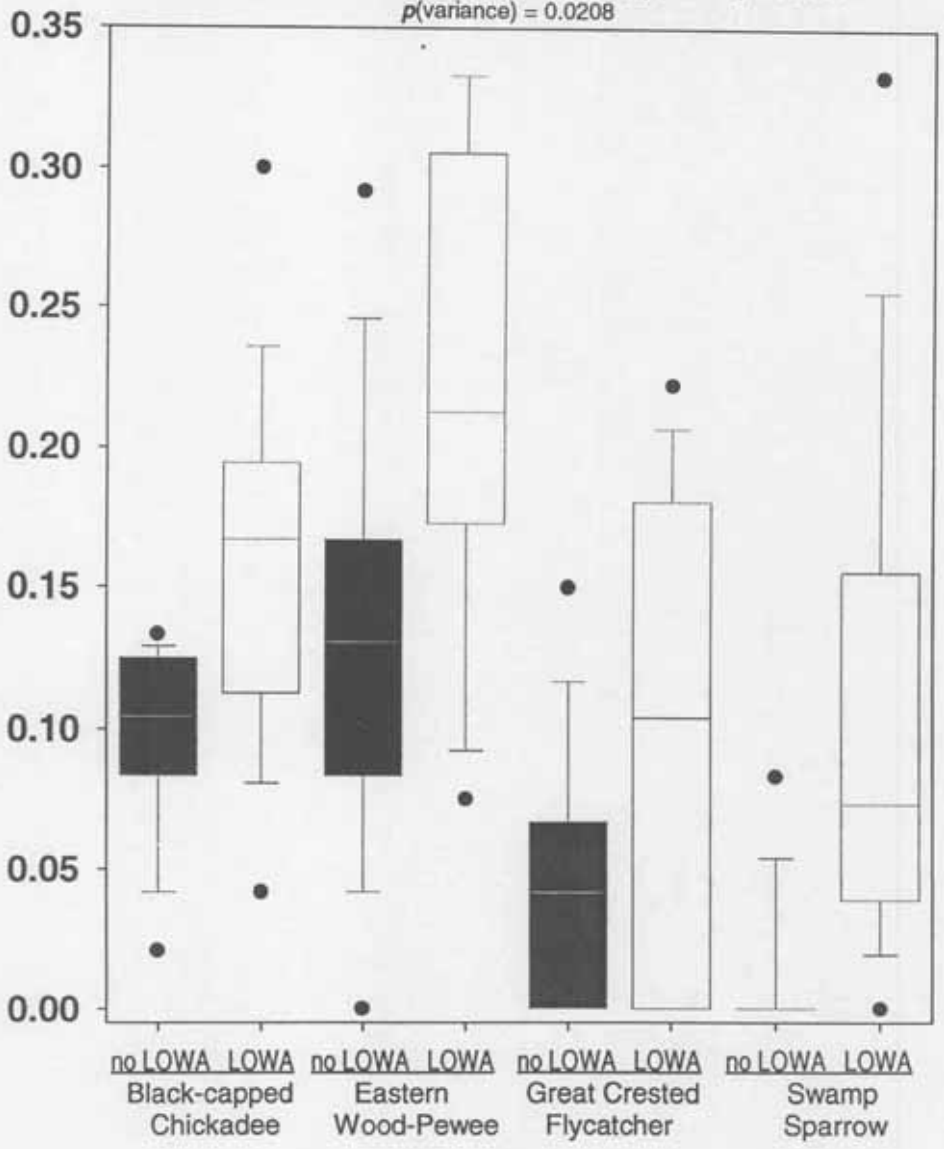


Figure 8. Average number of Black-capped Chickadees, Eastern Wood-Pewees, Swamp Sparrows, and Great Crested Flycatchers detected along streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).

Black-capped Chickadees: p(mean III) = 0.0076, p(mean I) = 0.0066
Eastern Wood-Pewees: p(mean III) = 0.0506, p(mean I) = 0.0226
Great Crested Flycatchers: p(variance) = 0.0338
Swamp Sparrows: p(mean III) = 0.0044, p(mean I) = 0.0014
p(variance) = 0.0208



Three species, Common Yellowthroat, Chipping Sparrow and Eastern Towhee, had higher mean numbers of individuals detected per point count in areas with no breeding Louisiana Waterthrushes, as did open habitat specialists (Figure 12-13). Eastern Towhee (Figure 12) and the non-breeding migrants (Figure 13) also showed more variance for areas without Louisiana Waterthrushes.

Stream and Stream Bank Habitat Significant differences were found between streams with and without Louisiana Waterthrushes. Streams with Louisiana Waterthrushes had significantly more rifle and less run habitat than those without (Figure 14). Pool habitats (Figure 14) showed more variance in responses among streams without than those with Louisiana Waterthrushes. Streams with Louisiana Waterthrushes also exhibited significantly more non-vertical stream/stream bank interface (Figure 1 S), and more variance among the observed means. On the stream bank itself, significantly more bare soil, and less vegetation were evidenced, although no single vegetation component (moss, herbaceous, or woody stems) showed a significant difference (Figure 1 S). The percentage of instream rock, and instream rock with an additional 15 cm of water in stream were found significantly more among streams with Waterthrushes (Figure 16).

Aquatic Invertebrates One-hundred and fifty-six different species or taxa were identified from the 240 samples collected from the 22 streams in southeastern Minnesota (Appendix B). These taxa were evaluated individually or as groups for their association with Louisiana Waterthrushes.

Figure 9. Average number of Permanent Residents, and Permanent Residents of disturbed habitat detected along streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).

Permanent Residents: p(mean III) = 0.0432, p(mean I) = 0.0430
Permanent Residents of Disturbed Forest: p((mean III) = 0.0388, p(mean I) = 0.0368

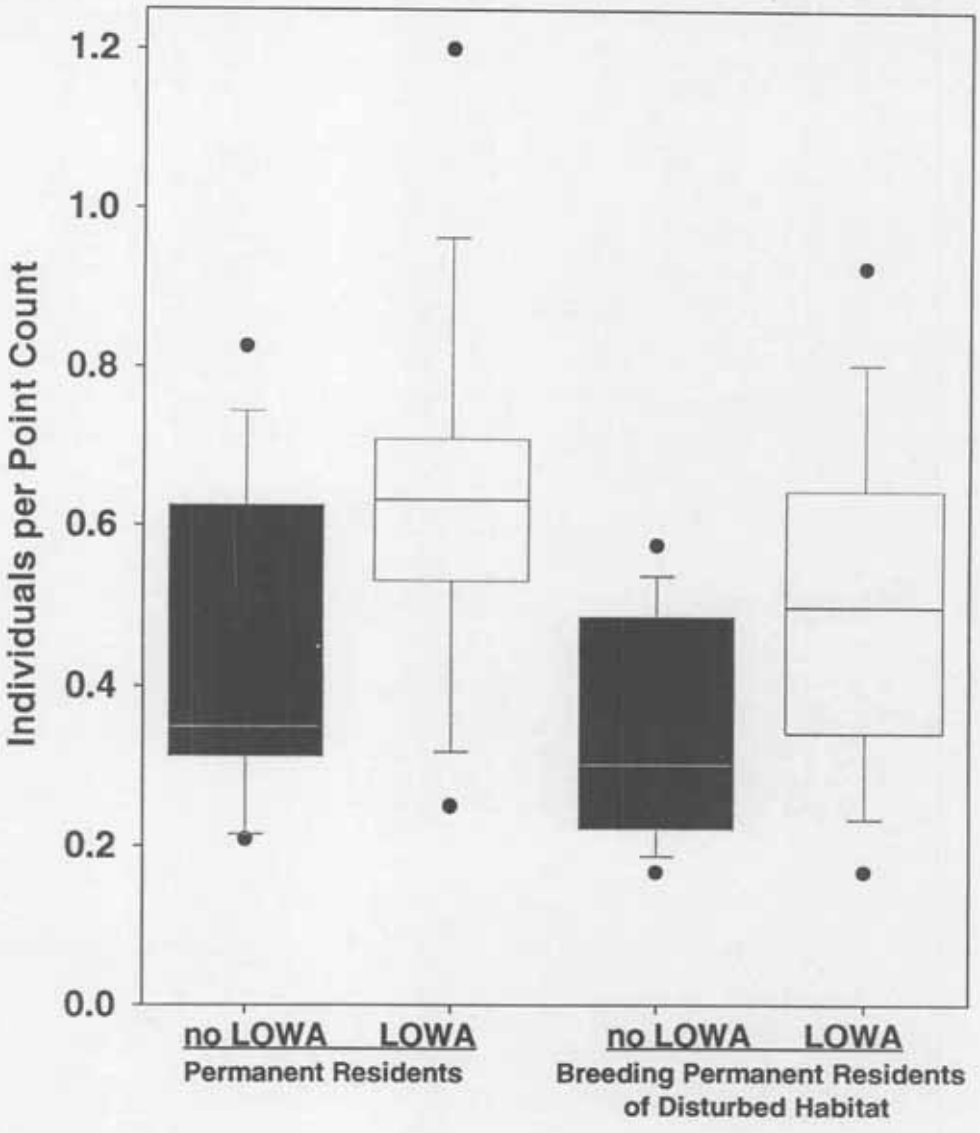


Figure 10. Average number of breeding, continental migrants of contiguous forest along streams in southeastern Minnesota,with and without breeding Louisiana Waterthrushes (LOWA).
p(mean III) = 0.0432, *p*(mean I) = 0.0430

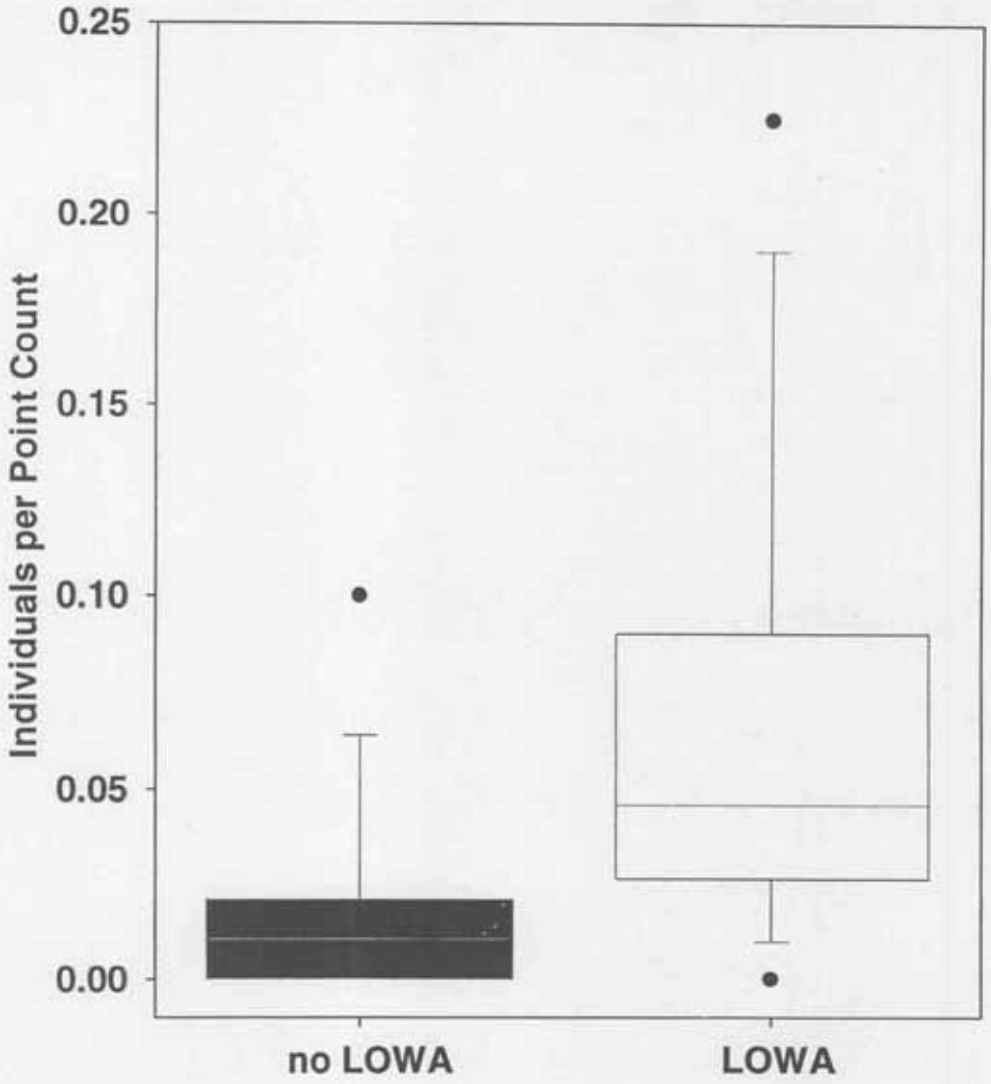


Figure 11. Number of species detected along streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).
p(mean III) = 0.0526, *p*(mean I) = 0.0366

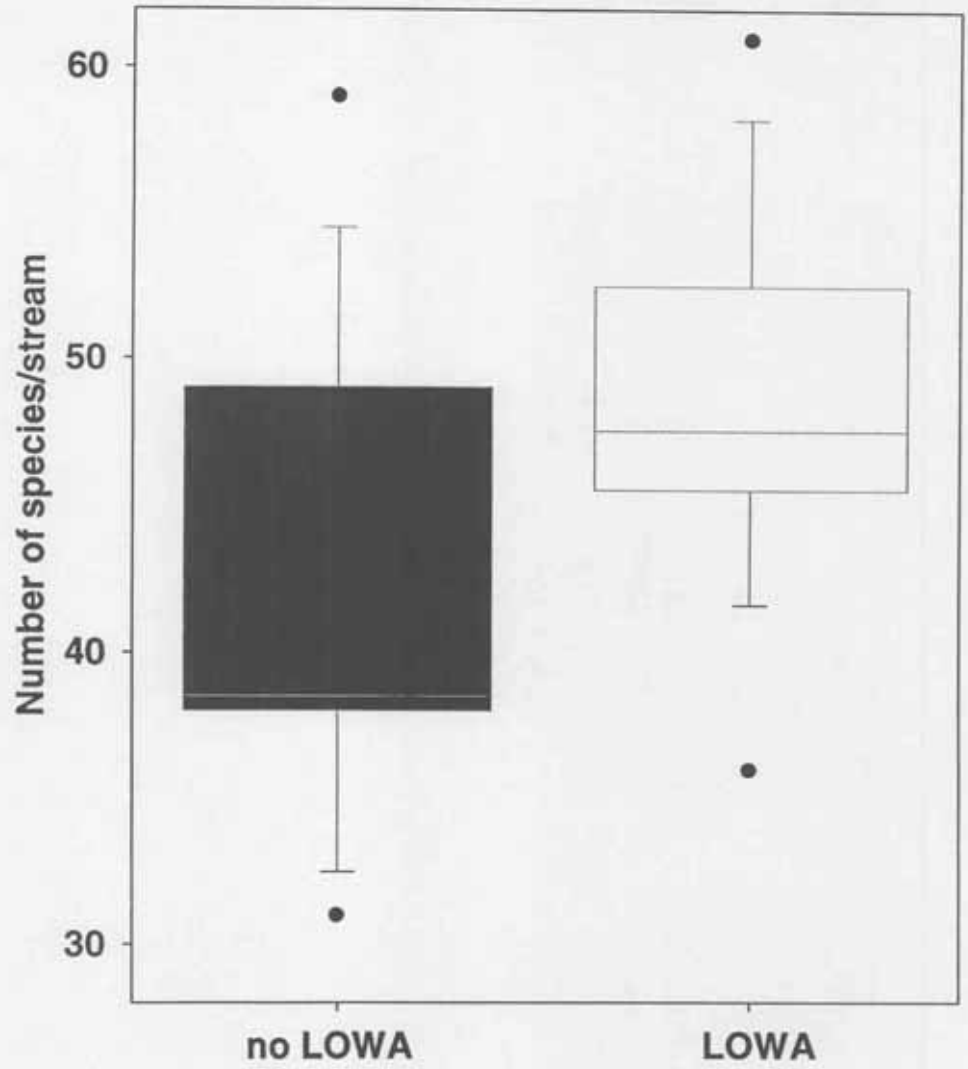


Figure 12. Average number of Common Yellowthroats, Eastern Towhees and Chipping Sparrows detected along streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).

Common Yellowthroat: p(mean III) = 0.0858, p(mean I) = 0.0460
Eastern Towhee: p(mean III) = 0.0142, p(mean I) = 0.0058
p(variance) = 0.0074
Chipping Sparrow: p(mean III) = 0.0546, p(mean I) = 0.0130

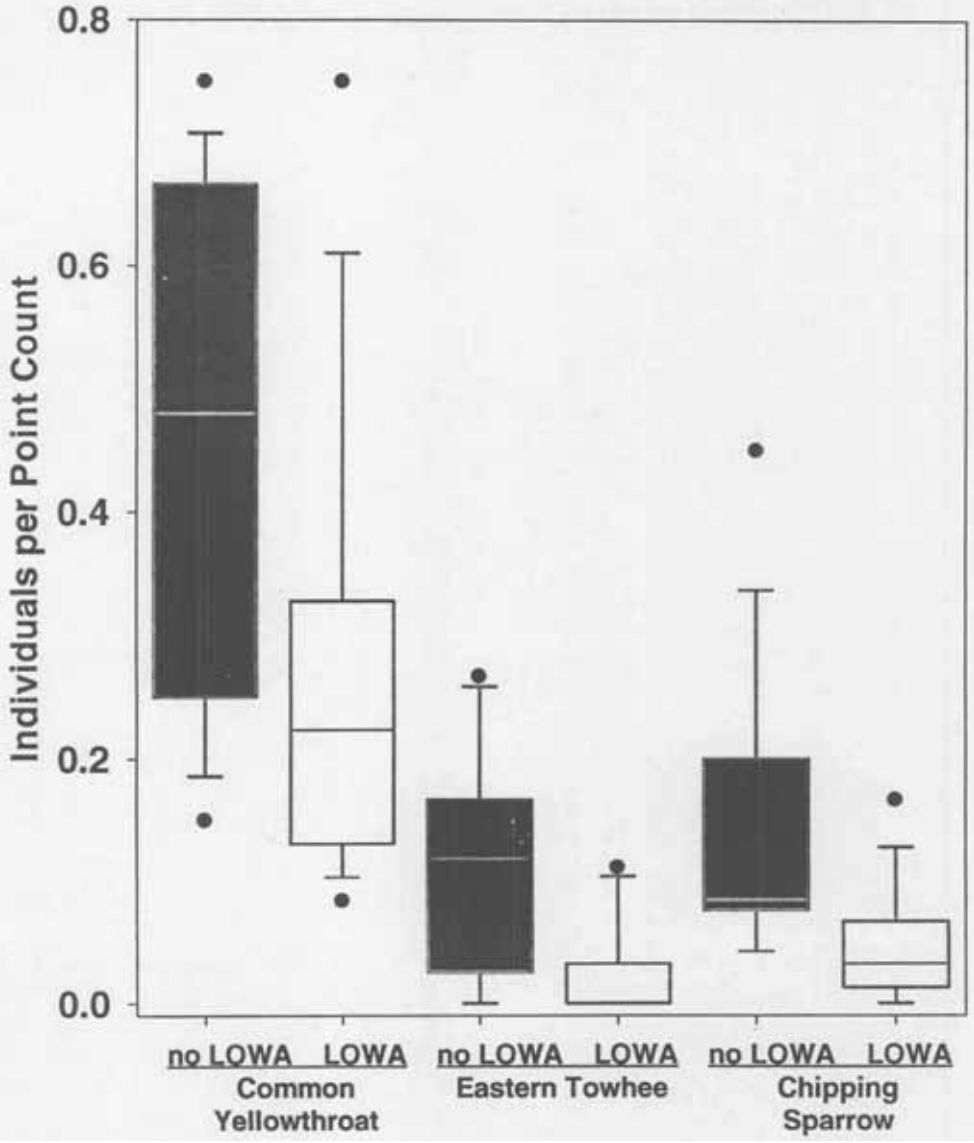


Figure 13. Average number of open habitat species and transient migrants detected along streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).

Open Habitat Species: p(mean III) = 0.0556, p(mean I) = 0.0430
Transient Species: p(variance) = 0.0316

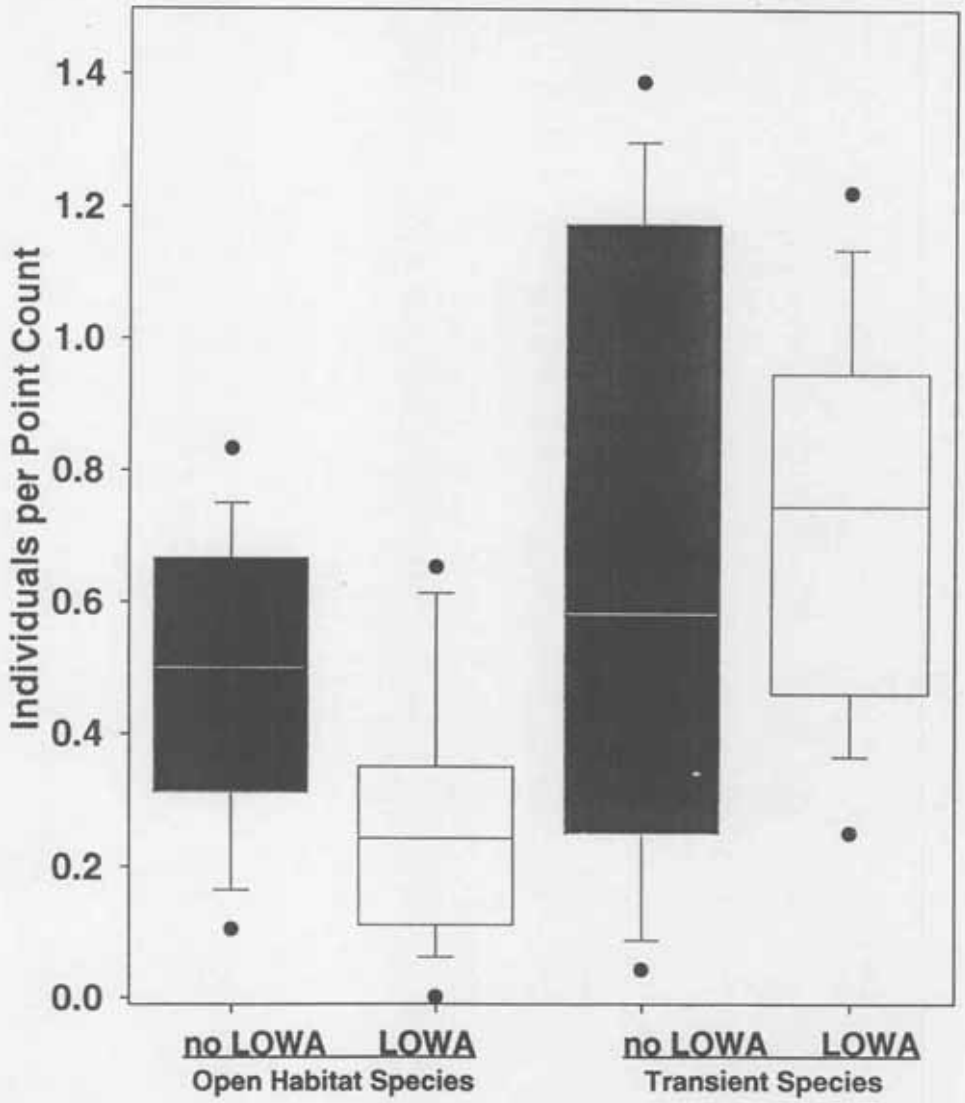


Figure 14. Percentage of stream in riffle, run and pool habitats among streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).

Riffle: p(mean III) = 0.0484, p (mean I) = 0.0330
Run: p(mean III) = 0.0322, p(mean I) = 0.0220
Pool: p(variance) = 0.0228

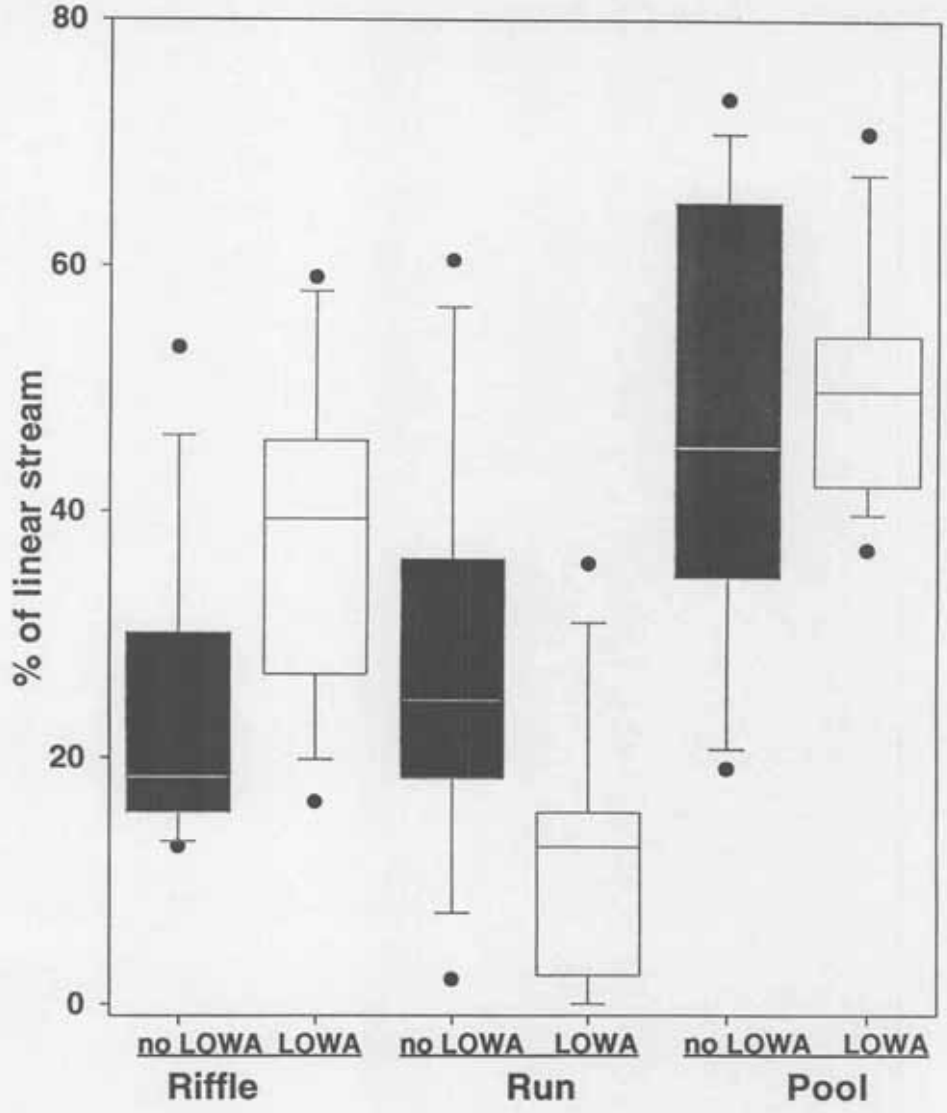


Figure 15. Percentage of stream edge, and exposed and vegetated stream banks along streams in southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).
Stream Edge: p (mean III) = 0.0012, p (mean I) = 0.0002
p (variance) = 0.0252
Exposed Bank: p (variance) = 0.0294
Vegetated Bank: p (variance) = 0.0354

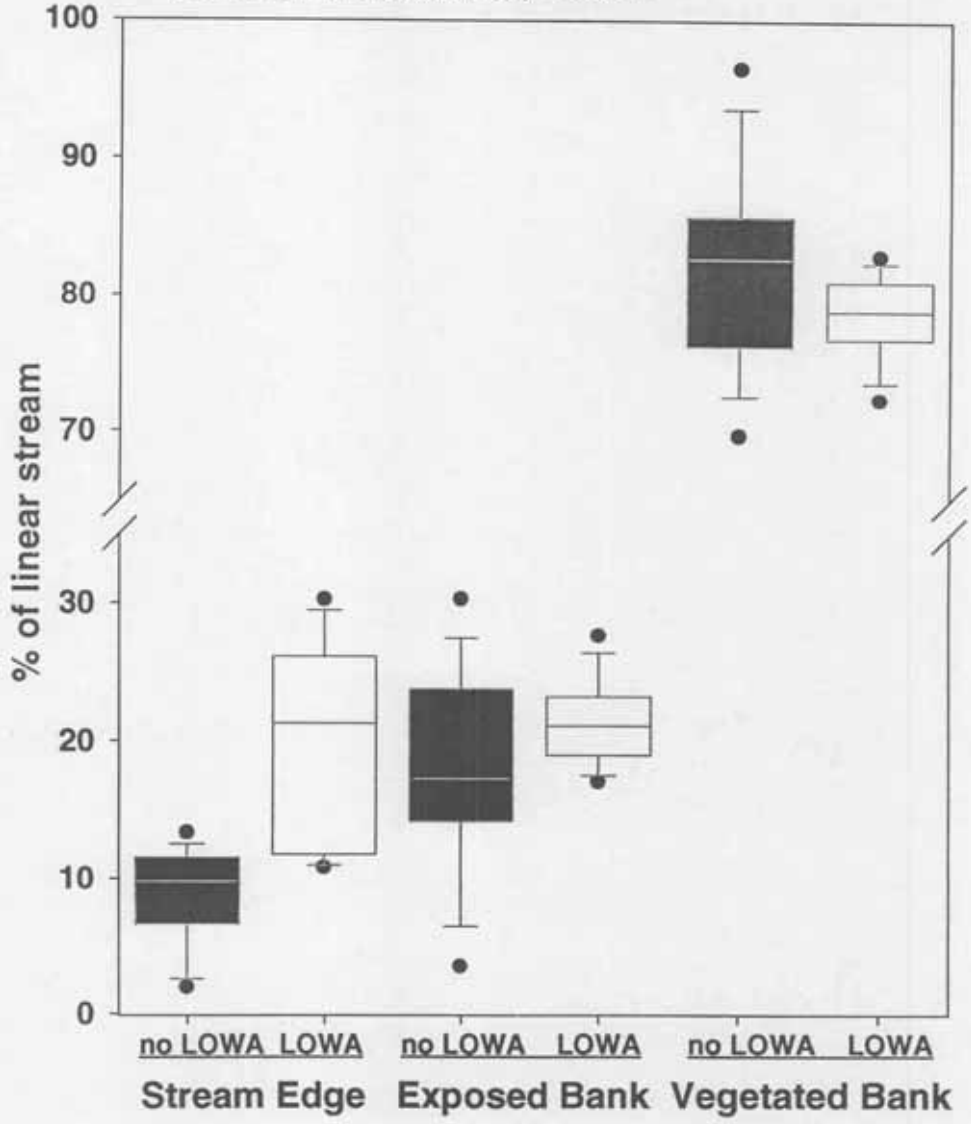
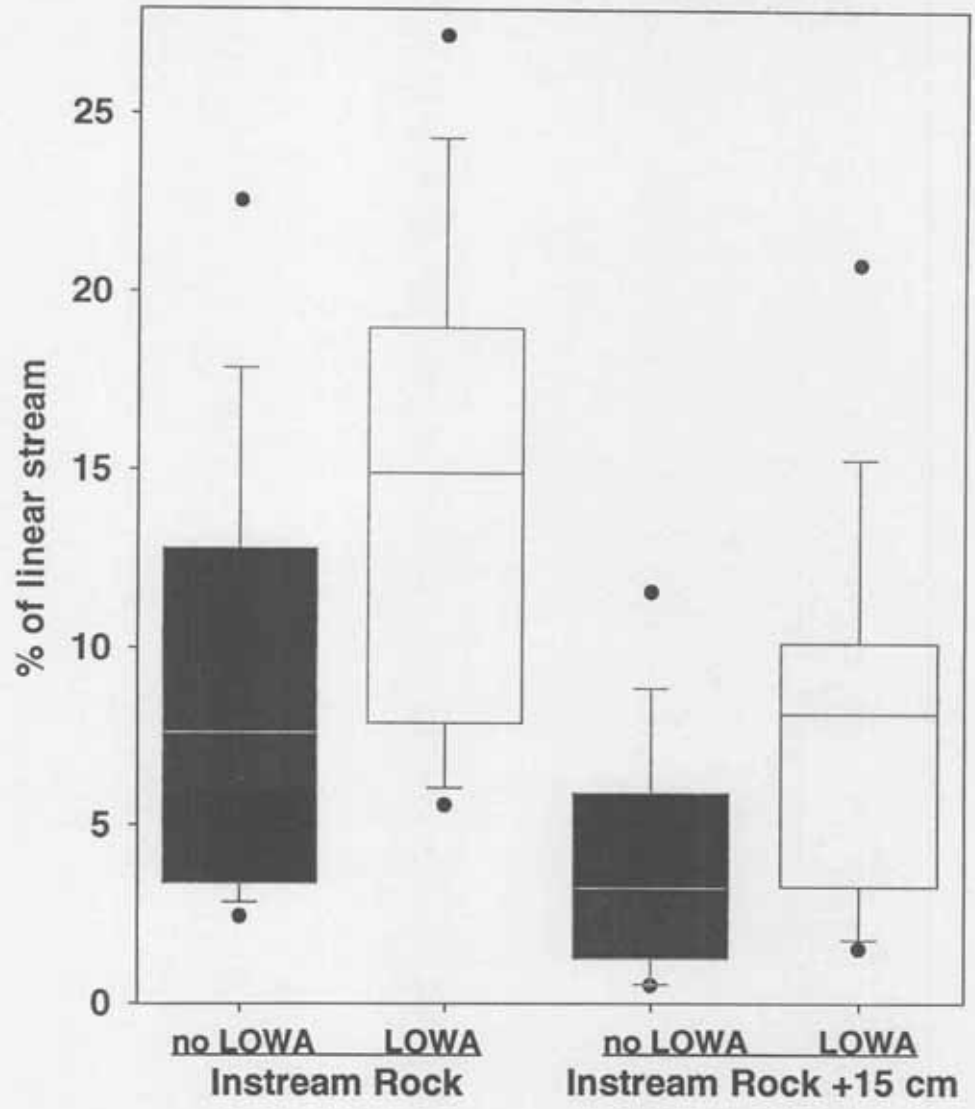


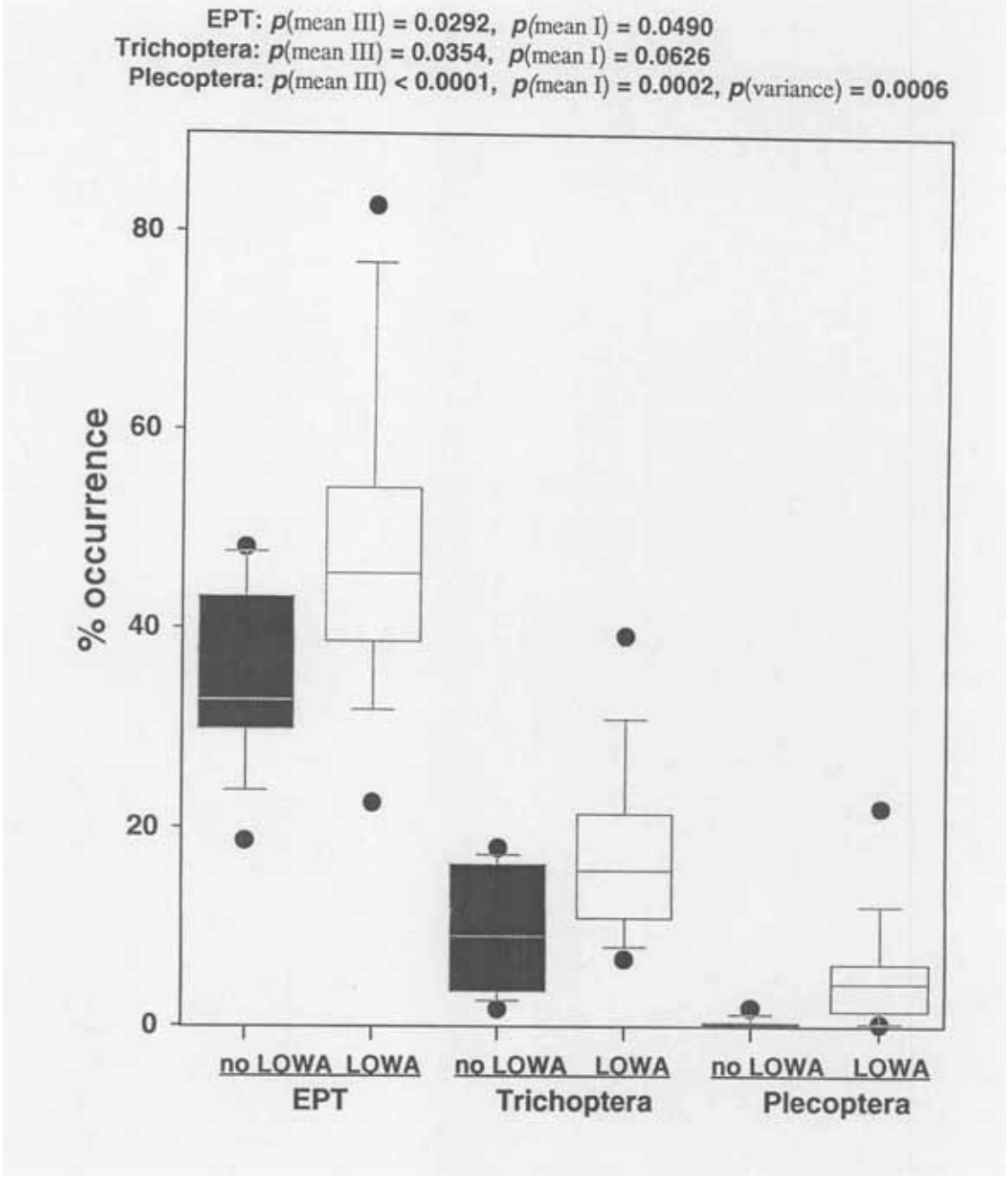
Figure 16. Percentage of instream rock and rock+15 cm exposed within streams of southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).
Instream Rock: p(mean I) = 0.0470
Instream Rock +15 cm: p(mean I) = 0.0412



Among streams with Louisiana Waterthrushes, significantly greater EPT, Trichoptera, and Plecoptera dominance were measured, compared to those without Louisiana Waterthrushes (Figure 17). Plecoptera dominance in streams with waterthrushes showed significantly more variability than streams without waterthrushes (Figure 17).

Water quality of streams both with and without Louisiana Waterthrushes ranged from 1.70 to 4.96 using the Hilsenhoff Biotic Index (HBI, on a scale of 0-10, with 0 being best water quality). No significant differences were found in either of the water quality indices (HBI or Family Biotic Indices (FBI)) or among the occurring invertebrates eaten by Louisiana Waterthrushes.

Figure 17. Average Ephemeroptera-Plecoptera-Trichoptera (EPT), Trichoptera and Plecoptera dominace, in streams of southeastern Minnesota, with and without breeding Louisiana Waterthrushes (LOWA).



Discussion

Natural History My study provides additional natural history and ecology for Louisiana Waterthrushes. Timing of migration, courtship behavior and nesting are in agreement with published accounts (Janssen 1994 and Robinson 1995). In my study, territory length estimates (460 m, n=46) fall between those in Ithaca, NY (400 m, n=8, Eaton 1958), and southern Illinois (930 m, n=7,. Robinson 1990). Territory size is suspected to be a function of resource requirements, defendability, and population density (Robinson 1990). Among American Dippers (*Cinclus mexicanus),* a species with coinciding life history requirements of Louisiana Waterthrushes, Price and Bock (1983) found that territory size and selection is based first on nest-site quality and secondly, food availability.

Nest locations in southeastern Minnesota appear to follow a relatively narrow prescription. They are typically located within 1.5 m from the stream, on banks about 21 ° less than vertical, and facing ~94° (east), often less. According to Robinson (1995) and Eaton (1958) 18 of 26 nests were on the south sides of ravines, three on the north side, and five on the west side. Together, all nest observations suggest that nationwide Louisiana Waterthrushes build nests facing north and east, rather than south and west. Robinson (1995) conjectured that nest placement usually occurs on dry side creeks or ravines, suggesting that avoidance of predation may be more important than foraging economics in determining nest site selection. In contrast, only four of the 23 nests I located were not on the main stream, none of these nests were in dry ravines, and all were within 5 m of the main stream. Streams where Louisiana Waterthrushes nested had significantly less vegetation, and more exposed earth on the banks than those without.

These observations, and the low occurrence of recorded predation, suggest that perhaps predators are avoided most effectively where nests are placed on dark, steep banks above the water line and well within the territory.

The leaf nest base of Louisiana Waterthrushes has been described as large and bulky (Kimball and Garrett 1997). The number of leaves moved by the pair to create the nest base implies that it is important, but the function of a thick nest base is not known. Louisiana Waterthrush nests often look like of a pile of leaf litter that is falling into the stream, or a leaf pack stranded by high flows. The combination of leaf base and nest location resembles natural leaf accumulation patterns and suggests use of leaves may help conceal the nest. Nests of other riparian obligate species seemingly share this nest location and concealment behavior including the Rusty-backed Spinetail *(Cranioleuca vulpina),* Dippers, and Buff-rumped warblers *(Phaeothlypis fulvicauda)* (Collias and Collias 1984, Kingery 1996, Skutch 1954). The dominance of sugar maple leaves in the nest bases may be a function of what is available, or they may be preferred by Louisiana Waterthrushes for other reasons. The other species present in the leaf bases reflect the presence of mature riparian forest communities where Louisiana Waterthrush nests were located.

Reproductive Success Louisiana Waterthrush reproductive success is directly related to the presence or absence of Brown-headed Cowbird nest parasitism (Figure 5 and 6). In the presence of Brown-headed Cowbird parasitism (0.8 fledglings/pair), Louisiana Waterthrushes theoretically cannot effectively replace themselves after two years of

reproduction. Overall, Brown-headed Cowbird parasitism rates fall at the low end of reported Louisiana Waterthrush rates (Robinson 1995). Despite relatively low parasitism rates, the impact that Brown-headed Cowbirds have on the Louisiana Waterthrush population in Minnesota appears significant.

Annual Louisiana Waterthrush reproductive success estimated in southeastern Minnesota is lower than published estimates. Although many physical and biological factors could influence the seemingly low reproductive success, the only other Louisiana Waterthrush estimate is based on a sample size of seven pairs (Robinson 1995). Among its congeners, Eaton (1995) in his extensive review does not report Northern Waterthrush annual reproductive rates, and those for Ovenbird (VanHorn and Donovan 1994) range from 0-2.9 fledglings per pair. Ovenbird reproductive success coincides much more with Minnesota's Louisiana Waterthrush reproductive rates than those reported by Robinson (1995).

Co-occurring Avian Species The bird community comparisons between areas with and without Louisiana Waterthrushes suggest certain habitat requirements. In particular, species that require mature and interior forest were detected more frequently in areas with breeding Louisiana Waterthrushes. Ovenbirds and Red-eyed Vireos, typical forest interior specialists, were expected to be significant, but they were not. These species were almost always present, but were very often at a higher elevation than the stream and outside the 50 m radius. Cavity nesting species overall, and Great-crested Flycatchers and Black-capped Chickadees in particular, were detected significantly more in areas with

waterthrushes suggesting that forests in these areas include trees in a variety of life stages (including decay).

Species present less frequently in areas with Louisiana Waterthrushes included Common Yellowthroats, Chipping Sparrows, and Eastern Towhees. These species regularly use brushy or disturbed habitat (Green 1991), supporting why they were detected as not occurring with Louisiana Waterthrushes in mature forests. Additionally the open habitat species group (Bank and Northern Rough-winged Swallows, and Field and Grasshopper Sparrows) were also detected significantly more often iii areas without Louisiana Waterthrushes.

Stream and Stream Bank Habitat Stream habitat measurements and aquatic invertebrate analyses confirm observations previously made by investigators who have studied this species. Louisiana Waterthrushes forage for aquatic invertebrates along stream edges and from rocks in streams. My study documents that streams along which Louisiana Waterthrushes bred had significantly more stream edge and instream rock habitats available. Stream areas with rocks and more edge and rifle habitats were observed significantly more in areas with Louisiana Waterthrushes. The deeper the riffle, and the less rock and edge, changes the stream habitat classification into a run or a pool. Runs were found significantly less where there were waterthrushes, and the variability in the amount of pool observed was also less.

Co-occurring Aquatic Invertebrates The aquatic invertebrate assemblages show distinct and measurable differences between areas with and without Louisiana Waterthrushes. Aquatic invertebrates are the primary food source for Louisiana Waterthrushes. The aquatic invertebrates do reflect the habitat sampled, in addition to the preferred diets of Louisiana Waterthrushes. Both the HBI and FBI showed no significant differences, although streams with Louisiana Waterthrushes showed more variability in the range of values observed. Together, Ephemeroptera, Plecoptera, and Trichoptera (EPT) were found in greater abundance in streams with breeding waterthrushes. Plecoptera and Trichoptera were also found significantly more among streams with Louisiana Waterthrushes than in streams not occupied by Louisiana Waterthrushes.

These three results are logical, as these streams also had significantly more riffle habitat, and many Ephemeroptera, Plecoptera, and Trichoptera are associated with rifles. If the findings by Price and Bock (1983) concerning American Dippers are applicable to Louisiana Waterthrushes, little difference between the aquatic invertebrate assemblages would be expected. Because reported diets of waterthrushes included over 90% of invertebrates sampled in streams, it is likely that the invertebrates present will be included in the diet, suggesting a generalist foraging strategy.

Although the aquatic invertebrate samples among sites are comparable, they do not reflect the dominance of rifle habitats in the streams where there were Louisiana Waterthrushes, or any accompanying biomass variation.

Conservation and Management Implications -

Conservation of Louisiana Waterthrushes in southeastern Minnesota is most broadly an issue of habitat management and conservation. Following are listed those recommendations that appear to be most important for successful reproduction by Louisiana Waterthrushes

- Louisiana Waterthrushes require riparian forests for habitat and food. Mature and maturing riparian streamside forests are limited. Consequently, protection of contiguous riparian forests adjoining ephemeral – 3rd order streams is a priority for Louisiana Waterthrush conservation. Human resource use that disturbs the integrity or processes of either the forest or stream threaten the continued presence and productivity of Louisiana Waterthrushes.
- Stream quality is important as foraging habitat for Louisiana Waterthrushes. Good water quality, and relatively high amounts of riffle and accompanying exposed rock and stream edge provide not only food, but foraging habitat for Louisiana Waterthrushes.
- Brown-headed Cowbird parasitism of Louisiana Waterthrush nests has a dramatic impact on their annual reproduction. By protecting contiguous forest habitat and limiting the creation of openings, particularly near streams, Brown-headed Cowbirds will not be "encouraged" to penetrate larger tracts of forest.
- Nest locations for Louisiana Waterthrushes in southeastern Minnesota are typically positioned within meters of the stream on a bank that is steep (69° slope), and relatively free of vegetation. These locations are inherently at risk. If

nest site quality is a primary factor for the Louisiana Waterthrush in determining habitat use, as for the American Dipper (Price and Bock 1983), then protection of these microhabitat components is critical. Unstable stream banks should be evaluated as part of a dynamic, fluvial landscape. In this context, occasional slumped banks and erosion are part of the fluvial process and the sediment load should be managed at the watershed rather than reach or valley segment scale.

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CHAPTER 2. Trout Habitat Improvement Projects and Avian Communities of Southeastern Minnesota

Introduction -

During the past 20 years, concern has arisen among conservation scientists concerning loss and degradation of native habitats worldwide. Within the Western Hemisphere, research has been centered on songbird population trends and forest habitat loss and fragmentation (Martin and Finch 1996, J. M. Hagan III and D. W. Johnston 1989). Within North America, habitat fragmentation has been identified as a predictor of increased nest predation and Brown-headed Cowbird *(Molothrus ater)* nest parasitism for many forest songbirds (Robinson 1995) Much of management research has focused on the link between large scale land management, especially forestry and agricultural practices, and population dynamics and reproductive success of a diversity of avian species. However, little research has evaluated the effects of relatively smaller scale management practices, such as trout habitat improvement, on avian communities.

Trout habitat improvement is a suite of management strategies used to improve habitat suitability for larger sized trout and increase angler use. Habitat improvement (HI) is practiced on streams identified as not attaining management goals, particularly recruitment and size class objectives. HI projects occur within and modify and instream channel processes, but indirectly affect much of the contiguous riparian zone. HI projects generally cover 100-300 m of any individual stream segment, but subsequent project restoration and adjacent projects may grow to encompass 500-2000+ m of a stream over 60 years. The direct disturbance created 11 doing the projects can locally eliminate herbaceous, woody understory and canopy vegetation while constructing the project and introduce grasses and other undesirable plants to the forested riparian zone.

Trout HI in southeastern Minnesota is targeted at both the native brook trout *(Salvelinus fontinalis)* and introduced brown trout *(Salmo trutta).* Reproducing naturalized brown trout are the primary management objective (Thorn et al. 1997). The effectiveness of HI as a management strategy for increasing the standing stock of trout has been fairly well documented (Burgess and Bider 1980, Hunt 1988, Stewart 1995). In Quebec (Burgess and Bider 1980), HI increased mink *(Mustela vison)* and Eastern Chipmunk *(Tamius striatus)* activity and the biomass of both crayfish (Cambarus bartoni) and emerging aquatic insects. Because avian species and communities respond to habitat, particularly vegetation changes (Sanders and Edge 1998), one would expect quantifiable differences in areas of trout habitat improvement (HI). Variation in the avian community does not necessarily suggest changes in productivity, though. Consequently, a riparian obligate species, the Louisiana Waterthrush, was targeted as a possible indicator of habitat condition. The Louisiana Waterthrush is a Minnesota Species of Special Concern (Coffin and Pfanmueller 1988, Natural Heritage and Nongame Research Program 1996). In southeastern Minnesota, the Louisiana Waterthrush is closely associated with designated trout streams, and its life history is very closely tied to riparian environments (Chapter 1 - *Louisiana Waterthrush Ecology in Southeastern Minnesota).*

The present study initiated in 1996, to study possible impacts of trout HI projects on avian communities of riparian forests in southeastern Minnesota. Objectives of this study were to:

1. Identify avian species and communities of riparian forests associated with and without trout HI projects.
2. Evaluate avian communities species, and habitat, breeding, and migration guilds to deduce associations with trout HI and Louisiana Waterthrushes.
3. Determine if reproductive success and other life history characteristics of the Louisiana. Waterthrush, a riparian obligate species, differ between streams with and without HI.

Study Area –

The study area was located in the unglaciated or Driflless Area Ecoregion (Omernik and Gallant 1988) of the state in southeastern Minnesota (Figure 1). The region is characterized by high bluffs dissected by steep valleys. Three major river systems, the Root, Whitewater and Zumbro, dominate the landscape and ultimately drain into the Mississippi River. Each of these rivers is supported by a large network of tributaries. Forest cover in this region is primarily restricted to steep slopes and narrow valleys. Native plant communities grade from predominantly maple-basswood forest *(Acer* spp. and *Tilia americana)* along the upper valley slopes and small streams on north facing slopes, to drier oak forest *(Quercus* spp.) on south facing slopes and bluff tops. Lowland hardwood forest occurs in valley bottoms, with occasional small black ash *(Fraxinus nigra)* swamps. Several rare plant communities found in the study areas include algific talus slopes and northern hardwood-conifer forest habitats (Minnesota County Biological Survey 1996a,b, and 1997a,b,c). Historically, native plant communities on the blufftops

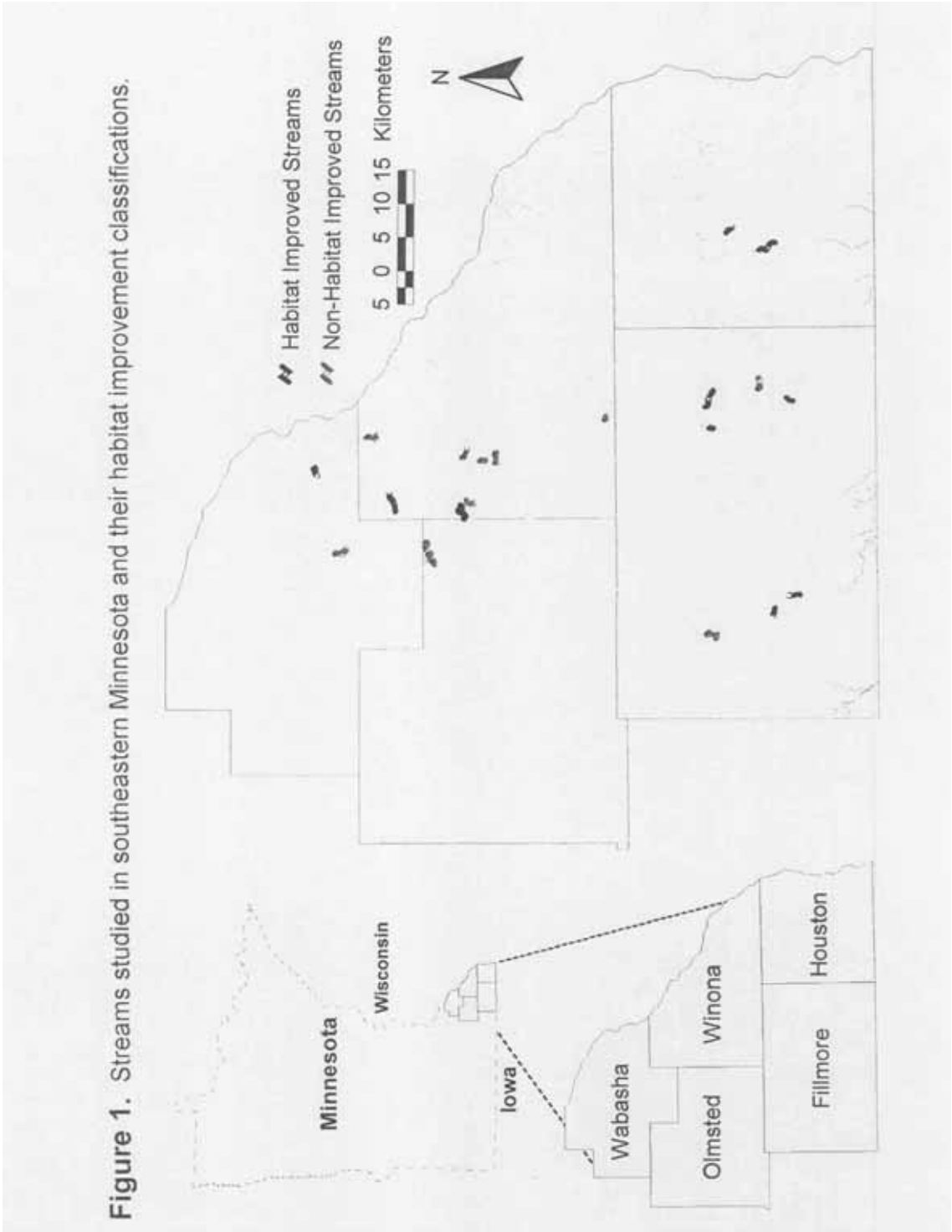


Figure 1. Streams studied in southeastern Minnesota and their habitat improvement classifications.

were largely prairie and oak savanna. However, most of the native vegetation has been converted to row crops (primarily corn and soybeans) or pasture.

Twenty-two stream segments covering a five county area were included in the study (Table 1). All streams or rivers ranged from 1st to 3rd order State designated trout streams (managed for: *Salmo trutta, Salmo gairdneri, and Salvelinus fontinalis),* each surrounded by approximately 90% forest cover. Using the *Trout Streams of Southeastern Minnesota* map (Section of Fisheries 1995) and personal conversations with Area Fisheries Headquarters in Lake City and Lanesboro, streams with HI were selected. Eleven of the study sites had history of HI projects; on 11 sites no record of HI. Twelve of the study sites had breeding Louisiana Waterthrushes, and ten had none. Two streams, the South Branch Whitewater tributary (trout present, but not a designated trout stream) and the South Fork of the Root River (50% forest cover) deviated from these qualifications. A minimum distance of 1 km separated study sites on the same stream (South and Middle Branches Whitewater). Diamond and Hemmingway creeks included -l 00 m of pasture on one side of the stream.

Methods –

Point Counts To provide a measure of the breeding season avian community and aid in identifying streams used by Louisiana Waterthrushes, point count surveys were used at each study site during May and June of 1995 and 1996 (Bibby, Burgess and Hill 1992). Point counts were conducted after the dawn chorus (in May after 0625, in June after 0545) and under suitable weather conditions (no rain, little wind, and temperature >0°C).

Table 1. Study area counties, streams, sample sizes, and years.

County and Stream	Drainage	Point Counts	Years
Wabasha County			
West Indian Creek	Zumbro	9	1996 - 1997
Snake Creek	Mississippi	5	1996 - 1997
Winona County			
South Branch Whitewater I	Whitewater	10	1996 - 1997
South Branch Whitewater II	Whitewater	6	1997
South Branch Whitewater tributary	Whitewater	5	1996 - 1997
Middle Branch Whitewater I	Whitewater	9	1996 - 1997
Middle Branch Whitewater II	Whitewater	6	1996 - 1997
Trout Run Creek	Whitewater	9	1996 - 1997
Trout Creek	Whitewater	6	1996 - 1997
Beaver Creek	Whitewater	10	1996 - 1997
Hemmingway Creek	Root	3	1996 - 1997
Olmsted County			
Logan Branch	Whitewater	10	1996 - 1997
North Branch Whitewater	Whitewater	5	1996 - 1997
Fillmore County			
Canfield Creek	Root	9	1996 - 1997
Forestville Creek	Root	6	1996 - 1997
Spring Valley Creek	Root	7	1996 - 1997
Diamond Creek	Root	9	1996 - 1997
Gribben Creek	Root	4	1997
Shattuck/Nepstad Creek	Root	10	1996 - 1997
South Fork Root	Root	5	1996 - 1997
Houston County			
East Beaver Creek	Root	10	1996 - 1997
Badger Creek	Root	5	1996 - 1997

Each point count lasted seven minutes, and either I (1996 and 1997) or an assistant (1997) recorded all birds, and squirrels seen or heard as either inside or outside a 50 m radius, sex, and how detected. Care was taken not to double count individuals within or across point counts. Point counts were established 10 m from the nearest stream, at least 50 m from the nearest edge (e.g. forest/grassland, or forest/crop fields), and at 200 m intervals along a given stream. I maximized the number of point counts along a given stream as habitat permitted, with up to ten point counts per study site (Table 1). At the conclusion of each point count, two minutes of Louisiana Waterthrush taped playback were used to solicit responses; three territorial calls (~15 seconds), followed by silence (~45 seconds), and then repeated. All responses, and extent of responses were noted as such and separated from standard point count data.

For analyses, I included only males within the 50 m radius. In the case of non-sexually dimorphic species (e.g. Black-capped Chickadee, Blue Jay) half the individuals counted were included. Point counts were summarized for a given site and corrected for area which resulted in an average number of males detected per point count per site. Community analyses were based on habitat, breeding and migration status as assigned by Green (1991 and 1995); forest use designations were taken from Freemark and Collins (1989). For single species comparisons, only southeastern Minnesota breeding species detected ten or more times were used. Squirrels *(Sciurus niger, S. carolinensis,* and *Tamsciurus hudsonicus)* were grouped together for analyses.

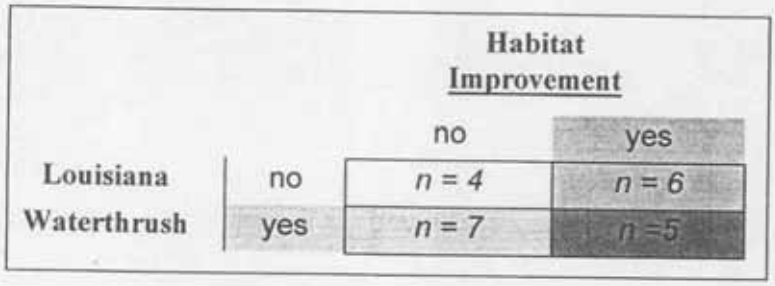
Nest Searching Point count and playback information formed the basis of nest searching, augmented with additional visual observation of pairs and taped call playback.

Louisiana Waterthrush pairs were tracked throughout the season, including territory establishment, pairing, nesting, and fledging. I located nests by observing males and females, and actively searching within their territories for nest locations. Once a nest was found, i recorded nesting stage and evidence of Brown-headed Cowbird *(Molothrus ater)* parasitism. Checks were made every 5-7 days to determine the fate of the nest. During nest searching and subsequent visits, every effort was made to limit impacts of observers in the vicinity of the nest. To reduce subsequent detection of nests by predators, all observers wore rubber boots (either knee-high or hip-waders) and made their approach by water. No nests were touched until either the nestlings fledged or the nest was destroyed.

Nest Measurements Information on the physical characteristics of Louisiana Waterthrush nests was recorded after fledging or nest destruction. For each nest I used a meter tape and compass to measure vertical height (m) and horizontal distance (m) from the stream, bank slope (°), slope aspect (°), and direction of stream flow (°). Nest construction materials and the number and species of leaves included in the nest were also noted.

Statistics - Comparisons among avian species and communities were first made for areas with and without trout HI. Comparisons were then made again, including presence or absence of Louisiana Waterthrushes as a factor (Figure 2). Two factor randomization tests with 10,000 iterations (MACANOVA V4.1) evaluated differences in both means and variances of both weighted and unweighted samples (Oehlert and Bingham 1999). P-values were considered significant at $p \leq 0.05$.

Figure 2. Sampling design, analysis categories, sample sizes, and labels.



For Louisiana Waterthrush nests and trout HI, analyses were made using a randomization version of a t-test in MACANOVA. P-values were considered significant at $p \leq 0.05$.

Results -

HI and Avian Species and Communities

Streams with HI showed significant differences in avian species composition as compared to streams without HI. Larger numbers of Chipping and Field Sparrows, Brown-headed Cowbirds, and Red-winged Blackbirds were detected along streams with HI, than without HI (Figure 3-4). Red-winged Blackbirds and the squirrel community also showed more variance in detection among streams with HI.

Detection rates were higher in HI versus no HI streams for several community groupings, including residents of disturbed forest, species indicative of forest edge habitats, and all continental migrants of disturbed forest, open habitats or water (Figure 5-8). Variation in the detection rates were also greater among permanent residents, including those of both disturbed and intact forest. Streams with HI showed fewer detections of Eastern Phoebes, and reduced variation in detections of American Redstarts (Figure 9).

HI and Louisiana Waterthrushes

No significant effects were detected in the reproductive success, nest placement or nest construction of Louisiana Waterthrushes between streams with HI, versus those without. However, final sample sizes were small, and likely did not have adequate power to detect differences. In general, nests in areas without HI had larger Louisiana Waterthrush clutch sizes, chicks, and fledglings. These areas without HI also had more Brown-headed Cowbird eggs laid and chicks, but fewer fledglings per nest. Nests along streams without HI were horizontally closer to the stream, but vertically higher and on

Figure 3. Point count detections of Chipping and Field Sparrows along streams with and without habitat improvement (HI).

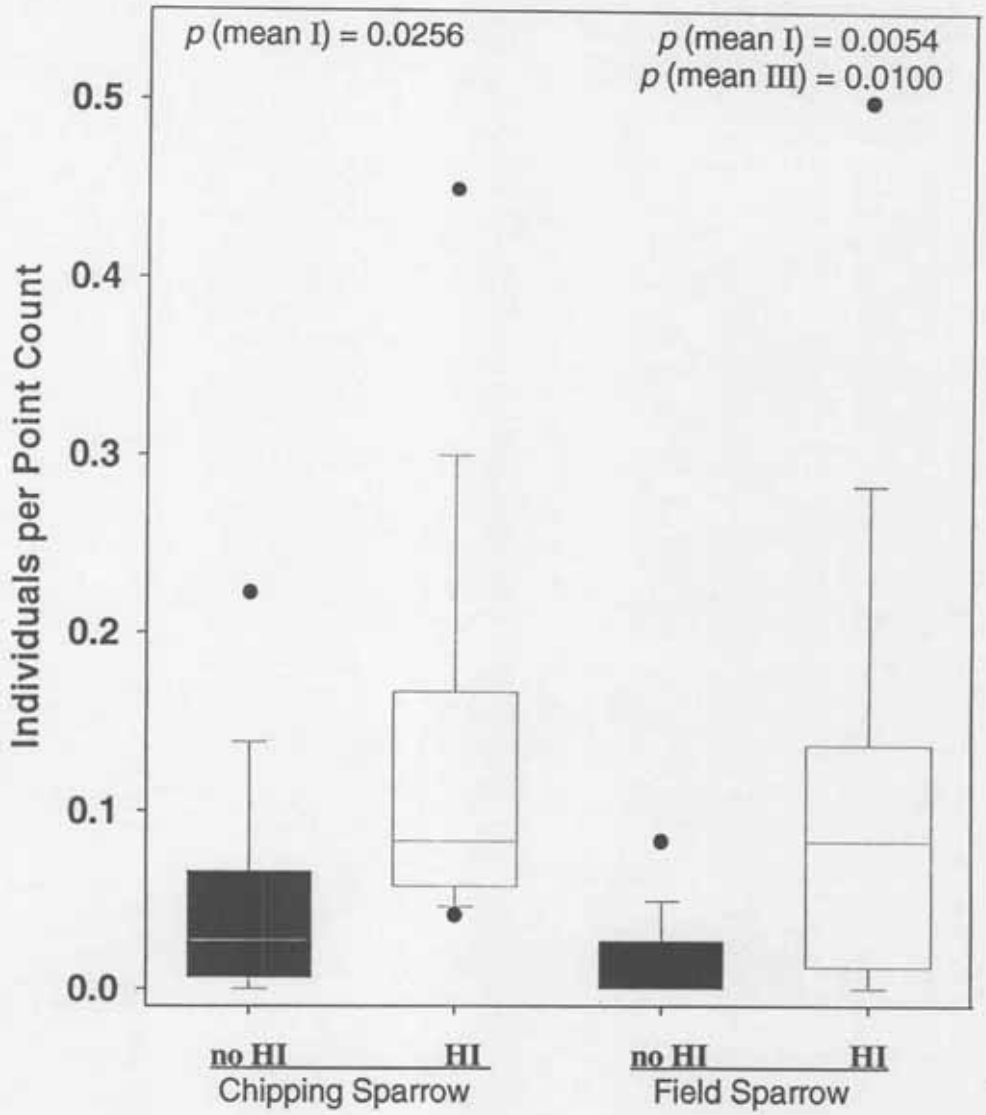


Figure 4. Point count detections of Brown-headed Cowbirds and Red-winged Blackbirds along streams with and without habitat improvement (HI).

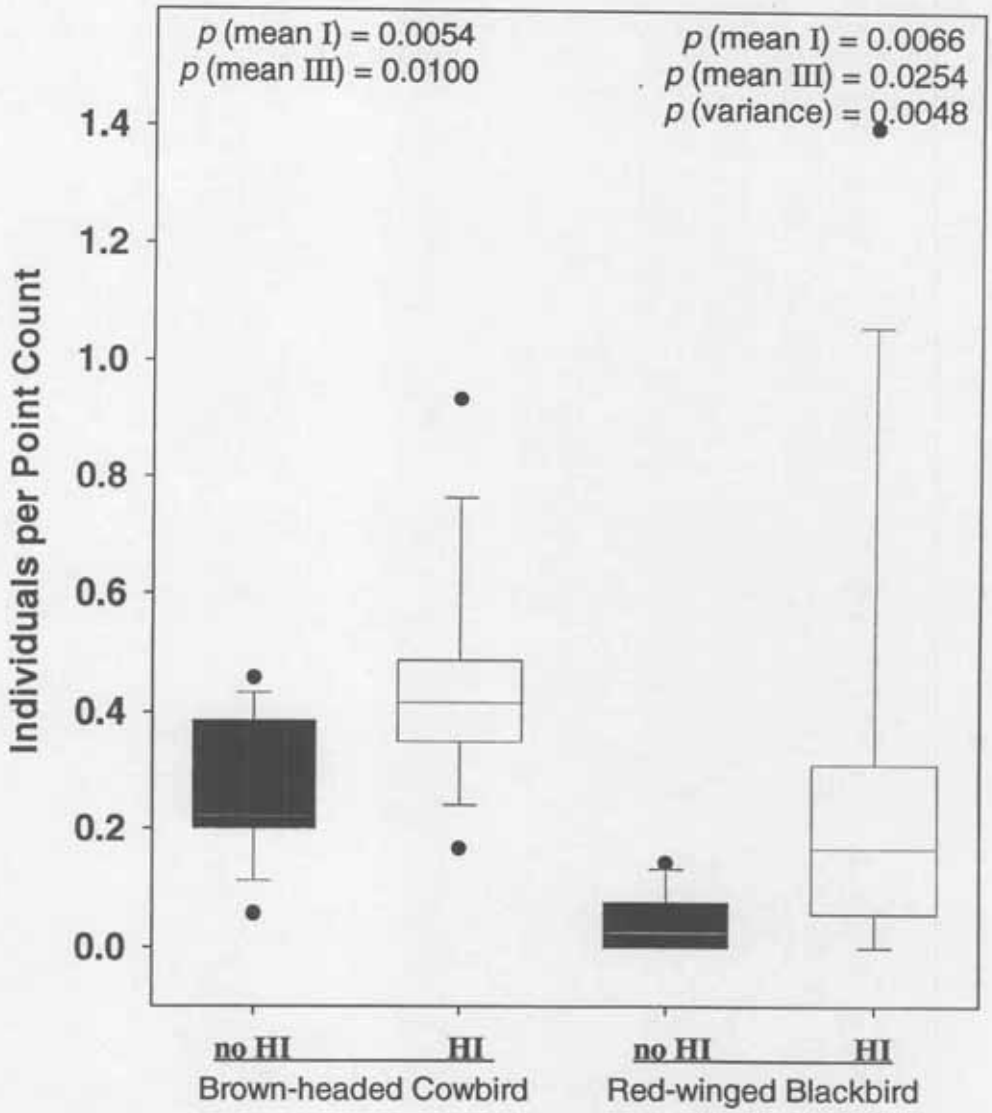


Figure 5. Point count detections of continental migrants, disturbed forest species, and forest edge species along streams with and without habitat improvement (HI).

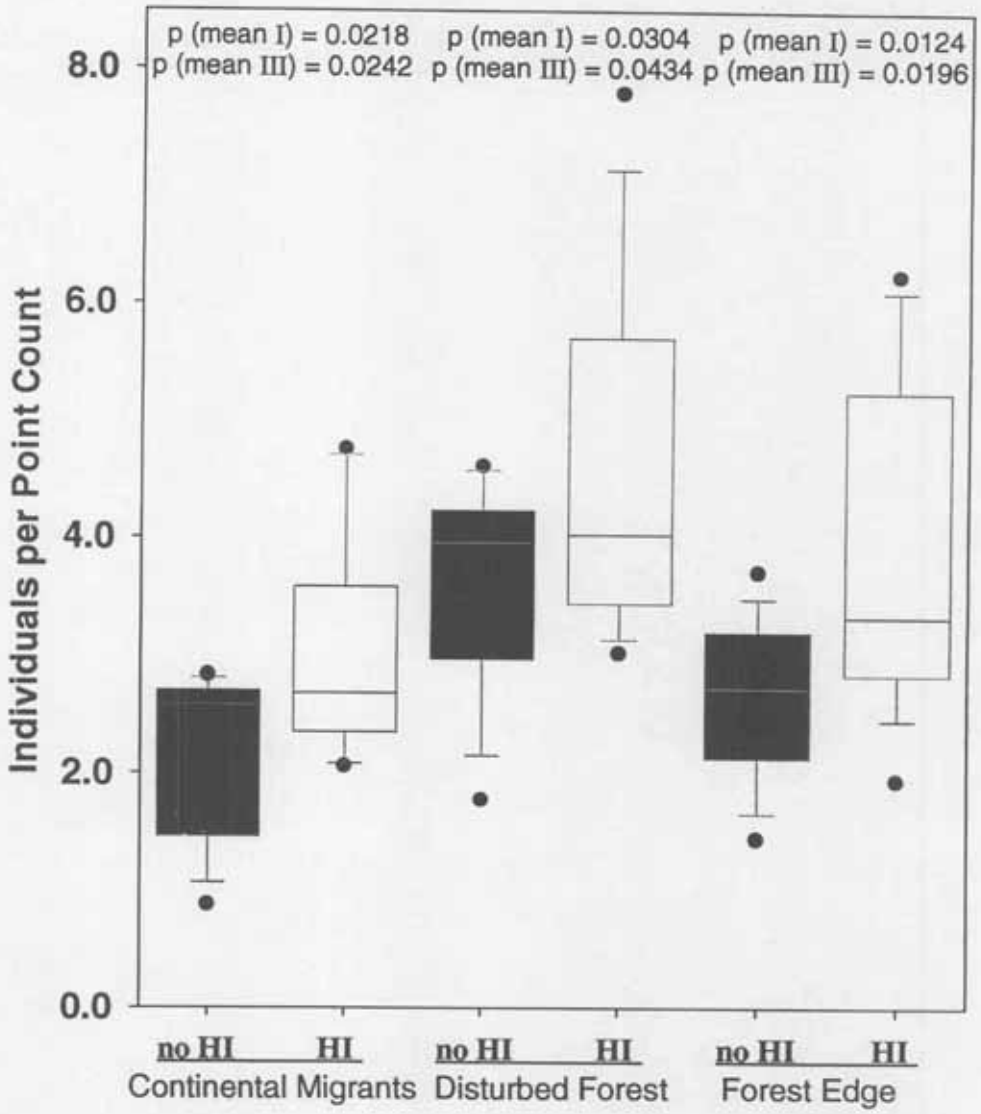


Figure 6. Point count detections of breeding continental migrants of disturbed open and water habitats along streams with and without habitat improvement (HI).

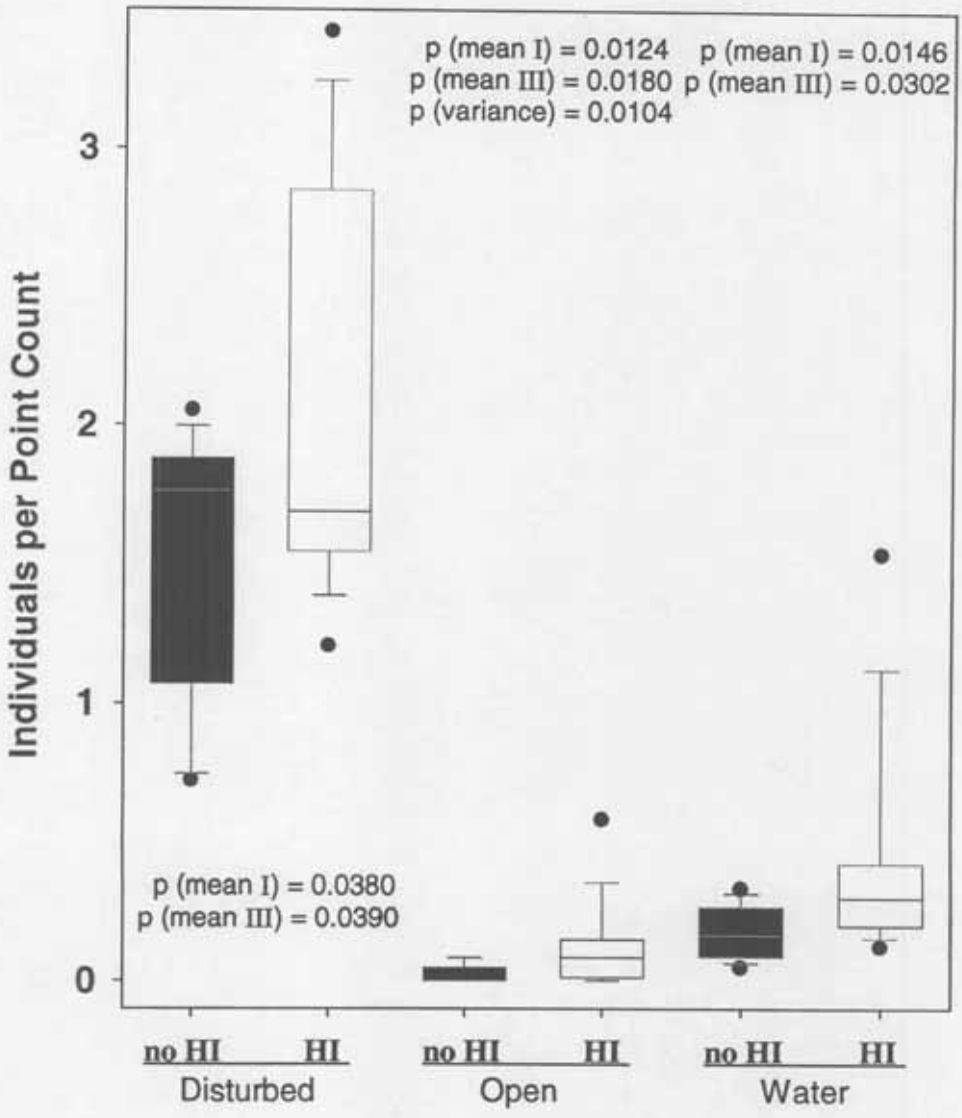


Figure 7. Point count detections of Water associated species and squirrels along streams with and without habitat improvement (HI).

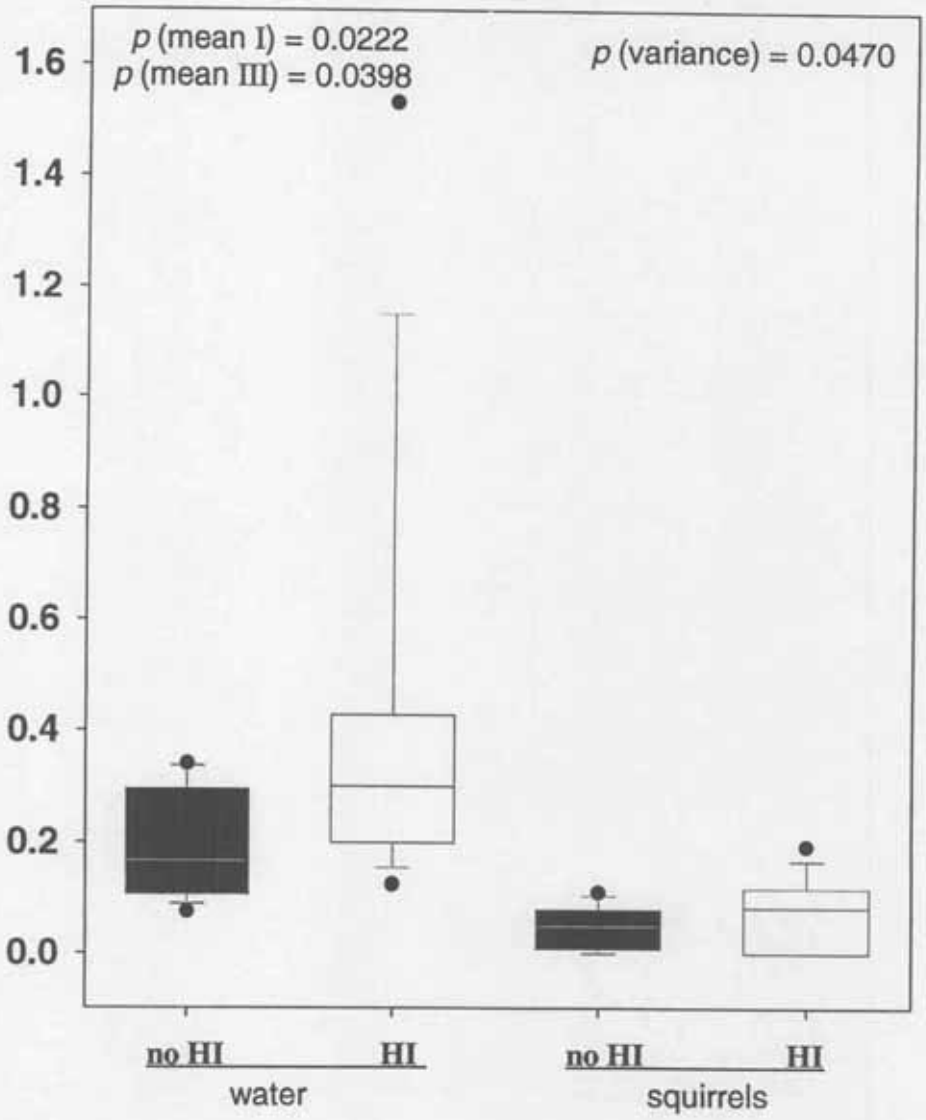


Figure 8. Point count detections of permanent residents, and permanent residents of forest and disturbed habitats along streams with and without habitat improvement (HI).

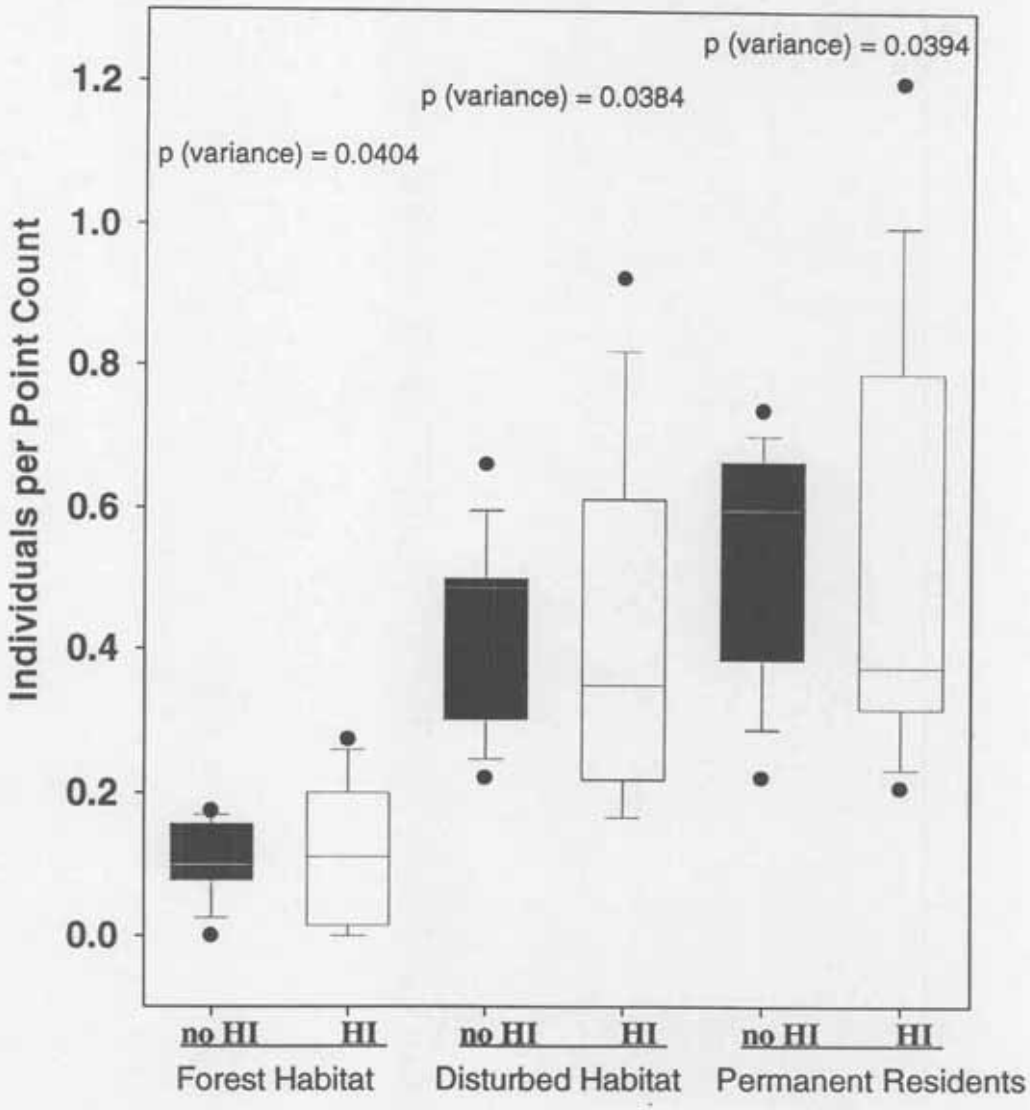
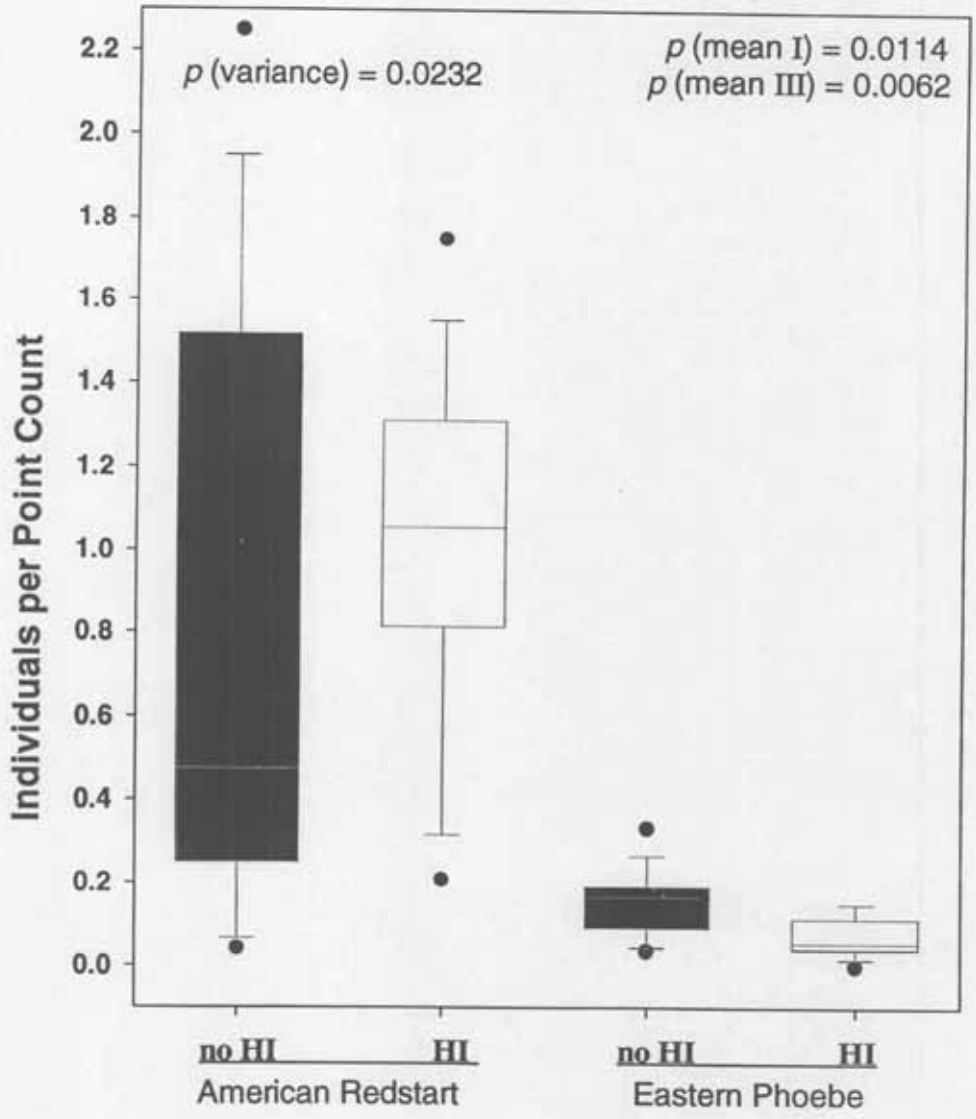


Figure 9. Point count detections of American Redstarts and Eastern Phoebes along streams with and without habitat improvement (HI).



more steeply sloped banks. The leaf nest-bases of Louisiana Waterthrushes along streams with no improvement had fewer leaves (-50%) than those along improved streams.

HI, Louisiana Waterthrushes, and Avian Species and Communities

Among streams with no waterthrushes, habitat improved sites had significantly more American Goldfinches, Field Sparrows, and Red-winged Blackbirds detected, when compared to sites without HI (Figure 10-12). More broadly (Figure 13-14), open habitat and forest edge species were found significantly more among sites with HI than without. More variation in detection was significantly higher for Red-winged Blackbirds, Warbling Vireos, and Acadian Flycatchers (Figure 15-16) among sites with HI. Significantly fewer Eastern Phoebes (Figure 17) were detected at stream that had been habitat improved than those that were not.

Sites with Louisiana Waterthrushes and HI had significantly higher numbers of Brown-headed Cowbirds (Figure 18) compared to sites without HI. Variance in the detections of Common Yellowthroats, Great Blue Herons and Ruffed Grouse was greater among habitat improved sites, while less variance was observed for House Wrens (Figure 19-22). Similarly, more permanent forest residents (Figure 23) were observed at sites with HI, as compared to those without.

Among sites with no HI, significantly more Louisiana Waterthrushes, Swamp Sparrows and Veerys (Figure 24-26) were detected during point counts along streams with breeding Louisiana Waterthrushes as opposed to those without. Variance in the detections of Louisiana Waterthrushes, Veerys, Warbling Vireos, Acadian Flycatchers (Figure 15-16) and species associated with open habitat (Figure 27) was also greater

Figure 10. Point count detections of American Goldfinches along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).
Interaction between HI and LOWA: p (mean) = 0.0128

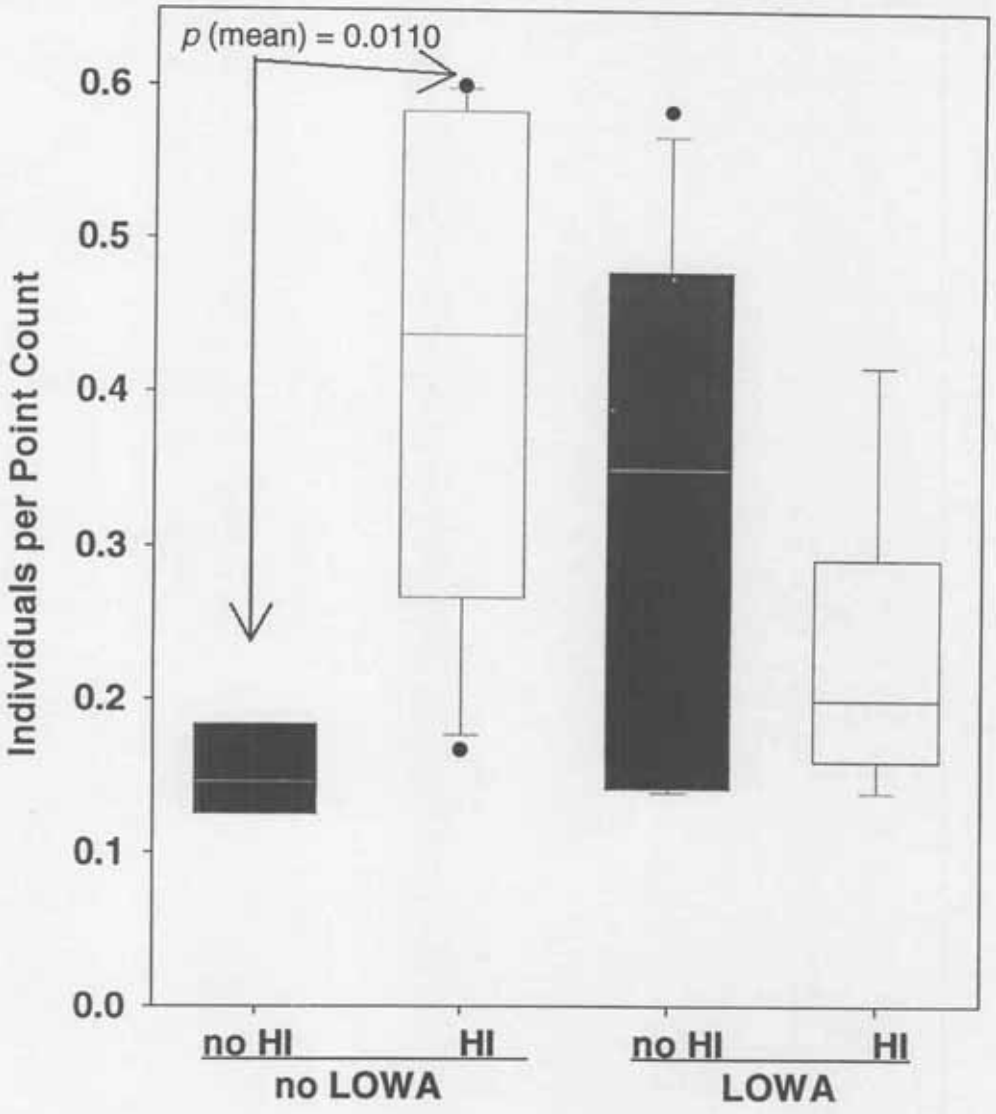


Figure 11. Point count detections of Field Sparrows along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

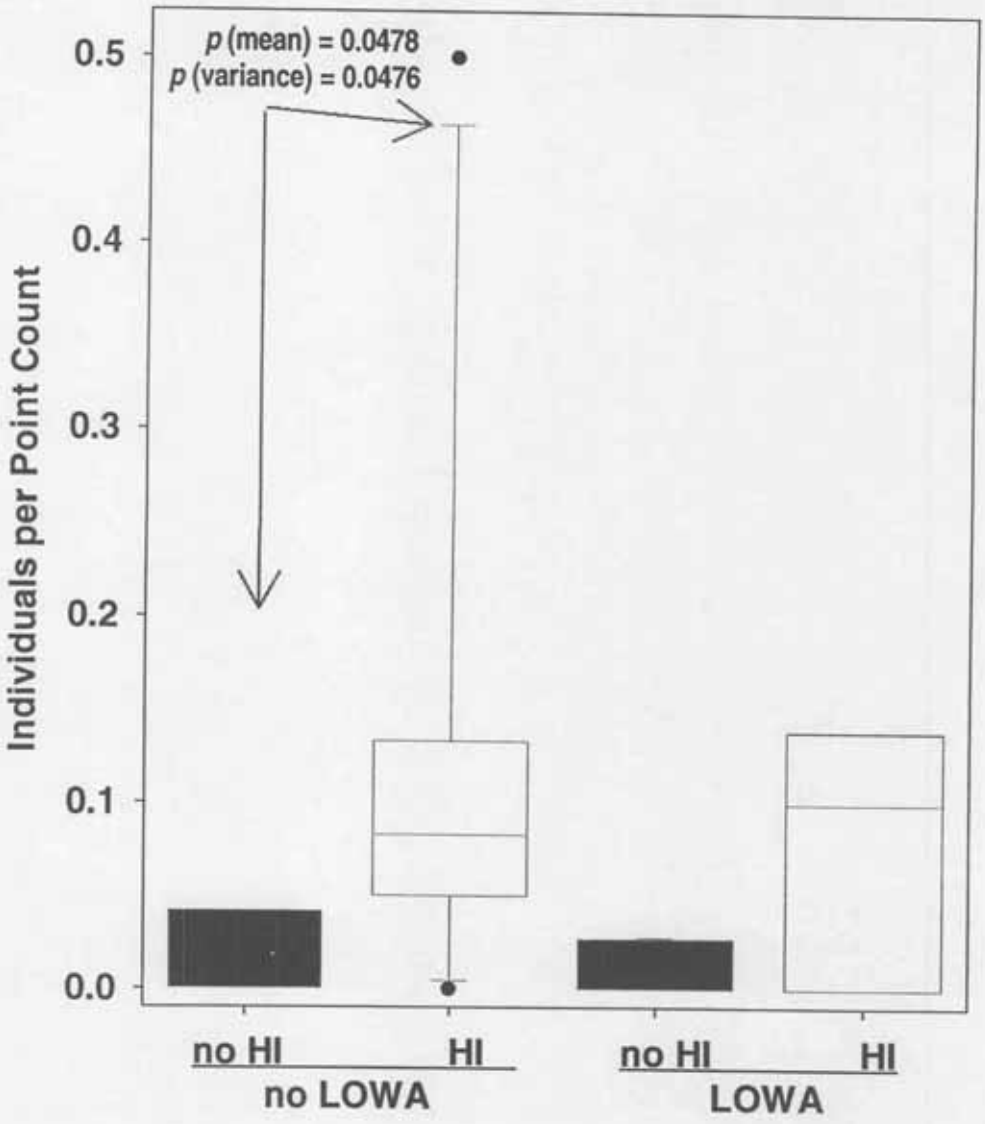


Figure 12. Point count detections of Red-winged Blackbird along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

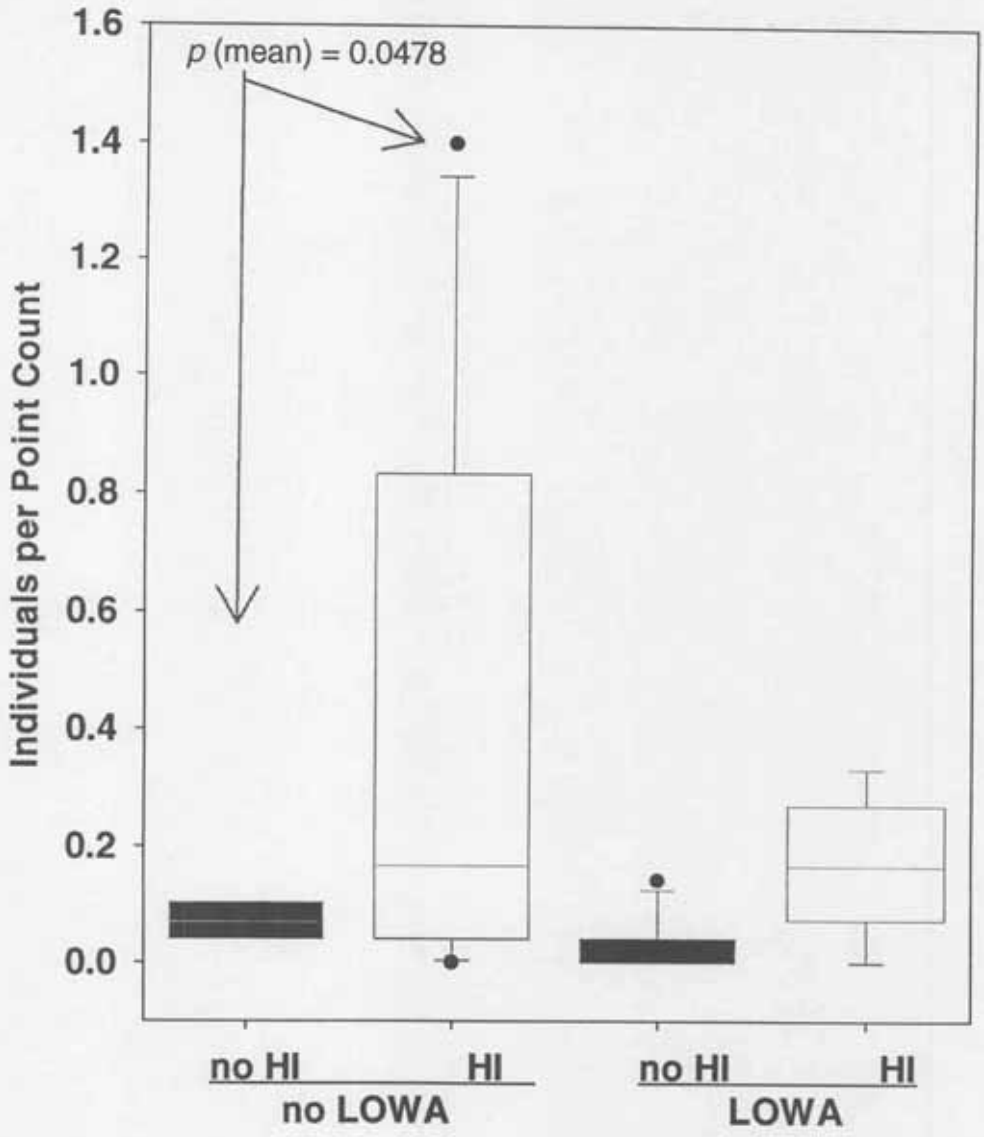


Figure 13. Point count detections of continental migrating - open habitat species along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

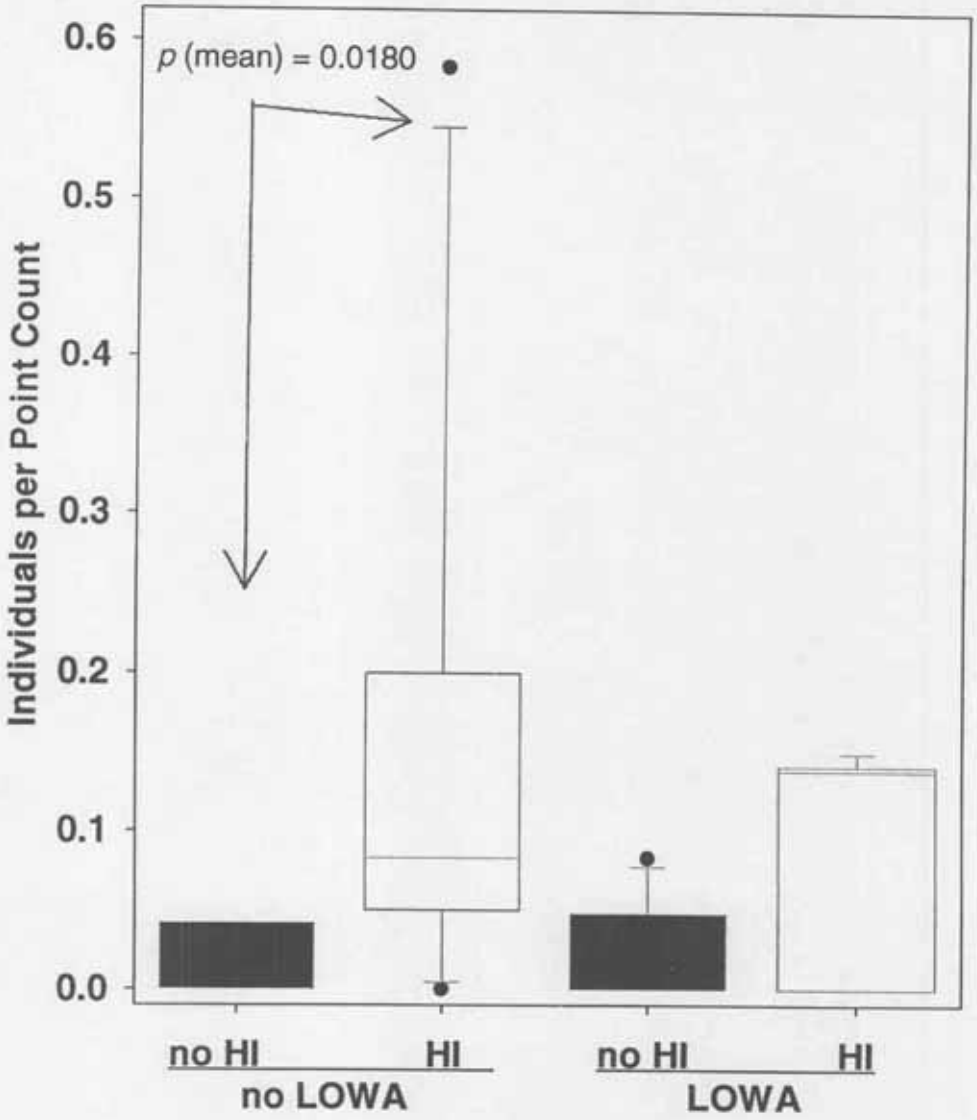


Figure 14. Point count detections of forest edge habitat species along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

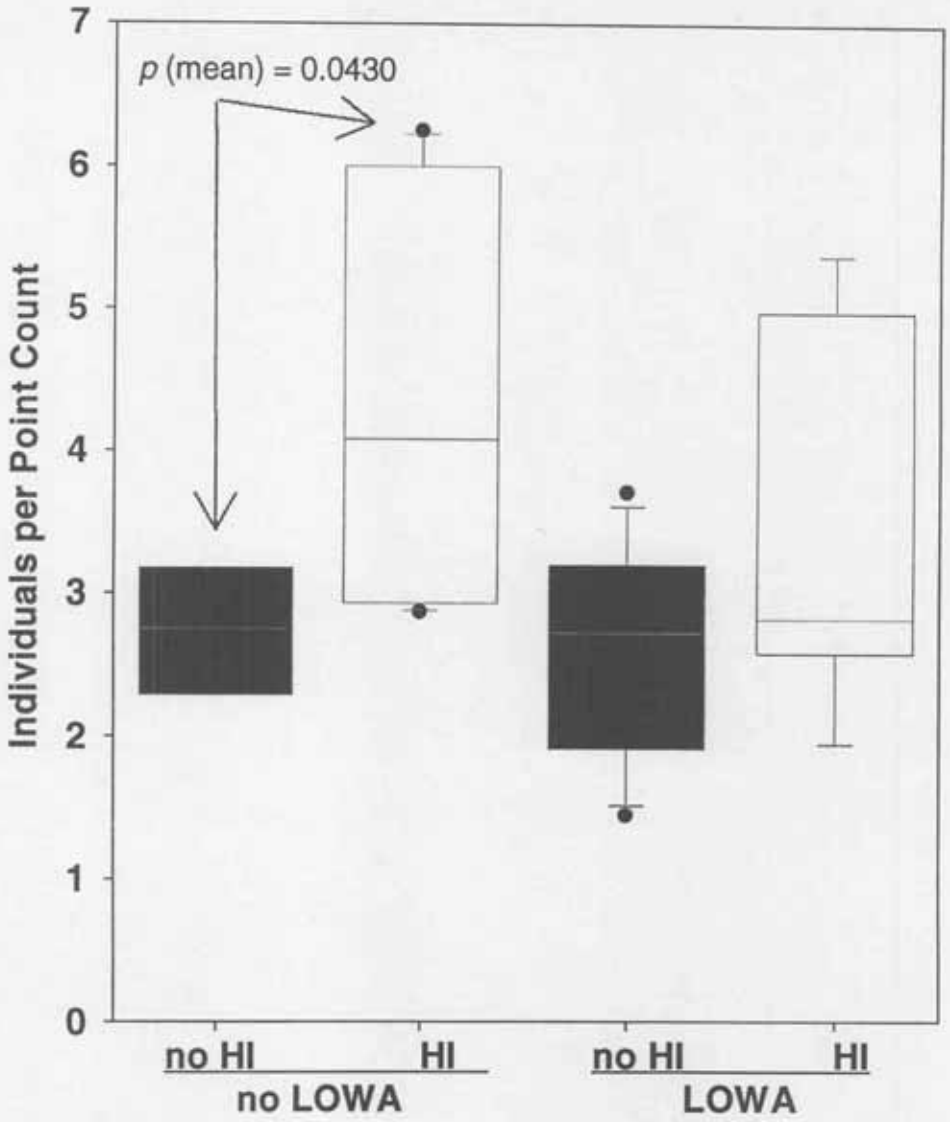


Figure 15. Point count detections of Warbling Vireos along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

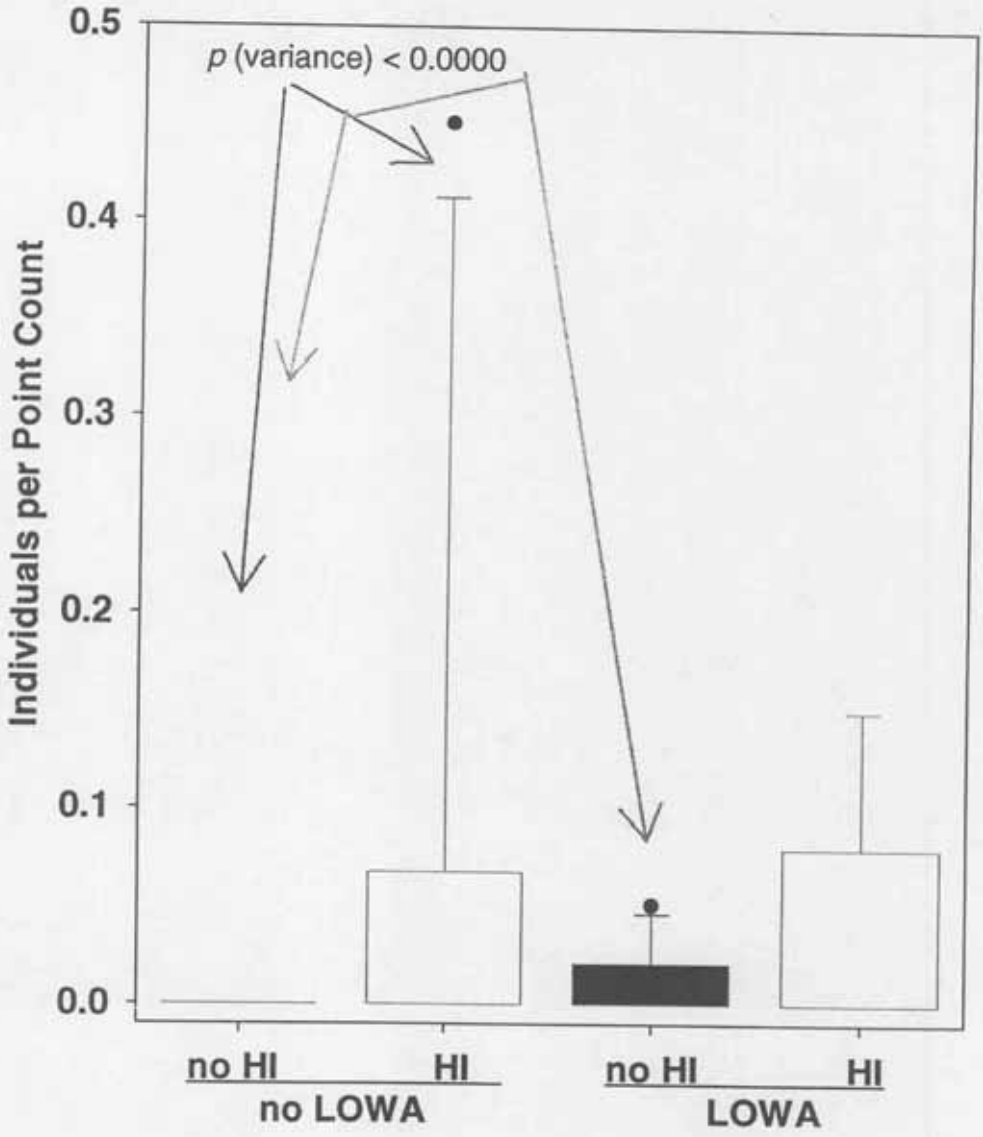


Figure 16. Point count detections of Acadian Flycatchers along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

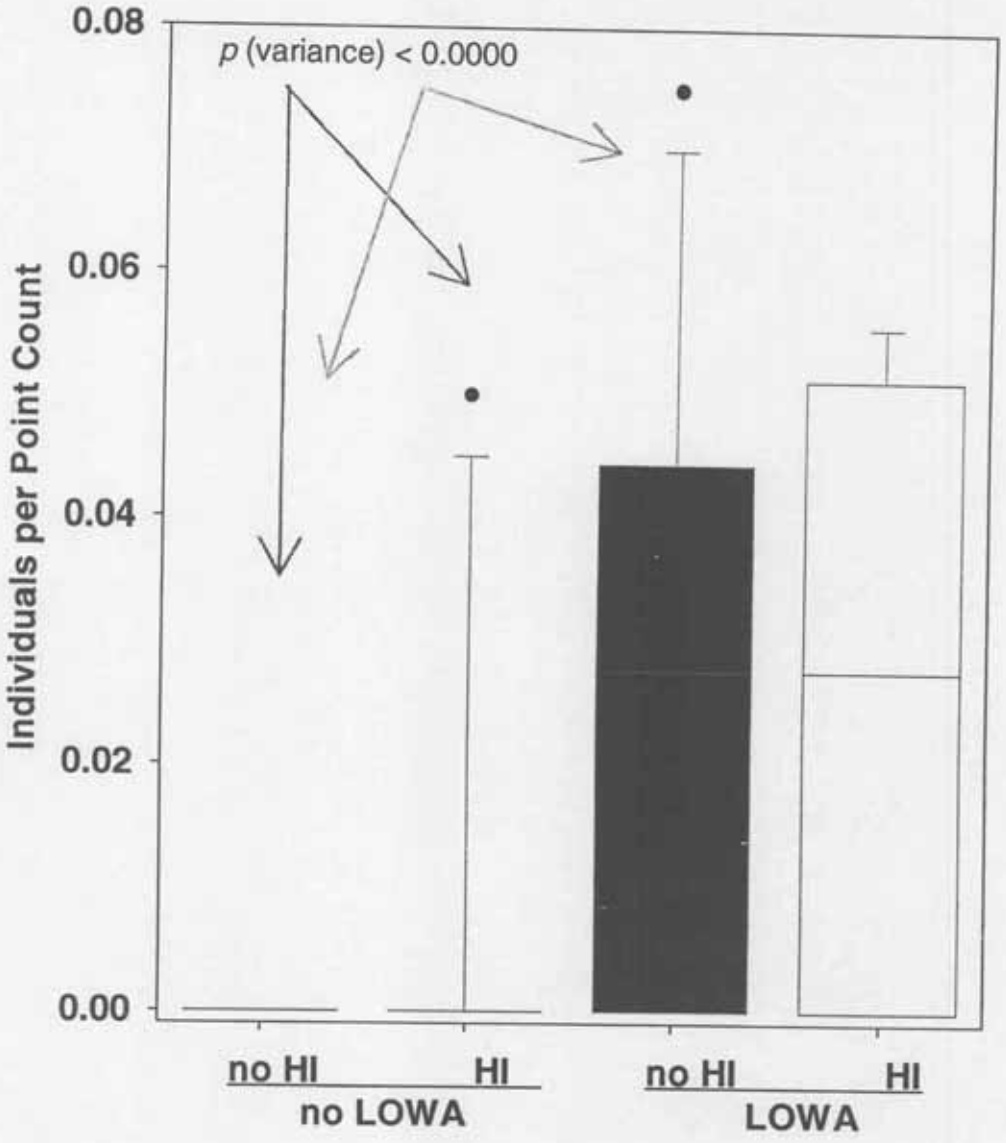


Figure 17. Point count detections of Eastern Phoebes along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

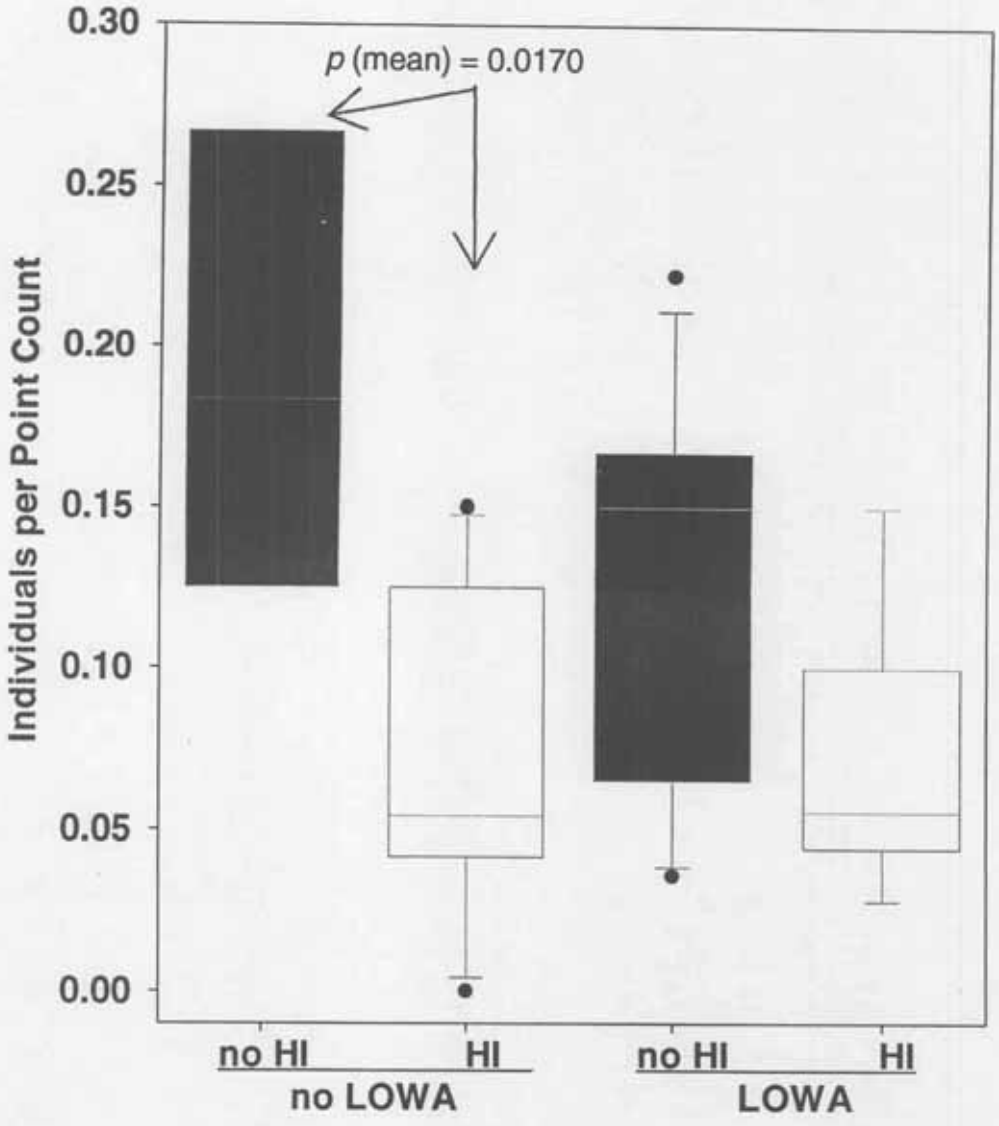


Figure 18. Point count detections of Brown-headed Cowbirds along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

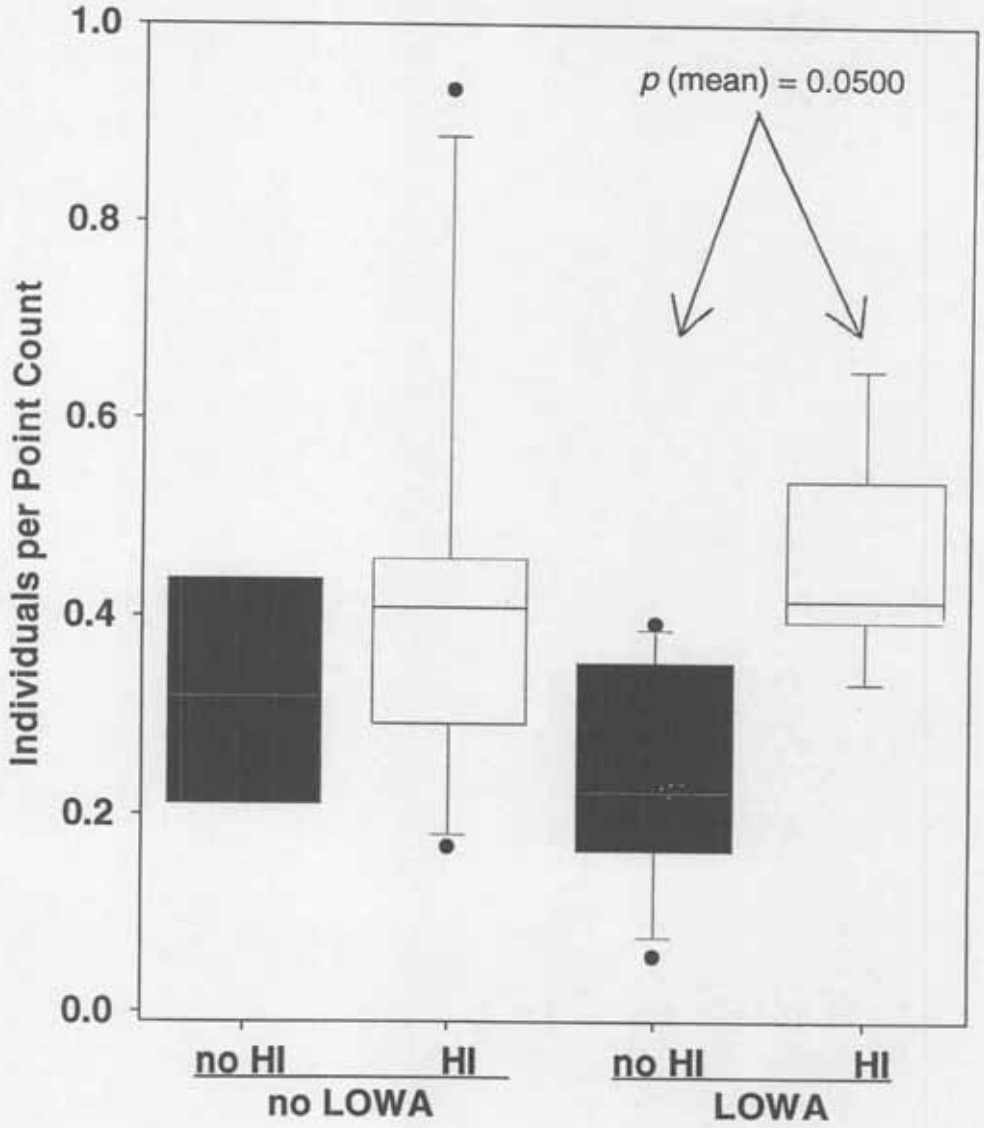


Figure 19. Point count detections of Common Yellowthroats along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

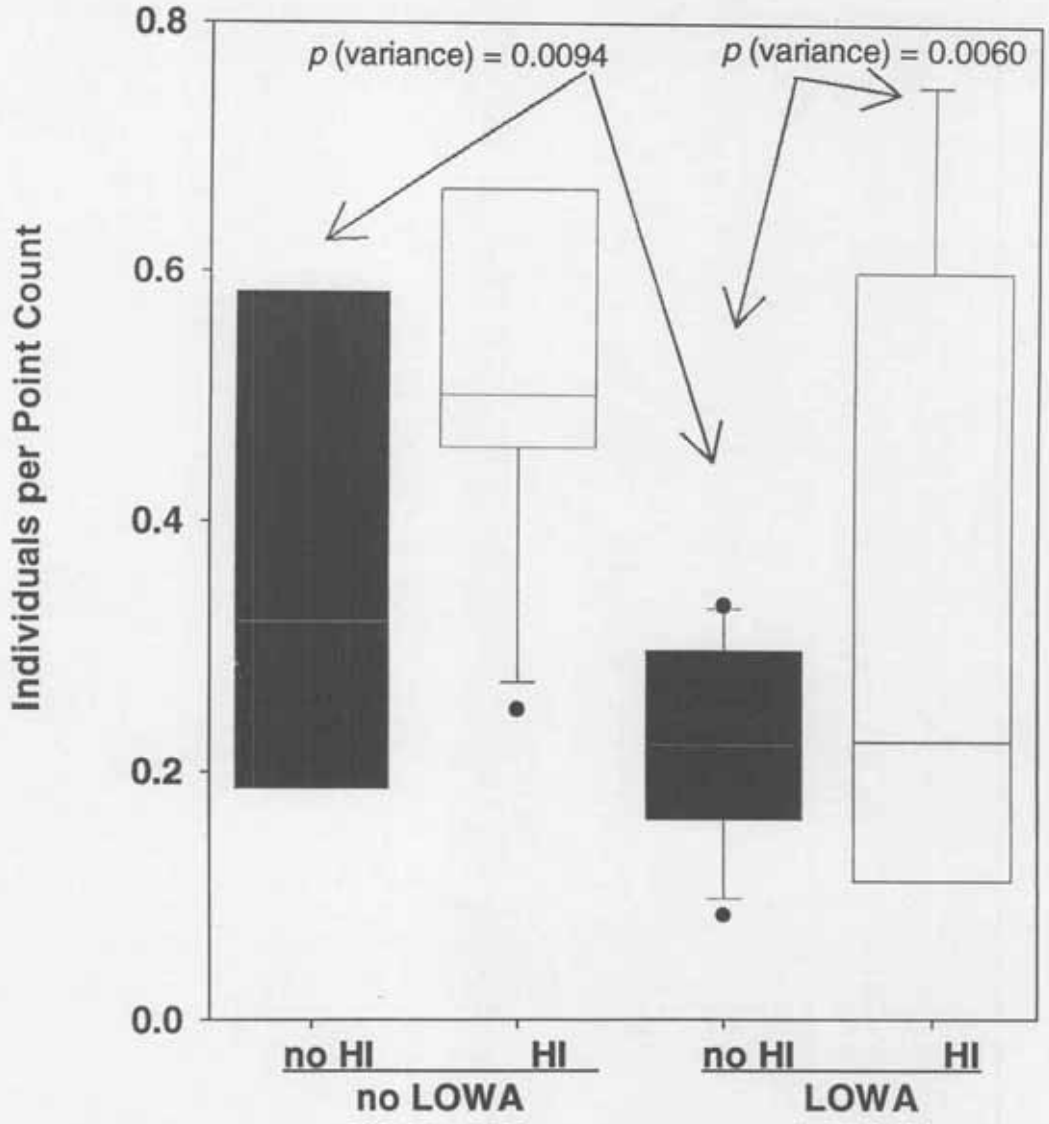


Figure 20. Point count detections of Great-Blue Herons along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

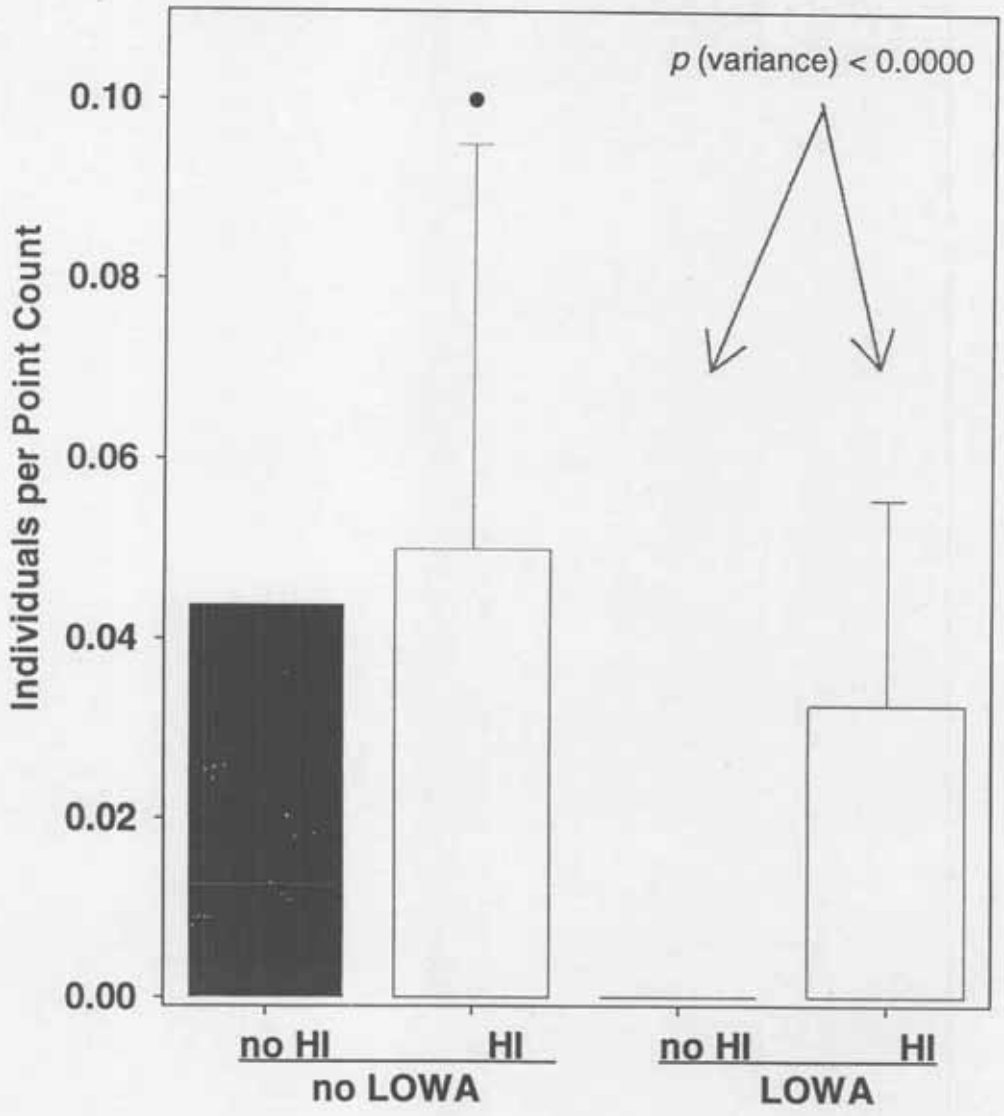


Figure 21. Point count detections of Ruffed Grouse along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

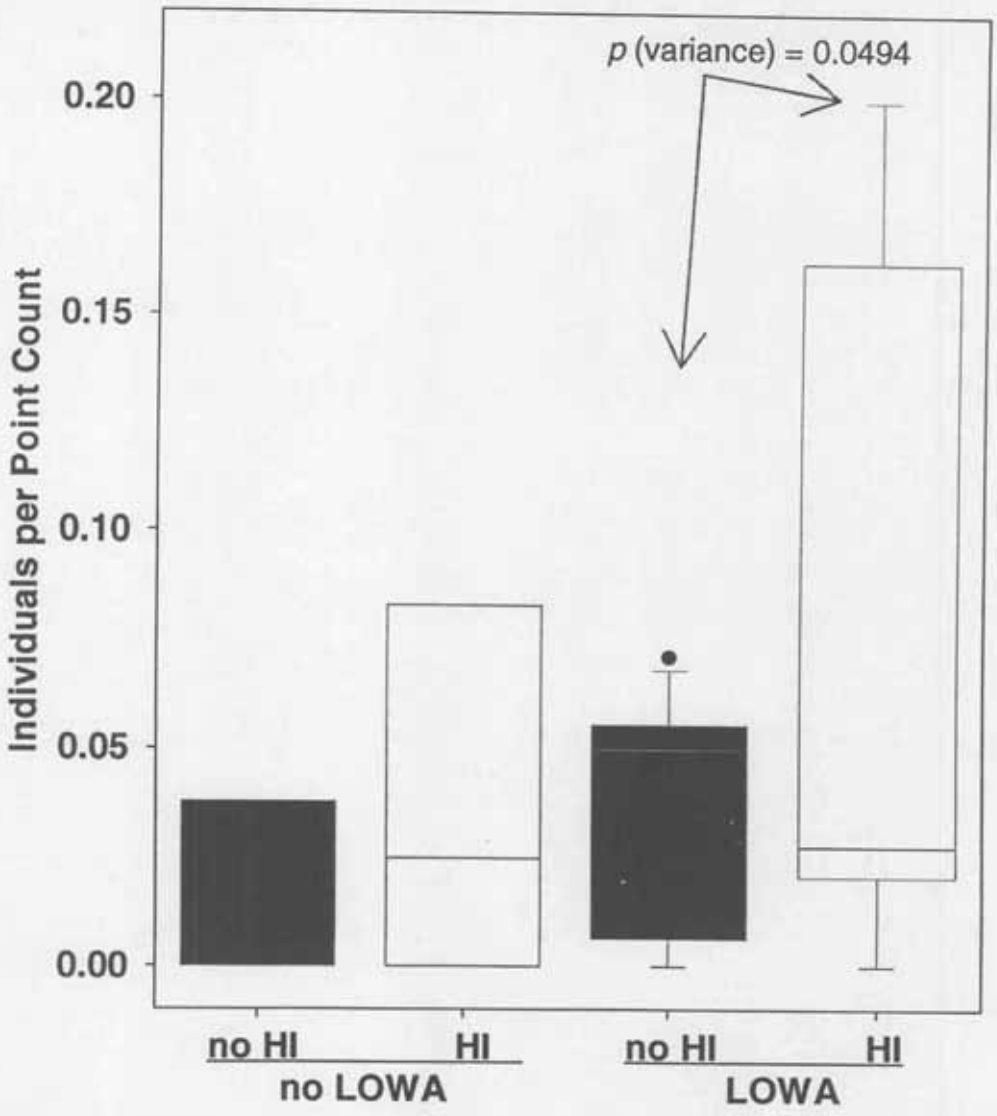


Figure 22. Point count detections of House Wren along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

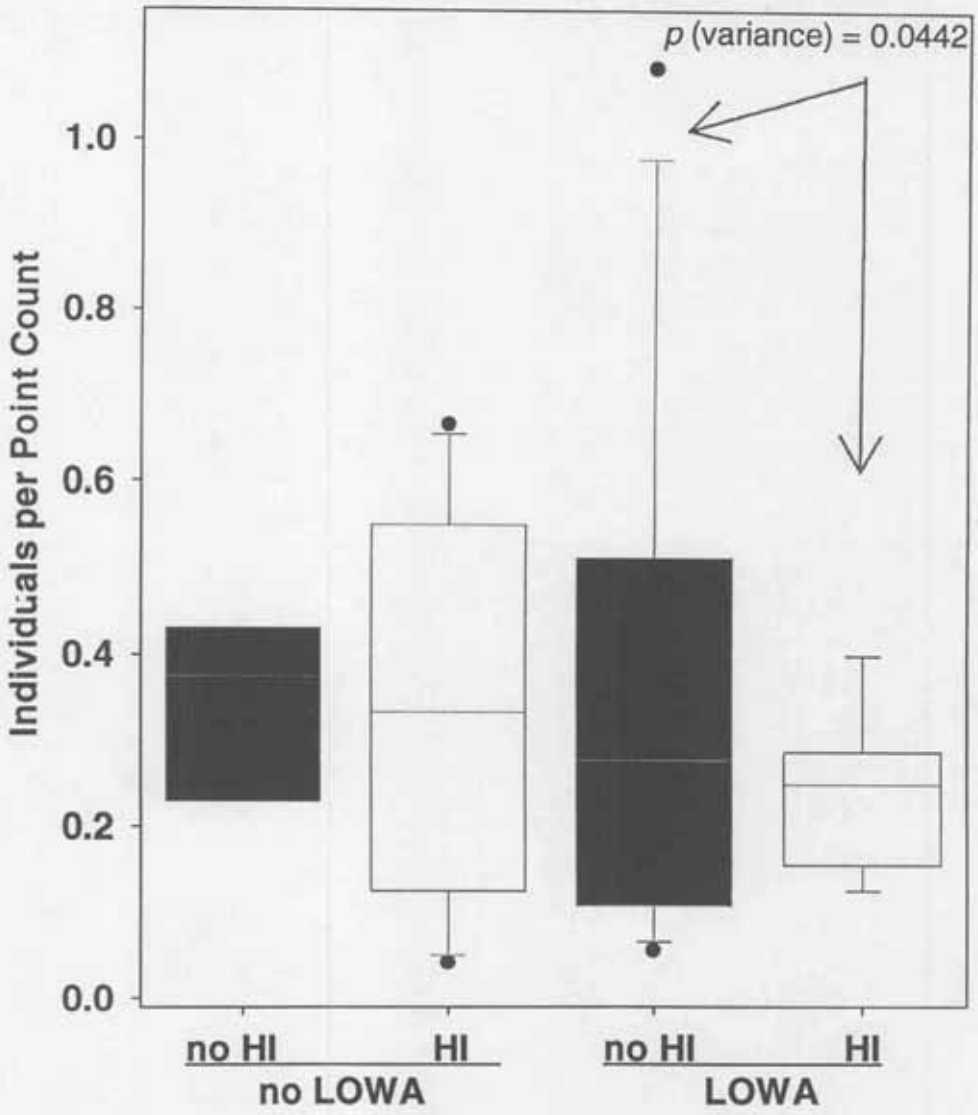


Figure 23. Point count detections of permanent residents of forested habitat along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

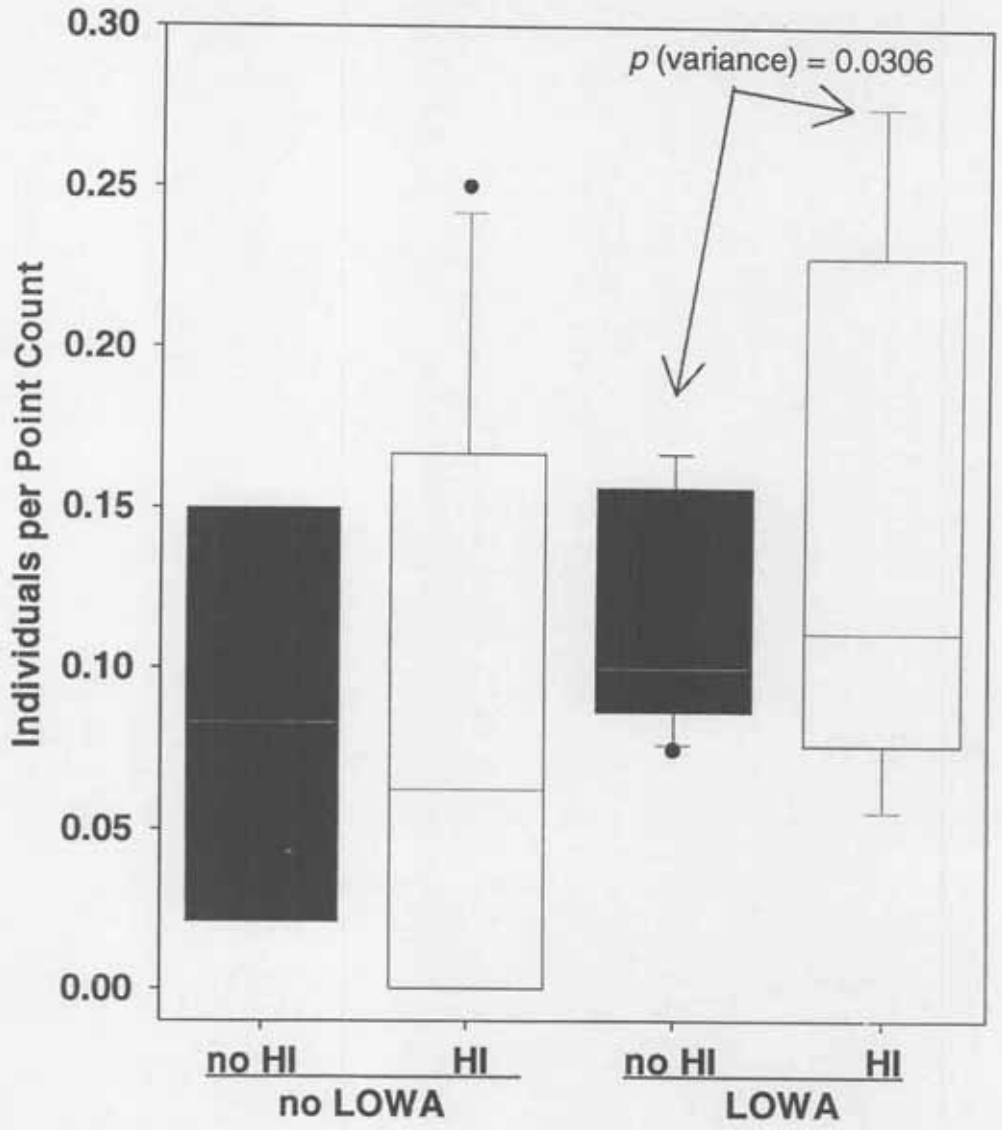


Figure 24. Point count detections of Louisiana Waterthrushes along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

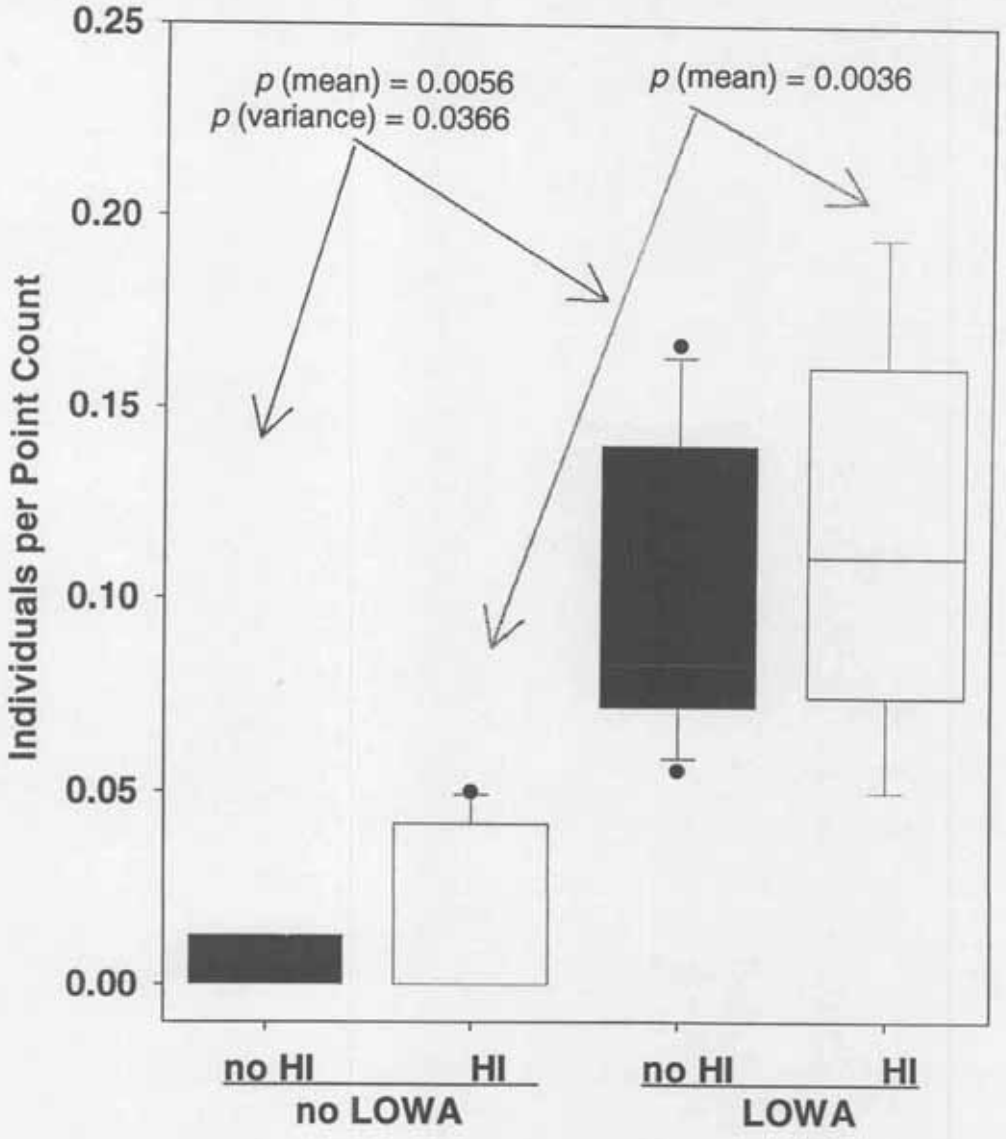


Figure 25. Point count detections of Swamp Sparrows along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

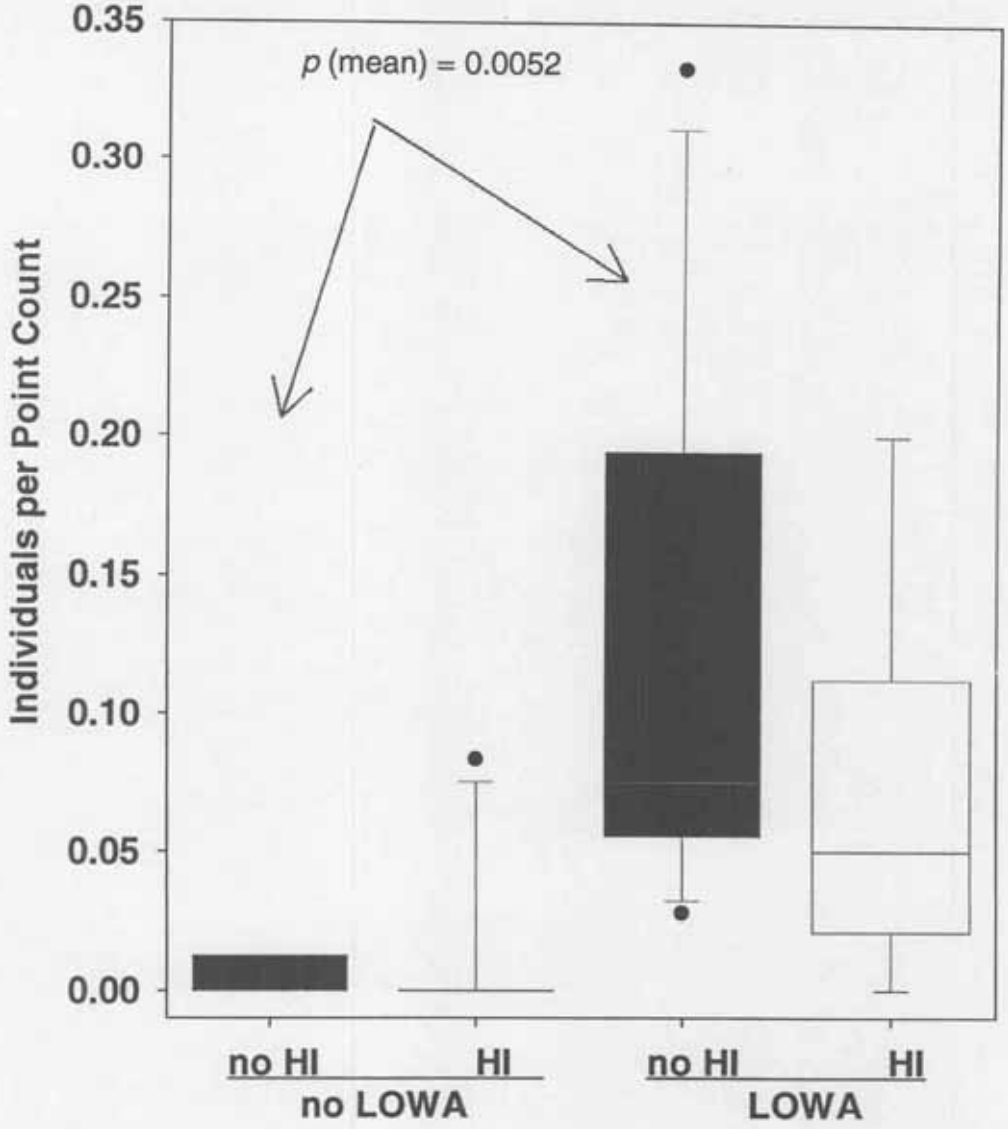


Figure 26. Point count detections of Veerys along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

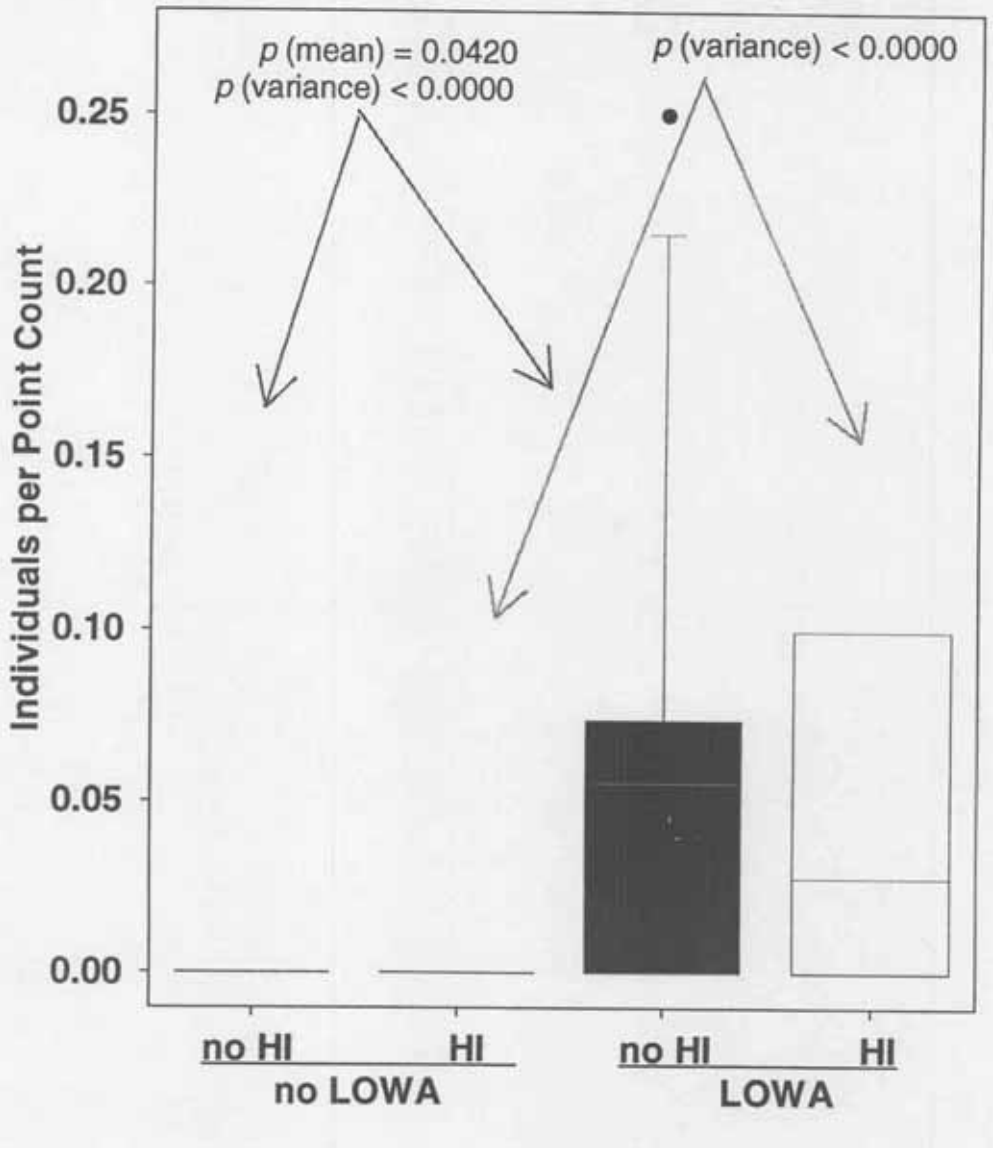
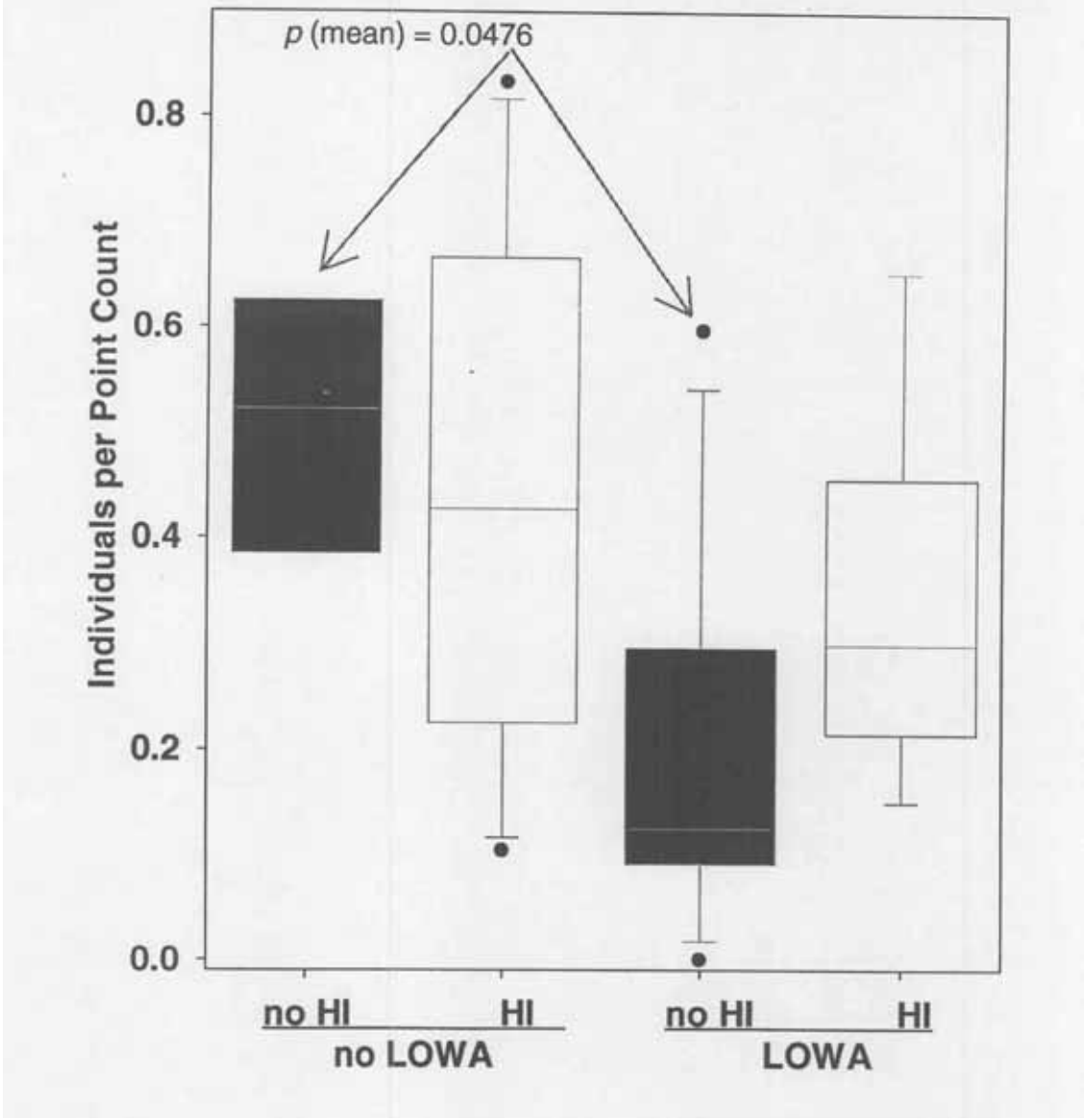


Figure 27. Point count detections of open habitat species along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).



among the Louisiana Waterthrush breeding sites. Significantly less variance in Common Yellowthroat (Figure 19) detections was observed among those with breeding Louisiana Waterthrushes.

Comparing those habitat improved locations with and without breeding Louisiana Waterthrushes, the trends continue. Significantly greater species richness, and numbers of Black-capped Chickadees, Blue Jays, transient continental forest species, and permanent residents of disturbed habitat were detected during point counts in sites with breeding Louisiana Waterthrushes versus those without (Figure 28-33). Variance in detections at those same locations was significantly greater for Great-crested Flycatchers, Winter Wrens, Hairy and Pileated Woodpeckers, and among the continental migrating-forest species community (Figure 34-38). Fewer American Crows and Eastern Towhees (Figure 39-40) were detected at habitat improved locations with breeding Louisiana Waterthrushes than those without.

Figure 28. Species richness for study areas from point counts along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

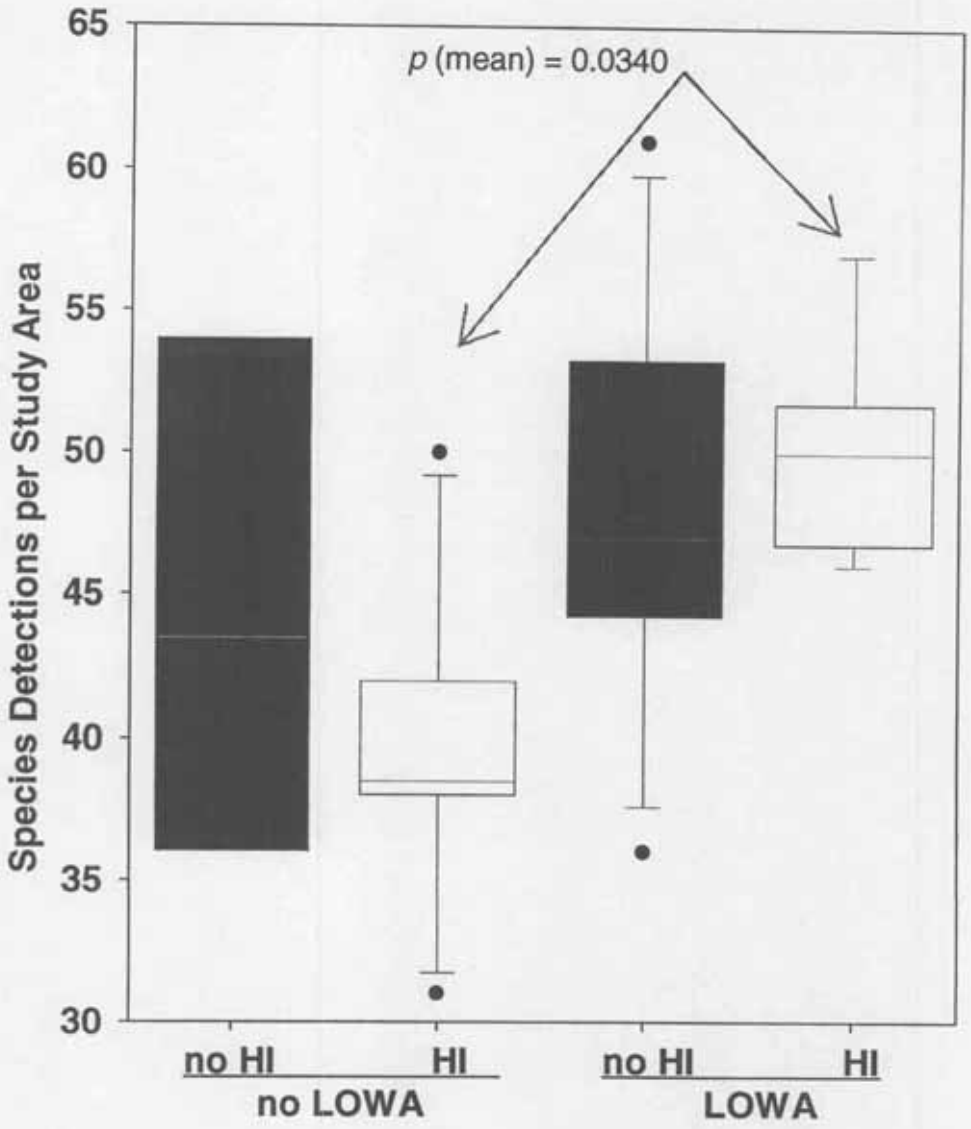


Figure 29. Point count detections of Black-capped Chickadees along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

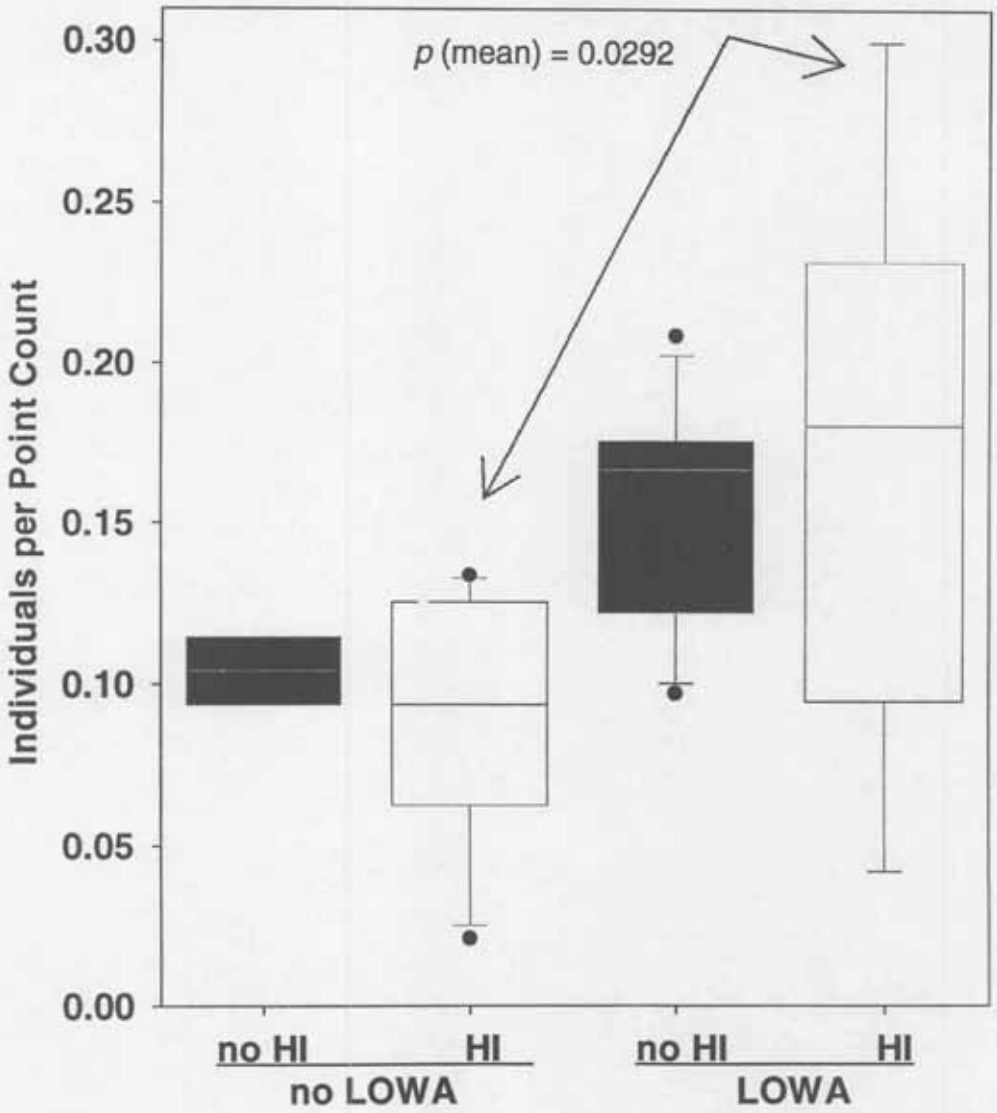


Figure 30. Point count detections of Blue Jays along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

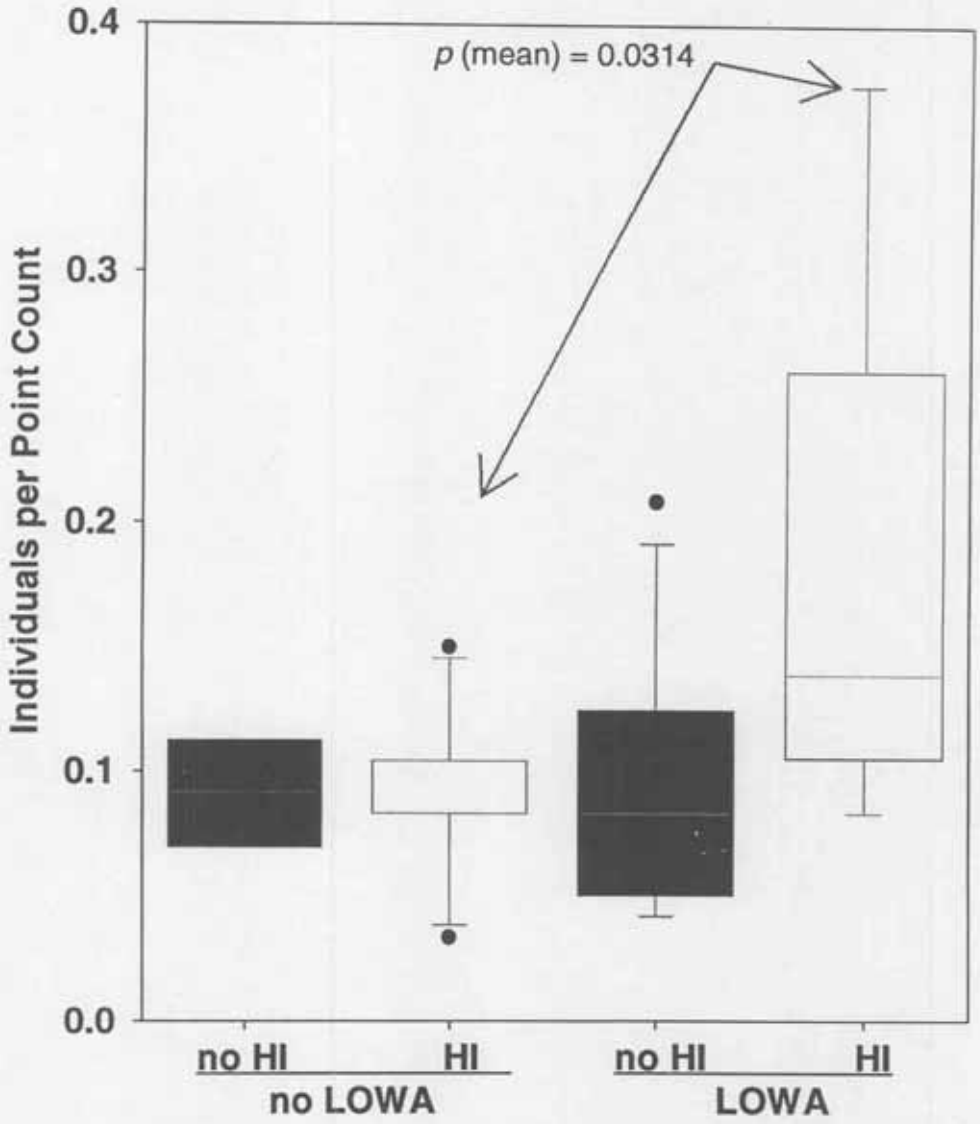


Figure 31. Point count detections of transient continental migrants of forested habitat along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA). Interaction between HI and LOWA: p (mean) = 0.0286

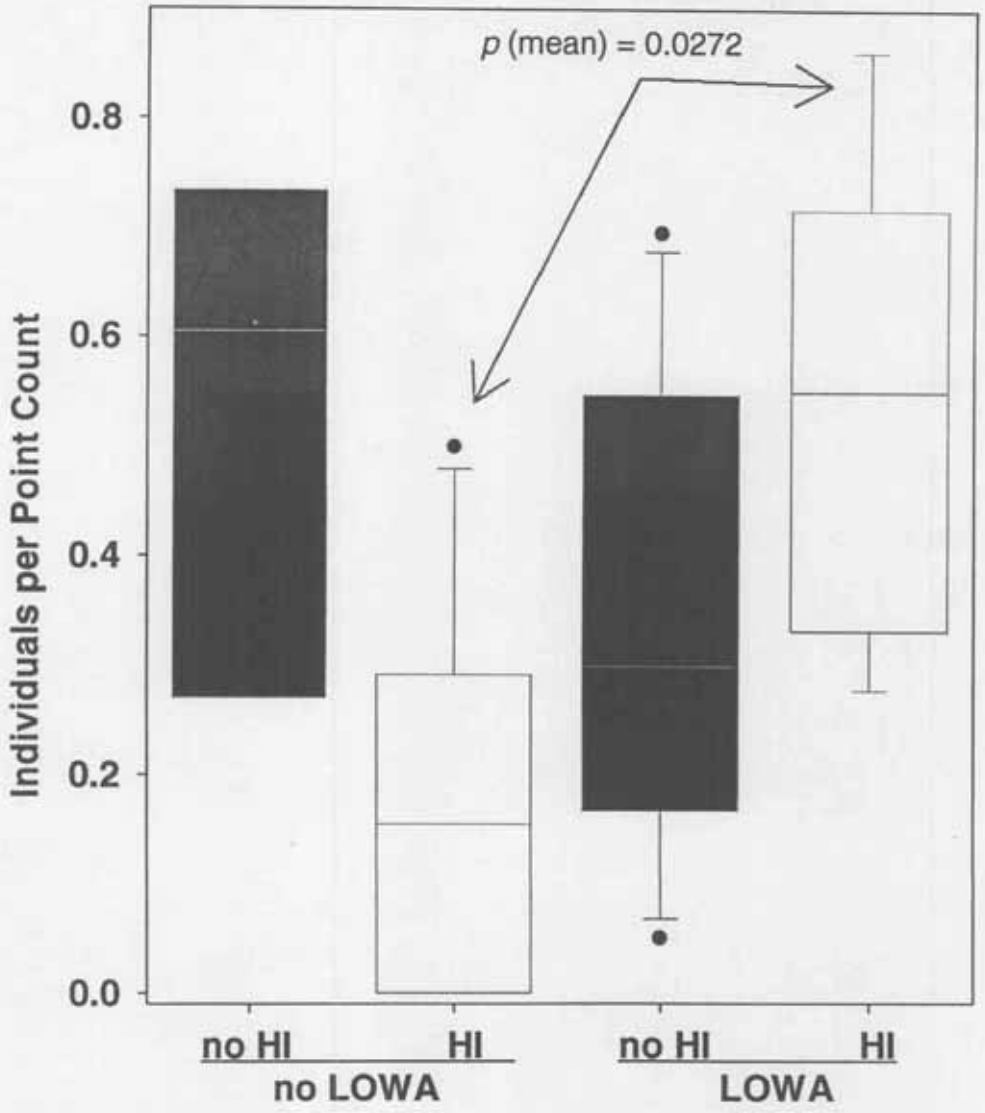


Figure 32. Point count detections of permanent resident species along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

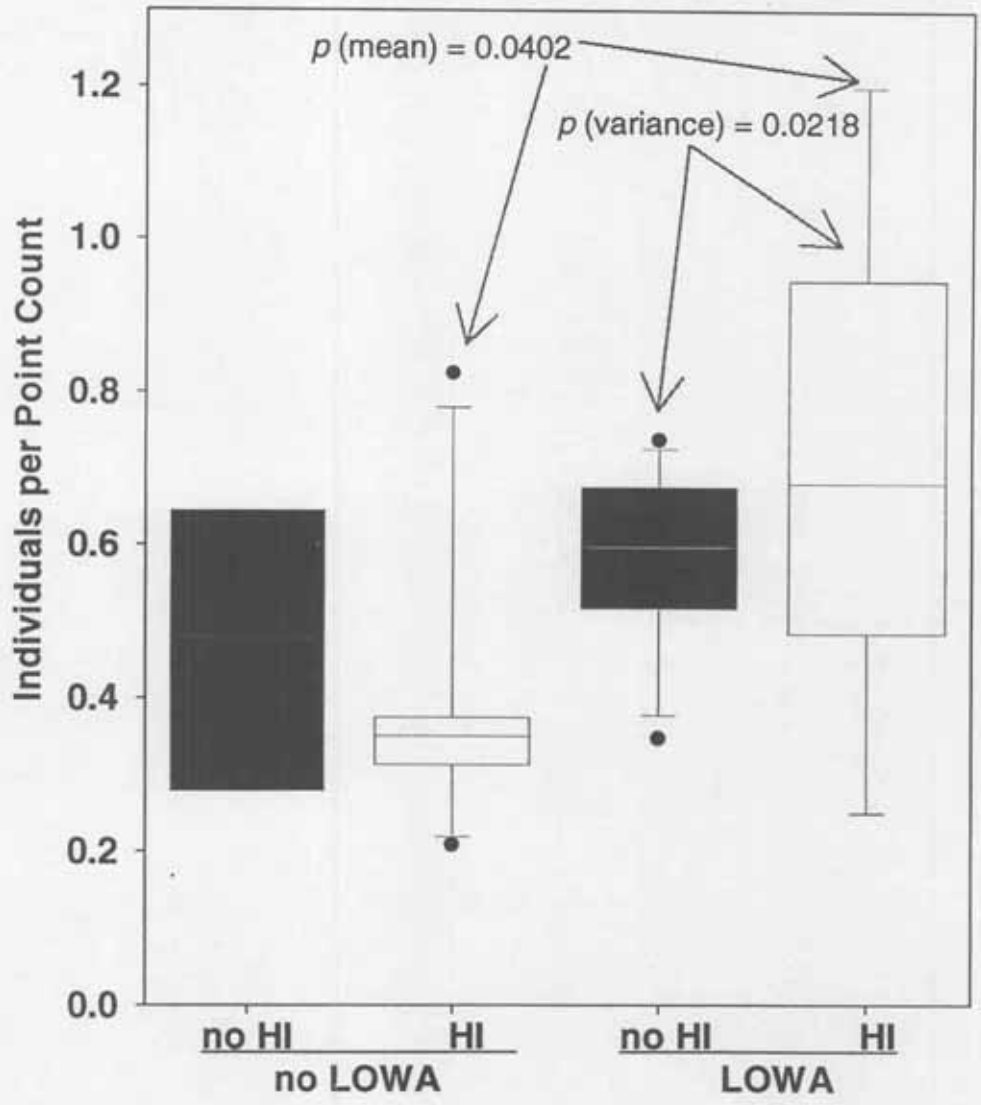


Figure 33. Point count detections of breeding resident species of disturbed habitat along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

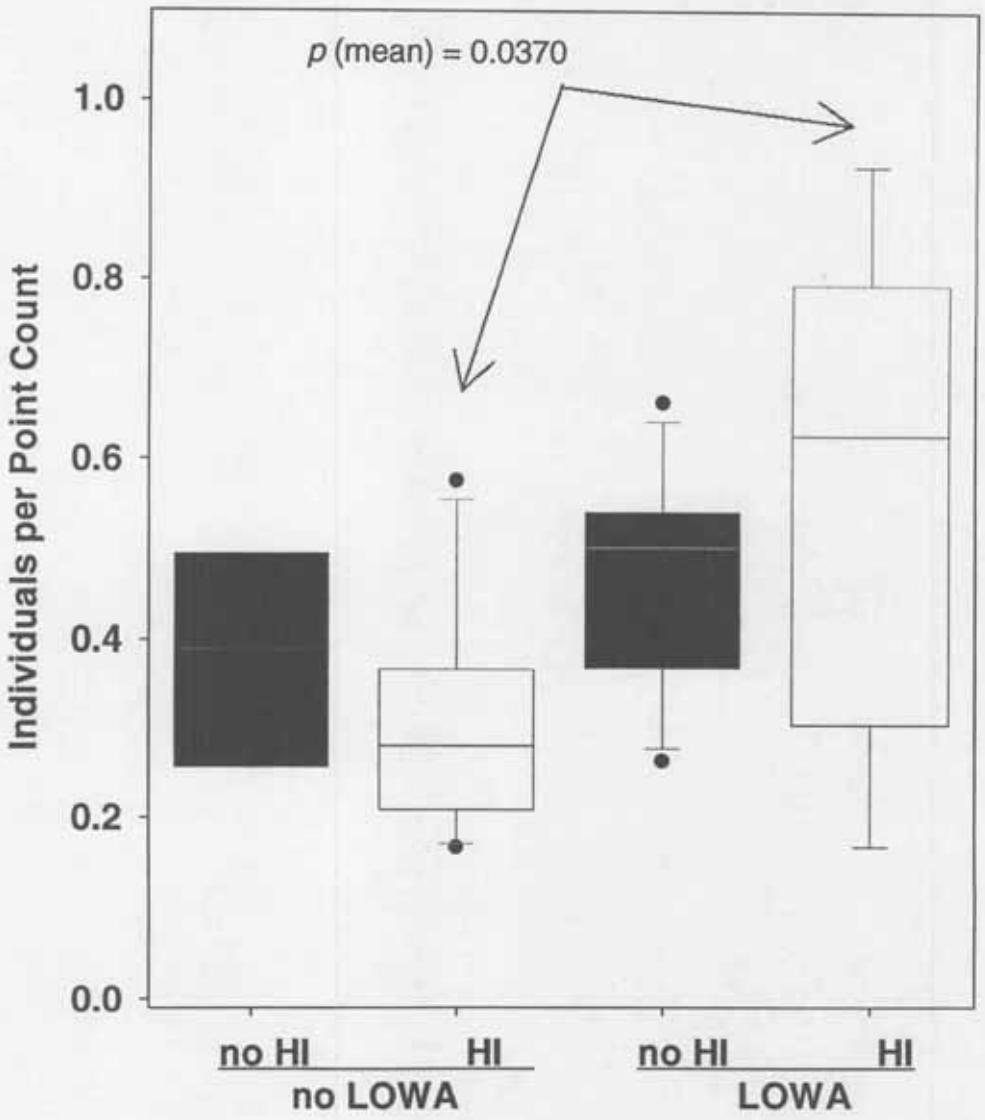


Figure 34. Point count detections of Great-crested Flycatchers along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

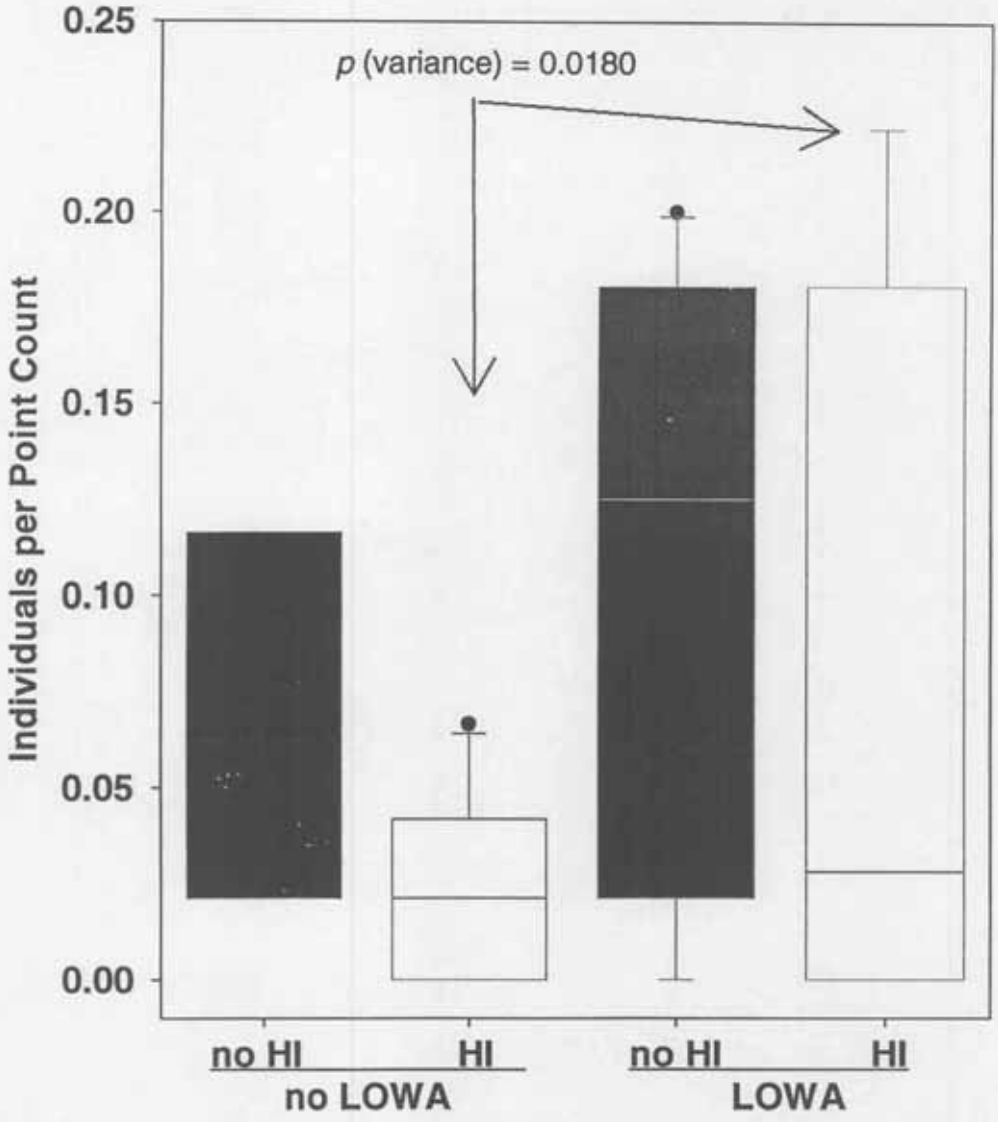


Figure 35. Point count detections of Winter Wrens along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

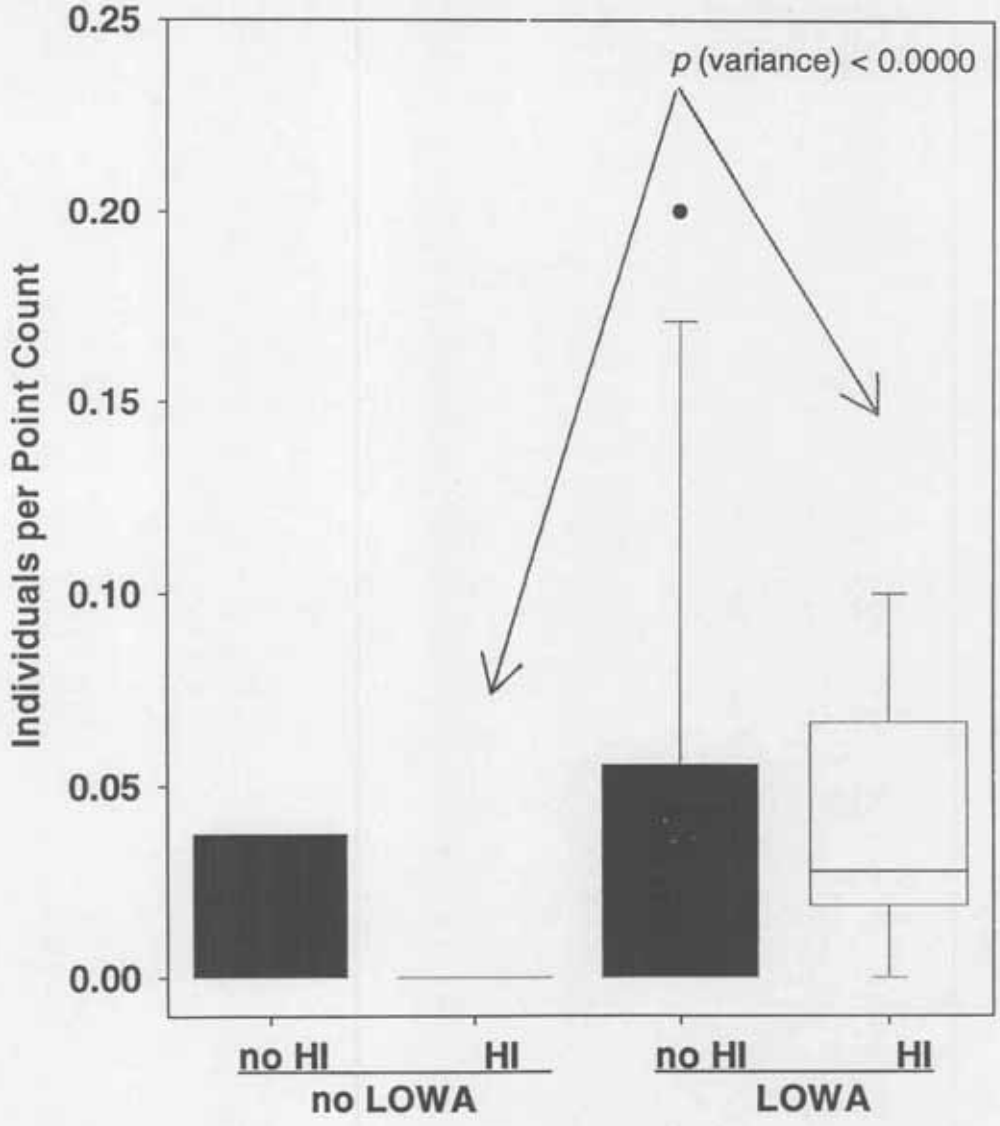


Figure 36. Point count detections of Hairy Woodpeckers along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

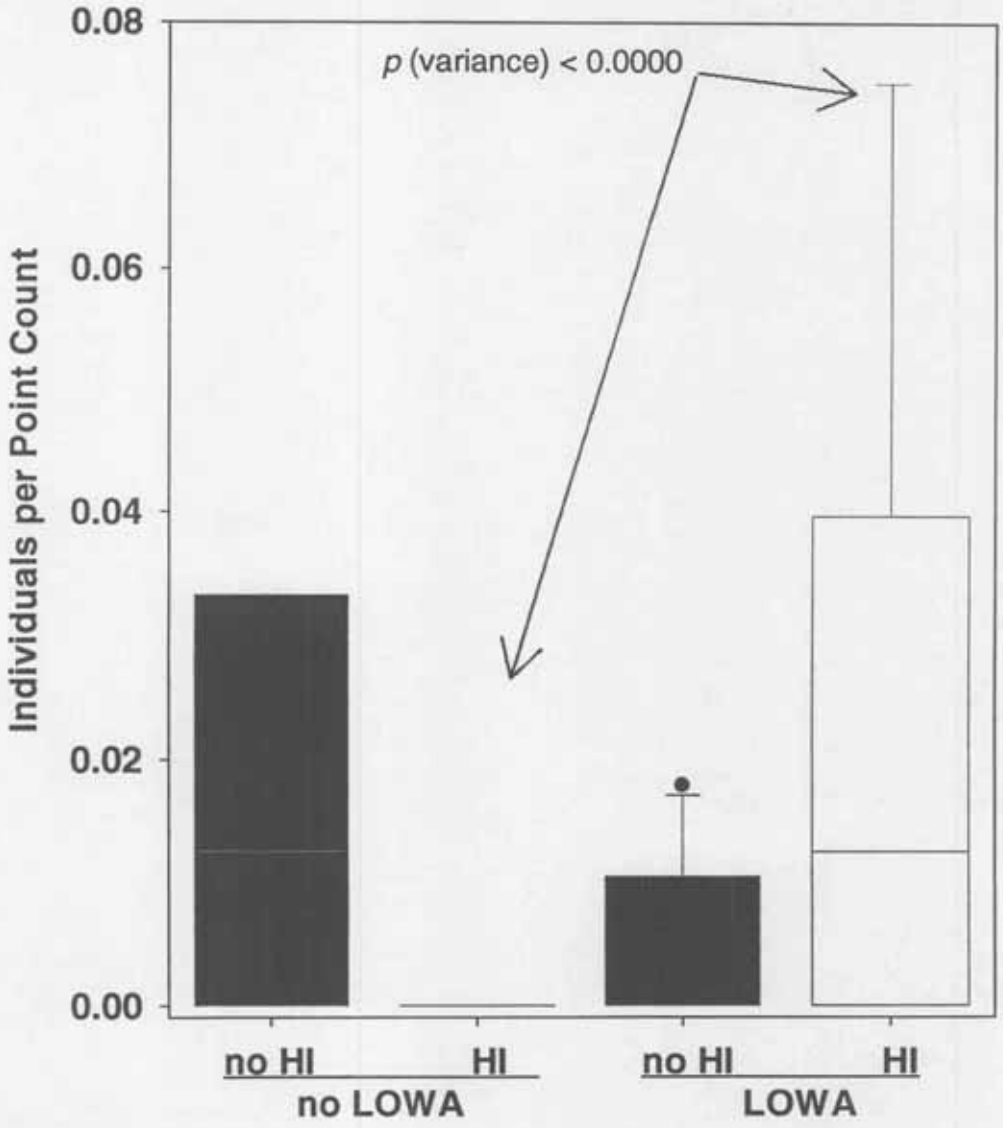


Figure 37. Point count detections of Pileated Woodpeckers along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

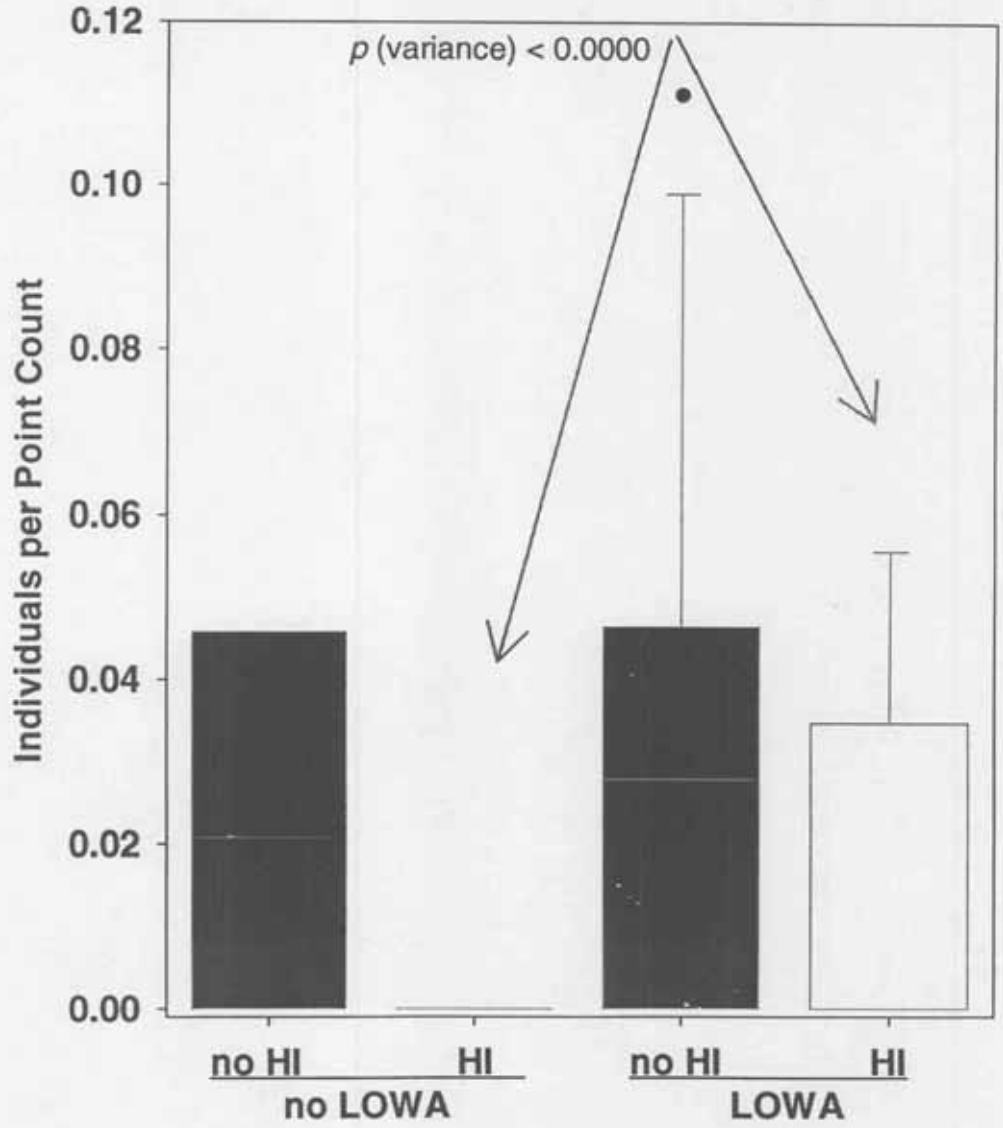


Figure 38. Point count detections of continental migrating breeding species of forest along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

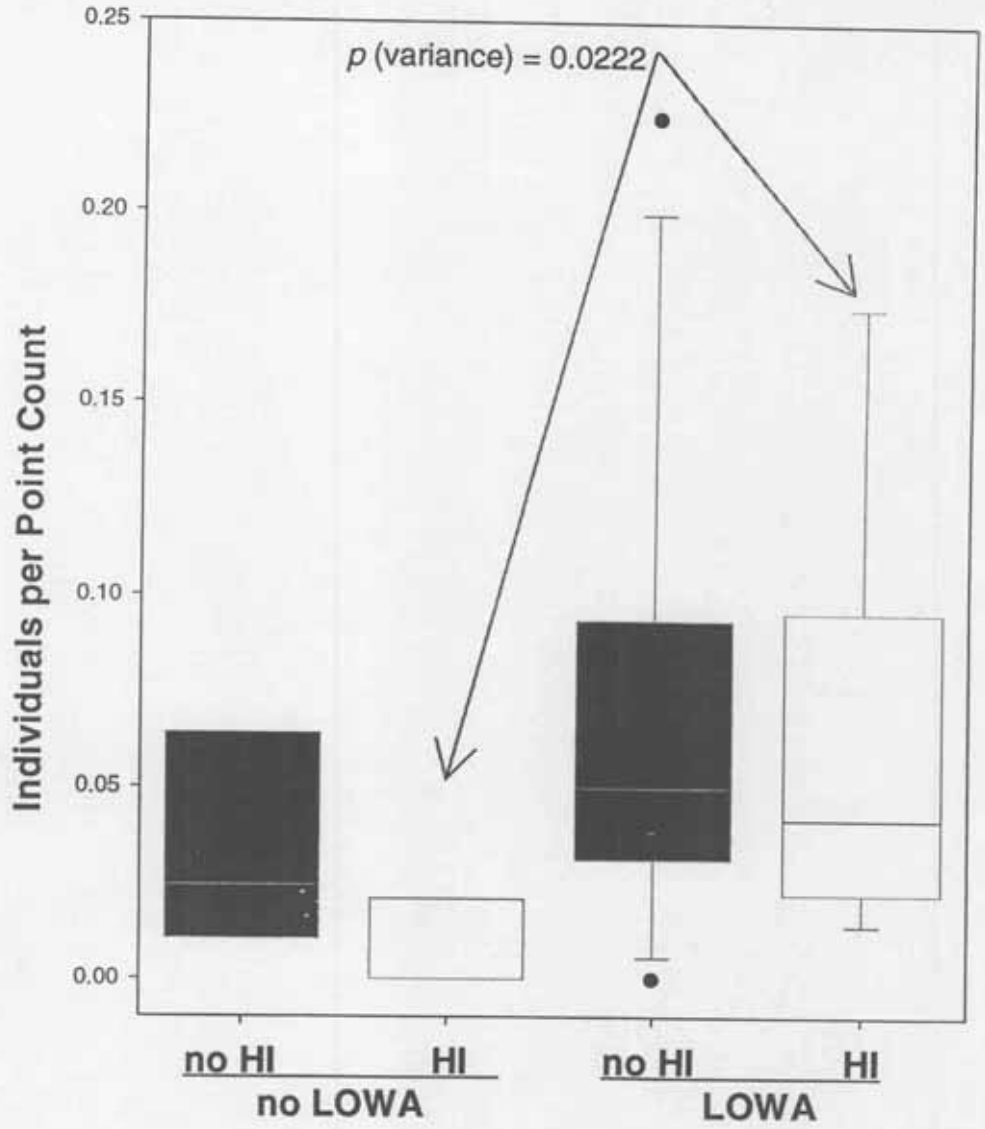


Figure 39. Point count detections of American Crows along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).

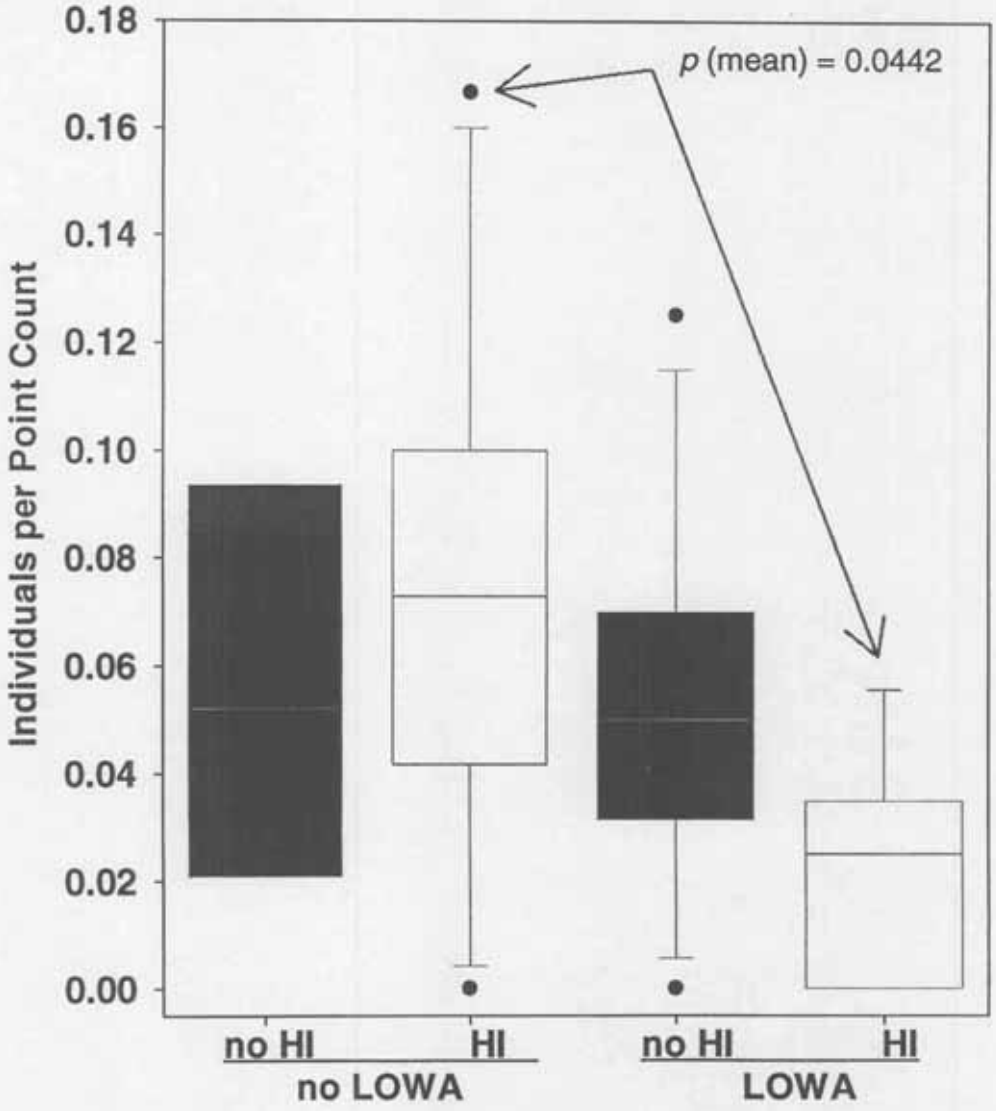
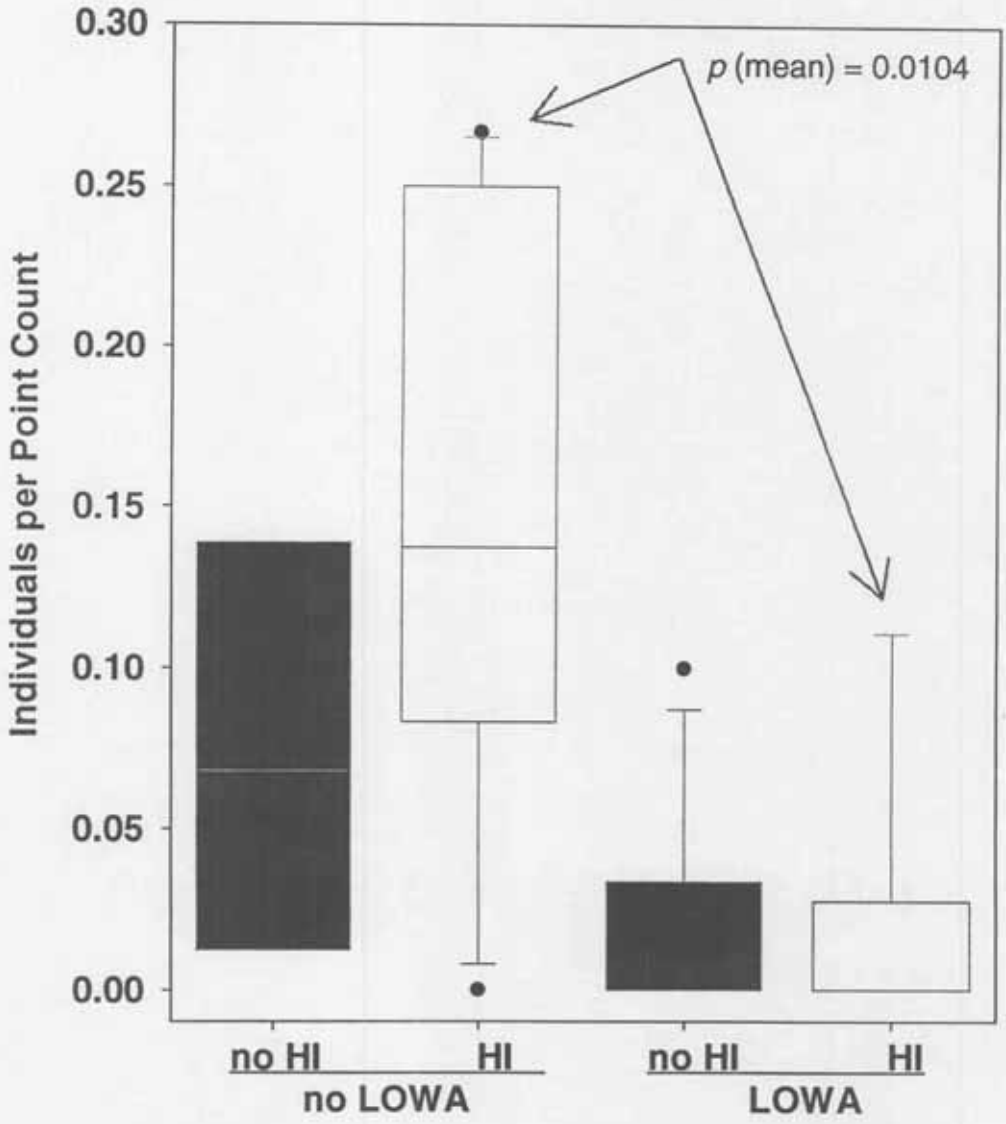


Figure 40. Point count detections of Eastern Towhees along streams with and without habitat improvement (HI) and Louisiana Waterthrushes (LOWA).



Discussion -

Several significant trends among avian species are evident when describing streams with and without HI. Species and communities significantly associated with habitat unproved streams include more grassland and disturbance related species. Conversely, species significantly associated with non-habitat improved streams include more forest interior species. These two trends hold whether or not the breeding status of Louisiana Waterthrushes along those streams is included in the analyses.

HI and Avian Species and Communities

Species detected more significantly along HI streams include Chipping and Field Sparrows, Red-winged Blackbirds and Brown-headed Cowbirds. Field Sparrows, Red-winged Blackbirds and Brown-headed Cowbirds were previously predicted to respond favorably to reductions in the woody canopy and thinning of shrubs and saplings (Stauffer and Best 1980). Among the community groupings, those that appear to be positively associated with HI are open/disturbed habitats (open, disturbed forest, water), forest edges, resident species, continental migrants, and squirrels.

One species showed a very significant negative association with HI, the Eastern Phoebe. Although such a strong result was somewhat unexpected, Eastern Phoebes are frequent although not obligate residents of riparian zones. As a flycatcher, the Eastern Phoebe diet is 90% insects throughout the year but higher during the spring and summer (Weeks 1994). They are known to respond to aquatic insect hatches along trout streams. Eastern Phoebes also nest in the vicinity of streams, either on man-made or natural nesting structures. The clearing of woody plants from riparian zones has a negative

impact on the usefulness of nesting structures for Eastern Phoebes (Weeks 1994). It is possible that the significantly reduced point count responses observed for Eastern Phoebes in areas with HI are a reflection of decreased levels of woody plants or a lack of the vertical rock outcrops used for nesting.

HI, Louisiana Waterthrushes, and Avian Species and Communities

Habitat improved sites continue to show increased numbers of disturbance/open habitat associated species and communities even if those sites with Louisiana Waterthrushes are eliminated from the analysis. The Eastern Phoebe response to HI with no Louisiana Waterthrushes remained significant. Acadian Flycatcher responses to HI are also of interest as it is also a Species of Special Concern (Natural Heritage and Nongame Research Program 1996). Acadian Flycatchers have a significant positive association with Louisiana Waterthrushes (Chapter 1), and an increase in the point count variance for areas with either HI or waterthrushes. The strongest relationship is with waterthrushes. Despite the statistical significance for variance, the number of detected Acadian Flycatchers was small, and results are likely biologically inconclusive. Acadian Flycatchers did not demonstrate a significant response to selective timber harvesting in southern Illinois (Robinson and Robinson 1999).

Among sites those site with Louisiana Waterthrushes, the Brown-headed Cowbird showed significantly greater responses to HI than sites without HI. Several studies have provided evidence that linear habitats, such as streams are more vulnerable to brood parasitism than associated broad forest tracts (Brittingham and Temple 1983, Airola

1986). HI appears to further magnify the Brown-headed Cowbird impact already associated with streams where Louisiana Waterthrushes breed.

The lack of a significant and demonstrated impact of HI on Louisiana Waterthrush life history characteristics should not be considered conclusive. Louisiana Waterthrush distribution across southeastern Minnesota, and much of the United States is patchy, and nests are notoriously difficult to locate. Additional years of data collection may more closely define a relationship between HI and Louisiana Waterthrush reproduction. What can not be ignored is that factors such as Brown-headed Cowbirds are associated with HI disturbances in forests and will significantly impede Louisiana Waterthrush reproductive success.

Overall, results suggest that those riparian forests surrounding trout HI projects have more openings than the surrounding forest. As with livestock grazing in riparian zones in western North America, generally birds do no respond directly to the presence of livestock but rather the resulting changes in vegetation structure (Sanders and Edge 1998). Although these results do not directly support the causation of HI leading to forest openings, that relationship can not be eliminated. An alternative rational is that HI projects were located within existing openings, such as tree fall gaps. In most forests, occasional openings exist, particularly along the stream corridor. However, frequent HI prescriptions of tree removal creates more openings within closed canopy forest. This also contradicts the concept that HI projects in a forested riparian zone are deliberately placed in existing openings.

HI openings differ from natural openings in the size and degree of disturbance. As openings in the forest become larger, disturbance and grassland species would be

expected to be more numerous. The response to such habitats from the avian species and community is reflected in the point count data. Where HI appears to come into direct conflict with forest interior birds is where these projects are either requested or established in intact tracts of mature forests that coincide with cold-water streams. In southeastern Minnesota, the remaining tracts of forest are under state ownership as either State Parks, Forests, or Wildlife Management Areas. These forested areas, because of regional geology, often include the coldwater streams ideal for trout. Louisiana Waterthrushes require micro-habitat features (Chapter 1), most often found in intact, mature forest, along streams. The features that HI locally reduces removes are those microhabitat characteristics required by Louisiana Waterthrushes: eroding banks, shallow streams, large amounts of riffle and rock.

Conservation and Management Implications -Conservation of Louisiana Waterthrushes and avian communities associated with riparian forests in southeastern Minnesota is most broadly an issue of habitat management and conservation. Following are listed those recommendations that appear to be most important for consideration in conserving the avian communities of forested trout streams.

- Trout HI appears to come into conflict with forest interior bird management when these projects are either requested or established in intact tracts of mature forests that coincide with cold-water streams. Mature and maturing riparian streamside forests are limited. Consequently, protection of contiguous riparian forests adjoining ephemeral - 3`d order streams is a priority for forest bird and Louisiana Waterthrush conservation in southeastern Minnesota: Human resource use that disturbs the integrity or processes of either the forest or stream threaten the continued presence and productivity of Louisiana Waterthrushes and other forest birds.
- Riparian forests surrounding trout HI projects have more openings than the surrounding forest. These opening introduce disturbed habitat and grassland bird species into forests. Additionally, openings encourage Brown-headed Cowbird parasitism of Louisiana Waterthrush nests in addition to the other forest nesting. By protecting contiguous forest habitat and limiting the creation of openings, particularly near streams, Brown-headed Cowbirds will not be "encouraged" to penetrate larger tracts of forest.

- Although some avian species responses are most attributable to vegetation structure, Louisiana Waterthrushes require several stream related physical microhabitat features necessary for completion of their life history (see Chapter l). HI may locally eliminate the availability of several of these features required for nesting.

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CHAPTER 3. Trout Habitat Improvement Projects, Macroinvertebrate Communities and Riparian Physical Habitats of Southeastern Minnesota

Introduction

Trout habitat improvement is a suite of management strategies used to improve habitat suitability for larger sized trout and increase angler use of streams. Habitat improvement (HI) is practiced on streams identified as not attaining management goals, particularly recruitment and size class objectives. HI projects occur within and modify the instream channel processes, but indirectly affect much of the contiguous riparian zone. HI projects generally cover 100-300 m of any individual stream segment, but subsequent project restoration and adjacent projects may grow to encompass 500-2000+ m of a stream over 60 years. The direct disturbance created in doing the projects can locally eliminate herbaceous, woody understory and canopy vegetation while constructing the project and introduce grasses and other undesirable plants to the riparian zone. Secondary impacts include changing previous flood regimes and influencing forest succession.

Habitat improvement to affect trout populations can be dated to at least 1908 (Armistead). Records of erosion control HI in Minnesota began about 1946, with a management shift toward creating instream cover by the early 1970s (Thorne et al 1997). The Wisconsin Department of Natural Resources (previously Wisconsin Conservation Department) initiated these management shifts and efforts continue today in both the Wisconsin and Minnesota DNRs (White and Brynildson 1967, Frankenberger and Fassbender 1967, Frankenberger 1968, Hunt (1971, 1976, 1982, 1988, 1993), Claggett 1990, Thorn (1988a, 1988b, 1992)).

Trout HI in southeastern Minnesota is targeted at both native brook trout (*Salvelinus fontinalis*) and introduced brown trout (*Salmo trutta*). Reproducing naturalized brown trout are the primary management objective (Thorn et al. 1997). The effectiveness of HI as a management strategy for increasing the standing stock of trout has been fairly well documented (Burgess and Bider 1980, Hunt 1988, Stewart 1995).

Unintended and secondary impacts of HI on non-targeted species have been wildly variable in their results. In Quebec (Burgess and Bider 1980), HI increased mink (*Mustela visor)* and Eastern Chipmunk (*Tamius striatus*) activity and the biomass of both crayfish (*Cambarus bartoni*) and emerging aquatic insects in areas improved for brook trout. Among terrestrial vertebrates, voles (*Microtus pennsylanicus*) were consistently less active during the two years after project completion, and hares (*Lepus arnericanus*) and shrews (*Sorex palustris*) only during the second year. Several species showed mixed results including red squirrels (*Tamiasciurus hudsonicus*), deer mice (*Peromyscus mariculattis*), salamanders (*Eurycea bislineata*), frogs (*Rana clamitans* and *R. sylvatica*) and American Toad (*Bufo arnericanus*).

Analyses of nongame fish species in southeastern Minnesota, offer conflicting results on the possible impacts HI. Kwak (1993) found that nonsalmonids as a whole increased in both density and biomass for one stream, and only in biomass for the other stream. Brook Stickleback (*Culcaea ircorstars*) occurred only in the reference (not improved) area of one stream, while white suckers (*Catostomas commersoni*) were about 300% larger in improved zones. Longnose dace *(Rhirichthyes* cataractae), and slimy and mottled sculpins (*Cottus cognatus, C. bairdi*) were present in both reference and improved sites, although mottled sculpin density and biomass were less at the improved

site. Species diversity results were conflicting, with one stream showing greater and the other stream reduced diversity in the improved reach. Conversely, Quin and Mundahl (1994) found higher nongame populations end increased diversity among the reference compared to the HI areas of five streams.

Since macroinvertebrate species respond to habitat changes (Plafkin et al 1989, Waters 1995, Merritt and Cummins 1996), quantifiable differences should be reflected in invertebrate communities following trout HI. Louisiana Waterthrush, a Minnesota Species of Special Concern (Coffin and Pfanmuller 1988, Natural Heritage and Nongame Research Program 1996) and a riparian obligate species was examined as a possible indicator of habitat condition. In southeastern Minnesota, the Louisiana Waterthrush is closely associated with designated trout streams, and its life history is closely tied to aquatic macroinvertebrates and stream geomorphology (Chapter *1- Louisiana Waterthrush Ecology in Southeastern Minnesota).*

The present study investigated macroinvertebrate species and assemblages to quantify impacts of HI on forested trout streams in southeastern Minnesota in 1996-1997. Objectives of this study were to:

1. Identify macroinvertebrate species and assemblages in forested streams associated with and without HI projects.
2. Identify physical habitat features in forested streams with and without HI projects.
3. Evaluate trends among macroinvertebrate species and assemblages and habitat features in forested trout streams in relation to both Louisiana Waterthrushes and HI projects.

Study Area

The study area was located in the unglaciated or Driftless Area Ecoregion (Omernik and Gallant 1988) of the state in southeastern Minnesota (Figure 1). The region is characterized by high bluffs dissected by steep valleys. Three major river systems, the Root, Whitewater and Zumbro, dominate the landscape and ultimately drain into the Mississippi River. Forest cover in this region is primarily restricted to steep slopes and narrow valleys. Native plant communities grade from predominantly maple-basswood forest *(Acer* spp. and *Tilia americana)* along the upper valley slopes and small streams on north facing slopes, to drier oak forest *(Quercus* spp.) *on* south facing slopes and bluff tops. Lowland hardwood forest occurs in valley bottoms, with occasional small black ash *(Fraxinus nigra)* swamps. Several rare plant communities found in the study areas include algific talus slopes and northern hardwood-conifer forest habitats (Minnesota County Biological Survey 1996a,b, and 1997a,b,c). Historically, native plant communities on the blufftops were largely prairie and oak savanna. However, most of the native vegetation has been converted to row crops (primarily corn and soybeans) or pasture.

Twenty-two stream segments in a five county area were included in the study (Table 1). Eleven study sites had HI projects, and eleven had none (Figure 2). Twelve of the study sites had breeding Louisiana Waterthrushes, and ten had none. Most streams were State designated trout streams *(Salnao triitta, S. gairdrreri, Saloelirrns fonlinalis)* ranging from 1st to 3rd order and were surrounded by approximately 90% forest cover. Only two streams, South Branch Whitewater tributary (trout present, but not a designated trout stream) and the South Fork of the Root River (50% forest cover) deviated from

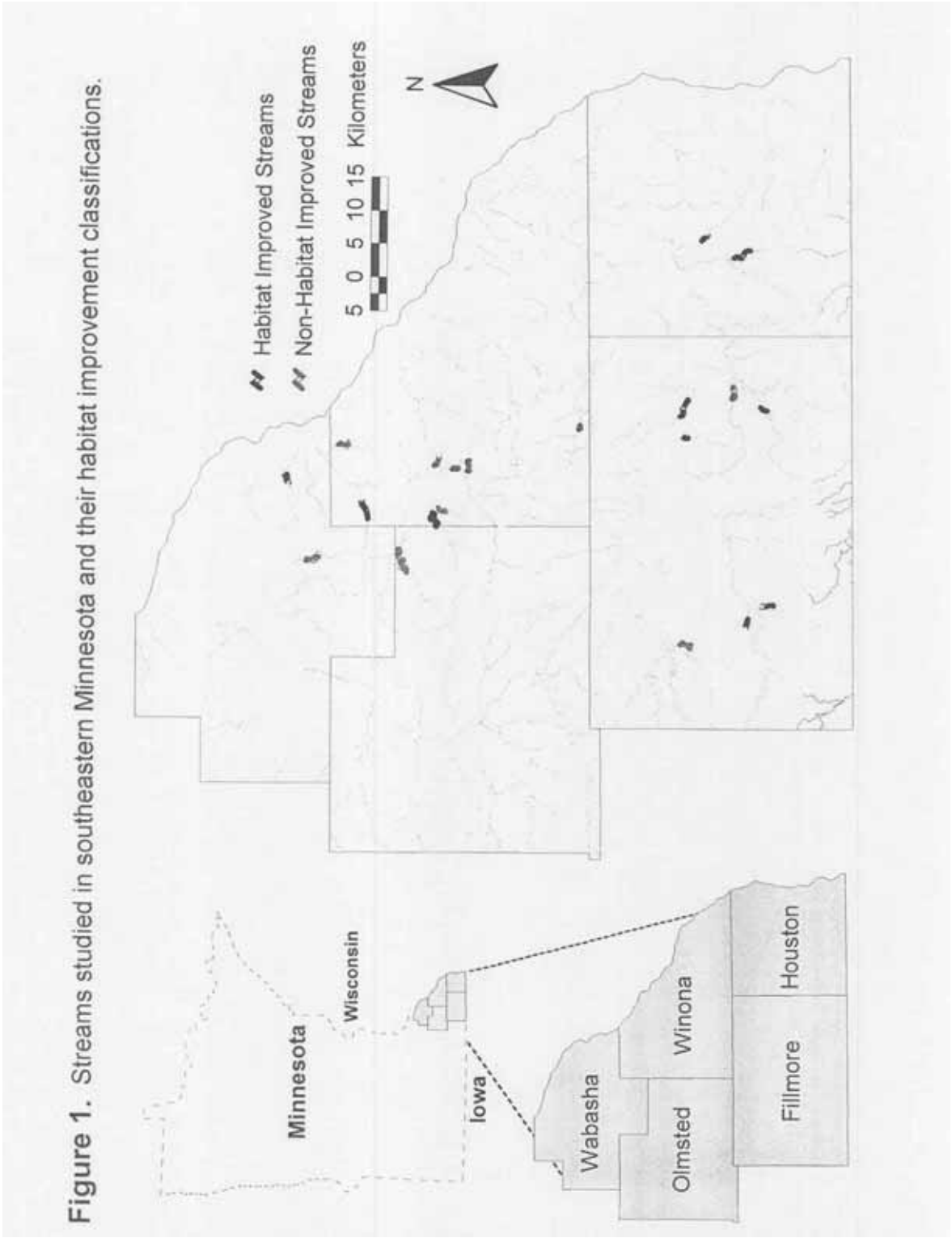


Figure 1. Streams studied in southeastern Minnesota and their habitat improvement classifications.

Table 1. Study area counties, streams, sample sizes, and years.

County and Stream	Drainage	Aquatic Samples	Years
Wabasha County			
West Indian Creek	Zumbro	3	1996 - 1997
Snake Creek	Mississippi	2	1996 - 1997
Winona County			
South Branch Whitewater I	Whitewater	3	1996 - 1997
South Branch Whitewater II	Whitewater	3	1997
South Branch Whitewater tributary	Whitewater	2	1996 - 1997
Middle Branch Whitewater I	Whitewater	3	1996 - 1997
Middle Branch Whitewater II	Whitewater	2	1996 - 1997
Trout Run Creek	Whitewater	3	1996 - 1997
Trout Creek	Whitewater	2	1996 - 1997
Beaver Creek	Whitewater	3	1996 - 1997
Hemmingway Creek	Root	1	1996 - 1997
Olmsted County			
Logan Branch	Whitewater	3	1996 - 1997
North Branch Whitewater	Whitewater	2	1996 - 1997
Fillmore County			
Canfield Creek	Root	3	1996 - 1997
Forestville Creek	Root	2	1996 - 1997
Spring Valley Creek	Root	2	1996 - 1997
Diamond Creek	Root	3	1996 - 1997
Gribben Creek	Root	1	1997
Shattuck/Nepstad Creek	Root	3	1996 - 1997
South Fork Root	Root	2	1996 - 1997
Houston County			
East Beaver Creek	Root	3	1996 - 1997
Badger Creek	Root	2	1996 - 1997

these criteria. A minimum distance of 1 km separated study sites on the same stream (South and Middle Branches Whitewater). Diamond and Hemmingway creeks included ~100 m of pasture on one side of the stream.

Methods

Aquatic Invertebrates I collected aquatic benthic invertebrates using a Surber sampler (30.5 cm x 30.5 cm x S cm) to compare the invertebrate assemblages between streams with and without HI and/or Louisiana Waterthrushes. I collected benthic invertebrates at the riffle closest to every third point count (600 m intervals) starting with the second point count *(see* discussion of methods in Chapter 1 or 2), At each riffle, three random locations were selected and sampled May - June, 1996 and 1997 and coincided with point count surveys; 20 streams were sampled in 1996 and 22 streams in 1997 (Table 1). Each sample was stored in Khale's solution in 1996 and 70% EtOH in 1997. In the lab, samples were pooled for a given date and riffle. One hundred randomly selected invertebrates from each riffle were identified using a 10 x 10 grid (Hilsenhoff 1982). Resource specialists from the Minnesota Department of Natural Resources identified the invertebrates to species or the lowest level of taxonomy possible.

The Hilsenhoff Biotic (HBI) and Family (FBI) Indices (Hilsenhoff 1987 and 1988), Simpson and Brillouin's diversity indices, species richness, Ephemeroptera - Plecoptera Trichoptera (EPT) and Chironomid dominance, and three indices of invertebrates eaten by Louisiana Waterthrushes (Eaton 1958, Craig 1987, Robinson 1995) were evaluated. The Waterthrush-Eaton Index is based on invertebrate species identified from stomach content analyses of Louisiana Waterthrushes, including

Trichopterans, Ephemeropterans, Plecopterans, Coleopterans, Hemipterans, Neuropterans, and Diplopods (Eaton 1958).

The Waterthrush-Craig Index contains invertebrates species consumed during enclosure experiments including Trichoperans, Ephemeropterans, Dipterans, Oligochaetes, and Isopods (Craig 1987). The waterthrush-total index includes the taxa listed in both Craig and Eaton, in addition to benthic aquatic invertebrates species reported elsewhere: odonate larvae, dytiscid larvae, crustaceans, and earthworms (Robinson 1995). Samples were averaged within study areas for a given month, then across years by month, and finally across months.

Stream and Streambank Habitat Quantified estimates and measurements of stream and stream bank habitats were collected during July 1996 and 1997. At each study stream, the length of riffle, run, and pool components was measured. Definitions of these components are given by Platts et al. (1983).

Within each of these sections (riffle, run, pool), several estimates were made including exposed hard substrate (gravel, cobble, boulder), stream edge, and bank surface composition. The amount of exposed hard substrate as a percentage of the stream surface was estimated for April and July. Estimated stage in April was 15 cm higher than in July. Stream edge is the percentage of streambank/stream interface with a slope less than 90°. Lastly, in each section the percentage of exposed bank, and vegetation types (moss/lichen, herbaceous, woody material) on the streambanks was estimated. Each of the estimated percentages was adjusted for area and averaged for the entire stream.

Reassessment of streams measured during 1996 showed little change in 1997. Therefore 1996 evaluations were employed both years.

Statistics - Comparisons among aquatic invertebrates and physical habitats were made for areas with and without habitat improvement, and breeding Louisiana Waterthrushes. A randomization tests with 10,000 iterations (MACANOVA V4.1, Oehlert and Bingham 1999) evaluated differences in both means and variances of both weighted and unweighted samples. Pvalues were considered significant at $p \leq 0.05$.

Results

Macroinrertebrates and HI Projects

Streams with HI had significantly lower HMI values than non-HI segments (Figure 3). Significantly increased variation was seen in chironomid dominance, the LOWA-Craig Index, and both the Simpson and Brillouin diversity indices for sites with HI than for nonHI segments (Figure 4-5).

Macroinvertebrates, Louisiana Waterthriishes and HI

Between areas with breeding Louisiana Waterthrushes (LOWAs), significantly greater variance was observed for % pool, chironomid dominance, HBI, and species richness among areas with HI compared to those without HI (Figure 6-9). In contrast, significantly less % riffle and April exposed substrate were observed among LOWA streams with HI, as compared to those without (Figure 10-11).

Figure 2. Sampling design, analysis categories, sample sizes, and labels.

		Habitat Improvement	
		no	yes
Louisiana Waterthrush	no	*n* = 4	*n* = 6
	yes	*n* = 7	*n* =5

Figure 3. Hilsenhoff Biotic Index (HBI) scores for streams with and without habitat improvement (HI).

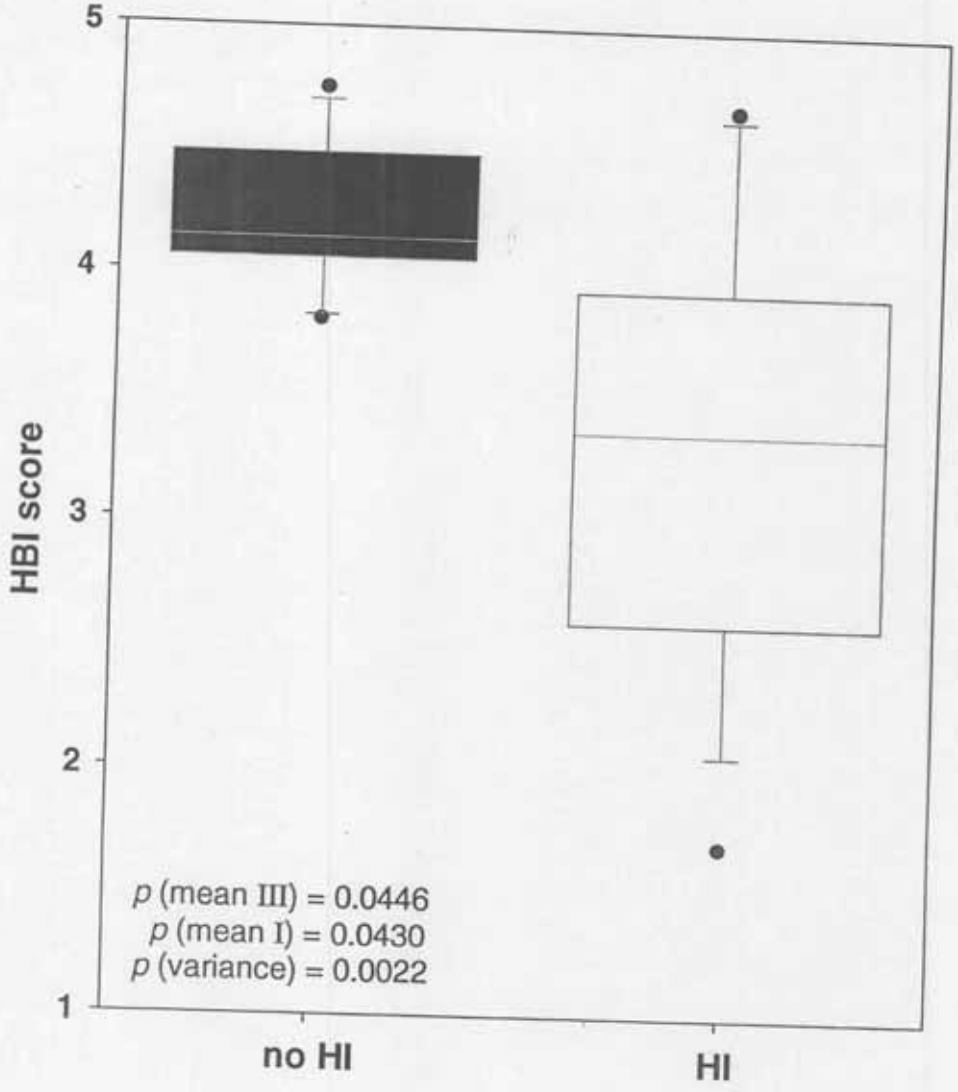


Figure 4. Chironomid dominance and Louisiana Waterthrush (LOWA) - Craig index values for streams with and without habitat improvement (HI).

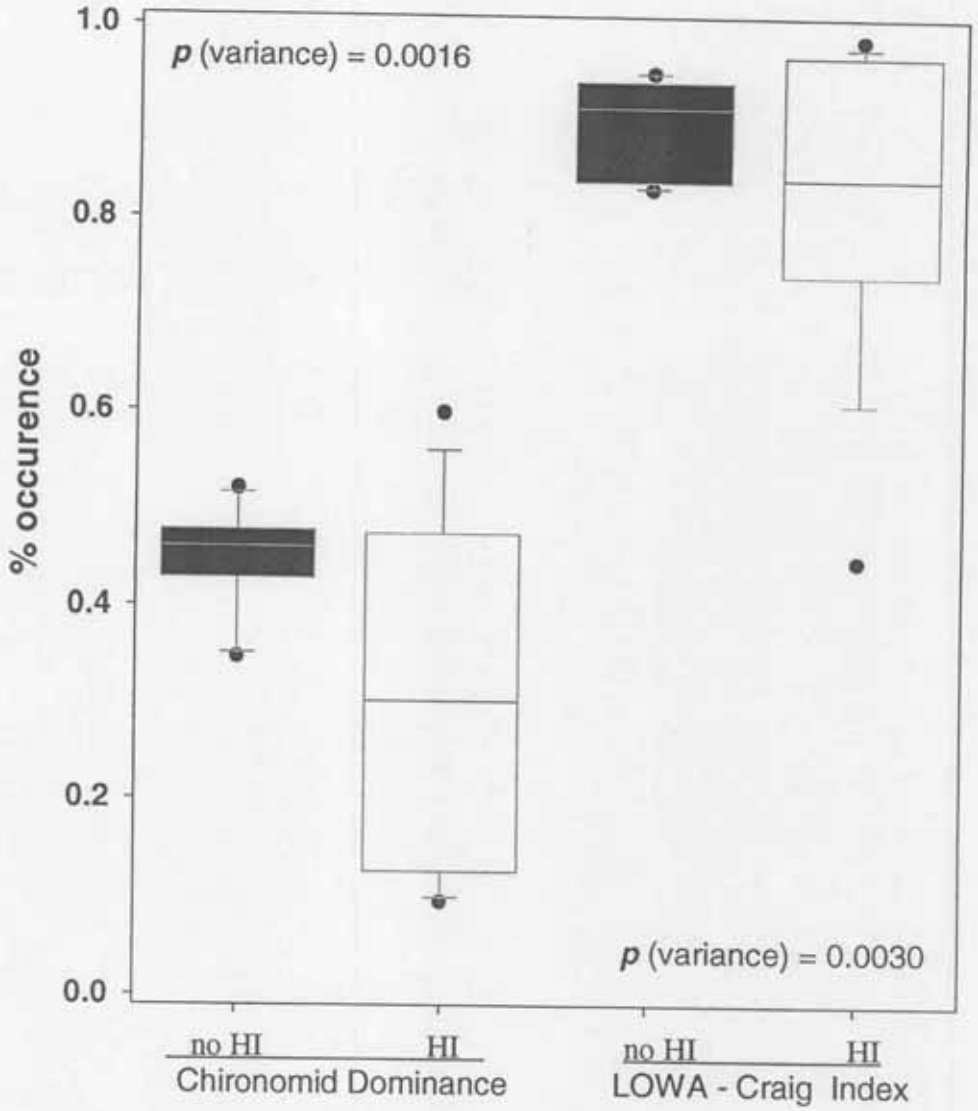


Figure 5. Simpson and Brillouin diversity scores for streams with and without habitat improvement (HI).

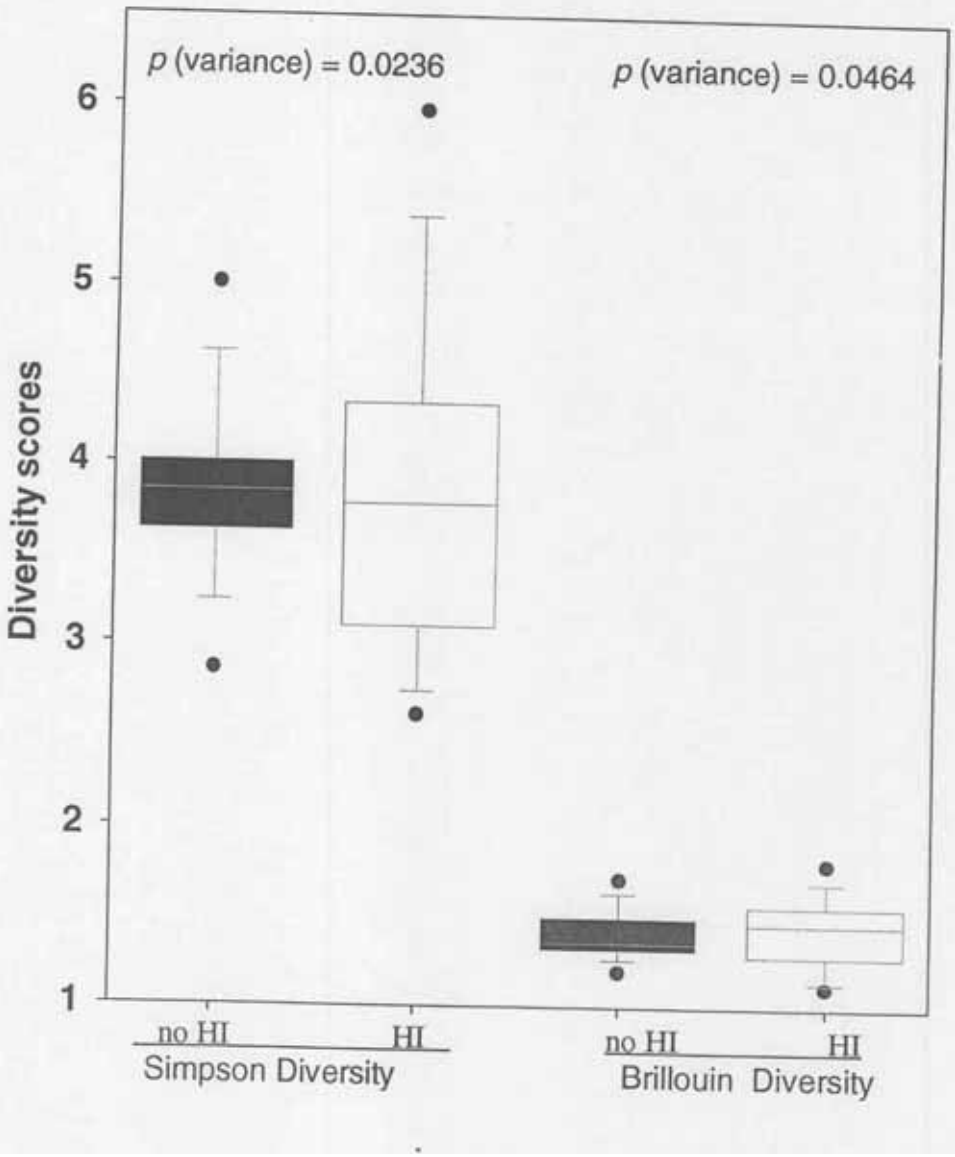


Figure 6. Pool occurence in streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

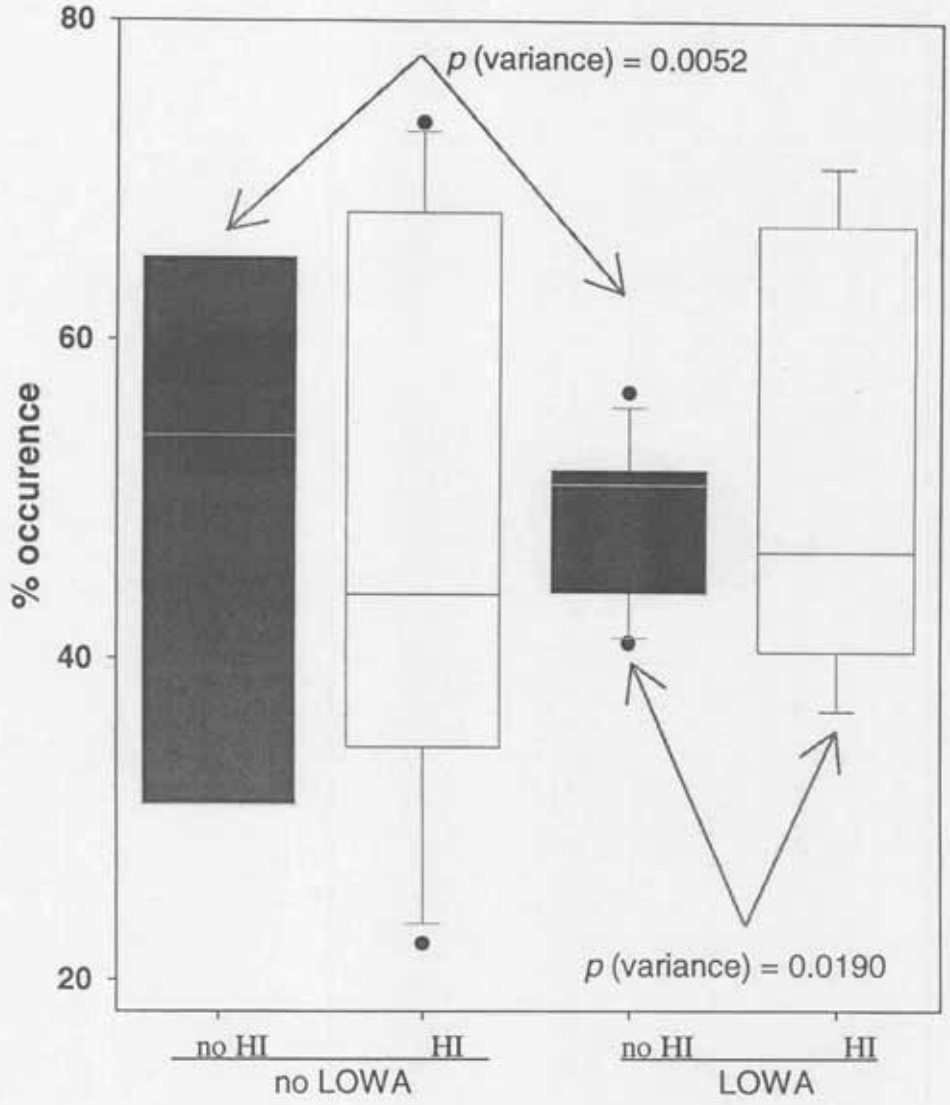


Figure 7. Chironomid dominance in streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

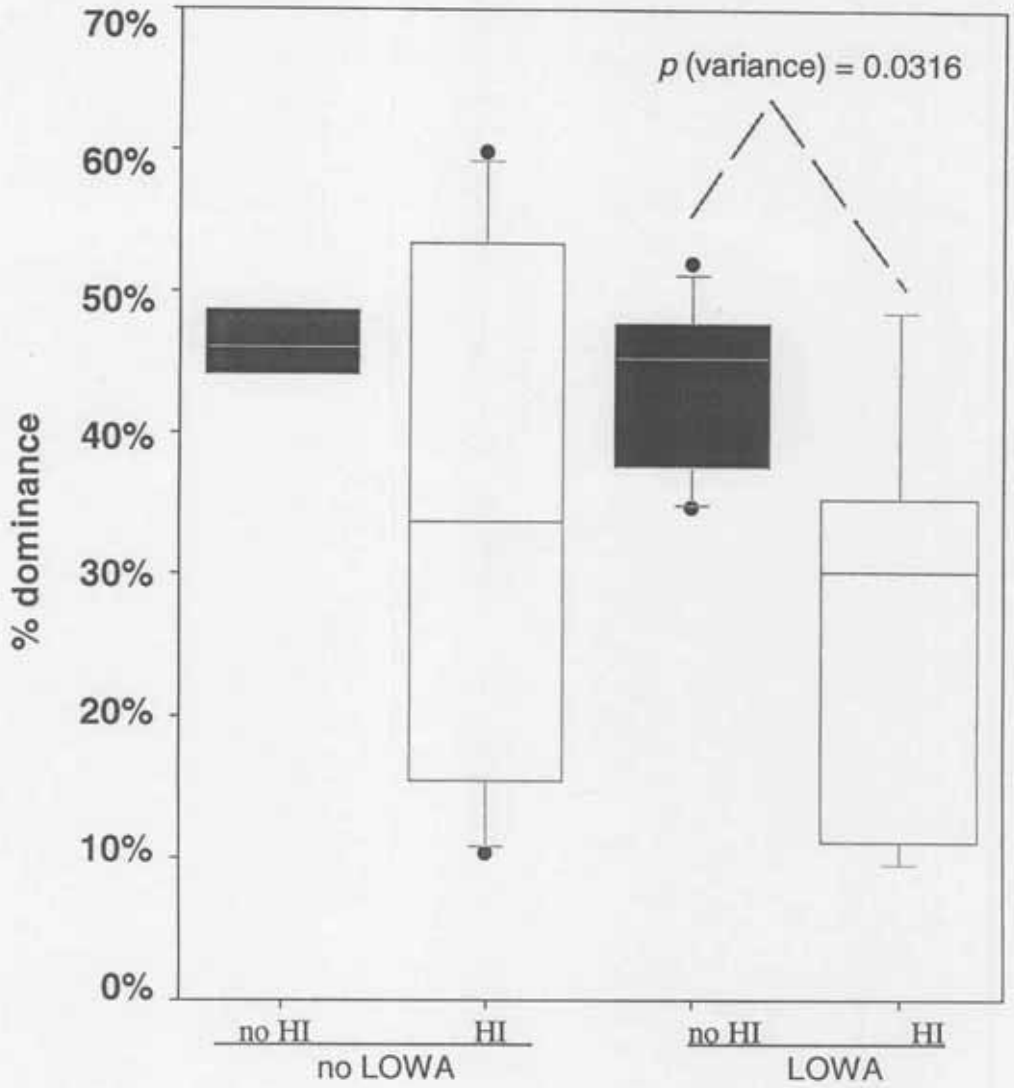


Figure 8. Hilsenhoff Biotic Index (HBI) scores for streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

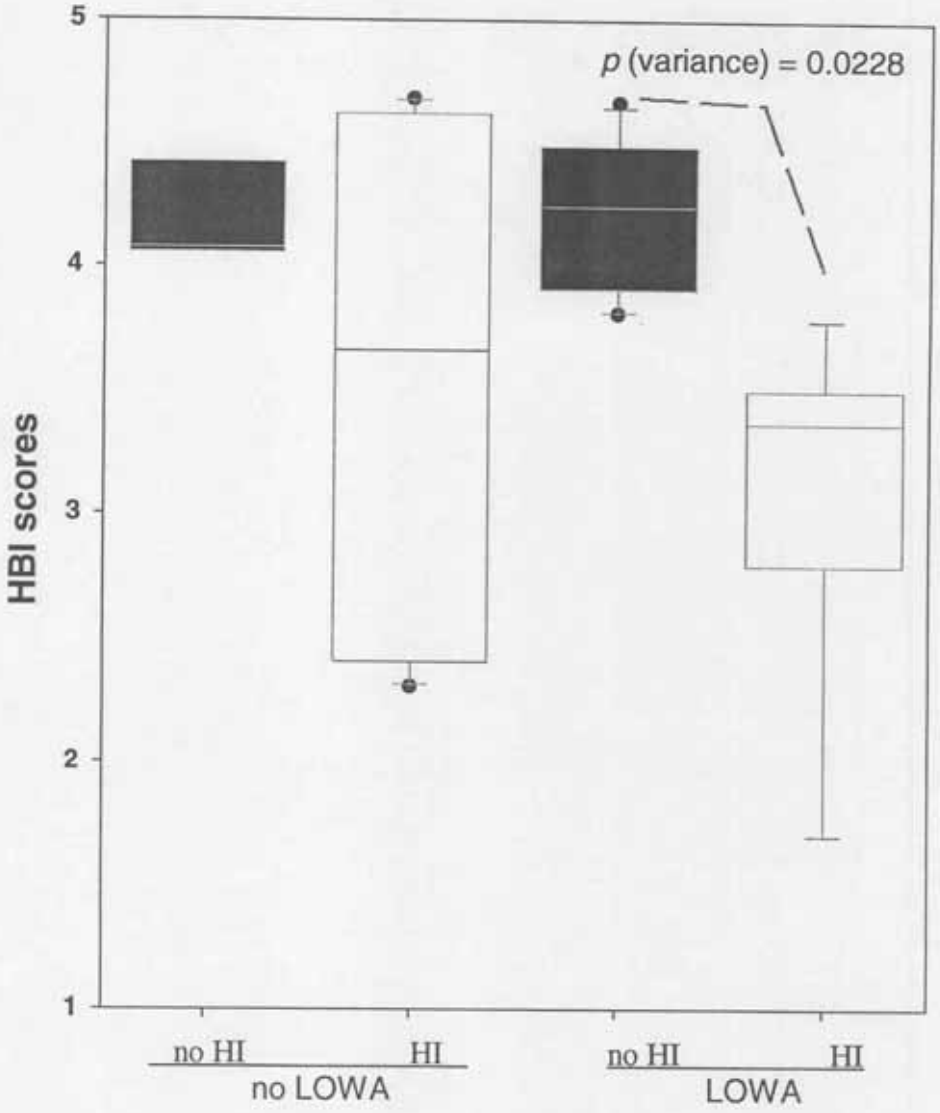


Figure 9. Invertebrate richness in streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

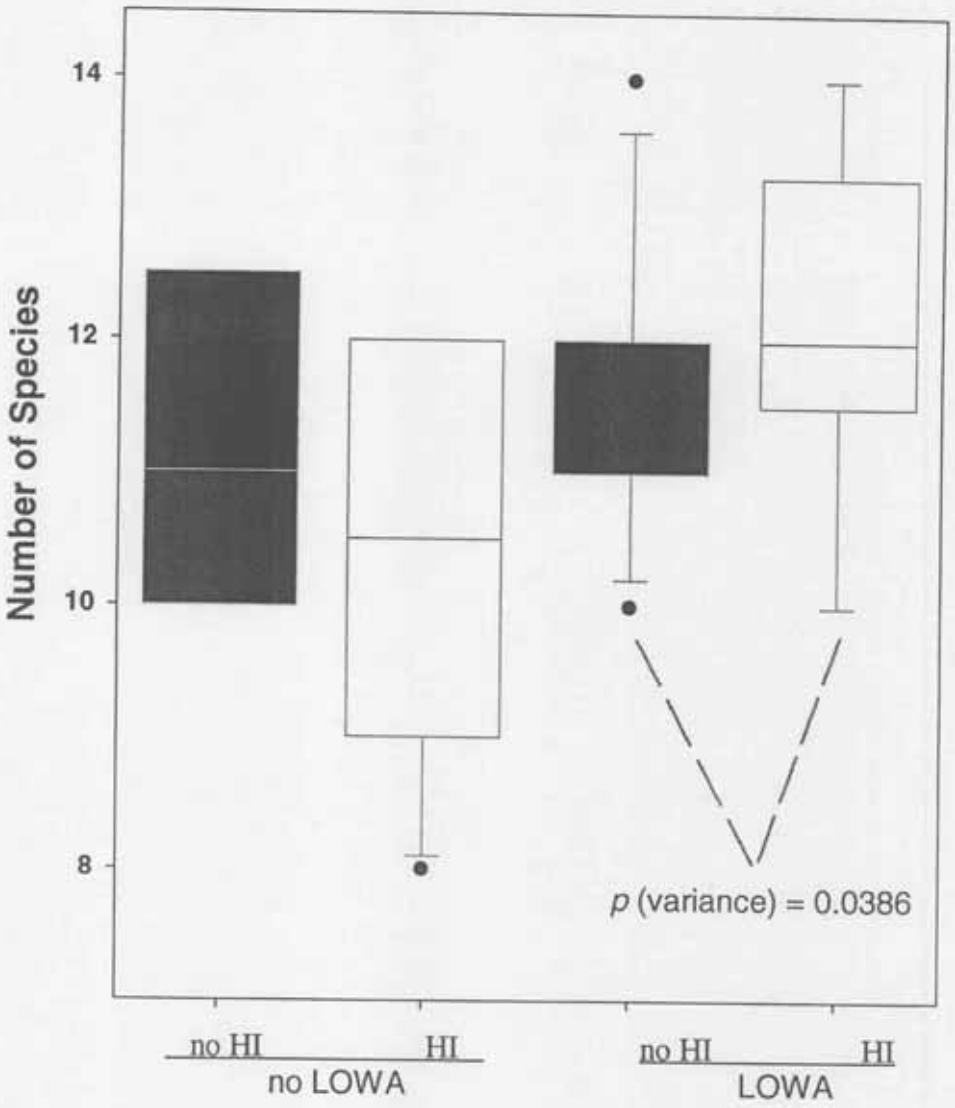


Figure 10. Riffle occurence in streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

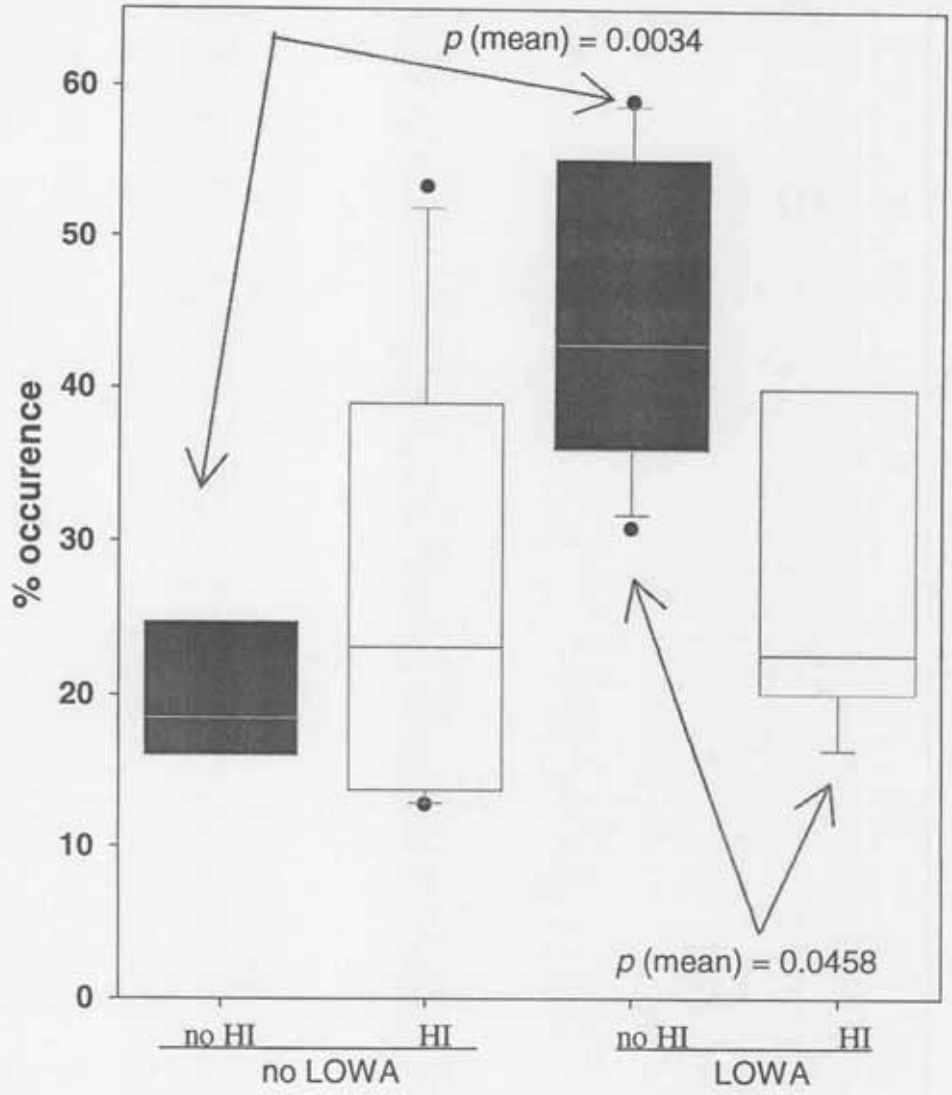
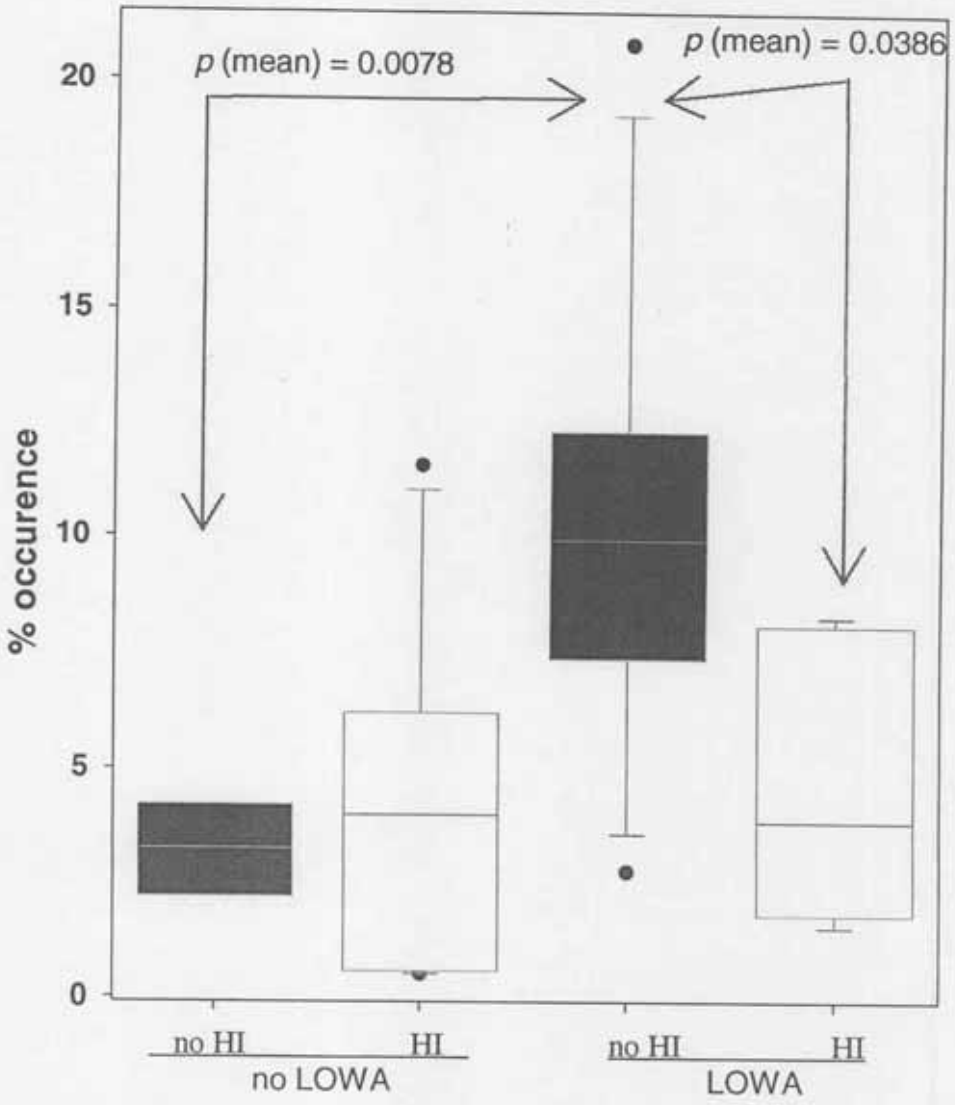


Figure 11. Exposed substrate in April for streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).



Among areas with no HI, significantly more % riffle, April exposed substrate (Figure 9-10), July exposed substrate, and % stream edge were observed among streams with breeding LOWAs than those without LOWAs (Figure 12-13). A significantly reduced % run was observed among those streams with LOWAs (Figure 14). Additionally, the variance of % pool was significantly lower among streams with LOWAs, compared to those without LOWAs (Figure 6).

Among the streams that had HI, significantly greater values were observed for EPT, Trichoptera and Plecoptera dominance, and the LOWA-Eaton index, as compared to those without LOWA (Figure 15-18). Additionally, the Plecoptera dominance values (Figure 17) varied significantly more among streams with LOWA than those without. Conversely, the LOWA-Eaton index, % vegetated bank, and % exposed soil responses had less variance among those streams with Louisiana Waterthrushes as compared to those. without (Figure 18-20).

Figure 12. Exposed substrate in July for streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

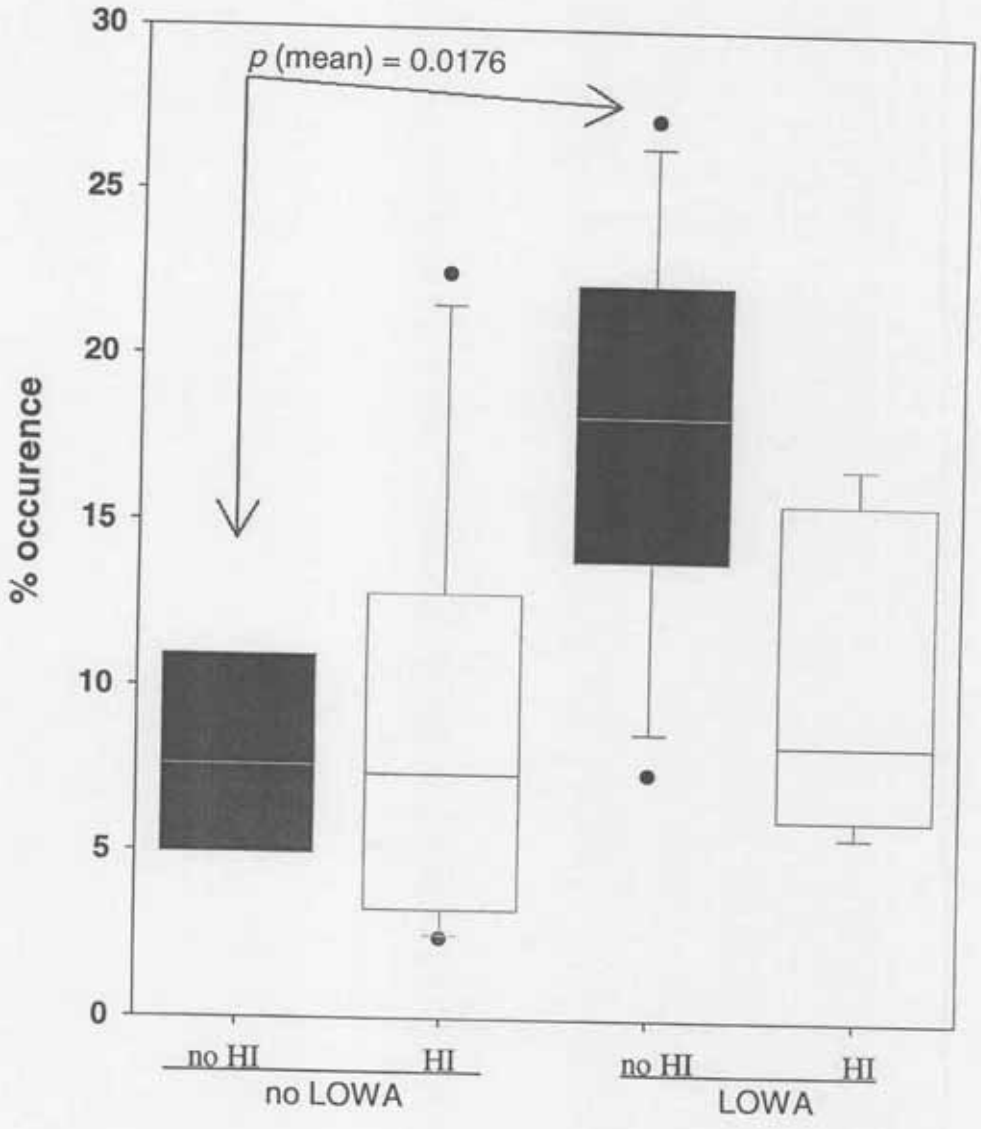


Figure 13. Stream edge for streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

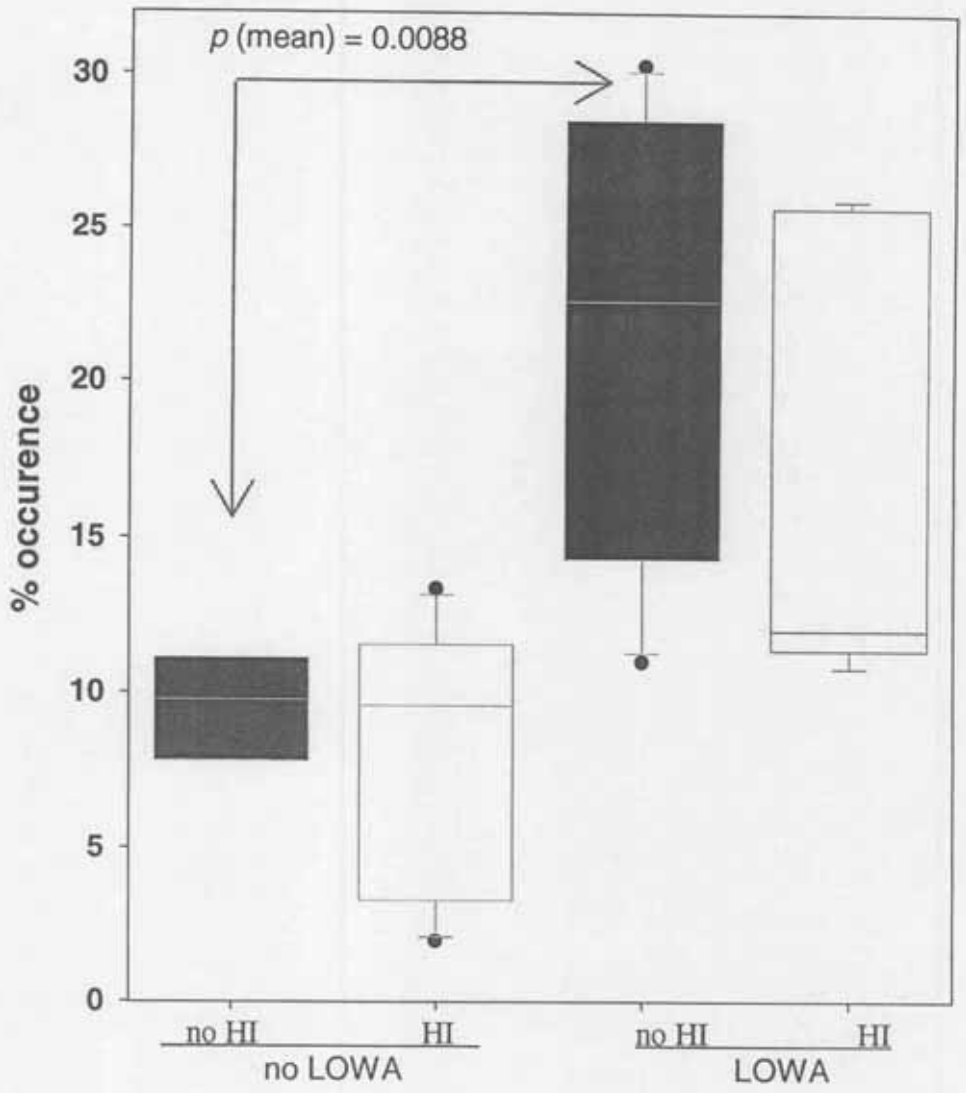


Figure 14. Percentage of run habitat for streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

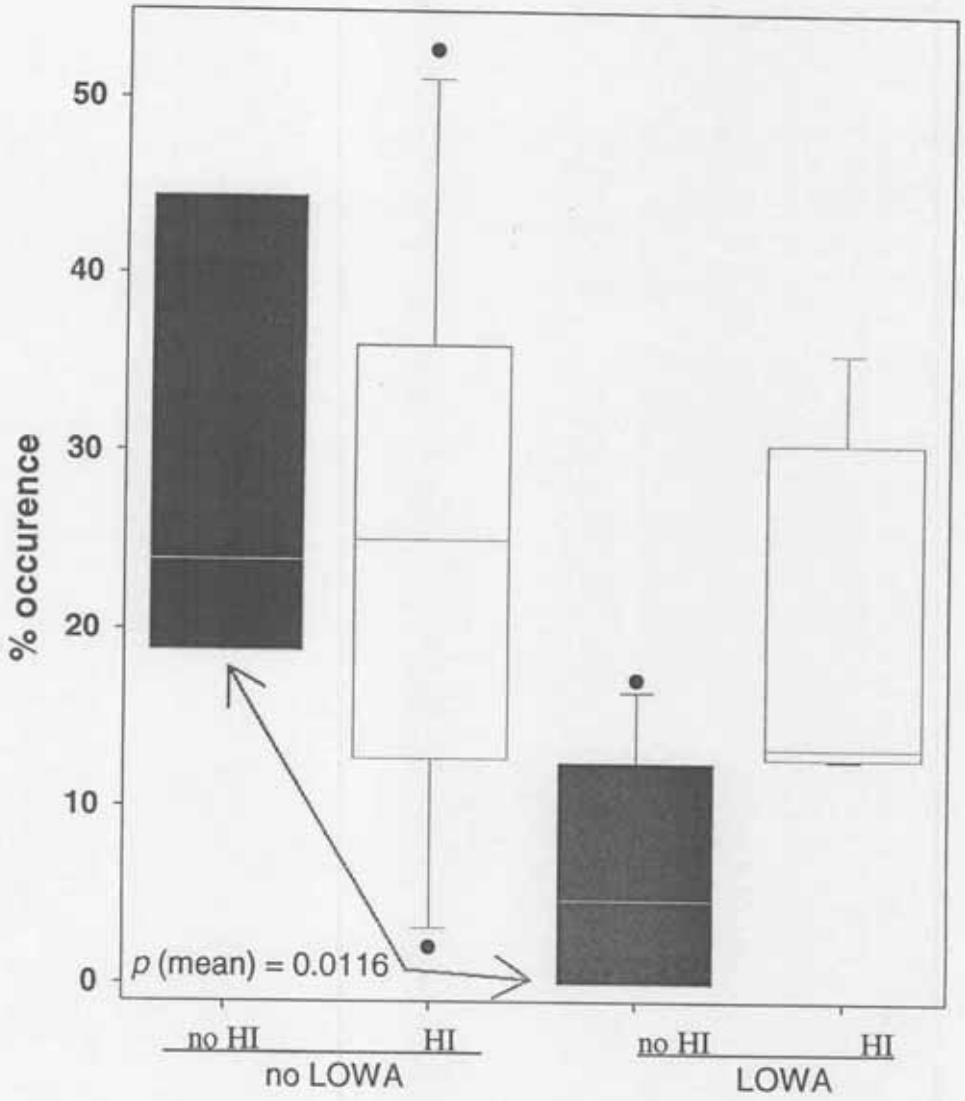


Figure 15. Percent EPT in streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

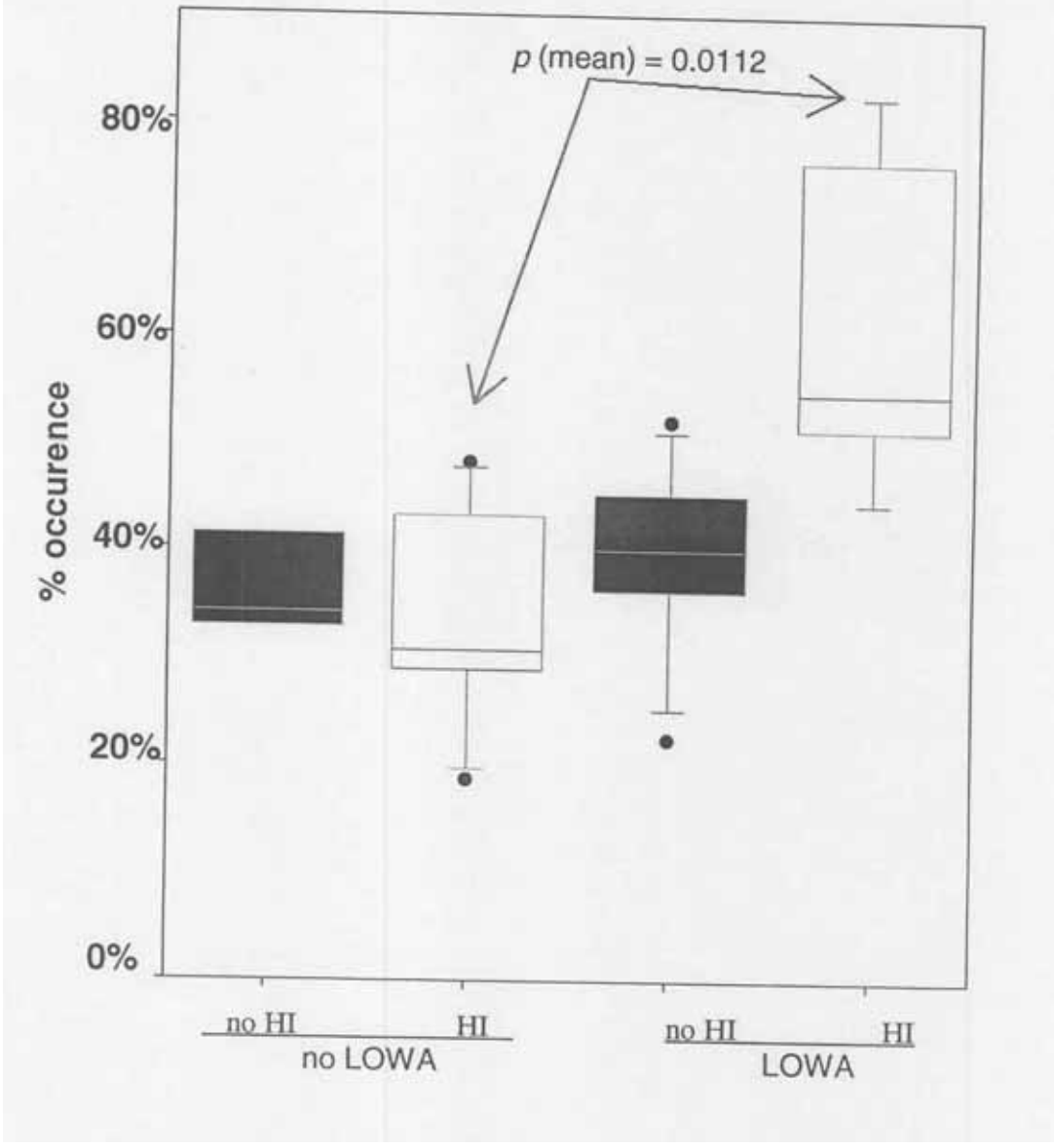


Figure 16. Trichoptera dominance in streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

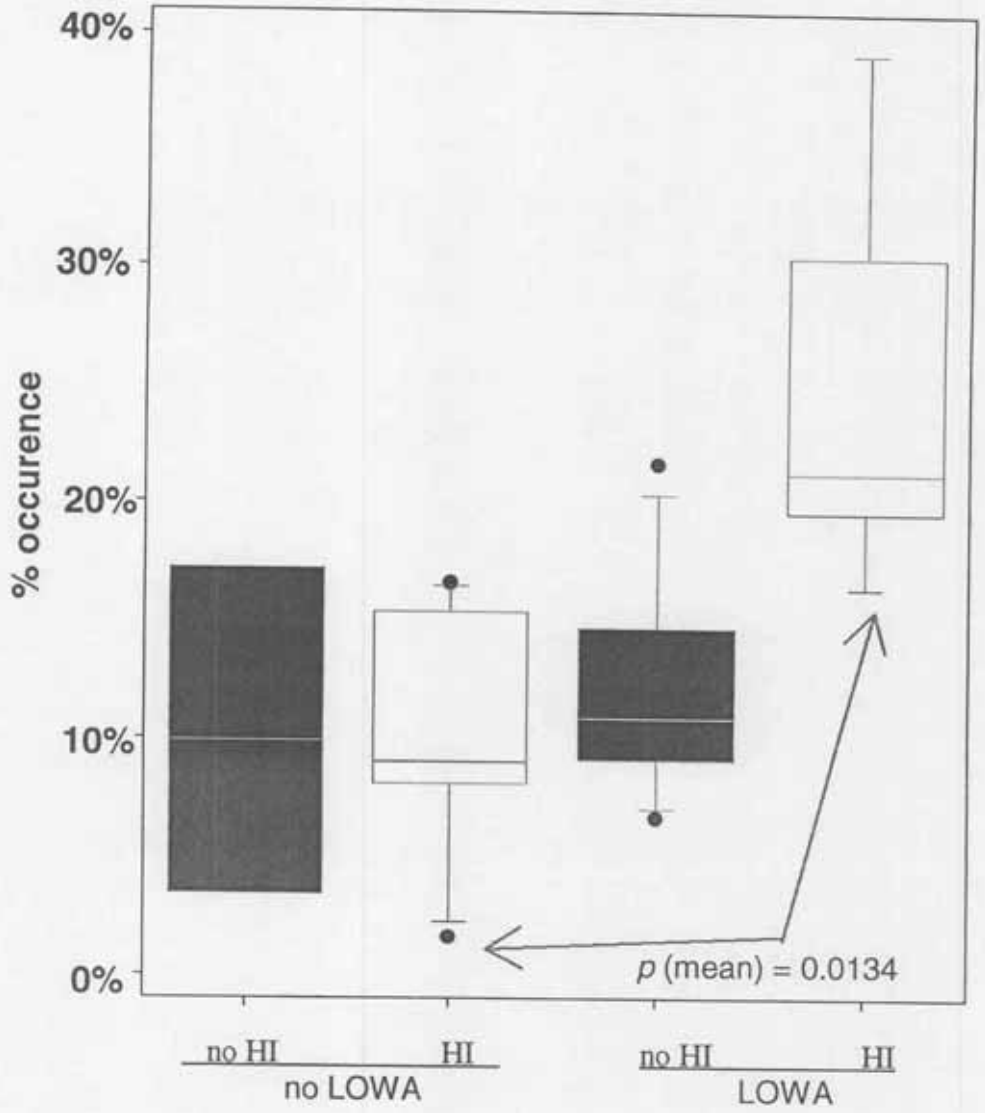


Figure 17. Plecoptera dominance in streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

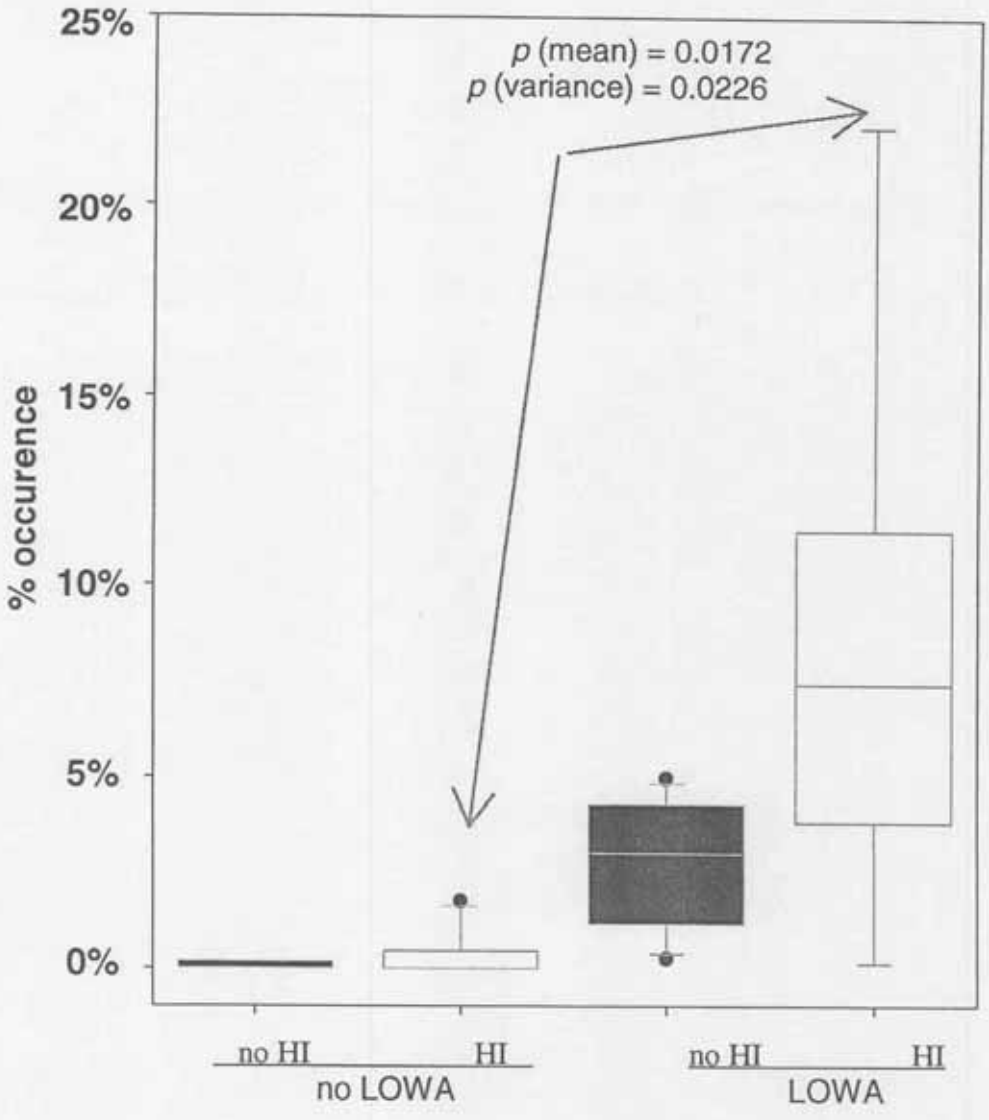


Figure 18. LOWA-Eaton Index between streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).

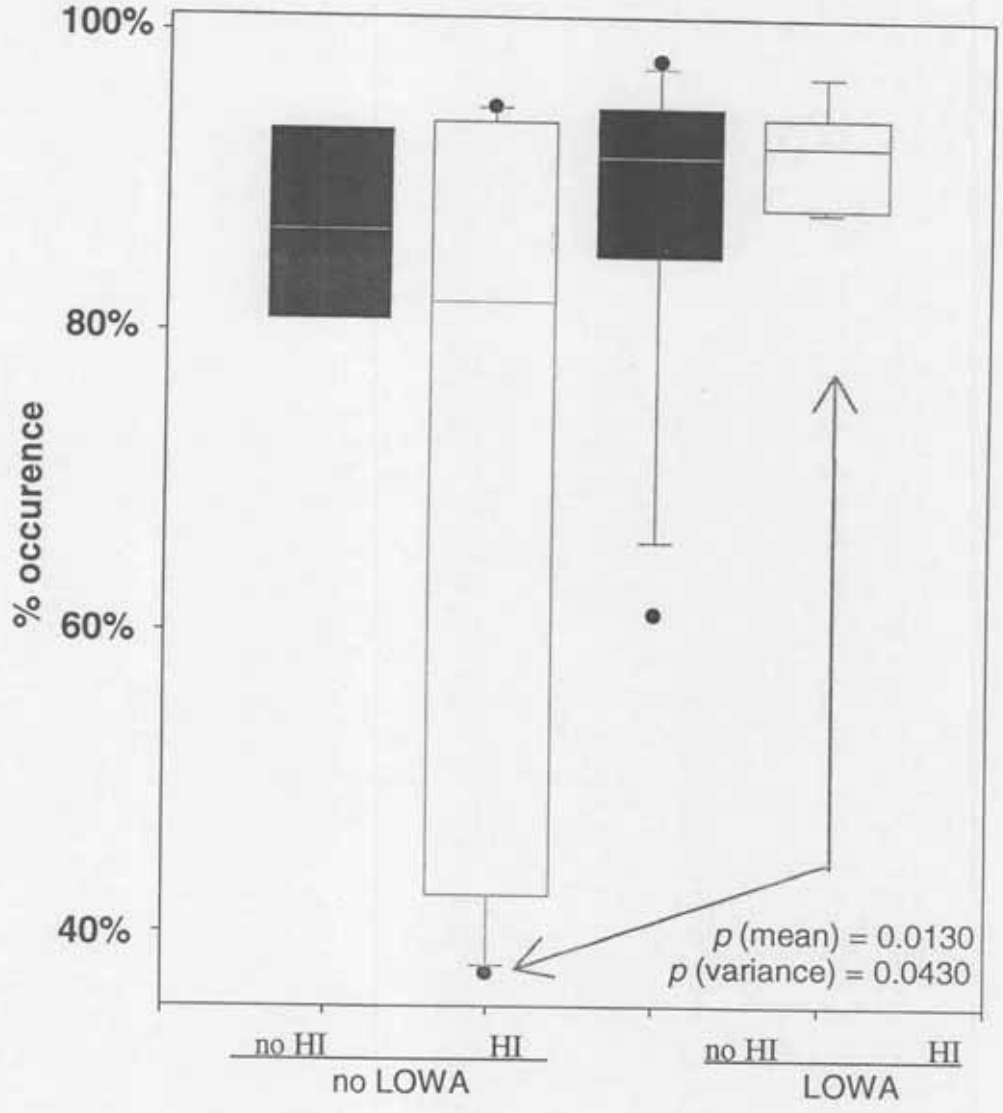
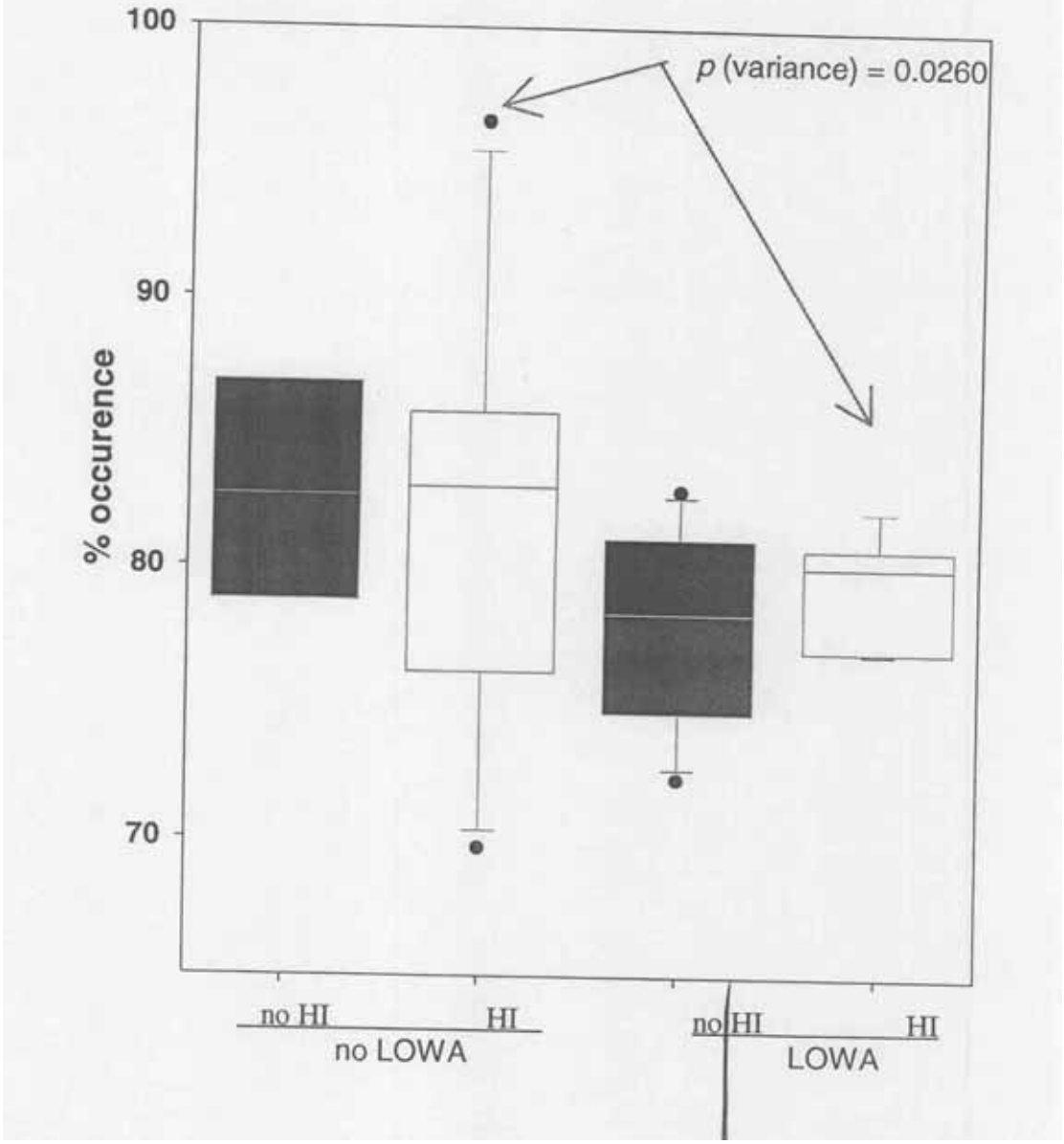


Figure 19. Vegetated bank cover for streams both with and without Louisiana Waterthrushes (LOWA) and habitat improvement (HI).



Discussion

Macroinvertebrate Species, Assemblages and HI Projects

The macroinvertebrate analyses demonstrate relatively consistent patterns. The streams with HI showed significantly reduced HBI scores, when compared to streams without HI. Several factors may have helped to produce these results. The Hilsenhoff Biotic Index (HBI) is a measure of organic pollution, including silt and other fine particles (Hilsenhoff 1982). As streambanks are stabilized and the stream narrowed, the erosion process is temporarily slowed and the stream flow velocity increases. Consequently, the stream substrate is scoured of the remaining fine particles, leaving coarse sand, gravel, and cobble. As these fine particles disappear, so do the immediate indicators of organic pollution. One of the most significant indicators of organic pollution is chironomid abundance. In this study, streams with HI showed an increased range in scores, particularly in the direction of reduced chironomid dominance. Reducing chironomid dominance will reduce HBI scores. The LOWA-Craig Index also exhibited a similar trend, with dominance scores showing a wider range of values among rifles of HI streams. Decreases in the LOWA-Craig Index suggests that the number of invertebrates available for consumption declines as well, possibly reducing the suitability of the habitat for Louisiana Waterthrushes.

Simpson and Brillouin diversity scores present another view of habitat improvement and aquatic invertebrates. Both scores display significantly increased variation among the responses for rifles of HI streams compared to streams without HI. These scores reiterate the previous findings, but also the additional insight that the variety of organisms is not as consistent among rifles of HI streams. Secondly, it suggests that HI

riffle habitat is patchy, both better and worse than average as illustrated by the chironomid dominance and HBI scores.

Physical Habitat and HI Projects

The stream and streambank habitat measures in this study showed no significant differences between the riffles in forested streams with and without HI. These results could be genuine, or may be complicated by the sampling design and inclusion of Louisiana Waterthrushes as a selection criteria.

Macroinvertebrates, Habitats, HI Projects and Louisiana Waterthrushes

Physical habitat analyses that consider both HI presence and Louisiana Waterthrush breeding status show several distinct patterns. First, among sites with Louisiana Waterthrushes, the percentage of rifle habitat is found significantly less among sites where HI occurred. This trend of riffle habitat decline with HI was also observed by Kwak (1993). Concurrently, among sites with no HI, sites with Louisiana Waterthrushes have higher percentages of rifle habitat. This inverse relationship for pool habitat was observed and reported by Kwak (1993). Although not significant, run habitat was more abundant among Louisiana Waterthrush streams with HI than without HI. Similarly stream edge and exposed substrates were significantly less abundant where there were no Louisiana Waterthrushes, or among streams with HI.

The physical habitat results from HI include a reduction in riffle and an increase in pool and run habitats. These shifts are a logical outcome of HI efforts to narrow stream width and increase stream velocity. These efforts result in scour that cleans riffles, and

lengthens pools. Aquatic invertebrate assemblages reflect the observed differences in physical habitat between streams with and without HI and/or Louisiana Waterthrushes. Not surprisingly, riffles in habitat improved areas exhibit macroinvertebrate assemblages suggestive of clean substrates: fewer chironomids and greater % EPT. Although the aquatic invertebrate samples among sites are comparable, they do not reflect the greater proportion of riffle habitats in streams where there was no HI. Taking into consideration that there are fewer riffles among HI streams (particularly where there are Louisiana Waterthrushes) are they as productive as the greater proportion of riffles in streams without HI? The results are inconclusive on this point, and require more extensive sampling of all habitats in streams.

Are Louisiana Waterthrushes in southeastern Minnesota impacted by HI? In these analyses, key habitat factors required by Louisiana Waterthrushes are found less frequently or with lower probability among streams with HI: riffle, stream edge, exposed substrates, exposed bank. Louisiana Waterthrushes follow a fairly narrow habitat prescription *(see* Chapter 1). In those instances where streams with HI fell within this narrow prescription and Louisiana Waterthrushes were present, either required habitat features were maintained, or the stream had regained its dynamic processes. Additionally, the riparian zones avian communities of HI streams reflect those of disturbed habitats *(see* Chapter 2). Although unintended, HI does appear to have direct and indirect impacts on Louisiana Waterthrushes, the riparian avian community, macroinvertebrates, and their associated habitats.

Conservation and Management Implications -

Conservation of forested trout streams in southeastern Minnesota is most broadly an issue of management cooperation. Following are recommendations that appear most important for the integrity of riparian zones along forested trout streams.

- Wildlife habitat includes the stream. Influence on the stream extends from outside of the riparian zone. Protection of riparian zones and critical upland habitat will begin to restore the integrity of these riparian ecosystems, leading ultimately to stream health. Synthesizing all facets of a natural resource agency toward holistic ecosystem management of riparian zones requires integrating larger spatial and longer time scale planning.
- Southeastern Minnesota has 960 km of designated trout streams. Habitat requirements of Louisiana Waterthrushes coincide with fewer than 5-6% (56 km) of those streams, most of these miles in forested headwaters, or where small tributaries feed larger streams. Serious consideration should be given to experimentally restoring and maintaining these streams as brook trout habitat by managing the watershed and riparian zone in cooperation with other natural resource managers. Low order forested streams were once good habitat for both brook trout and Louisiana Waterthrushes in southeastern Minnesota. These is no reason why brook trout and Louisiana Waterthrushes could not coexist along these streams again.
- Habitat improvement and any other riparian management projects should be initiated in situations deemed appropriate after consultation with other natural resource managers. Proposals should include an evaluation of suspected

secondary impacts of proposed projects: plant elimination, vegetation structure, avian communities, aquatic macroinvertebrates, non-game fish, effects of increased visitation and angler use (trampling in particular) for these same components, and what efforts need to be made to reduce or mitigate impacts and protect the integrity of the system. Particular focus should continue on those species included in the State list of Endangered, Threatened, and Special Concern Species and their habitat requirements. These efforts could be made in the context of "experimental" or adaptive management leading to a greater understanding of the impacts of projects on the ecosystem.

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Appendix A. Birds detected during point counts in southeastern Minnesota 1996 and 1997, and the analysis categories.

Common Name[1]	*Scientific Name*[1]	breeds	migratory status[2]	habitat[3]	forest use[4]
Great Blue Heron	*Ardea herodias*	yes	continental	water	
Turkey Vulture	*Catharses aura*	yes	continental	disturbed forest	interior/
Canada Goose	*Branta canadensis*	yes	continental	water	
Wood Duck	*Aix sponsa*	yes	continental	water	
Mallard	*Anas platyrhynchos*	yes	continental	water	
Broad-winged Hawk	*Buteo platypterus*	yes	neotropical	contiguous forest	interior
Red-tailed Hawk	*Buteo jamaicensis*	yes	continental	disturbed forest	edge
Ruffed Grouse	*Bonasa umbellus*	yes	resident	contiguous forest	interior/edg
Wild Turkey	*Meleagris gallopavo*	yes	resident	contiguous forest	interior/edg
Spotted Sandpiper	*Actitis macularia*	yes	neotropical	water	
Mourning Dove	*Zenaida macroura*	yes	continental	disturbed forest	edge
Black-billed Cuckoo	Coccyzus *erythropthalmus*	yes	neotropical	contiguous forest	interior/edg
Ruby-throated Hummingbird	*Archilochus colubris*	yes	neotropical	disturbed forest	edge
Belted Kingfisher	*Ceryle alcyon*	yes	continental	water	
Red-headed Woodpecker	*Melanerpes erythrocephalus*	yes	resident	disturbed forest	edge
Red-bellied Woodpecker	*Melanerpes carolinus*	yes	resident	contiguous forest	interior/edg
Yellow-bellied Sapsucker	*Sphyrapicus varius*	yes	continental	contiguous forest	interior/edg
Downy Woodpecker	*Picoides pubescens*	yes	resident	disturbed forest	interior/edg
Hairy Woodpecker	*Picoides villosus*	yes	resident	contiguous forest	interior
Northern Flicker	*Colaptes auratus*	yes	resident	disturbed forest	interior/edg
Pileated Woodpecker	*Dryocopus pileatus*	yes	resident	contiguous forest	interior
Olive-sided Flycatcher	*Contopus cooperi*	no	neotropical	contiguous forest	
Eastern Wood-Pewee	*Contopus virens*	yes	neotropical	contiguous forest	interior/edg
Yellow-bellied Flycatcher	*Empidonax flaviventris*	no	neotropical	contiguous forest	
Acadian Flycatcher	*Empidonax virescens*	yes	neotropical	contiguous forest	interior
Willow Flycatcher	*Empidonax traillii*	yes	neotropical	water	
Least Flycatcher	*Empidonax minimus*	yes	neotropical	contiguous forest	edge
Eastern Phoebe	*Sayornis phoebe*	yes	continental	disturbed forest	interior/edg
Great Crested Flycatcher	*Myiarchus crinitus*	yes	neotropical	disturbed forest	interior/edg
Yellow-throated Vireo	*Vireo flavifrons*	yes	neotropical	contiguous forest	interior/edg
Blue-headed Vireo	*Vireo solitarius*	no	neotropical	contiguous forest	
Warbling Vireo	*Vireo gilvus*	yes	neotropical	disturbed forest	edge
Philadelphia Vireo	*Vireo philadelphicus*	no	neotropical	contiguous forest	
Red-eyed Vireo	*Vireo olivaceus*	yes	neotropical	contiguous forest	interior/edg
Blue Jay	*Cyanocitta cristata*	yes	resident	disturbed forest	interior/edg
American Crow	*Corvus brachyrhynchos*	yes	resident	disturbed forest	edge
Tree Swallow	*Tachycineta bicolor*	yes	neotropical	disturbed forest	edge
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	yes	neotropical	open	
Bank Swallow	*Riparia riparia*	yes	neotropical	open	

Appendix A. *continued.*

Common Name[1]	*Scientific Name*[1]	breeds	migratory status[2]	habitat[3]	forest use[4]
Black-capped Chickadee	*Poecile atricapillus*	*yes*	resident	disturbed forest	interior/edg
Tufted Titmouse	*Baeolophus bicolor*	yes	resident	contiguous forest	interior/edg
White-breasted Nuthatch	*Sitta carolinensis*	yes	resident	disturbed forest	interior
Brown Creeper	*Certhia americana*	yes	continental	contiguous forest	interior
House Wren	*Troglodytes aedon*	yes	neotropical	disturbed forest	edge
Winter Wren	*Troglodytes troglodytes*	yes	continental	contiguous forest	interior
Ruby-crowned Kinglet	*Regulus calendula*	no	continental	contiguous forest	
Blue-gray Gnatcatcher	*Polioptila caerulea*	yes	neotropical	contiguous forest	interior/edg
Veery	*Catharus fuscescens*	yes	neotropical	contiguous forest	interior
Wood Thrush	*Hylocichla mustelina*	yes	neotropical	contiguous forest	interior/edg
American Robin	Turdus *migratorius*	yes	continental	disturbed forest	edge
Gray Catbird	*Dumetella carolinensis*	yes	neotropical	disturbed forest	interior/edg
Brown Thrasher	*Toxostoma rufum*	yes	continental	disturbed forest	edge
Cedar Waxwing	*Bombycilla cedrorum*	yes	continental	disturbed forest	edge
Blue winged Warbler	*ermivora pinus*	yes	neotropical	contiguous forest	edge
Golden-winged Warbler	*Vermivora chrysoptera*	no	neotropical	contiguous forest	
Tennessee Warbler	*Vermivora peregrina*	no	neotropical	contiguous forest	
orange-crowned Warbler	*Vermivora celata*	no	continental	contiguous forest	
Nashville Warbler	*Vermivora ruficapilla*	no	neotropical	contiguous forest	
Northern Parula	*Parula americana*	no	neotropical	contiguous forest	
Yellow Warbler	*Dendroica petechia*	yes	neotropical	disturbed forest	edge
Chestnut-sided Warbler	*Dendroica pensylvanica*	no	neotropical	contiguous forest	
Magnolia Warbler	*Dendroica magnolia*	no	neotropical	contiguous forest	
Black-throated Blue Warbler	*Dendroica caerulescens*	no	neotropical	contiguous forest	
Yellow-romped Warbler	*Dendroica coronata*	no	continental	contiguous forest	
Black-throated Green Warbler	*Dendroica virens*	no	neotropical	contiguous forest	
Palm Warbler	*Dendroica palmarum*	no	neotropical	contiguous forest	
Blackpoll Warbler	*Dendroica striata*	no	neotropical	contiguous forest	
Cerulean Warbler	*Dendroica cerulea*	yes	neotropical	contiguous forest	interior
Black-and-white Warbler	*Mniotilta varia*	no	neotropical	contiguous forest	
American Redstart	*Setophaga ruticilla*	yes	neotropical	contiguous forest	interior
Ovenbird	*Seiurus aurocapillus*	yes	neotropical	contiguous forest	interior
Northern Waterthrush	*Seiurus noveboracensis*	no	neotropical	contiguous forest	
Louisiana Waterthrush	*Seiurus motacilla*	yes	neotropical	contiguous forest	interior
Mourning Warbler	*Oporornis philadelphicus*	no	neotropical	contiguous forest	
Common Yellowthroat	*Geothlypis trichas*	yes	neotropical	disturbed forest	interior/edg
Wilson's Warbler	*Wilsonia pusilla*	no	neotropical	contiguous forest	
Canada Warbler	*TVilsonia canadensis*	*no*	neotropical	contiguous forest	
Scarlet Tanager	*Piranga olivacea*	yes	neotropical	contiguous forest	interior

Appendix A. *continued*.

Common Name[1]	*Scientific Name*[1]	breeds	migratory status[2]	habitat[3]	forest use[4]
Eastern Towhee	*Pipilo erythrophthalmus*	yes	continental	disturbed forest	interior/edg
Chipping Sparrow	*Spizella passerina*	yes	neotropical	disturbed forest	edge
Field Sparrow	Spizelda *pusilla*	yes	continental	open	edge
Grasshopper Sparrow	*Ammodramus savannarum*	yes	continental	open	
Song Sparrow	*Melospiza melodic*	yes	continental	disturbed forest	edge
Lincoln's Sparrow	*Melospiza lincolnii*	no	continental	contiguous forest	
Swamp Sparrow	*Melospiza georgiana*	yes	continental	water	edge
White-throated Sparrow	*Zonotrichia albicollis*	no	continental	contiguous forest	
Dark-eyed Junco	*Junco hyemalis*	no	continental	contiguous forest	
Northern Cardinal	*Cardinalis cardinalis*	yes	continental	disturbed forest	interior/edg
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	yes	neotropical	contiguous forest	interior/edg
Indigo Bunting	*Passerina cyanea*	yes	neotropical	disturbed forest	edge
Red-winged Blackbird	*Agelaius phoeniceus*	yes	continental	water	edge
Common Grackle	*Quiscalus quiscula*	yes	continental	disturbed forest	edge
Brown-headed Cowbird	*Molothrus ater*	yes	continental	disturbed forest	edge
Baltimore Oriole	*Icterus galbula*	yes	neotropical	disturbed forest	edge
American Goldfinch	*Carduelis tristis*	yes	continental	disturbed forest	edge

[1] Common and scientific names from American Ornithologists' Union (1998).
[2] Migratory status from Green (1995).
[3] Habitat categories from Green (1991).
[4] Forest use classifications obtained from Freemark and Collins (1989).

Appendix B. Aquatic Invertebrates collected in southeastern Minnesota during 1996-1997.

Phylum	Class	Order	Family	Genus species
Annelida	Hirudinea			
	Oligochaeta			spp.
			Naididae	spp.
Arthropoda	Arachnida	Acarina		spp.
			Hydracarina	spp.
	Crustacea	Amphipoda		spp.
			Gammaridae	spp.
				Gammarus spp.
				pseudolimnaeus
		Decapoda	Cambaridae	*Orconectes virilis*
		Isopoda	Asellidae	*Asellus* spp.
Arthropoda	Entognotha	Collembola		spp.
Arthropoda	Insecta	Coleoptera	Curculionidae	spp.
				Lixus spp.
			Dryopidae	*Helichus* spp.
			Dytiscidae	spp.
				Agabus spp.
				spp. (*larvae*)
				Ilybius spp.
			Elmidae	*Optioservus fastiditus*
				spp. (*larvae*)
				spp.
				Stenelmis crenata
				spp.
				spp. (*larvae*)
			Haliplidae	*Haliplus* spp.
Arthropoda	Insecta	Diptera	Athericidae	*Atherix* spp.
				variegata
			Ceratopogonidae	spp.
				spp. (*larvae*)
				Bezzia/Palpamyia spp.
				Culicoides spp.
			Chironomidae	spp.
			Empididae	spp.
				spp. (*pupae*)
				Chelifera spp.
				Clinocera spp.
				Hemerodromyia spp.
				spp. (*pupae*)
			Ephydridae	spp.
			Psychodidae	spp.
				Pericoma spp.
			pupae	*Psychomyia* spp.

Appendix B. *continued*.

Phylum	Class	Order	Family	Genus species
Arthropoda	Insecta	Diptera	Simuliidae	spp. *(pupae)*
				Ectemnia spp.
				Prosimulium multidentatum
				spp. *(pupae)*
				spp.
				Simulium Jenningsi/luggeri
				spp.
				tuberosum
				venustum
				vittatum
				Stegoptera spp.
			Stratiomyidae	*Euparyphus spp.*
			Tabanidae	spp.
				Chrysops spp.
				Tabanus spp.
			Tipulidae	spp. *(pupae)*
				Antocha spp.
				Dicranota spp.
				Hexatoma spp. (larvae)
				spp.
				Limnophila spp.
				Pedicia spp.
				Tipula spp.
Arthropoda	Insecta	Ephemeroptera	Baetidae	*spp.*
				spp. (larvae)
				Acentrella spp.
				Baetis brunneicolor
				diabasa
				flavistriga
				intercalaris
				spp.
				vagans
			Caenidae	*Brachycerus spp.*
			Ephemerellidae	spp. *(larvae)*
				Ephemerella excrucians
				inermis
				spp.
				subvaria
				Serratella deficiens
			Heptageniidae	spp.
				Heptagenia diabasia
				Stenonema femoratum
				spp.
				terminatum
				vicarium
			Leptophlebiidae	spp.
Arthropoda	Insecta	Hemiptera		spp.
			Corixidae	*Hesperocorixa spp.*
				Sigara spp.
Arthropoda	Insecta	Megaloptera	Corydalidae	*Nigronia spp.*
			Sialidae	*Sialis spp.*

Appendix B. *continued*.

Phylum	Class	Order	Family	Genus species
				ssp.
Arthropoda	Insecta	Plecoptera	Nemouridae	*Amphinemura spp.*
				Nemoura trispinosa
			Perlidae	*Paragentina media*
				Paragentina spp.
			Perlodidae	*Clioperla clio*
				Isogenoides spp.
				Isoperla marlynia
				Isoperla signata
Arthropoda	Insecta	Trichoptera		spp. *(pupae)*
			Brachycentridae	ssp.
				spp. (larvae)
				Brachycentrus americanus
				occidentalis
				Micrasema kluane
				ssp.
			Glossosomatidae	spp. *(pupae)*
				Glossosoma spp.
			Hydropsychidae	ssp.
				Ceratopsyche alhedra
				bronta
				ssp.
				sparna
				walkeri
				Cheumatopsyche spp.
				Hydropsyche betteni
				morosa bifida
				slossone
				spp.
				spp. (larvae)
				vexa
			Hydroptilidae	spp.
				Hydroptila spp.
				Oxyethira spp.
			Lepidostomatidae	*Lepidostoma spp.*
			Leptoceridae	spp.
				Oecetis disjuncta
				ssp.
			Limnephilidae	ssp.
				spp. (larvae)
				Anabolia spp.
				Asynarchas ssp.
				Frenesia spp.

Appendix B. *continued*.

Phylum	Class	Order	Family	Genus species
Arthropoda	Insecta	Trichoptera	Limnephilidae	*Hesperophylax designatus*
				spp.
				Limnephilus spp.
				Pycnopsyche spp.
			Philopomatidae	spp.
				Chimarra atterima
			Polycentropodidae	ssp.
				Paranyctiophylax spp.
			Rhyacophiladae	*Rhyacophila* spp.
			Uenoidae .	*Neophylax* spp.
Mollusca	Bivalvia	Veneroida	Sphariidae	spp.
Molluscs	Gastropods			*Limax* spp.
			Fossaria	ssp. ssp.
			Lymnaeidae	*Lymnaea* spp.
			Physidae	*Physa* spp.
Nematoda	Turbellaria			ssp.
		Tricladida		spp.
Nematomorpha		Isonychiidae		*Isonychia* spp.