Appendix 1.

Bird Names in Alphabetical Order (including page where each bird is pictured)

(Please see pages 45-49 for a table showing which birds were encountered at the study sites listed in evolutionary order.)

Bird species	Photo on page:
Acadian Flycatcher *(Empidonax virescens)*	
Alder Flycatcher *(Empidonax alnorum)*	
American Bittern *(Botaurus lentiginosus)*	41
American Black Duck *(Anas rubripes)*	23
American Coot *(Fulica americana)*	42
American Crow *(Corvus brachyrhynchos)*	18
American Goldfinch *(Carduelis tristis)*	40
American Kestrel *(Falco sparverius)*	31
American Redstart *(Setophaga ruticilla)*	24, 42
American Robin *(Turdus migratorius)*	10, 17, 32
American Tree Sparrow *(Spizella arborea)*	62
American Wigeon *(Anas americana)*	41
American Woodcock *(Scolopax minor)*	66
Bald Eagle *(Haliaeetus leucocephalus)*	17
Baltimore Oriole *(Icterus galbula)*	12
Barn Swallow *(Hirundo rustica)*	27, 60
Barred Owl *(Strix varia)*	
Bay-breasted Warbler *(Dendroica castanea)*	17
Bell's Vireo *(Vireo bellii)*	
Belted Kingfisher *(Megaceryle alcyon)*	32
Black Tern *(Chlidonias niger)*	
Black-and-white Warbler *(Mniotilta varia)*	17, 28
Black-backed Woodpecker *(Picoides arcticus)*	31
Black-billed Cuckoo *(Coccyzus erythropthalmus)*	68
Blackburnian Warbler *(Dendroica fusca)*	
Black-capped Chickadee *(Poecile atricapillus)*	12, 34
Black-crowned Night-Heron *(Nycticorax nycticorax)*	62
Blackpoll Warbler *(Dendroica striata)*	22
Black-throated Blue Warbler *(Dendroica caerulescens)*	17, 22
Black-throated Green Warbler *(Dendroica virens)*	44
Blue Jay *(Cyanocitta cristata)*	18
Blue-gray Gnatcatcher *(Polioptila caerulea)*	
Blue-headed Vireo *(Vireo solitarius)*	43
Blue-winged Teal *(Anas discors)*	13, 66, 76
Blue-winged Warbler *(Vermivora pinus)*	13
Bobolink *(Dolichonyx oryzivorus)*	25, 29
Bonaparte's Gull *(Larus philadelphia)*	50
Brewer's Blackbird *(Euphagus cyanocephalus)*	
Broad-winged Hawk *(Buteo platypterus)*	13
Brown Creeper *(Certhia americana)*	
Brown Thrasher *(Toxostoma rufum)*	
Brown-headed Cowbird *(Molothrus ater)*	19
Bufflehead *(Bucephala albeola)*	13
Canada Goose *(Branta canadensis)*	
Canada Warbler *(Wilsonia canadensis)*	26
Canvasback *(Aythya valisineria)*	26, 62
Cape May Warbler *(Dendroica tigrina)*	16
Caspian Tern *(Hydroprogne caspia)*	
Cedar Waxwing *(Bombycilla cedrorum)*	22, 32
Chestnut-sided Warbler *(Dendroica pensylvanica)*	54, 74
Chimney Swift *(Chaetura pelagica)*	13
Chipping Sparrow *(Spizella passerina)*	44
Clay-colored Sparrow *(Spizella pallida)*	
Common Grackle *(Quiscalus quiscula)*	42
Common Loon *(Gavia immer)*	15
Common Merganser *(Mergus merganser)*	31, 41
Common Moorhen *(Gallinula chloropus)*	26
Common Nighthawk *(Chordeiles minor)*	
Common Raven *(Corvus corax)*	43
Common Tern *(Sterna hirundo)*	
Common Yellowthroat *(Geothlypis trichas)*	40
Connecticut Warbler *(Oporornis agilis)*	
Cooper's Hawk *(Accipiter cooperii)*	60
Dark-eyed Junco *(Junco hyemalis)*	28
Double-crested Cormorant *(Phalacrocorax auritus)*	
Downy Woodpecker *(Picoides pubescens)*	12, 34
Dunlin *(Calidris alpina)*	
Eastern Bluebird *(Sialia sialis)*	18
Eastern Kingbird *(Tyrannus tyrannus)*	
Eastern Meadowlark *(Sturnella magna)*	25
Eastern Phoebe *(Sayornis phoebe)*	40
Eastern Screech-Owl *(Megascops asio)*	
Eastern Towhee *(Pipilo erythrophthalmus)*	
Eastern Wood-Pewee *(Contopus virens)*	
European Starling *(Sturnus vulgaris)*	14
Evening Grosbeak *(Coccothraustes vespertinus)*	44
Field Sparrow *(Spizella pusilla)*	
Forster's Tern *(Sterna forsteri)*	62
Fox Sparrow *(Passerella iliaca)*	
Franklin's Gull *(Larus pipixcan)*	
Gadwall *(Anas strepera)*	71
Golden-crowned Kinglet *(Regulus satrapa)*	40
Golden-winged Warbler *(Vermivora chrysoptera)*	26
Gray Catbird *(Dumetella carolinensis)*	16, 24
Gray Jay *(Perisoreus canadensis)*	29
Gray-cheeked Thrush *(Catharus minimus)*	
Great Blue Heron *(Ardea herodias)*	15
Great Crested Flycatcher *(Myiarchus crinitus)*	
Great Egret *(Ardea alba)*	41
Great Horned Owl *(Bubo virginianus)*	10
Greater Scaup *(Aythya marila)*	
Greater Yellowlegs *(Tringa melanoleuca)*	32
Green Heron *(Butorides virescens)*	32
Green-winged Teal *(Anas crecca)*	53
Hairy Woodpecker *(Picoides villosus)*	31
Henslow's Sparrow *(Ammodramus henslowii)*	67
Hermit Thrush *(Catharus guttatus)*	40, 74
Herring Gull *(Larus argentatus)*	39
Hooded Merganser *(Lophodytes cucullatus)*	43, 73
Hooded Warbler *(Wilsonia citrina)*	
Horned Lark *(Eremophila alpestris)*	
House Finch *(Carpodacus mexicanus)*	
House Sparrow *(Passer domesticus)*	30
House Wren *(Troglodytes aedon)*	31
Indigo Bunting *(Passerina cyanea)*	14

Appendix 2.

Birds Without Borders – *Aves Sin Fronteras*® Partners and Collaborators

BWB-ASF has been fortunate to establish many partnerships and collaborations (listed below) during the time that this international project has been in existence. We are grateful to have been able to work with these organizations. So that our research results could become part of larger databases, we followed established protocols and then submitted our research results to existing initiatives whenever possible. (BWB-ASF research data have been submitted to the programs marked with an asterisk.)

Wisconsin

- Environment Canada – Great Lakes Marsh Monitoring Program*
- Institute for Bird Populations – Monitoring Avian Productivity and Survivorship Program (MAPS, bird banding during the breeding season)*
- Lake Pewaukee Sanitary District
- Land O' Lakes Historical Society
- Montana Cooperative Wildlife Research Unit – Breeding Biology Research and Monitoring Database (BBIRD, database of nest success and habitat measurements)*
- Partners in Flight – U.S. and Mesoamerican Groups
- University of Wisconsin-Milwaukee Field Station
- U.S. Department of Agriculture – Soil Conservation Service
- U.S. Farm Service Agency
- U.S. Fish and Wildlife Service – Division of Bird Habitat Conservation
- U.S. Geological Survey – Bird Banding Laboratory*
- Wisconsin Bird Conservation Initiative
- Wisconsin Breeding Bird Atlas*
- Wisconsin Department of Natural Resources*
- Wisconsin Society for Ornithology

Belize

- Belize Association of Private Protected Areas
- Belize Audubon Society
- Belize Biodiversity Initiative*
- Belize Botanical Gardens
- Belize Central Statistics Office – Environmental Statistics Unit*
- Belize Friends for Conservation and Development
- Belize Institute of Archeology
- Belize Zoo and Tropical Education Center (Sharon Matola, Director)
- Biodiversity and Environmental Resource Data System of Belize*
- Chaa Creek Nature Reserve (Mick and Lucy Fleming)
- Cheers Restaurant (Anita and Christie Tupper)
- Carol Farneti-Foster and Richard Foster, Wildlife Photographers
- Government of Belize Ministry of Agriculture and Fisheries and the Belize Agricultural Health Authority
- Government of Belize Ministry of Natural Resources, the Environment and Industry – the Forestry Department and Conservation Division
- Green Hills Farm (Jan Meerman and Tineke Boemsa)
- Institute for Bird Populations – Monitoring Overwintering Survival Program (MoSI, bird banding during the non-breeding season)*
- Manomet Bird Observatory
- Mesoamerican Biological Corridor
- Mesoamerican Society for Biology and Conservation
- Monkey Bay Wildlife Sanctuary
- Programme for Belize
- Protected Areas Conservation Trust
- Sibun Watershed Association*
- Society for the Promotion of Eco-cultural Tourism and the Environment
- The Nature Conservancy – Latin American Division
- Toledo Institute for Development and Environment
- United Nations Development Program/Global Environmental Facility – Small Grants Programme (Philip Balderamos, National Coordinator – Belize)

Appendix 3.

Research Techniques Used

Birds Without Borders – *Aves Sin Fronteras*® research methods are based on standardized scientific protocols. At the start of the project, we researched bird-monitoring techniques and contacted scientists to discuss their protocols. Our goal was to be able to compare our research results to those of other scientists. We also made plans to submit our research findings to existing monitoring projects so that our results could become part of larger databases. To accomplish this, we established collaborations with existing initiatives (see page 81 for a list of collaborators). Following are the research techniques we used to study Wisconsin's birds and their habitats.

Bird Banding

Richard Brodzeller

A bird is gently removed from a mist net. (1997 photo)

BWB-ASF Staff

To safely transport birds from the mist net to the banding station, they are stored in soft cloth bags.

Richard Brodzeller

While one staff member bands a Wood Thrush, another records data about the bird. The band is made of lightweight aluminum and fits loosely on the bird's leg. (1997 photo.)

Bird banding involves capturing birds in special nets called mist nets, carefully removing them, placing a numbered aluminum band on their lower leg, examining and taking measurements, and then releasing the birds. Bird banding requires specialized training and a permit from the U.S. government. Banding does not harm the birds in any way. Banding provides valuable information on the condition, age and sex of the birds captured. It also allows researchers to determine the species and numbers of birds present in a given location as well as whether the bird is breeding in the area. The information on birds banded is submitted to the Bird Banding Laboratory of the U.S. Geological Survey, where it is added to a comprehensive database. Banding provides valuable information on migration routes and timing, species that are increasing or decreasing over time, breeding and non-breeding populations, site fidelity to breeding and wintering (non-breeding) areas, and longevity of individuals.

Richard Brodzeller

A bird is captured in a mist net.

Richard Brodzeller

A bird being banded.

Richard Brodzeller

A researcher holds up a bird's leg to show the band.

Richard Brodzeller

A bird that has been banded is ready for release.

If you find a banded bird, contact the Bird Banding Laboratory:
Online at:
www.pwrc.usgs.gov/bbl
or by calling:
1-800-327-2263

You also may write to:
Bird Banding Laboratory
USGS Patuxent Wildlife Research Center
12100 Beech Forest Rd.
Laurel, MD 20708

You will need to report the band number, location and date the bird was found as well as how you got the band and your name and address. After reporting the band, you will receive a Certificate of Appreciation that has information about when and where the bird was originally banded.

BWB-ASF bird banding was conducted according to the methods of Weise (1988 and pers. comm.) and McCracken et al. (1999 a,b). Breeding condition of banded birds was determined through the methods of Burton and DeSante (1998). Ageing and sexing of captured birds was based on Pyle (1997).

Counting Birds

To count the bird species and numbers present in a given area, we used point counts (Ralph et al. 1993, 1995, and Howe et al. 1997) and censusing (McCracken et al. 1993). Point counts involve standing at a series of points for three to ten minutes and counting all of the birds seen or heard. Censusing involves walking slowly on an established route and counting all of the birds seen or heard.

We also conducted bird surveys for secretive nocturnal marsh birds at Wisconsin's Rosendale and Pewaukee study sites using the protocol of the Marsh Monitoring Program (LPBO and EC 1997). To stimulate these birds to vocalize, a tape containing the calls of six species was played for five minutes. All birds heard during these five minutes and for five subsequent minutes were counted.

Migration Monitoring

In order to detect all of the birds utilizing the study site during migration, we used the technique described in the Long Point Bird Observatory migration-monitoring protocol (McCracken et al. 1993). The bird species present were sampled daily using mist-netting, a standardized census and casual observations. Combining these three methods allowed us to maximize our chances of detecting the bird species using the study site each day. The census route encompassed the habitats present at the study site, including the areas in which the mist nets were located. All birds seen or heard were recorded, and care was taken to avoid counting birds twice. The census took about one hour to complete; it began and ended within the first three hours after sunrise.

Vicki Piaskowski

Binoculars are used to observe birds during the census. Researchers also listen for songs and calls to identify birds along the census route.

In addition, researchers recorded birds detected throughout the day. From three to eight hours after sunrise, birds were recorded as "other" observations. The total number of each species banded and recaptured was combined with the census and "other" observations to compile a Daily Estimated Total (DET) for each species. All researchers were involved in calculating the DET to provide an accurate estimate of each species' abundance at the site on a given day.

Bird banding was conducted daily during the monitoring period (five to six days per week). Birds were captured using tethered nylon mist nets 12 m by 2.6 m in size, of 30 mm mesh with 4 shelves. Nets were opened by sunrise and operated for six or more hours. Nets were closed early if weather conditions (temperature, wind, rain) were unsafe for capturing birds. All birds were banded with a U.S. Bird Banding Laboratory numbered aluminum leg band. Evaluation of fat class and breeding condition were based on Burton and DeSante (1998). Age and sex were determined according to Pyle (1997).

Northern Saw-whet Owl Banding

Vicki Piaskowski

This Northern Saw-whet Owl was captured in a mist net.

In 1999, BWB-ASF staff member Ryan Atwater developed a nocturnal fall owl-banding program at the Land O' Lakes, Wis., study site. Birds were captured using four-tier, 60 mm mesh and three-tier, 66 mm mesh mist nets that were 12 m by 2.6 m in length. A continuous-loop cassette tape containing the male Saw-whet Owl solicitation call was played from dusk to dawn (Erdman and Brinker 1997). Banding began on the evening of August 25 and was conducted one to two nights per week through September 20. Banding was then conducted almost every night from September 20 through October 13.

In 2000 owl banding was conducted following a similar protocol, although the location of nets was changed by a new bander. Banding began on the evening of September 4 and was conducted one night per week through September 18, from dusk to 1:30 a.m. From September 18 through October 31, banding was conducted seven nights per week from dusk to dawn, weather permitting.

Owls were aged and sexed according to the methods of Brinker et al. (1997) and Pyle (1997).

Determining the Birds Breeding at the Wisconsin Study Sites

USFWS/Dave Menke

This Eastern Bluebird is carrying food that it will most likely feed to its young.

The criteria we used to document bird species breeding at the study sites were described in the Wisconsin Breeding Bird Atlas *Atlasing Handbook* (WI BBA 1995) and later published in Cutright et al. (2006). Some behaviors that indicated birds were breeding at the site included birds carrying nesting material such as sticks or grass, carrying food, or building nests. Also, we recorded observations of recently fledged young birds (birds that had just left the nest and were probably under the care of their parents).

Richard Brodzeller

Blowing on the feathers allows banders to see the bird's abdomen to determine if it has a brood patch.

We were able to document that a bird was breeding at the study site if we observed a brood patch when examining a captured bird. When female birds and some male birds are incubating eggs, the feathers on the abdomen are lost and the area becomes filled with fluid and blood vessels. This is called a brood patch, which allows for the efficient transfer of heat to the eggs and nestlings.

We also did nest searching and monitoring, which are described below.

Nest Searching and Monitoring

The most accurate way of determining if a bird's nesting attempt is successful is to locate the nest and monitor it until the young are old enough to leave the nest (fledge). Nests are monitored (the number of eggs or young present are counted) when found and then every three to four days until the young fledge or the nest fails due to predation or other causes (Martin et al. 1997). To minimize disturbance to the birds and decrease the risk of predation, nests are monitored from a distance when possible and as quickly as possible. Prior to approaching a nest, researchers search the area for any sign of possible predators, particularly avian predators such as Blue Jays, American Crows or hawks. Care is taken not to leave a dead-end trail to the nest that mammalian predators could follow. If vegetation obscures the nest contents, a stick is used to move aside the vegetation so that no human scent is left at the nest site. If the nest is beyond reach, a pole with a mirror attached is used to view the nest contents.

Kari Van Allen

Red-eyed Vireo nestlings are reflected in the mirror during nest monitoring.

Vicki Piaskowski

A researcher uses a stick to move aside grasses while checking a nest. (1999 photo)

BWB-ASF Staff

BWB-ASF staff monitored even the most challenging nests! (Note: This is a staged photo.)

Scent Station Surveys for Potential Nest Predators

To determine the species of mammalian carnivores (potential nest predators) present at each of the study sites, we conducted scent-station surveys five times during one breeding season at each study site. We utilized the methods described in Linhart and Knowlton (1975), Roughton and Sweeney (1982), and Zielinski (1995). Scent stations can be made of aluminum plates or wooden boards covered with a substance in which mammals leave their tracks. Various types of bait can be used to attract mammals to the scent stations including meat, carrion, fish or commercial fatty-acid scent tablets.

Vicki Piaskowski

Preparing a track plate for the scent station survey. (2001 photo)

Kevin Bronson

Raccoon tracks are evident on this plate.

Aluminum plates coated with sand were used at the Pewaukee study site in 1999. At the Rosendale study site in 2000, aluminum-coated boards coated with black soot were used. At the Land O' Lakes study site in 2001, soot-covered plates were used once; after that sand-covered plates were used. We used fatty-acid scent tablets as bait to attract mammals to the scent station. The plates were set out in the early evening at different locations within and on the edges of the nest-monitoring plots. The scent stations were not placed in the vicinity of known active nests, to avoid attracting predators to the nest location. In the early morning, we identified the animal tracks left on the plate overnight. While walking to check the scent stations, staff also recorded the mammal species observed.

Vegetation Measurements

Larry Hopwood

A tree diameter is measured.

Vicki Piaskowski

Recording data during vegetation measurements. (2001 photo)

To describe the habitats important to birds, we did detailed measurements of the vegetation in the areas where we banded birds, searched for and monitored nests, and conducted point counts. We made these vegetation

measurements based on the methods of Mueller-Dombois and Ellenberg (1974), Ralph et al. (1993), Howe et al. (1997), and Martin et al. (1997).

Sampling the Arthropod Food Resources Available to Birds

To learn about the foods available to birds at the Pewaukee study site during spring migration of 2000 and 2001, we sampled both flying and sessile arthropods twice weekly. (Sessile arthropods are those found on vegetation such as leaves, flowers, twigs and branches.) In order to include the three habitats present at the site (upland forest, marsh and the transition zone between), two east-west transects were established 250 m apart starting in the upland forest and proceeding down slope into the marsh. Three points, 120 m apart, were marked along each transect. At each of these six points, arthropods were sampled using the following methods.

Flying arthropods were sampled using a modification of the method of Hutto (1981). Traps consisting of white 10 cm^2 boards coated with Tanglefoot® (a sticky substance) were hung on hooks attached to vertical ropes. The top of the rope was placed at the maximum height of the vegetation; the bottom extended to ground level. The sticky traps were placed at 0.5 m increments along the complete length of the hanging rope from 0.5 m above ground level to canopy level. After 24 hours, each trap was removed, placed in a resealable plastic bag, labeled and frozen. The arthropods captured were identified and counted by examining both sides of each trap under a binocular microscope. We quantified the number of flying arthropods in each habitat as follows: [mean arthropods per trap = (total arthropods on all traps/total number of traps)].

BWB-ASF Staff

Pole and ropes used to hang sticky traps in an area without tall trees.

BWB-ASF Staff

Sticky board coated with Tanglefoot®.

Sessile arthropods were captured from 2 m above ground to canopy level (20-35 m above ground) using a modification of the branch clipping method of Johnson (2000). A plastic bag was quickly placed over a randomly selected branch, cinched, and a 0.5 m length of branch was clipped into the bag. The plastic bag was fumigated with Victor® Poison-free Mint pesticide. After the arthropods expired, the clipping was removed from the bag, carefully examined, and all arthropods present on leaves, flowers, and branches were removed and added to the bag. The bags containing the arthropods from each branch clipping were frozen. The arthropods from each clipping were removed from the bag, examined under a binocular microscope and categorized by order.

BWB-ASF Staff

Climbing to the forest canopy to sample arthropods. (2000 photo)

Richard Brodzeller

Cutting a branch clipping to sample sessile arthropods. (2001 photo)

To aid in the identification of arthropods, a reference collection of arthropods from the study site was prepared. We also used several insect reference texts (Borror and White 1970, Barnes 1987, Borror et al. 1989), published drawings, photographs and descriptions of arthropod parts (Ralph et al. 1985).

Sampling the Fruits and Flying Arthropods Available for Birds During Fall Migration

To characterize the fruits that were available as food for birds during fall migration, we sampled the fruits present at the Pewaukee study site based on a modification of the protocol of Stransky and Halls (1980). Eight randomly selected plots were chosen (four in the upland woods and four in the marsh), and the fruits present were sampled three times during the fall migration periods of 2000 and 2001. Fruits were sampled over a five-day period on approximately August 15, September 15, and October 15. The species of fruit were identified and the numbers of ripe, rotten, and unripe fruits were tallied. With this sampling protocol, we were able to summarize information on the fruits present at 298 points throughout the study site.

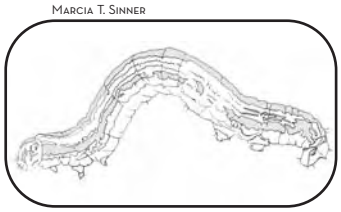
Flying arthropods were sampled using sticky traps as described above. Due to time constraints, sessile arthropods were not sampled during fall migration.

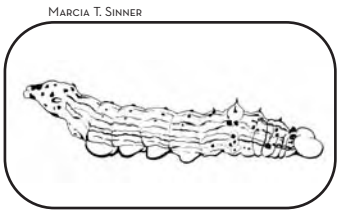
Determining the Diets of Birds During Migration

A number of methods exist to learn about birds' diets. BWB-ASF chose to look at bird fecal samples to prevent any harm to the birds. After birds were captured in mist nets, they were removed and placed in a cloth bag. Birds were removed from the bag, banded, examined and released. In many cases the birds left a fecal sample in the cloth bag, which was removed, placed in a resealable plastic bag, refrigerated and then frozen later in the day.

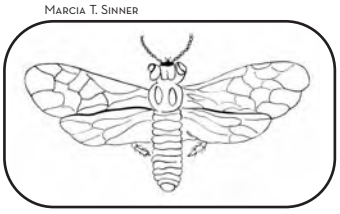
Bird fecal samples were later examined using dissecting microscopes; the amounts and species of identifiable arthropod body structures, fruit pigments, and fruit matter were recorded. To confirm both the identification of each arthropod structure and the arthropod order from which the structure came, we used the Pewaukee study site arthropod reference collection and the resources described above. For reference, permanent slides and photographs were made of the arthropod structures found in the fecal samples. We were able to identify 85 arthropod body structures from 12 arthropod orders and 7 arthropod structures common to several orders in bird fecal samples (manuscript in revision).

Body structures from these arthropods were found in bird fecal samples.

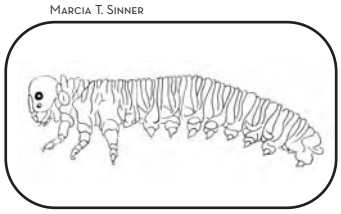




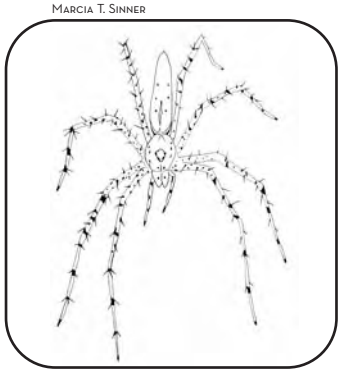
Butterfly and moth caterpillars (larvae of *Lepidoptera*)

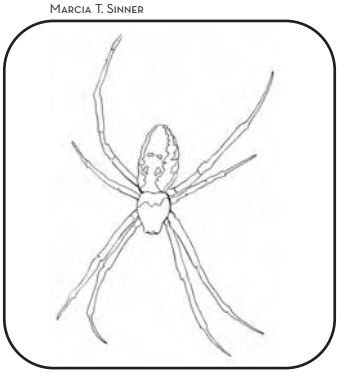


Sawflies (*Hymenoptera*)

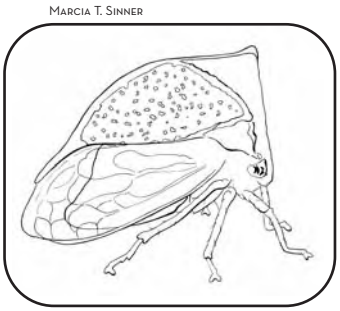


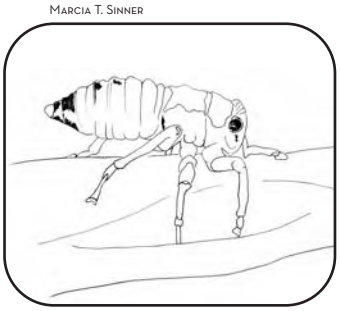
Sawfly caterpillars
(larvae of *Hymenoptera*)



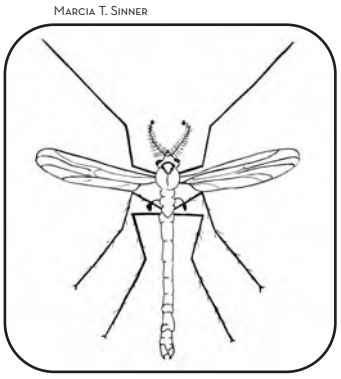


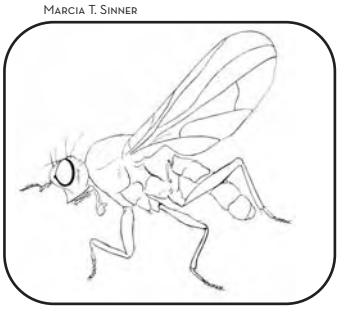
Spiders (*Araneae*)





Leafhoppers, cicadas and aphids (*Homoptera*)





Flies (*Diptera*)

Appendix 4.

BWB-ASF Staff Presentations and Publications

(Abstracts or full text available as PDFs at: www.zoosociety.org/Conservation/BWB-ASF/list.php)

1998

Conference: North American Ornithological Conference, St. Louis, Missouri

Poster: *Modification of point counts to enhance species detectability during the non-breeding season in Belize, Central America*
By V. Piaskowski and O. A. Figueroa

1999

Publication:

Albanese, G. and V. D. Piaskowski. 1999. An inexpensive elevated mist net apparatus. *North American Bird Bander* 24: 129-134.

2001

Conference: Mesoamerican Society for Biology and Conservation Congress, San Salvador, El Salvador

Poster (Spanish): *Birds of the Sibun riverine forest, Runaway Creek Nature Preserve, Belize*
By O. A. Figueroa, W. Martinez, M. Teul and V. Piaskowski
*(This data was further analyzed and was published in *Ornitología Neotropical* 17: 333-352)

Conference: American Ornithologists' Union Meeting, Seattle, Washington

Poster: *Resource sampling of arthropods in all vegetation strata and correlation with arthropods identified in fecal samples of insectivorous warblers at a spring migration stopover site*
By V. Piaskowski and G. Albanese

2002

Conference: Smithsonian Institution Birds of Two Worlds Symposium, Shepardstown, West Virginia

Roundtable discussion: *Cooperative work among scientists of two worlds*
By V. Piaskowski and O. A. Figueroa

Conference: Wisconsin Society for Ornithology Meeting, Ripon, Wisconsin

Presentation: *Conservation contributions of the Birds Without Borders* – Aves Sin Fronteras® *project*
By V. Piaskowski

Conference: Belize and the Wider Caribbean Conference, San Ignacio, Belize

Poster: *Demographics of resident and migratory bird species in central Belize*
By O. A. Figueroa, V. D. Piaskowski, W. E. Martinez and M. Teul
*(This data was further analyzed and was later published in *Caribbean Geography* 13: 69-87)

Conference: Mesoamerican Society for Biology and Conservation Congress, San Jose, Costa Rica

Presentation (Spanish): *Breeding season bird banding in pine savanna habitats in Belize*
By V. Piaskowski, O. A. Figueroa, M. Teul and W. Martinez

Presentation (Spanish): *Conservation of the Jabiru stork (Jabiru mycteria) in Belize*
By O. A. Figueroa, V. Piaskowski and R. Cal

Poster (Spanish): *The breeding biology of the Fork-tailed Flycatcher (Tyrannus savana) in lowland pine savanna habitats in Belize*
By M. Teul, V. Piaskowski, O. A. Figueroa and W. Martinez
*(This data was further analyzed and was later published in *Ornitología Neotropical* 18: 47-59)

Poster (Spanish): *The breeding biology of the Gray-crowned Yellowthroat (Geothlypis poliocephala palpebralis) in lowland pine savanna habitats in Belize*
By W. Martinez, V. Piaskowski, O. A. Figueroa and M. Teul
*(This data was further analyzed and was later published in *Ornitología Neotropical* 15: 155-162)

2003

Publications:

Figueroa, O. A. and G. Albanese. 2003. The nest and eggs of the Mangrove (Maya) Vireo *(Vireo pallens semiflavus)*. *Ornitologia Neotropícal* 13: 437-439.

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Conference: American Ornithologists' Union Meeting, Champaign-Urbana, Illinois
Poster: *Breeding season bird banding in pine savanna habitats in Belize*
By V. Piaskowski, O. A. Figueroa, W. Martinez and M. Teul
Conference: Mesoamerican Society for Biology and Conservation Congress, Tuxtla, Chiapas, Mexico
Poster (Spanish): *The biodiversity of central Belize's Runaway Creek Nature Preserve*
By M. Teul, V. D. Piaskowski, W. E. Martinez and K. M. Williams

2004
Publications:
Figueroa, O. A., W. Martinez, M. Teul, G. Albanese, and V. D. Piaskowski. 2004. Additional notes on eight bird species from Belize. *Cotinga* 21: 31-33.
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2005
Conference: Wisconsin Society for Ornithology/Wisconsin Bird Conservation Initiative Symposium (Neotropical Migrants: Insuring their return) Wisconsin Rapids, Wisconsin
Presentation: *Habitat associations of Neotropical migrants in Belize during the non-breeding season*
By: V. D. Piaskowski, M. Teul, K. M. Williams and R. N. Cal
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Presentation: *The Zoological Society of Milwaukee's conservation efforts in Belize*
By: V. D. Piaskowski, M. Teul, R. N. Cal and K. M. Williams

Publication:
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Publications:
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Piaskowski, V. D., M. Teul, R. N. Cal, K. M. Williams, and D. Tzul. 2006. *The Birds Without Borders* – Aves Sin Fronteras® *Recommendations for Landowners: How to Manage Your Land to Help Birds (Belize and Mesoamerica edition)*. Foundation for Wildlife Conservation, Inc., and Zoological Society of Milwaukee. Milwaukee, Wisconsin, U.S.A.

2007
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Presentation: *Banding in the tropics: Birds Without Borders* – Aves Sin Fronteras® *research in Belize*.
By: V. D. Piaskowski

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Poster: *The Birds Without Borders* – Aves Sin Fronteras® *Project: Involving Private Landowners in Belize and Wisconsin in Bird Conservation*.
By V. Piaskowski, K. Williams, M. Teul, R. Cal, D. Tzul and G. Boese.

Publication:
Piaskowski, V. D., G. Albanese, and K. L. Maute. In revision. Identification guide to arthropod body structures present in the feces of insectivorous wood warblers (Parulidae).

Appendix 5.

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Appendix 6.

Further Background Information on Migration and Nest Success

Migration

Migration Stopover

As described on pages 14-15, most songbirds stop a number of times to rest and feed during migration at stopover sites, or staging areas. The length of time birds stay at stopover areas can vary from one day to several weeks.

Finding suitable stopover sites during migration has profound consequences for a bird's survival (Moore and Yong 1991). The quality of the stopover site affects the bird's ability to find sufficient food, how vulnerable it is to predators and how exposed it is to adverse environmental conditions. Finding suitable spring migration stopover sites also can influence the bird's later reproductive success.

In two studies on the physiology of migration, McWilliams and Karasov (2001) and Karasov (2005) learned that some migratory birds' digestive-tract tissues decrease in both size and function during migration. This occurs in some species that fast while migrating. Upon arriving at a stopover site, these birds need to rebuild their digestive organs. When the organs are rebuilt, the foods that birds eat allow them to gain weight and store additional fat to continue their journey.

What Birds Eat During Spring Migration

(For drawings of some arthropods that birds eat during spring migration, please see pages 15-16.)

During spring migration songbirds eat mainly arthropods (spiders and insects). Birds feed (forage) on flying arthropods or find this food in the developing leaves and flowers of trees and shrubs. Caterpillars (*Lepidoptera* larvae) are the food most commonly eaten by birds that forage on plants (Feeny 1970, Graber and Graber 1983, Thiollay 1988). *Lepidoptera* larvae were the most common food eaten by warblers at the Pewaukee study site in spring (see Appendix 7 for more information).

Birds time their migration so that they arrive when insects are available. In one study, Graber and Graber (1983) found that the spring arrival of warblers in southern Illinois coincided with irruptions of *Lepidoptera* larvae. Studies have shown that birds also eat other types of arthropods. In addition to caterpillars, warblers at the Pewaukee study site fed mainly on *Araneae* (spiders), *Homoptera* (leafhoppers, cicadas and aphids), *Diptera* (flies) and *Hymenoptera* (sawflies, bees, wasps and ants). Other studies have found that birds also eat *Coleoptera* (beetles) and *Hemiptera* (true bugs) (Cooper et al. 1990, Yard et al. 2004). Sealy (1988) observed Cape May Warblers feeding on *Collembola* (springtails).

During spring migration birds can encounter unpredictable and harsh weather conditions and delayed development of vegetation; so birds may move to the edge of water to feed on flying aquatic insects (Ewert and Hamas 1996). Midges and emerging aquatic insects can be a very important early source of food for birds near lakes, coastal marshes and wetlands (Smith et al. 2004, Ewert et al. 2006).

What Birds Eat During Fall Migration

(For pictures of some of the fruits eaten by birds during fall migration please see pages 16-17.)

During fall migration birds supplement their diet with a variety of fruits that grow on both native and non-native plants. Although we list the non-native fruits that a number of researchers have observed birds eating, *please do not plant non-native plants as they can be very invasive and crowd out more beneficial native plants.* The fact that birds have modified their diet to feed on non-native fruits shows how adaptable birds can be. It is not known if non-native fruits provide as much food value as native fruits. Some researchers have found that some birds avoid non-native fruits (Ewert et al. 2006).

The type of fruit that birds eat depends on their bill size and shape, what is available during the migration period and where they stop to rest and feed. (The following information describes bird studies conducted in the eastern U.S.) Suthers et al. (2000) found that the abundance and/or the quality of fruits appeared to be the resource that attracted migrants to specific areas of their study site. They found that migrants ate the fruits of panicled dogwood, red cedar and non-native multiflora rose. Parrish (1997) learned that birds fed on the fruits of northern arrowwood, northern bayberry, and pokeweed but also fed on insects, including *Hymenoptera*, *Diptera*, and *Coleoptera*. Ewert et al. (2006) contacted a

number of researchers and learned that during fall migration birds also feed on gray dogwood, honeysuckle, grape, buckthorns, rough-leaved dogwood, Virginia creeper and mulberries.

At the Pewaukee study site, birds fed on arthropods during fall migration, but some supplemented their diet with fruits. The most commonly eaten fruits were the non-native common and glossy buckthorn; these were also the most abundant at the study site. Birds also fed on a number of other native and non-native fruits. (See Appendix 7 for information on the fruits eaten).

Nest Success

When researchers wish to verify whether a bird is successfully breeding in an area, the best way is to find and monitor nests to determine the outcome. Nests are checked every three to five days to prevent disturbance to the nesting birds. If an event such as hatching or fledging is expected, the nest may be checked every two days. Monitoring continues until the nest fails or until the young fledge (successfully leave the nest). (Please see Appendix 3 for the methods that BWB-ASF used to study nests.)

An estimate of nesting success can be calculated in different ways. A Percent estimate can be calculated for each species as follows: % successful nests = (number of successful nests/total nests found). A more accurate estimate of nest success can be calculated using the Mayfield method, details of which can be found in his publications (1961, 1975). This method takes into account the point in the nesting cycle when the nest was found (e.g., incubating eggs or feeding young). For example, a nest found when the young are almost ready to leave the nest is more likely to succeed than a nest found while eggs are beginning to be incubated. In order to include a nest in Mayfield calculations, it must reach at least the incubation stage, where an adult bird is incubating eggs. For the Mayfield calculations, the number of days that the nest was observed during the incubation and nestling periods and the number of nests lost during those periods are used. Calculations also include the length of the incubation and nestling period for that particular species. The Mayfield nest-success estimate provides a more accurate estimate of a species' nest success than the Percent method. For the Mayfield calculations to be statistically significant, Hensler and Nichols (1981) recommend a sample size of at least 20 nests.

There is little information in the literature regarding the level of nest success required to maintain sustainable bird populations, most likely because many complex factors are involved. However, some authors have tackled the huge job of summarizing the published literature on nest success for different species and written reviews of this information. Nice (1957) summarized 35 published studies on open-nesting (non-cavity) species in which data on at least 30 nests were presented. In her summary, she found that the success of 7,788 nests was 49% using the Percent method.

Ricklefs (1969) analyzed nesting mortality reported in published studies. Because of yearly variation in nesting success, he analyzed studies that continued over longer periods. His analysis included studies in which more than 50 nests were presented, although in some cases he did use data describing fewer nests. Disturbance in the study area can be an important factor in nest success; so he excluded data in his analyses from highly developed areas and included only data from areas that were undeveloped, rural and/or park-like. Ricklefs found that the nest success for open-nesting songbirds ranged from 29% to 87% using the Percent method; however, these values varied widely by species and location. For example, Red-winged Blackbird nest success varied by location, ranging from 23.9% to 61.3%.

Martin (1992) summarized information on nesting success for migratory birds that spend the non-breeding season south of the U.S. border. He included studies that had data on a minimum of 15 nests and information on the causes of mortality. For the 32 species analyzed, he found that nesting success averaged 44% using the Percent method. For 17 of these 32 species where he had sufficient data to calculate Mayfield estimates, he found that nest success was 42%. Based on the 17 species for which he could compare the Percent method to the Mayfield method, he found that the Percent method overestimates nesting success.

Scientists at the Montana Cooperative Wildlife Research Unit have developed a program to gather more standardized data on nesting success for non-game birds (birds that are not hunted). The Breeding Biology Research and Monitoring Database (or BBIRD, Martin et al. 1997) includes standardized protocols in which researchers collect data on bird nests along with very detailed vegetation measurements. Researchers are encouraged to submit their data to this large database so that breeding success and habitats important for successful breeding can be determined using large sample sizes. BWB-ASF submitted breeding bird and vegetation data from our three Wisconsin study sites to the BBIRD program.