

Current Understanding of Aerial Insectivore Population Declines in Canada March 2012 Workshop – Preliminary Summary Report

Aerial insectivore declines and conservation concerns

There is considerable evidence of precipitous, wide-spread declines in many Canadian populations of birds that feed in flight on insects – the Aerial Insectivores (e.g. swallows, swifts, nightjars and some of the flycatchers). Throughout North America, declines in abundance and contractions in breeding range began to appear in the 1990s, and have since become evident in many regions and across many species.

Although the one common trait across all of Aerial Insectivores is their diet of aerial insects, it remains unknown whether their declines do indeed have a common cause, or instead whether individual species or species groups are affected by different factors. Numerous hypotheses for these wide-spread declines have been proposed, including:

- Declines in aerial insect populations, particularly those species important in the diets of Aerial Insectivores on breeding, migration and wintering grounds
- Habitat loss on breeding, migration and wintering grounds (e.g. loss of wetlands and grasslands, changes in agricultural and forestry practices, loss of nesting structures)
- Habitat degradation (e.g. reduced productivity/survival due to changes in the type or timing of food, predation, dispersal, light pollution, interspecific competition, parasites or disease, anthropogenic mortality)
- Environmental contaminants (e.g. acid rain, declines in calcium in wetlands, changes in pesticide uses, heavy metals, increases in flame retardants and uses of endocrine disrupters)
- Changes in weather due to climate change (e.g. drought, increasing frequency of cold and wet periods in the breeding season, hurricane frequency during autumn migration, asynchrony of insect food emergence and breeding diet needs, smog, and availability of food on migration and in winter)
- Other possible issues (e.g. dispersal, human persecution, light pollution affecting insects, incidental impacts of human activities)

Workshop goals

While valuable research on these species has already been undertaken by academic, governmental and non-governmental researchers, there is little direct evidence of specific causes of declines. Given the large number of species affected, and the broad spatial scales and rapid pace of declines, Aerial Insectivore research and conservation represents a challenge best addressed through collaborative efforts.

From 20-22 March 2012, a diverse group of 28 researchers (and 3 remote contributors; see Appendix 1) with experience relevant to understanding Aerial Insectivore declines met at Bird Studies Canada's headquarters in Port Rowan, Ontario. Building on a previous workshop held in Ottawa in March 2009, this meeting provided a scientific forum for considering the potential causes of population declines of Canada's Aerial Insectivores. The goals of this meeting were to (i) provide updates of recent research and monitoring; (ii) examine evidence for links between potential causes of decline and observed population changes; (iii) identify important priority directions for future research on causes and mechanisms of decline, focal research species or species-groups, and collaborative opportunities; and (iv) produce an updated report on the status of our understanding of Aerial Insectivore declines and on research needed to support conservation action.

New information presented

Status and trends

- North American Breeding Bird Survey (BBS) data indicate consistent 30-40 year declines for many species. New analyses of BBS results using hierarchical Bayesian methods suggest that long-term

declines of many Aerial Insectivores may have extended over 40 years. The evidence is ambiguous whether the rates of decline increased in the mid-1980s.

- Breeding Bird Atlas data corroborate declines and range contractions for many species. Initial concern over the extent and rate of Aerial Insectivore population declines in Canada originated largely from the second Ontario Breeding Bird Atlas, which indicated a major decrease in the occurrence of swallows, swift and nightjars between 1981-85 and 2001-05; trends among flycatchers, which feed lower in the air column, were less consistent. More recent data from the Maritimes Breeding Bird Atlas identified similar declines in 11 of 16 Aerial Insectivore species over a 20-year period, with particularly rapid decreases among Bank Swallows, Cliff Swallows, Barn Swallows, Chimney Swifts, and Eastern Kingbirds.
- Migration monitoring data suggest that numbers and condition of migrating birds are lower. Data from the Canadian Migration Monitoring Network also show that more Aerial Insectivore populations across Canada are decreasing rather than increasing, with declines in mean spring body weight in several species, suggesting that the birds may not be meeting their nutritional requirements during migration or winter.
- Rates of decline vary among species. Declines are greater for long-distance than short-distance migrants, suggesting either that conditions have deteriorated for these birds on migration or on the wintering grounds, or that long-distance migrants are more vulnerable to other problems such as a phenological mismatch (i.e. where the timing of key life cycle events, such as breeding, is out of synch with the timing of peak resource availability, such as insect emergence). Declines are generally greatest and more widespread among swallows, swifts and nightjars. Flycatchers, on average, are also declining, although a few species are stable or increasing. Open-country species are declining more than aerial insectivores that inhabit forests.

Changes in vital rates

- Reduced productivity. An intensive Tree Swallow nest-box study in an agricultural landscape in southern Québec supports links between reduced productivity and agricultural intensification. Long-term studies of Tree Swallows highlighted a decline in nesting productivity in Alberta, potentially linked to changing wetland conditions, and a drop in both recruitment and male body condition contributing to reduced abundance at a site in southern Ontario.
- Variation in survivorship. Estimates of apparent survival of adult Tree Swallows varied among years and breeding areas, but geographic patterns remain to be explored, and links to dispersal, insect abundance and wintering ground changes remain uncertain.

Testing hypotheses for declines

- Variation in insect populations. Suction traps from two Canadian locations indicate substantial variation in insect abundance both within and among years, and offer a promising method for directly testing changes in the composition and energetic value of Aerial Insectivores' foraging base. A 40-year study of Tree Swallows at Long Point, Ontario recorded strong fluctuations in both insect abundance and local weather factors, with associated variation in nesting productivity, but did not detect any long-term decline in insects in that area.
- Breeding vs. non-breeding factors. A comparative study of Barn Swallows, Tree Swallows and Eastern Kingbirds at one site in central Ontario between the 1980s and 2011 showed local population declines of two of the three species (excepting Tree Swallow), but provided little support for local breeding-site decline hypotheses (e.g. insect population change, calcium limitation), suggesting that causes may be acting outside the breeding season.
- Breeding site availability. An investigation of Chimney Swift habitat use in Ontario suggested that although artificial towers may not provide an ideal thermal microclimate, many masonry chimneys remain unoccupied, and thus a decline in the availability of breeding habitat (i.e., chimneys) does not appear to be limiting at the moment in this region. Recent surveys of Bank Swallows on Lake Erie also suggested that nesting habitat is not currently fully saturated.
- Other factors. Evidence for stronger declines in several Aerial Insectivores on the Canadian Shield of Ontario, compared to off-shield sites just further south, supports the need for further investigation of

calcium-limitation. Direct evidence of Barred Owl predation on Barn Swallow nests in British Columbia serves as a reminder to consider the influence of predation and increasing raptor populations, at least at the local level. In Québec, some species have shown changes in numbers potentially correlated with broad-scale climate parameters and predator abundance.

Innovative tools to assess declines

- Geolocators. Miniature geolocators that record day break and day-length, and hence latitude and longitude over many months, are now small enough to allow the tracking of migration routes and connectivity in small-bodied birds. Dozens of Purple Martins have already been tracked, and this technology will soon be applied to other Aerial Insectivores, including Barn, Bank and Tree Swallows, Black Swifts, Eastern Whip-poor-wills and Common Nighthawks.
- Stress hormones. Measuring variation in levels of stress hormones (e.g. corticosterone) provides an opportunity to detect potential links between environmental variation and individual performance.
- Stable isotopes and genetic markers. Stable isotopes continue to provide a valuable indication of migratory connectivity, and together with measurement of corticosterone levels in feathers, offer the possibility of isolating key seasonal differences between stable and declining populations. Stable isotopes are now being used in combination with DNA bar-coding to identify historical changes in the trophic-level and insect composition of Chimney Swift diets, based on accumulations of guano within chimney roost sites. Results suggest that diet composition has changed over time, but it is unclear whether this is implicated in population declines.

Recommendations for future research directions

During a full day of group discussions, workshop attendees identified promising future research directions that could contribute to an improved understanding of the mechanisms driving Aerial Insectivore declines. Among the numerous ideas presented, about a dozen priority topics were highlighted as having the potential to address key research questions and to provide particularly valuable insight, and hence merit immediate attention. These include research that can be applied across many species, as well as questions best addressed for specific focal species. They collectively underscore the need both for re-analyses of existing long-term data and for collection of new data using novel approaches and innovative tools.

The following were among the initial research directions identified (subject to final approval of workshop participants), either for multiple Aerial Insectivore species or for specific focal species:

Multi-species studies: Year-round

- Understanding migratory patterns. Enhance understanding of migratory connectivity, identify key habitats used on migration, and relate these to patterns of decline, through geolocator-tracking of individuals from both stable and declining populations and a range of breeding locations. This could build upon the established tracking of Purple Martins and new pilot studies of other focal species currently underway (Barn, Bank and Tree Swallows, Black Swifts, Eastern Whip-poor-wills and Common Nighthawks).
- Investigating impacts of weather. Analyse historical correlations between significant weather events occurring in seasonal habitats (e.g. droughts in Amazon wintering grounds, hurricanes during peak fall migration, or sudden cold-snaps during or in advance of the breeding season) and changes in abundance, age ratios or migration timing (i.e. indices of changes in survival and productivity). Such studies could also incorporate broad-scale weather patterns associated with the El Niño Southern Oscillation events and the North Atlantic Oscillation.

Multi-species studies: Breeding season

- Improving estimates of key demographic parameters. Estimate rates of dispersal and philopatry of both adult and juvenile birds, using tools such as stable isotopes, geolocators, radio-tracking and expanded mark-recapture studies, both to better measure 'true' demographic survivorship (instead of local 'apparent' survivorship) and to identify links among breeding populations (e.g. source-sink dynamics and demographic rescue effects).

- Understanding importance of insect availability. Initiate broad-scale monitoring of key aspects of insect composition, distribution, abundance and phenology across the breeding season, as well as during spring and autumn migration periods, and among years (and/or re-sample historical insect study sites), covering diverse regions and a gradient of latitudes and longitudes, through application of various insect traps designed to sample throughout the air column. Timing and abundance of insect peaks should also be examined in relation to climatic factors, timing of bird breeding, pesticide application and contaminant levels.
- Investigating patterns of decline across species. Overlay maps of breeding distribution and abundance changes across species, in order to identify commonalities in timing of population declines and/or key regions or habitats where declines are steepest.

Multi-species studies: Non-breeding seasons

- Assessing impacts that may affect wintering populations. Overlay wintering distribution and abundance changes across species, in order to identify commonalities in timing of population declines and/or key regions or habitats used by populations that have experienced particularly rapid rates of change. Wintering range overlays that are linked to broad breeding ranges and weighted to population trends will explore possible sources of geographical gradients in population changes on the breeding grounds and consider whether there are particular wintering regions of high research or conservation interest.
- Identifying key locations used outside the breeding season. Locate and evaluate the importance of key roosting and congregation sites during post-fledging, migration and wintering, with particular focus on philopatry to individual sites, habitat change, food supply, and probability of post-fledging mortality. Citizen science (e.g. eBird records), perhaps in combination with weather radar or geolocators, could prove valuable in locating these sites and recording their attributes.
- Investigating changes in migration and potential mismatch with food availability. Undertake a continental-level comparison of changes in migratory and breeding phenology with both local-scale weather and broad-scale climatic fluctuations (similar to broad European phenology studies), to determine whether environmental changes may have altered the timing of migration or breeding, and thus contributed to a mismatch between breeding-season (or migratory season) resource demand and insect food supply.
- Assessing demographic parameters through the annual cycle. Investigate temporal changes in age distribution, sex ratios or morphological measures (e.g. body mass) among migrants in spring and fall, as indices of potential changes in productivity or survivorship during migration, winter or the breeding season.

Focal-species studies

- Tree Swallow population model. Construct a detailed annual life-cycle model for Tree Swallows, incorporating estimates of survival and productivity from all available long-term studies in North America (e.g. via a collaborative Tree Swallow working group). This would enable quantification of the relative importance of different vital rates to population change, and provide for direct evaluation of the effects of conservation measures and environmental changes (e.g. variation in habitat, food supply) on population growth rates across a large number of sites and geographic regions.
- Comparative studies of Tree and Barn Swallows. Build upon existing long-term studies of Tree Swallows (short-distance migrants) and Barn Swallows (long-distance migrants) to establish a comparative study of survival, productivity and abundance between the two species breeding at the same sites, at several locations across Canada and the U.S. which represent both stable and declining populations. Investigate the potential for similar contributions from the Citizen Science network of Purple Martin nest box enthusiasts in the U.S. and Canada.
- Coordinated studies of Chimney Swift foraging and productivity. Examine the diet and foraging behaviour of Chimney Swifts in several breeding areas using direct and indirect methods (e.g. insect bolus collection, nest-cameras, radio-telemetry), to identify food and habitat requirements and links to productivity. Similar studies could be undertaken with some of the other lesser-known Aerial Insectivore species (e.g. nightjars, flycatchers).

- Coordinated nightjar population assessment. Initiate a landscape-scale assessment of the breeding distributions and migratory movements of the nightjars (e.g. Common Nighthawk, Eastern Whip-poor-will) using a combination of existing databases (e.g. atlases, Breeding Bird Survey) and new tools (e.g. geolocators).

Additional research priorities

Many additional research directions were suggested that also merit further attention, such as landscape-scale calcium-limitation studies, continued trials of Chimney Swift nest-site preference (e.g. artificial chimneys or boxes), assessments of pesticide impacts both directly on insectivores and indirectly on populations of forage insect species, and sociological or aerial-photo studies of spatiotemporal changes in barn availability.

Current state of understanding about Aerial Insectivore declines

Whereas earlier attention at the 2009 Aerial Insectivore workshop focused on assessing the influence of specific causes such as predation, pesticides and acid rain, recommendations from the 2012 workshop centred largely around the need for better baseline information on demography, seasonal distribution and resource requirements, and the types of tools that might be used to provide this insight.

Discussions at this meeting also highlighted the need to better understand whether temporal 'break-points' in population trends may have occurred (e.g. in the mid-1980s as suggested by earlier analyses), to enable us to identify the timing of population change. Careful monitoring of current and future trends is equally critical, to determine whether any declining populations have stabilized and thus the extent to which current demographic measures are relevant to interpreting past trend patterns.

The meeting participants agreed that the causes of Aerial Insectivore declines have not yet been ascertained. Current evidence did not permit the complete elimination of any potential causes, but consensus was reached that populations may be impacted by stressors on breeding grounds, during migration, or in wintering areas – or perhaps most likely, some cross-seasonal combination of factors. Participants therefore agreed to focus on assessing changes in key population parameters and vital rates, as well as linkages across the annual cycle, in order to better understand mechanisms of impact and thus to contribute to identification of causes of decline.

Remaining gaps and future collaborations

Although numerous scientific perspectives on Aerial Insectivores were presented at this meeting, it is important to note that some aspects were not fully represented by the workshop attendees. In particular, the lack of direct contributions pertaining to insect population trends, pesticides and contaminants, and potential impacts outside of Canada should be considered when interpreting the conclusions and recommendations presented here. Species coverage focused primarily on those Aerial Insectivores showing the largest declines (especially swallows, swifts and nightjars), with particular attention to species such as Tree Swallow and Barn Swallow which have been the subject of numerous studies. Future consideration of population trends and demographics of flycatchers, for which less information is available, may be instructive, particularly if new data suggest that population drivers may differ for these species.

The collective effort invested in this workshop stimulated valuable focused discussion, developed potential research collaborations, and helped to identify common research themes. The continuation of such information exchange and the expansion of research collaborations will contribute to improved understanding of the causes of declines of Canada's Aerial Insectivores and of potential conservation actions to reverse population declines.

Report prepared by Anna M Calvert

4 April, 2012

Appendix 1. Participants in the workshop “*Current Understanding of Aerial Insectivore Population Declines in Canada*”, held in Port Rowan, Ontario, 20-22 March 2012.

| Name | Affiliation |
|-----------------------------------|---|
| Debbie Badzinski | Bird Studies Canada |
| Marc Bélisle | Université de Sherbrooke |
| Peter Blancher | Environment Canada (Scientist Emeritus) |
| Mike Cadman | Environment Canada (Canadian Wildlife Service - Ontario) |
| Anna Calvert | workshop coordinator (Bird Studies Canada) |
| Alaine Camfield | Environment Canada (Canadian Wildlife Service - HQ) |
| Bob Clark | Environment Canada (Wildlife Research Division) |
| Erica Dunn | Environment Canada (Scientist Emeritus) |
| Richard Elliot | Environment Canada (Wildlife Research Division) |
| Myles Falconer | Bird Studies Canada |
| Charles Francis | Environment Canada (Canadian Wildlife Service - HQ) |
| Kevin Fraser | York University |
| Audrey Heagy | Bird Studies Canada |
| Keith Hobson | Environment Canada (Wildlife Research Division) |
| Geoff Holroyd | Environment Canada (Wildlife Research Division) |
| David Hussell | Ontario Ministry of Natural Resources (retired) |
| Elsie Krebs | Environment Canada (Wildlife Research Division) |
| Dayna LeClair | University of Guelph (MSc student) |
| Oliver Love | University of Windsor |
| Christine Madliger | University of Windsor (PhD student) |
| Nancy Mahony | Environment Canada (Wildlife Research Division) |
| Ally Manthorne | Bird Studies Canada |
| Jon McCracken | Bird Studies Canada |
| Alex Mills | York University |
| Jean-Pierre Savard | Environment Canada (Scientist Emeritus) |
| Adam Smith | Environment Canada (Canadian Wildlife Service - HQ) |
| Elisabeth van Stam | Bird Studies Canada |
| Becky Whittam | Environment Canada (Canadian Wildlife Service - Atlantic) |
| <i>Remote contributors</i> | |
| Fran Bonier | Queen’s University |
| Fiona Hunter | Brock University |
| Joe Nocera | Trent University/Ontario Ministry of Natural Resources |