Surveying for bird carcasses resulting from window collisions: a standardized protocol

Stephen B. Hager[1] **and Bradley J. Cosentino**[2]

[1]**Department of Biology, Augustana College, Rock Island, Illinois, United States of America**
[2]**Department of Biology, Hobart and William Smith Colleges, Geneva, New York, United States of America**

ABSTRACT

Collisions with building windows are thought to be a significant source of mortality for urban birds. Past studies on bird-window collisions have used a variety of survey methods to estimate the magnitude of mortality, and few have constructed methods in light of the biases related to scavengers and worker abilities that lead to imperfect detection of carcasses. Adoption of a systematic carcass survey protocol in future studies would reduce site-specific biases and among-site survey variability, which in turn would improve the accuracy of mortality estimates at all scales. We present here a standardized carcass survey protocol that serves two basic functions: (a) it is simple and inexpensive to implement, and (b) it accounts for the removal of carcasses by scavengers and detection of carcasses by field workers. Consistent with these goals, we added a variety of approaches with particular aspects of the protocol for researchers to chooose from depending on the goals of their study. The following topics are addressed in the protocol: 1. Preparing for surveys, 2. Supplies, 3. Frequency of surveys throughout the study, 4. When during the day to complete surveys, 5. Field worker behavior during surveys, 6. The pre-survey carcass 'clean-up', 7. How to conduct carcass surveys, 8. Carcass collection and containment, 9. Identifying species of bird carcasses, 10. Data collection and management, and 11. Duration of carcass surveys.

Keywords: Survey Methodology, Bird Carcasses, Carcass Persistence, Carcass Detection, Bird-window Collisions, Avian Mortality, Urban Ecology

INTRODUCTION

Collisions with building windows are thought to be a significant source of mortality to birds in urban landscapes (Klem, 1989; Bayne et al., 2012; Hager et al., 2013; Machtans et al., 2013; Loss et al., 2014). Much of our understanding of bird-window collisions has been generated from studies that range from incidental mortality observations to those employing systematic sampling and that also accounted for the biases (e.g., scavenging of bird carcasses) that lead to imperfect detection of carcasses (Loss et al., 2014). Widespread adoption of a systematic carcass survey protocol in future studies would reduce site-specific biases and among-site survey variability, which in turn would improve the accuracy of mortality estimates at all scales. This is especially important for large-scale studies interested in understanding how the magnitude of mortality varies among regions and among the species vulnerable to hitting windows.

We present here a standardized carcass survey protocol that is relatively simple in its design and use, and that is widely applicable across sites and conditions. Its simplicity is derived from the fact that, with the proper training, anyone can use it to effectively document bird carcasses resulting from window collisions. Moreover, supplies and equipment are inexpensive. Applicability of the protocol stems from recent research assessing bird carcass detection next to buildings in urban landscapes (Hager et al., 2012, 2013). Thus, it reduces bias associated with imperfect detection of carcasses due to the effects of scavengers and field worker abilities. In addition, the protocol follows Fair et al. (2010) for recommendations on collecting procedures of bird carcasses.

Evaluating the Effectiveness of the Protocol

An early version of the protocol was successfully used by Hager et al. (2013) to assess the factors influencing bird-window collisions in an urban landscape in northwestern Illinois, USA. Since that study, we have made several minor improvments, such as requiring two passess around each study

building in opposite directions so that field workers visualize the study area from multiple perspectives. The protocol presented here includes these improvements and is currently being used by approximately 50 sites to assess the drivers of bird-window collisions across North America (for details, see https://sites.google.com/a/augustana.edu/eren-bird-window-collisions-project).

THE CARCASS SURVEY PROTOCOL

1. Preparing for Surveys

a. Before bird carcasses can be documented and collected, researchers must establish the goal(s) of the research project related to bird-window collisions. In addition, all birds that die from window collisions are protected by law, and researchers will need to secure any necessary carcass collecting permits from federal, state, and local agencies. Information on Federal 'Salvage Permits' (which allow one to legally salvage bird carcasses) may be found online through the United States Fish and Wildlife Service. Rules and permitting regarding carcass collection vary among states. State and local wildlife agencies will have information about bird-carcass collection permits. For example, in Illinois, the Department of Natural Resources handles all permitting, and one must have a 'Scientific Collecting Permit' to collect bird carcasses resulting from window collisions. Researchers may also need to acquire approval by their campus Institutional Animal Care and Use Committee (IACUC) to study bird-window collisions. The processing time for permits and IACUC approval will take about three months.

b. Select study buildings according to the goals of the research project. You must obtain permission from all building owners/operators before walking on their property and searching for bird carcasses.

c. Create a map of the study area depicting the names and locations of study buildings. Print hard copies for workers to take in the field.

d. Create a data sheet in a word processor and print enough hard copies for field workers to use in the field (see File S1 for a carcass survey data sheet template).

e. Train all field workers. Searching for bird carcasses along the perimeter of buildings is not difficult. However, workers that do not have experience looking for and systematically documenting dead birds must be trained prior to the start of official carcass surveys. Training naive workers: (1) provides valuable hands-on field experience with the survey protocol and (2) maximizes the chances that field workers within and among research projects are documenting bird carcasses in the same way, i.e., according to the protocol.

Training field workers should include:

- how to search for dead birds along the edges of study buildings
- example pictures bird carcasses on the ground and on various types of ground cover
- how to safely handle carcasses
- how to record data on data sheets in the field
- how to document dead birds with photographs
- how to organized and secure data sheets so that the data collected are not lost

If interested, researchers may visit a webpage that functions as part of a carcass survey training workshop at Augustana College: https://sites.google.com/a/augustana.edu/carcass-survey-materials.

f. Distribute zip lock (sandwich) carcass bags to field workers. One box each of small (for small carcasses) and large (for large carcasses) bags should be enough for one season.

g. Prepare simple and organized field binders or clip boards for use by field workers (Fig. 1). All workers should bring these items into the field each survey-day: (a) hard copies of survey data sheets (see Article S1), (b) field carcass survey information sheet (see Article S2), and (c) bird carcass identification tags (see Article S3).

2. Supplies and Equipment

The following supplies and equipment should be used by field workers completing carcass surveys.

a. Digital camera (or cameras in smart phones / tablets).

b. Scissors.

c. Field binder or clipboard with building map(s), data sheets, and carcass identification tags.

d. Zip lock (sandwich) body bags: small and large.

e. Plastic grocery bag to temporarily carry carcasses found during surveys.

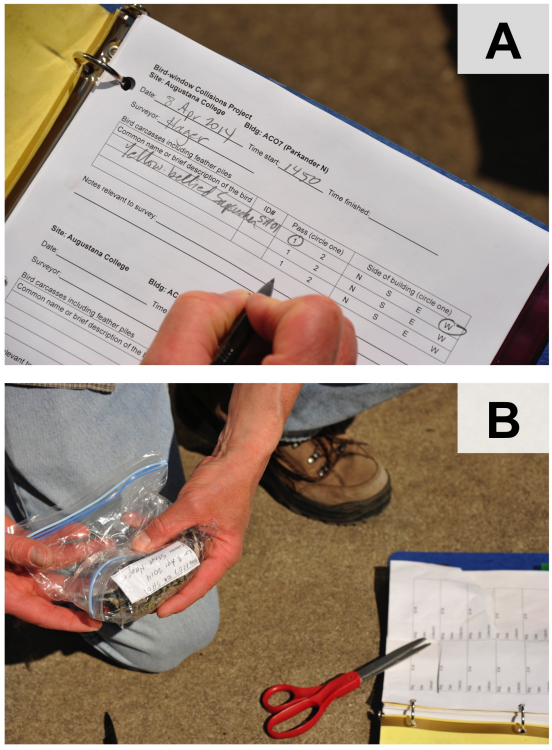

Figure 1. Binder containing (A) data sheets and (B) carcass identification tags.

3. Frequency of Surveys Throughout the Study

The frequency of carcass surveys for a study should be determined in light of evidence indicating how long carcasses persist at a site once they are introduced in the field. Previous research in the upper Midwestern United States suggests that bird carcasses remain undisturbed by scavengers for a minimum of three days (Hager et al., 2012). Thus, researchers may wish to complete carcass surveys at intervals of three days.

However, scavenger communities vary regionally, which may introduce variation in the persistence times of carcasses (Hager et al., 2012). Given this, researchers may wish to customize the survey interval for their site in one of two ways. First, they could assume that carcass persistence is less than 3 days and simply opt to conduct daily consecutive surveys. Daily consecutive surveys would reduce the effects of imperfect detection resulting from scavenger removal of carcasses (Hager et al., 2012). It should be noted that if some event, e.g., severe weather, a field worker who is ill, etc., prevents fieldwork for a day during the official survey period, then surveys should be resumed the following day (see "6. The Pre-survey Carcass 'Clean-up'" below). Unfortunately, the next survey-day cannot count toward overall total and must be considered another clean-up survey. Again, the clean-up survey reduces detection bias on the first day of official sampling.

Second, rather than working under the assumption that carcass persistence is less than 3 days, researchers could determine the most appropriate carcass survey interval for a site by conducting a scavenger study that provides estimates of carcass persistence. See Hager et al. (2012) for an example of how one might assess carcass persistence.

4. When to Complete Surveys During the Day

Knowing when to conduct surveys during the day comes from two forms of information: (1) evidence of when collision mortality is highest and lowest within a 24-hour period, and (2) how long carcasses persist throughout the daylight hours.

Our current understanding of the daily timing (i.e., a 24-hour interval) of collisions suggests that mortality is highest between sunrise and early afternoon and lowest from late afternoon to sunrise the next day (Klem, 1989). Data on carcass persistence in the upper Midwest suggests that most scavenging occurs at night (Hager et al., 2012). Given these patterns, carcass surveys should be done in the mid- to

Figure 2. An arms length (nearly 2 meters) extending from the edge of study buildings is a good approximator of the width of the carcass survey transect.

late-afternoon hours to have the best chances of finding carcasses if they are present.

Alternatively, researchers may want to survey for carcasses at the most appropriate time for their study location. If this option is pursued, there are two important pieces of information to consider. First, not all birds are equally vulnerable to hitting windows (Hager et al., 2013; Loss et al., 2014), and variation in bird community structure among regions likely leads to regional variation in the daily timing of collision mortality. Unfortunately, assessing when collisions happen during the day is logistically difficult, and time and labor intensive.

Second, the daily timing of carcass removal may also be variable across regions that have unique assemblages of scavenger species. For example, gulls (*Larus* spp.) were observed to remove stunned and dead birds resulting from window collisions in the morning daylight hours in downtown Toronto, Canada (Evans Ogden, 1996). In addition, humans (such as landscape personnel or custodial staff) may act as 'scavengers' by intentionally or unintentionally removing carcasses around buildings anytime during the day.

Unlike assessing the daily timing of mortality, it would be more logistically feasible for researchers to assess the actions of scavengers throughout a 24-h period to gain site-specific information on carcass persistence. This can be done over the course of 2-3 days by randomly placing bird carcasses (e.g., 1 carcass/building) at study buildings, then monitoring the persistence of those carcasses at intervals of 2 hours beginning at sunrise. Knowledge of the persistence of carcasses throughout the day would provide valuable insight into when carcass surveys should be completed.

5. Field Worker Behavior During Surveys

Field workers must respect the privacy of all building occupants while conducting carcass surveys. They should remain quiet and never peer into the windows of buildings. There should be a 'zero-tolerance' policy for workers that fail in this regard.

Field workers are prohibited from using mobile devices (cell phones, tablets, etc.) for texting, Internet use, or phone calls. Use of mobile electronics during surveys will reduce a worker's ability to detect carcasses. If a text or call must be taken, then field workers should stop surveys, be brief, and resume carcass searches when finished.

Field workers should handle carcasses according the protocol below (see "8. Carcass Collection

and Containment"). If interested, the following link is a YouTube video that demonstrates this protocol: https://www.youtube.com/watch?v=uu3rvJCdkYQ.

6. The Pre-survey Carcass 'Clean-up'

The day before the first official survey day, researchers should complete carcass surveys around all buildings as described in "7. How to Conduct Carcass Surveys" found below. Data sheets should be filled out and carcasses identified to species, if at all possible. This information should not be included in analyses of mortality rates because carcasses may persist at sites for variable periods of time. Variation in the number of carcasses found at sites may be due to variation in mortality, or it may be due to variation in scavenging pressure. Removing carcasses before official surveys allows researchers to be reasonably certain that any carcasses found on day 1 of the official survey period resulted from a window collision within the previous 24-hour period. Carcasses found during 'clean-up' surveys may still provide helpful information related to other objectives, e.g., determining types of species that are susceptible to collisions.

If some event, e.g., severe weather, a field worker who is ill, etc., prevents fieldwork for a day during the official survey period, then surveys should be resumed the following day. Unfortunately, the next survey-day cannot count toward overall total and must be considering another 'clean up' survey. Again, previous research has shown that daily, consecutive surveys reduce bias associated with imperfect detection more than surveys completed with larger time intervals.

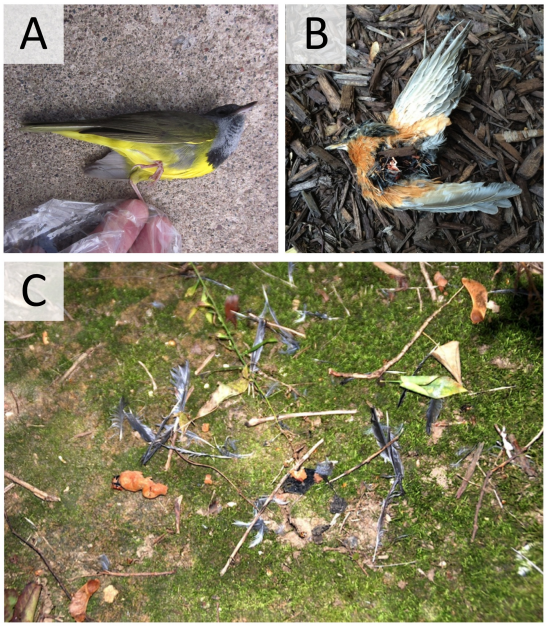

Figure 3. Condition of bird carcasses encountered in the field. (A) Whole and intact (Mourning Warbler), (B) less than whole and much of the soft tissue missing (American Robin), and (C) feather piles (Gray Catbird), which are formed by scavengers and decomposers, that contain bundles and single feathers from the wings, chest, and tail. Some piles may contain body parts (wing, tail, and legs) and small pieces of uneaten soft tissue (e.g., viscera). Feather piles are confined to a roughly circular area with a diameter of up to around 50 cm and would be expected to persist in the same spot for at least 24 hours.

7. How to Conduct Carcass Surveys

This section describes how field workers should search for and document bird carcasses around study buildings.

a. The width of the survey transect from a building's wall is 2 meters, or just beyond width of one's arms held out horizontal to the ground (Fig. 2). All bird carcasses found within this transect are assumed to have arisen from window collisions. The condition of bird carcasses in the field may range from whole, intact bodies (Fig. 3A) to partial carcasses, which contain most of the body (Fig. 3B). Carcasses can be further reduced to little more than a circular collection of feathers, so-called 'feather piles', by

scavengers and decomposers (Fig. 3C). A carcass in any of these forms is detectable and evidence of window collisions.

b. We suggest that field workers make two independent passes around each study building. This recommendation is based on a previous study showing that the probability of a field worker detecting a carcass on a single pass can be as low as 0.7 (Hager et al., 2013).

Two methods can be used to make multiple passes around a building. First, a single worker may make the two passes. We suggest that the first and second passes be made in opposite directions so that the worker visualizes the study area from multiple perspectives. Upon finding a bird carcass, a field worker should remove it and identify the pass in which it was found, pass 1 or pass 2. Second, two workers can each make a single pass around a study building at the same time, with each worker walking in opposite directions. To ensure that searches performed by each field worker at a building are independent, workers should not communicate about the outcome of the search (i.e., finding or not finding carcasses) until the survey is completed. Each worker should note all carcasses during the survey but left in place until after the survey is completed. Once both observers have completed searching, the workers should record (1) the number of carcasses found by each observer, and (2) the total number of independent carcasses found at the site. Carcasses can be removed after both observers have independently searched the site. More passes may be completed to ensure that carcasses are detected.

If you have information on the probability of detecting a carcass on a single pass, the cumulative probability of detecting a carcass in multiple passes (P_c) can be quantified as $P_c = 1 - (1 - P)^N$, where P is the average detection probability during a single pass and N is the number of independent passes made. Note that multiple passes by a single observer may not be statistically independent. See Supplemental Information Text S1, Figure S1, and Table S1 in Hager et al. (2013) for methods on how to estimate detection probability for each worker.

c. Search the top, inside, and on the ground around all shrubs that are located within the survey transect. Sift thoroughly within thick ground cover, such as ivy. Make sure to search completely around and under trashcans (Fig. 4).

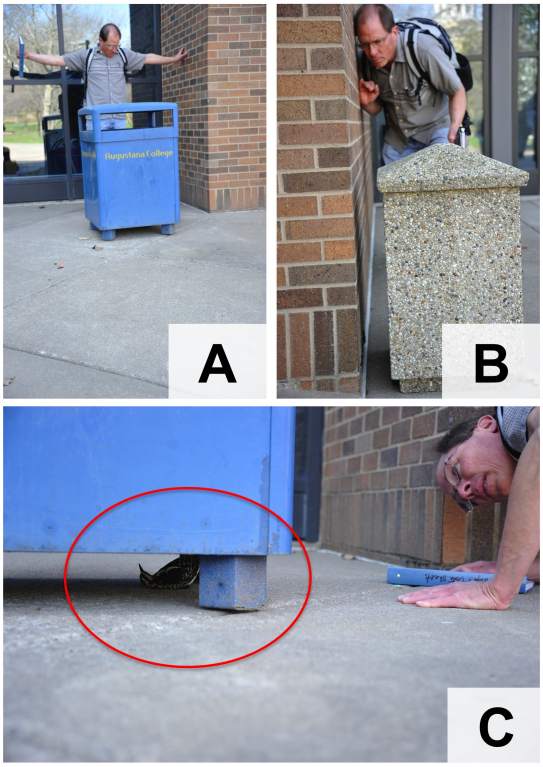

Figure 4. Search for carcasses in all structures that lie within (A) the survey transect at the edge of buildings. This includes woody vegetation, (B) around cigarette butt receptacles and (C) under trashcans.

8. Carcass Collection and Containment

Collecting bird carcasses resulting from window strikes is relatively safe in terms of heath concerns, e.g., pathogens and parasites, to field workers. The following procedures are recommended to contain bird carcasses with minimal exposure to humans.

a. Immediately after a complete or partial carcass (e.g., feather pile) is found, field personnel should invert a zip lock plastic bag (sandwich bag) and use this bag as 'gloves' to manipulate the carcass into the various positions for photo documentation (Fig. 5).

Figure 5. Field worker approaching a bird carcass during a survey and using an inverted zip lock bag as a glove to position the bird for photo documentation. Note smartphone camera in left hand of the field worker.

b. Take one picture each of the bird's ventral, dorsal, and lateral aspects for identification purposes (Fig. 6).

c. If a partial carcass is found (e.g., Fig. 3B and 3C), field workers use the same protocol as above except take only one picture.

d. After pictures are taken, workers should grab the carcass (or all feathers in the case of feather piles) with the inverted zip lock and reverse the bag over the carcass to establish the bag's original position (Fig. 7). Zip the bag shut and place it in another zip lock bag so that the bird is 'double-bagged'. Workers should carry bagged carcasses in a plastic grocery bag until the end of the survey-day (less than 3 hours), at which time they will be placed in a Biohazard Bag and stored in a laboratory freezer.

Any carcasses not identified immediately in the field will be removed from the freezer and examined under a laboratory fume hood and, using the inner zip lock bag as a 'glove', position it for inspection of species-specific characters. After identification in the laboratory, carcasses will, again, be double-bagged as before and stored in Biohazard bags in the freezer. Researchers may want haz-chem personnel to take custody of carcasses in Biohazard Bags for later incineration. Alternatively, researchers may keep carcasses for other purposes, e.g., study skin preparation for final deposition in museums, etc.

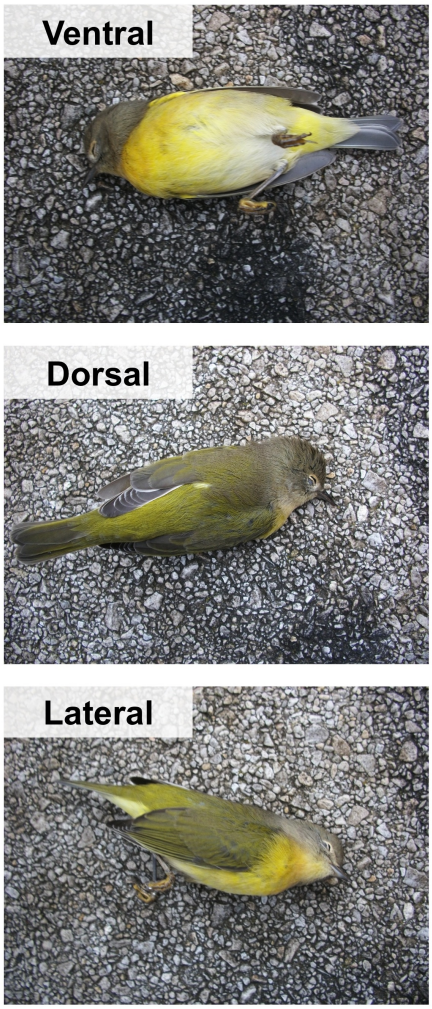

Figure 6. Nashville Warbler carcass found at Augustana College. It may have been difficult to identify this bird without views from all three orientations since at just one orientation this species may resemble other warblers, including Mourning Warbler, Yellow Warbler, Orange-crowned Warbler, Wilson's Warbler, and Common Yellowthroat.

9. Identifying Species of Bird Carcasses

Researchers should identify all bird carcasses to species, if at all possible. Another advantage of conducting daily consecutive surveys is the nearly all carcasses found will be whole, intact birds that are amenable to identification. Of course, some species and species groups will remain difficult, if not impossible, to identify without vocalizations, such as the *Empidonax* flycatchers.

a. Useful hard copy identification guides:
- *National Geographic Field Guide to the Birds of North America*
- *The Peterson Field Guides* to birds of Western and Eastern North America
- *The Sibley Field Guides* to birds of Western and Eastern North America
- *Identification Guide to North American Birds* (Pyle, 1997)

b. Useful online resources:
- *All About Birds*, http://www.allaboutbirds.org (free)
- *The Birds of North America*, http://bna.birds.cornell.edu (paid subscription only)

10. Data Collection and Management

This section explains how data should be collected in the field and later uploaded to an online database for data security and management.

Figure 7. From top left to bottom right, a field worker demonstrating how to safely collect and contain a bird carcass and how to include carcass identification tags with the carcass.

a. Field workers should complete hard copy data sheets (see "1. Preparing for Surveys") in the field immediately after each survey of each building (Fig. 8).

NOTE: Data sheets must be completed whether or not bird carcasses are found at buildings. Data on carcass surveys that result in no bird carcasses is important information and is consistent with best practices for conducting research on bird-window collisions (Loss et al., 2014).

b. It is recommended that survey data be uploaded to an online database immediately after field work. Use of online databases secures the field data collected and automatically organizes it for supervisors.

One online database that works well is 'Google Forms', which is one of the products available through Google Drive (https://drive.google.com). It is relatively easy to create a Google Form, and the data submitted for each form automatically populate a Google Spreadsheet (another product of Google Drive). An example of a Google Form used for a project on bird-window collisions at Augustana College is found at: https://docs.google.com/forms/d/1xe4rCn9wMrALr9TSBAgoeF-ZC2gxYbn0inxzLvrfVR8/edit?usp=sharing.

NOTE: Project personnel must have Google accounts in order to use Google Drive and its associated products, such as Google Forms.

c. In addition, it is recommended that field workers upload pictures of all carcasses documented for a day to an online photo-hosting site at the end of carcass surveys. Google Folders (yet, another product available through Google Drive) work well here, too. Use of an online photo-hosting site secures the pictures taken and automatically organizes them for supervisors. In addition, supervisors may look at pictures remotely and identify carcasses to species, although direct examination of a carcass may be necessary if bird identification is not possible from pictures.

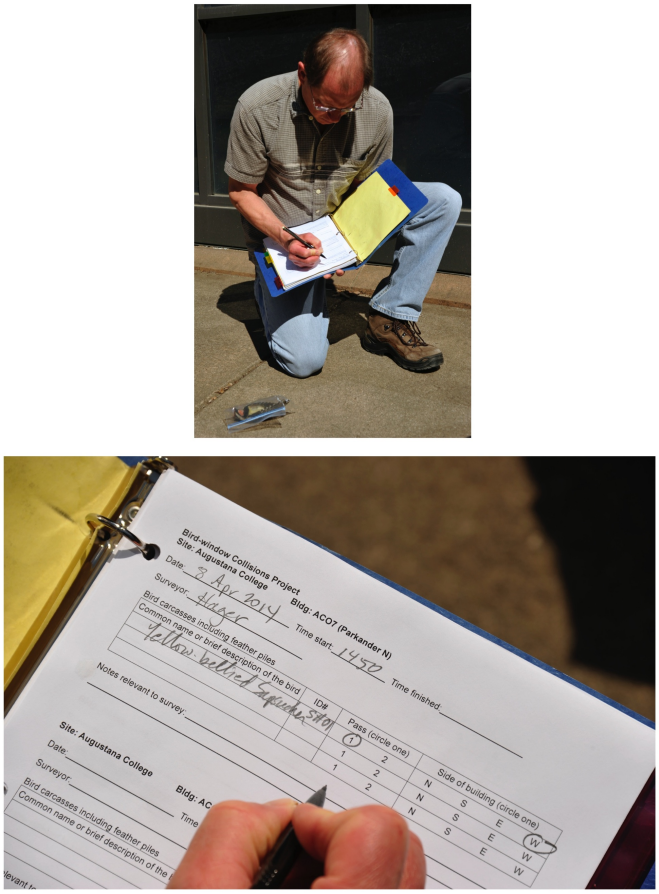

Figure 8. A field worker filling out data sheets after carcass selection and at the end of a building survey.

11. Duration of Carcass Surveys

The amount of time required to complete one building survey (i.e., 2 full passes around a building) varies with the size of the building and whether or not carcasses are found.

If no carcasses are found, it takes roughly 5 minutes to survey a small 2-story house with 1,500 squared feet of living space. In contrast, a full survey around a 5-story low-rise commercial building (8,500 squared feet) will take about 30 minutes.

Researchers will need to add 5-7 more minutes for each bird carcass documented regardless of building size.

After all data are collected in the field, it will take workers another 12-15 minutes to (1) upload data to an online database, and (2) upload any digital photos to a photo-hosting site.

ACKNOWLEDGMENTS

The Ecological Research as Education Network (http://erenweb.org) helped us organize collaborators who are using this protocol to assess the drivers of bird-window collisions across North America. We thank Dr. Brian Tugana for photo-documenting parts of the carcass survey protocol.

REFERENCES

Bayne, E. M., Scobie, C. A., and Rawson-Clark, M. (2012). Factors influencing the annual risk of bird–window collisions at residential structures in alberta, canada. *Wildlife Research*, 39(7):583–592.

Evans Ogden, L. J. (1996). Collision course: the hazards of lighted structures and windows to migrating birds.

Fair, J. M., Paul, E., Jones, J., and Council, O. (2010). *Guidelines to the use of wild birds in research*. Ornithological Council.

Hager, S. B., Cosentino, B. J., and McKay, K. J. (2012). Scavenging affects persistence of avian carcasses resulting from window collisions in an urban landscape. *Journal of Field Ornithology*, 83(2):203–211.

Hager, S. B., Cosentino, B. J., McKay, K. J., Monson, C., Zuurdeeg, W., and Blevins, B. (2013). Window area and development drive spatial variation in bird-window collisions in an urban landscape. *PloS one*, 8(1):e53371.

Klem, D. (1989). Bird-window collisions. *Wilson Bull*, 101(4):606–620.

Loss, S. R., Will, T., Loss, S. S., and Marra, P. P. (2014). Bird-building collisions in the united states: Estimates of annual mortality and species vulnerability. *The Condor*, 116(1):8–23.

Machtans, C. S., Wedeles, C. H., and Bayne, E. M. (2013). A first estimate for canada of the number of birds killed by colliding with building windows première estimation canadienne du nombre d'oiseaux morts par collision avec les fenêtres de bâtiments. *Avian Conservation and Ecology*, 8(2):6.

Pyle, P. (1997). Identification guide to north american birds slate creek press. *Bolinas CA*.