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Bird consumption of sweet and tart cherries

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Abstract: Identifying species responsible for crop damage is an important first step in developing management strategies. Previous studies have surveyed bird species flying through cherry orchards but have not documented which species were consuming cherries. We conducted traditional surveys and behavioral observations in orchards of sweet cherries (*Prunus avium*) and tart cherries (*Prunus cerasus*) in Michigan during 2010 to compare results from the 2 techniques. American robins (*Turdus migratorius*) were detected most frequently during sweet cherry surveys, while behavioral observations showed that cedar waxwings (*Bombycilla cedrorum*) consumed more sweet cherries than did robins. Chipping sparrows (*Spizella passerina*) were the most commonly detected species during tart cherry surveys, while observations showed that American robins and common grackles (*Quiscalus quiscula*) consumed the most tart cherries. Although observational work is more labor-intensive than surveys, observations are more likely to provide accurate information on the relative importance of fruit-consuming species.

***Key words*:** American robin, birds, cedar waxwing, fruit consumption, human–wildlife conflicts, Michigan, sweet cherries, tart cherries

Loss of fruit crops to birds is a significant problem (Virgo 1971, Dolbeer et al. 1994, Simon 2008). In addition to outright consumption, birds damage fruit, leading to reduced quality and increased susceptibility to pests and pathogens (Pritts 2001). Cherry losses in Michigan were reported at 17% several decades ago (Stone 1973). Equivalent and higher losses have been reported in other studies for sweet cherries (*Prunus avium*) and tart cherries (*Prunus cerasus*; Guarino et al. 1974, Tobin et al. 1991, Curtis et al. 1994).

Bird-induced losses can have profound economic impacts for cherry growers. The top 10 cherry-exporting nations produce a collective annual yield valued at greater than $1 billion (Food and Agriculture Organization of the United Nations 2007). The costs associated with bird damage in just 7 states in the United States were estimated in the tens of millions of dollars annually, both in actual fruit losses and efforts to deter birds (U.S. Department of Agriculture 1998). Despite these costs, research to address the issue of bird damage to fruit has been limited (e.g., Stone 1973, De Grazio 1978, Avery et al. 1993, Berge et al. 2007, Conover and Dolbeer 2007) and piecemeal, hindering the systematic development and evaluation of effective bird management techniques.

Critical components of wildlife damage control programs include identifying the species causing the damage and understanding the ecology of the problem species (Dolbeer et al. 1994, Tracey et al. 2007). In this study, we documented the different bird species consuming cherries, as well as characteristics of their foraging behavior in orchards. Previous studies to identify bird pests on cherries utilized surveys of birds flying into orchards or perched on fruit trees (Guarino et al. 1974, Tobin et al. 1991, Curtis et al. 1994). A limitation of these studies is that they simply documented the presence of a species in an orchard and did not quantify actual damage to the fruit caused by each species. Assessing the amounts of fruit consumed by different bird species by actually observing birds' foraging behavior is a critical first step in developing effective bird management techniques (Virgo 1971, Boudreau 1972, Tourenq et al. 2001). The objectives of our study were to: (1) compare results from traditional bird surveys and behavioral observations with regard to the impact of different bird species on cherries; and (2) document components of foraging behavior, including group size and location of birds within trees that may influence fruit damage levels and guide development of management techniques.

Study area

The study was conducted in 4 tart and 5 sweet cherry orchards in Leelanau County, Michigan, during the summer of 2010. All of the orchards were under conventional management regimes for insect and disease control throughout the study. The orchards did not have bird deterrent techniques in place, with the exception of American kestrel (*Falco sparverius*) nest boxes that were mounted in, or immediately adjacent to, four of the orchards. Kestrels may deter birds from orchards because they occasionally take birds as prey (Smallwood and Bird 2002), although their impact on bird damage levels has not been rigorously tested and was not the focus of the present study.

Two techniques were used to assess bird activity in orchards. Surveys, similar to those used in previous studies, occurred between 0630 and 0700 hours when observers moved slowly through orchards and recorded all birds observed in cherry trees. The second technique, behavioral observation, was conducted between 0700 and 1030 hours and between 1800 and 2000 hours. During the observations, observers walked through orchards searching for birds. When a bird was detected in a cherry tree, the observer kept the bird in sight for as long as possible and recorded the number of cherries eaten or damaged (hereafter, consumed) by the bird, the number of conspecifics in the same tree during the observation (i.e., group size) and whether the bird foraged in the top or bottom half of the tree canopy. When the bird flew from the tree or was lost from sight, that observation ended, and the observer began to search for another bird. The low height of most trees (<5 m) and the relatively open nature of the orchards and foliage within trees made observations relatively easy to conduct. Birds foraging in the interior of trees were somewhat more difficult to observe than those foraging on the ends of branches. However, observers were still able to record their foraging behavior. We divided the number of cherries consumed by the duration of the observation time to calculate the number of cherries consumed per minute.

Surveys took place before behavioral observations and, so, could have influenced observations. Birds sometimes flew to another tree in the same orchard when humans walked by but rarely left the orchard altogether. Given this minor response to humans, we do not believe surveys strongly influenced results from behavioral observations.

The total size of the orchards used for surveys and observations were 4.0 ha for sweet cherry orchards (n = 5; range = 0.6–1.1 ha) and 2.3 ha for tart cherry orchards (n = 4; range = 0.2–0.8 ha).

We conducted surveys from June 15 to July 9, 2010, and behavioral observations from June 2 to July 9, 2010, for sweet cherries and from June 14 to July 9, 2010, for tart cherries. Early observations focused on sweet cherries because they ripen earlier than tart cherries, and earlier-ripening fruits suffer the greatest bird damage (Tobin et al. 1991). June drop, the point at which cherry trees abort fruits that will not mature, began approximately June 14, 2010. After June drop, the remaining fruit ripens rapidly. We conducted 9 hours of surveys and 119 hours of behavioral observations in sweet cherries and 7 hours of surveys and 57 hours of behavioral observations in tart cherries.

Data analysis

Data for group size and the number of cherries consumed per minute did not meet the normality assumption necessary for ANOVA. Therefore, we used non-parametric Wilcoxon 2-sample tests to make pair-wise comparisons of group size and cherries consumed per minute for the 3 species most commonly observed consuming sweet cherries: cedar waxwings (*Bombycilla cedrorum*), American robins (*Turdus migratorius*), and common grackles (*Quiscalus quiscula*). We used group-size data only from observations during which ≥1 cherry was consumed. Data from very short observations resulted in high numbers of cherries consumed per minute. For example, 1 bird observed for only 2 seconds consumed 1 cherry, which resulted in a value of 30 cherries consumed per minute. Because birds observed for a minute or more never showed such a rate of consumption that high, we used observations only where birds were observed for ≥1 minute in the species comparisons of cherries consumed per minute. We report means ± SDs.

Orchard characteristics

We gathered information on basic orchard characteristics from owners or managers (Table 1). To quantify percentages of land-cover types around the orchards, we used data from the 2010 Michigan Cropland Data Layer for Leelanau County, Michigan (U.S. Department of Agriculture 2010), which incorporates a 2010 census of 53 crop types with non-crop land cover data from the 2001 National Land-cover Database (Homer et al. 2007). Orchards were spatially identified using GPS coordinates of a single position within each orchard. We created a 300-m buffer zone around each of these positions. Twenty land-cover classes were identified in the buffer zones ,including 10 crop and 10 non-crop classes. Land-cover class areas within the buffers were tabulated using the Spatial Analyst Tool in ArcMap (Environmental Systems Research Institute 1999–2010) and were converted to percentages of total buffer area. We report the land-cover types comprising at least 80% of each buffer (Table 1).

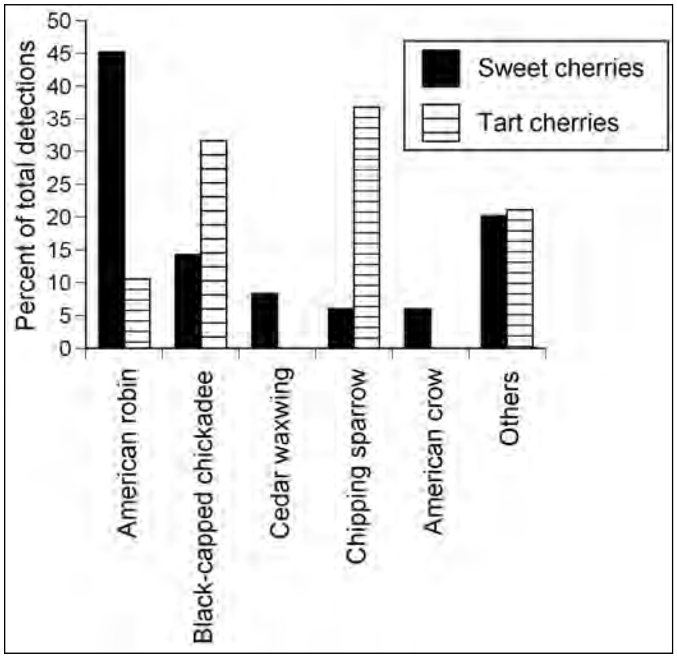

Figure 1. Percentage of total detections of various bird species detected during surveys in sweet and tart cherry orchards in Leelanau County, Michigan, 2010.

Results

Survey detections

We observed 13 bird species during the surveys conducted in orchards of sweet cherries: American robins (*Turdus migratorius*), the most commonly detected; black-capped chickadees (*Poecile atricapillus*); cedar waxwings (*Bombycilla cedrorum*); chipping sparrows (*Spizella passerina*); and American crows (*Corvus brachyrhynchos*). These bird species accounted for approximately 80% of all detections (Figure 1). American robins, black-capped chickadees, and chipping sparrows were the most commonly detected in tart cherry orchards, accounting for approximately 79% of all detections (Figure 1).

Foraging patterns from behavioral observations

During behavioral observations, we observed 7 species consuming sweet cherries. Cedar waxwings consumed nearly 5 times as many sweet cherries as did American robins and common grackles (*Quiscalus quiscula*; Figure 2). American robins, cedar waxwings, and common grackles were observed consuming tart cherries during behavioral observations (Figure 2).

Birds were observed consuming sweet cherries more often than tart cherries. During 119 hours of behavioral observations in sweet cherries, we observed 180 birds in sweet cherry trees; 103 of those individuals consumed a total of 179 cherries. Ninety-five of the 103 individuals were observed in the top half of the tree, seven in the lower half and 1 individual bird foraged in both the top and bottom halves of the tree. During 57 hours of observations in tart cherries, we observed 47 birds in tart cherry trees; seven of those individuals consumed a total of 11 tart cherries. All 7 individuals were observed consuming cherries in the top half of the tree.

Cedar waxwings and American robins consumed similar numbers of sweet cherries

Table 1. Characteristics of orchards in which bird surveys and observations were conducted in Leelanau County, Michigan, 2010.

Orchard name	Tree age (yrs)	Tree density (per ha)	Average canopy height (m)	Average canopy width (m)	Cultivars	Root stocks	80% Land covers[1]
Sweet cherries							
Bahle	22	247	4.9	4.3	Emperor Francis, Gold Cavalier, Sam, Ulster	Standard	Developed, cherries, grassland
Mawby	23	247	4.9	4.3	Emperor Francis, Gold, Ulster	Standard	Cherries, alfalfa
Grant	15	247	4.6	3.7	Emperor Francis, 13N739, 13688 (WhiteGold),13N109, 13481, Beta, 47127, 471	Standard	Deciduous forest, developed, woody wetlands, cherries
Send	12	272	4.6	3.7	Emperor Francis, Sam, Ulster, Gold	Standard	Cherries, developed
Station	14	340	6.1	4.6	Emperor Francis, Ulster, Gold, Napoleon, Rainier	Standard	Cherries, alfalfa, grassland
Tart cherries							
Bahle	30	336	4.3	3.7	Montmorency	Standard	Developed, cherries, grassland
Mawby	16	336	4.3	3.7	Montmorency	Standard	Cherries, deciduous forest
Shugart	17	319	4.3	3.7	Montmorency	Standard	Cherries
Station	15	360	6.1	4.6	Balaton, Montmorency	Standard	Cherries, alfalfa, grassland, developed

[1]All orchards had mowed grass as the understory.

per minute (1.0 ± 0.6 and 1.0 ± 0.5, respectively, Wilcoxon 2-sample test, $Z = 0.51$, $P = 0.61$, $n = 50$). Cedar waxwings and common grackles also consumed similar numbers of sweet charries per minute (grackles: 1.3 ± 1.1, Wilcoxon 2-sample test, $Z = 0.57$, $P = 0.57$, $n = 49$), as did grackles and robins (Wilcoxon 2-sample test, $Z = -0.04$, $P = 0.97$, $n = 19$).

Group size

Cedar waxwings were observed in significantly larger conspecific groups ($\bar{x} = 4.2$ individuals ± 3.8 SD) when consuming sweet cherries than either common grackles (2.6 ± 4.6) or American robins (1.2 ± 0.5), while group sizes of robins and grackles were not significantly different (Wilcoxon 2-sample tests, $Z = -4.13$, $P < 0.001$, $n = 80$; $Z = -5.07$, $P < 0.001$, $n = 79$; $Z = -0.47$, $P = 0.64$, $n = 37$, respectively).

Discussion

If this study had used only survey data, we likely would have concluded that American robins were more important sweet cherry consumers than were cedar waxwings. In contrast, behavioral observations showed that cedar waxwings consumed many times more sweet cherries than American robins did (Figure 2). In addition, mean group size of foraging cedar waxwings was significantly higher than common grackle group size and 4 times that of American robins. These findings suggest that waxwings should be the first target of bird management efforts in sweet cherries in the study region.

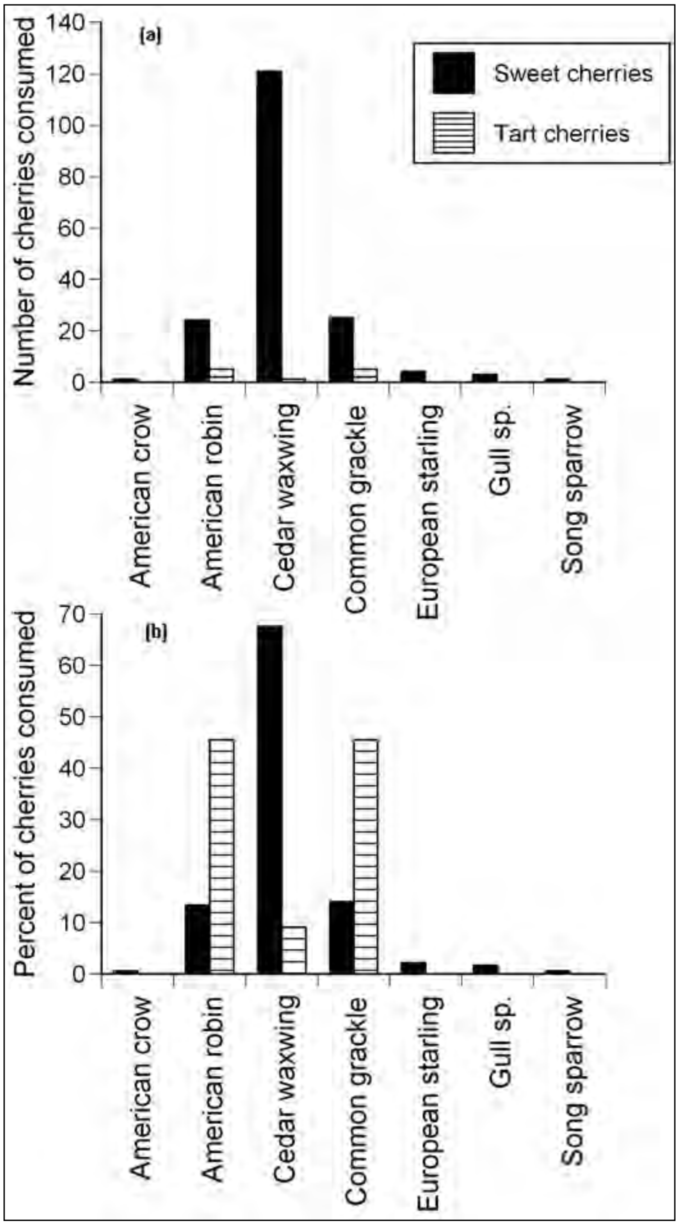

Figure 2. Number (a) and percentage (b) of sweet and tart cherries consumed by various bird species during behavioral observations in orchards in Leelanau County, Michigan, 2010.

In tart cherries, results from the surveys and the observations correspond in that American robins were commonly detected and observed, particularly if we discount survey detections of species that are primarily insectivorous and granivorous, like black-capped chickadees and chipping sparrows. Common grackles, however, were not detected during tart cherry surveys, although they were observed consuming cherries during behavioral observations. Thus, the observations provided a more accurate picture of which species were consuming tart cherries than the survey data. Overall, bird consumption of tart cherries was lower than consumption of sweet cherries, which may be generally explained by the earlier ripening of sweet cherries (Tobin et al. 1991) and their higher sugar content (Stevens and De Bont 1980). We spent fewer hours and traversed fewer ha in tart cherries than in sweet cherries, but we do not believe this introduced any systematic bias in our results. However, we caution that yields and quality of tart cherries were low in 2010 (Agricultural Marketing Service 2011), likely because cold weather reduced pollination, so our results might underestimate the typical extent of bird damage.

Most foraging birds were observed in the top half of the trees' foliage. Thus, fruit damage may be unequally distributed in trees, which corresponds to previous work documenting spatial patterns in bird damage (Somers and Morris 2002, Tracey and Saunders 2010). These results indicate that damage assessments focused on the lower, easily accessible (to humans) branches of cherry trees may underestimate overall damage, based on the species we documented as important cherry consumers.

Our study demonstrates the value of observations in ranking species as to their relative impact on fruit crops. Simple surveys of bird presence in orchards, vineyards, or fields are unlikely to provide enough information to guide bird management efforts. The additional information gained through observations, including which species consume fruits, fruit consumption rates, group size, and foraging locations, will be critical to management efforts. For example, some frugivorous bird species, as European starlings

(*Sturnus vulgaris*), are unable to digest sucrose, a sugar not found in cherries and blueberries (Martinez del Rio et al. 1988). This result has led to suggestions that the development of high-sucrose cultivars may be one strategy to reduce bird damage (Brugger and Nelms 1991, Brugger et al. 1993, Socci et al. 1997). In addition, a test of sucrose sprayed on blueberries showed that it might be a deterrent (Socci et al. 1997). Cedar waxwings, however, are able to digest sucrose, although inefficiently (Martínez del Rio et al. 1989), and the presence of sucrose in or on fruit may not reduce waxwing fruit consumption (Avery et al. 1995). Thus, the identification of the relative impact of different species on fruit will inform and guide management efforts, particularly in the case of strategies that may be effective against some species and not others.

We caution that the relative importance of different bird species as consumers of particular crops will vary geographically and temporally. For example, cedar waxwings are not as abundant in western North America as in eastern North America (Gough et al. 1998) and are likely to play less of a role as a consumer of cherries in the West compared to the East. Observations, such as those described here, will be important in documenting these types of geographic patterns. Also, European starlings are significant cherry pests in the western United States and Europe; anecdotal information, and previous reports from growers in our study region indicate that they are regularly seen in orchards. Given the lack of starling detections reported here, it is possible that starling numbers were particularly low in 2010. Data from multiple years will be valuable in assessing the importance of various bird species over a longer time scale.

Although observational work tends to be more labor-intensive than surveys, we believe the added information far outweighs the costs and will be a valuable supplement to more commonly collected data, such as those on population sizes and distributions and time budgets (e.g., Peer et al. 2003). As an alternative to actual observers, investigators have successfully used video cameras to record bird activity in fruit crops. The feasibility of this method will depend on characteristics of the fruit, bird species, and the resources available to investigators (M. Grieshop, assistant professor of entomology, Michigan State University, personal communication).

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