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CHAPTER 12

The Economic Impact of Blackbird Damage to Crops

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CONTENTS

12.1	Examples of Direct or Primary Damage Estimates.....	208
12.1.1	Rice.....	208
12.1.2	Sunflower.....	208
12.1.3	Corn	209
12.2	Assessing Costs and Benefits of Bird Management Tools.....	210
12.3	Estimates of Indirect or Secondary Damage	212
12.4	Case Study—Sunflower Damage.....	212
12.4.1	Introduction	212
12.4.2	Methods.....	212
12.4.3	Results	212
12.4.4	Summary	214
12.5	Research Needs.....	214
	References.....	215

There are nearly 1,000 species of birds in North America, some of which provide obvious economic benefits like egg production, meat production, bird watching, or hunting (American Bird Association 2016). Some bird species, however, can cause a considerable amount of damage to U.S. agriculture, with estimates of annual damage caused by birds in the United States exceeding US\$4.7 billion (Pimentel et al. 2005). Blackbirds (Icteridae) are one group of birds in North America that can cause significant economic damage to commercial grain crops, and to a lesser extent vine and tree crops (Wilson et al. 1989; Dolbeer 1990; Linz et al. 2011; Anderson et al. 2013).

Four species of blackbirds—red-winged blackbird (*Agelaius phoeniceus*), common grackle (*Quiscalus quiscula*), yellow-headed blackbird (*Xanthocephalus xanthocephalus*), and brown-headed cowbird (*Molothrus ater*)—are primarily responsible for damage to sprouting and ripening grain crops (Lowther 1993; Twedt and Crawford 1995; Yasukawa and Searcy 1995; Peer and Bollinger 1997). During late winter, these species commonly can be found feeding on food

present in concentrated animal feedlot operations (Dolbeer et al. 1978). For much of the year, however, these birds forage on insects, waste grain, and weed seeds, thus providing valuable ecological services.

The direct economic damage created by birds typically falls into the three broad categories of destruction, depredation, and disease transmission. Total economic damage (D) of a particular bird species is the sum across these three categories and across time, as follows:

$$D = \sum_{n=1}^t (\text{Destruction}_n + \text{Depredation}_n + \text{Disease}_n)$$

Destruction refers to destroyed property (e.g., bird strikes to aircraft and defecation on statues, golf courses, buildings, and bridges), equipment (e.g., vehicles, farm equipment, cables, irrigation equipment), nonconsumptive damage to crops, usually associated with roosting behaviors, and contamination of water, grains, and livestock feed. A substantial portion of the overall economic impact of birds is through depredation of crops, the focus of this paper.

In this chapter, we review (1) available crop damage data collected over the last five decades, (2) economic analyses that define the level of damage, and (3) estimates of the costs and benefits of particular blackbird management methods. We then present an economic analysis example using regional economic models known as input–output (IO) models (Richardson 1972; Treyz et al. 1991). These models take into account the effects of damage on the economy as a whole, including loss of jobs as a result of reduced production. These analyses provide data for documenting economic losses and justifying the use of resources to reduce damage.

12.1 EXAMPLES OF DIRECT OR PRIMARY DAMAGE ESTIMATES

Although blackbirds are known to damage many crops, we focus on direct damage to rice, corn and sunflower because these commodities are their favored foods over large geographic areas and therefore have garnered much attention from scientists (Linz et al. 2015). Detailed food habit and damage analyses are presented elsewhere in this book.

12.1.1 Rice

Rice planted in the southeastern United States and California is available to foraging birds after seeding in the spring and while ripening prior to harvest in the summer and fall. Recent objective damage surveys are not available; however, in the 1980s blackbird damage to newly planted rice in southwestern Louisiana and east Texas amounted to US\$8 million (Wilson et al. 1989; Decker et al. 1990).

Cummings et al. (2005) used a mail survey to gather information on bird damage from rice growers in the United States and found that between 1996 and 2000 the average annual blackbird damage to newly planted rice ranged from 6% to 15%, and the average percent loss to ripening rice ranged from 6% to 14%. Growers in Arkansas and Louisiana reported the highest damage, with blackbirds causing US\$8.7 million in damage to rice in 2001. Cummings et al. (2005) estimated the total damage in the United States to be US\$13.4 million.

12.1.2 Sunflower

Sunflower is a minor crop in North America that is typically grown in a semi-arid climate (U.S. Department of Agriculture 2016). Blackbird damage is the most common reason that sunflower producers in North Dakota stop planting sunflower (Linz et al. 2011; Hulke and Kleingartner



Figure 12.1 Typical damage by red-winged blackbirds to a ripening oilseed sunflower head in North Dakota. (Courtesy of USDA Wildlife Services.)

2014; Figure 12.1). Ripening sunflower is particularly vulnerable to blackbirds because the crop is susceptible for 8 weeks, from early seed-set in mid-August until harvest in mid-October (Cummings et al. 1989; Linz et al. 2011).

When bird damage to sunflower became an economic issue in the 1970s, scientists sought to define the extent, magnitude, and frequency of sunflower losses across the sunflower-growing areas of North Dakota, South Dakota, and Minnesota (Guarino 1984). In 1979 and 1980, Hothem et al. (1988) conducted statewide bird damage survey in these states and found that blackbird damage averaged 1.4% across years and was valued at US\$6.5 million annually. Further, nearly 21% of the fields received >1% damage, while 5% showed >10% damage.

In 2003, 20 years after Hothem and colleagues conducted their survey, Peer et al. (2003) updated the sunflower damage estimates using a bioenergetic approach combined with population data. They calculated that the combined fall population of male and female red-winged blackbirds, yellow-headed blackbirds, and common grackles was 75 million and that each bird ate an average of US\$0.072 of sunflower annually. Total loss was estimated to be 1.7% and was valued at US\$5.4 million.

In 2009 and 2010, Klosterman et al. (2013) used 120 3.2 × 3.2 km block sampling design established by Ralston et al. (2007) to objectively assess bird damage to randomly selected sunflower fields in North Dakota's Prairie Pothole Region, a core sunflower-growing area. They found that average annual blackbird damage was 2.7%, valued at US\$3.5 million.

Finally, from 2001 to 2013 (except 2004), national surveys of blackbird damage in physiologically mature sunflower fields were conducted throughout the foremost sunflower-growing states (Kandel and Linz 2016). These surveys are expected to be carried out on a periodic basis for the foreseeable future. We detail these results in a case study presented in Section 12.4 using regional economic models (also known as *IO models*; Richardson 1972; Treyz et al. 1991).

12.1.3 Corn

While rice and sunflower are grown in specific regions of North America, corn is planted widely (U.S. Department of Agriculture 2016). Corn loss to birds in 24 states in the United States in 1970

was estimated to be about US\$9 million (Stone et al. 1972). From 1977 to 1979, damage surveys conducted in Ohio, Michigan, Kentucky, Tennessee, and Ontario showed that primary damage (the actual corn removed by the birds) averaged about 0.6% (Dolbeer 1981), with <2.5% of cornfields in Ohio having losses >5%. In 1981, Besser and Brady (1986) conducted a survey of bird damage to ripening field corn in 10 major producing states and found that only 2% of the corn ears were damaged.

Weatherhead et al. (1982) used bioenergetics and population data to estimate that in 1979 blackbirds damaged 0.41% of the field corn grown in Quebec valued at about C\$279,000. This number was substantially lower than a government estimate of C\$16 million. Their study and others have pointed out that qualitative judgements on crop damage should not be used as a basis for determining the economic impact of wildlife damage (e.g., Dolbeer 1981; Besser 1985; Dolbeer et al. 1994).

In 1993, a field survey on corn crops in the top 10 corn-producing states showed that birds damaged 0.19% of field corn, resulting in a total of US\$25 million in damages (Wywiałowski 1996). Finally, Klosterman et al. (2013), using the same study design previously discussed for sunflower, determined that bird damage to cornfields in North Dakota in 2008 and 2009 averaged 0.2%, valued at US\$1.3 million.

We conclude from these examples that overall blackbird damage to crops is low industry-wide. However, bird damage is economically important to a small percentage of producers that farm near favored roost sites. We are encouraged that wildlife managers and industry executives are seeking data to clearly define the problem and more effectively allocate resources to manage damage. Finally, we noted that objective surveys of damage to sunflower are relatively recent, whereas the data for corn is aged, and little objective data has been gathered to clarify the level and geographic extent of bird damage to rice.

12.2 ASSESSING COSTS AND BENEFITS OF BIRD MANAGEMENT TOOLS

Modern commodity producers evaluate the cost and benefits of using crop inputs to maximize profits. The use of various bird damage management techniques can be costly and therefore warrant close scrutiny prior to providing recommendations for their use. Here, we provide several examples where scientists evaluated the cost and benefits of various blackbird management strategies.

DeGrazio et al. (1971, 1972) and Stickley et al. (1976) provided overall cost estimates of using a chemical-frightening agent to protect corn. However, Dolbeer (1981) was an early advocate of using a cost-benefit equation to determine when the use of damage-control measures was warranted economically. He found that in most damage scenarios the cost of using a chemical-frightening agent exceeded the dollars saved by reducing damage. He further concluded that damage would need to exceed 4.6% in a field to be justified. His conclusion was based on the cost of aerially applied treated baits (US\$13.71/ha) versus the value of the crop US\$2.15/bushel and yields of 250 bushel/ha.

Weatherhead et al. (1980) tested the idea of using decoy traps in cornfields to capture blackbirds and therefore reduce damage. They calculated that the cost of the trap, food, and labor over 98 days amounted to about C\$333.00 and the cost per captured bird was C\$1.01/bird. Corn was valued at C\$0.145/kg at the time of the study. Given an individual bird might eat 0.53 kg during the damage season, an individual bird was worth only C\$0.08. The authors concluded that this method of population management was not economically efficient.

Cummings et al. (1986) evaluated a combined propane exploder and CO₂ pop-up scarecrow in sunflower and found that it was effective, particularly if used before an ingrained feeding pattern had developed. The effectiveness of propane cannons, however, was shown to be limited to relatively small areas and damage needed to exceed 18% to be cost beneficial (Table 12.1).

Table 12.1 Methods That Are Commercially Available to Sunflower Producers to Help Reduce Sunflower Damage Caused by Blackbirds in the Prairie Pothole Region of the United States

Method	Cost ^a	Threshold ^b	Comments
Propane cannons	\$110/ha	120 birds/ha ^c	1 unit/3 ha
Repellents			
Flock Buster [®]	\$50/ha	–	Questionable efficacy
Bird Shield [™]	\$42/ha	–	Questionable efficacy
Decoy crops	\$375/ha	800 birds/ha ^d	Situational efficacy
Desiccation	\$24/ha	1000 birds/ha ^e	Saflufenacil + glyphosate
Roost-site destruction	\$95/ha	238 birds/ha ^f	Aquatic glyphosate

Source: Linz et al. 2011.

Note: Costs (US\$) and economic threshold-for-use are estimates.

^a When applicable, includes estimated cost of aerial application (US\$12/ha).

^b The number of birds per hectare at the breakeven point of application cost.

^c Amortized over a 10-year life expectancy for propane cannon.

^d Cost is based on loss of opportunity of lands in agricultural production. Costs are less for lands not in agricultural production (e.g., CRP). Also, the threshold estimate is based on decoy crops protecting crops of confectionery sunflower (Hagy et al. 2008).

^e Based on advancement of harvest of 7 days and 0.009 kg sunflower eaten per day per bird @ US\$0.37 per kg sunflower (Peer et al. 2003). Does not include savings related to faster dry down to avoid plant lodging due to insect and disease damage.

^f Amortized over 4-year life expectancy of treatment.

Blackwell et al. (2003) assessed the economics of proposed use of lethal control to manage an estimated population of 27 million red-winged blackbird in the sunflower-growing region of North Dakota. They modelled the potential population effects of removing a maximum of 2 million red-winged blackbirds annually over a 5-year campaign during spring migration. Assuming US\$0.07 in damage per bird and variable annual culls of 1.2 million with density compensation, Blackwell et al. (2003) calculated that after 5 years the population would remain between 78.5% and 93.2% of the original 27 million individuals, with a total net benefit of US\$386,103–US\$776,026 over 5 years. The results from these models led to the conclusion that culling red-winged blackbirds at this level would produce only a marginal economic impact on the sunflower industry; therefore a lethal control program was not pursued.

Hagy et al. (2008) calculated the costs and benefits of using wildlife conservation food plots (WCFP) as a blackbird bird management tool (Chapter 10, this volume). The U.S. Department of Agriculture offered candidate sunflower producers US\$375.00/ha to plant WCSP with histories of elevated blackbird damage. The WCFP produced an average of 1,290 kg/ha and birds removed 435 kg/ha, valued at US\$160.95/ha. Hagy et al. (2008) concluded that the cost–benefit ratio was 3.4:1, indicating economic inefficiency.

We conclude that over the last four decades scientists have been cognizant of the need to include costs and benefits of bird damage management techniques. For a technique to be cost-effective, the cost of the control measure must be less than the anticipated monetary loss (Dolbeer 1981). Obviously, a producer growing a valuable crop can afford to expend more resources to protect the crop. For example, confectionery varieties of sunflower are more valuable than oilseed varieties and thus might warrant extra protection from depredating blackbirds.

These analyses are important for individual growers. However, economists are often asked what wildlife damage means to the economic health of the entire industry. Obviously, if bird damage to a particular crop is widespread and severe, the entire industry and associated macroeconomy could be impacted. In the following section, we provide background and a case history on how loss of production due to bird damage can damage an economy.

12.3 ESTIMATES OF INDIRECT OR SECONDARY DAMAGE

Direct (i.e., primary) damages can generate indirect (i.e., secondary) impacts due to economic factors that create linkages to established economic sectors (Figure 12.2). Regional economic models (also known as *IO models*) attempt to quantify the impacts on output as a result of input changes in a regional economy (Richardson 1972; Treyz et al. 1991). The model then uses existing estimates of direct impacts as inputs into the regional economic model to quantify the resulting indirect impacts, thereby calculating the total effect on macroeconomic indicators like employment and gross domestic product (GDP) in a specified regional economy. A dynamic regional economic model has been developed to generate annual forecasts and simulate behavioral responses to compensation, price, and other economic factors (REMI: Model Documentation—Version 9.5; Treyz et al. 1991). For example, when birds consume sunflower, fewer sunflower enter the supply chain and as a result sunflower is not processed into products (Elser et al. 2016).

To capture this in a regional economic model, two forecasts are created (Figure 12.2). The first forecast is the control or baseline forecast in which no bird damage to sunflower has occurred and the model projects economic conditions within a region on the basis of trends in historical data. The second forecast is the alternate forecast in which bird damage to sunflower has reduced the amount of sunflower into the supply chain and the model must account for changes in variables such as industry-specific income, value added, and employment. The model then compares the two forecasts to determine the overall impact to the regional economy.

12.4 CASE STUDY—SUNFLOWER DAMAGE

12.4.1 Introduction

From 2001 to 2013 (except 2004), the National Sunflower Association (Mandan, ND) sponsored a comprehensive production survey of physiologically mature sunflower (*Helianthus annuus*) fields in the Canadian province of Manitoba and eight states in the United States (Kandel and Linz 2015). Trained teams of surveyors randomly stopped at one sunflower field for every 4,047–6,070 ha. Yield was based on plant stand, head size, seed size, percent filled seeds, center seed-set, and percent loss due to bird feeding at two random locations within the field. Loss due to bird damage was estimated based on sample charts with examples of various levels of bird damage.

12.4.2 Methods

The data were pooled during the most recent 5 years (2009 to 2013) in the United States for statistical analysis (Kandel and Linz 2015). The overall percentage of sunflower damaged and percentage of oilseed and confectionery sunflower hybrids damaged did not differ across the five study years, hence study years were combined for further analyses. Confectionery and oilseed hybrids, however, produce achenes that are fundamentally different in oil content, size, and hull thickness, so the damage data were presented for both variety types. Additionally, confectionery achenes are also sold at a premium over oilseeds (U.S. Department of Agriculture 2016). Total economic impact was calculated using a model of the regional economy (i.e., IO model) that predicts how a change in one industry can affect revenue and employment throughout the economy.

12.4.3 Results

Across all eight states, mean oilseed yield was 1,456 kg/ha and annual blackbird damage was 2.59%, whereas confectionery fields yielded an average of 1,420 kg/ha and blackbirds damaged

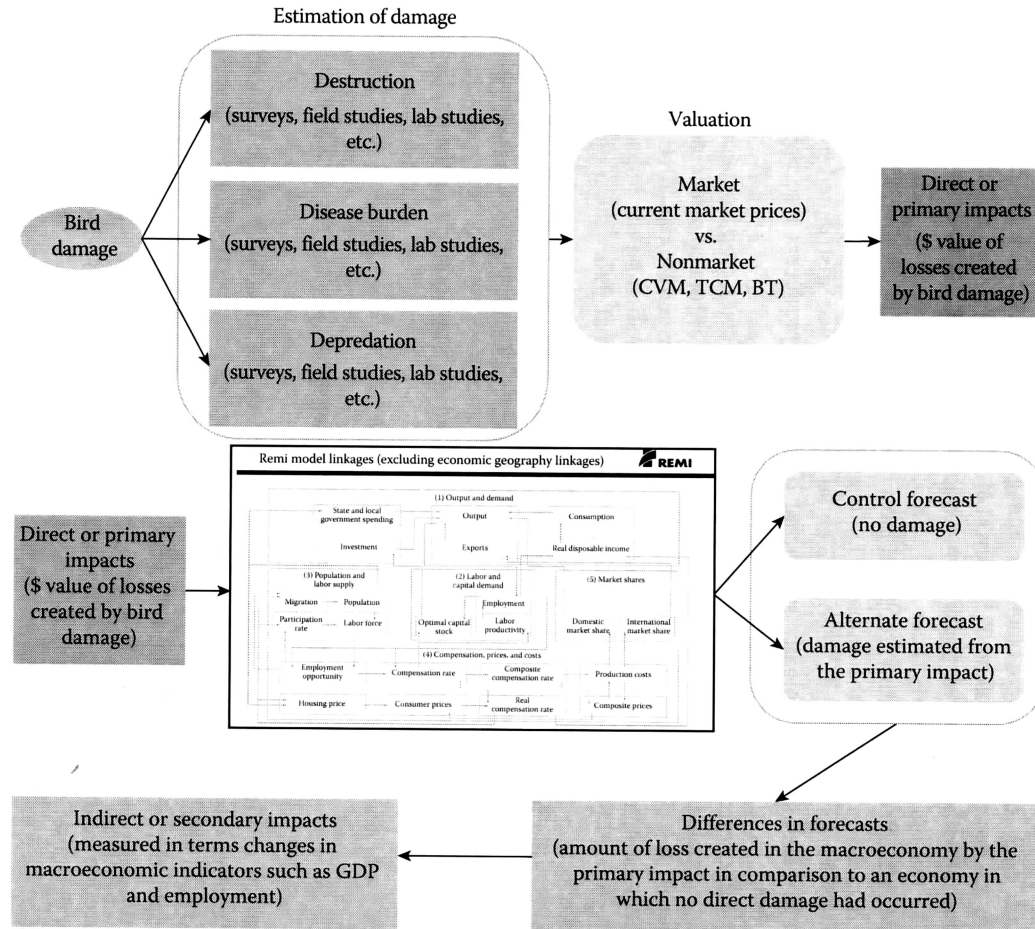


Figure 12.2 Determination of direct (primary) and indirect (secondary) economic impacts.

1.66% of the crop. Overall, blackbird damage to oilseed and confectionery varieties was valued at US\$13.26 million and US\$4.3 million annually, respectively. The average annual (direct + indirect) economic impact for bird damage to sunflower production in the eight study states was US\$29.5 million and reduced employment by 14 jobs (U.S. Department of Agriculture 2015).

12.4.4 Summary

From our review of direct-impact studies, we conclude that blackbird prebreeding populations can sometimes cause significant damage to spring-seeded crops, especially rice (Meanley 1971; Wilson et al. 1989). In fact, severe blackbird damage to newly planted rice can result in a total loss and require that the crop be replanted (Wilson et al. 1989).

The postbreeding blackbird population, which increases about 45% after nesting, likely exceeds 350 million individuals (Peer et al. 2003; Rosenberg et al. 2016). These birds typically damage 1%–2% of ripening grain crops, but most of that damage is within 8 km of a roost where a few farmers suffer most of the damage (Dolbeer 1981; Otis and Kilburn 1988; Wywiałowski 1996). These losses would seem inconsequential if damage was distributed evenly; however, bird damage becomes economically significant if individual producers lose >5% of their crop (Dolbeer 1980; Linz and Homan 2011).

Historically, researchers obtained the market value of the affected crop from government publications and subtracted the value of the damage to determine the estimated direct impact to growers (e.g., Dolbeer 1981; Cumming et al. 2005; Hagy et al. 2008; Linz and Homan 2011; Anderson et al. 2013). Direct estimates of bird damage provide valuable information on the impact of damage to individual growers and associated industries. However, additional information on the impacts of reduced production rippling through the economy can be obtained by using regional economic models. Modelling impacts in this way can translate the primary impacts of birds into regional impacts on revenue and jobs, expanding the general public's perception of the potential benefits of preventing or combatting bird damage. These indirect impacts not only help estimate the total impact of bird damage but also help engage a broader audience by highlighting the implications of bird damage for local communities and economies.

12.5 RESEARCH NEEDS

Our review of the literature has revealed an incomplete understanding of the economic damages and control costs arising from blackbirds. Further, recent objective surveys assessing bird damage to corn and rice are not available. Given that these surveys are costly, bioenergetics models and population estimates should be updated on a periodic basis to provide valuable information (see Weatherhead et al. 1982; Peer et al. 2003). These improved data and associated research insights need to be integrated into future management decisions to identify economically efficient (or at least the most cost-effective) management strategies for birds. Lastly, regional economic models should be used to rigorously link primary damage impacts to the appropriate economic sector in order to estimate secondary impacts.

To mitigate damage caused by blackbirds, substantial resources have been committed to management and control efforts. These efforts impose both direct costs (in terms of outlays of actual dollars on lethal and nonlethal control efforts) as well as indirect costs (in terms of lost time and resources devoted to controlling birds). Management and control costs, however, are categorically different than damages inflicted by birds. These two forms of expense should therefore be recorded separately as they are accounted for differently in regional economic models.

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