Why Birds Matter in Agricultural Landscapes

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Why Birds Matter in Agricultural Landscapes

Dan Wenny
San Francisco Bay Bird Observatory

Chris Whelan
Moffitt Cancer Center
University of Illinois-Chicago

University of Chicago Press, August 2016
Goals for today

- Describe ecosystem services
- Overview of ecosystem services provided by birds
  - In natural areas & agro-ecosystems
- Summary and Some things you can do
Ecosystem Services

- Natural processes and products that benefit human society

- **Provisioning Services**
  - Food Production
  - Water
  - Wood and Fiber
  - Fuel

- **Supporting Services**
  - Nutrient Cycling
  - Soil Formation
  - Primary Production
  - Habitat Provision

- **Regulating Services**
  - Climate Regulation
  - Flood Regulation
  - Water Purification

- **Cultural Services**
  - Spiritual
  - Aesthetic
  - Educational
  - Recreational

Source: Millennium Ecosystem Assessment, 2005.
Birds provide all types of ecosystem services

- **Provisioning**
  - Food, clothing, fertilizer, insulation
- **Cultural**
  - Decoration, art & literature, spiritual, tourism
- **Supporting and regulating**
  - Pest control, pollination, seed dispersal, nutrient cycling, ecosystem engineers, scavengers, environmental indicators
why birds?

● most birds fly
● respond to environmental changes
● occur in virtually all habitats
● very well known (compared to other animal groups)
● most diurnal and convenient to observe & study
● public connects with birds (unlike snakes, most insects, etc)
Conceptual framework 1

- Biodiversity is a non-renewable resource
- Ecosystem services depend on biodiversity
- Higher levels of biodiversity promote:
  - more efficient delivery
  - potentially higher levels of ecosystem services
- Human land use patterns can greatly affect ecosystem services
  - “conventional” vs ecological agriculture
Loss of ecosystem services in Madagascar after deforestation
What happens without birds?

Seed dispersal

Nutrient Cycling

Ecosystem engineers

Scavengers
Ecological Roles of Birds

- Most bird services arise from foraging behavior:
  - predation (invertebrates, fish, birds, mammals, seeds...)
  - pollination
  - seed dispersal
  - scavenging
  - nutrient cycling
  - ecosystem engineers (usually nesting not foraging)
Trophic structure within ecosystems

Top-down versus bottom-
Why Agricultural Landscapes Matter

- 40% of land used for agriculture

- Land use in agro-ecosystems can have a big impact on bird populations

- How do the ecological roles of birds fit in on agricultural land?
  - Beneficial or detrimental?
Pest Control - invertebrates

5700 + 1700 species
Herbivores like caterpillars can do tremendous damage to native and cultivated plants.
Birds as Insecticide

Birds as biological insecticide: why bird insectivores are not DDT

• Each bird species has its own fundamental niche – its own unique way of making its living
• Each species hunts in a unique way, dependent upon its unique adaptations of wings and tail, legs, bill, sight – each has a unique foraging strategy
• This means it is difficult for an insect herbivore to develop a “one size fits all” defense against bird insectivores.
Bird Foraging and Coexistence

- Plants represent structurally distinct resource patches
- Bird species exhibit tradeoffs in their resource exploitation of these patches
- Tradeoffs promote coexistence and help explain community structure
- Diverse community of insectivorous bird species: Effective, RESISTANCE-PROOF biological insecticide
Birds as Practitioners of Insect Topiary

**Topiary:**

Practice in which shrubs or other plants are trimmed with garden shears into sculptures (a classic example of “sheer” madness!!)
Insect Topiary: birds sculpt insect densities through consumption
Do prairie birds provide services or disservices on adjacent conventional farms?

Megan Garfinkel
PhD Candidate
University of Illinois at Chicago
Prairies and grasslands act as source habitat for Midwest farmland birds

Photos by Richard Hickson
Services:
- Birds eat “pests”

Disservices:
- Birds eat arthropod predators
- Birds eat crops
Year 1: Study sites at Nachusa Grasslands
Crops were enclosed within cage exclosures to prevent birds from foraging for potential pests.
Year 1: Economic Effects of birds

**CORN:**
- Service
  - $115.28/acre

**SOY:**
- Disservice
  - $145.54/acre
How do bird diets explain exclosure results?
Year 2: Methods

1. Exclosures in six soybean fields adjacent to grasslands
   - 3 sites at Nachusa
   - 3 sites at forest preserves in Kane and DeKalb counties

2. Bird banding/fecal DNA diet analysis
Year 2 Results: Birds did not affect soybean grain yield
Birds can control insect pests in agricultural ecosystems, precluding the use of expensive pesticides!

Numerous other examples:

- apple orchards
- coffee plantations
- broccoli
Seed-eating birds

1100 + 1000 species

- Crop pests or weed seed control?
- Few experimental studies in agroecosystems
Birds as granivores

- bill shape
- gizzard

Granivores as crop pests

- Presence does not mean crop pest
- Impact often over-estimated
- Most granivores also eat insects
  - services may outweigh disservices
- Very few species implicated as crop pests
Red-billed quelea

- Most abundant wild bird species (1.5 billion)
- Specialized on annual grasses (including crops)
- Significant pest locally
- Also eats insects
- Guano
- Eaten by people

Pest control “cure” may be worse than the disease
Red-winged blackbird

- Crop pest in corn
- Official crop damage 20%
- Actual damage <1%
- Now less palatable varieties
- Eat insects, including more significant crop pests
- Similar situation in rice fields
Granivores as weed seed control

- Can birds control weeds seeds in cropland?
  - Or are weed populations more controlled by environmental conditions?

- What characteristics attract seed-eating birds to farms (agro-ecosystems)
Exclosure experiments

Complementary ecosystem services provided by pest predators and pollinators increase quantity and quality of coffee yields
Results from exclosures

- Small mammals and invertebrates eat most seeds in agroecosystems
- Seed predation by birds adds to that total
- Seed removal often 90%
- Bottom up > Top down

Definitely need more research in this area

Post-dispersal weed seed predation in Michigan crop fields as a function of agricultural landscape structure.
Pest Control - rodents

- Raptors track changes in rodent abundance
- Evidence suggests raptors can control rodents but few experiments demonstrating top-down effects

300 + 1100 species
Control of pest birds and mammals

Raptors - hawks and owls
Shrikes - predatory songbirds
Loggerhead shrike –

Though a songbird, it is a skilled and lethal predator.

Shrikes will take large insects, small birds and mammals, lizards, and amphibians.

Loggerhead shrike
Photo from Richard Hickson
Mammalian farm pests:

Rodents
- mice and voles
- squirrels
- gophers

California ground squirrel, photo by Howcheng

Botta's pocket gopher, Photo by Davefoc

California vole, photo by Jerry Kirkhart
Mammalian farm pests:

Rabbits

Desert cottontail
Photo by Howcheng

Black-tailed jackrabbit
Photo by Gary L. Clark
A juvenile Red-tailed Hawk *Buteo jamaicensis* eating its prey (*California* meadow vole *Microtus californicus*); seaside bluffs of Half Moon Bay, California.

Photo by [Steve Jurvetson](https://www.jurvetson.com/)

A juvenile Red-tailed Hawk *Buteo jamaicensis* eating its prey (*California* meadow vole *Microtus californicus*); seaside bluffs of Half Moon Bay, California.
Predatory effectiveness increases with age and experience

Hatch-year red-tailed hawk
Photo from Fordham University
Cooper’s hawks
As with all hawks in the genus Accipiter, Cooper’s are bird specialists.

They may help control pest bird species.

Adult Cooper’s hawk
Photo from Vanillakirsty
Scavenging: the under-appreciated ecosystem service
Pollination

- 600 + 350 species
- All continents except Europe, Antarctica
- 5-10% of plant species
- 5.4% of 960 ag crops
  - Most are bee-pollinated
Frugivores and Seed Dispersal

• 1400 +2600 bird species
• 50,000 – 80,000 plant species
Advantages of Seed Dispersal

- Escape from predation and competition
- Colonization of open sites
- Directed dispersal to the best sites
- Gene flow
- Enhanced germination
certain species may be particularly important dispersers*

*large-gaped tropical frugivores

Nurse plants and treefall gaps

Seed dispersal by birds and mammals drives plant succession in many habitats
Most species require seed dispersal by birds
Seed Dispersal - Waterbirds

ducks & geese, shorebirds, gulls, rails

Disperse seeds of aquatic plants and eggs of invertebrates

Scatterhoarding by Corvids

Pines & Oaks
Long distances
Suitable sites
### Frugivory & Seed dispersal in agroecosystems

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>● fruit damage in orchards, vineyards, berries</td>
<td>● May eat insect pests</td>
</tr>
<tr>
<td>● Cost of deterrence</td>
<td>● Help regenerate hedgerows and natural areas</td>
</tr>
<tr>
<td>● Spread invasive species</td>
<td></td>
</tr>
<tr>
<td>● Species considered crop pests:</td>
<td></td>
</tr>
<tr>
<td>● American robin</td>
<td></td>
</tr>
<tr>
<td>● Cedar waxwing</td>
<td></td>
</tr>
<tr>
<td>● European starling</td>
<td></td>
</tr>
</tbody>
</table>
A review and synthesis of bird and rodent damage estimates to select California crops

Crop Protection 30 (2011) 1109–1116

Karen Gebhardt a, b, Aaron M. Anderson a, Katy N. Kirkpatrick a, Stephanie A. Shwiff a, *

Table 2

Expected yield loss per damaged acre, percent of total acreage that suffers damage, and percent of total yield that is lost to bird and rodent pests.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Expected Yield Loss Per Damaged Acre (%)</th>
<th>Acres Damaged (% of total)</th>
<th>Expected Damage (% yield loss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almond</td>
<td>5.1</td>
<td>50.8</td>
<td>2.6</td>
</tr>
<tr>
<td>Artichoke</td>
<td>11.8</td>
<td>70.0</td>
<td>8.3</td>
</tr>
<tr>
<td>Broccoli</td>
<td>9.5</td>
<td>42.1</td>
<td>4.0</td>
</tr>
<tr>
<td>Carrots</td>
<td>0.4</td>
<td>40.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Cherries</td>
<td>11.1</td>
<td>34.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Citrus, oranges</td>
<td>1.0</td>
<td>30.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Citrus, lemons</td>
<td>3.5</td>
<td>30.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Grapes, table</td>
<td>5.4</td>
<td>67.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Grapes, wine</td>
<td>10.7</td>
<td>67.5</td>
<td>7.2</td>
</tr>
<tr>
<td>Hay, alfalfa</td>
<td>24.0</td>
<td>17.0</td>
<td>4.1</td>
</tr>
<tr>
<td>Lettuce</td>
<td>6.1</td>
<td>42.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Melons</td>
<td>4.2</td>
<td>17.5</td>
<td>0.7</td>
</tr>
<tr>
<td>Nursery, flower</td>
<td>3.0</td>
<td>20.0</td>
<td>0.6</td>
</tr>
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<td>Nursery, container</td>
<td>5.0</td>
<td>100.0</td>
<td>5.0</td>
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<tr>
<td>Peaches</td>
<td>1.6</td>
<td>40.0</td>
<td>0.6</td>
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<tr>
<td>Pistachios</td>
<td>8.4</td>
<td>53.0</td>
<td>4.5</td>
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<tr>
<td>Rice</td>
<td>0.7</td>
<td>39.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Rice, wild</td>
<td>5.4</td>
<td>93.0</td>
<td>5.0</td>
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<tr>
<td>Spinach</td>
<td>6.1</td>
<td>42.1</td>
<td>2.6</td>
</tr>
<tr>
<td>Strawberry</td>
<td>2.6</td>
<td>30.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Tomato</td>
<td>0.8</td>
<td>30.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Walnut</td>
<td>5.0</td>
<td>40.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
## Table 8
Current bird damage in fruit production by crop and state.

<table>
<thead>
<tr>
<th></th>
<th>Blueberry</th>
<th>Wine grape</th>
<th>Honeycrisp apple</th>
<th>Sweet cherry</th>
<th>Tart cherry</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Damage – per hectare</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>$2063</td>
<td>$247</td>
<td></td>
<td>$1129</td>
<td></td>
</tr>
<tr>
<td>MI</td>
<td>$1871</td>
<td>$430</td>
<td>$1885</td>
<td>$746</td>
<td>$225</td>
</tr>
<tr>
<td>NY</td>
<td>$1609</td>
<td>$230</td>
<td>$3892</td>
<td>$5197</td>
<td>$430</td>
</tr>
<tr>
<td>OR</td>
<td>$4571</td>
<td>$573</td>
<td>$299</td>
<td>$746</td>
<td>$104</td>
</tr>
<tr>
<td>WA</td>
<td>$2444</td>
<td>$946</td>
<td>$7267</td>
<td>$2417</td>
<td>$3042</td>
</tr>
<tr>
<td><strong>Damage – statewide</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>$2,649,875</td>
<td>$49,099,613</td>
<td></td>
<td>$12,378,205</td>
<td></td>
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<tr>
<td>MI</td>
<td>$14,052,402</td>
<td>$2,472,268</td>
<td>$1,498,906</td>
<td>$2,090,723</td>
<td>$2,251,261</td>
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<tr>
<td>NY</td>
<td>$585,753</td>
<td>$3,452,595</td>
<td>$1,373,583</td>
<td>$1,188,371</td>
<td>$261,530</td>
</tr>
<tr>
<td>OR</td>
<td>$11,238,095</td>
<td>$2,675,986</td>
<td>$23,454</td>
<td>$3,253,331</td>
<td>$27,062</td>
</tr>
<tr>
<td>WA</td>
<td>$4,653,105</td>
<td>$12,892,063</td>
<td>$26,758,486</td>
<td>$31,974,215</td>
<td>$1,843,721</td>
</tr>
</tbody>
</table>
Apple orchards (Australia)

- low fruit damage (1.9%)
- Birds ate codling moth larvae
- 12% more apple damage when birds excluded
- Net benefit of birds in apple orchards

- Fewer fruit-eating birds in areas with kestrel boxes
- Every $1 spent on nest boxes saves $84 - $357 in sweet cherries
- Regional benefit of > $2 million
New Zealand vineyards

- Fewer birds in areas with falcons
- Less crop damage
- $200 - $300/ha benefit
Variation in fruit damage

- % damage to cherries varies year to year and region to region
- Higher % damage when:
  - Overall crop size small
    - Absolute damage similar
  - Orchard isolated from other cherry orchards
  - Orchard adjacent to less forest cover
Survey respondents willing to pay $0.41 - $0.76 more for apples and grapes that “embodied practices they considered more natural”

In this case nest boxes for kestrels
What can we do to build biodiversity and boost ecosystem services on the farm?

Figure 1. Birds provide ecosystem services such as pest and weed control (a and c) and disservices such as intraguild predation and crop damage (b and d) in agroecosystems. This panel of images illustrates (a) an Eurasian hoopoe (Upupa epops) carrying a mole cricket, a potential crop pest; (b) an eastern bluebird (Sialia sialis) with a spider, demonstrating intraguild predation; (c) a twite (Carduelis flavirostris) feeding on weed seeds; and (d) a juvenile Lewis’s woodpecker (Melanerpes lewis) consuming an apple and causing crop damage. Photographs: (a) Matthias Tschumi, (b) Brian Lasenby/Shutterstock.com, (c) Pettery Hytönen, and (d) Megan Miller.
Integrated Pest Management - Managing the Landscape

Flower strip on margin of a crop provides natural predator habitat.

Landscape diversity enhances biological control of an introduced crop pest in the north-central USA

M. M. Gardiner,1,5 D. A. Landis,1 C. Gratton,2 C. D. DiFonzo,1 M. O’Neal,3 J. M. Chacon,4 M. T. Wayo,1 N. P. Schmidt,3 E. E. Mueller,2 and G. E. Heimpel4
EFFECT OF ARTIFICIAL PERCHES AND NESTS IN ATTRACTING RAPTORS TO ORCHARDS


ABSTRACT: Artificial perches and nest boxes were placed in three Pacific Northwest orchards to assess their effectiveness in attracting birds of prey to reduce vole populations. The data indicated that birds could be attracted under some conditions, but vole populations were not significantly affected. Additional factors such as vegetative biomass and human activity may limit their usefulness in reducing rodent populations under intensive agricultural conditions.

Published at Univ. of Calif., Davis. 1990.

Photo
Credit
Oregon Tilth

Intercropping sunflower in organic vegetables to augment bird predators of arthropods

Gregory A. Jones*, Kathryn E. Sieving
Department of Wildlife Ecology and Conservation, 110 Newins-Ziegler Hall, University of Florida, Gainesville, FL 32611-0430, United States
Received 27 May 2005; received in revised form 9 March 2006; accepted 21 March 2006
Available online 3 May 2006

Avian Conservation Practices Strengthen Ecosystem Services in California Vineyards

Julie A. Jedlicka1*, Russell Greenberg2, Deborah K. Letourneau1
1 Department of Environmental Studies, University of California Santa Cruz, Santa Cruz, California, United States of America, 2 Migratory Bird Center, Smithsonian Conservation Biology Institute, National Zoological Park, Washington, DC, United States of America
Perches

Many birds of prey will hunt from perches, others hunt while flying, and some do both.

Provision of perches can boost their presence and their hunting success.

Adult short-eared owl
Photo by Ron Dudley
Intercropping or companion planting to attract natural enemies of garden and farm crop pests

Photos thanks to Contours Landscapes
Companion cropping can be constructed to maximize yield, irrespective of attracting natural predators.

Choosing crops that grow well together and attract natural predators will increase the overall benefits that accrue from the practice.
Farmers’ Opinions about Bird Conservation and Pest Management on Organic and Conventional North Florida Farms

Susan K. Jacobson, Kathryn E. Sieving, Greg Jones, John McElroy, Beida Chen, Mark E. Hostetler, and Sarah W. Miller

Figure 1. Farms can provide good habitat for birds as long as certain practices are adopted.
Credits: UF/IFAS

Figure 2. Organic farmers usually grow many different crops and rely on biological interactions and IPM strategies for pest control.
Credits: Greg Jones

Figure 4. A Great-crested Flycatcher with insect in beak, perched on a nestbox. Insect-eating birds might aid farmers by helping to lower insect pest populations on farms.
Credits: Karl E. Miller
Perch designs are readily found on the web.
Construct and deploy bird boxes

Plans are readily available on the web

- bluebird boxes
  often bring in swallows

- kestrel boxes
  kestrels are a small falcon

http://www.birdwatching-bliss.com/bluebird-house-plans.html
Conclusions

Actions to help birds on the farm

- Manage the landscape to provide bird habitat
- Erect hunting perches for birds of prey
- Deploy nest boxes - bluebirds, swallows, kestrels, barn owls
- Intercrop bird habitat with agricultural crops
- Buy shade-grown coffee and other bird-friendly agricultural crops

Photos from Utah State University Extension Services
Acknowledgements

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- Jo Ann Baumgartner – Wild Farm Alliance
- University of Chicago Press