Why Birds Matter
A Brief Introduction to Ecosystem Services

SFBBO Birdy hour
30 April 2020

Many photos used in this presentation are licensed under the Creative Commons Attribution-Share Alike license.
Acknowledgements

- Chris Whelan – Moffitt Cancer Center
- Çağan Şekercioğlu - University of Utah
- Megan Garfinkel – University of Illinois at Chicago
- Ron Davis – He actually read the book!
- Jo Ann Baumgartner – Wild Farm Alliance
- University of Chicago Press and all the coauthors of Why Birds Matter

This presentation summarizes the work of many researchers. While I can’t list them all here please see the notes section for citations to some of the key papers
Goals for today

- Define/describe ecosystem services (ES101)
  - Be ready for the quiz

- Overview of ecosystem services provided by birds
  - Pest control
  - Seed dispersal
  - Scavenging
  - Maybe some bonus content if we have time

- Some things you can do
Ecosystem Services

- Natural processes and products that benefit human society

Human economy based on natural resources
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
What is an ecosystem?

Major interacting system of organisms (animals, plants, fungi, bacteria) and the physical environment
Biomes characterized by climate, soil, and vegetation
Ecosystems driven by biogeochemical cycles

The Carbon Cycle
Non-replaceable resources

- Top soil
- Ground water
- Biodiversity

nonrenewable on human timescale; perhaps renewable on geologic/evolutionary timescale
Biotic control of ecosystem function

Food Chain

Food Web
Energy from sun flows up the pyramid to the apex predator
Each level about 10% of the next lower level (you can feed many more vegetarians than carnivores)
Decomposers off to the side
Conceptual framework

- 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” agriculture vs ecological farming
Loss of ecosystem services in Madagascar after deforestation

example of the value of biodiversity for ES – question is how to quantify the value
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)
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)
5700 + 1700 species

Pest Control - invertebrates

Most important Bird ES by # species
about 75% of all bird spp eat some inverts
huge diversity of morphologies & foraging behaviors
Herbivores like caterpillars can do tremendous damage to native and cultivated plants.
insects

plants

birds

(?)

The enemy of my enemy is my friend.
Bird Predation on Forest Insects: An Exclosure Experiment

RICHARD T. HOLMES, JOHN C. SCHULTZ, PHILIP NOTHNAGLE

DOI: 10.1126/science.206.4417.462
Missouri white oaks

Experimental treatments
• Cage (insects but no birds)
• Control (insects and birds)
• Insecticide (no insects)
• Measured plant growth

...an experiment on cascading effects.
Missouri white oaks - Results

Insectivorous Birds Increase Growth of White Oak through Consumption of Leaf-Chewing Insects
September 1994
Ecology 75(7):2007-2014
DOI: 10.2307/1941605
Robert J Marquis
Christopher J Whelan
Birds can control insect pests in agricultural ecosystems, precluding the use of harmful pesticides!

Numerous other examples
apple orchards
coffee plantations
broccoli

Summarized in:
Ecosystem Services Provided by Birds
June 2008
DOI:
10.1196/annals.1439.003
Christopher J Whelan
Dan Wenny
Robert J Marquis
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.

Also, pesticides and herbicides quickly lead to resistant pests
Do prairie birds provide services or disservices on adjacent conventional farms?

Megan Garfinkel
University of Illinois at Chicago
• Birds can affect crops in a number of ways through trophic interactions
• No obvious signs of direct songbird damage to established corn or soy.
• A purdue study found little to no damage to established field corn or soy by birds. Birds like turkeys may damage newly emerged crops, but not when they are established
• Birds can also do a combination of service/disservice
Year 1: Study sites at Nachusa Grasslands
Crops were enclosed within cage exclosures to prevent birds from foraging for potential pests

- harvested and dried crops from exclosures and control plots to compare yield
- Dried them to constant weight
Year 1: Economic Effects of birds

CORN:
Service
$115.28/acre

SOY:
Disservice
- $145.54/acre
None of the soybean pests detected generally cause extreme economic damage at normal densities.

How do we explain the fact that birds seem to be providing a service in corn, and a disservice in the adjacent soy field?

The main difference here is that northern corn rootworms are known for causing real economic damage in corn, whereas all of the soy pests that I detected, such as the one-spotted stink bug, generally don’t cause high levels of damage in soy at normal densities. So although lots of birds are eating beneficial arthropod predators, this isn’t enough to disrupt the biological control by arthropods in corn, but it may be in soy, leading to increased crop yield when birds are excluded from the crops.
Year 2 Results: Birds did not affect soybean grain yield.
In the months of May and June they were menaced by a danger as bad as the persecution of mobs. Myriads of crickets came down the mountain sides into the valley, like a vast army marshaled for battle, and began to destroy the fields. Nothing that man could do was able to stop the steady onward march of the voracious crickets. The settlers were hapless before them. When all seemed lost, and the Saints were giving up in despair, the heavens became clouded with gulls, which hovered over the fields. They ate, they gorged upon the pests. This took place day by day until the crickets were destroyed.

The people gave thanks, for this was to them a miracle. Surely the Lord was merciful and had sent the gulls as angels of mercy.
Pest Control - rodents

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

Seed-eating birds

1100 + 1000 species

- Crop pests or weed seed control?
- Few experimental studies in agroecosystems
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
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.
Scavengers

40 + 300 species

New World – 7 spp
Old World – 15 spp.
East Africa:

64% of ungulate deaths
“non-predatory”

26 million kg annually
Translation: lots of dead stuff out there
Vulture declines in India

- Declines up to 95% in past 25 yrs
- Diclofenac residue in cattle
- Increase in disease
- Increase in rats, feral dogs
- $34 billion in increased health costs 1993-2006

Counting the cost of vulture decline—An appraisal of the human health and other benefits of vultures in India
Markandya, A; Taylor, T; Longo, A; et al.
Ecological Economics 2008
Zoroastrians

Dokhna
Tower of Silence
Man missing in Grand Canyon

Tuesday, April 08, 2008

A Grand Canyon resident reported missing has been found dead 300 feet below a popular point looking out onto the Bright Angel Trail, the National Park Service said Monday.

The man was reported missing March 14, prompting a search in the Grand Canyon. His body was found Friday, when a wildlife biologist noted intense condor activity in one area and then hiked to a vantage point to spot the body.
Nutrient Cycling

950 species of seabirds
Guano for fertilizer

- Important in 1800's
- Peru was main exporter
- Until Haber-Bosch process
The Guano Wars

- Guano Island Act 1856
  - US vs UK vs Venezuela
- 1864-1866
  - Spain vs Peru
  - Spain vs Chile
- 1879-83
  - Chile vs Peru + Bolivia
Pollination

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

- New Zealand mistletoes
  - Plant population declines after bird extirpation
- Bahamas post-hurricane
  - Fruit set declined 74%
- Competition from introduced honeybees
- Forest fragmentation in Australia
  - Reduced gene flow

Cascading Effects of Bird Functional Extinction Reduce Pollination and Plant Density
January 2011
Science 331(6020):1068-71
DOI: [10.1126/science.1199092](https://doi.org/10.1126/science.1199092)
Sandra Helen Anderson
Dave Kelly
Jenny J. Ladley
Jon Terry

40% of bird species eat at least some fruit
20-25% of seed plant species potentially dispersed by birds
Advantages of Seed Dispersal

- Escape from predation and competition
- Colonization of open sites
- Directed dispersal to the best sites
- Gene flow
- Enhanced germination

compared to no dispersal (falling under parent plant)
certain species may be particularly important dispersers*

*large-gaped tropical frugivores with lek breeding systems

FIG. 3. One-year seedling survival, proportion of mortality caused by fungal pathogens, and seedling height (mean +/- SD) for seeds dispersed by bellbirds (open bars) and four other species (shaded). Seeds dispersed by bellbirds were more likely to survive to 1 year ($X^2 = 4.6$, df = 1, $P = 0.03$), and the resulting seedlings ($n = 17$) were taller ($t$ test = 2.37, df = 36, $P = 0.02$) than were seedlings from seeds dispersed by the other four species ($n = 21$). Bellbird sites had a lower incidence of mortality by fungal pathogens than did the seedlings from seeds dispersed by the other four species ($X^2 = 4.28$, df = 1, $P = 0.03$).

Nurse plants and treefall gaps

Seed dispersal by birds and mammals drives plant succession in many habitats
Mistletoes

Most species require seed dispersal by birds
Seed Dispersal - Waterbirds

ducks & geese, shorebirds, gulls, rails

Disperse seeds of aquatic plants and eggs of invertebrates


no systematic survey so # species involved not clear (birds, plants, or inverts)
Scatterhoarding by Corvids

Pines & Oaks
Long distances
Suitable sites
Loss of dispersers


ultimately a shift in forest plant composition: large-seeded trees become less common, small-seeded and wind-dispersed species become more common
### Frugivory & Seed dispersal
**Service or Disservice?**

<table>
<thead>
<tr>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>• fruit damage in orchards, vineyards, berries</td>
<td></td>
</tr>
<tr>
<td>• Cost of deterrence</td>
<td>• May eat insect pests</td>
</tr>
<tr>
<td>• Spread invasive species</td>
<td>• Help regenerate hedgerows and natural areas</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>
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>0.5</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>7.4</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>0.3</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>
<tr>
<td>Nursery, container</td>
<td>5.0</td>
<td>100.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Peaches</td>
<td>1.6</td>
<td>40.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Potatoes</td>
<td>8.4</td>
<td>53.0</td>
<td>4.5</td>
</tr>
<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>
</tr>
<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>Wheat</td>
<td>5.9</td>
<td>40.0</td>
<td>2.8</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

Orchard 6 was most intensely managed so not much opportunity for birds to be beneficial
• Fewer fruit-eating birds in areas with kestrel boxes
• Every $1 spent on nest boxes saves $8.4 - $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

Ecosystem Engineers

Woodpeckers - 180 species,
Burrows & cavity nesters - 1000 species
Hummingbirds regularly use sapsucker wells
Provisioning and Cultural Services

- Food
- Insulation
- Fertilizer
- Decoration

- Art & Literature
- Music & dance
- Myths & religions

- Tourism
- Hunting
- Falconry
- Pets
US - $12 billion (all hunting)
World - $25 billion
Soup $60

Nests
$1000/pound

in Hong Kong
Honeyguides

On the way to a bee’s nest, a honeyguide uses a particular call and responds to a human voice by increasing call frequency.

After arriving at a bee’s nest, the honeyguide gives a few distinctive indication calls and then perches silently near the nest.
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Frank Chapman's 1886 Feathered Hat Census</td>
<td></td>
</tr>
<tr>
<td>7 Grebes</td>
<td>5 Blue Jay</td>
</tr>
<tr>
<td>1 Green-backed Heron</td>
<td>3 Eastern Bluebird</td>
</tr>
<tr>
<td>1 Virginia Rail</td>
<td>4 American Robin</td>
</tr>
<tr>
<td>1 Greater Yellowlegs</td>
<td>1 Northern Shrike</td>
</tr>
<tr>
<td>5 Sanderling</td>
<td>1 Brown Thrasher</td>
</tr>
<tr>
<td>1 Laughing Gull</td>
<td>1 Bohemian Waxwing</td>
</tr>
<tr>
<td>21 Common Tern</td>
<td>23 Cedar Waxwing</td>
</tr>
<tr>
<td>1 Black Tern</td>
<td>1 Blackburnian Warbler</td>
</tr>
<tr>
<td>2 Ruffed Grouse</td>
<td>3 Blackpoll Warbler</td>
</tr>
<tr>
<td>1 Greater Prairie Chicken</td>
<td>3 Wilson's Warbler</td>
</tr>
<tr>
<td>16 Northern Bobwhite</td>
<td>2 Tree Sparrow</td>
</tr>
<tr>
<td>2 California Quail</td>
<td>1 White-throated Sparrow</td>
</tr>
<tr>
<td>1 Mourning Dove</td>
<td>15 Snow Bunting</td>
</tr>
<tr>
<td>1 Northern Saw-whet Owl</td>
<td>1 Bobolink</td>
</tr>
<tr>
<td>21 Northern Flicker</td>
<td>2 Meadowlarks</td>
</tr>
<tr>
<td>2 Red-headed Woodpecker</td>
<td>5 Common Grackle</td>
</tr>
<tr>
<td>1 Pileated Woodpecker</td>
<td>9 Northern Oriole</td>
</tr>
<tr>
<td>1 Eastern Kingbird</td>
<td>3 Scarlet Tanager</td>
</tr>
<tr>
<td>1 Scissor-tailed Flycatcher</td>
<td>1 Pine Grosbeak</td>
</tr>
<tr>
<td>1 Tree Swallow</td>
<td></td>
</tr>
</tbody>
</table>
45 million bird enthusiasts in US
$32 million spent in 2001
$85 million in overall economic activity
860,000 jobs
Not the
Bird-man of Lascaux, France
16,500 ybp
The Crane Wife – Japanese folk tale
Alfred Hitchcock’s The Birds – (all fake, don’t believe it)
Swan Lake
Aesop’s Fables
Birds in music

- Eurasian Common Cuckoo
  - Beethoven: 6th symphony
- Goldfinch
  - Vivaldi: Il Gardellino flute concerto
  - Mozart: Piano Concerto in G, No. 17
- Nightingale
  - Rameau: Air du Rossignol
- Scarlet Tanager
  - Dvorak: American String Quartet
- Vaughn Williams – The Lark Ascending
Horus = Barbary falcon?
Toth = sacred ibis
Ra = Lanner falcon
false idols
• Part of being human is living in a world with birds

• Difficult to calculate the value
Conclusions

Actions to help birds

- 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
- Keep cats indoors (and don’t feed ferals)

Photos from Utah State University Extension Services
Birds as Bio-indicators

- Citizen science programs
- 20% of bird species at risk
- 6% functionally extinct

- By 2100:
  - 6-14% of birds extinct
  - 7-25% functionally extinct
More study needed