Why Birds Matter in Agricultural Landscapes

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Why Birds Matter in Agricultural Landscapes

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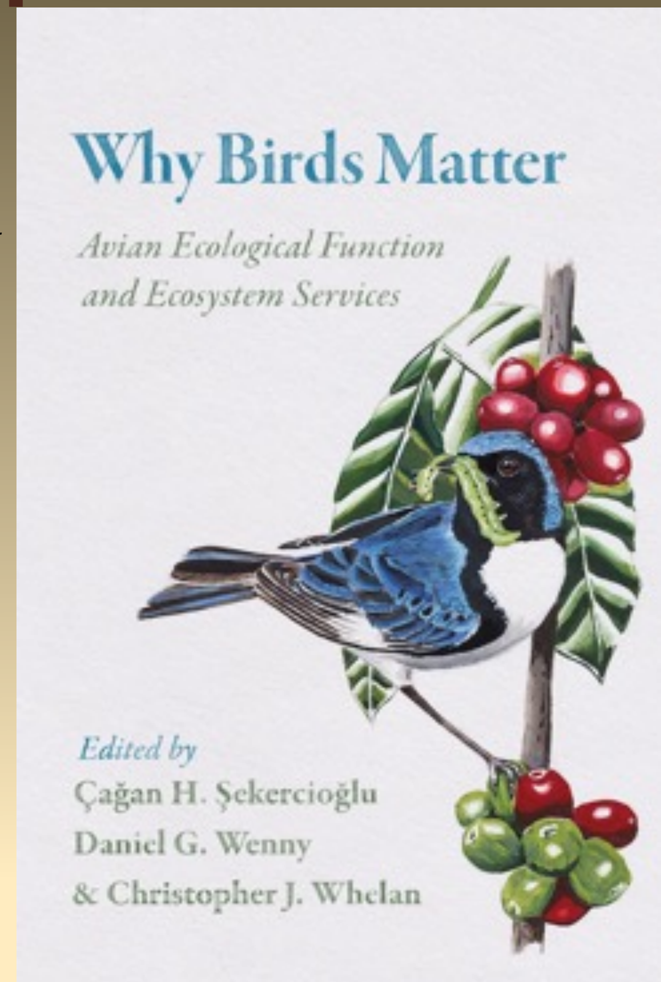


University of Chicago Press, August 2016

MOFFITT CANCER CENTER

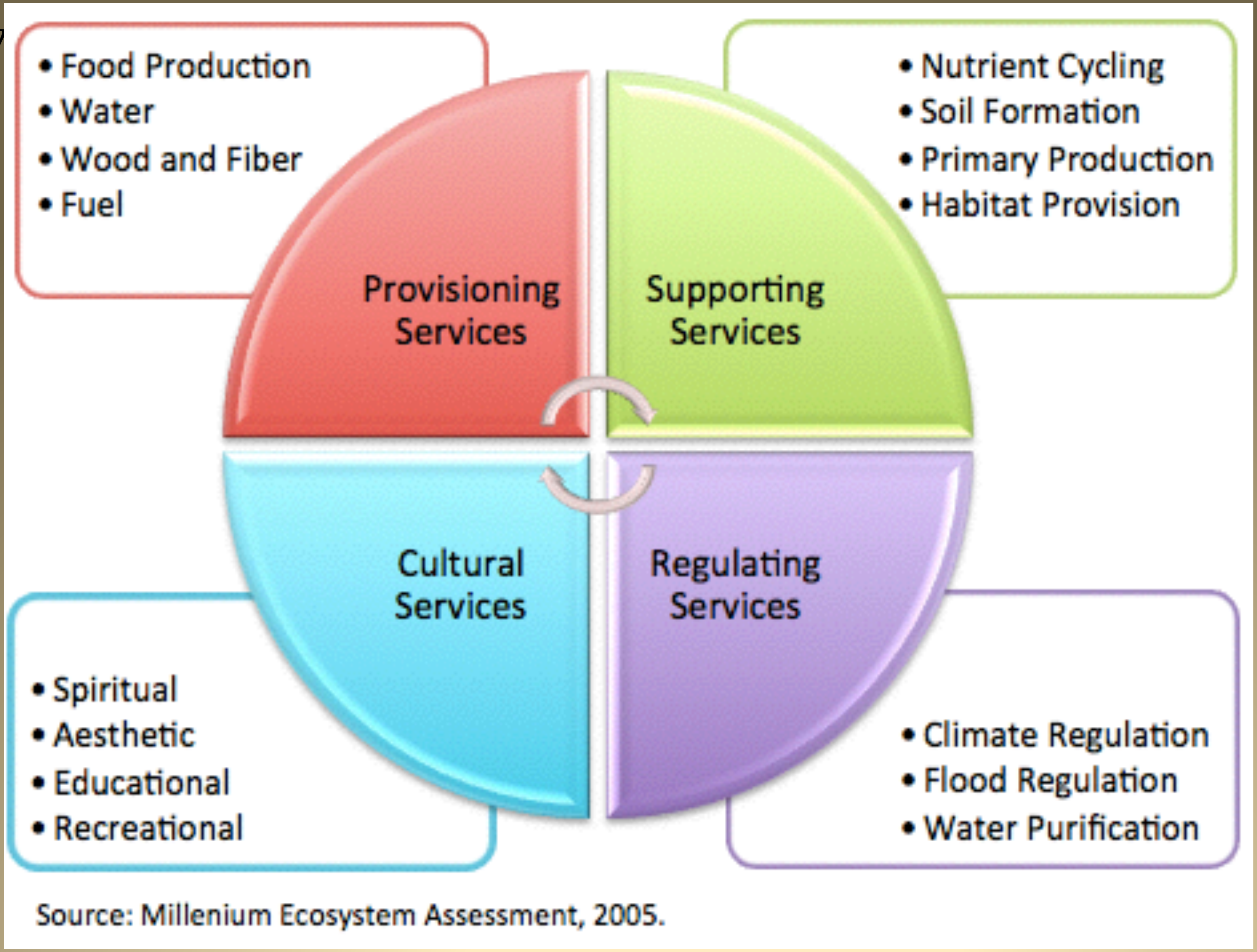
SAN FRANCISCO BAY BIRD OBSERVATORY

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



Birds provide all types of ecosystem services

- Provisioning
  - Food, clothing, fertilizer, insulation
- Cultural
  - Decoration, art & literature, spiritual, tourism
- <u>Supporting and regulating</u>
  - 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

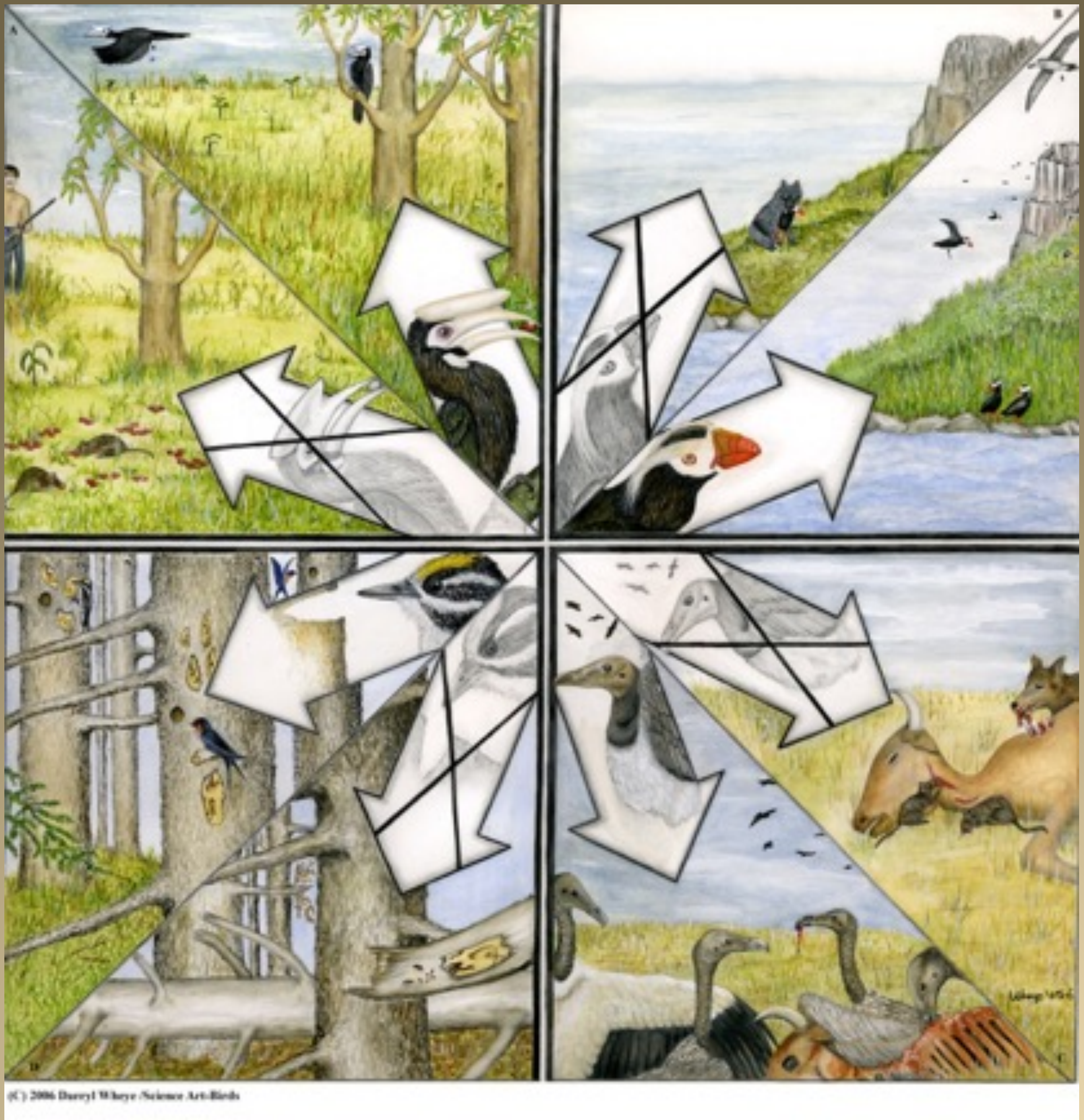
What happens without birds?

Seed dispersal

Nutrient Cycling

Ecosystem engineers

Scavengers

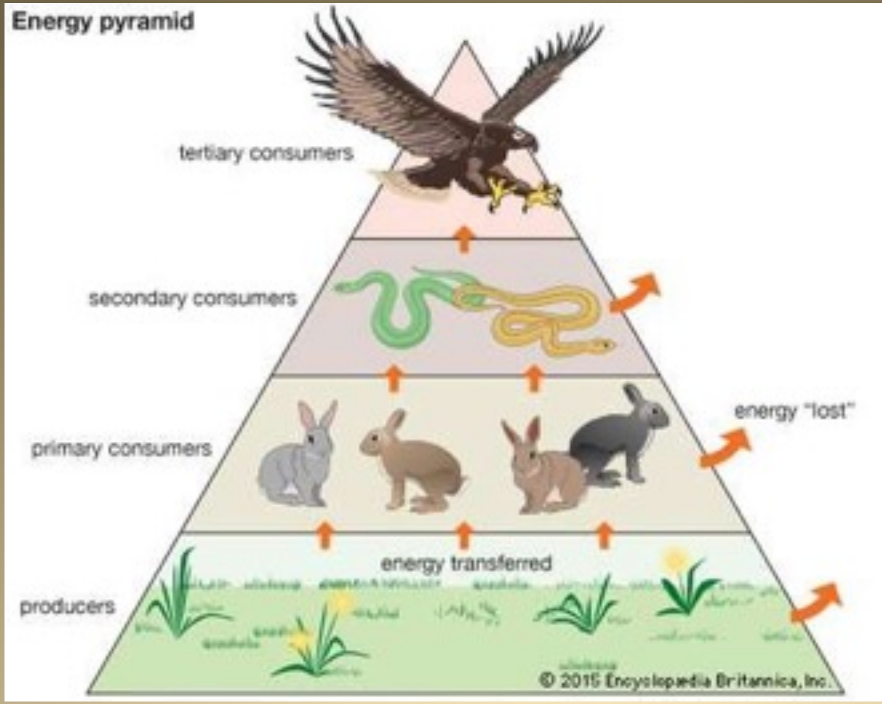


Ecological Roles of Birds

- 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

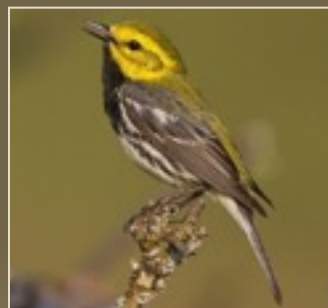
- Plants represent structurally distinct resource patches
- Bird species exhibit tradeoffs in their resource exploitation of these patches
- Tradeoffs promote coexistence and help explain community structure
- Diverse community of insectivorous bird species: Effective, RESISTANCE-PROOF biological insecticide

Birds as Practitioners of Insect Topiary

Topiary:

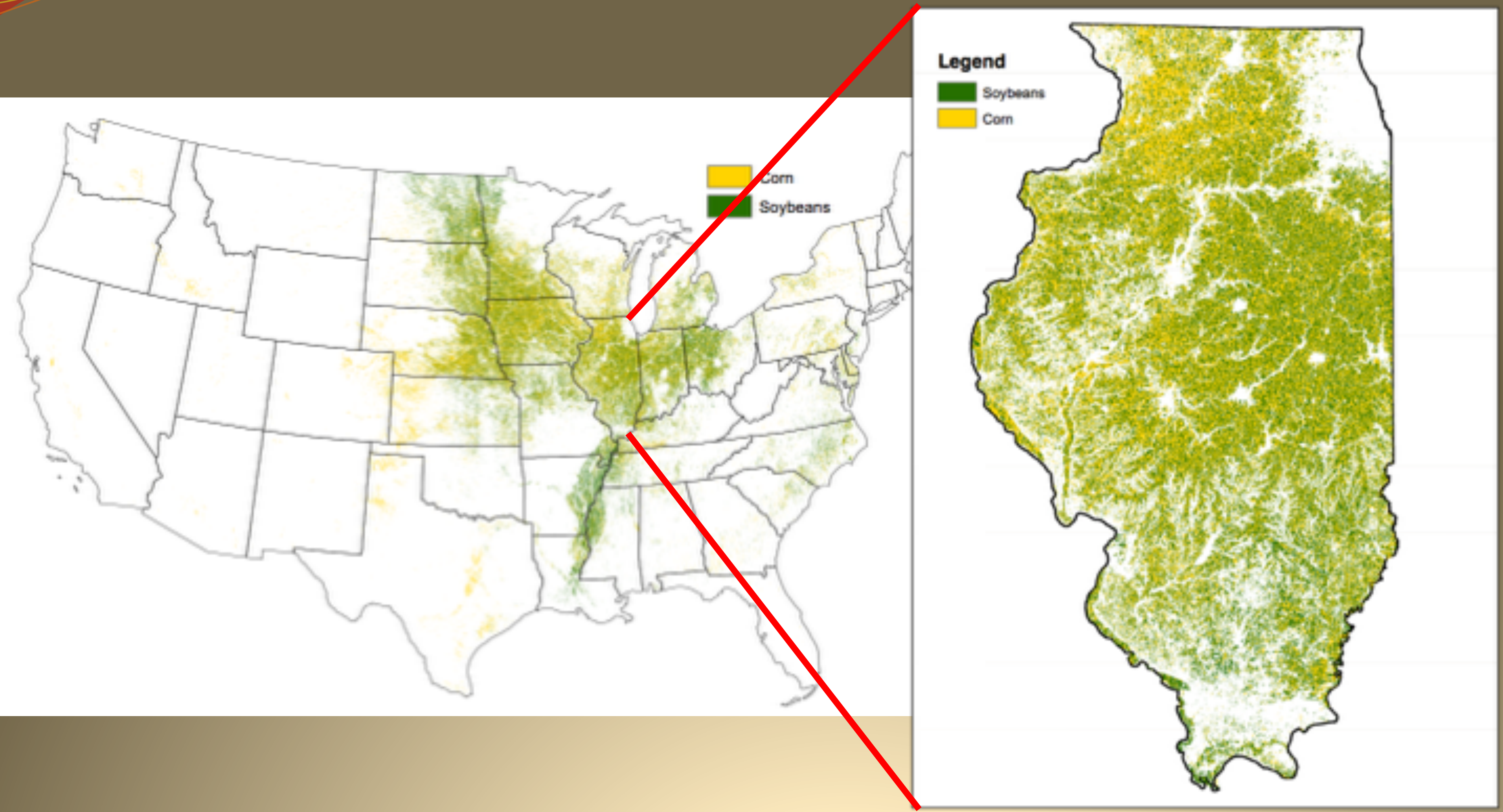
Practice in which shrubs or other plants are trimmed with garden shears into sculptures (a classic example of "sheer" madness!!)

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


Corn
Soybeans
Legend
Soybeans
Corn

Prairies and grasslands act as source habitat for Midwest farmland birds

Photos by Richard Hickson

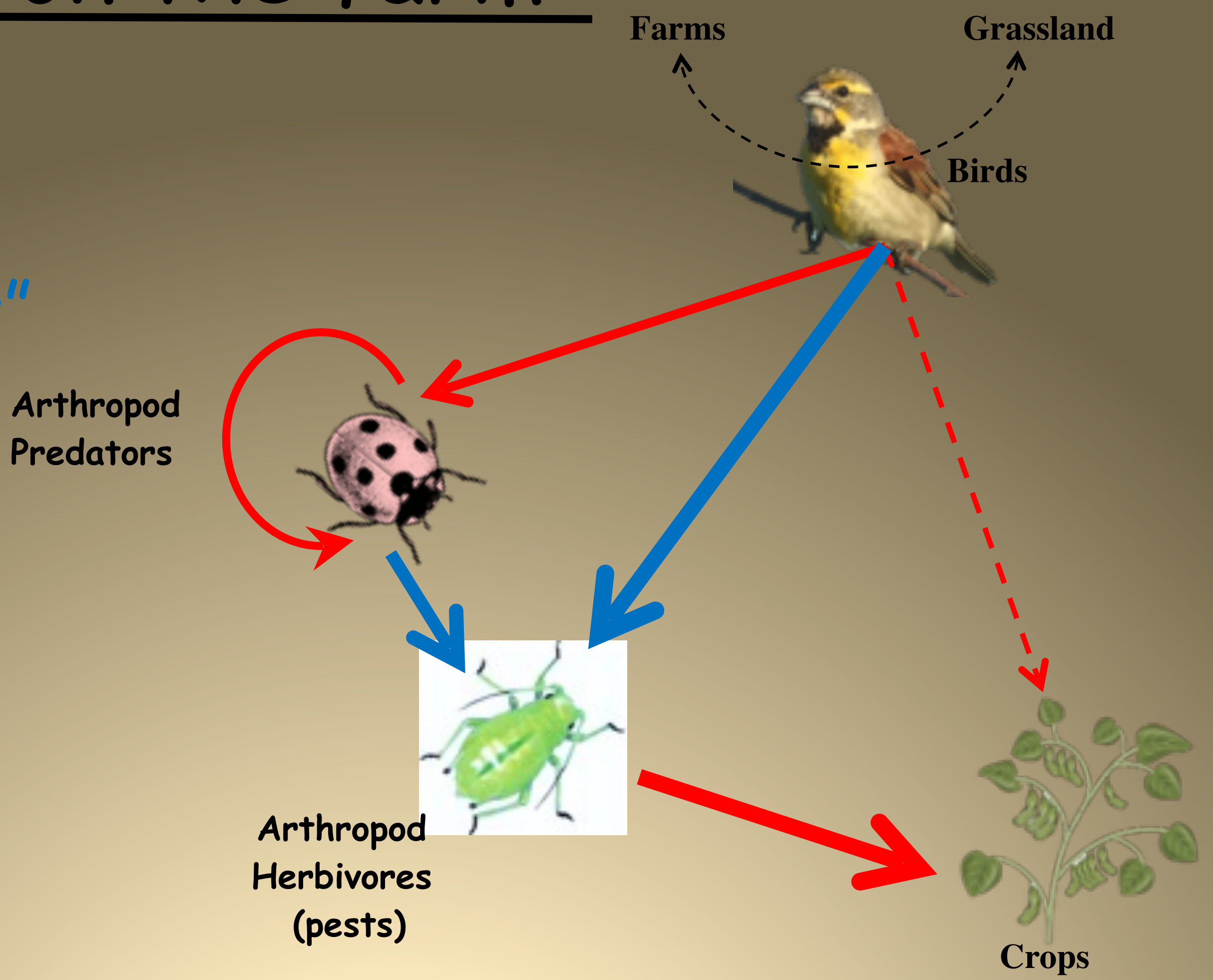
Birds down on the farm

Services:

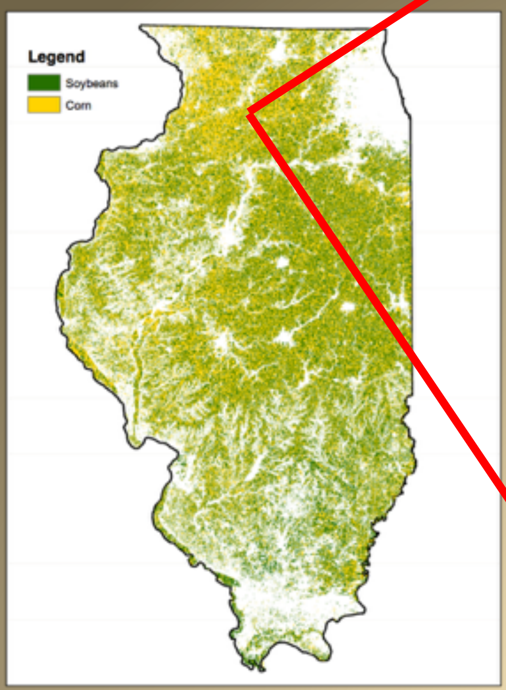
- Birds eat "pests"

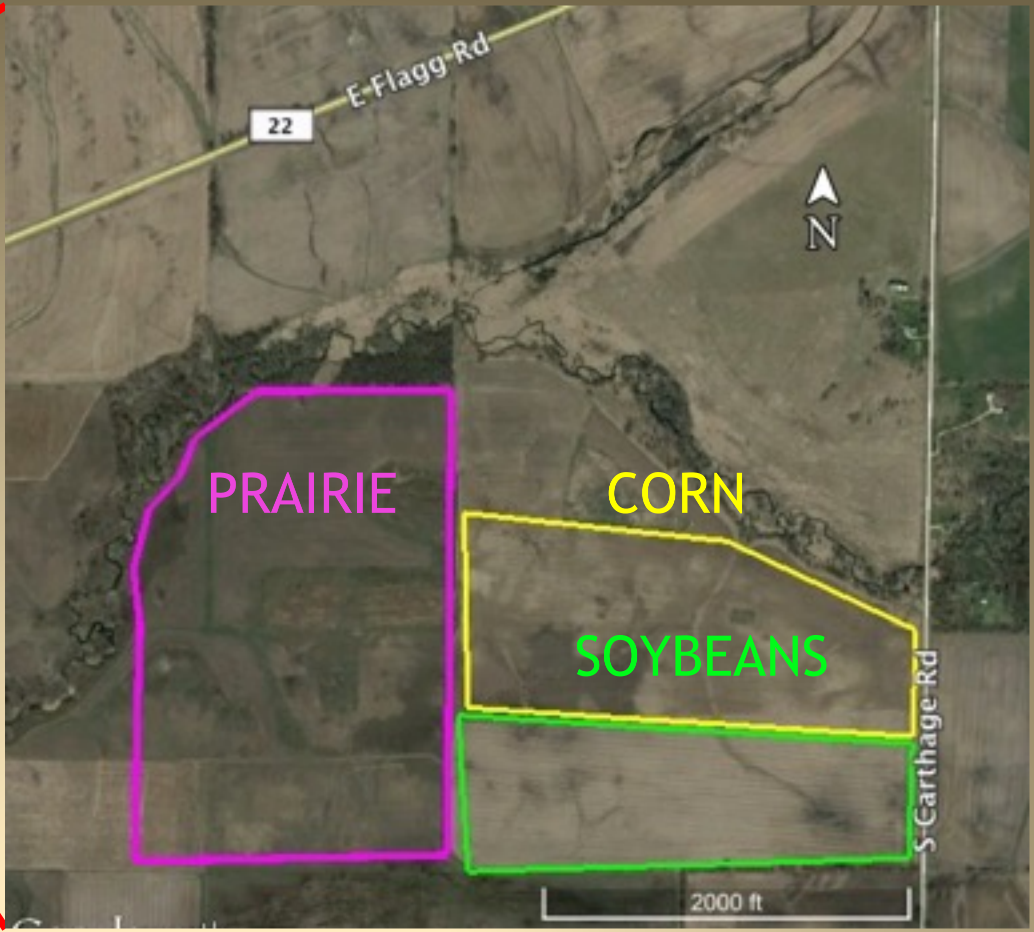
Disservices:

- 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

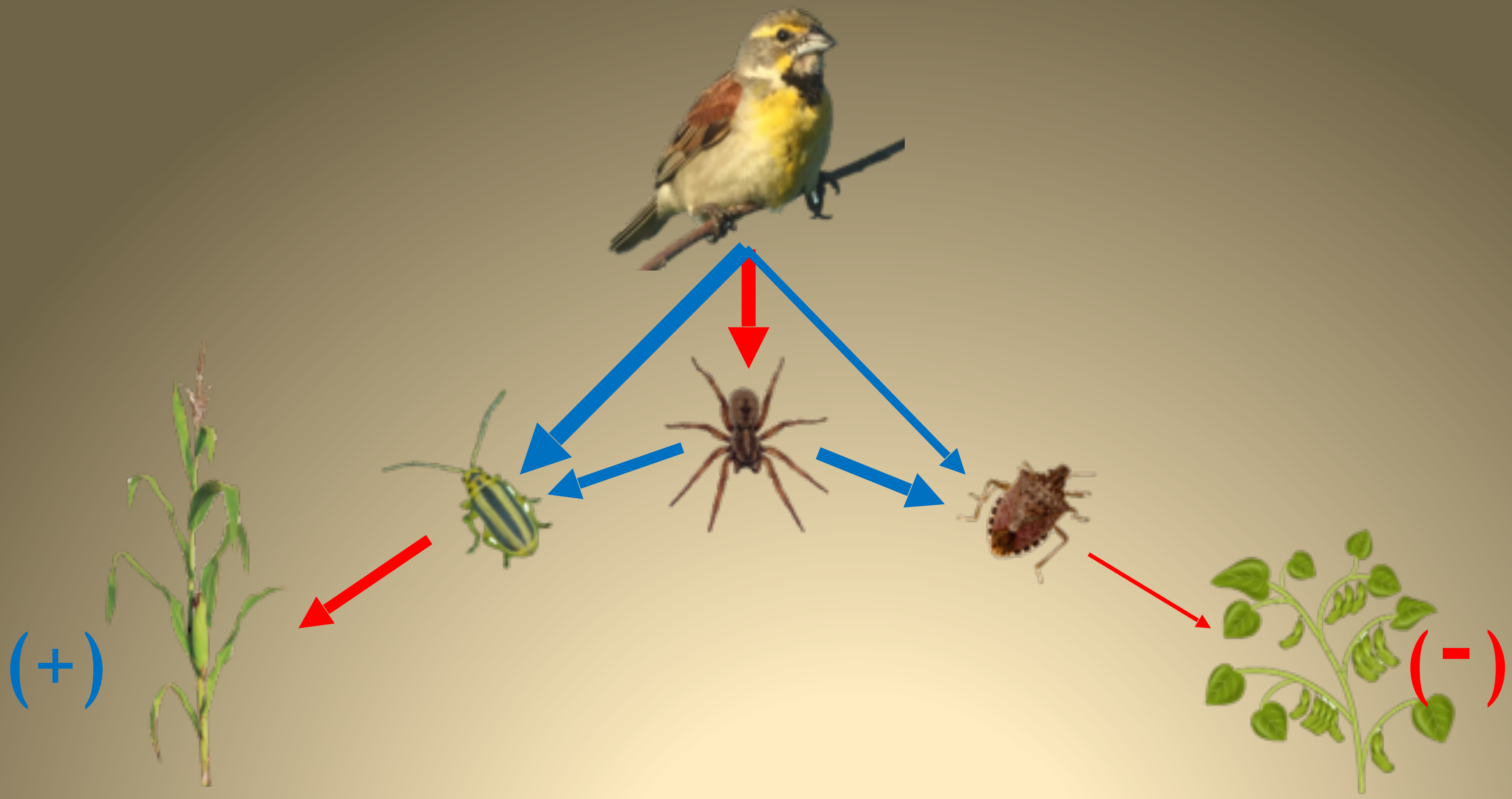
$115.28/acre

SOY:

Disservice

- $145.54/acre

How do bird diets explain exclosure results?



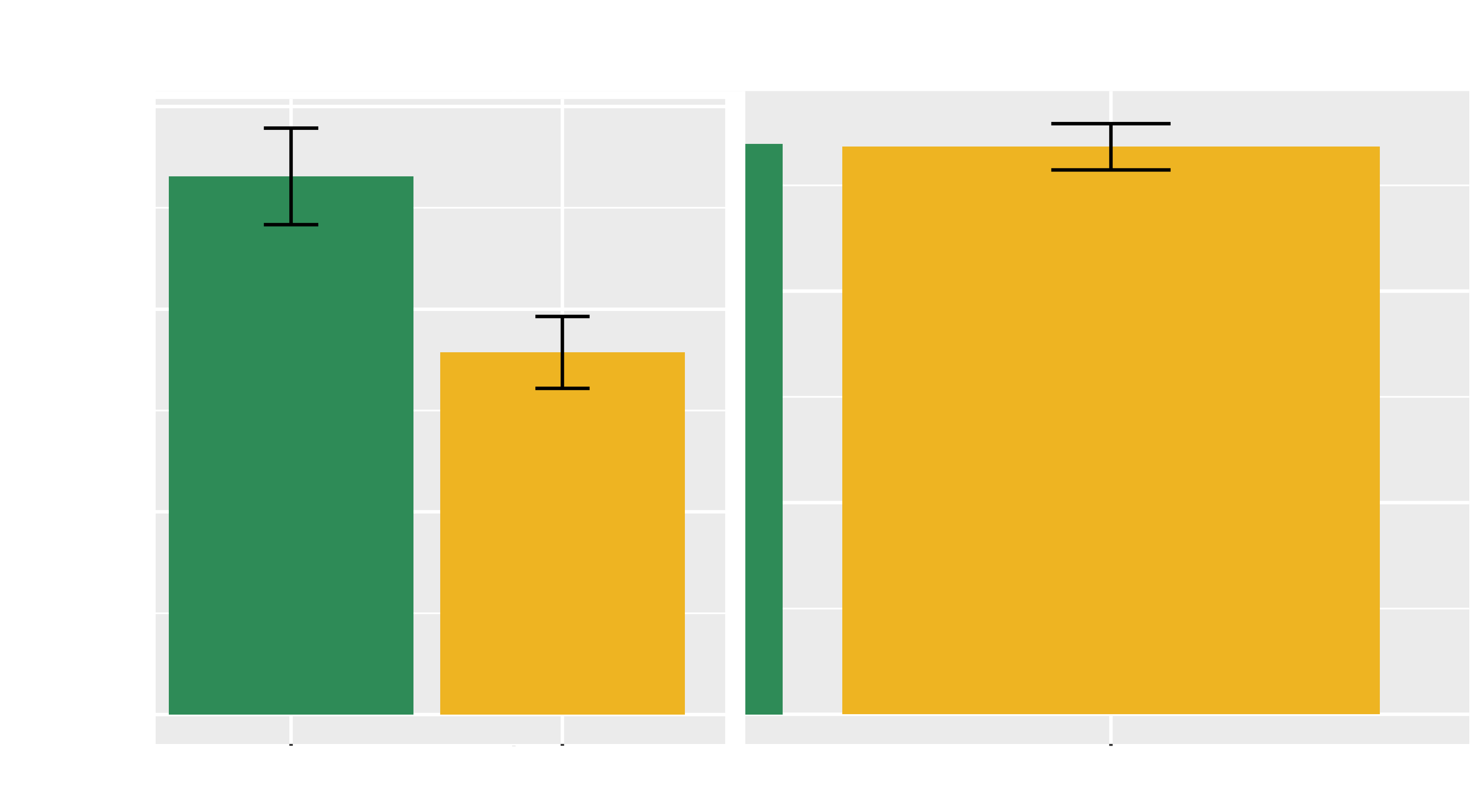
Year 2: Methods

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



2.

Year 2 Results: Birds did not affect soybean grain yield



Numerous other examples

- apple orchards
- coffee plantations
- broccoli

Birds can control insect pests in agricultural ecosystems, precluding the use of expensive pesticides!

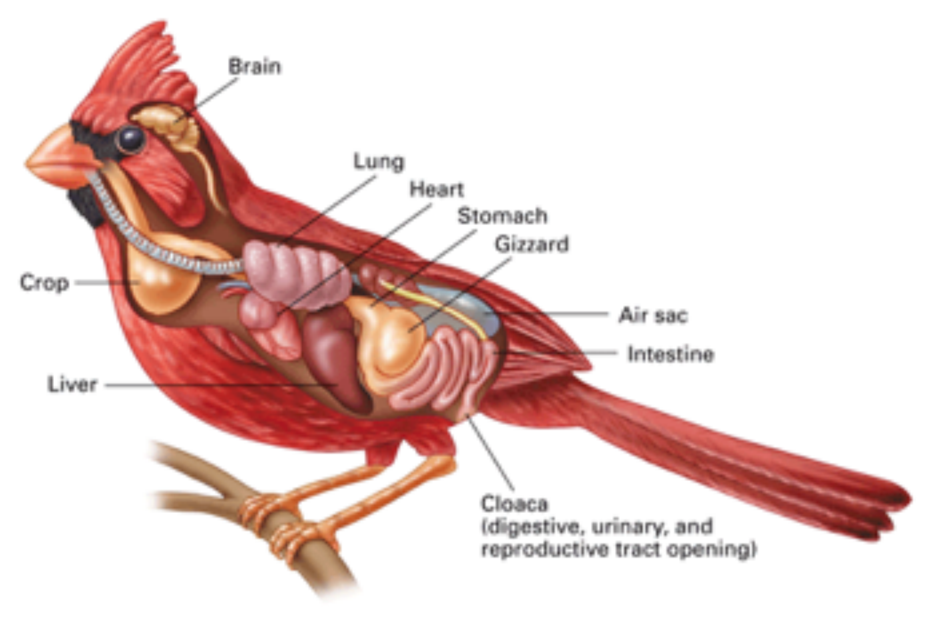
Seed-eating birds

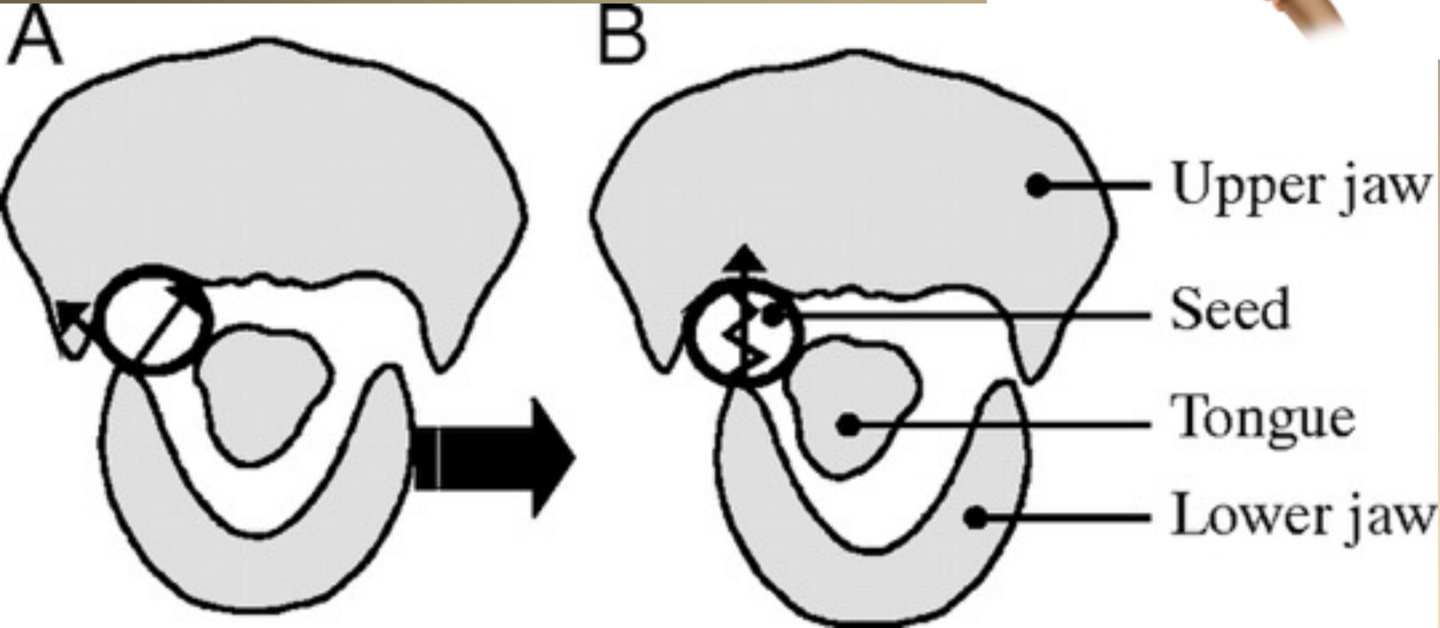
1100 + 1000 species

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

Birds as granivores

- bill shape
- gizzard





van der Meij & Bout 2006. Seed husking time and maximal bite force in finches. J Exp Biol 209:3329-3335.

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


Bernard Dupont

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


Alan Brock

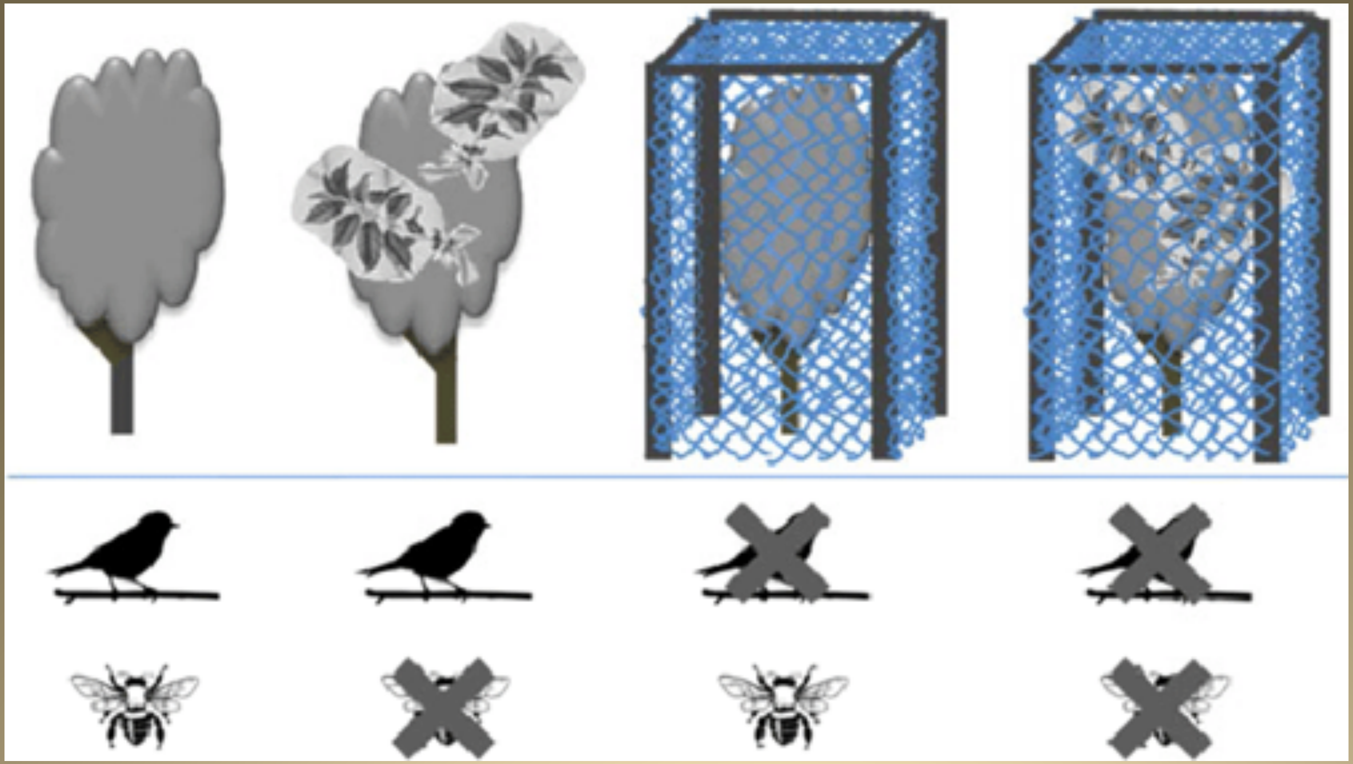

Phil Kahler

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



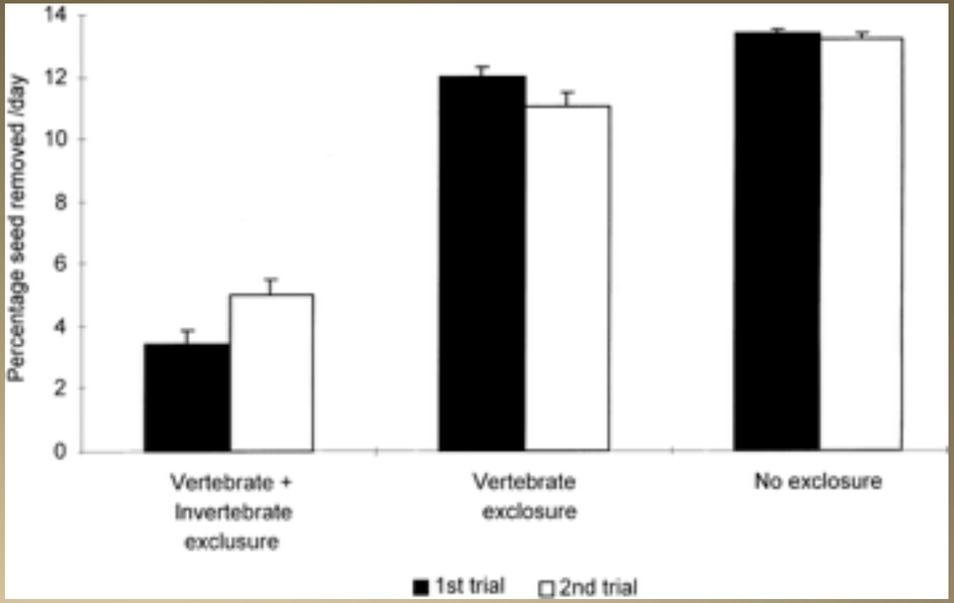
Complementary ecosystem services provided by pest predators and pollinators increase quantity and quality of coffee yields
Classen et al. 2014 Proceedings of the Royal Society B: Biological Sciences 281(1779):20133148 DOI: 10.1098/rspb.2013.3148

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



Post-dispersal weed seed predation in Michigan crop fields as a function of agricultural landscape structure.
Menalled et al. 2000 Agriculture, Ecosystems and Environment 77 (2000) 193–202

- Definitely need more research in this area

Pest Control - rodents

300 + 1100 species

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

Control of pest birds and mammals

Raptors – hawks and owls

Shrikes – predatory songbirds

Barn owl Peter Trimming

Short-eared owl Sumeet Moghe

Red-tailed hawk - Greg Hume

Long-eared owl
Richard Hickson

Red-tailed hawk - Snowmanradio

Loggerhead shrike
Photo from Richard
Hickson

Loggerhead shrike –

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

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

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

Immature red-tailed hawk in action

Photo by Steve Jurvetson
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

Adult Cooper's hawk
Photo from Vanillakirsty

Cooper's hawks

As with all hawks in the genus Accipiter, Cooper's are bird specialists.

They may help control pest bird species.

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

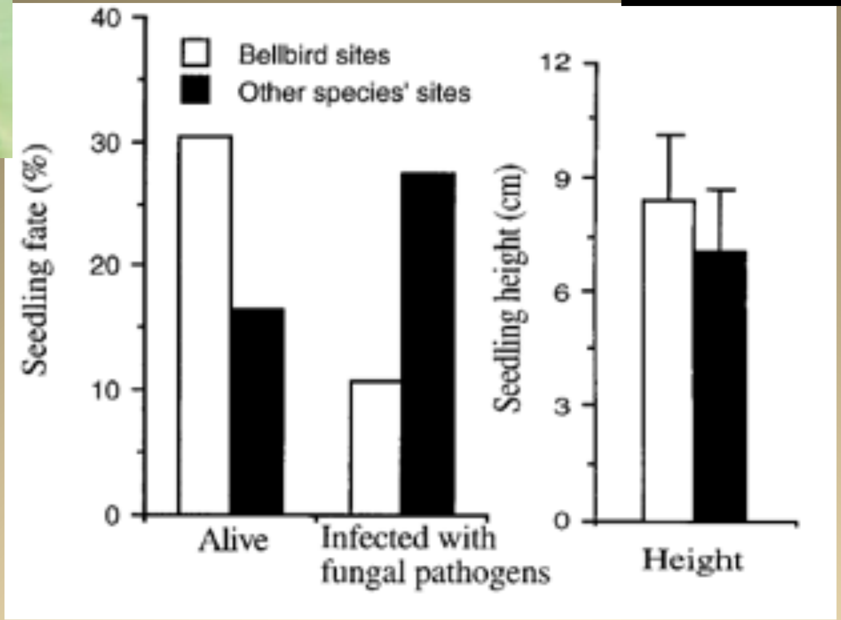
- 1400 +2600 bird species
- 50,000 – 80,000 plant species

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

Wenny, D.G. & D.J. Levey. 1998. Directed seed dispersal by bellbirds in a tropical cloud forest. *Proc. Natl. Acad. Sci. USA* ***95: 6204–6207.***

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

Green & Elmberg 2014 *Biol. Rev.* ***89, pp. 105–122.***

Scatterhoarding by Corvids

Pines & Oaks

Long distances

Suitable sites

Loss of dispersers

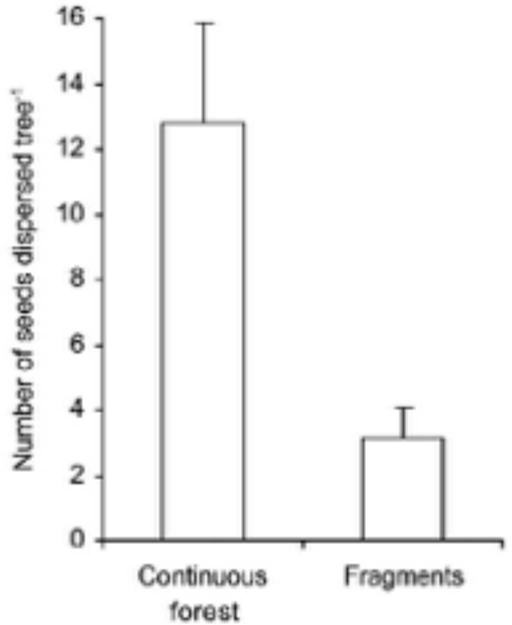
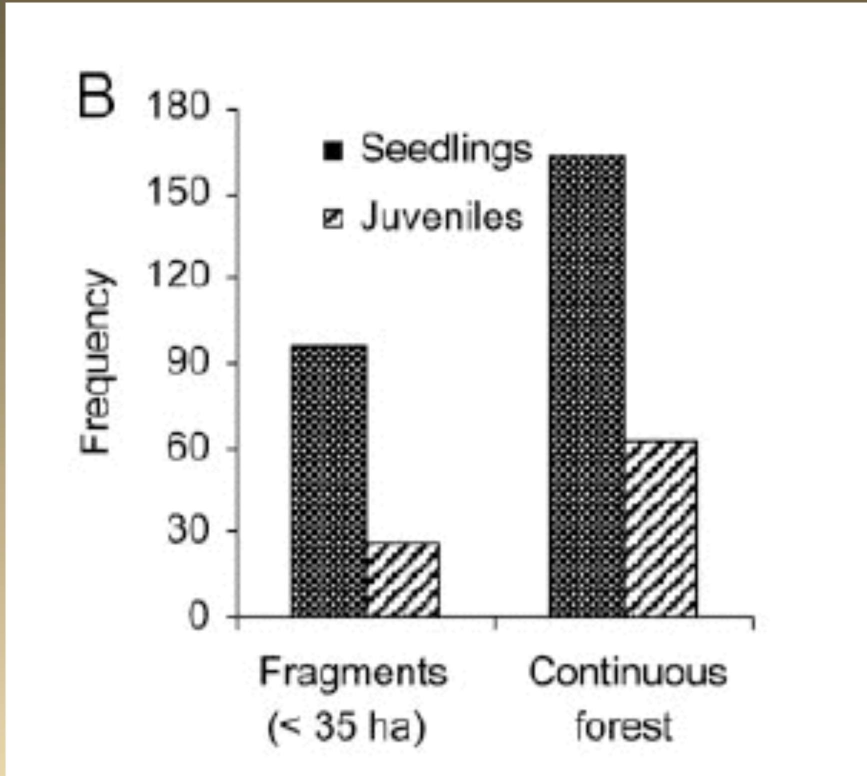


Fig. 1. Seed removal differs between trees in the continuous forest and small fragments (Mann–Whitney U test, $U = 31.5$, $P < 0.01$). This difference remains for 10 continuous forest trees clearly comparable in crop size to fragment trees (Mann–Whitney U test, $U = 22$, $P < 0.05$).



Cordeiro, N.J. & H.F. Howe. 2003. Forest fragmentation severs mutualism between seed dispersers and an endemic African tree. *Proc. Natl. Acad. Sci. USA* ***100:*** 14052–

Frugivory & Seed dispersal in agroecosystems

Costs

- fruit damage in orchards, vineyards, berries
  - Cost of deterrence
- Spread invasive species
- Species considered crop pests:
  - American robin
  - Cedar waxwing
  - European starling

Benefits

- May eat insect pests
- Help regenerate hedgerows and natural areas

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.

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

Bird damage to select fruit crops: The cost of damage and the benefits of control in five states

Crop Protection 52 (2013) 103–109

A. Anderson [a,*], C.A. Lindell [b], K.M. Moxcey [a], W.F. Siemer [c], G.M. Linz [d], P.D. Curtis [c], J.E. Carroll [c], C.L. Burrows [e], J.R. Boulanger [c], K.M.M. Steensma [f], S.A. Shwiff [a]

Table 8
Current bird damage in fruit production by crop and state.

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

Apple orchards (Australia)

Peisley et al. (2016), Cost-benefit trade-offs of bird activity in apple orchards. PeerJ 4:e2179

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

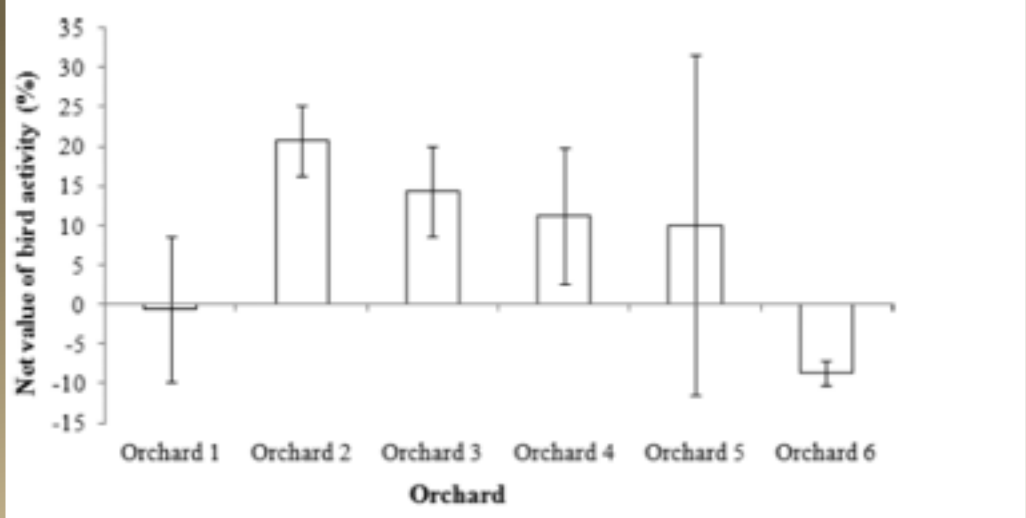


Figure 5 **Net value of bird activity in apple orchards when considering a cost-benefit trade-off (i.e., reduction in insect damaged fruit minus amount of bird damaged fruit).** Orchards are listed 1–6 from lowest intensity management to highest intensity. Error bars show 95% confidence intervals.

DOI: 10.1111/1365-2664.13172

RESEARCH ARTICLE

Journal of Applied Ecology

Falcons using orchard nest boxes reduce fruit-eating bird abundances and provide economic benefits for a fruit-growing region

Megan E. Shave[1,2] | Stephanie A. Shwiff[3] | Julie L. Elser[3] | Catherine A. Lindell[1,2,4]

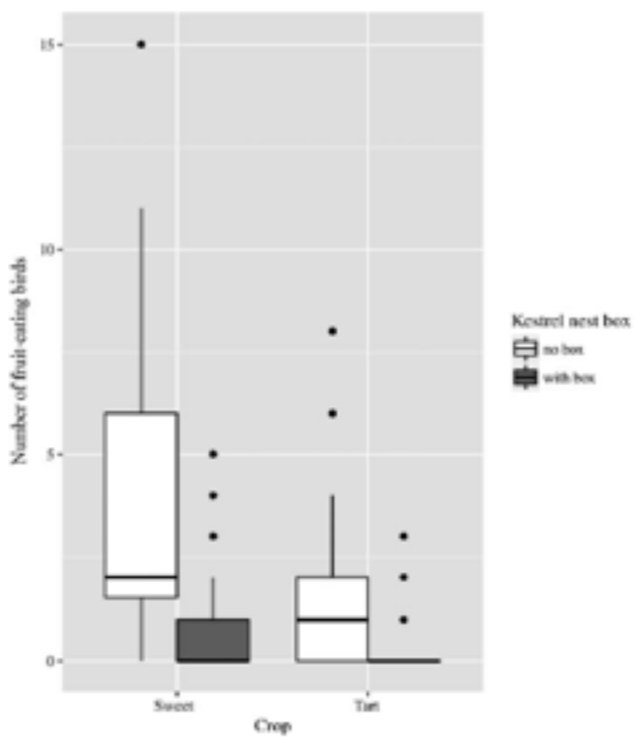


FIGURE 4 Numbers of fruit-eating birds (medians and interquartile ranges [IQRs]) observed per 10-min survey in fixed-width survey areas at sweet and tart orchard blocks with and without active nest boxes. Boxplot whiskers extend 1.5 IQRs

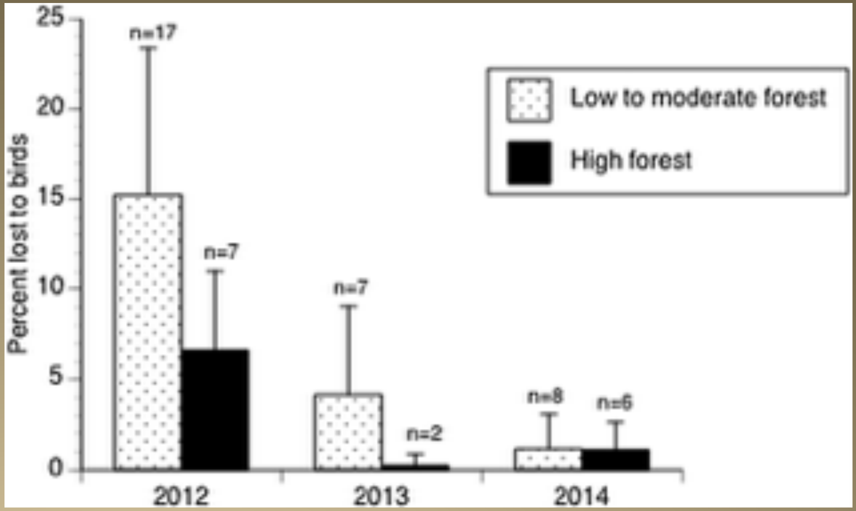
- Fewer fruit-eating birds in areas with kestrel boxes
- Every $1 spent on nest boxes saves $84 - $357 in sweet cherries
- Regional benefit of > $2 million

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



Consumer Willingness to Pay for Bird Management Practices in Fruit Crops

CHI-OK OH, ZACHARY HERRNSTADT, and PHILIP H. HOWARD
Department of Community Sustainability, Michigan State University, East Lansing, Michigan, USA

Agroecology and Sustainable Food Systems, 39:782–797, 2015

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

Available online at www.sciencedirect.com

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Biological Control

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Maximizing ecosystem services from conservation biological control: The role of habitat management

Anna K. Fiedler[a,*], Doug A. Landis[a], Steve D. Wratten[b]

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

Photo credit : © Copyright Living Countryside, www.ukagriculture.com.

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. HEIMPEL[4]

EFFECT OF ARTIFICIAL PERCHES AND NESTS IN ATTRACTING RAPTORS TO ORCHARDS

LEONARD R. ASKHAM, Department of Horticulture and Landscape Architecture, Washington State University, Pullman, Washington 99164-6414.

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.

Proc. 14th Vertebr. Pest Conf. (L.R. Davis and R.E. Marsh, Eds.)
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. Jedlicka[1]*, Russell Greenberg[2], Deborah K. Letourneau[1]

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

Adult short-eared owl
Photo by Ron Dudley

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.

Intercropping or companion planting to attract natural enemies of garden and farm crop pests

Photos thanks to Contours Landscapes

Temporal Differentiation of Crop Growth as One of the Drivers of Intercropping Yield Advantage

Nan Dong[1], Ming-Ming Tang[1], Wei-Ping Zhang[1], Xing-Guo Bao[2], Yu Wang[1], Peter Christie[1] & Long Li[1]

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.

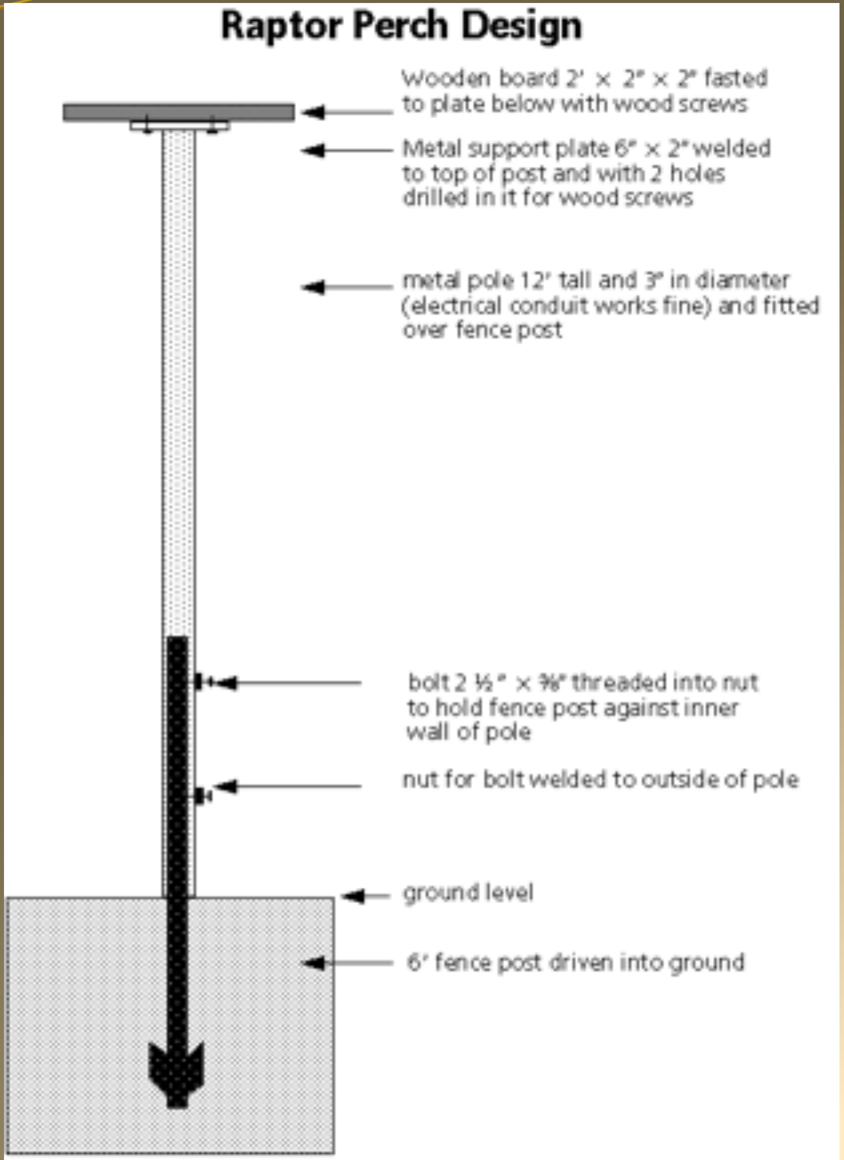
Farmers' Opinions about Bird Conservation and Pest Management on Organic and Conventional North Florida Farms[1]

Susan K. Jacobson, Kathryn E. Sieving, Greg Jones, John McElroy, Beida Chen, Mark E. Hostetler, and Sarah W. Miller[2]

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

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

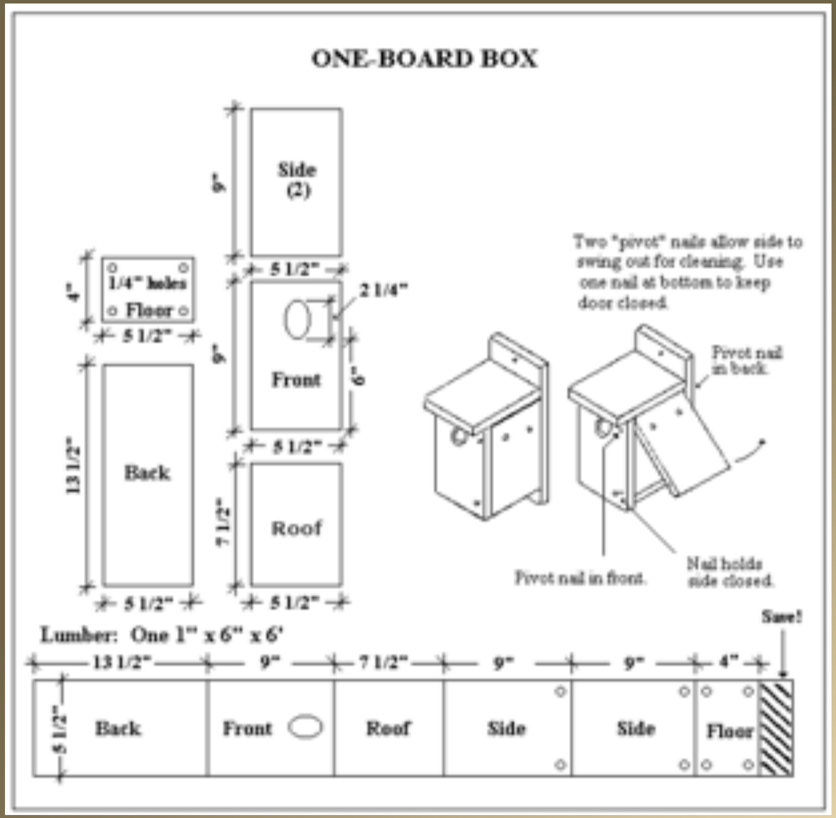


Illinois Natural History Survey

Photo from Sara Kross

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

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