Networks for Life

Your role in creating biological corridors

Doug Tallamy
University of Delaware

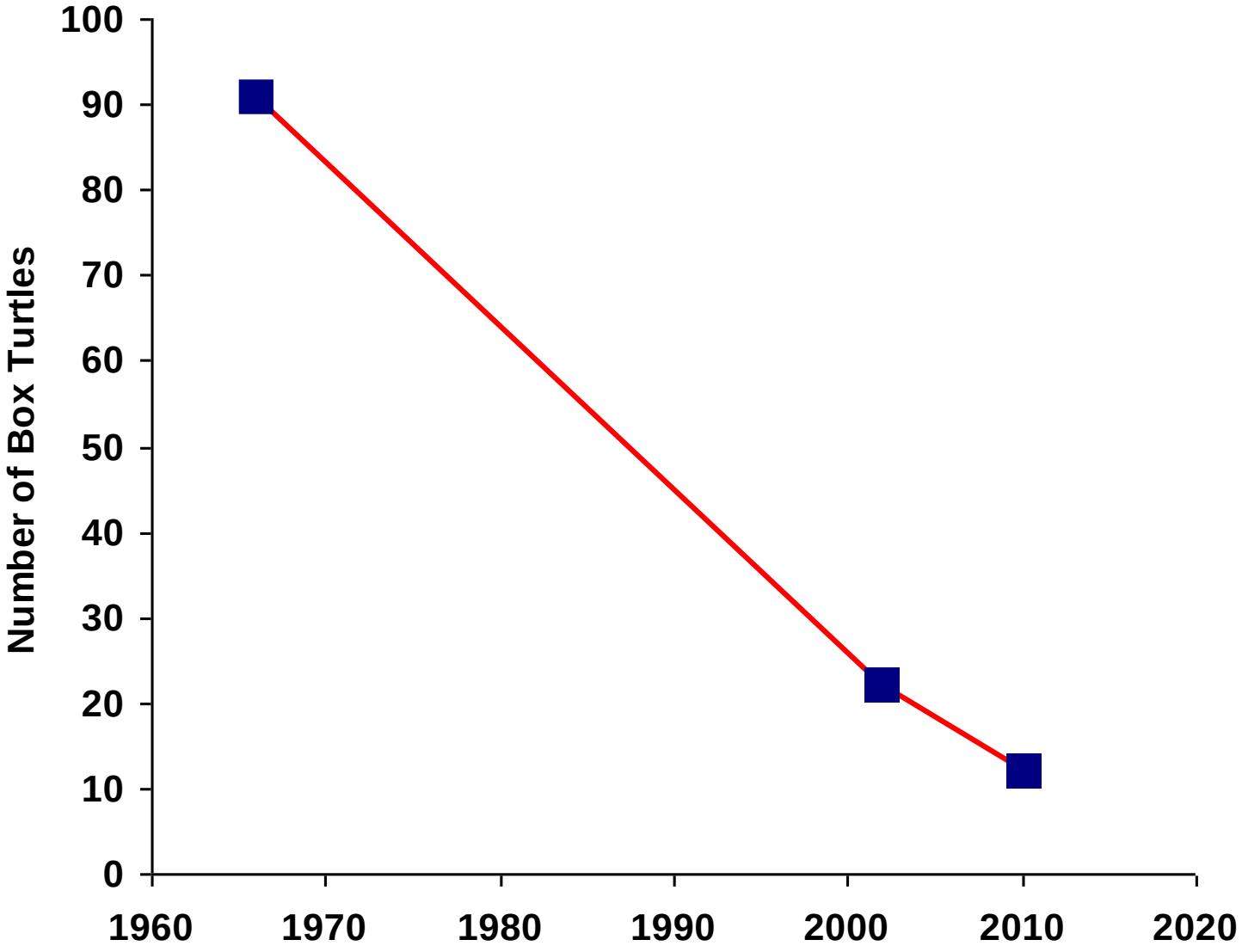

Box turtles can live 80 yrs

35 acre woodlot: University of Delaware

91 turtles in 1968

UD woodlot
has been isolated
for 100 yrs

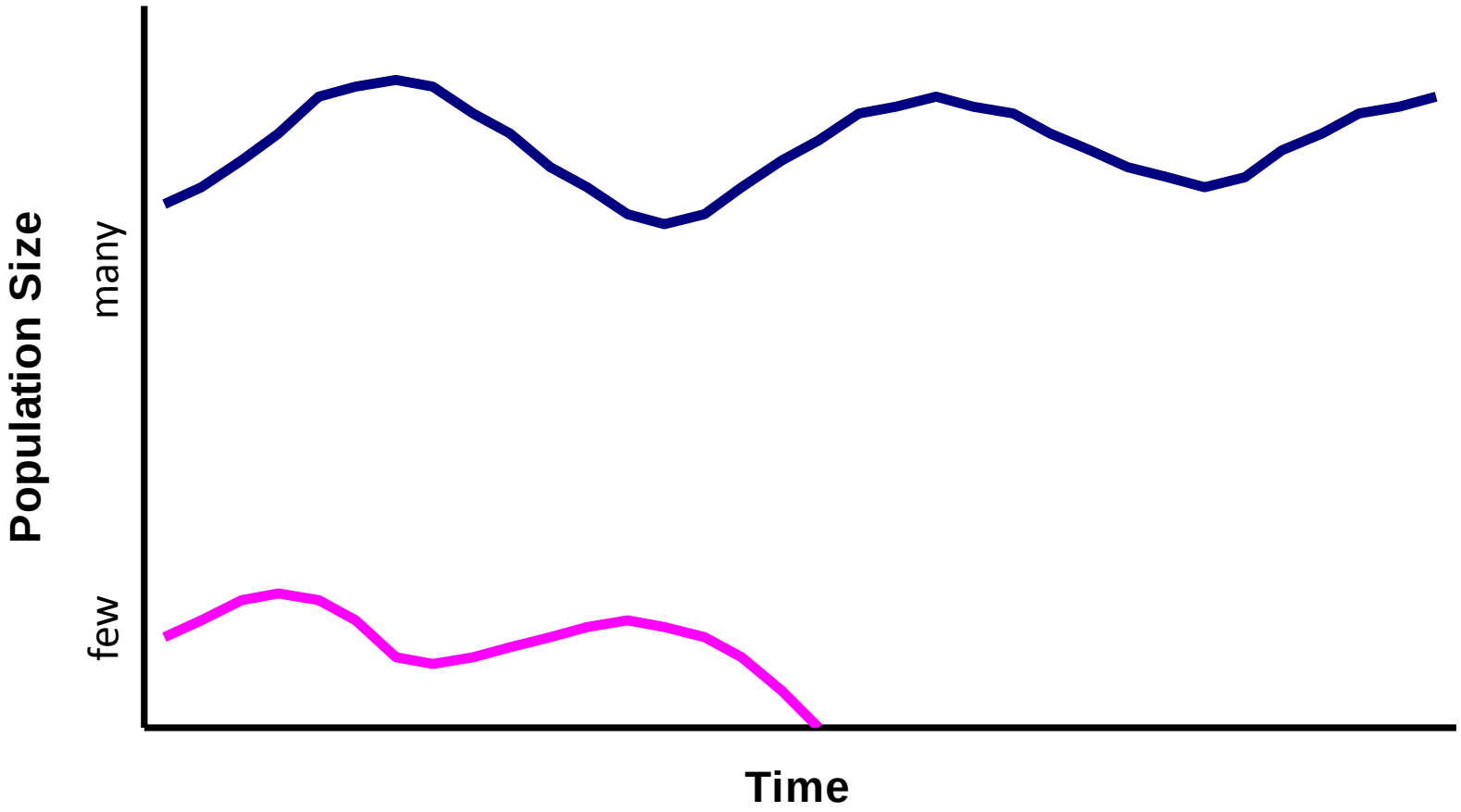

Leaving the woodlot is deadly
LONG
310·C



This population is realizing it's extinction debt

It’s not just box turtles that suffer from fragmentation

Biodiversity cannot be sustained in habitat fragments because they are too small and too isolated.


Population Size
many
few
Time

Our natural areas are not large enough to sustain nature

Not only are viable habitats fragmented, they have also been invaded by 3300 species of introduced plants.


Conserving habitat
fragments does not
conserve ecosystems

What has fragmentation done to our biodiversity?

436 spp of North American birds are threatened with extinction

State of the Birds 2016

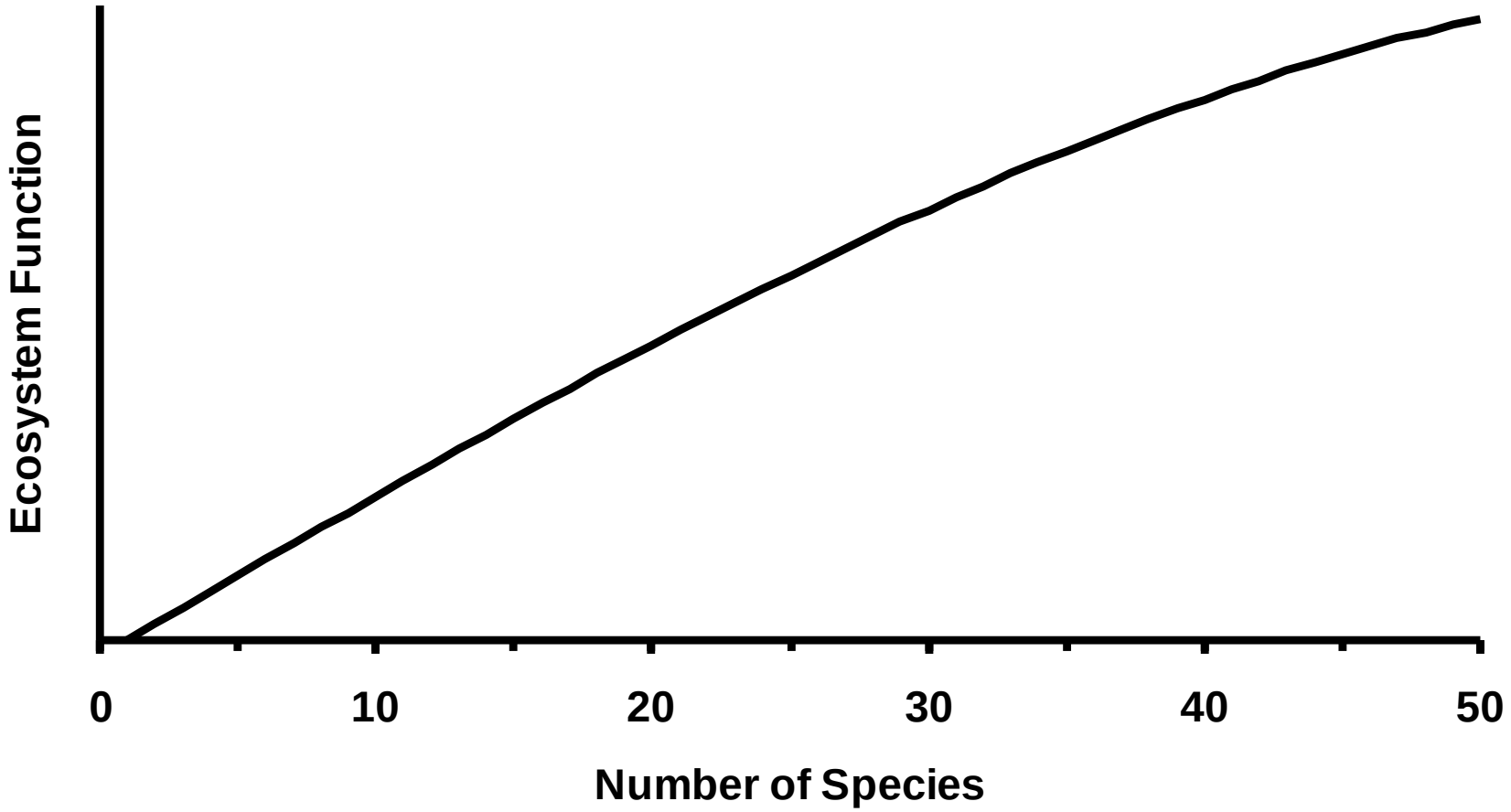
50% fewer song birds today compared to 40 years ago


So what?

How many species do we need?

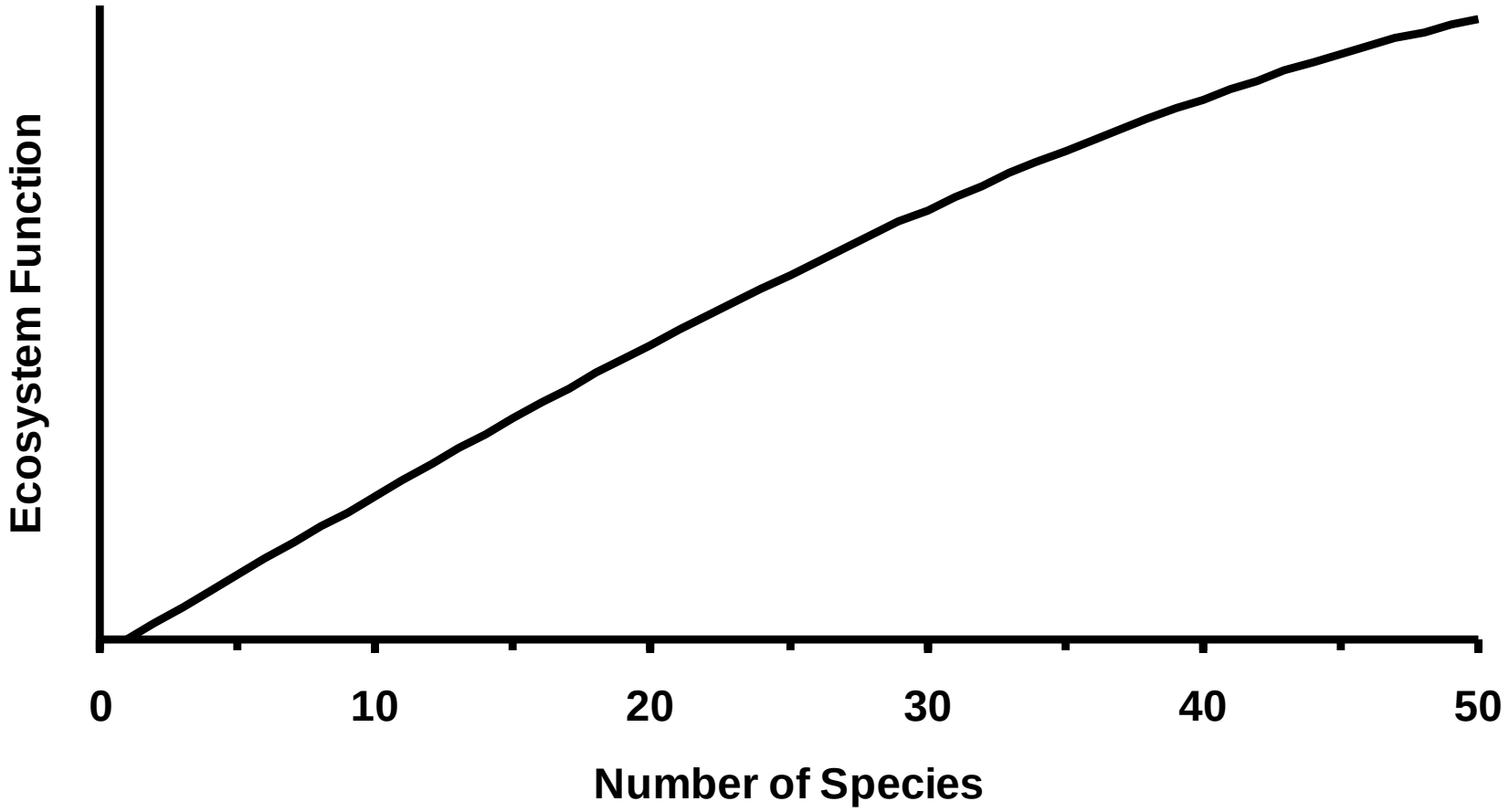
Ecosystems function locally!

So think about local extinction, not global extinction



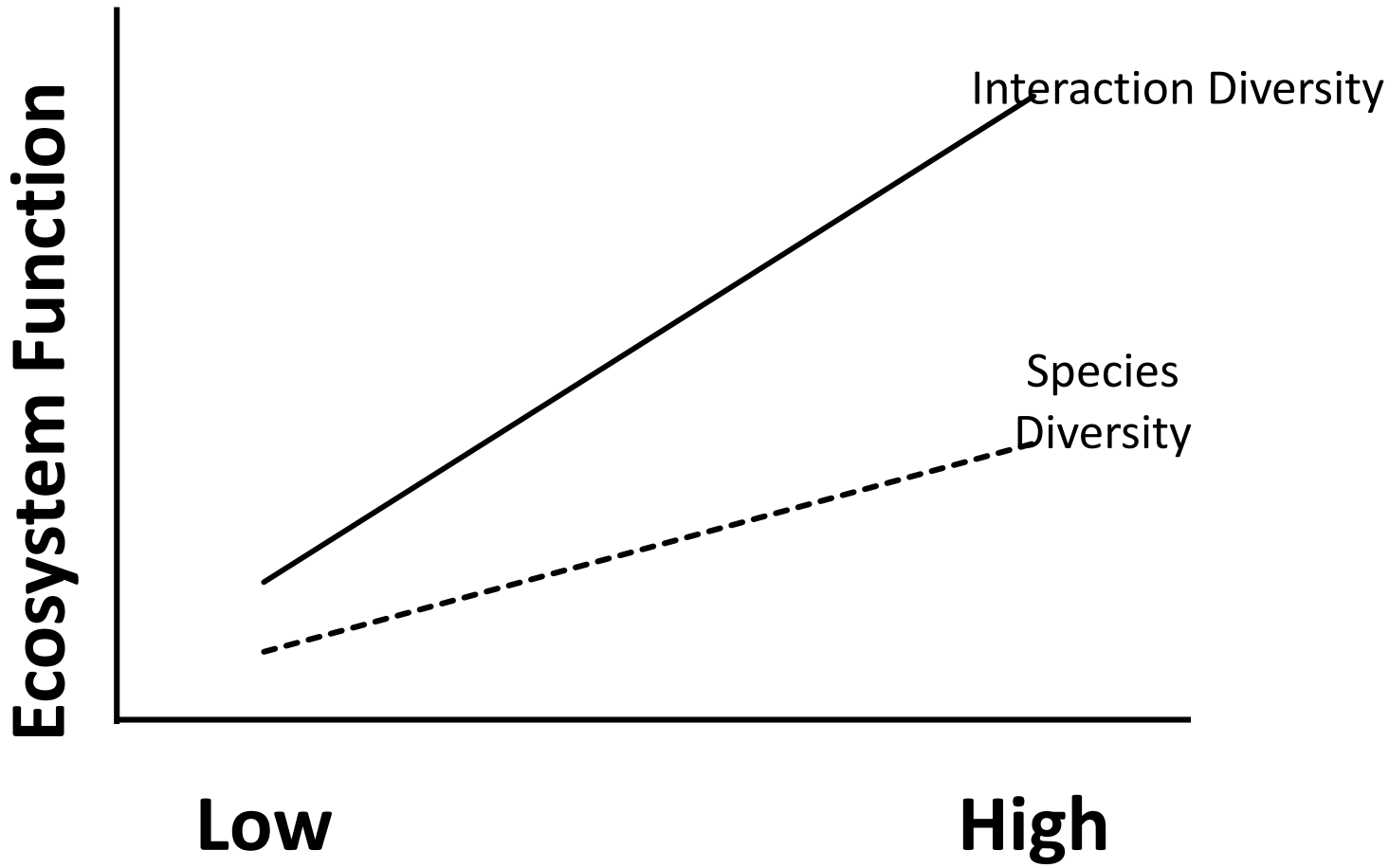
The Law of Nature

MacArthur 1955



Reich et al. 2012
Maestre et al. 2012
Naeem et al. 2012

Interaction diversity is more important than species diversity.



Dyer et al. 2016


So how many interactions among species do we need?


All of them!

Why?

Because biological interactions run our ecosystems!

Biological interactions are essential to ecosystems because they:

- Increase stability
- Improve biogeochemical processes
- Increase productivity
- Decrease susceptibility to biotic invasions

David Tilman, Peter Price, Don Strong

Biological ineractions = ecosystem services!

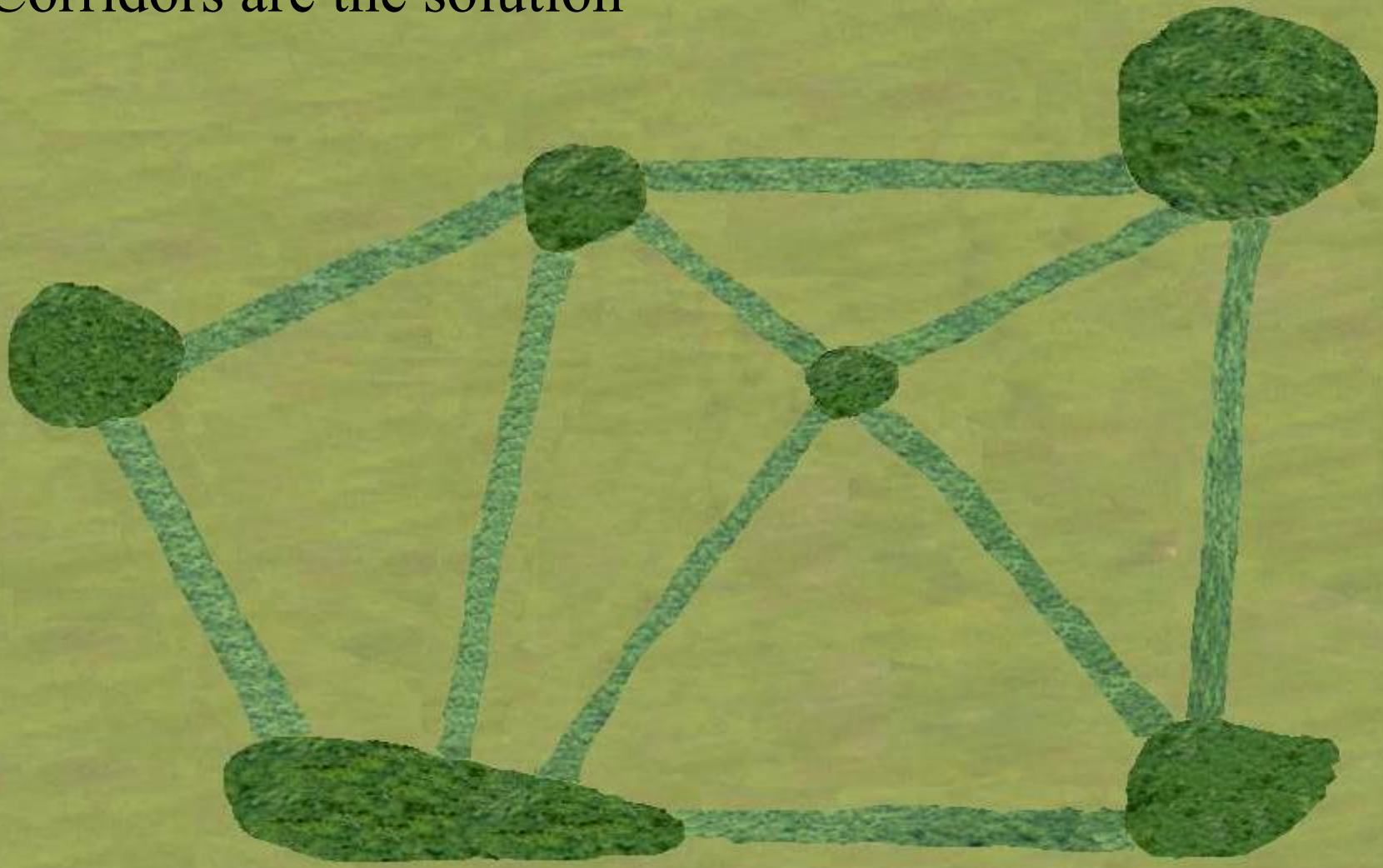
We have degraded 60% of the earth's ability to produce ecosystems services

Millennium Ecosystem Assessment 2005

Biological interactions are an essential, non-renewable natural resource, and yet we are fragmenting them to local extinction.

Fragmentation is the problem

Corridors are the solution



If corridors connect isolated habitat patches

- the patches are no longer isolated
- so the populations within them are no longer tiny
- so they are no longer subject to local extinction when they fluctuate

Convenient opportunities for corridors:

- Mountain ridges
- Riparian corridors
- Power lines
- Roads
- Rangelands

Riparian corridors

Power-lines; another convenient corridor opportunity

300,000 km of power-lines in the U.S.

Roads as convenient corridors

Over 4 million miles of paved roads in the U.S.

Roadside real estate provides an excellent opportunity to help native bees

The question is not “Do roadside restorations kill animals?”

They do.

Rather it is “Do roadside restorations produce more animals than they kill.?”

Rangeland as effective biological corridors

There are 770 million acres of rangeland in the U.S.

20.7 times bigger than Illinois!

Mountain ridges, riparian corridors, roadways, power-lines, and rangeland could work because they are convenient!

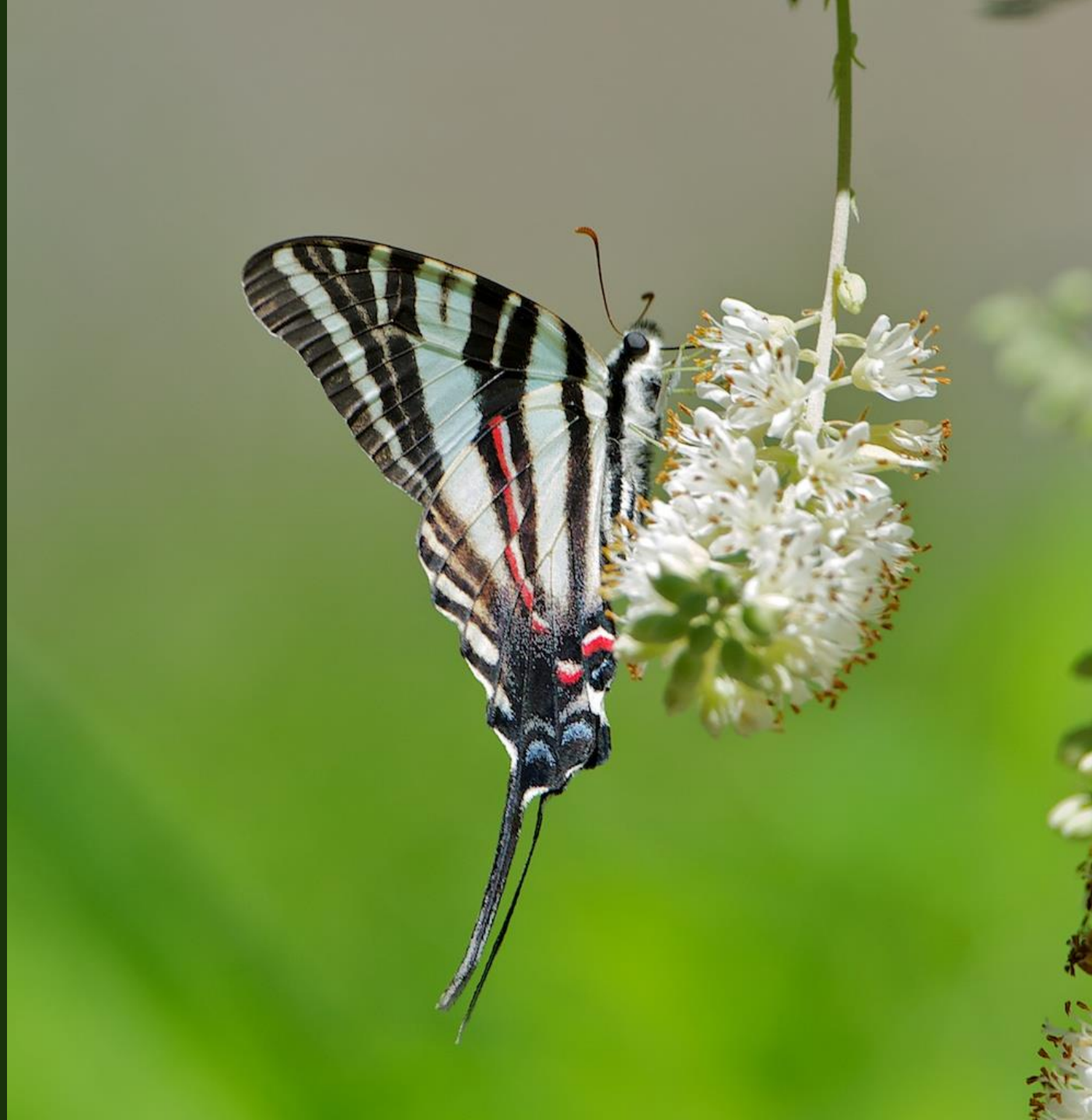
Unfortunately, we don't always have a convenient corridor option every place we need one.

What should we do?

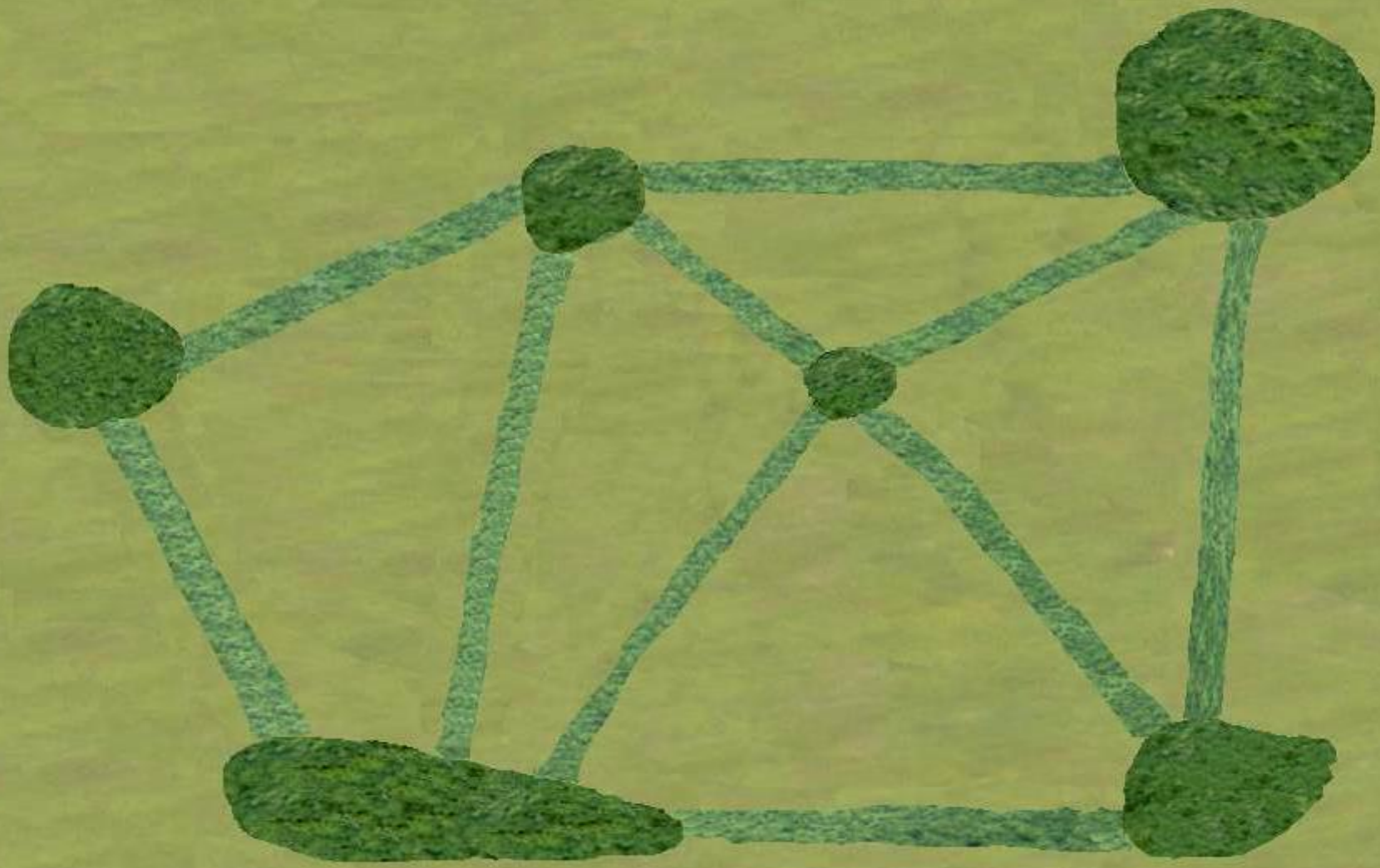
Restore all of our managed landscapes so that some level of corridor function exists everywhere.


We need to share where
live, work, and farm.

We can save nature if we learn to live with nature.

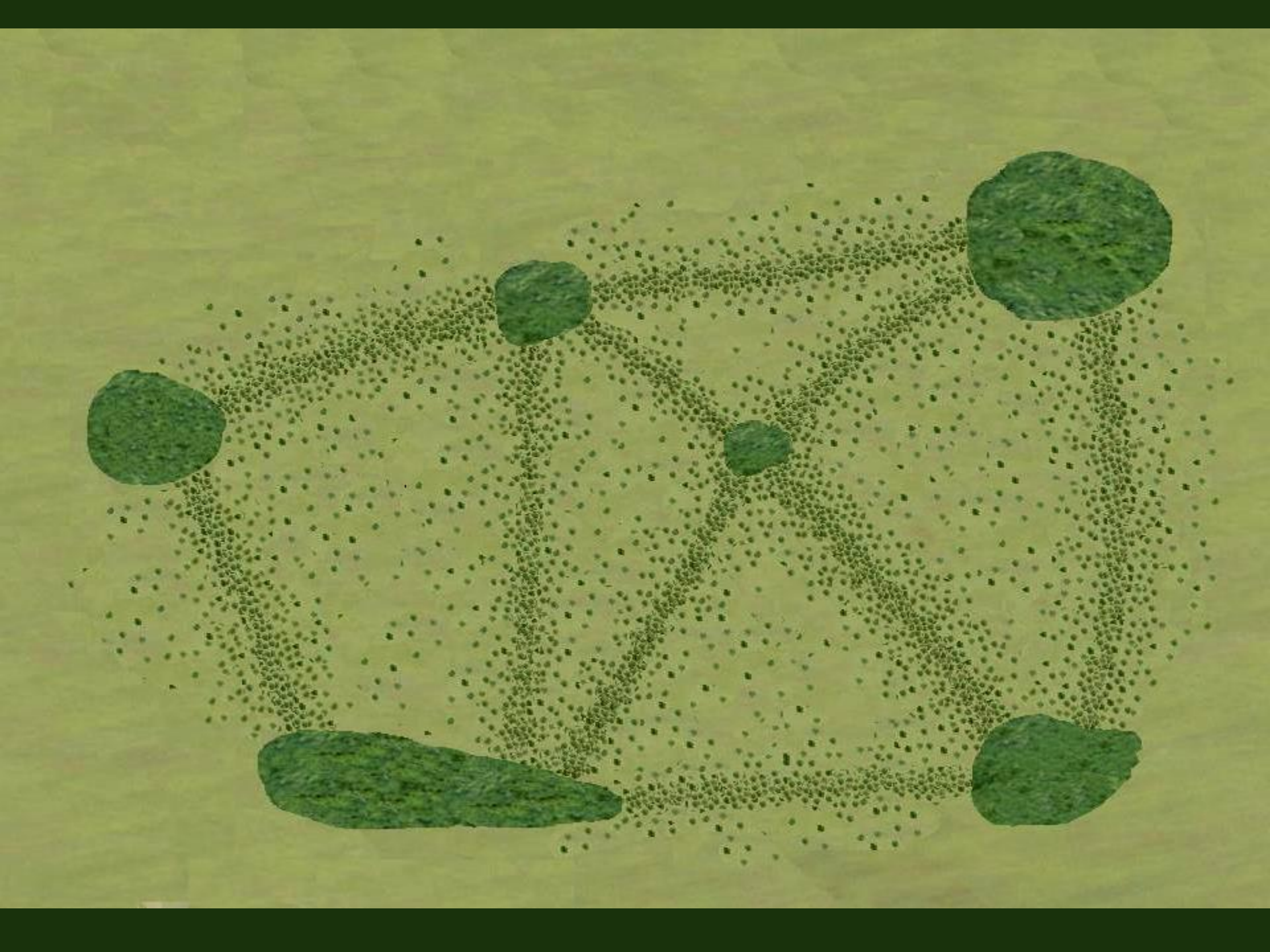


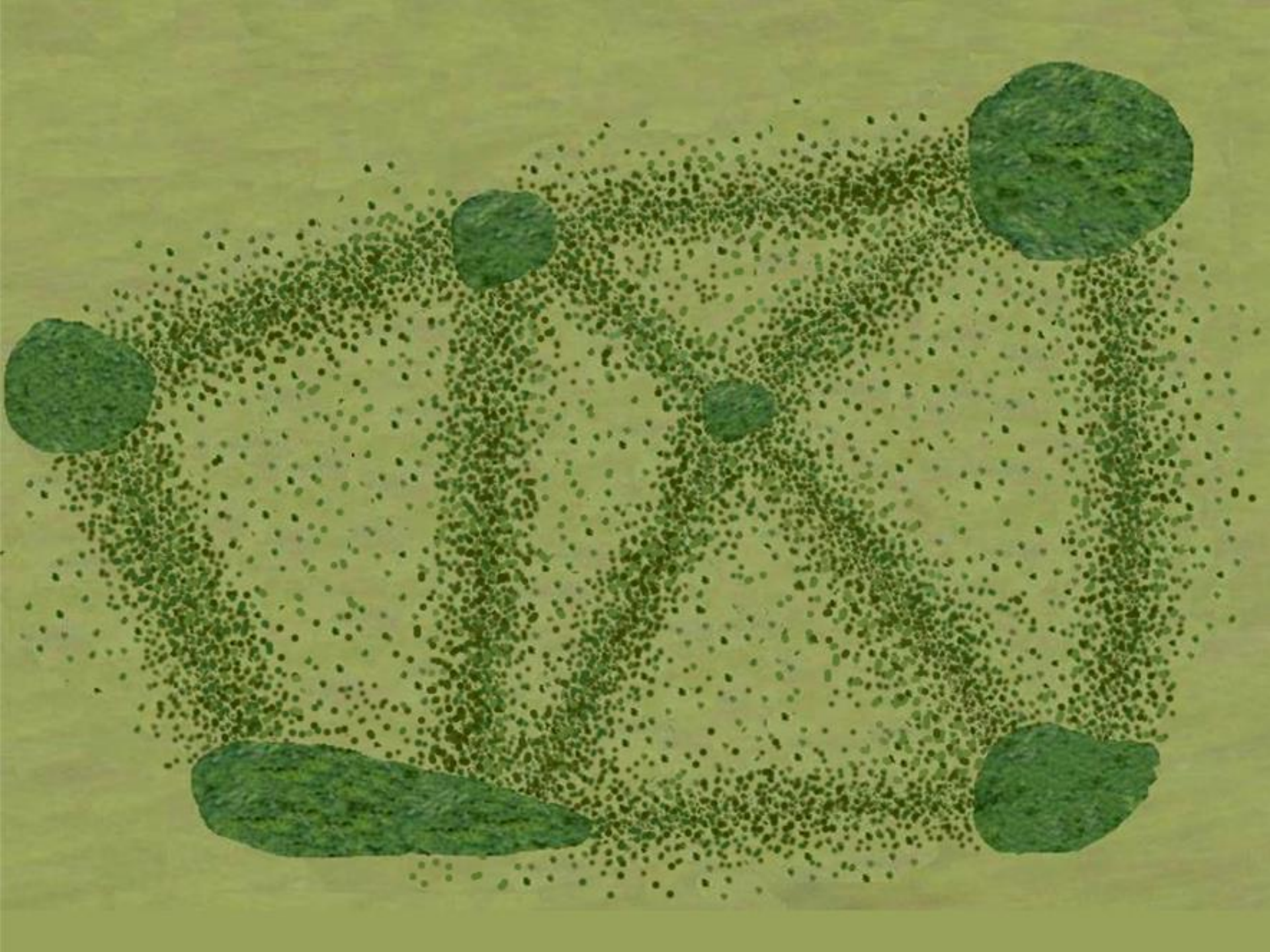
Our standard approach to biological corridors is not enough



Biological corridors must do more than facilitate movement;

they must support life!





What do we build our corridors out of ?

Plants that make insects!


Plants that make
caterpillars


Caterpillars are inordinately
important in terrestrial food webs.


In fact, most birds rear young
on caterpillars

Why caterpillars?

It could be because
they are beautiful

Pandora sphinx

Calleta silk moth

Spiny rose caterpillar


Hieroglyphic moth


Spun glass caterpillar

It could be because they have cool names

Green marvel


Once-charred punkie


Confused woodgrain


Cynical groundcat

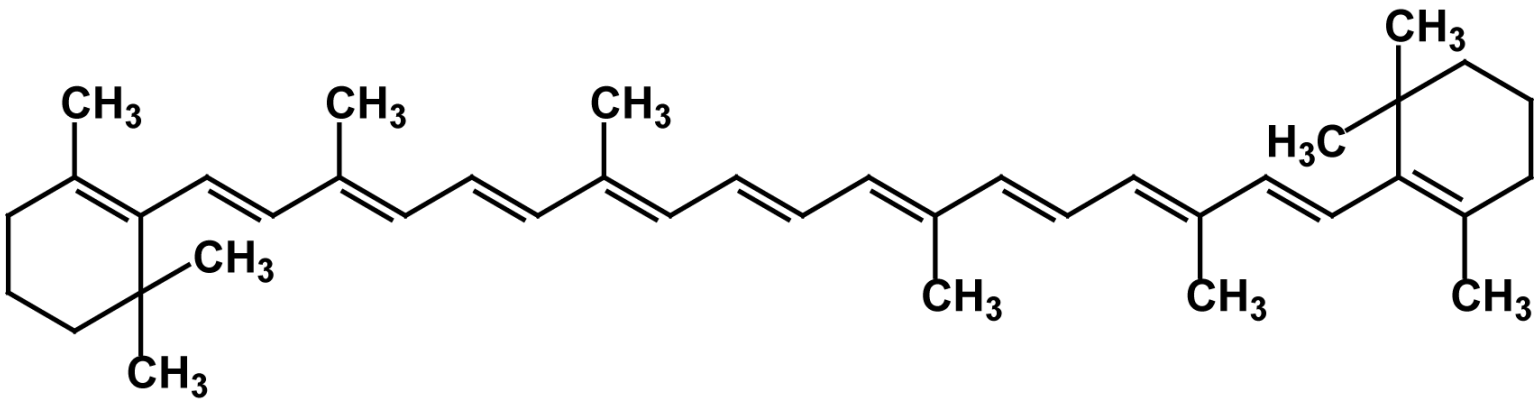

The Neighbor

The Donald

1) Soft

1) soft
2) high in protein
3) high in lipids
4) best source of carotenoids

Essential carotenoids



lutein

crocetin

zeaxanthin

Six Types of Carotenoids

α-carotene

lycopene

β-carotene

Why do birds need carotenoids?

Improve sexual attractiveness

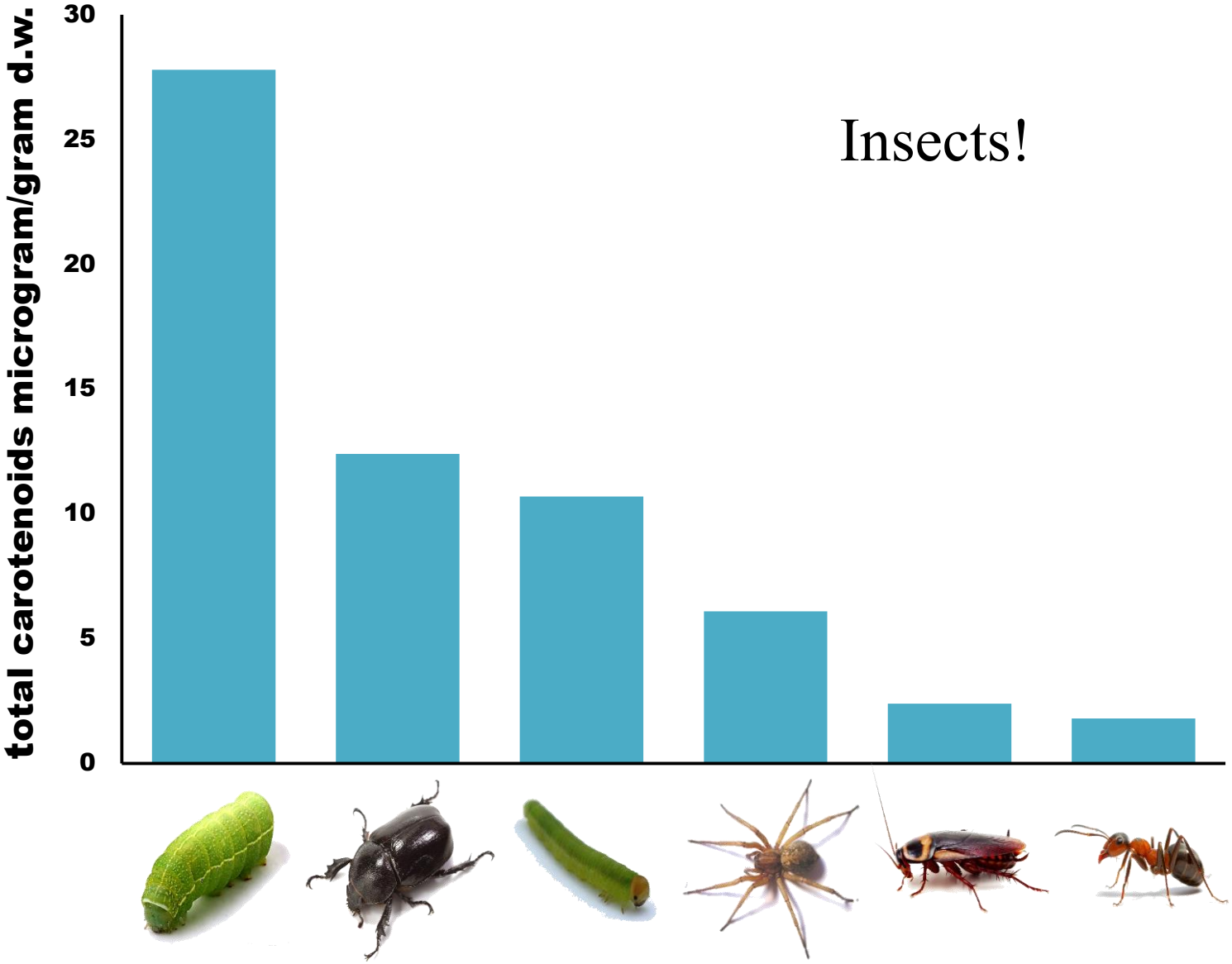
Antioxidants that protect proteins and DNA from oxidative damage

Stimulate the immune system

Improve color vision

Improve sperm vitality

McGraw 2009



Eeva et al 2010. J. Chem Ecol. 36: 608-613.

For most birds, caterpillars
are not optional!

How many caterpillars do we need to make in our corridors?


To rear one clutch they must catch
6,240 to 9,120
caterpillars!

0.35 oz

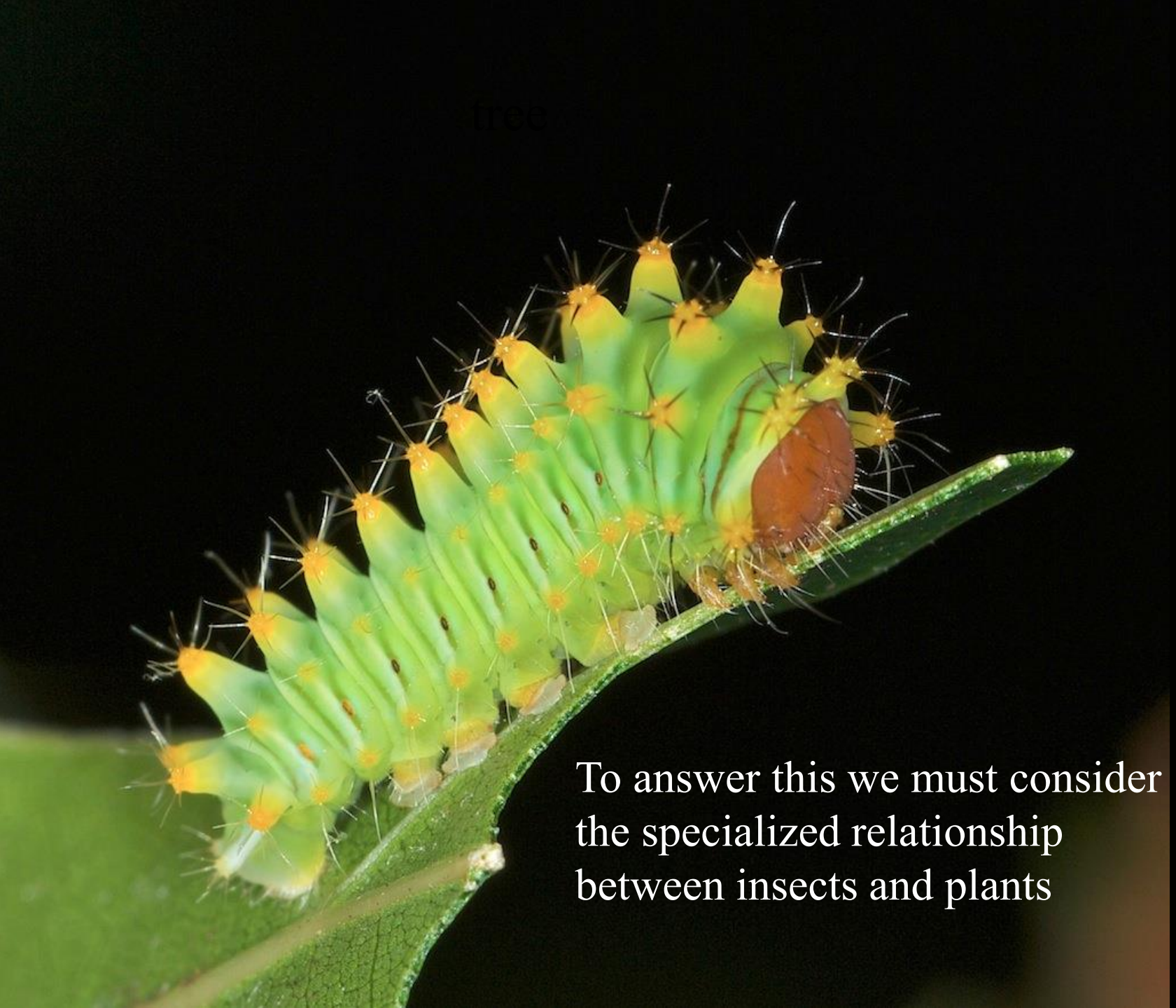
Red-bellied woodpecker weighs 8 times more than a chickadee !

Birds that eat insects

Tyrannidae (tyrant flycatchers)
Laniidae (shrikes)
Vireonidae (vireos)
Corvidae (crows & jays)
Alaudidae (larks)
Hirundinidae (swallows)
Paridae (titmice)
Remizidae (verdins)
Aegithalidae (bushtit)
Sittidae (nuthatches)
Certhiidae (creepers)
Troglodytidae (wrens)
Pycnonotidae (bulbul)
Regulidae (kinglets)
Sylviidae (Old World warblers)
Muscicapidae (old world flycatchers)
Timaliidae (babblers)
Turdidae (thrushes)
Mimidae (mockingbirds & thrashers)
Sturnidae (starlings) introduced
Prunellidae (accentors)
Motacillidae (pipits & wagtails)
Bombycillidae (waxwings)
Ptilogonatidae (silky-flycatcher)
Peucedramidae (olive warbler)
Parulidae (wood warblers)
Coerebidae (bananaquits)
Thraupidae (tanagers)
Emberizidae (sparrows& buntings)
Cardinalidae (cardinals & grosbeaks)
Icteridae (blackbirds & orioles)
Fringillidae (finches)
Ploceidae (weaver finches)
Passeridae (Old World Sparrows)
Podicipedidae (grebes)
Ardeidae (herons)
Threskiornithidae (ibises & spoonbills)
Anatidae (ducks, geese & swans)
Accipitridae (hawks, kites & eagles)
Falconidae (falcons)
Phasianidae (turkeys & grouse)
Odontophoridae (new world quail)
Rallidae (rails, gallinules & coots)
Aramidae (limpkins)
Gruidae (cranes)
Charadriidae (plovers)
Recurvirostridae (avocets & stilts)
Jacanidae (Jacana)
Scolopacidae (sandpipers & phalaropes)
Laridae (gulls & terns)
Columbidae (pigeons & doves)
Cuculidae (cuckoos & roadrunners)
Tytonidae (barn owls)
Strigidae (owls)
Caprimulgidae (goatsuckers)
Apodidae (swifts)
Trochilidae (hummingbirds)
Trogonidae (trogons)
Alcedinidae (kingfishers)
Picidae (woodpeckers)

No insects…no baby birds!

What types of landscapes are capable of producing such insect diversity and numbers?



To answer this we must consider the specialized relationship between insects and plants

Plants
don’t want
to be eaten!

Plants defend their tissues with distasteful chemicals


But insects DO
eat plants.
How?

They specialize on only a few types of plants!

90% of the insects that eat plants can develop and reproduce only on the plants with which they share an evolutionary history.

(Forister et al. 2014)

Red cedars defend their tissues with beta-thujaplicin, a toxic monoterpene.

Specialization can be a curse in today's world

Monarchs have declined 96.4% since 1976

90% of all phytophagous insects
are host plant specialists

We can use the knowledge that most insects are specialists to build landscapes that support effective food webs!

Blinded sphinx;
Black cherry

Chestnut schyzura;
Viburnum dentatum

Drab prominent; Sycamore

8-spotted forester; Grape

Lunate zale:
Black cherry

Spicebush swallowtail; Spicebush

Tufted bird dropping moth;
Black cherry

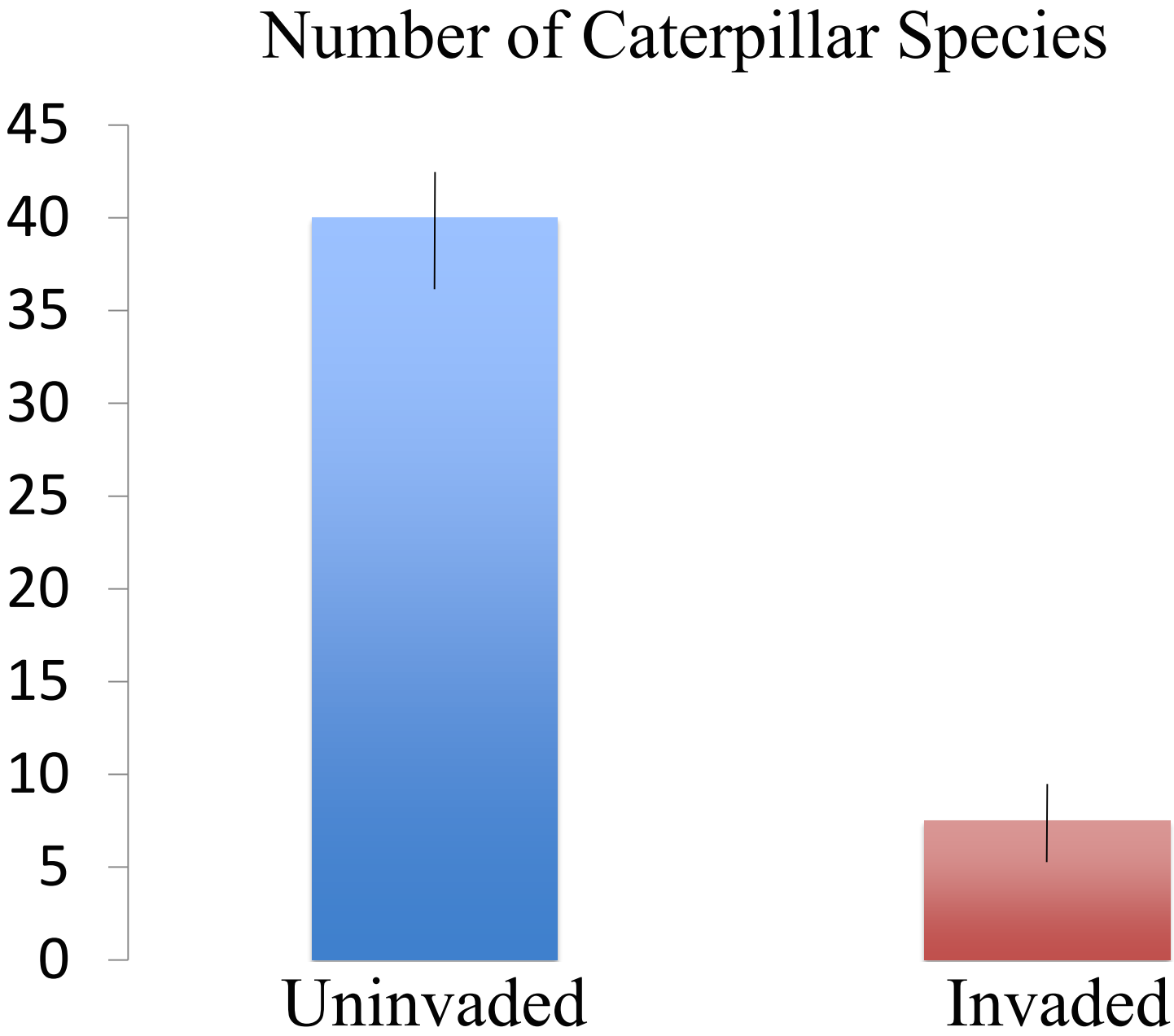
Remember

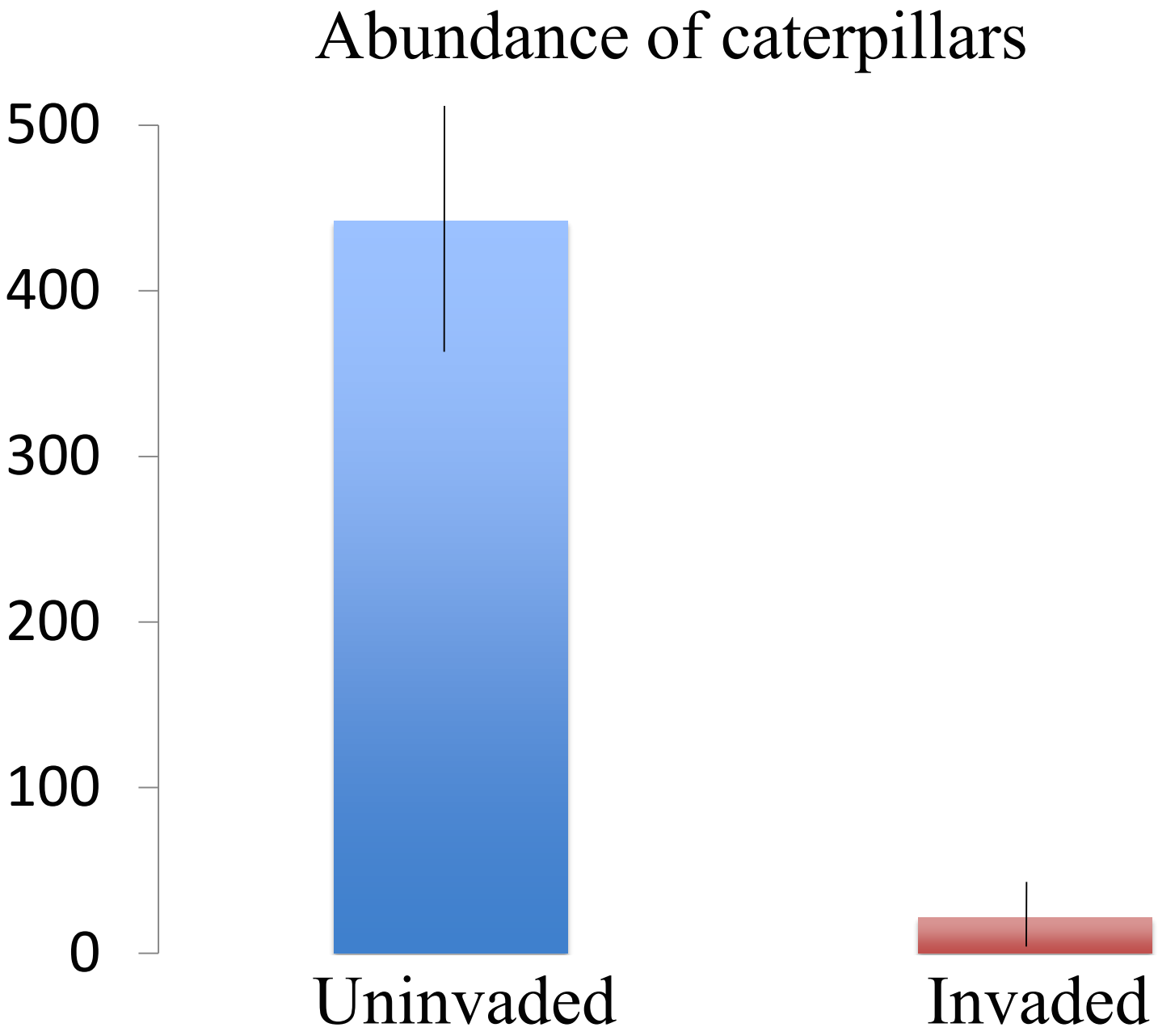
90% of the insects that eat plants can only eat the plants with which they co-evolved!

It’s not just birds that need insects!

A world without insects is a world without biological diversity.


What happens when
we replace native plant
communities with
plants from outside our
local ecosystems?


Number of Caterpillar Species
45
40
35
30
25
20
15
10
5
0
Uninvaded
Invaded


Abundance of caterpillars
500
400
300
200
100
0
Uninvaded
Invaded

Which trees should we be sure to have in our landscapes?

Quercus (557)
Prunus (456)
Salix (455)
Betula (411)
Populus (367)
Malus (308)
Acer (297)
Vaccinium (294)
Alnus (255)
Carya (235)
Ulmus (215)
Pinus (201)
Crataegus (168)
Rubus (163)
Picea (150)
Fraxinus (149)
Tilia (149)
Pyrus (138)
Rosa (135)
Corylus (131)
Juglans (129)
Castanea (127)
Fagus (127)
Amelanchier (124)
Larix (121)
*Cornus (*118)
Abies (117)
Myrica (108)
Viburnum (104)
Ribes (99)
Ostrya (94)
Tsuga (92)
Spiraea (89)
Vitis (79)
Pseudotsuga (76)
Robinia (72)
Carpinus (68)
Sorbus (68)
Comptonia (64)
Hamamelis (63)
Rhus (58)
Rhododendron (51)
Thuja (50)
Diospyros (46)
Gleditsia (46)
Ceanothus (45)
Platanus (45)
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Juniperus (42)
Sambucus (42)
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Aesculus (33)
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Berberis (12)
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Frangula (11)
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Caragana (10)
*Clethra (*10)
Rhamnus (10)
Pyracantha (9)
Morus (9)
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Ginkgo (5)
Decodon (5)
Diervilla (5)
Gymnocladus (5)
Hydrangea (5)
Cotinus (4)
Eremochloa (4)
Genista (4)
Indigofera (4)
Pueraria (4)
Leucothoe (4)
Philadelphus (4)
Phoradendron (4)
Sideroxylon (4)
Cedrus (3)
Cissus (3)
Cotoneaster (3)
Hedera (3)
Lagerstroemia (3)
Myrtus (3)
Tamarix (3)
Deutzia (2)
Lavandula (2)
Lycium (2)
Melia (2)
Paulownia (2)
Phoenix (2)
Sophora (2)
Sorbaria (2)
Weigela (2)
Calycanthus (2)
Gaultheria (2)
Litsea (2)
Menziesia (2)
Pieris (2)
Staphylea (2)
Abelia (1)
Bambusa (1)
Broussonetia (1)
Buddleja (1)
Buxus (1)
Calluna (1)
Camellia (1)
Clerodendrum (1)
Colutea (1)
Forsythia (1)
Koelreuteria (1)
Laburnum (1)
Phyllostachys (1)
Poncirus (1)
Pterostyrax (1)
Sapium (1)
Thamnocalamus (1)
Vincetoxicum (1)
Callicarpa (1)
Dirca (1)
Leiophyllum (1)
Menispermum (1)
Nemophila (1)
Osmanthus (1)
Stewartia (1)
Metasequoia (0)
Vitex (0)
Ceratonia (0)
Cercidiphyllum (0)
Exochorda (0)
Firmiana (0)
Grewia (0)
Kalopanax (0)
Kerria (0)
Kolkwitzia (0)
Nandina (0)
Phellodendron (0)
Pseudosasa (0)
Rhodotypos (0)
Stephanandra (0)
Styphnolobium (0)
Tetradium (0)
Toona (0)
Zelkova (0)
Adlumia (0)
Arceuthobium (0)
Berchemia (0)
Borrichia (0)
Cladrastis (0)
Empetrum (0)
Eubotrys (0)
Itea (0)
Loiseleuria (0)
Nestronia (0)
Styrax (0)
Xanthorhiza (0)
Zenobia (0)

“Native Plant Finder”

Launch “ very soon”

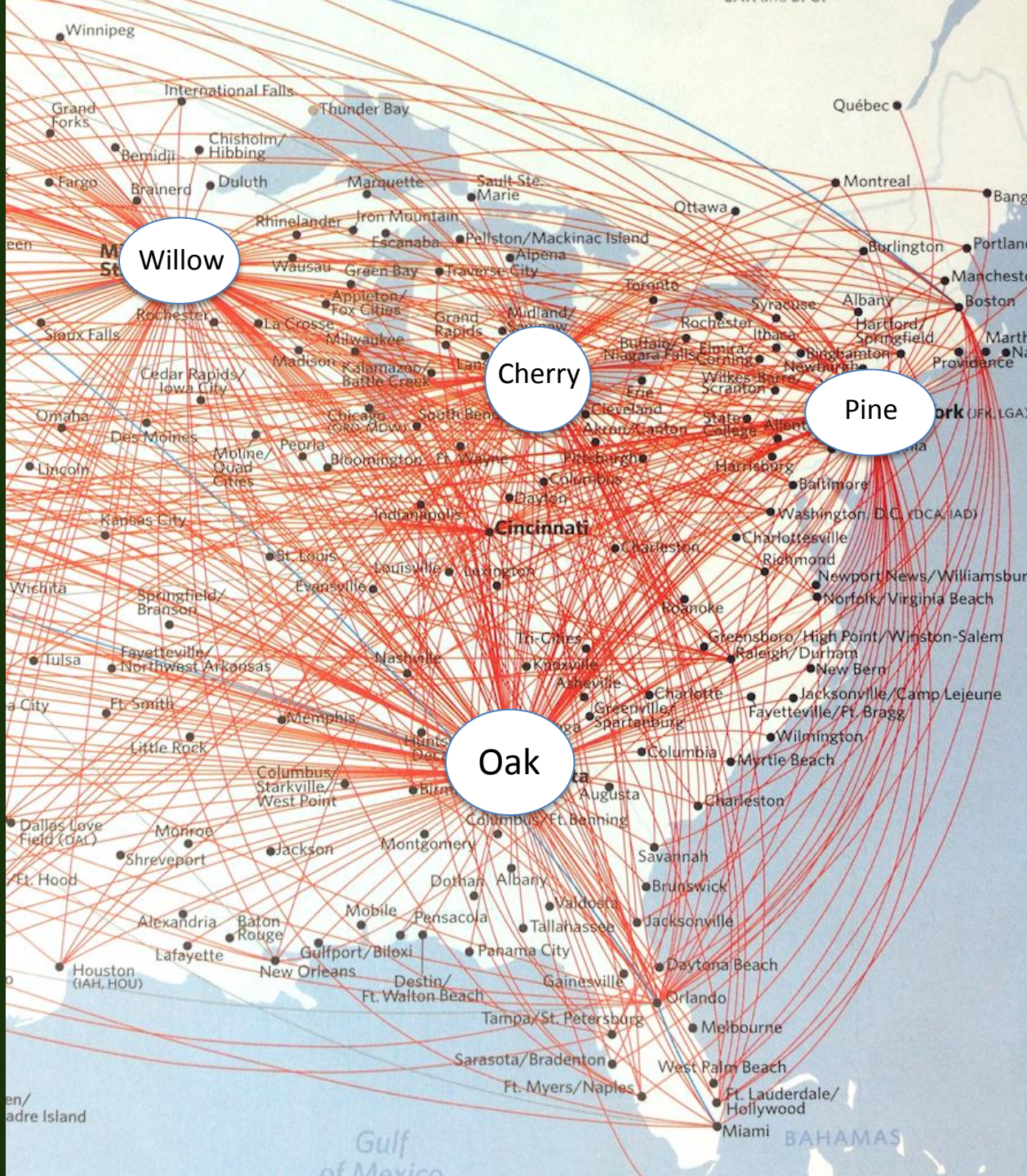
National Wildlife Federation

Plants that serve as key sources of food are called

Foraging Hubs


Winnipeg
International Falls
Thunder Bay
Québec
Grand Forks
Chisholm/ Hibbing
Bemidji
Fargo
Brainerd
Duluth
Marquette
Sault Ste. Marie
Montreal
Ottawa
Rhinelander
Iron Mountain
Escanaba
Pellston/Mackinac Island
Minneapolis/ St. Paul
Wausau
Green Bay
Alpena
Traverse City
Burlington
Toronto
Manchester
Boston
Appleton/ Fox Cities
Syracuse
Albany
Rochester
La Crosse
Grand Rapids
Midland/ Saginaw
Rochester
Hartford/ Springfield
Sioux Falls
Milwaukee
Flint
Buffalo/ Niagara Falls
Elmira/ Corning
Ithaca
Binghamton
Providence
Madison
Kalamazoo/ Battle Creek
Lansing
Newburgh
Cedar Rapids/ Iowa City
Detroit
Wilkes-Barre/ Scranton
White Plains
Erie
Omaha
Chicago (ORD, MDW)
South Bend
Cleveland
Akron/Canton
State College
New York (JFK, LGA, Newark
Allentown
Des Moines
Peoria
Moline/ Quad Cities
Bloomington
Ft. Wayne
Philadelphia
Lincoln
Pittsburgh
Harrisburg
Columbus
Baltimore
Dayton
Kansas City
Indianapolis
Cincinnati
Washington, D.C. (DCA, IAD)
Charlottesville
St. Louis
Louisville
Lexington
Charleston
Richmond
Wichita
Evansville
Newport News/Williamsburg
Springfield/ Branson
Roanoke
Norfolk/Virginia Beach
Tri-Cities
Greensboro/High Point/Winston-Salem
Tulsa
Fayetteville/ Northwest Arkansas
Nashville
Knoxville
Raleigh/Durham
New Bern
Asheville
Charlotte
Jacksonville/Camp Lejeune
Ft. Smith
Greenville/ Spartanburg
Fayetteville/Ft. Bragg
Memphis
Chattanooga
Wilmington
Little Rock
Huntsville/ Decatur
Columbia
Myrtle Beach
Columbus/ Starkville/ West Point
Atlanta
Birmingham
Augusta
Charleston
Dallas Love Field (DAL)
Columbus/Ft. Benning
Monroe
Montgomery
Savannah
Shreveport
Jackson
Ft. Hood
Dothan
Albany
Brunswick
Valdosta
Alexandria
Baton Rouge
Mobile
Pensacola
Jacksonville
Tallahassee
Lafayette
Gulfport/Biloxi
Panama City
Houston (IAH, HOU)
New Orleans
Destin/ Ft. Walton Beach
Daytona Beach
Gainesville
Orlando
Tampa/St. Petersburg
Melbourne
Sarasota/Bradenton
West Palm Beach
Ft. Myers/Naples
Ft. Lauderdale/ Hollywood
Miami
BAHAMAS
Gulf of Mexico

Why hunt on oaks, cherries, willows and pines? Cause that's where the food is!!



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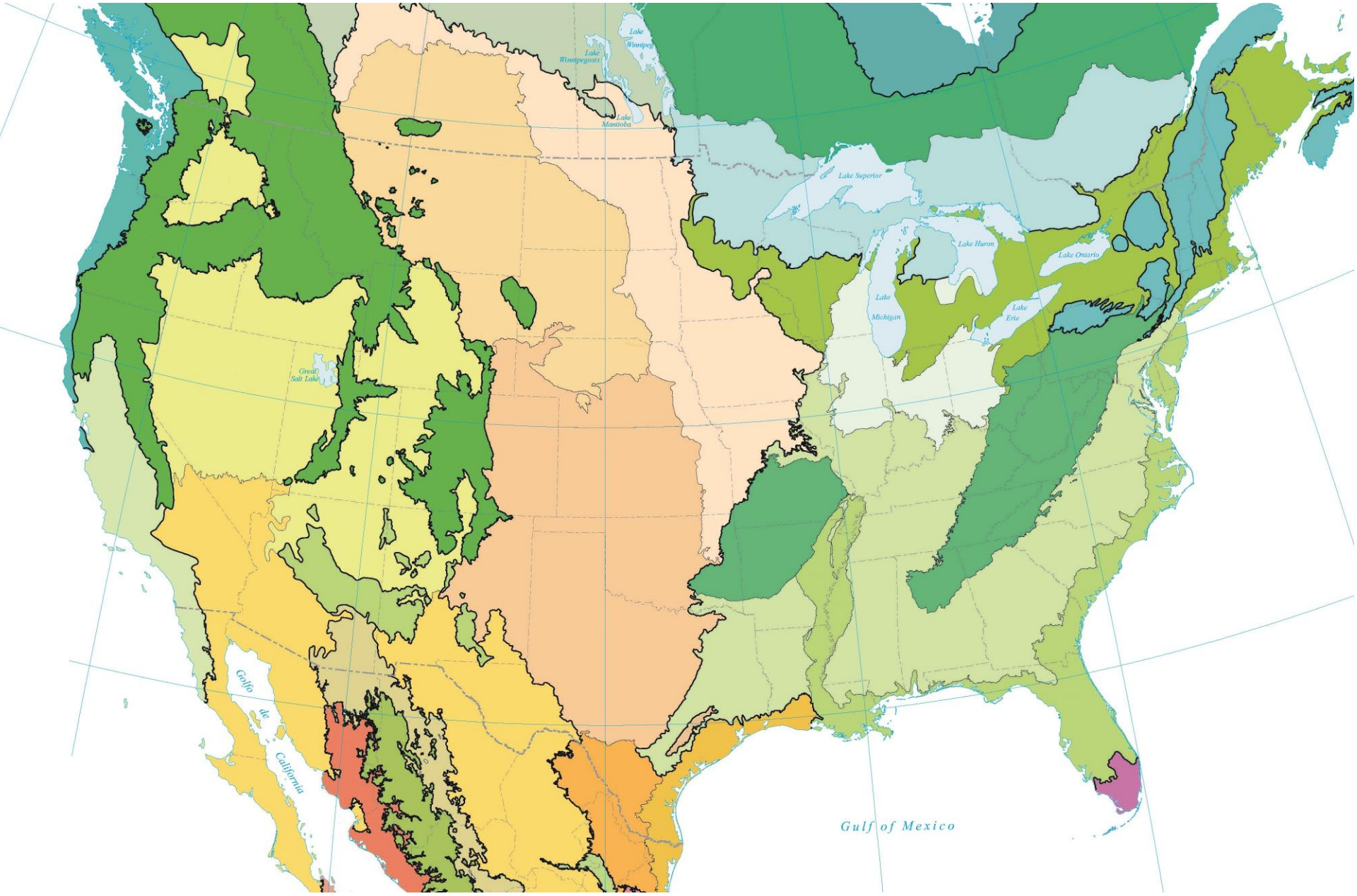
Pueraria (4)
Leucothoe (4)
Philadelphus (4)
Phoradendron (4)
Sideroxylon (4)
Cedrus (3)
Cissus (3)
Cotoneaster (3)
Hedera (3)
Lagerstroemia (3)
Myrtus (3)
Tamarix (3)
Deutzia (2)
Lavandula (2)
Lycium (2)
Melia (2)
Paulownia (2)
Phoenix (2)
Sophora (2)
Sorbaria (2)
Weigela (2)
Calycanthus (2)
Gaultheria (2)
Litsea (2)
Menziesia (2)
Pieris (2)
Staphylea (2)
Abelia (1)
Bambusa (1)
Broussonetia (1)
Buddleja (1)
Buxus (1)
Calluna (1)
Camellia (1)
Clerodendrum (1)
Colutea (1)
Forsythia (1)
Koelreuteria (1)
Laburnum (1)
Phyllostachys (1)
Poncirus (1)
Pterostyrax (1)
Sapium (1)
Thamnocalamus (1)
Vincetoxicum (1)
Callicarpa (1)
Dirca (1)
Leiophyllum (1)
Menispermum (1)
Nemophila (1)
Osmanthus (1)
Stewartia (1)
Metasequoia (0)
Vitex (0)
Ceratonia (0)
Cercidiphyllum (0)
Exochorda (0)
Firmiana (0)
Grewia (0)
Kalopanax (0)
Kerria (0)
Kolkwitzia (0)
Nandina (0)
Phellodendron (0)
Pseudosasa (0)
Rhodotypos (0)
Stephanandra (0)
Styphnolobium (0)
Tetradium (0)
Toona (0)
Zelkova (0)
Adlumia (0)
Arceuthobium (0)
Berchemia (0)
Borrichia (0)
Cladrastis (0)
Empetrum (0)
Eubotrys (0)
Itea (0)
Loiseleuria (0)
Nestronia (0)
Styrax (0)
Xanthorhiza (0)
Zenobia (0)

5% of the available native plant genera (foraging hubs) support 73% of the available caterpillar species

You could build a landscape using 95% of the available native plant genera and still only support 27% of the available Lepidoptera

Foraging Hubs Exist Everywhere!

They are consistent across
and within bioregions,
across latitudes, and
regardless of plant diversity


Lake Winnipeg
Lake Winnipegosis
Lake Manitoba
Lake Superior
Lake Huron
Lake Ontario
Lake Michigan
Lake Erie
Great Salt Lake
Golfo de California
Gulf of Mexico

Oaks = 557 species of caterpillars

Ginkgo = 4 species of caterpillars


Native *Prunus* = 456
species of caterpillars


Zelkova
supports
no caterpillars

Pieris japonica; 2 spp


Native *Viburnum* spp;
103 spp

We are not fooling the birds when we fail to plant foraging hubs!


Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Basswood
Sweetgum
American elm
Black cherry
Pin oaks
Willow oaks
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Japanese Maples
Silktree
Ginkgo
Saucer Magnolia
Black Poplar
Leyland Cypress
Crape Myrtles
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo,

You don’t have to save biodiversity for a living, but you do have to save it where you live!

“Novel ecosystems: theoretical and management aspects of the new ecological world order”

Richard J. Hobbs et al. (2006). Global Ecology and Biogeography 15, 1–7.

Novel Ecosystems: Intervening in the
New Ecological World Order. (2013), Wiley-Blackwell

The organisms in most of our ecosystems have no evolutionary history together

They have not had time to develop the specialized relationships (the interactions) that are nature

Species and their interactions disappear from novel ecosystems


We have usurped so much of the natural
world that we now need to build
functioning ecosystems at home

We must raise the bar for what we ask our landscapes to do:

1) Support life
2) Sequester carbon
3) Clean and manage water
4) Enrich soil
5) Support pollinators


Why do we need
pollinators?

80% of all plants and 90% of all angiosperms are pollinated by animals

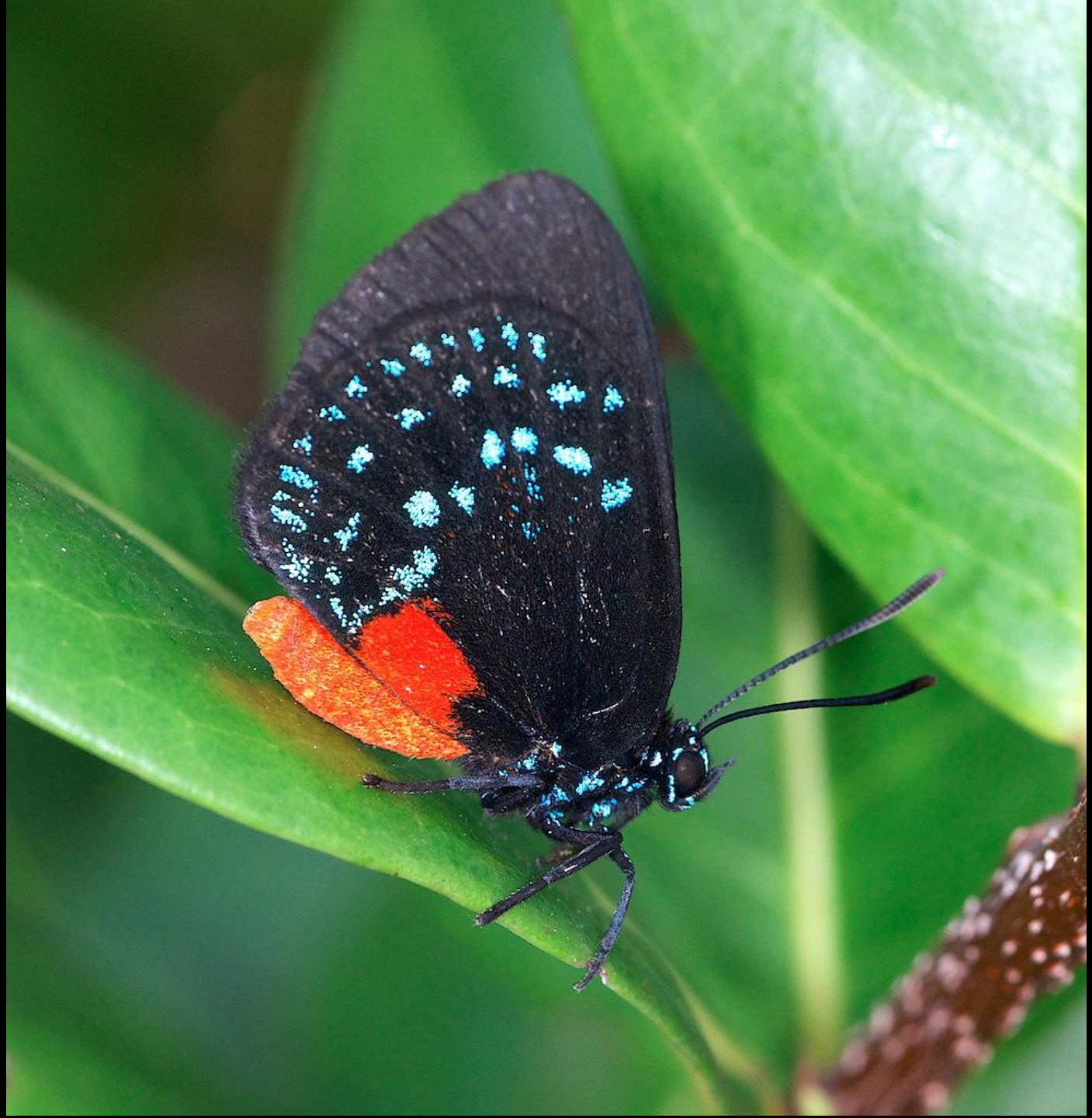
Losing our pollinators is not an option!

We are not talking about good land stewardship, we are talking about *essential* land stewardship!.

How effective can residential corridors be?

Homeowners in Florida have accidentally saved the *Atala* butterfly from extinction!

Attempts to list the Atala in the late 70s failed because no one could find any Atalas



Residential landscapes are such a powerful conservation tool the residents of Florida were able to save an endangered species without even trying!

Fortunately
nature is malleable,
resilient, and forgiving.

She will give us one more chance

Make America Native Again!