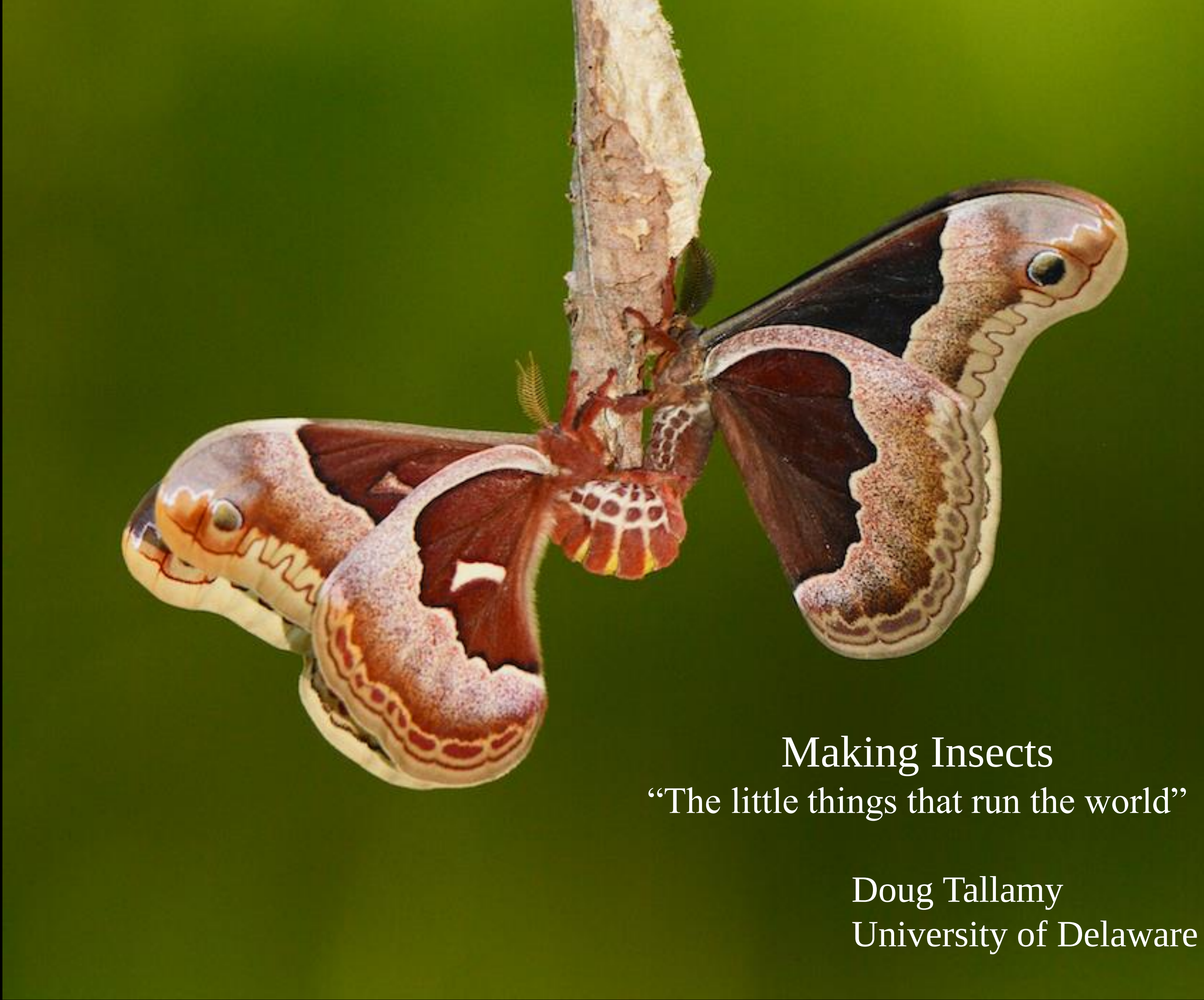
Making Insects
“The little things that run the world”
Doug Tallamy
University of Delaware

Edward O. Wilson

The Little Things That Run the World*
(The Importance and Conservation of Invertebrates)

On the occasion of the opening of the remarkable new invertebrate exhibit of the National Zoological Park, let me say a word on behalf of these little things that run the world. To start, there are vastly more kinds of invertebrates than of vertebrates. At the present time, on the basis of the tabulation that I have just completed (from the literature and with the help of specialists), I estimate that a total of 42,580 vertebrate species have been described, of which 6,300 are reptiles, 9,040 are birds, and 4,000 are mammals. In contrast, 990,000 species of invertebrates have been described, of which 290,000 alone are beetles—seven times the number of all the vertebrates together. Recent estimates have placed the number of invertebrates on the earth as high as 30 million, again mostly beetles—although many other taxonomically comparable groups of insects and other invertebrates also greatly outnumber vertebrates.

We don't know with certainty why invertebrates are so diverse, but a commonly held opinion is that the key trait is their small size. Their niches are correspondingly small, and they can therefore divide up the environment into many more little domains where specialists can coexist. One of my favorite examples of such specialists living in microniches are the mites that live on the bodies of army ants: one kind is found only on the mandibles of the soldier caste, where it sits and feeds from the mouth of its host; another kind is found only on the hind foot of the soldier caste, where it sucks blood for a living; and so on through various bizarre configurations.

Another possible cause of invertebrate diversity is the greater antiquity of these little animals, giving them more time to explore and fill the environment. The first invertebrates appeared well back into Precambrian times, at least 600 million years ago. Most invertebrate phyla were flourishing before the vertebrates arrived on the scene, some 500 million years ago.

Invertebrates also rule the earth by virtue of sheer body mass. For example, in tropical rain forest near Manaus, in the Brazilian Amazon, each hectare (or 2.5 acres) contains a few dozen birds and mammals but well over one billion invertebrates, of which the vast majority are not beetles this time but mites and springtails. There are about 200 kilograms dry weight of animal tissue in a hectare, of which 93 percent consists of invertebrates. The ants and termites alone compose one-third of this biomass. So when you walk through a tropical forest, or most other terrestrial habitats for that matter, or snorkel above a coral reef or some other marine or aquatic environment, vertebrates may catch your eye most of the time—biologists would say that your search image is for large animals—but you are visiting a primarily invertebrate world.

It is a common misconception that vertebrates are the movers and shakers of the world, tearing the vegetation down, cutting paths through the forest, and consuming most of the energy. That may be true in a few ecosystems such as the grasslands of Africa with their great herds of herbivorous mammals. It has certainly become true in the last few centuries in the case of our own species, which now appropriates in one form or other as much as 40 percent of the solar energy captured by plants. That circumstance is what makes us so dangerous to the fragile environment of the world. But it is otherwise more nearly true in most parts of the world of the invertebrates rather than the nonhuman vertebrates. The leafcutter ants, for example, rather than deer, or rodents, or birds, are the principal consumers of vegetation in Central and South America. A single colony contains over two million workers. It sends out columns of foragers a hundred meters or more in all directions to cut forest leaves, flower parts, and succulent stems. Each day a typical mature colony collects about 50 kilograms of this fresh vegetation, more than the average cow. Inside the nest, the ants shape the material into intricate sponge-like bodies on which they grow a symbiotic fungus. The fungus thrives as it breaks down and consumes the cellulose, while the ants thrive by eating the fungus.

The leafcutting ants excavate vertical galleries and living chambers as deep as 5 meters into the soil. They and other kinds of ants, as well as bacteria, fungi, termites, and mites, process most of the dead vegetation and return its nutrients to the plants to keep the great tropical forests alive.

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* *Address given at the opening of the invertebrate exhibit, National Zoological Park, Washington, D.C., on May 7, 1987.*

If insects were to disappear…

1) Most flowering plants would go extinct

2) The physical structure of most terrestrial habitats would change drastically without flowering plants

3) Most of the fresh water fishes, amphibians, birds, and mammals (and humans) would disappear in months
4) The biosphere would rot due to the loss of insect decomposers

Earth would return to a depauperate primitive state dominated by bacteria, algae and fungi, much as it was over 400 million years ago.

It was somber message, but it was ignored!

If we humans depend on insects……

National Insect Killing Week

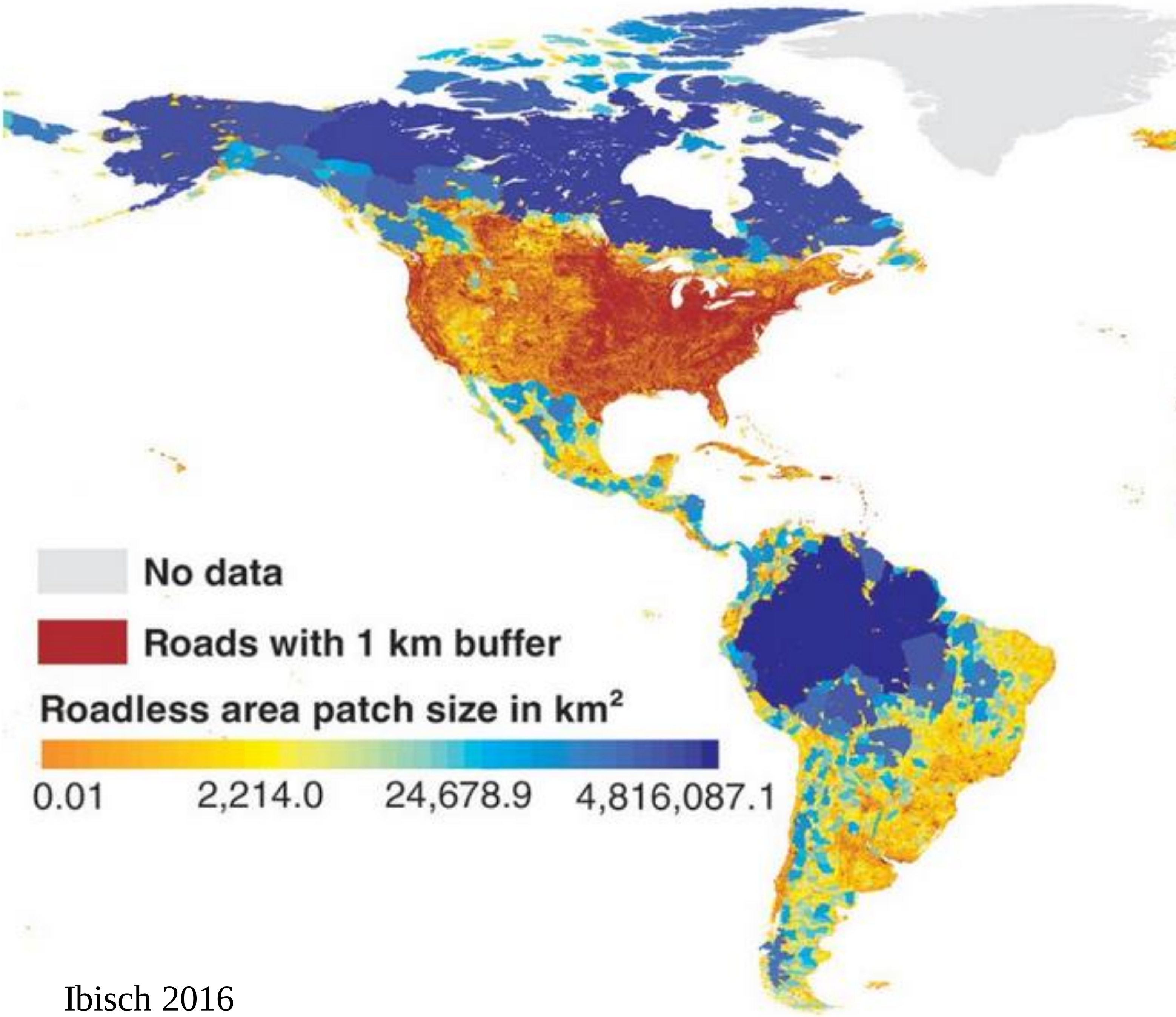
1929

Decorah Journal Thurs., July 16, 2009 B-3

EIGHTY YEARS AGO: This week is National Insect Killing Week, and it is receiving support from innumerable quarters. A campaign is gaining much support for increasing the use and popularity of household insecticides, both the liquid type and powders. To boost the sales of all brands of chemicals to rid the community of insects several local businesses are running bargain specials on insecticides – priced at under $1 per gallon.

We haven’t worried about insects because they have always been there.

There two reasons we can no longer rely on our natural areas to make enough insects


No data
Roads with 1 km buffer
Roadless area patch size in km²
0.01
2,214.0
24,678.9
4,816,087.1

Ibisch 2016


Food production now claims ½ of the
earth's land surface

770 million acres of rangeland in the U.S.

(21 times larger than Georgia)

We are winning our war against insects

50% mid-western native bee species have disappeared from their historic ranges in last century.

4 bumblebee species declined 96% in the last 20 years

3 bumblebee species are already extinct.

25% of our bumblebee species at risk of extinction

German insects have decline 5.3 fold since 1989

46 species of moths and butterflies have disappeared from Germany

Invertebrate abundance has declined 45% globally since 1974

Schwageral 2016

British Butterfly Declines

High brown fritillary	79%
Wood white	65%
Pearl-bordered fritillary	61%
White-letter hairstreak	53%
Duke of burgundy	52%


If we eliminate insects,
we eliminate the
animals that eat insects

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

How can we turn this around??

Let’s focus on the land that is easiest to fix….our properties

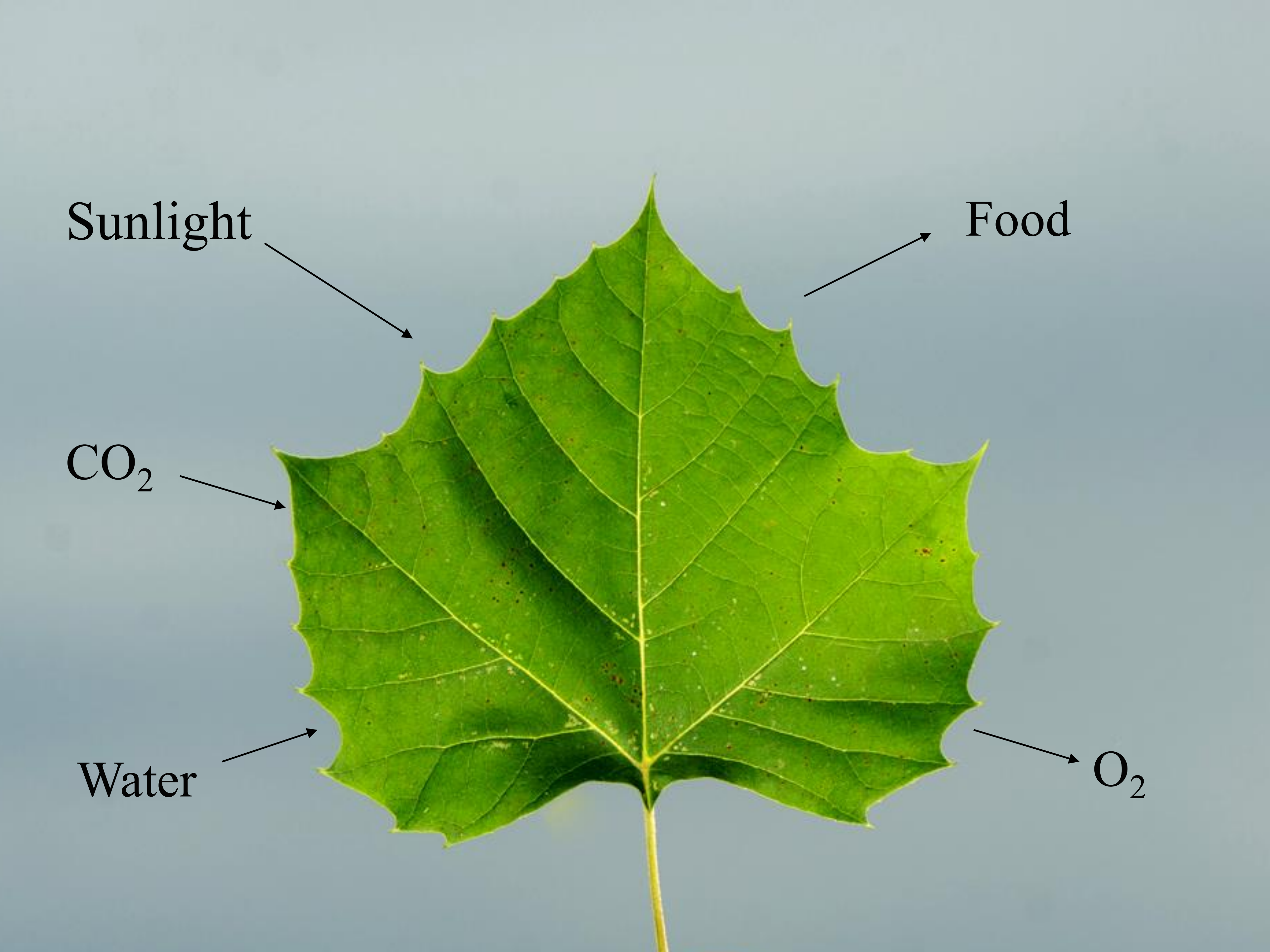
We must raise the bar for what we ask our landscapes to do:

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


Making insects accomplishes all
of theses things!

What does it take to make insects?

Energy!


Sunlight
Food
CO_2
Water
O_2

So, to make insects we first need plants

Plants make four types of insects

Insects that eat pollen and nectar

Insects that eat living plant parts

Insects that eat wood (xylem)

Insects that eat detritus (dead plant parts)

1) insects that eat terrestrial leaf litter
2) insects that eat submerged litter

Insects that eat pollen and nectar


Insects that eat
living plant parts

Insects that eat roots

Insects that eat leaf litter

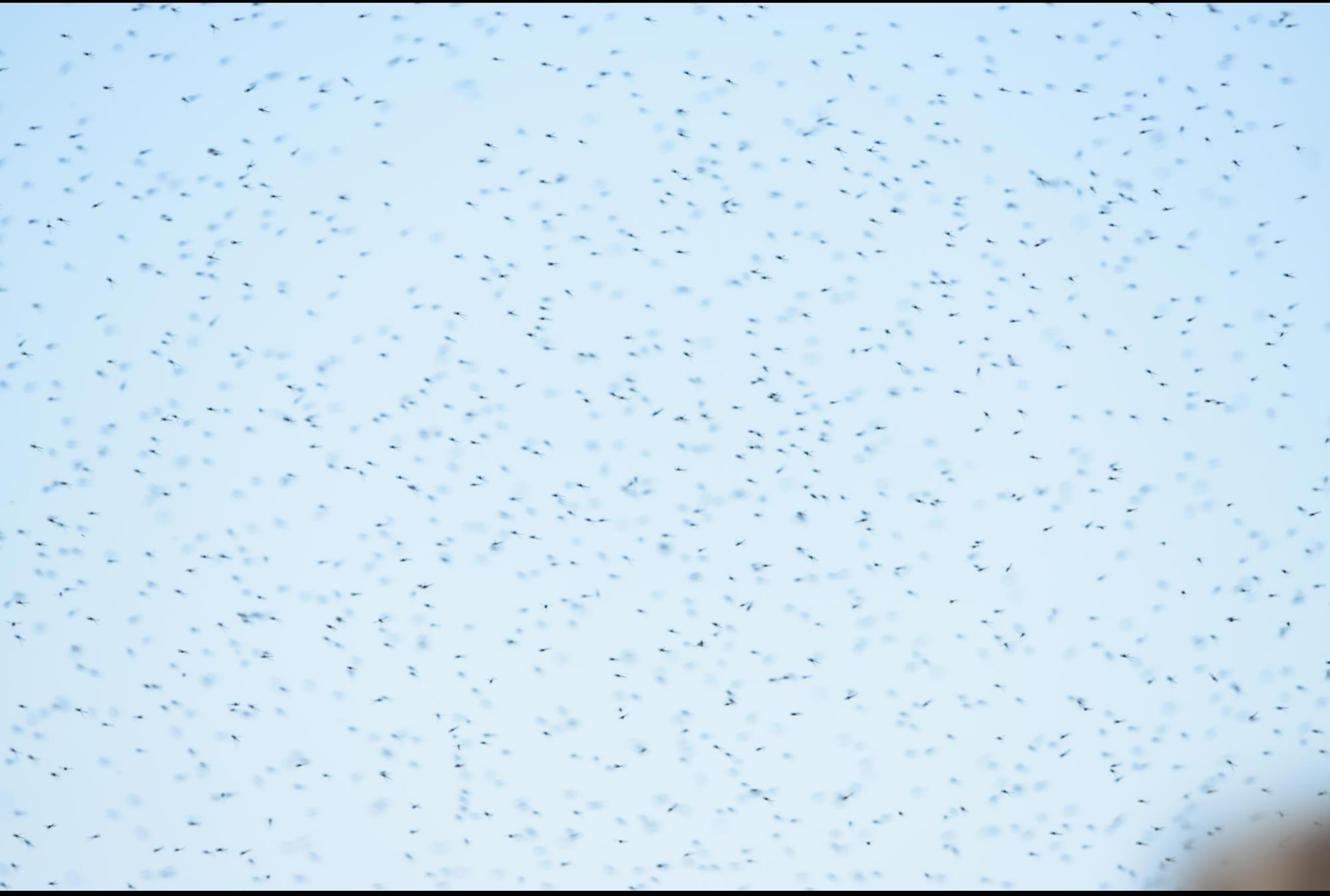

70 species of moths
eat detritus

1000’s of species of flies breed in decaying vegetation

Insects that eat standing wood

Insects that eat fallen wood


Insects that eat aquatic plants & detritus




If you make insects that eat plants you will make insects that eat insects

Each of these guilds of insects are necessary to run ecosystems, but they do not contribute to food webs equally.

How do we make aquatic insects at home?


Photo Rick Bartel

How do we make pollinators?


80% of all plants and 90% of all angiosperms are pollinated by animals
Losing our pollinators is not an option!

Who are our major pollinators?

1 species of honey bee

4000 species of natives bees

14,000 species of moths and butterflies

Yellow-jackets are not bees!

Where do native bees nest?

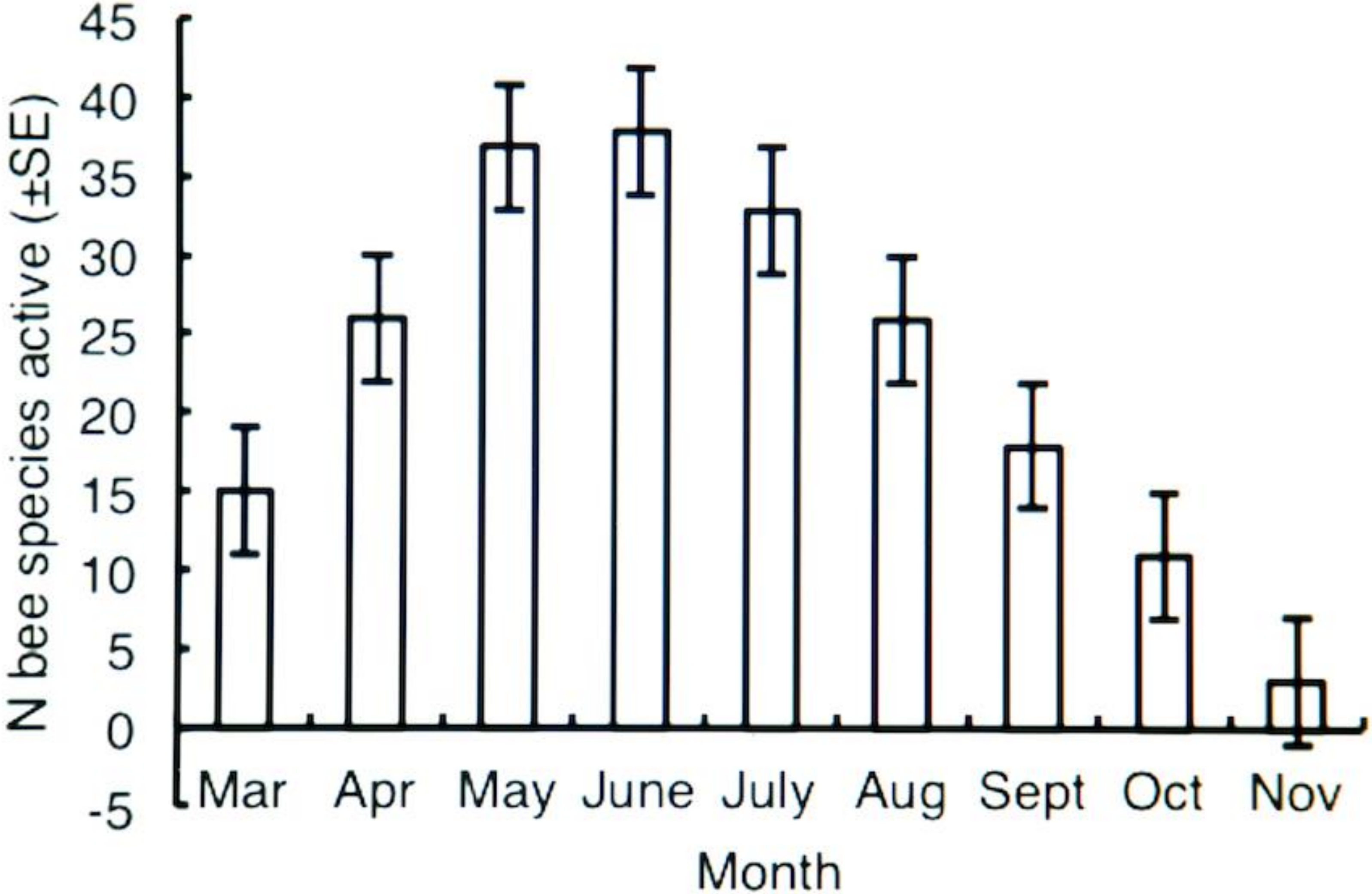
Ground nesters
Woody stem nesters
Pithy stem nesters



A R


What do bees need to reproduce?

Bees need pollen and nectar to reproduce



Fowler and Droege 2015

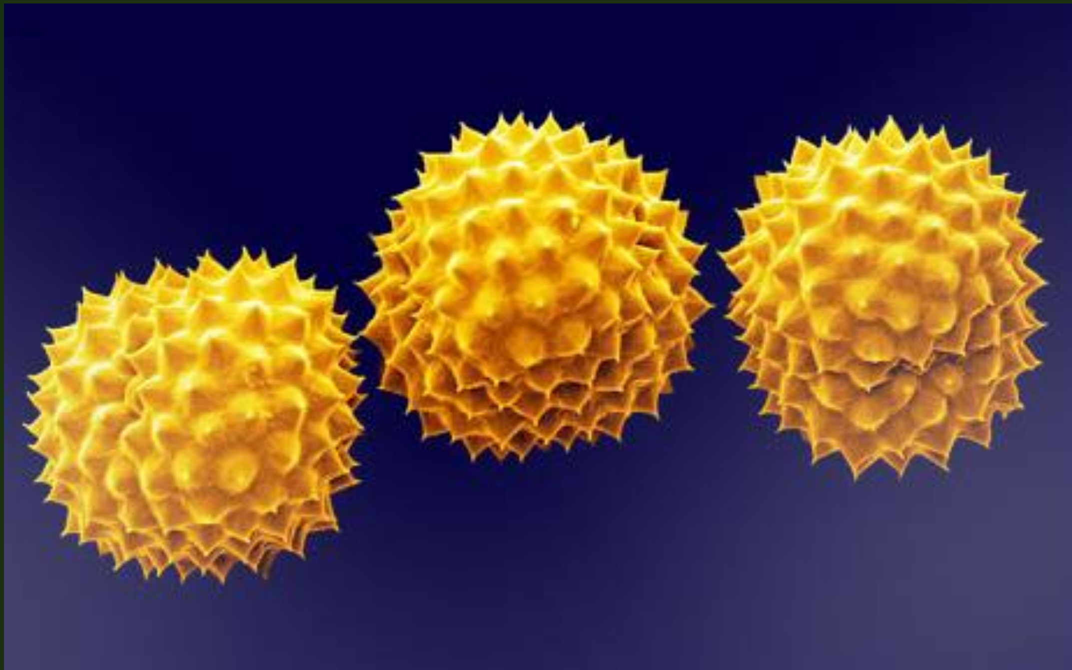
What species should we plant for native bees?

“Meet the needs of our specialists”

Sam Droege

Many bee species have been forced to specialize because all pollen is not created equal!

Flowering phenology
Visual and olfactory cues
Floral and pollen morphology
Nutritional value
- amino acids
- lipids
- secondary metabolites
- proteins
- starches
- sterols



Most productive plant genera for native bee specialists in New England

Solidago	Goldenrods	11 spp
Salix	Willows	8 spp
Symphyotrichum	Asters	7 spp
Vaccinium	Blueberries	5 spp
Euthamia	Goldentops	3 spp
Lysimachia	Yellow loosestrife	3 spp
Helianthus	Sunflowers	3 spp
Pontederia	Pickerelweed	2 spp

Fowler and Droege 2015

Andrena asteroides

Spring beauty

Andrena erigeniae

Includes Tree, Shrub, and Perennial Plant Profiles for the Midwest, Great Lakes, and Northeast Regions

BEES

An Identification and Native Plant Forage Guide

HEATHER HOLM Author of *Pollinators of Native Plants*

How should we feed our birds?

We can group birds
into guilds

Warblers

Thrushes

Woodpeckers

Wrens

Titmice,
chickadees,
bushtits

Jays

Vireos

Cardinals

How do we feed our fly catchers?

Meadows!

Caterpillars are essential to most bird group reproduction

Carolina chickadee feeds its young almost exclusively caterpillars


Why caterpillars?

It could be because they are beautiful

Pandora sphinx

Calleta silk moth

Spiny rose caterpillar

Curve-lined owlet

Black swallowtail

Hieroglyphic moth

Spun glass caterpillar

It could be because they have cool names


Green marvel


Once-charred punkie


Confused woodgrain


Cynical groundcat

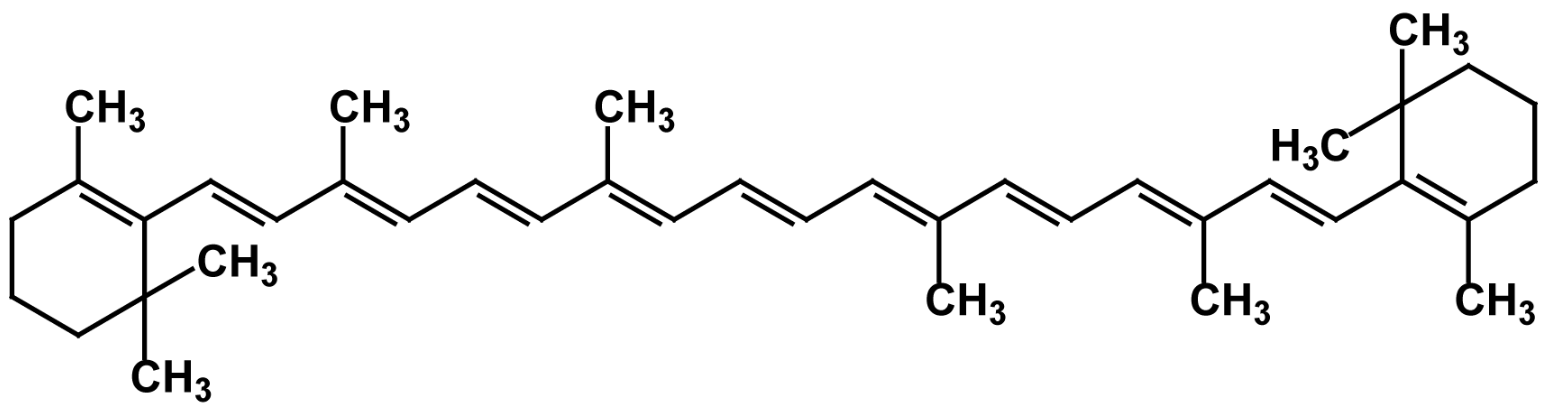

The Neighbor

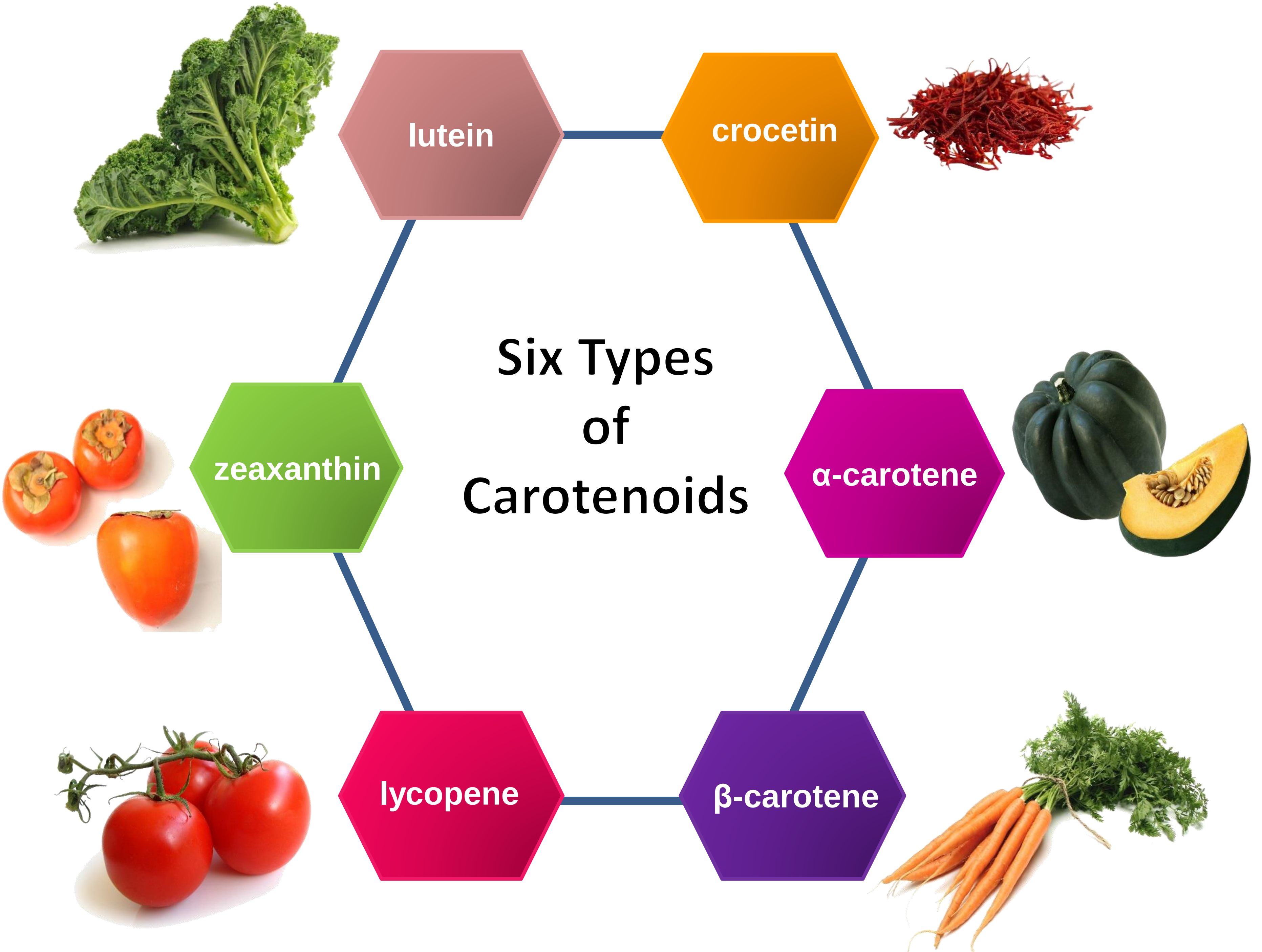
The Donald


1) soft

1) Soft
2) large
3) high in protein
4) high in lipids
5) best source of carotenoids

Essential carotenoids





Six Types of Carotenoids
lutein
crocetin
zeaxanthin
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

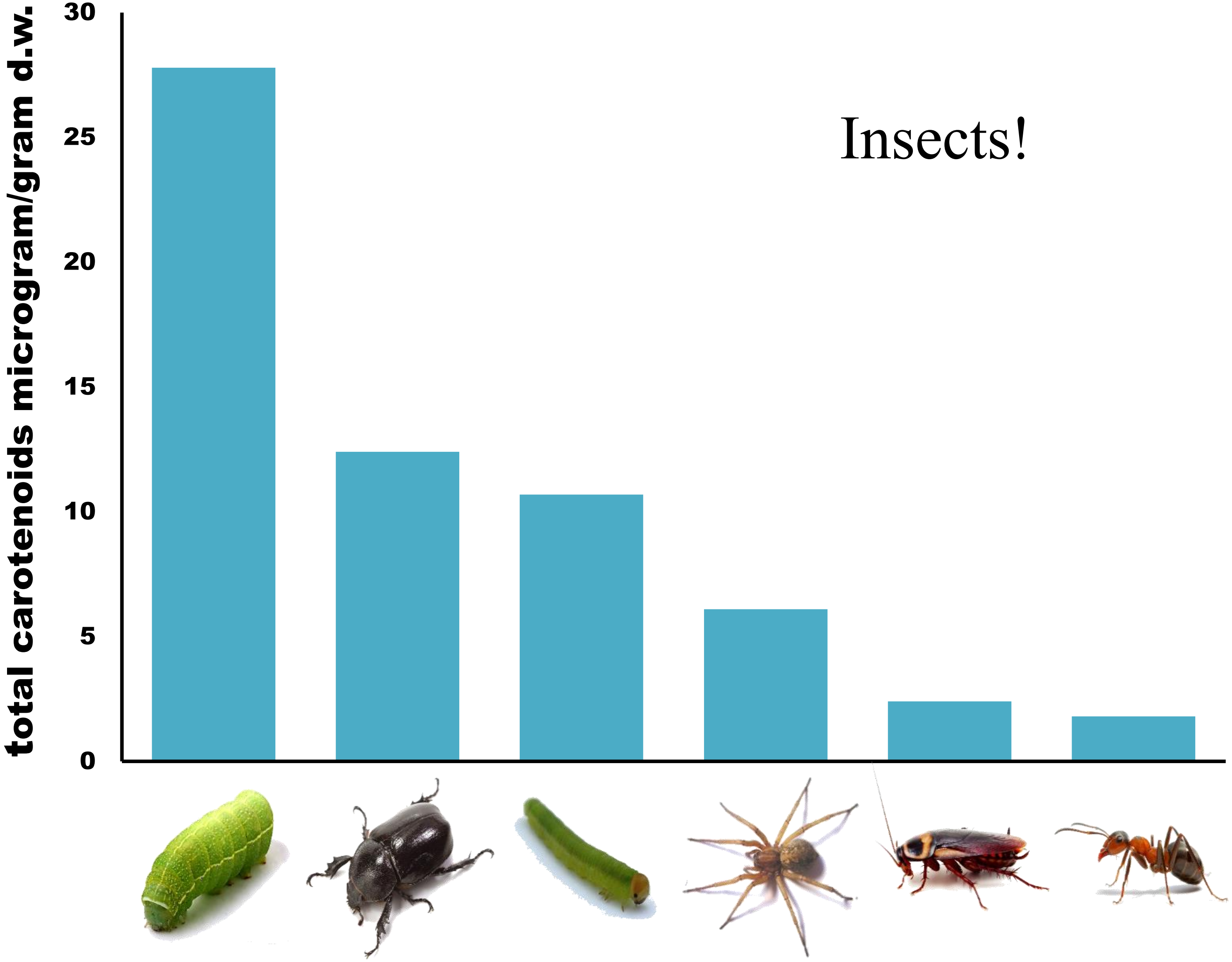
Improve sperm vitality

McGraw 2009

Chickadees can not make their own carotenoids….

they must get them indirectly from plants

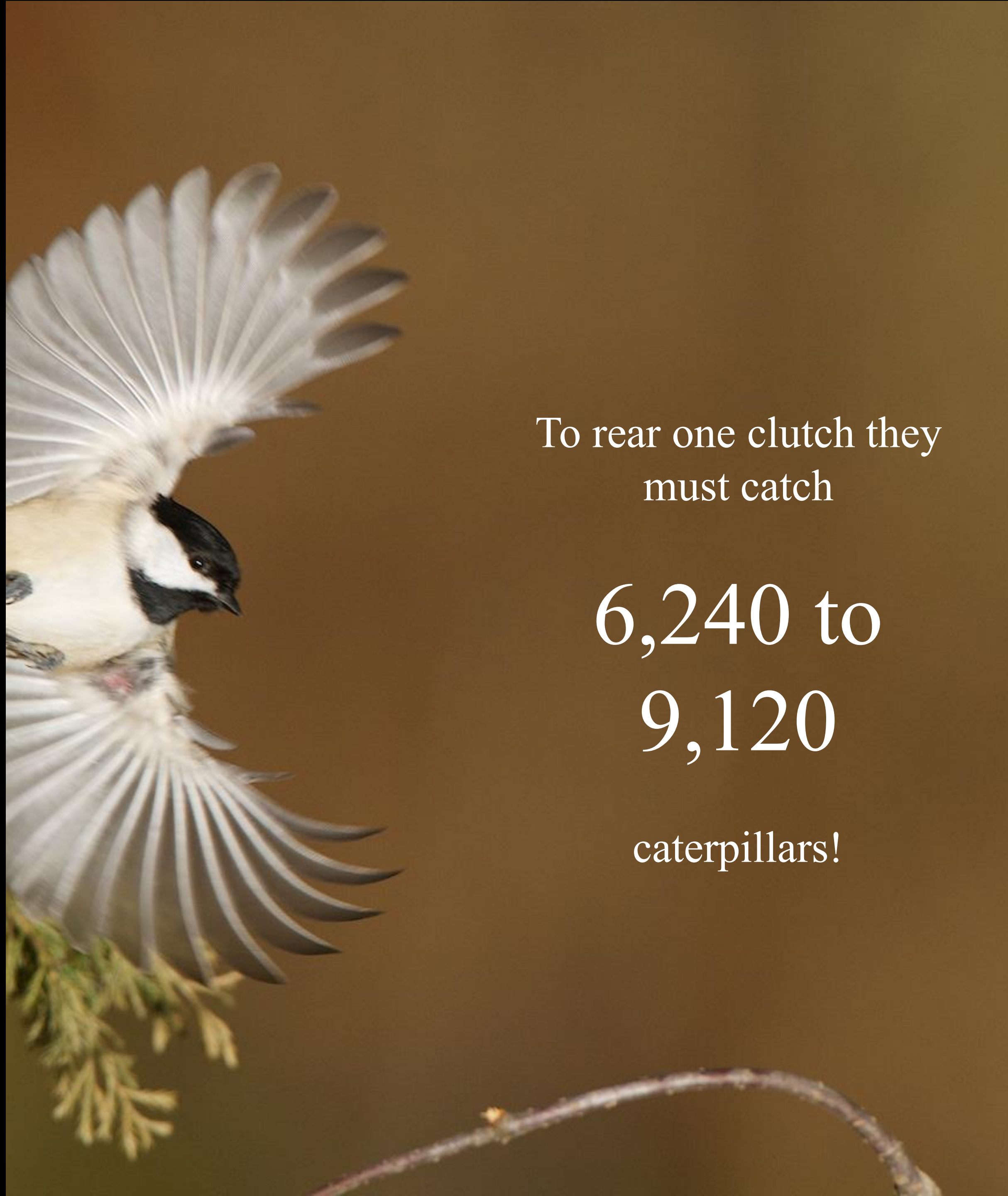
A chickadee doesn’t eat plants, so
it has to get carotenoids from
something that does eat plants.



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


For most birds, caterpillars
are not optional!

There can be no chickadees where there are not enough caterpillars!


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

How do we make that many caterpillars?

Let’s first talk about how *not* to make caterpillars


Lawn of the Month
Grow Glendale Gorgeous


We add caterpillars
to landscapes
by adding the plants
that make them

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

Plant choice matters!

White oak

Caterpillars on White Oak

July 25, 2014

Banded tussock moth	4
Nason’s slug	2
Pear slugs	104
Bagworms	3
Leaf-tip rollers	21
Yellow-necked caterpillar eggs	80
Yellow-necked caterpillars	115
Pyralid leaf rollers	4
Saddled prominent	3
Tortricid leaf tiers	34
Leaf miners	12
Geometrid inch worm	1
Bucculatrix ainsliella	1
Midrib webber	5
White-dotted prominent	2
Double-lined prominent	2
Douglasiidae	1
Lepidoptera eggs	12
Leaf folders	4

410 caterpillars

19 species

Black cherry

Caterpillars on Black Cherry

July 25 2014

Pear slugs	12
Saddleback caterpillar	1
Leaf-tier	1
Tent caterpillar eggs	175
Tenthredinid sawfly	1
Bucculatrix pomifoliella	8
Leaf –folder	3
Tufted bird dropping moth	2
Ugly nest caterpillar	13
Leaf miners	16
Large Pyralid	1
Acleris variegena	1
Bagworm	1
Leaf-roller	4

239 caterpillars
14 Species

Callery pear

Caterpillars on Bradford Pear

July 26, 2014

Geometrid inchworm	1

1 Caterpillar
1 Species

Burning bush

Caterpillars on Burning Bush

July 25, 2014

Leaf skeletonizers	4

4 caterpillars

1 species

Caterpillars on July 26 2014

White oak	233 caterpillars:	15 species
Black cherry	53 caterpillars:	10 species
Burning bush	2 caterpillars:	1 species
Callery pear	1 caterpillar:	1 species


Sunset Beach Inn and Grille
Conference Center
Restaurants
Lounge
Jacuzzi Suites
HOTEL OPEN
600
SUNSET BEACH
Sunset Grille


Sunset Beach Inn AND Grille
Conference Center
Restaurants
Lounge
Jacuzzi Suites
HOTEL OPEN
600
SUNSET BEACH
Sunset Grille


If we add caterpillars
to our suburban
ecosystems, we will
breeding birds!

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!

Which plants 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)
Gaylussacia (44)
Celtis (43)
Juniperus (42)
Sambucus (42)
Physocarpus (41)
Syringa (40)
Ilex (39)
Sassafras (38)
Lonicera (37)
Liquidambar (35)
Kalmia (33)
Aesculus (33)
Parthenocissus (32)
Photinia (29)
Nyssa (26)
Symphoricarpos (25)
Cydonia (24)
Ligustrum (24)
Shepherdia (22)
Liriodendron (21)
Magnolia (21)
Cephalanthus (19)
Cercis (19)
Smilax (19)
Wisteria (19)
Persea (18)
Arctostaphylos (17)
Ricinus (16)
Taxodium (16)
Chamaedaphne (15)
Toxicodendron (15)
Oxydendrum (14)
Ampelopsis (13)
Arbutus (12)
Asimina (12)
Berberis (12)
Acacia (11)
Euonymus (11)
Frangula (11)
Lindera (11)
Lyonia (11)
Caragana (10)
Clethra (10)
Rhamnus (10)
Pyracantha (9)
Morus (9)
Elaeagnus (9)
Chaenomeles (8)
Cytisus (8)
Ficus (8)
Catalpa (8)
Chamaecyparis (8)
Chionanthus (8)
Maclura (8)
Taxus (8)
Cupressus (7)
Andromeda (7)
Campsis (7)
Celastrus (7)
Halesia (7)
Ledum (7)
Ailanthus (6)
Clematis (6)
Ptelea (6)
Zanthoxylum (6)
Albizia (5)
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”

National Wildlife Federation

http://www.nwf.org/NativePlantFinder/

Glynn County Core Genera

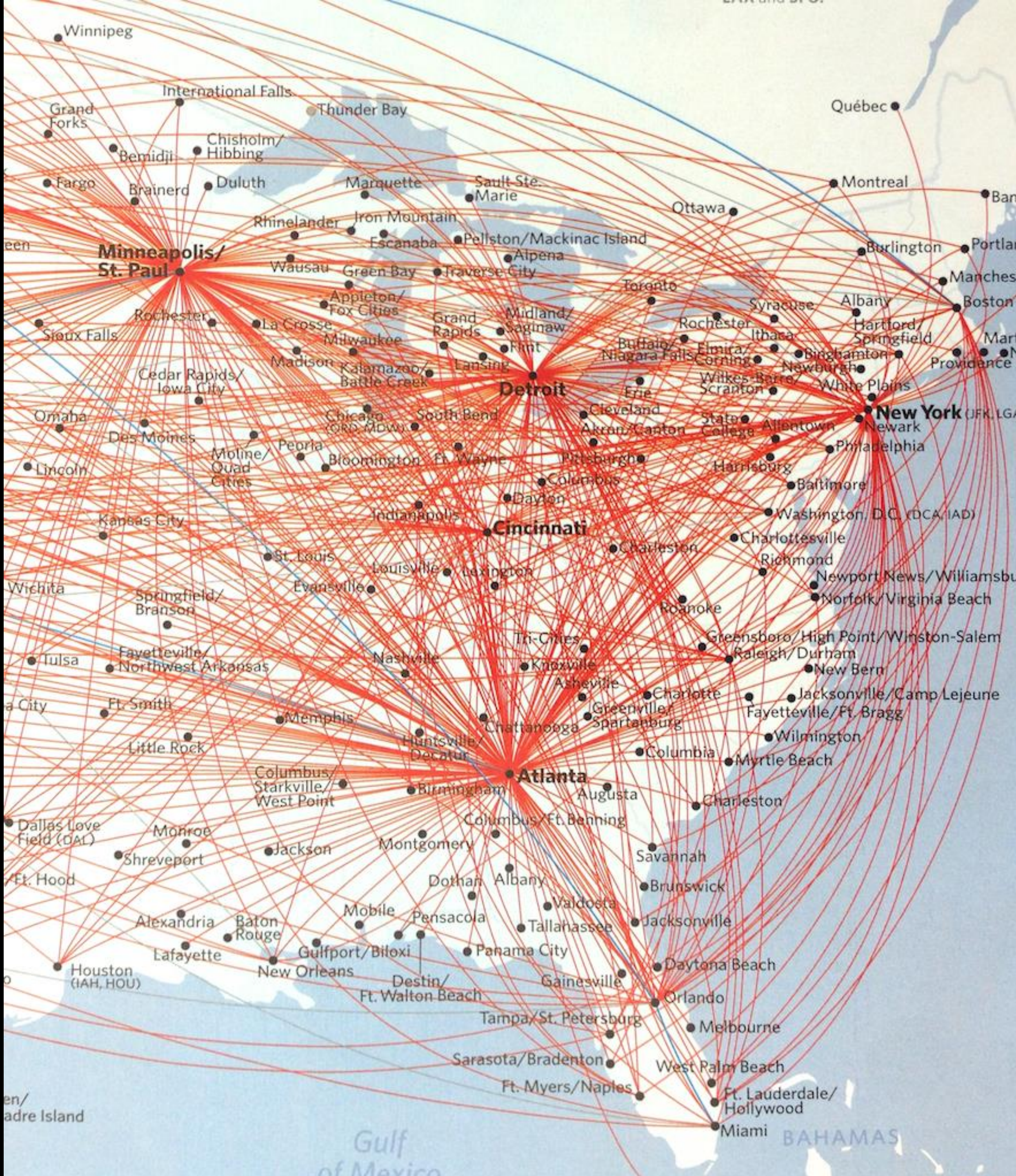
Woody Genera

Genus	**# Caterpillar spp**
Quercus	454
Prunus	324
Salix	247
Carya	229
Acer	223
Vaccinium	207
Pinus	145
Tilia	137
Alnus	137
Fraxinus	120
Crataegus	120
Rubus	120
Fagus	112
Castanea	112
Viburnum	102
Cornus	94
Amelanchier	80
Robinia	68
Vitis	68
Hamamelis	62
Azaleas	56
Persimmon	57

Herbaceous Genera

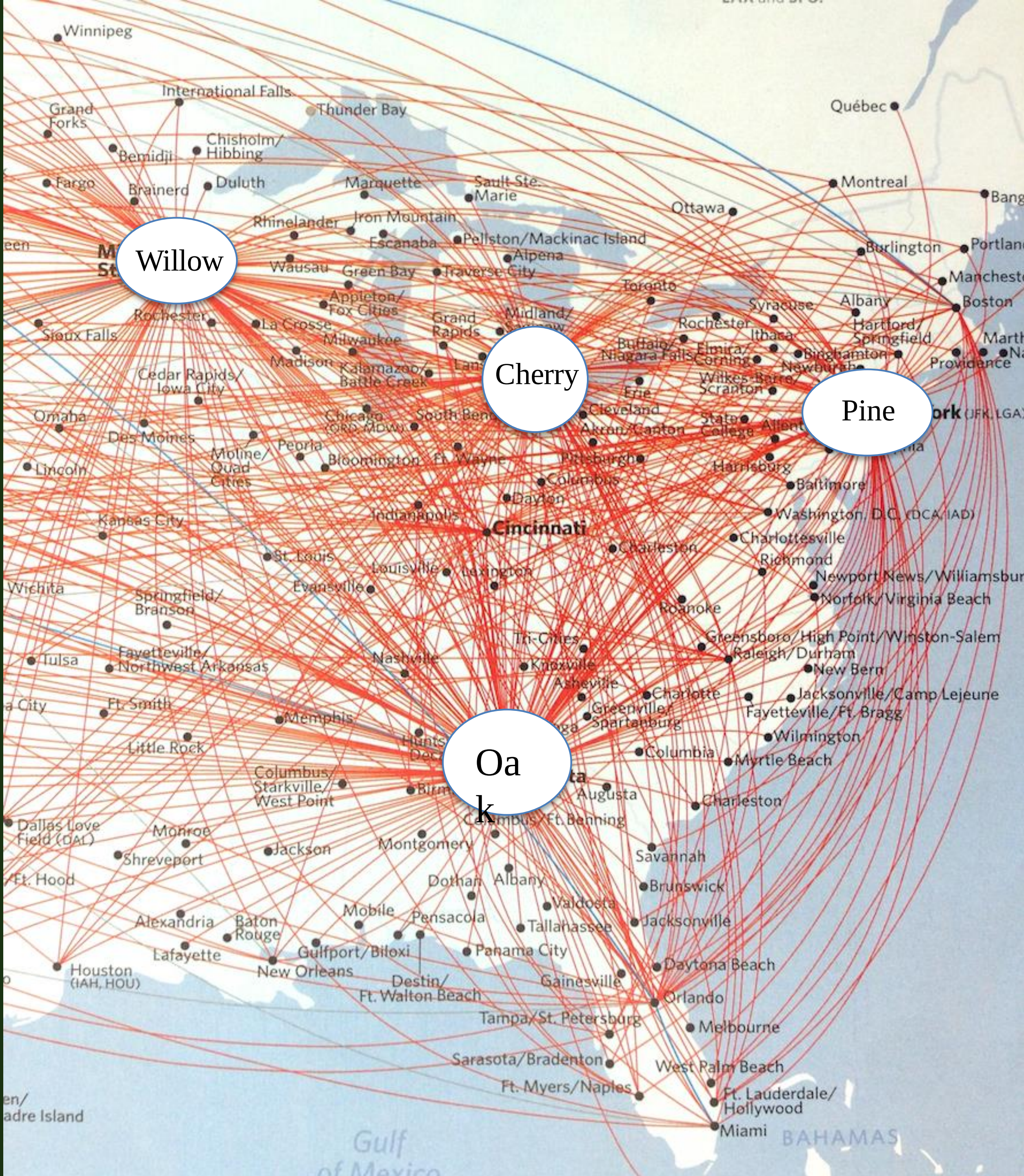
Genus	**# Caterpillar spp**
Solidago	94
Asters	80
Helianthus	67
Solanum	66
Ambrosia	54
Plantago	53
Ipomoea	47
Eupatorium	46
Hibiscus	34
Panicum	31
Amorpha	29
Cirsium	29
Persicaria	27
Erigeron	27
Lupinus	27
Baccharis	26
Viola	26
Vernonia	23
Desmodium	22
Baptisia	21
Oenothera	21
Bidens	20
Heterotheca	19

Plants that serve as key sources of food are called Foraging Hubs



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



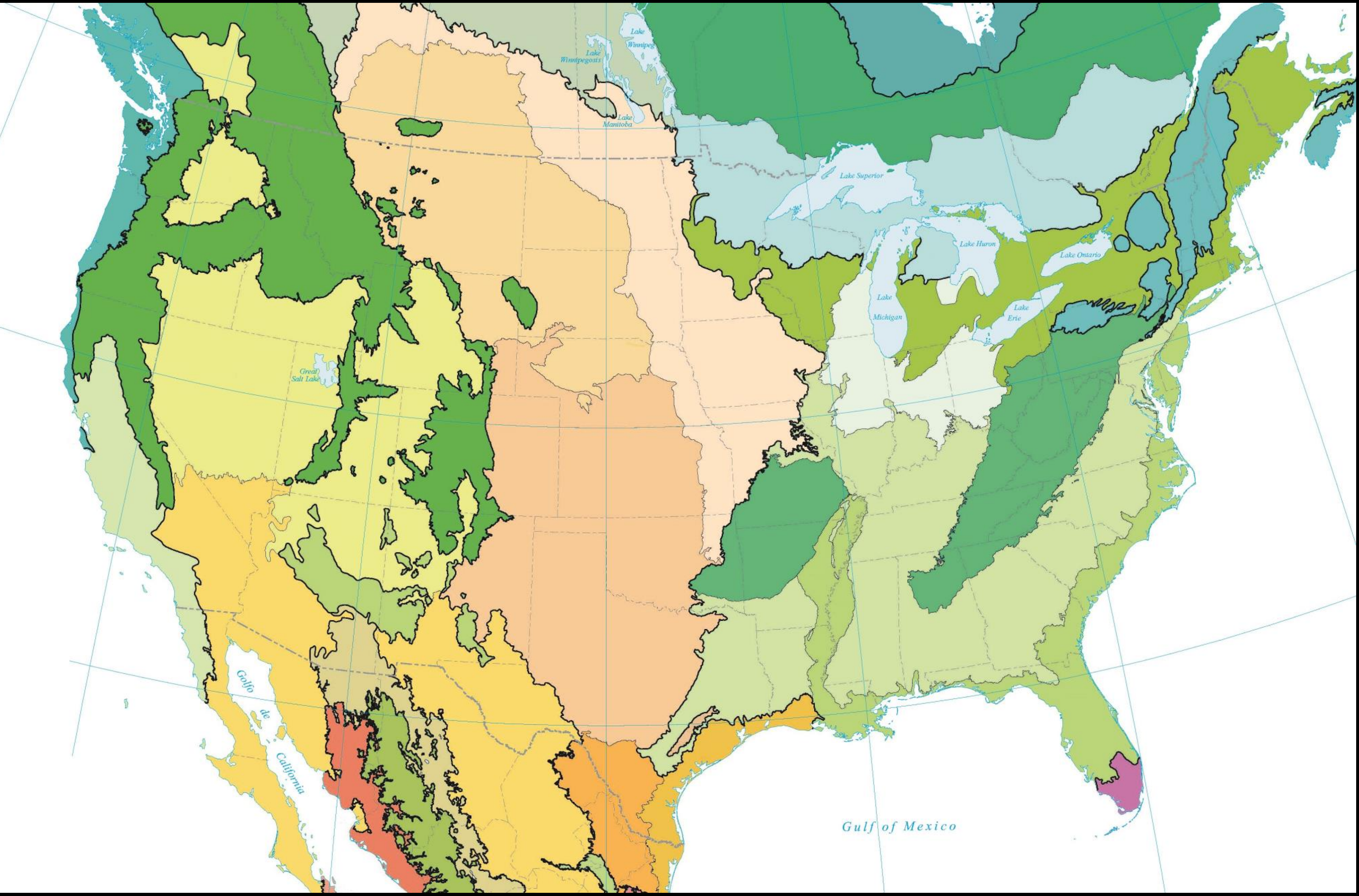
Quercus (557)
Prunus (456)
Salix (455)
Betula (411)
Populus (367)
Malus (308)
Acer (297)
Vaccinium (294)
Alnus (255)
Carya (235)
Ulmus (215)
Pinus (201)
Crataegus (168)
Rubus (163)
Picea (150)
Fraxinus (149)
Tilia (149)
Pyrus (138)
Rosa (135)
Corylus (131)
Juglans (129)
Castanea (127)
Fagus (127)
Amelanchier (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)
Gaylussacia (44)
Celtis (43)
Juniperus (42)
Sambucus (42)
Physocarpus (41)
Syringa (40)
Ilex (39)
Sassafras (38)
Lonicera (37)
Liquidambar (35)
Kalmia (33)
Aesculus (33)
Parthenocissus (32)
Photinia (29)
Nyssa (26)
Symphoricarpos (25)
Cydonia (24)
Ligustrum (24)
Shepherdia (22)
Liriodendron (21)
Magnolia (21)
Cephalanthus (19)
Cercis (19)
Smilax (19)
Wisteria (19)
Persea (18)
Arctostaphylos (17)
Ricinus (16)
Taxodium (16)
Chamaedaphne (15)
Toxicodendron (15)
Oxydendrum (14)
Ampelopsis (13)
Arbutus (12)
Asimina (12)
Berberis (12)
Acacia (11)
Euonymus (11)
Frangula (11)
Lindera (11)
Lyonia (11)
Caragana (10)
Clethra (10)
Rhamnus (10)
Pyracantha (9)
Morus (9)
Elaeagnus (9)
Chaenomeles (8)
Cytisus (8)
Ficus (8)
Catalpa (8)
Chamaecyparis (8)
Chionanthus (8)
Maclura (8)
Taxus (8)
Cupressus (7)
Andromeda (7)
Campsis (7)
Celastrus (7)
Halesia (7)
Ledum (7)
Ailanthus (6)
Clematis (6)
Ptelea (6)
Zanthoxylum (6)
Albizia (5)
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)

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 (Core Species) 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 Michigan
Lake Ontario
Lake Erie
Great Salt Lake
Golfo de California
Gulf of Mexico

Diversity of core genera is key

Add an oak	533 spp
add a willow	811 spp
add a cherry	961 spp
add a pine	1099 spp
add a birch	1172 spp
add a maple	1218 spp
add a hickory	1281 spp
add a poplar	1318 spp
add a viburnum	1351 spp
add an elm	1385 spp

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


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


Basswood
American elm
Sweetgum
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!

Do we have to make insects during the winter??

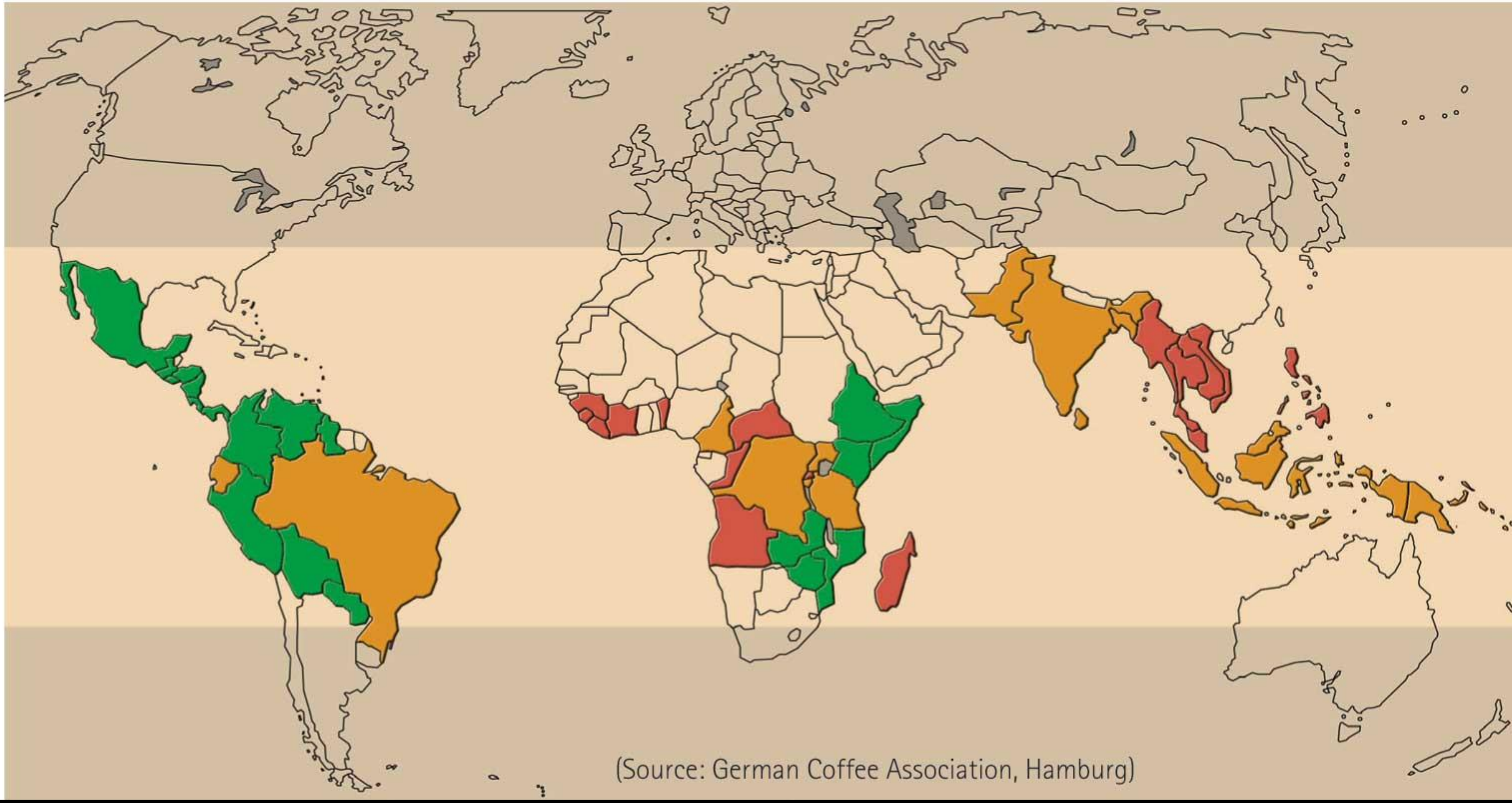

Bernd Heinrich


We need to make
caterpillars in the
summer AND winter!

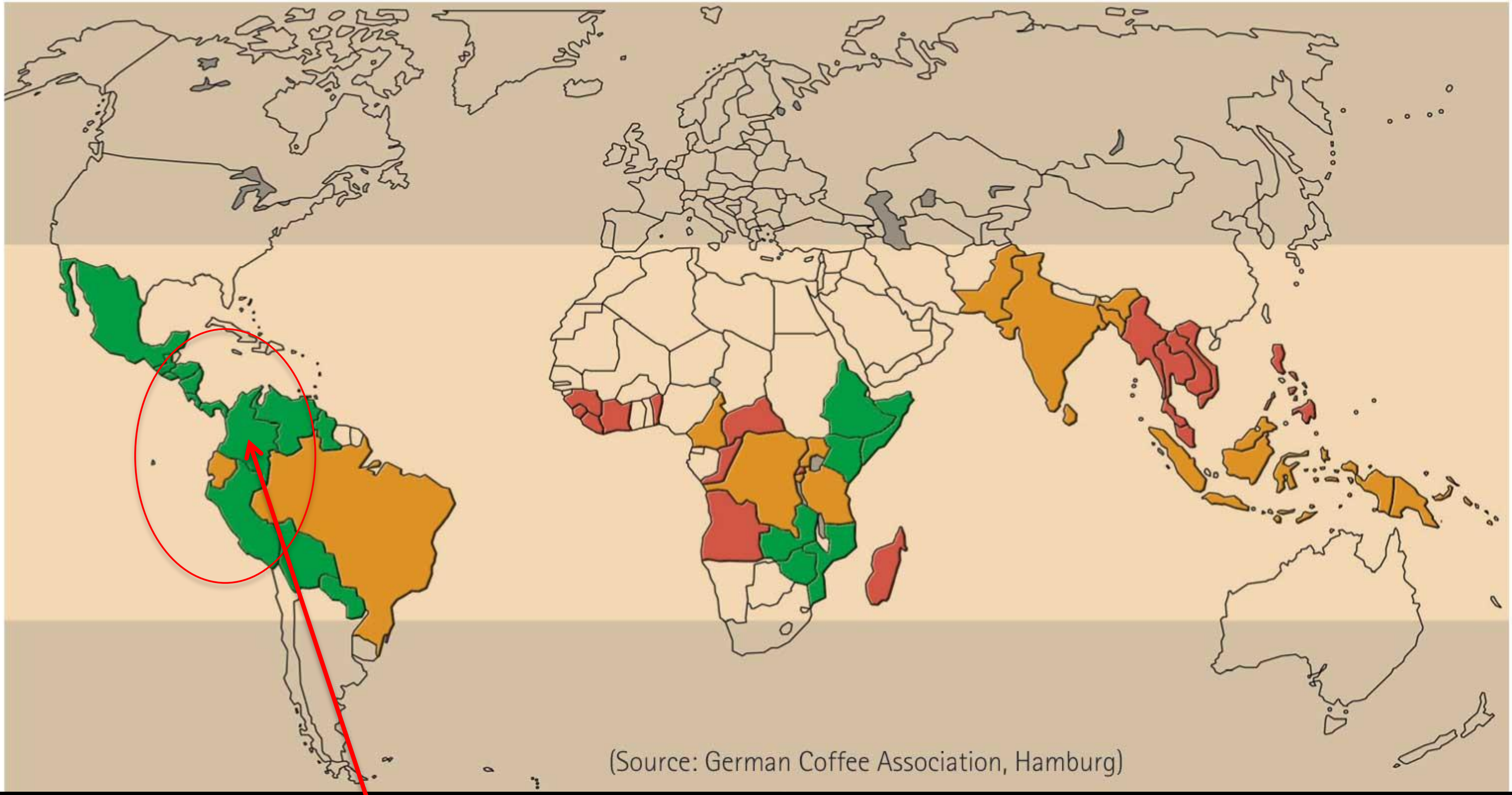

We must make insects both where migrants breed and where they winter

400 million
cups/day

The Coffee belt



The Coffee belt



5.4 million hectares

386 species of Neotropical migrants

And most overwinter in areas that are now coffee farms

Swallows and swifts

Orioles

Hummingbirds

Vireos

Tanagers

Buntings

Flycatchers


Thrushes


Warblers

Golden-wing
warbler

Cerulean warbler

54 species of North American warblers

42 species winter in coffee farms

These birds are migrating because they eat insects….so we need to make insects in coffee farms

There are two ways to grow coffee:

Shade coffee

Sun coffee


Only 30% of the
coffee grown is
shade coffee

BIRD FRIENDLY™

Smithsonian Migratory Bird Center

Criteria:12 tree species /hectare

Eucalyptus, mango and citrus are being used as shade trees in coffee more and more

Trees differ in their ability to produce insects

…and it is insects that Neotropical migrants need while they are in coffee farms

167 million coffee drinkers in the U.S.

Website:
coolbeansresearch.org

Facebook:
Facebook.com/CoolBeansResearch

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

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

Attempts to list the Atala as an endangered species failed because no one could find any Atalas

Residential landscapes are such a powerful conservation tool the residents of Florida were able to restore Atala populations without even trying!


Fortunately
nature is malleable,
resilient, and forgiving.


She will give us one
more chance

Make America Native Again!

Who’s going to make all of these insects ?