
Restoring Nature’s
Relationships
Doug Tallamy
University of Delaware

Specialization in the natural world, especially food specialization, is the rule rather than the exception

Specialization always starts with plants


0
1000
2000
3000
0
1000
2000
3000
kilometers

# Coral honeysuckle

Even animals we don’t think of as having specialized relationships with plants, often do

Carolina chickadee feeds its young almost exclusively caterpillars

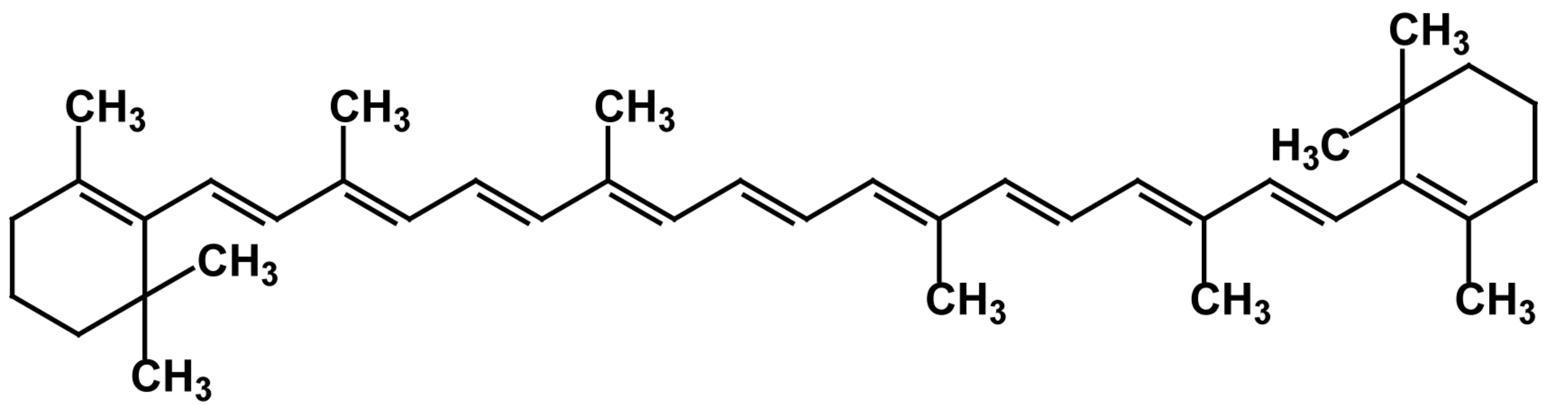
In fact, most birds rear young on caterpillars


Why caterpillars?

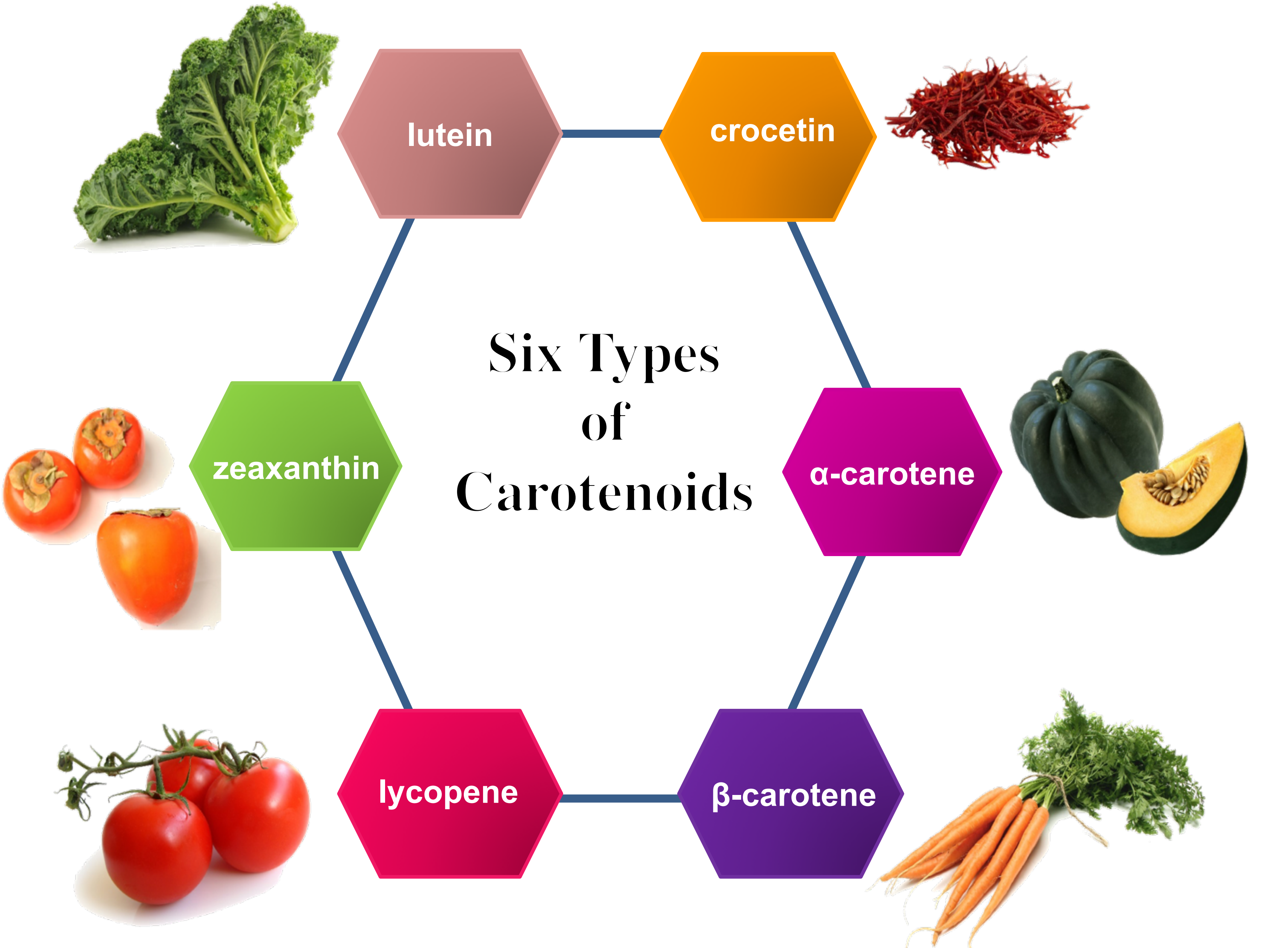

1) soft

1) Soft
2) large
3) nutritious
4) Low % of chitin
5) best source of carotenoids

# Essential carotenoids are only made by plants




Yet they are essential parts of vertebrate diets


lutein
crocetin
Six Types
of
Carotenoids
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

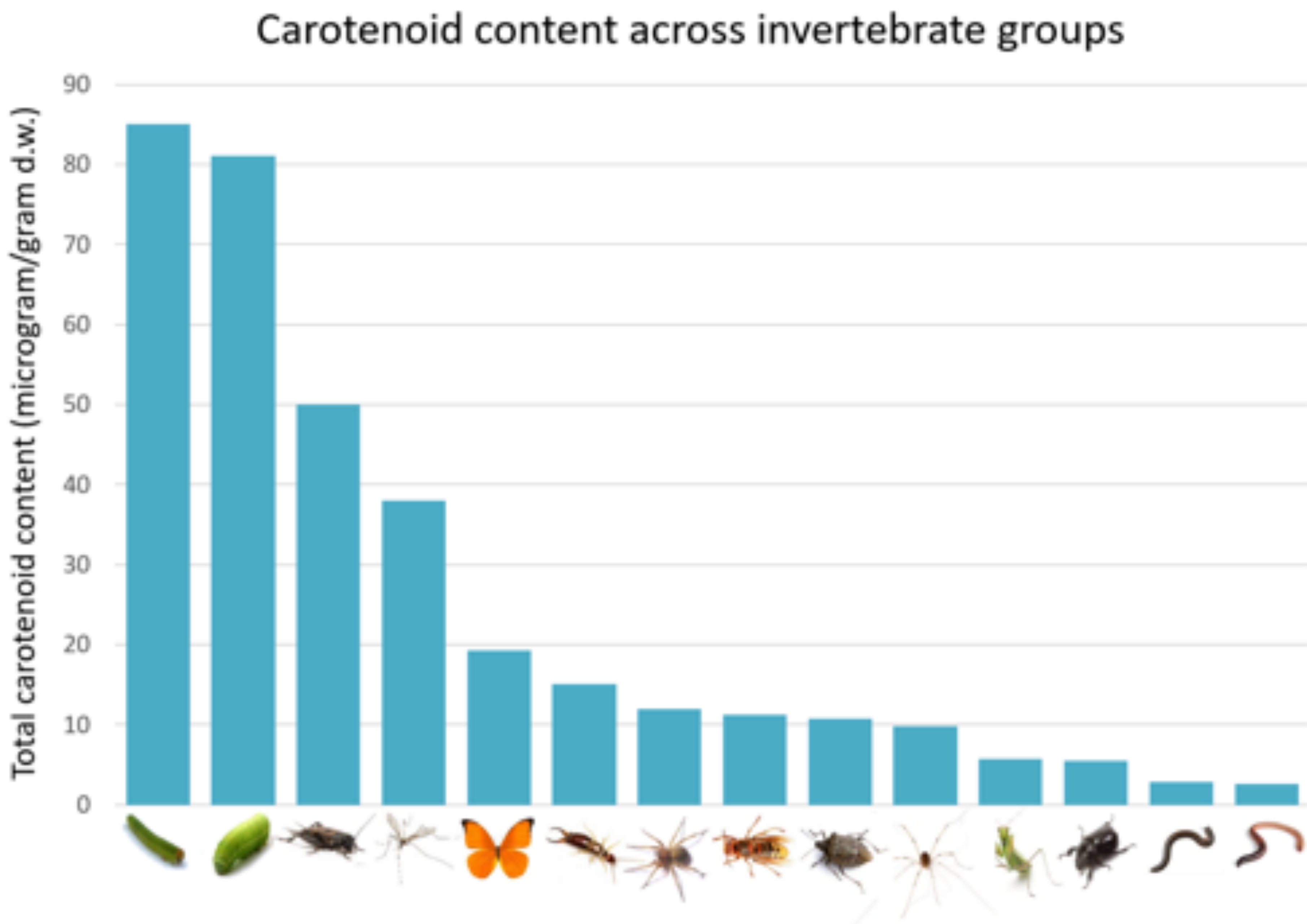
Improve color vision

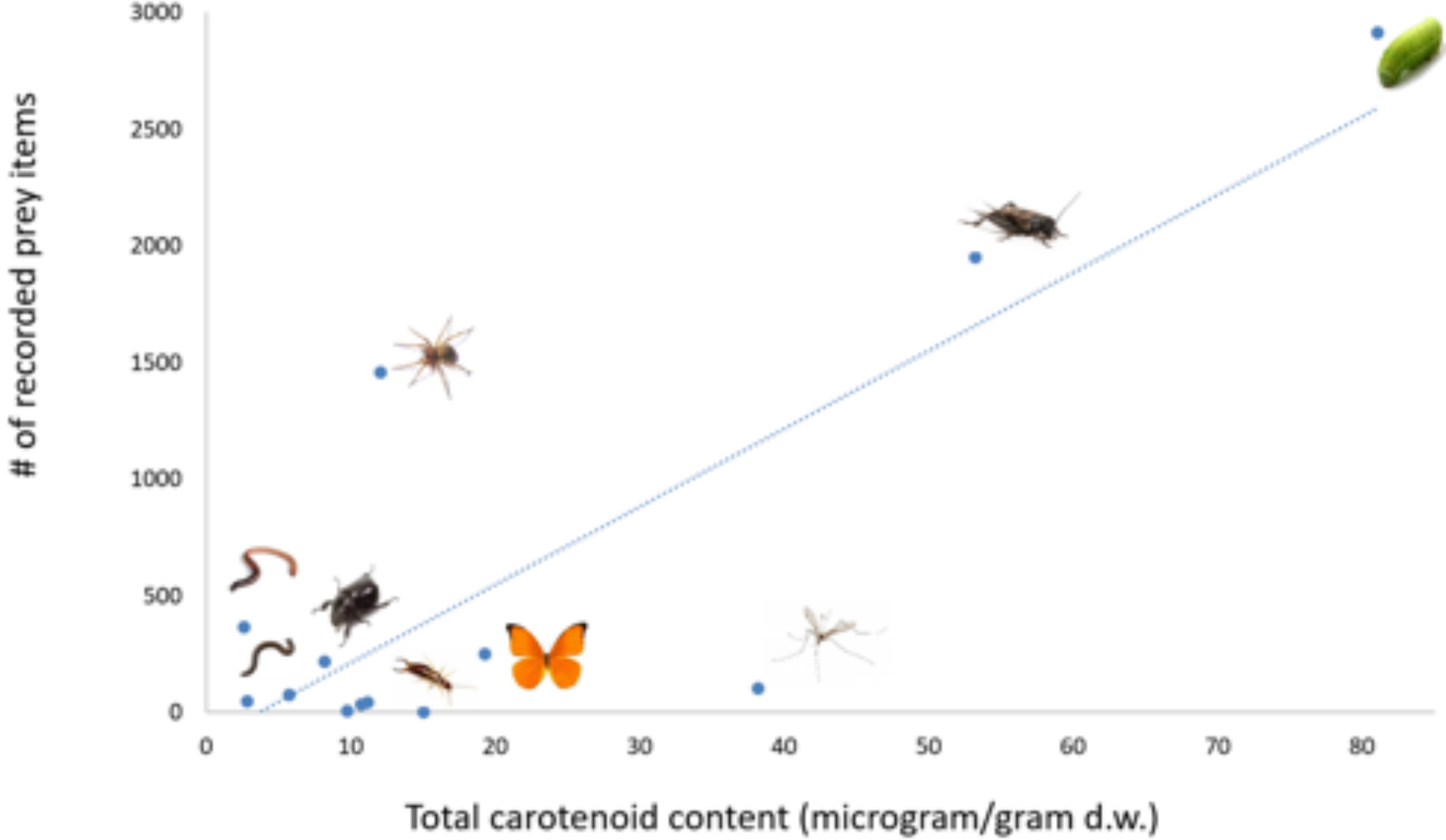
Improve sperm vitality

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.


Carotenoid content across invertebrate groups
Total carotenoid content (microgram/gram d.w.)
90
80
70
60
50
40
30
20
10
0




Based on 7628 observations by Kennedy


For most birds, caterpillars
are not optional!

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

How many caterpillars does it take to make a nest of chickadees?

Lots!

A pair can deliver food about every 3 min


30 caterpillars
in 27 min


Parents forage from 6 am til 8 pm

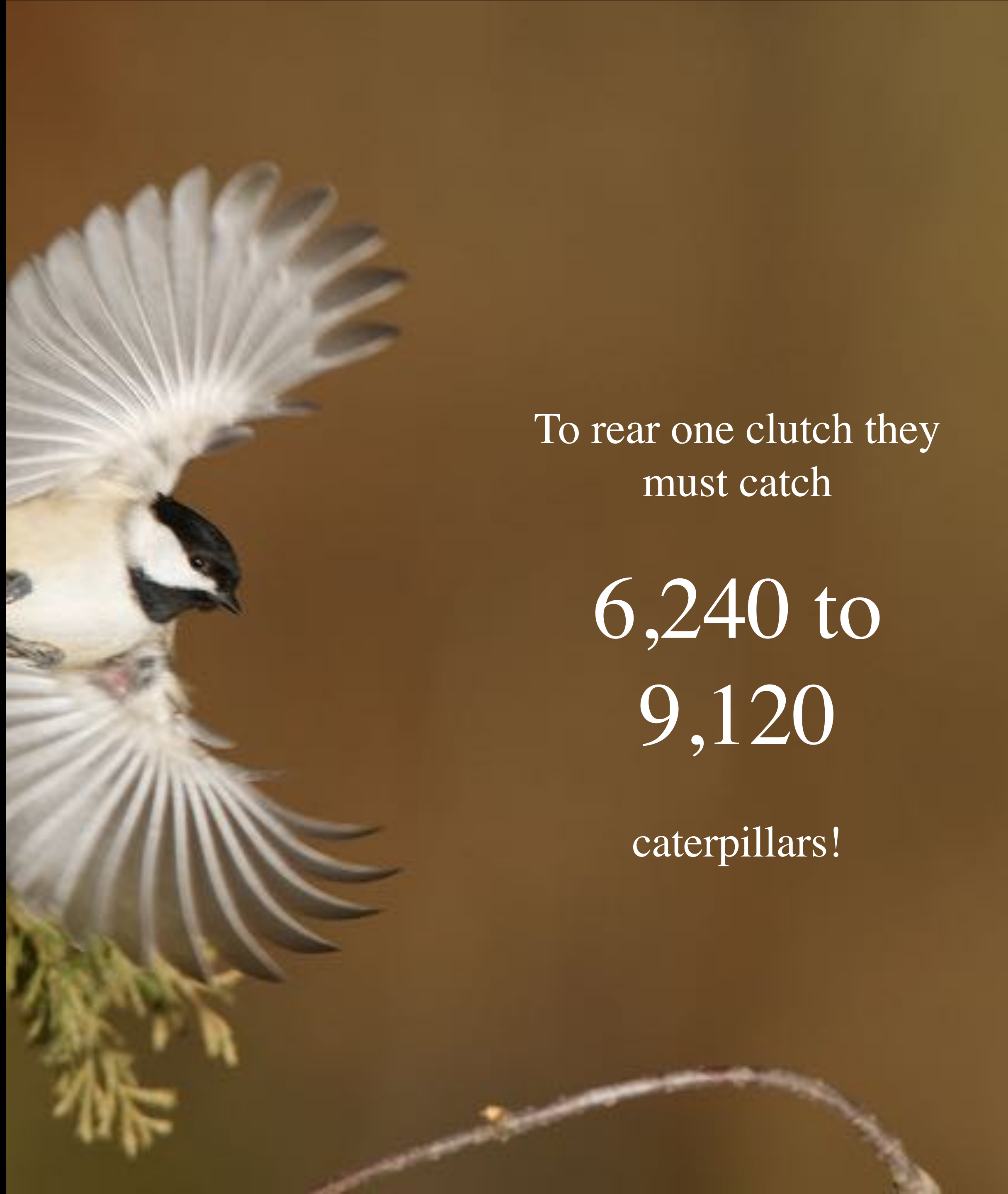
How many species of caterpillars do chickadees bring to the nest?

In three hours they brought back 17 species of caterpillars


936 moth
species

A chickadee pair brings 390-570 caterpillars to the nest per day (Brewer 1961).

Chickadees feed their young for 16 days before they fledge.


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 question we have to consider the specialized relationships 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)

Milkweeds are protected by cardiac glycosides

# What about
# the sticky latex sap?


Milkweed latex gels
when exposed to oxygen

The downside of specialization is that now milkweeds are all monarchs can eat.

Out of the 2137 plant genera found in North America, monarchs can only eat one, the Asclepius.


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

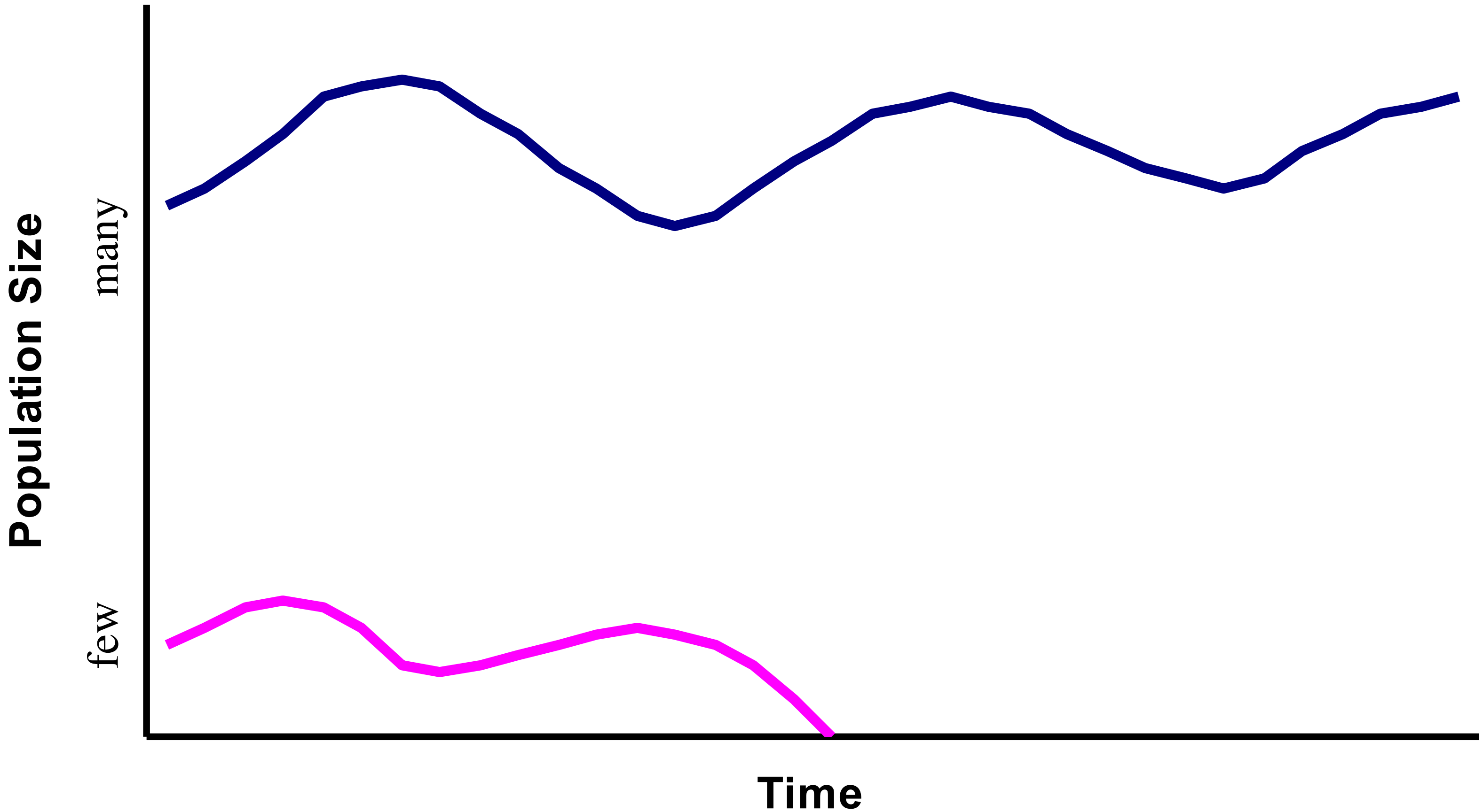
90% of the insects that eat plants can only eat the plants with which they co-evolved!

It’s not just birds that need insects!

A world without insects is a world without biological diversity.


Yet we ARE losing insects!

Why can’t biodiversity be sustained in our parks and preserves?


Population Size
many
few
Time

Our natural

areas are not

large enough

to sustain nature

David Quammen compares ecosystems to a Persian rug

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

We can measure what happens when we replace native plant communities with plants from outside of local food webs.

Tallamy, D. W. 2004. Do alien plants reduce insect biomass? Conservation Biology 18: 1689-1692.

Burghardt, K.T., D.W. Tallamy and W. G. Shriver. 2008. The impact of native plants on biodiversity in suburban landscapes. Conservation Biology 23:219-244.

Tallamy, D. W. and K. J. Shrophsire. 2009. Ranking lepidopteran use of native versus introduced plants. Conservation Biology 23:941-947.

Tallamy, D.W., M. Ballard, and V. D. D'Amico. 2010. Can alien plants support generalist insect herbivores. Biological Invasions 12: 2285-2292.

Burghardt, K.T., C. R. Philips, D.W. Tallamy and K.J. Shropshire. 2010. Non-native plants reduce abundance, richness, and host specialization in Lepidoptera communities. Ecosphere 1(5): art11. doi:10.1890/ES10-00032.1

Ballard, M., J. Hough-Goldstein and D.W. Tallamy. 2013. Arthropod communities on native and non-native early successional plants. Environmental Entomology 42: 851-859.

Burghardt, K. T. and D. W. Tallamy. 2013. Plant origin asymmetrically impact feeding guilds and drives community structure of herbivorous arthropods. Diversity and Distributions. 19: 1553-1565.

Brughardt, K. and D.W. Tallamy. 2015. Not all non-natives are equally unequal: Reductions in herbivore β-diversity depend on plant phylogenetic similarity to native community. Ecology Letters. .1111/ele.12492

Narango, D.L., D. W. Tallamy and P. P. Marra. 2017. Native plants improve breeding and foraging habitat for an insectivorous bird. Biological Conservation 213:42-50.

Narango, D.L., D. W. Tallamy and P. P. Marra. 2018. Nonnative plants reduce population growth of an insectivorous bird. PNAS. In press.

# 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
Grille
Conference Center
Restaurants
Lounge
Jacuzzi Suites
MOTEL OPEN


Sunset
Beach
Inn
Grille
Conference Center
Restaurants
Lounge
Jacuzzi Suites


Land ownership is
more than a privilege
it’s a responsibility
Roy Dennis

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)

5% of our native plants make 75% of the food that drives food webs

Keystone plants


i.e. some native plants are
much better at supporting
food webs than others

The question is not whether natives are better than nonnatives.

It’s whether we want ecologically productive plants in our landscapes or not!

Ginkgos grew in North America 7 million years ago. Are they native?

Ginkgo = 0 species of caterpillars

# Oaks = 510 species of caterpillars in northern NY


Native *Prunus* = 434
species of caterpillars


Willows host 426 caterpillar species


Zelkova
supports
no caterpillars

# *Pieris japonica*;  2 spp


Blueberries; 294 spp


Native *Viburnum* spp;
118 spp

English Ivy supports nothing


Burningbush supports no
caterpillars

# “Native Plant Finder”

## National Wildlife Federation

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

Use zip codes from the Buffalo area

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


Desiree Narango

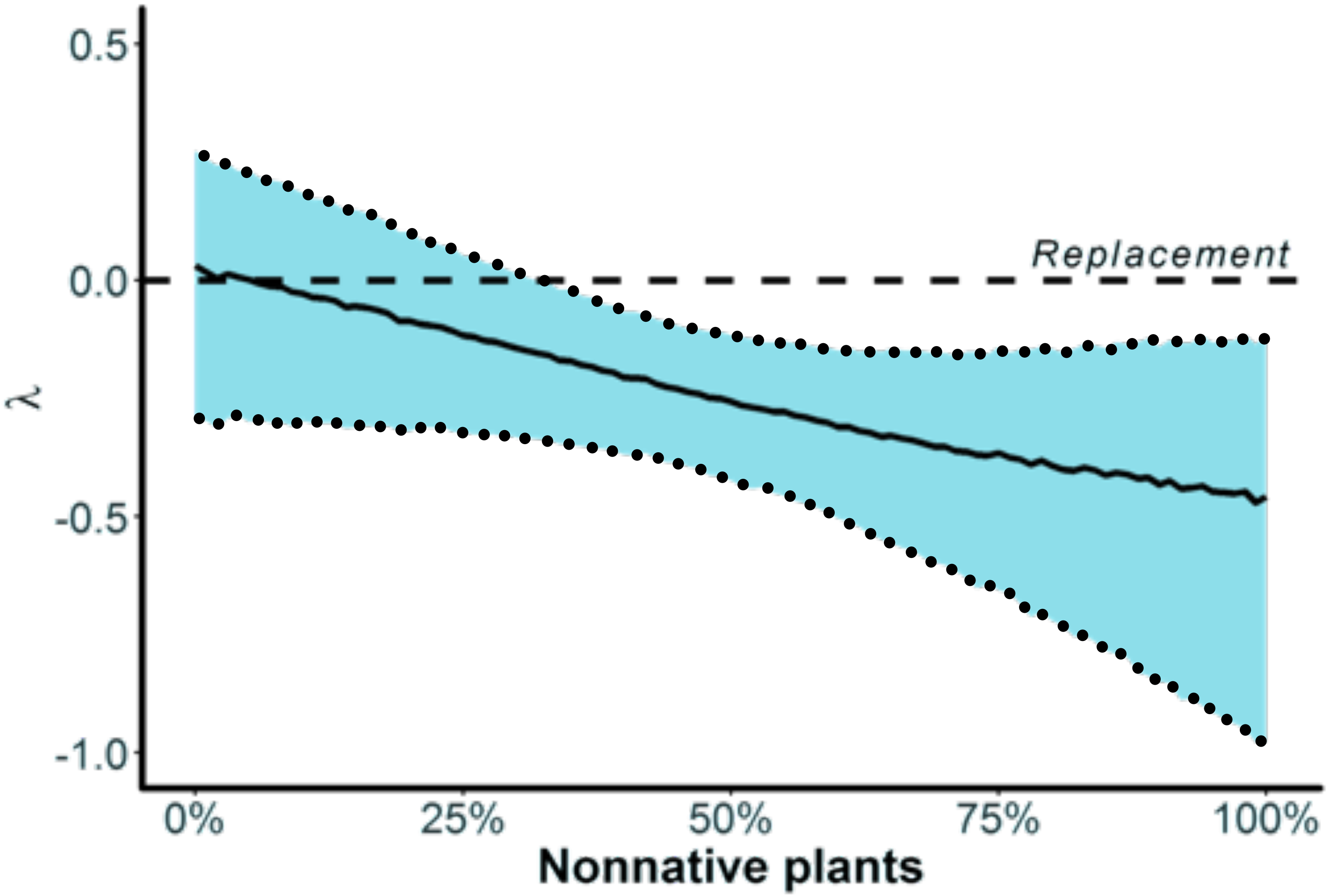

Basswood
American elm
Sweetgum
Black cherry
Pin oaks
Willow oaks


Japanese Maples
Silktree
Ginkgo
Saucer Magnolia
Black Poplar
Leyland Cypress
Crape Myrtles

Compared to native landscapes, yards dominated by introduced plants :

1) Produced 75% few caterpillars
2) Were 60% less likely to have breeding chickadee
3) Nests contained 1.5 fewer eggs
4) Nests were 29% less likely to survive
5) Nests produced 1.2 fewer fledglings
6) Delayed maturation by 1.5 days

# Population Growth



You don’t have to save biodiversity for a living, but please 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 that are nature

If specialized relations disappear from novel ecosystems, species disappear from novel ecosystems

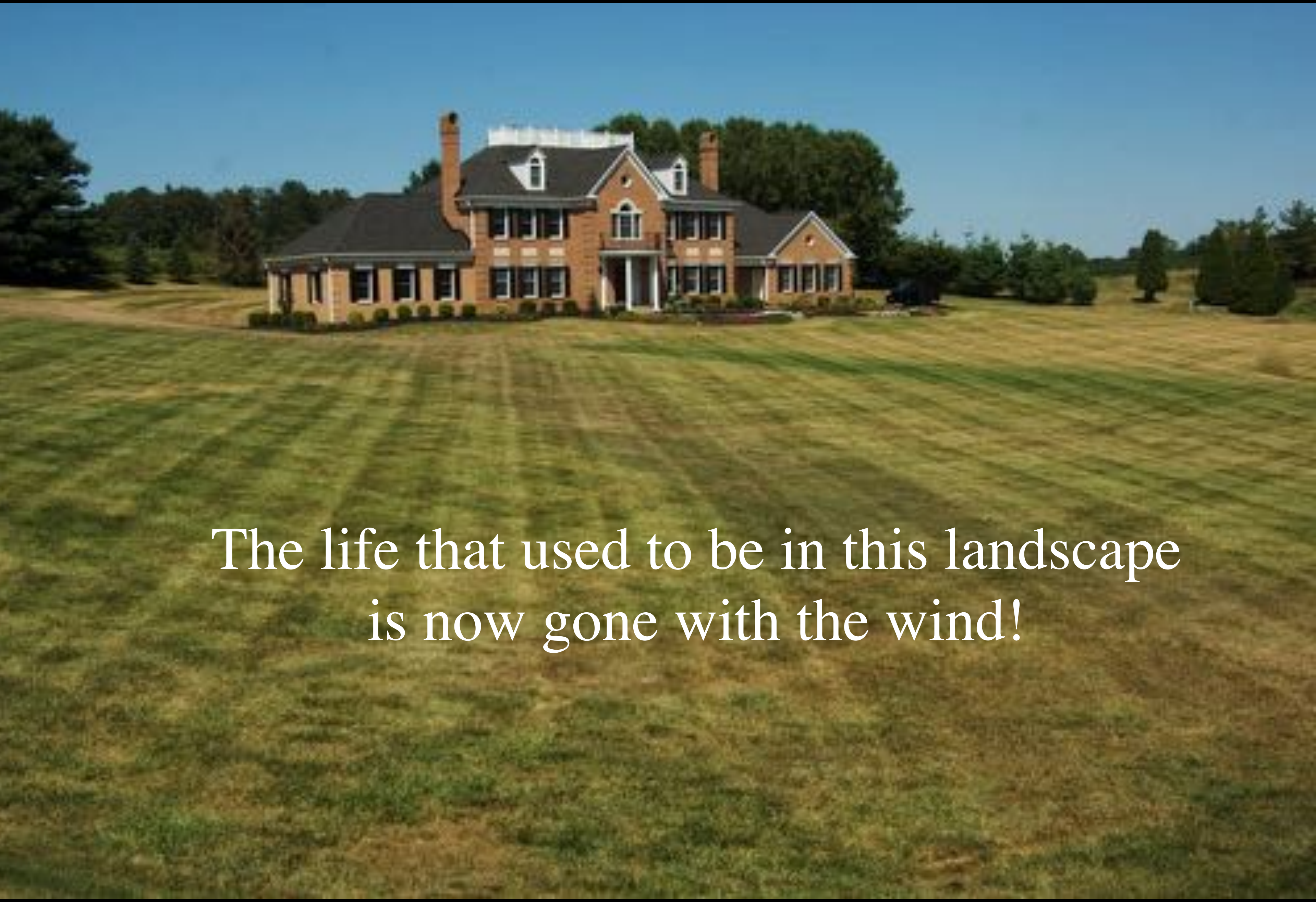

How many species
do we need?


All of them!

Biodiversity = ecosystem services.

We have degraded 60% of the earth’s ecosystems services

Millennium Ecosystem Assessment 2005


The life that used to be in this landscape
is now gone with the wind!

We need to rebuild the earth's Carrying capacity

85.6% of the U.S. east of the Mississippi is privately owned.

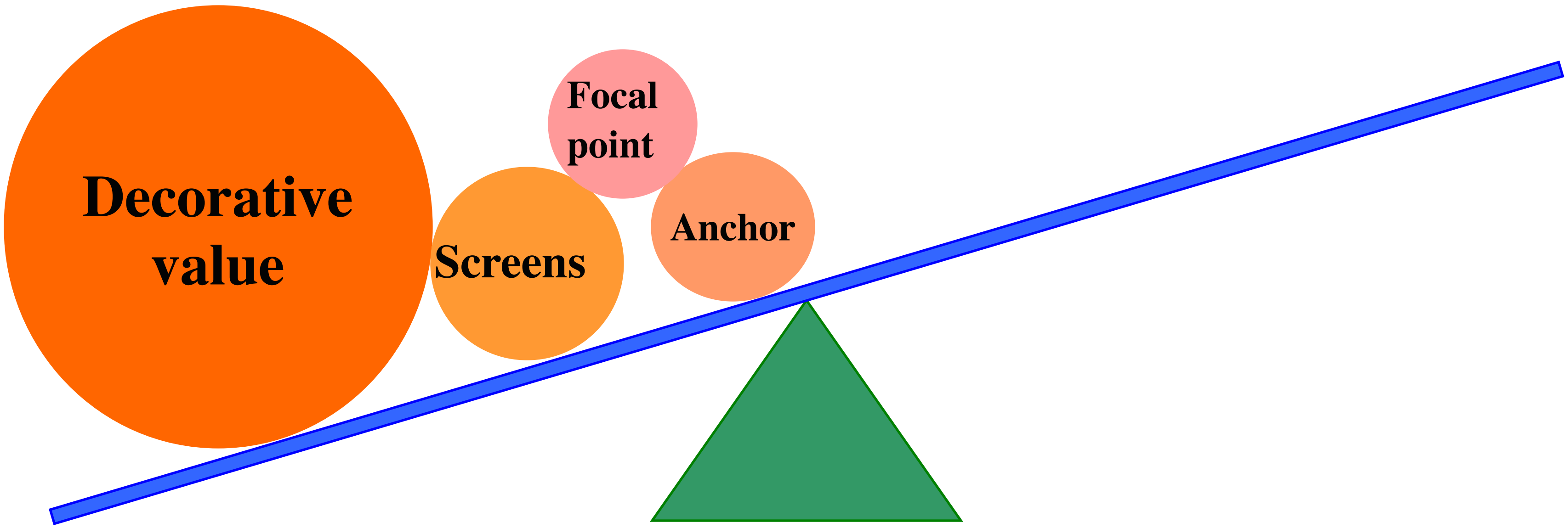
# To restore nature's relationships

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

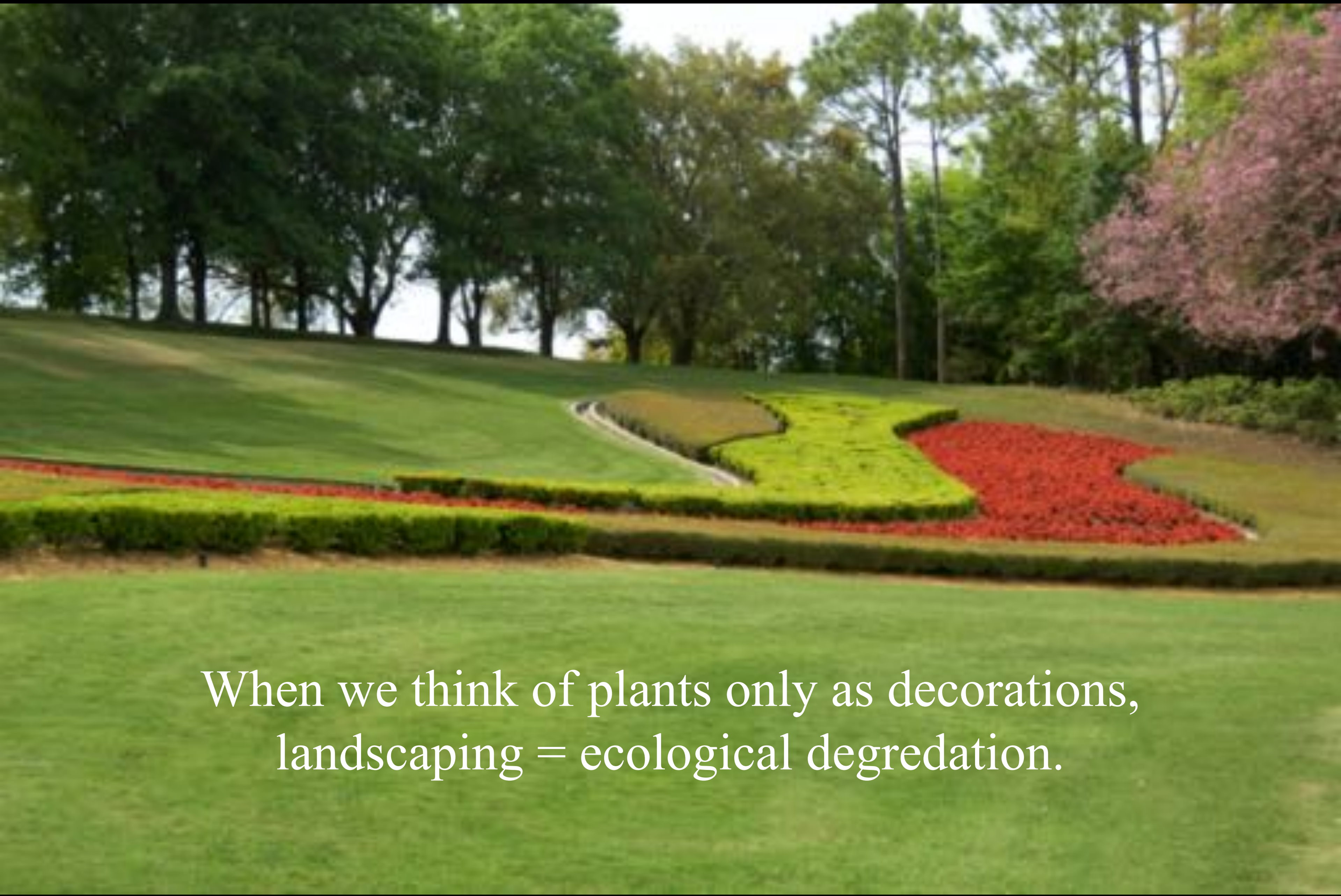
1) Support life
2) Sequester carbon
3) Clean and manage water
4) Enrich soil
5) Support pollinators

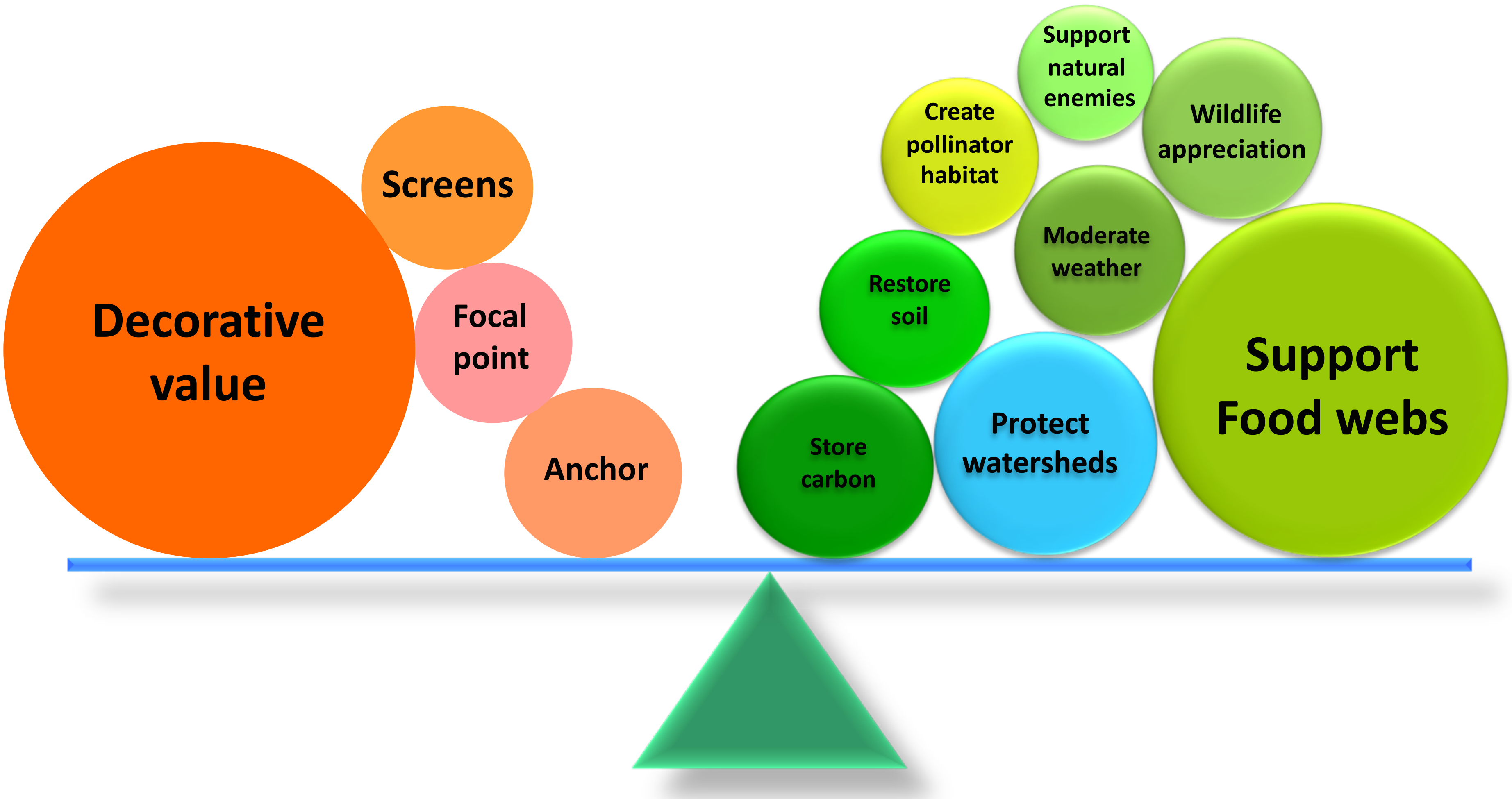
We are not talking about good land stewardship, we are talking about *essential* land stewardship!.


No food webs
Very little carbon sequestration
Actively destroying its watershed
No pollinators




Past criteria for choosing plants for our landscapes


When we think of plants only as decorations,
landscaping = ecological degredation.



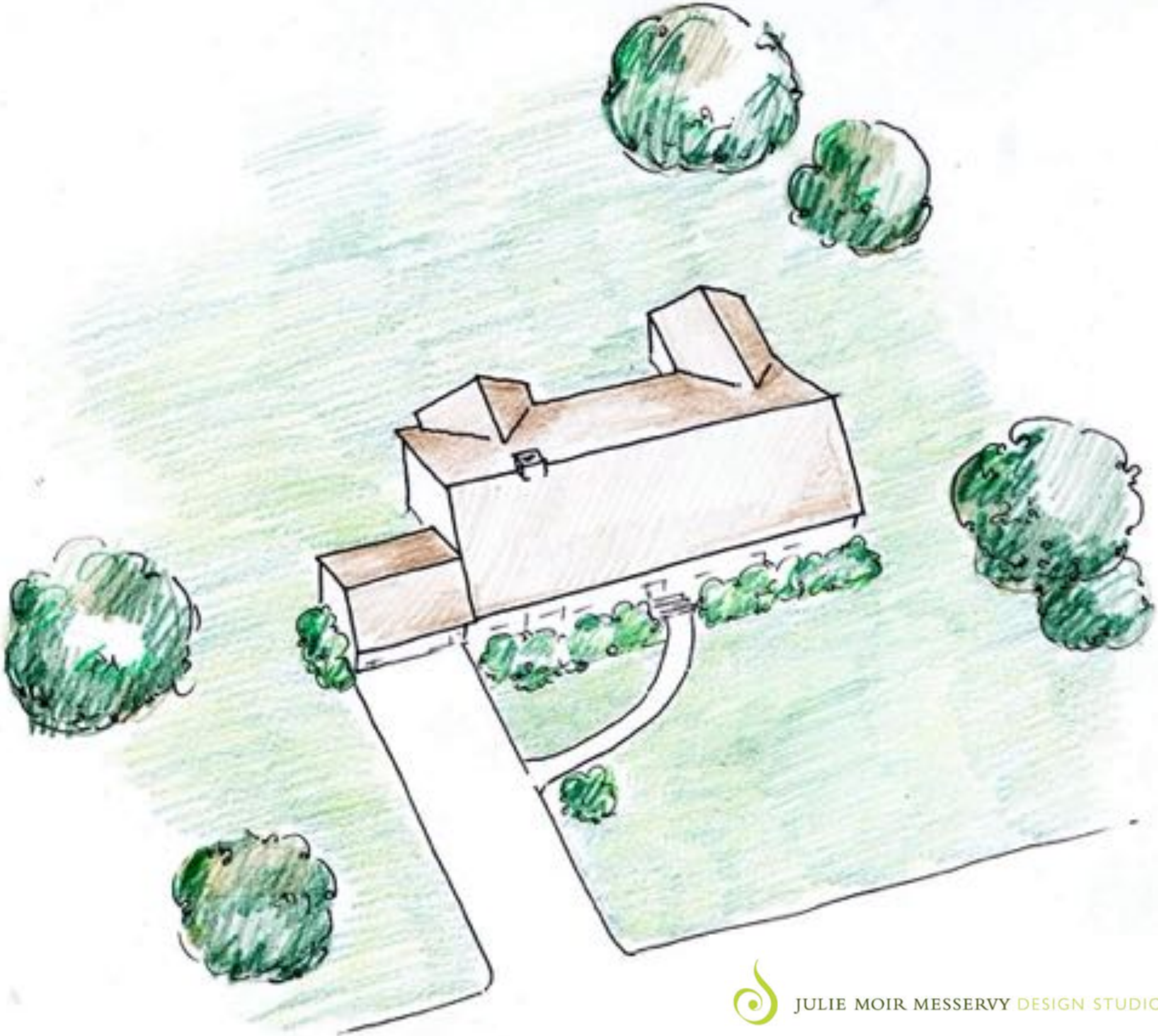

Future criteria for choosing plants for our landscapes

# If we add function to the criteria used to select plants, landscaping = ecosystem restoration

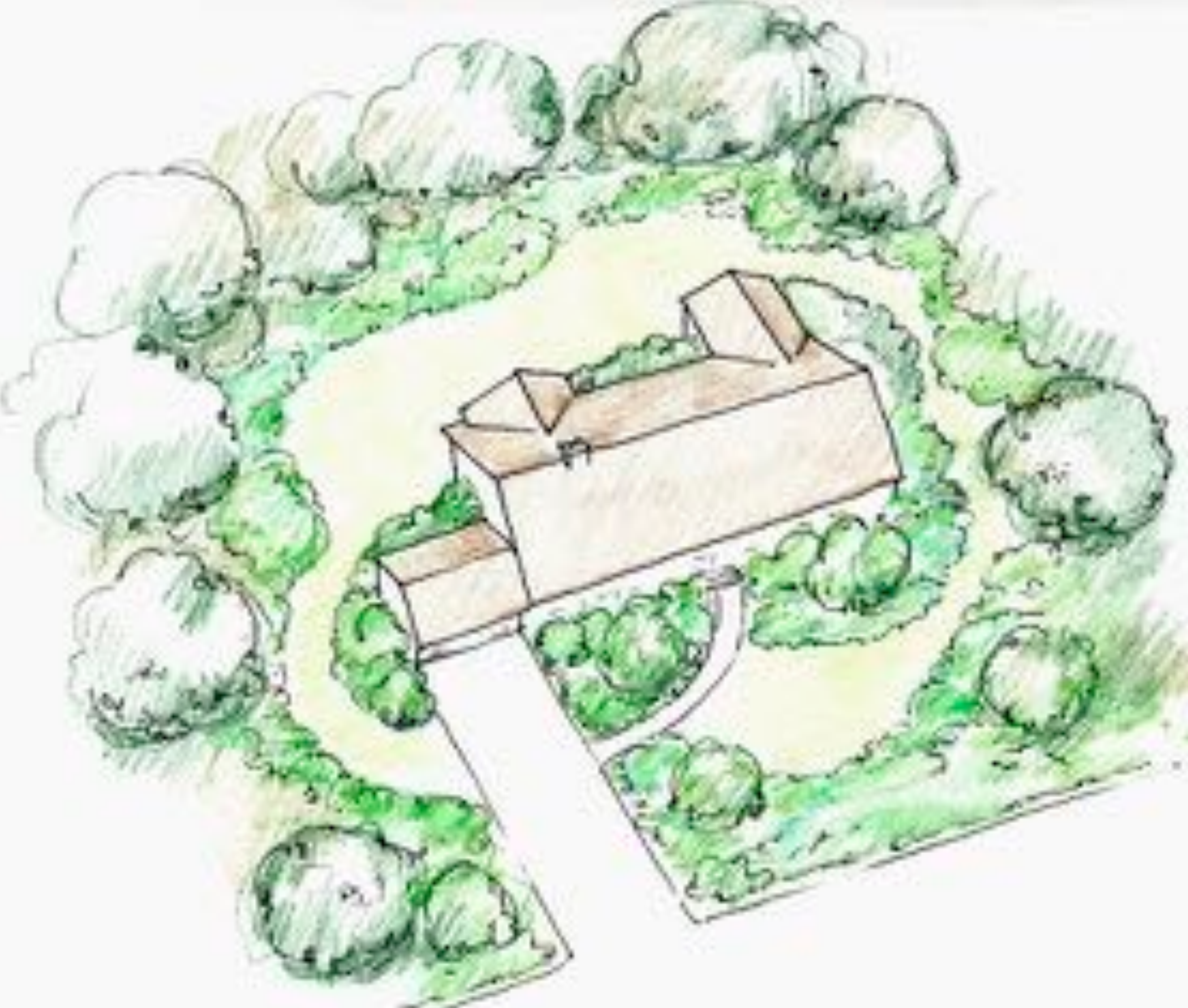

What does a
biodiversity-friendly
neighborhood
look like?

To share our neighborhoods with wildlife, we need to:

- Create corridors connecting natural areas
- Reduce the area now in lawn
- Begin the transition from alien ornamentals to native ornamentals



JULIE MOIR MESSERVY DESIGN STUDIO



If we replant half of the area now in lawn…..

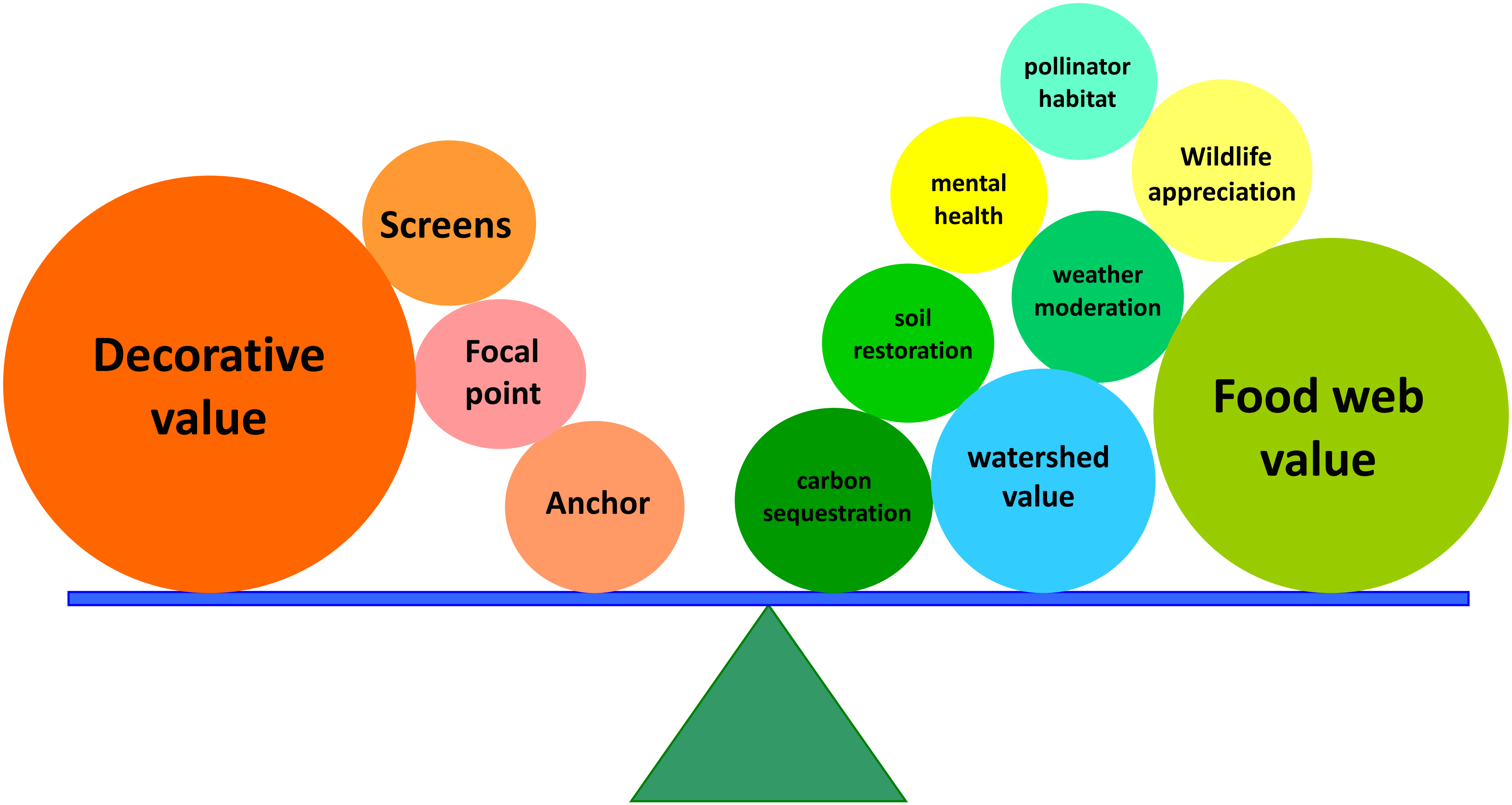
# 20 Million Acres

Adirondacks +
Yellowstone +
Yosemite +
Grand Tetons +
Canyonlands +
Mount Ranier +
North Cascades +
Badlands +
Olympic +
Sequoia +
Grand Canyon +
Denali +
Great Smoky Mountains

# the NATURE FIX

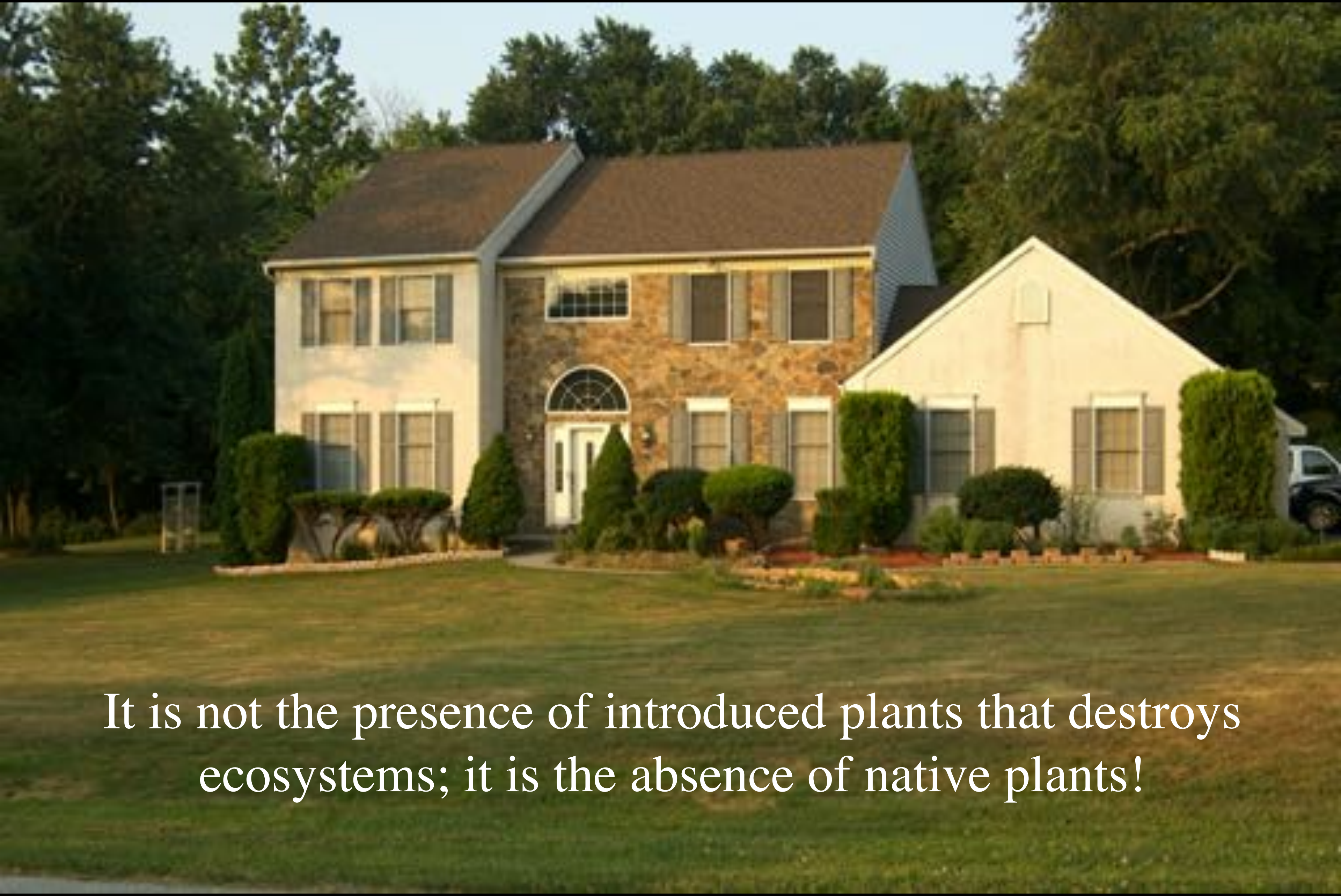
*Why Nature Makes Us Happier, Healthier, and More Creative*

FLORENCE WILLIAMS




Future criteria for choosing plants for our landscapes

# Does your yard have to be 100% natives?


It is not the presence of introduced plants that destroys ecosystems; it is the absence of native plants!

How do you know when you have succeeded?

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


Roger Hammer

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

Pandora sphinx

# Calleta silk moth


Spiny rose
caterpillar


Curve-lined owlet

# Fawn sphinx


Black swallowtail


rple crested
erpillar


Major Datana

# Hieroglyphic moth


Silvered prominent


Spun glass
caterpillar


Green marvel


Once-charred punkie


Confused woodgrain

Cynical groundcat


The Neighbor


e Donald


“Not My Caterpillar!”


Make America Native Again!

# Best Bets for Supporting Moths and Butterflies in Lancaster, PA

## Woody plants

| Genus | # moth spp |
|---|---|
| *Quercus* oaks | 525 |
| *Prunus* cherries | 443 |
| *Salix* willows | 395 |
| *Betula* birches | 382 |
| *Populus* aspen | 335 |
| *Acer* maples | 295 |
| *Malus* crabapple | 290 |
| *Vaccinium* blueberries | 290 |
| *Carya* hickories | 245 |
| *Alnus* alder | 233 |
| *Ulmus* elms | 203 |
| *Pinus* Pines | 179 |
| *Rubus* blackberry | 169 |
| *Crataegus* hawthorn | 168 |
| *Tilia* basswood | 164 |
| *Fraxinus* ash | 144 |
| *Juglans* walnut | 142 |

## Herbaceous plants

| Genus | # moth spp |
|---|---|
| *Solidago* Goldenrods | 130 |
| Asters | 117 |
| *Fragaria* strawberries | 78 |
| *Helianthus* sunflowers | 76 |
| *Plantago* plantain | 67 |
| *Solanum* horsenettle | 67 |
| *Polygonum* knotweed | 64 |
| *Lactuca* wild lettuce | 56 |
| *Ambrosia* ragweed | 55 |
| *Rumex* dock | 54 |
| *Eupatorium* Joe-pye | 50 |
| *Chenopodium* goosefoot | 42 |
| *Ipomoea* morning glory | 41 |
| *Poa* native grasses | 38 |
| *Urtica* nettles | 35 |
| *Amaranthus* pigweed | 34 |
| *Viola* Violets | 34 |