Islands in Space

Urban gardens as sanctuaries for bees and other pollinators

Neil Cunningham, Green Noise LLC

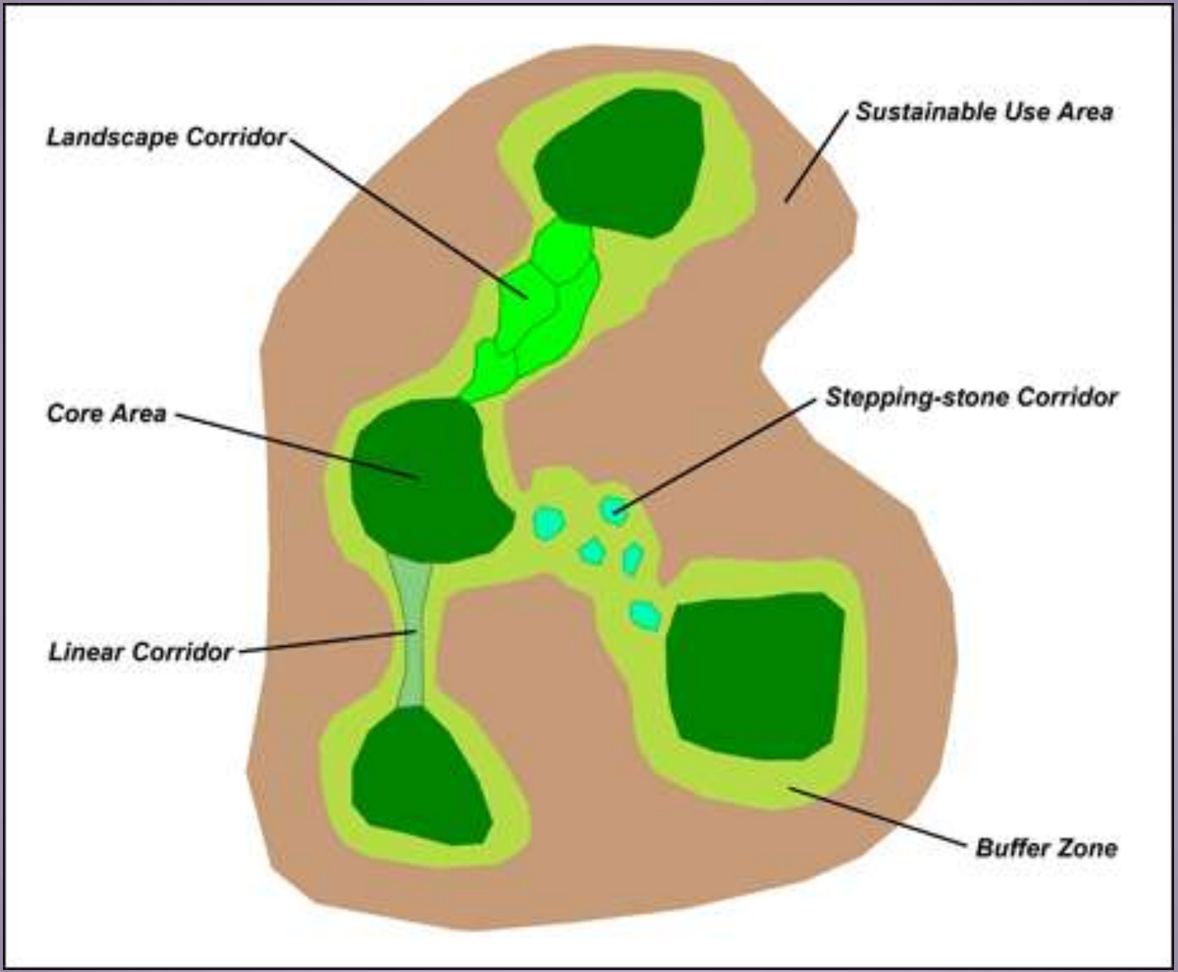
Image: Floating islands from *Castle in the Sky* by **Hayao Miyazaki**

Image: Floating hills of Pandora, from James Cameron’s *Avatar*

1

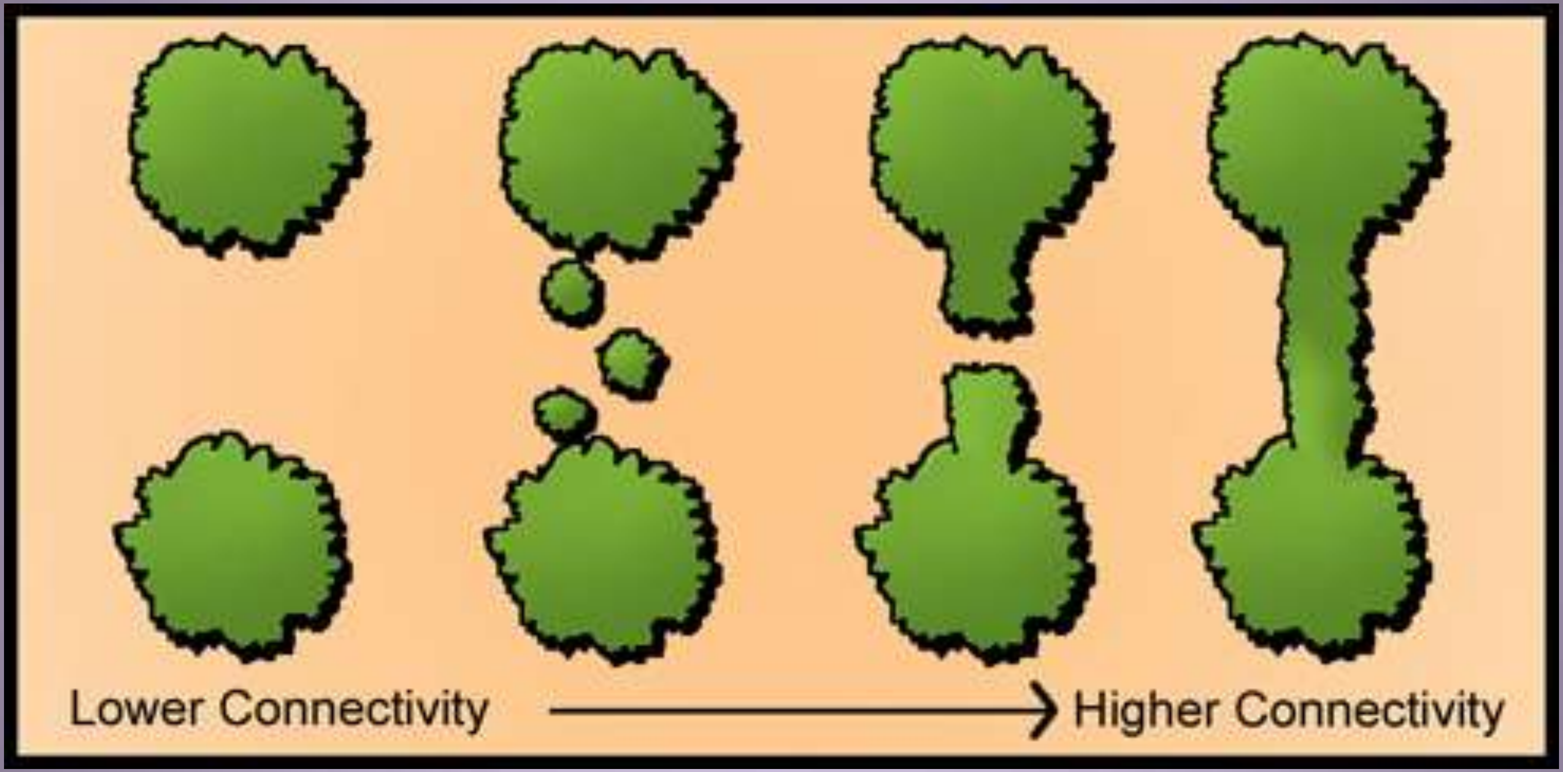
get a global view

“habitat islands” and fragmented areas

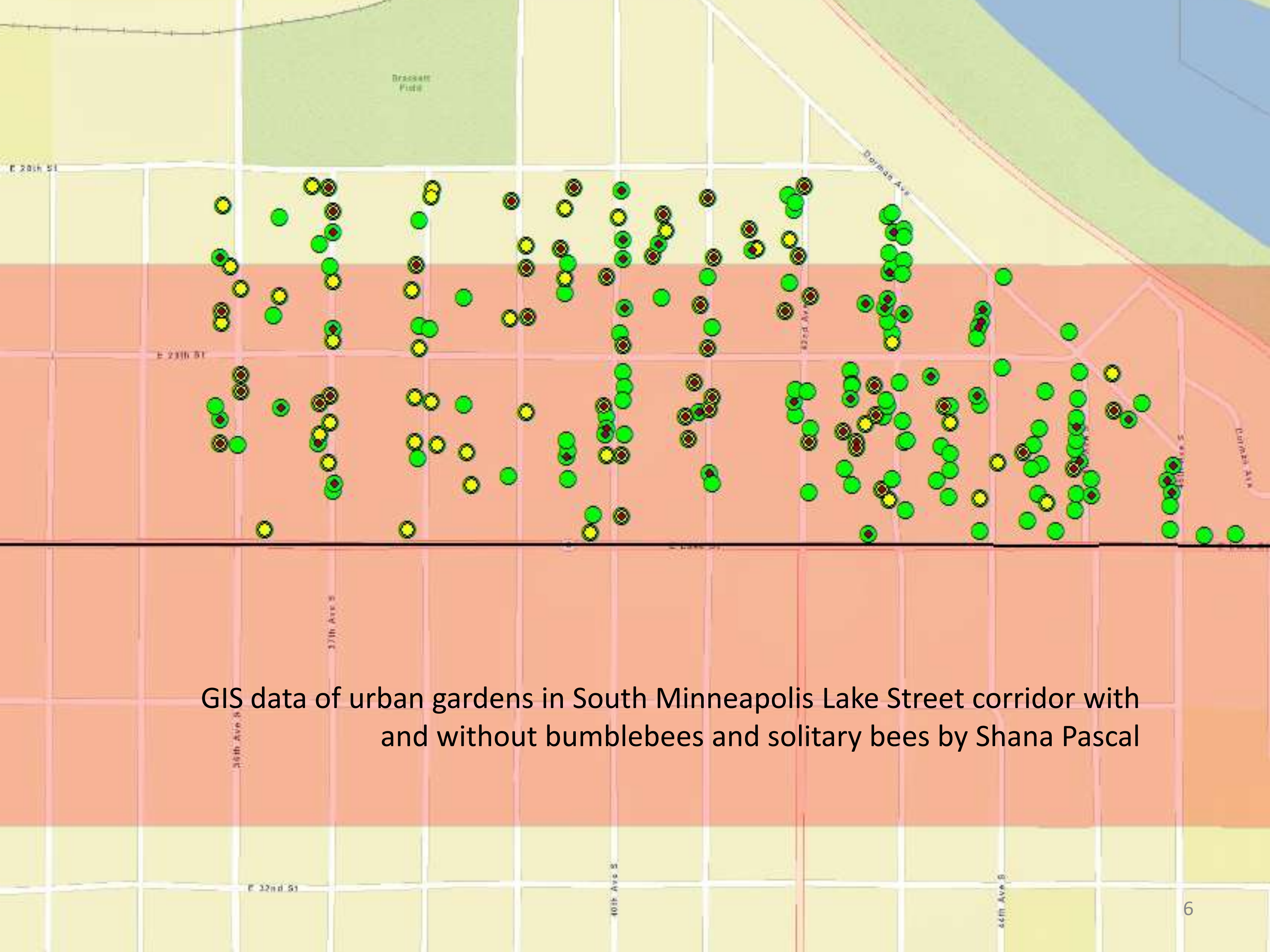


Biodiversity corridor concept map.
Image from: Asian Development Bank

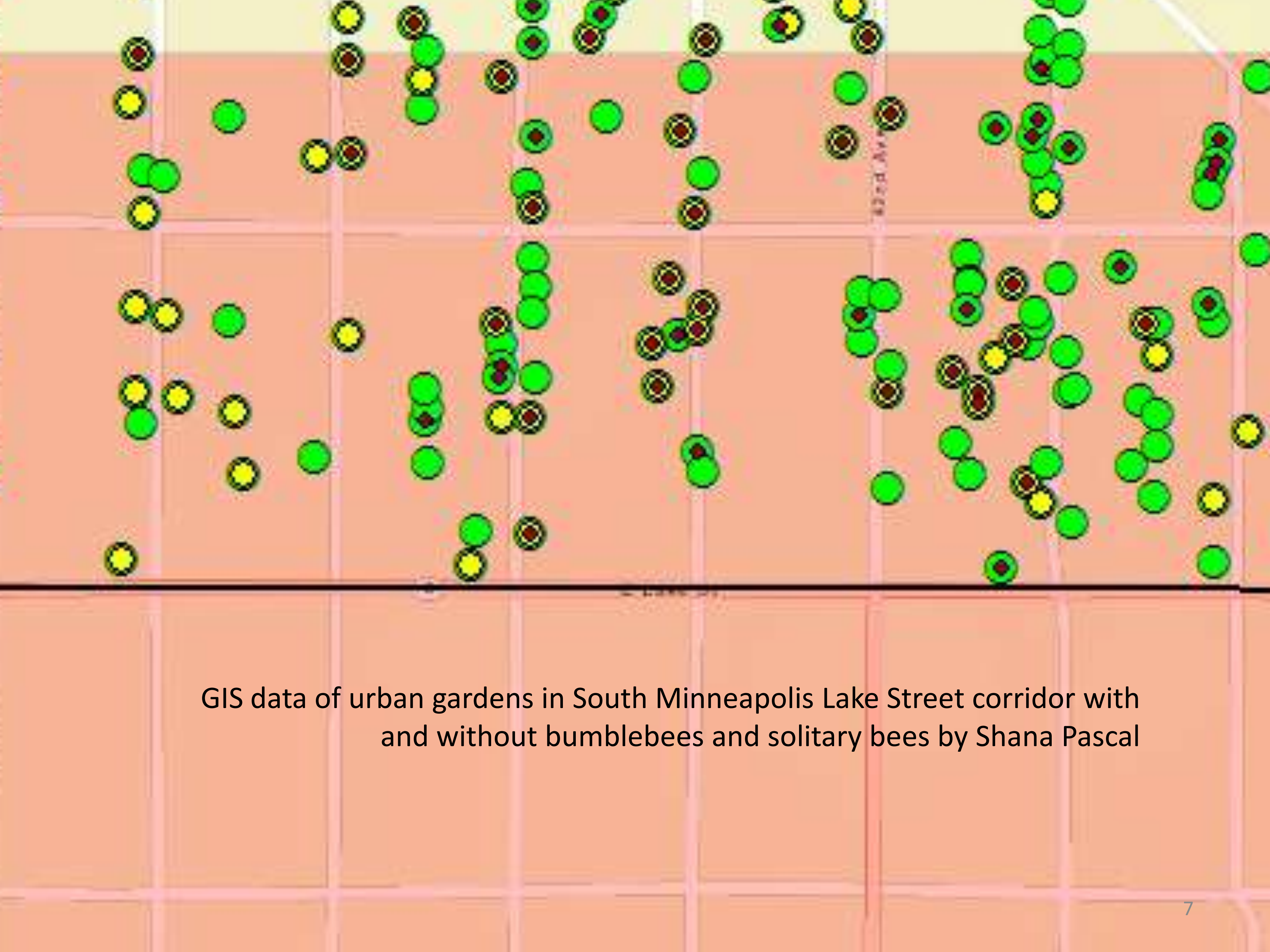
connectivity



Concept image: USDA, from Conservation Buffers
http://www.unl.edu/nac/bufferguidelines/guidelines/2_biodiversity/5



GIS data of urban gardens in South Minneapolis Lake Street corridor with and without bumblebees and solitary bees by Shana Pascal



GIS data of urban gardens in South Minneapolis Lake Street corridor with and without bumblebees and solitary bees by Shana Pascal

Lack of plant diversity / Low connectivity
Richfield Community Garden by the MSP Airport
circa 2007.

Lack of diversity / Low Connectivity / Minimal Habitat
Richfield Community Garden by the MSP Airport.

Blue orchard mason bee
Osmia lignaria
Photo: n/a

Landscaping work near the MN State Capitol

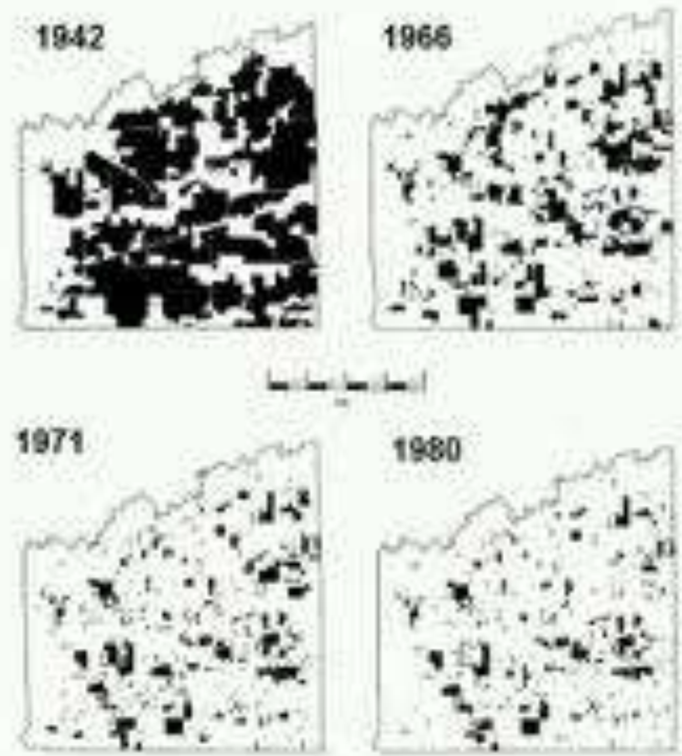
Change in forested vegetation

~200 km² area

Loss

Fragmentation

New land uses



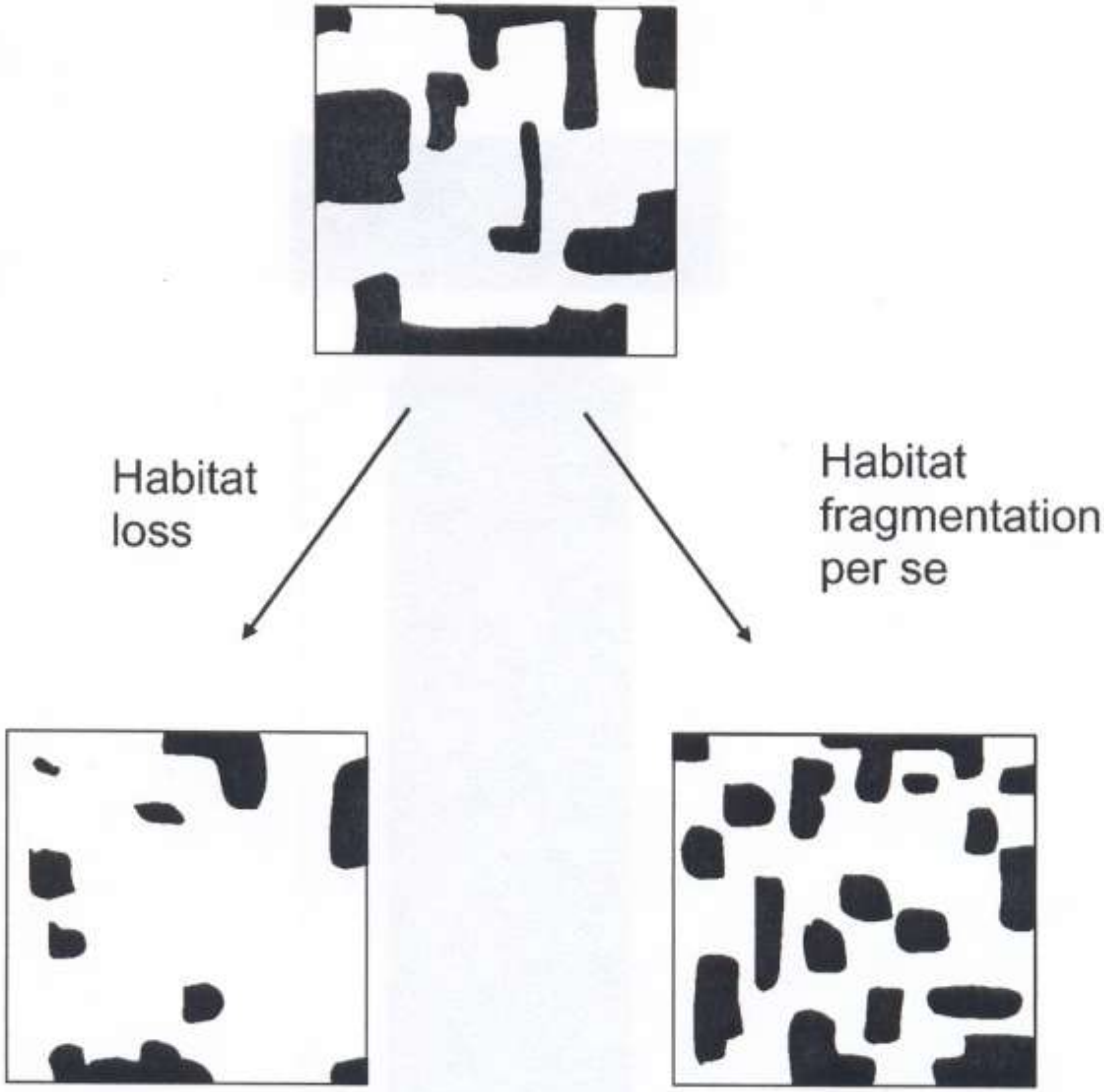


Figure 5 Both habitat loss and habitat fragmentation per se (independent of habitat loss) result in smaller patches. Therefore, patch size itself is ambiguous as a measure of either habitat amount or habitat fragmentation per se. Note also that habitat fragmentation per se leads to reduced patch isolation.


“traditional landscaping”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“urban gardening and urban farming”

the need for plant diversity in urban areas

Lack of diversity. Richfield Community Garden by the MSP Airport.

Lack of diversity. Richfield Community Garden by the MSP Airport.

an/suburban biodiversity connectivity

transformation

perennial gardening

Garden installation
with Design Center Garden Corps members, Spring 2003.

Spring 2003


Summer 2008

flowers = food

flowers = food

food = nectar + pollen

flowers = food

food = nectar + pollen

nectar = carbs + minerals

pollen = protein

2

make a flower plan

Flower plan

- Bloom time
- Size of flower
- Nutritional value
- Habitat benefits
  - Provides water
  - Provides protection from sun, wind, rain, predators

Bloom time

ennial Bloom Times at the Minnesota Department of Agriculture's Biological Control Teaching Greenhou

| Early Spring | | Later Spring/Early Summer | | Mid to Late Summer | | Late Summer to Early Fa

April | May | June | July | August | Septembe

creeping charlie | | woodland strawberry | | black cohosh | | goldenrod |

| dandelion | | woodland columbine | | joe pye weed | | Aster spp. |

| American plum | | false blue indigo | | bee balm | | sunflower | | sedum |

| viburnum | | rhubarb | | anise hysspop |

| lilac | | prairie coreopsis | | milkweed | | moonbeam coreopsis |

| large apple | | canada anenome | | elderberry |

| cup plant |

| black-eyed susan |

| prairie fireweed |

April 20 thru May 20

May 21 thru June 20

June 21 thru July 20

July 21 thru August 20

August 21 thru Sept.

creeping charlie

blooms mid to late April

Bumblebee on creeping charlie
Photo: Coleopteraman (2010), from BugGuide

American plum

blooms late April to early May

American plum flowers in early May 2009

Canada anenome

blooms mid to late May

Canada anenome, in bloom late May 2008

blue false indigo
blooms early June

bee balm

blooms early to mid July

goldenrod

blooms early August through September

Size of flower

Adult hoverfly on goldenrod flowers
Image by Gail Eichelberger
www.beautifulwildlife garden.com

Dill flowers
Image: Green Noise

Dianthus armeria flowers
Image: Green Noise

Nutritional value

Photo: Marlin, from cirrusimages.,com

Habitat benefits

Resources

- minnesotawildflowers.info
- Outback Nursery – St Paul
- Landscape Alternatives
- Prairie Restorations (seeds)
- Mother Earth Gardens
- Eggplant Urban Farm Supply

3

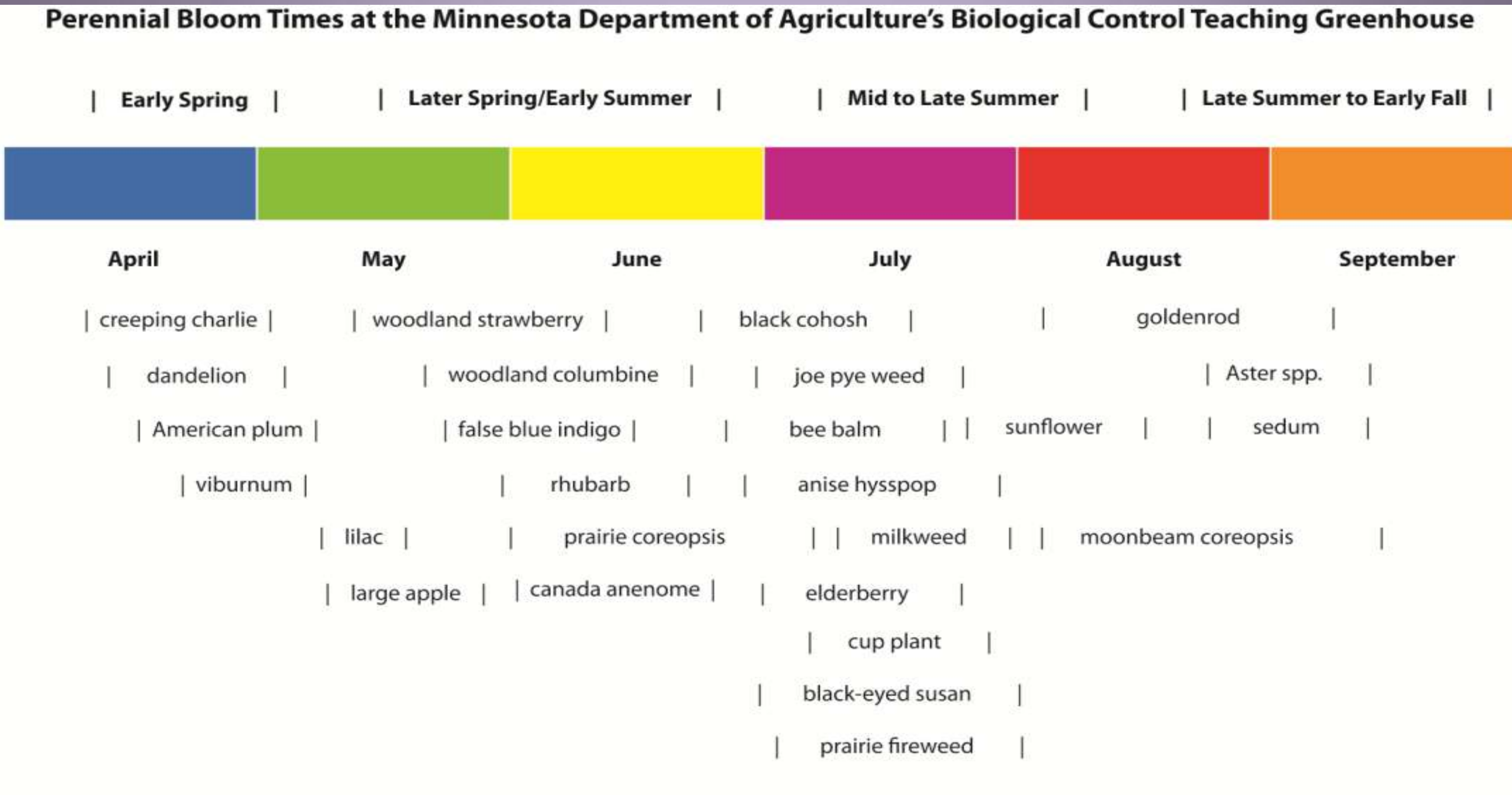
Start seeing other plants


urban/suburban biodiversity

Prairie area near Lake Elmo park reserve.

Parking lot planting by Patrick's Cabaret, Minneapolis

Landscaping work near the MN State Capitol.


Perennial Bloom Times at the Minnesota Department of Agriculture's Biological Control Teaching Greenhouse
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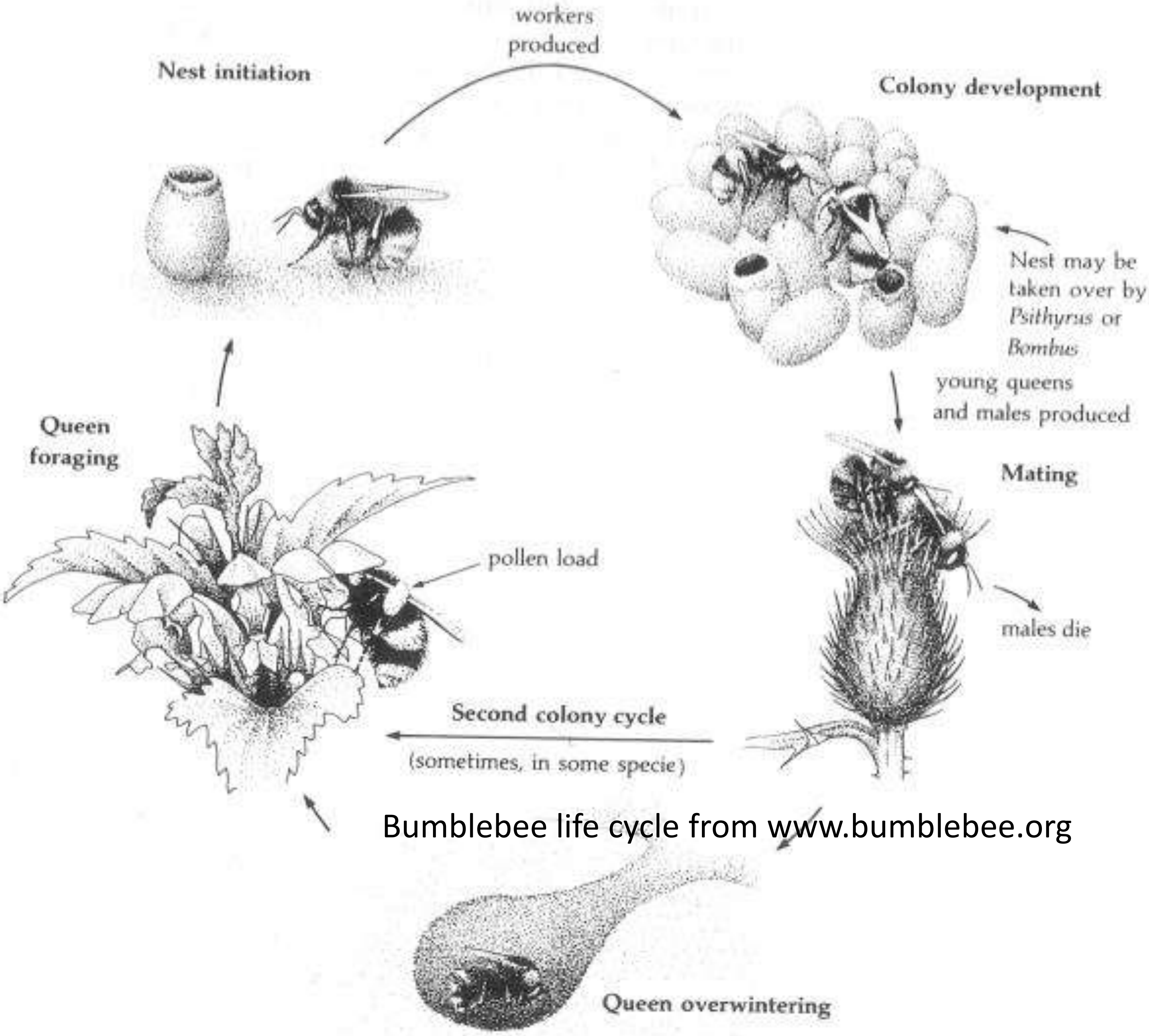
| cup plant |
| black-eyed susan |
| prairie fireweed |

5

Start seeing bees & other pollinators



Bumblebee life cycle from www.bumblebee.org

Bumblebee life cycle stages

- **Colony begins**: Queens emerge from hibernations.
- **Colony develops**: Workers (females) are produced.
- **Colony reproduces**: Males and queens are produced.
- **Colony disintegrates**. Males and new queens mate. Males die, and new queens forage and seek new overwintering places.

Queen bees are precious!

Bumblebee queen tricked into visiting a coneflower that grew and blossomed in a greenhouse and was planted outside. (April 2009)

Photo: Ecotorch, Flickr

Photo: Dr. David Inouye

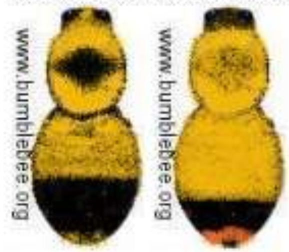
Bumblebees are effective pollinators of tomatoes because of a technique unique to bumblebees known as *buzz pollination*.

[Photo: David L. Green from www.pollinator.com]

“Flowers visited by **bumblebees produced larger** and **heavier** fruits than non-visited flowers. Because external maximum diameter, length and weight were highly dependent on seed set, the use of pollinators seems to be required to obtain sweet pepper fruits with improved quality characteristics.”

Source: Serrano, A.R. & Guerra-Sanz, J.M., 2006

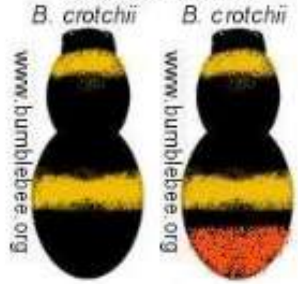
A somewhat random but interesting tidbit on the role of bumblebees and desirable fruit shapes.

Bombus bimaculatus B. bimaculatus  **Range**: Ontario, Maryland, New York, Pennsylvania, Maine, South Carolina, Virginia, West Virginia, south to Florida, west to Illinois, Kansas, Oklahoma, Mississippi, Kentucky. **Note**: a common species.	***Bombus impatiens*** B. impatiens  **Range**: Ontario, Maine, Georgia, Kentucky, Maryland, New Jersey, New York, Pennsylvania, South Carolina, Virginia, West Virginia, south to Florida, west to Michigan, Illinois, Kansas, Missouri, Wyoming.	***Bombus affinis*** B. affinis  **Range**: Quebec, Ontario south to Georgia, west to South Dakota and North Dakota. **Note**: Also known as the rusty-patched bumblebee. Once common, but its range has declined sharply since 1990, now found in only a few areas. Often has a bald patch between the wings in the middle of the thorax.
Bombus vagans vagans B. vagans  vagans **Range**: British Columbia east to Nova Scotia, Maryland, New York, Pennsylvania south to Georgia, West Virginia, Tennessee, South Dakota, Montana, Idaho, Washington.	***Bombus sandersoni*** B. sandersoni B. sandersoni  **Range**: Ontario to Newfoundland, south to Tennessee Virginia, West Virginia and North Carolina	***Bombus frigidus*** B. frigidus  **Range**: Alaska and Northwest territories, south to Colorado (high elevations only).
Bombus lucorum queen  **Range**: Alaska south to Southern British Columbia and Alberta, east through Yukon and North Western Territories. More>>>	***Bombus lucorum*** worker 	***Bombus lucorum*** male 

Bombus fraternus

Range: New Jersey down to Florida, North and South Dakota, Nebraska, Colorado and New Mexico.

Bombus crotchii



Range: California and Mexico

Bombus nevadaensis auricomus

Note: sometimes just called *Bombus auricomus*.

Range: Ontario to Florida, west to Texas, Oklahoma, West Virginia, Colorado, Wyoming, Montana, Saskatchewan, Alberta, British Columbia.

Bombus nevadensis nevadensis

Range: Alaska to California, Arizona, New Mexico east to Wisconsin, Mexico.

Bombus morrisoni

Range: British Columbia to California, east to South Dakota, Nebraska, Colorado, New Mexico.

Bombus pennsylvanicus pennsylvanicus

Range: Quebec, Ontario, Maryland south to Florida, west to Minnesota, S. Dakota, Nebraska, Colorado, New Mexico, Mexico.

Bombus pennsylvanicus sonorus

Note: sometimes known as *Bombus sonorus*

Range: Texas, west to California,

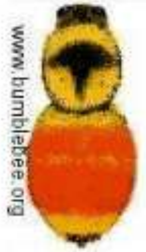
Bombus grisecollis

Range: Quebec, Kentucky, Maryland, Pennsylvania, South Carolina, Virginia, West Virginia, south to Florida, west to

Bombus perplexus

Range: Alaska to Maine, Maryland, New York, Pennsylvania, south to Wisconsin, Illinois, West Virginia, Florida, Alberta

www.bumblebee.org

Bombus ternarius B. ternarius  **Range**: Yukon east to Nova Scotia, New York, Pennsylvania south to Georgia, Michigan, Kansas, Montana, British Columbia.	***Bombus terricola terricola*** *B. terricola*  *terricola* **Range**: Nova Scotia to Florida, West to British Columbia, Montana, South Dakota. **Note**: Also known as the yellow-banded bumblebee. Once common, but its range has declined dramatically since 1990.	***Bombus terricola occidentalis*** B. terricola  occidentalis **Range**: Alaska south to northern California, Nevada, Arizona, New Mexico, South Dakota. **Note**: also known as ***Bombus occidentalis***. Often forages from red flowers, and nectar robs hummingbird pollinated flowers. Populations have decreased since 1990.
Bombus vandykei *B. vandykei*  **Range**: Washington to southern California	***Bombus vosnesenskii*** *B. vosnesenskii*  **Range**: British Columbia south to California, Nevada, Mexico	***Bombus californicus*** B. californicus  **Range**: British Columbia, Alberta south to California, Arizona, New Mexico, Mexico
Bombus rufocinctus *B. rufocinctus*  **Range**: Nova Scotia, New Brunswick, Quebec, west to British Columbia, south to California, Arizona, Wyoming, New Mexico, Kansas, Minnesota, Illinois, Michigan, New York, Vermont, Maine, Mexico.	***Bombus rufocinctus*** *B. rufocinctus*  **Range**: Nova Scotia, New Brunswick, Quebec, west to British Columbia, south to California, Arizona, New Mexico, Kansas, Minnesota, Illinois, Michigan, New York, Vermont, Maine, Mexico.	***Bombus rufocinctus*** *B. rufocinctus*  **Range**: Nova Scotia, New Brunswick, Quebec, west to British Columbia, south to California, Arizona, New Mexico, Kansas, Minnesota, Illinois, Michigan, New York, Vermont, Maine, Mexico.

www.bumblebee.org

solitary bees

Introducing: solitary bees

- About 70% of solitary bees nest in the ground.
- About 30% nest in wood or stems.
- They are efficient pollinators.
- Many are able to sting, but they are much less aggressive than social bees, and because their stings don't have barbs, their stings are reported to be much less painful.
- Some solitary bees are raised commercially, like the orchard mason bee (*Osmia lignaria*).

Photo: Marlin, from cirrusimages.,com

- Illustration of different solitary bee nesting behaviors by Celeste Green and Phyllis Thompson.

Illustration from the book *Bumblebee Economics* by Bernd Heinrich.

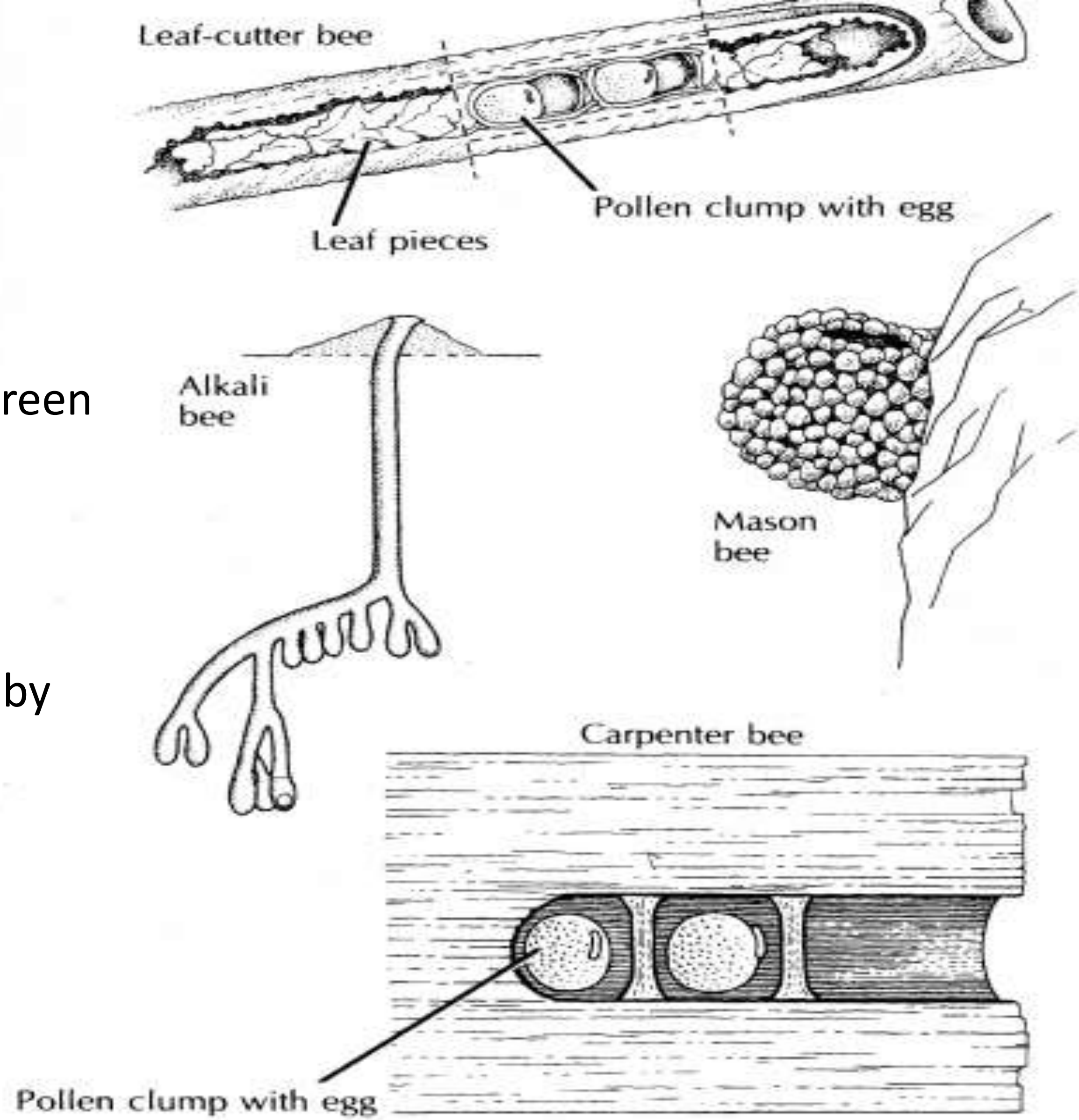


Fig. 2.2 Some of the different modes of nest construction used by solitary bees. The nest of the mason bee, *Hoplitis anthocopoides*, is constructed of pebbles glued together by glandular secretions. A leaf-cutter bee, *Megachile* sp., makes its nest in a hollow stem lined with fresh leaf pieces that envelop and separate the pollen balls of different cells. The nest of an alkali bee, *Nomia melanderi*, consists of cells branching from tunnels dug into the soil. The carpenter-bee,

Families and common names of common solitary bees

- **Apidae** – long-tongued
  - Anthophoridae (digger bees)
  - Xylocopidae (carpenter bees & small carpenter bees)
- **Halictidae** (sweat bees) – short-tongued
- **Andrenidae** (mining bees) – short-tongued
- **Colletidae** (plasterer, masked, yellow-faced and sometimes cellophane bees) – short - tongued
- **Megachilidae** (leafcutter or mason bees) – long-tongued
- **Melittidae** (no common name, includes clarkia bees) – long-tongued

Bees

Short tongued bees

- Family **Anthophoridae** (digger bees and carpenter bees)
- Family **Andrenidae** (small digger bees & ground nesters)
- Family **Halictidae** (green metallic bees or sweat bees, mining or burrowing bees)

Long tongued bees

- Family **Megachilidae** (leaf cutter bees, stem nesters)
- Family **Apidae** (honeybees, bumblebees, social bees)

Digger bees

- **Anthophoridae (Apidae)**

Melissodes spp.
Long-horned bee
Photo:Whitney Cranshaw, forestryimages.org

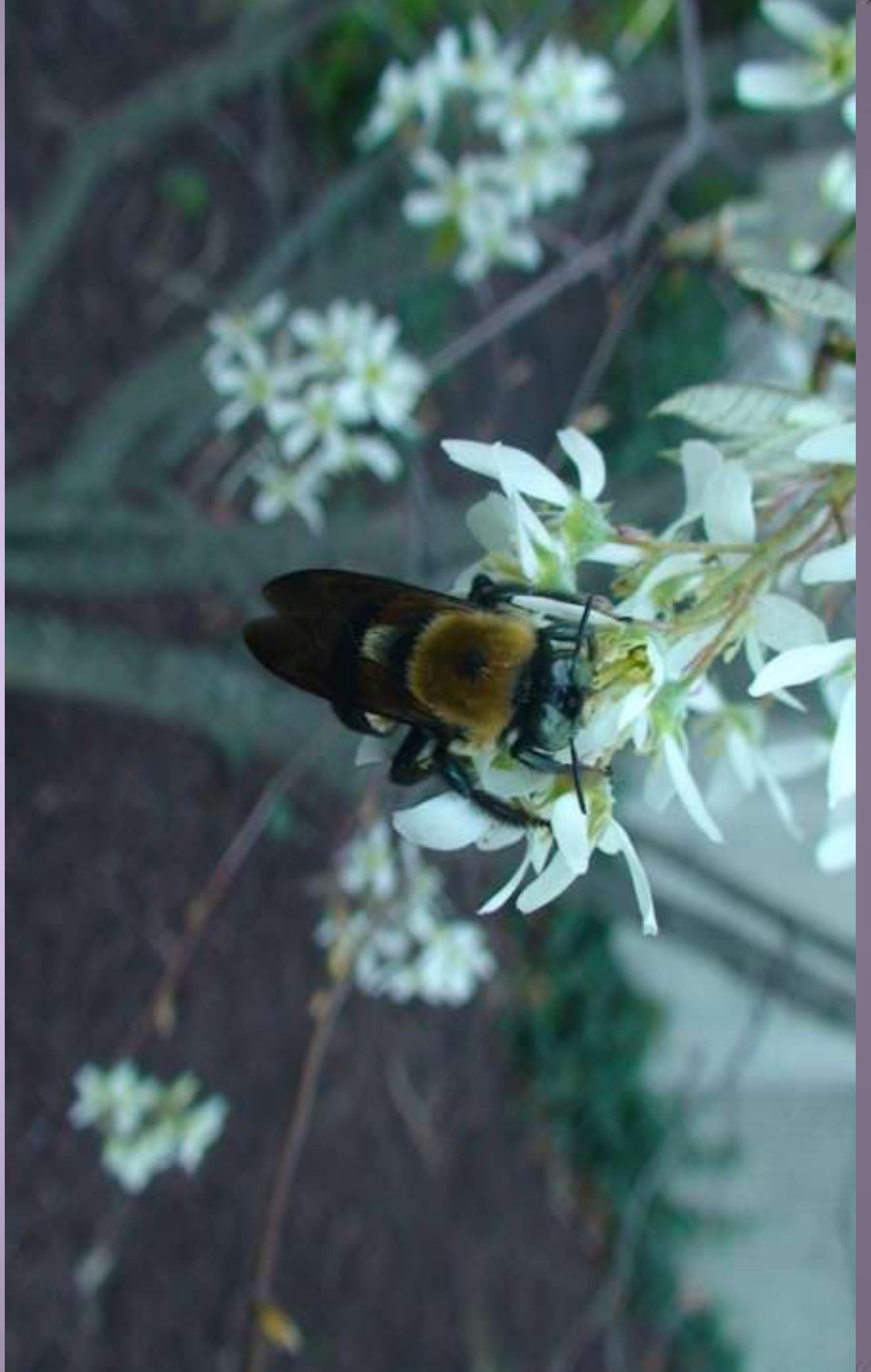
Habropoda laboriosa
Southeastern blueberry bee
Photo: Jerry A. Payne, www.insectimages.org

- **Xylocopidae (Apidae)**

Carpenter bee

Small carpenter bees

Can be considered a pest by some.



- **Halictidae**

  - Usually do not fly more than 200-300 feet from nesting area. [Source: ATTRA]

  - Some Halictid species show intermediate social behavior.

Agapostemon virescens
Photo: Beatriz Moisset Bugguide.net

Agapostemon spp.
Photo: Hartmut Wisch, Bugguide.net

- **Andrenidae**

Andrenids, or digger bees, are able to excavate dirt from loose soil to construct underground burrows they use to lay their eggs.

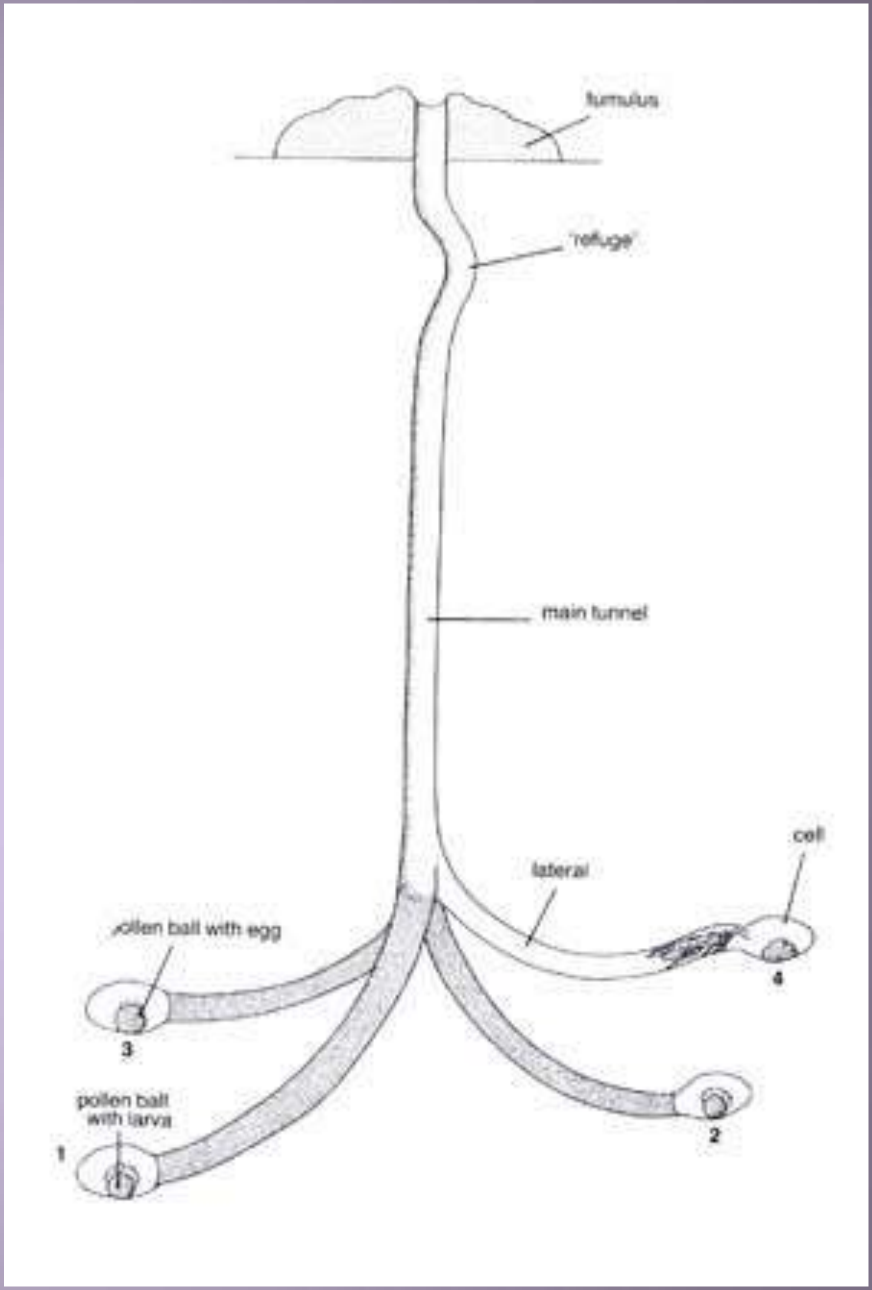
Andrena spp.
Photo: Cheryl Moorehead, Forestry Images.org

Andrena wollastoni
Photo: Peter Wirtz, Forestry Images.org

- **Andrenidae**

Nest diagram featuring tunnels Andrenid mining bees by Christopher O'Toole and Anthony Raw's book "Bees of the World.

Image taken from pencil and leaf website by Valerie Littlewood.



- **Collettidae**

Colletids secrete a plastic-like substance they use to waterproof their brood cells to protect them from being damaged by water. [Source: ATTRA]

Yellow-faced bee
Hylaeus spp.
Photo: Forest & Kim Starr, Forestry Images.org

Yellow-faced bee
Hylaeus spp.
Photo: David Cappaert, Forestry Images.org

- **Megachilidae**

Leafcutting bee
Osmia lribifloris
Photo: Jack Dykinga,
Forestry Images.org

- **Megachilidae**

leafcutter damage

Typical leafcutter damage
Photo: Whitney Cranshaw, Forestry Images.org

- Orchard mason bee

One of the most popular of the commercialized solitary bees.

Orchard mason bee larval cells in a wood chamber.
Photo: Dave M.
Photo from: BeeDiverse.com

Osmia spp.
Photo: Hartmut Wisch

Blue orchard mason bee
Osmia lignaria
Photo: n/a

Orchard mason bee pupae in a wood chamber.
Photo: Dave M.
Photo from: BeeDiverse.com

Top: Leafcutter bee pupae. Middle: Resin bee larvae.
Bottom row: Orchard mason bee pupae.
Photo: Mike N.
Photo from: BeeDiverse.com

Orchard mason bee houses sold by Knox Cellars (Washington)

What can we do

1) create/preserve habitat

Brush piles can be useful.

Dead trees can be habitat.

Begin to see the beauty of bare dirt areas.

See the beauty in mud.

Holes from digger bees (University of Georgia Photo).
Photo taken by Diane Stephens, Houston County (Georgia) Master Gardener

Holes from digger bees (University of Colorado Photo).
Photo taken by Howard Ensign Evans, Colorado State University

What can we do

Photo: Green Noise

*Inclusion does not mean or imply an endorsement increasing biodiversity,reducing pesticide use

Biological Control, Conservation

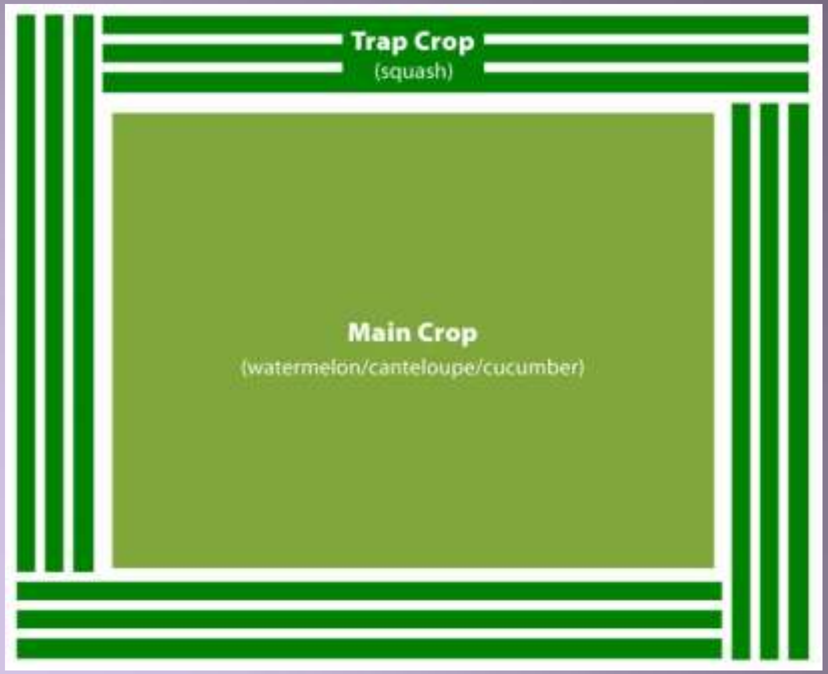
Photo: Green Noise

Biological Control, Conservation

Photo: Green Noise

what can we do

3) Plant the margins of existing garden plots or other natural areas.



Concept image: Dr. Ayanava Majumdar, Louisiana Gardener, 2/28/11

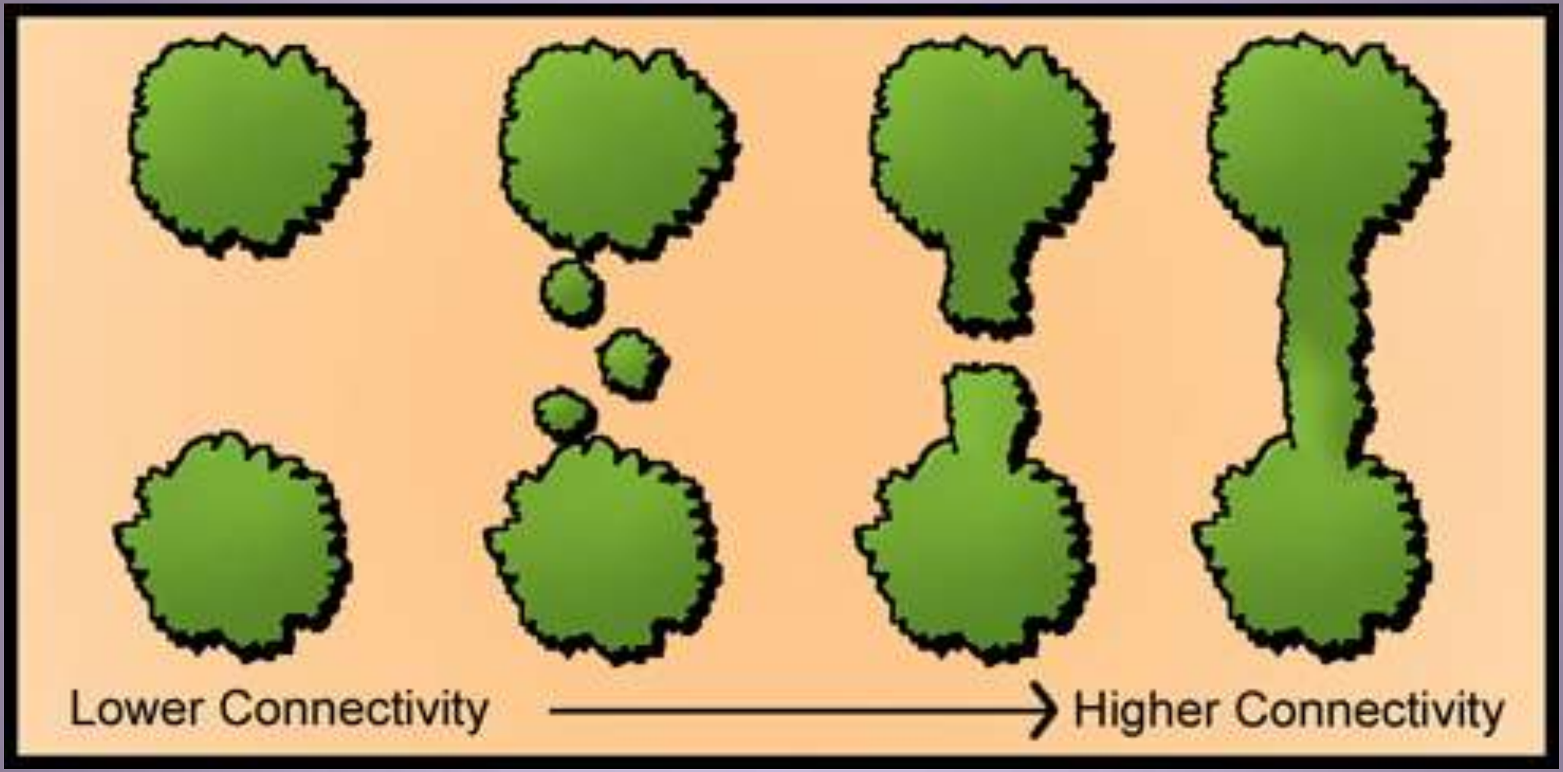
solitary bees and urban agriculture

Kremen et al. (2004) found that farms that were within a 2.4 km radius of areas with forty percent or more natural habitat **were able to rely solely on native bee communities for pollination**.

Additionally, Ricketts et al. (2008) found strong evidence that increased isolation from natural habitat results in a decline of native bee visitation rates.

There are many studies showing the relationship between distance and pollination in commercial agriculture, but not in **urban agriculture**. Ultimately, there is the potential for native pollinators to play a large role in **urban agriculture**, but we don't know how effective they will be in this very different landscape – one with presumably less native habitat nearby.

Source: "Pollination by Native Bee Communities in Berkeley, California Spring 2010" by Kevin Welzel.



Concept image: USDA, from Conservation Buffers
http://www.unl.edu/nac/bufferguidelines/guidelines/2_biodiversity/5

Value of insect pollination

300 commercial crops worldwide

- 84% of food crops are insect pollinated
- 80-85% of commercial hectares are pollinated by insects
- One-third of world food production is dependent on insects, mainly bees.

- The value of wild and/or managed pollinators in commercial crop production has been estimated in many countries using different methods. Ascribed values have varied dramatically depending on the methodology used, with managed honeybee annual values in the USA estimated at between US$1.6 billion and US$14.6 billion.

Source: Valuing Insect Pollination Services with Cost of Replacement
Mike H. Allsopp, Willem J. de Lange, Ruan Veldtman. 2008.

“ecology litany”

Adding Species creates biodiversity....

Biodiversity promotes opportunity.

Opportunity provides interactions.

Interactions builds resilience.

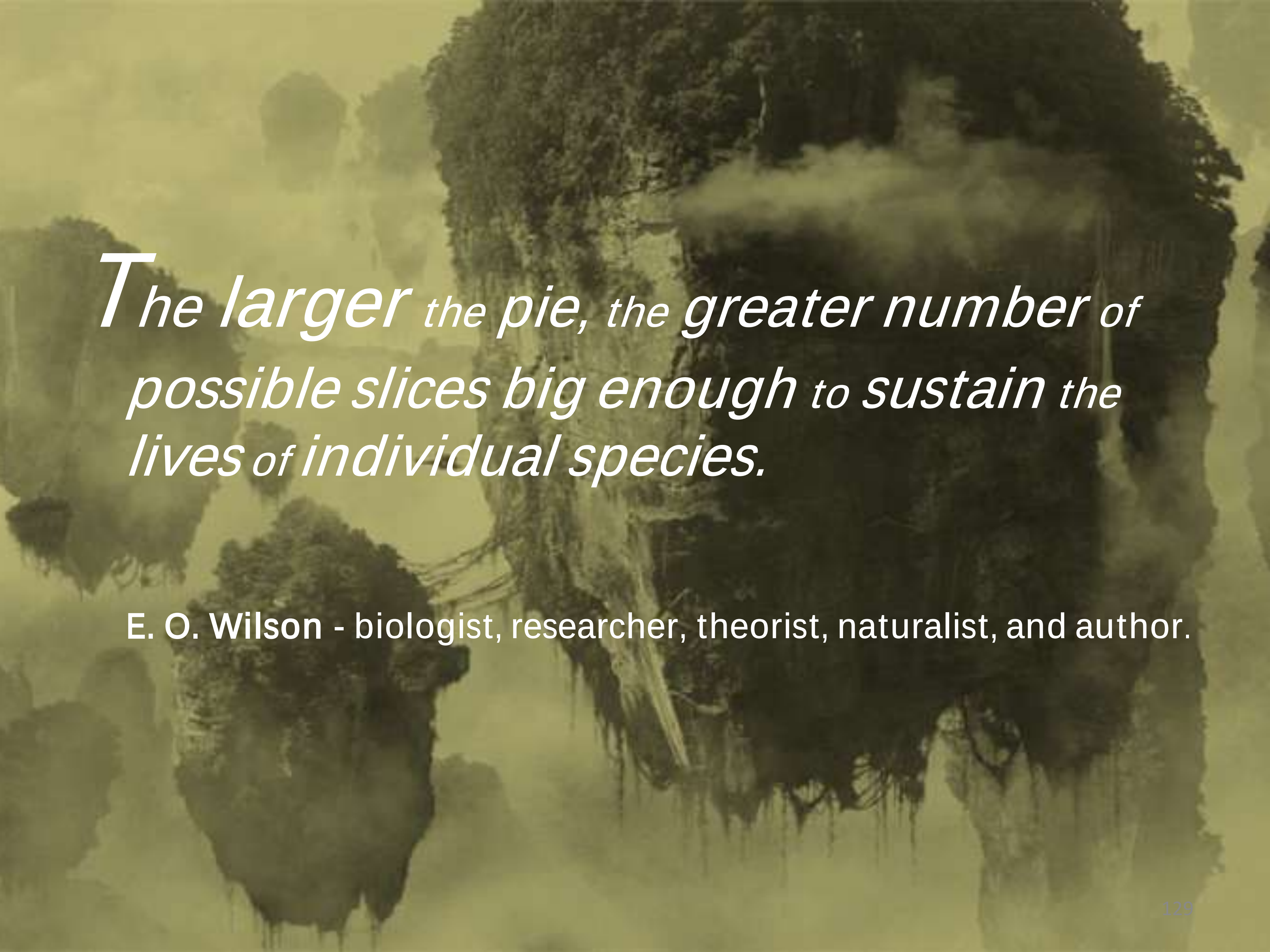
Resilience adds to stability.

Stability conserves energy.

Energy maintains health of systems.

Healthy systems support the continuity of species.

“Winning London's recent Beyond The Hive competition, the "Insect Hotel" is a five-star refuge for bugs living in urban environments. Architecture firm Arup Associates designed individual compartments in a mathematically-derived pattern known as a Voronoi tessellation to house an array of species spanning spiders, beetles and moths.”
www.coolhunting.com/design/urban-insect-ho.php



The larger the pie, the greater number of possible slices big enough to sustain the lives of individual species.

E. O. Wilson - biologist, researcher, theorist, naturalist, and author.

Mature American plums, early August 2009