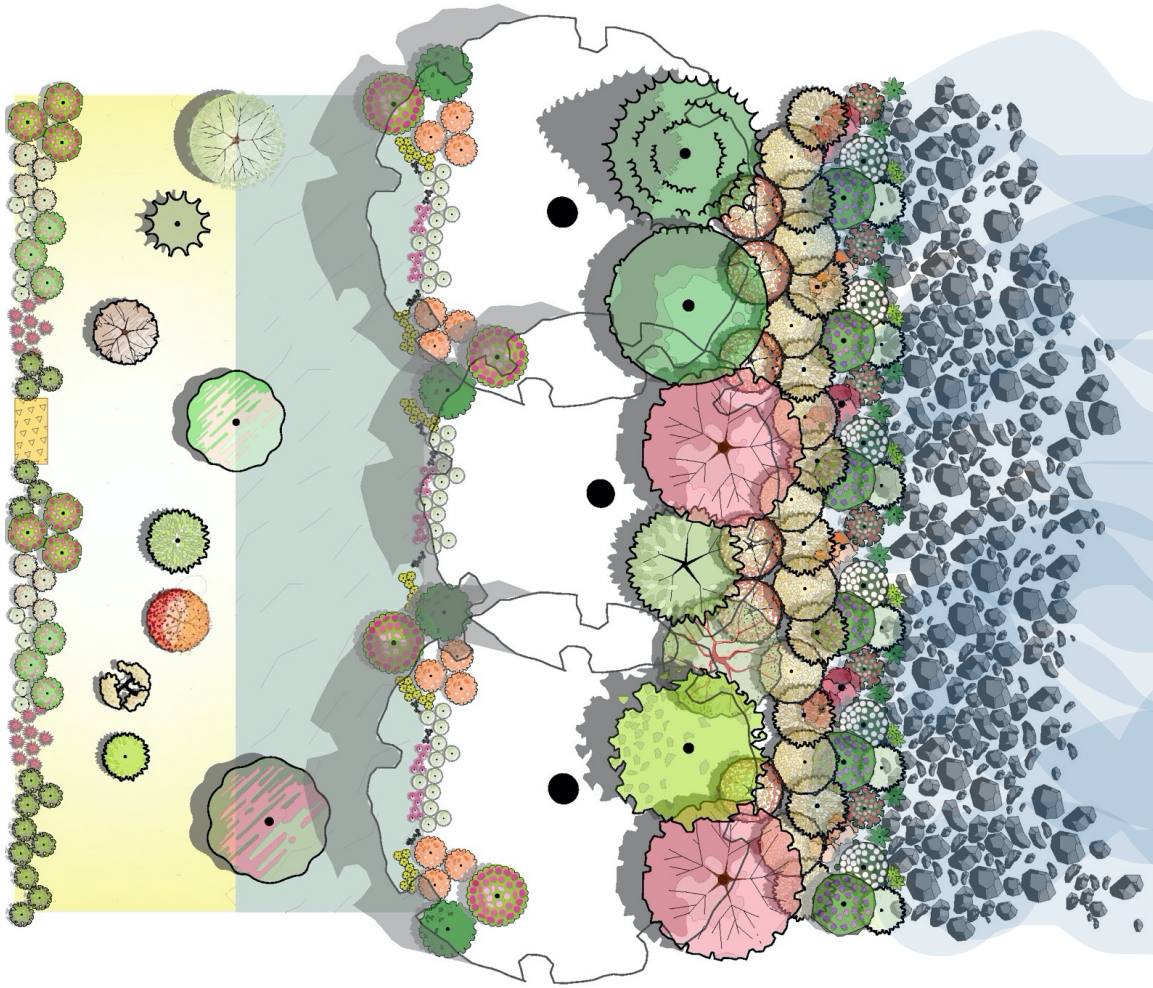


Riparian Buffers as Habitat

PLANTING FOR BIODIVERSITY AND CLIMATE RESILIENCE

EVAN ABRAMSON, M.Sc.
Principal
LANDSCAPE | NTERACTIONS

1: Context

Times we are living in

Importance of riparian buffers

Climate resiliency through buffer planting

Design precedents

A bioregional perspective

Photo illustration by Matt Dartman

Collapse of Nature

One million species threatened with extinction globally, including **over half the native bee species** in North America.

Insects essential for all ecosystems, as pollinators, food for other creatures and recyclers of nutrients.

Most insect species could vanish within a century at the current rate of decline.

Habitat loss cited as the most pressing problem. New classes of insecticides introduced in the last 20 years have also been especially damaging, particularly **neonicotinoids**.

"We are sleepwalking towards the edge of a cliff."

Carrington, D. 'Insect apocalypse' poses risk to all life on Earth, conservationists warn. Guardian News and Media. (2019, November 13).

Carrington, D. Humanity has wiped out 60% of animal populations since 1970, report finds. Guardian News and Media. (2018, October 29).

Sánchez-Bayo, F., Wyckhuys, K.A.G., Worldwide decline of the entomofauna: A review of its drivers, Biological Conservation. 232, 2019, 8–27.

Carrington, D. Plummeting Insect Numbers 'Threaten Collapse of Nature.' Guardian News and Media (2019, February 10).

J.-M. Bonmatin et al., Environmental fate and exposure; neonicotinoids and fipronil. Environ. Sci. Pollut. Res. Int. 22,35–67 (2015).

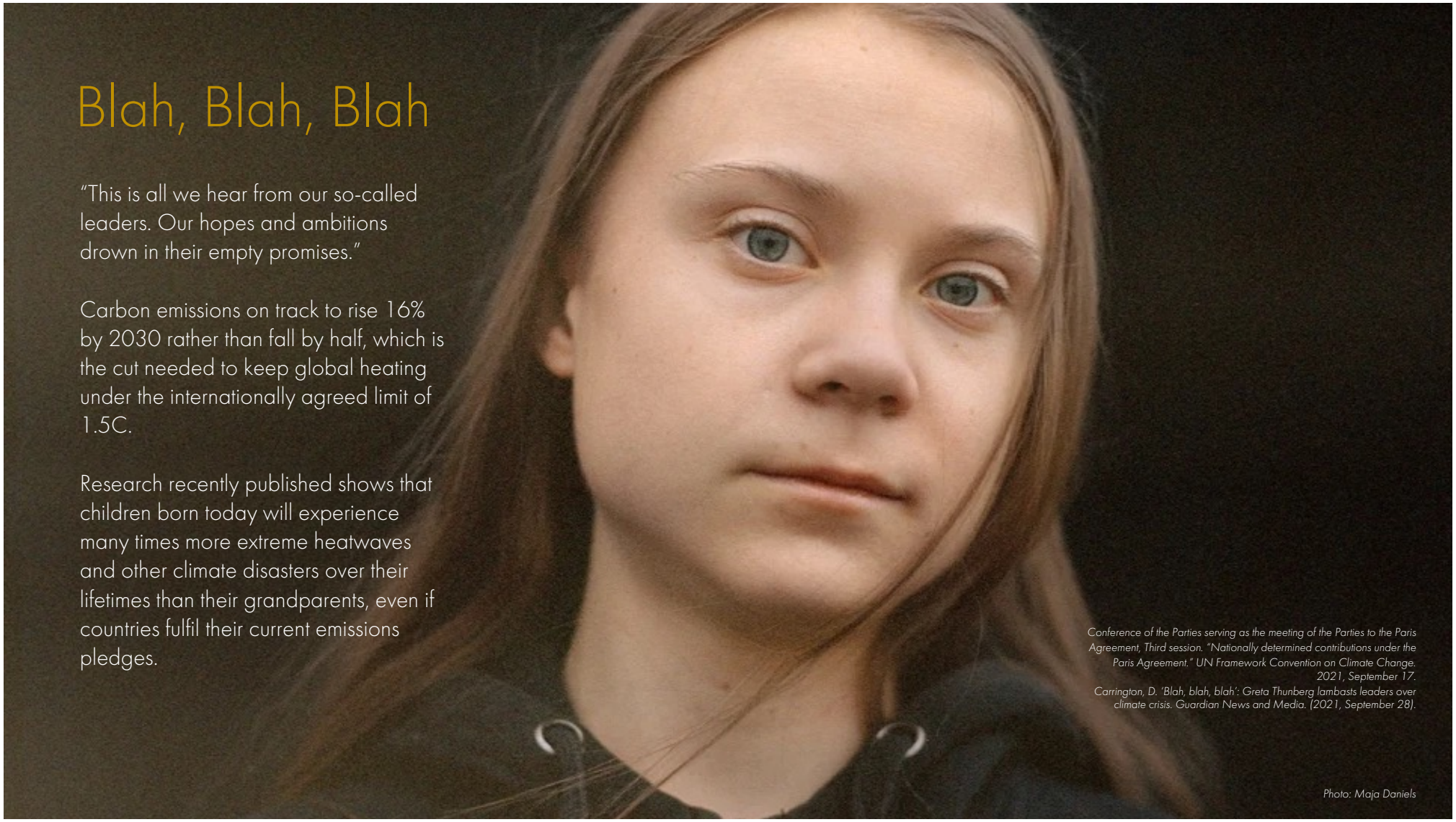
Photo illustration by Matt Dorfman

Blah, Blah, Blah

"This is all we hear from our so-called leaders. Our hopes and ambitions drown in their empty promises."

Carbon emissions on track to rise 16% by 2030 rather than fall by half, which is the cut needed to keep global heating under the internationally agreed limit of 1.5C.

Research recently published shows that children born today will experience many times more extreme heatwaves and other climate disasters over their lifetimes than their grandparents, even if countries fulfil their current emissions pledges.



Conference of the Parties serving as the meeting of the Parties to the Paris Agreement, Third session. "Nationally determined contributions under the Paris Agreement." UN Framework Convention on Climate Change. 2021, September 17.
Carrington, D. 'Blah, blah, blah': Greta Thunberg lambasts leaders over climate crisis. Guardian News and Media. (2021, September 28).

Photo: Maja Daniels

Importance of Riparian Buffers

As extreme weather events, including floods, droughts, and storms, are becoming more frequent and intense, dealing with pollutants from stormwater runoff has become a major challenge for policymakers and environmental managers in terms of sustaining stream water quality and aquatic ecosystems.

Changes in land cover types and spatial patterns are one of the key influencing factors that alter hydrological systems, leading to changes in stormwater runoff characteristics.

Park SR, Kim S, Lee SW. Evaluating the Relationships between Riparian Land Cover Characteristics and Biological Integrity of Streams Using Random Forest Algorithms. Int J Environ Res Public Health. 2021 Mar 19;18(6):3182. doi: 10.3390/ijerph18063182. PMID: 33808659; PMCID: PMC8003393.

Walkill View Farm Market, New Paltz, NY, October 26, 2021. Photo by Daniel Spitzer

Importance of Riparian Buffers

Riparian buffers can manage stormwater by mitigating surface runoff processes, such as decreasing flow velocity and increasing residence time.

Riparian zones provide several ecological functions, such as enhancing biodiversity, microclimate regulation, and increasing recreational opportunities.

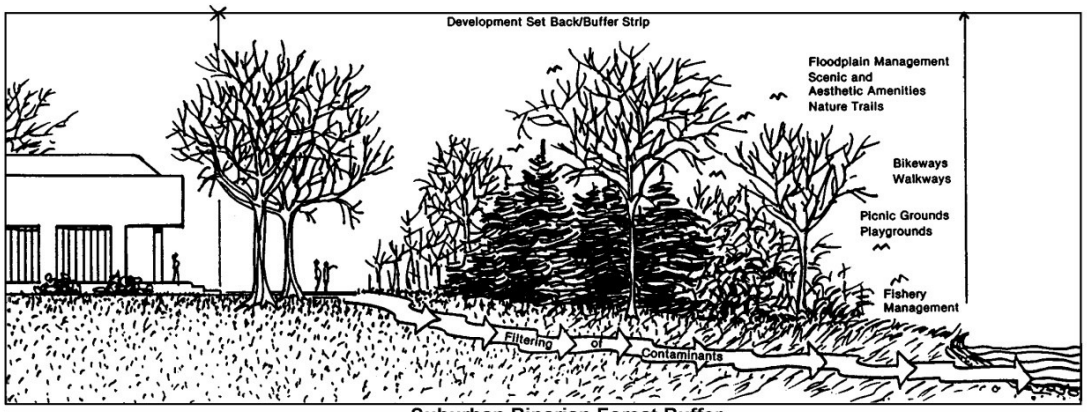
However, human activities and intensified land use cause fragmentation, loss, and degradation of riparian vegetation, which can negatively affect the biological integrity of streams.

Park SR, Kim S, Lee SW. Evaluating the Relationships between Riparian Land Cover Characteristics and Biological Integrity of Streams Using Random Forest Algorithms. Int J Environ Res Public Health. 2021 Mar 19;18(6):3182. doi: 10.3390/ijerph18063182. PMID: 33808659; PMCID: PMC8003393.

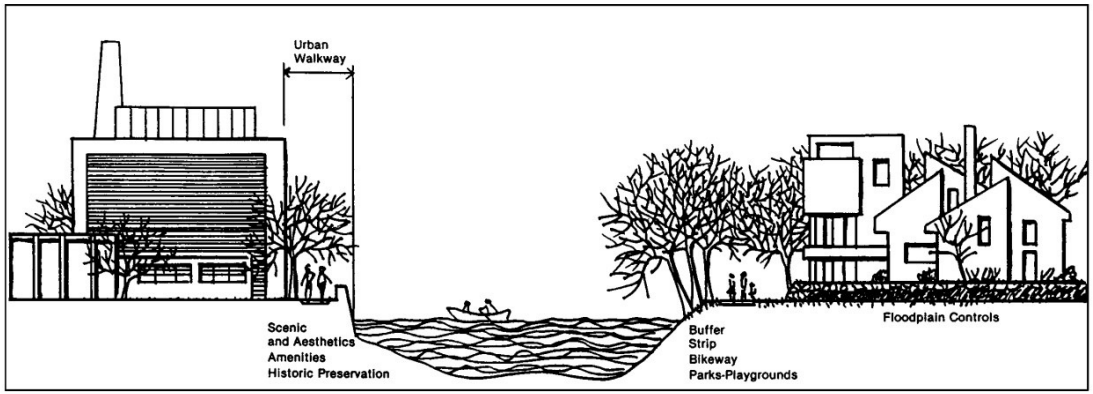
Walkill View Farm Market, New Paltz, NY, October 26, 2021. Photo by Daniel Spitzer

Riparian Buffer Benefits

1. Water Quality
2. Biodiversity
3. Productive Soils
4. Economic Opportunities
5. Protection and Safety
6. Aesthetics and Visual Quality
7. Outdoor Recreation



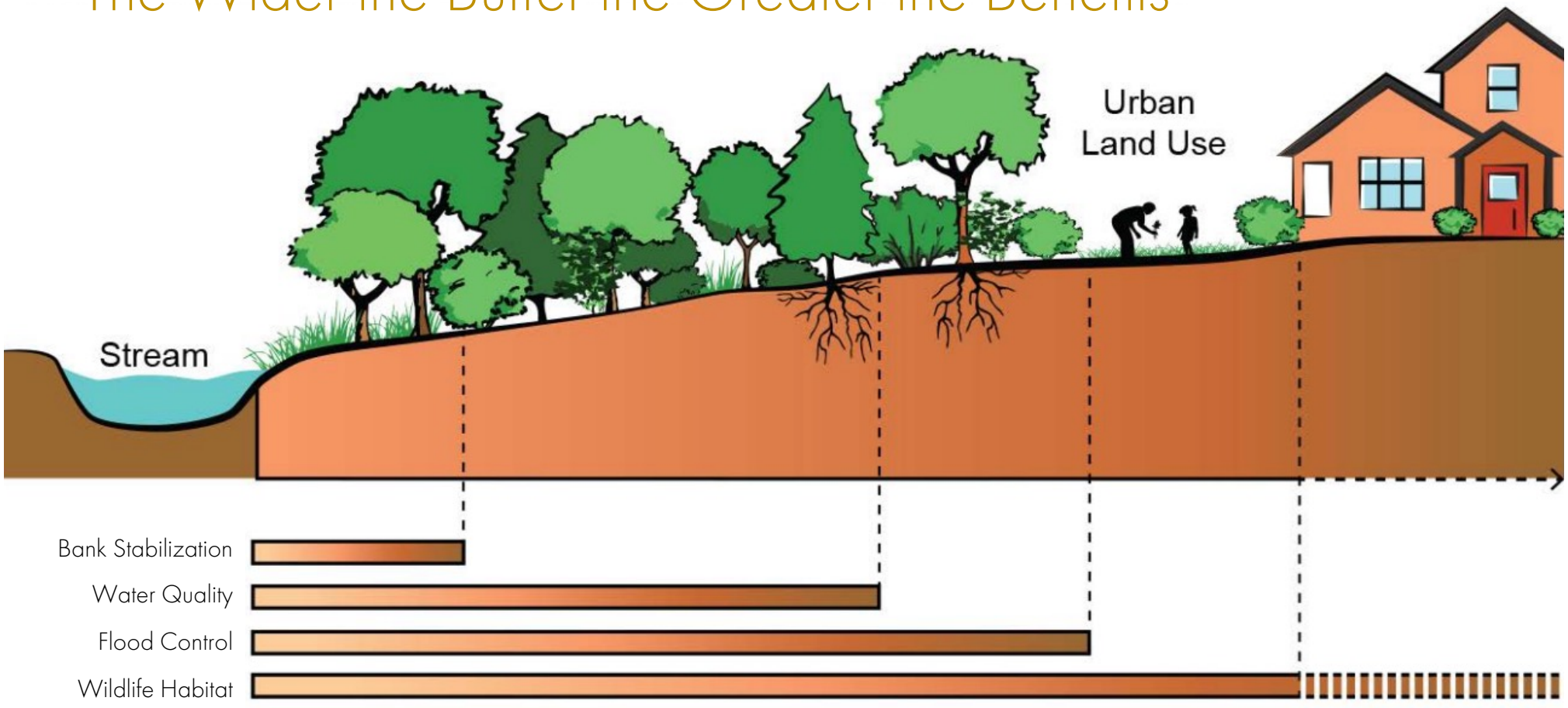
Suburban Riparian Forest Buffer



Urban Riparian Forest Buffer

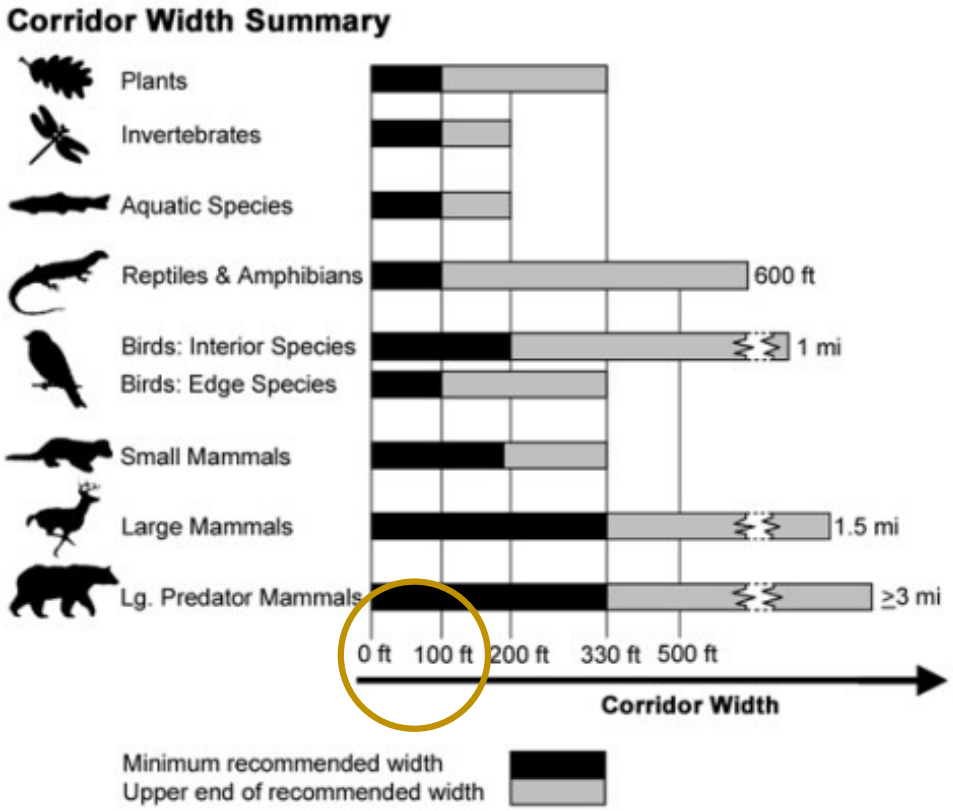
Chesapeake Bay Riparian Handbook: A Guide for establishing and maintaining riparian forest buffers. Chesapeake Bay. (1998). Retrieved January 31, 2023, from https://www.chesapeakebay.net/what/publications/chesapeake-bay-riparian-handbook-a-guide-for-establishing-maintaining-ripar

The Wider the Buffer the Greater the Benefits



Relationship between riparian buffer width and its functions (adapted from Hawes and Smith, 2005).
Distance of benefits varies due to site conditions such as slope.

The Wider the Buffer the Greater the Benefits



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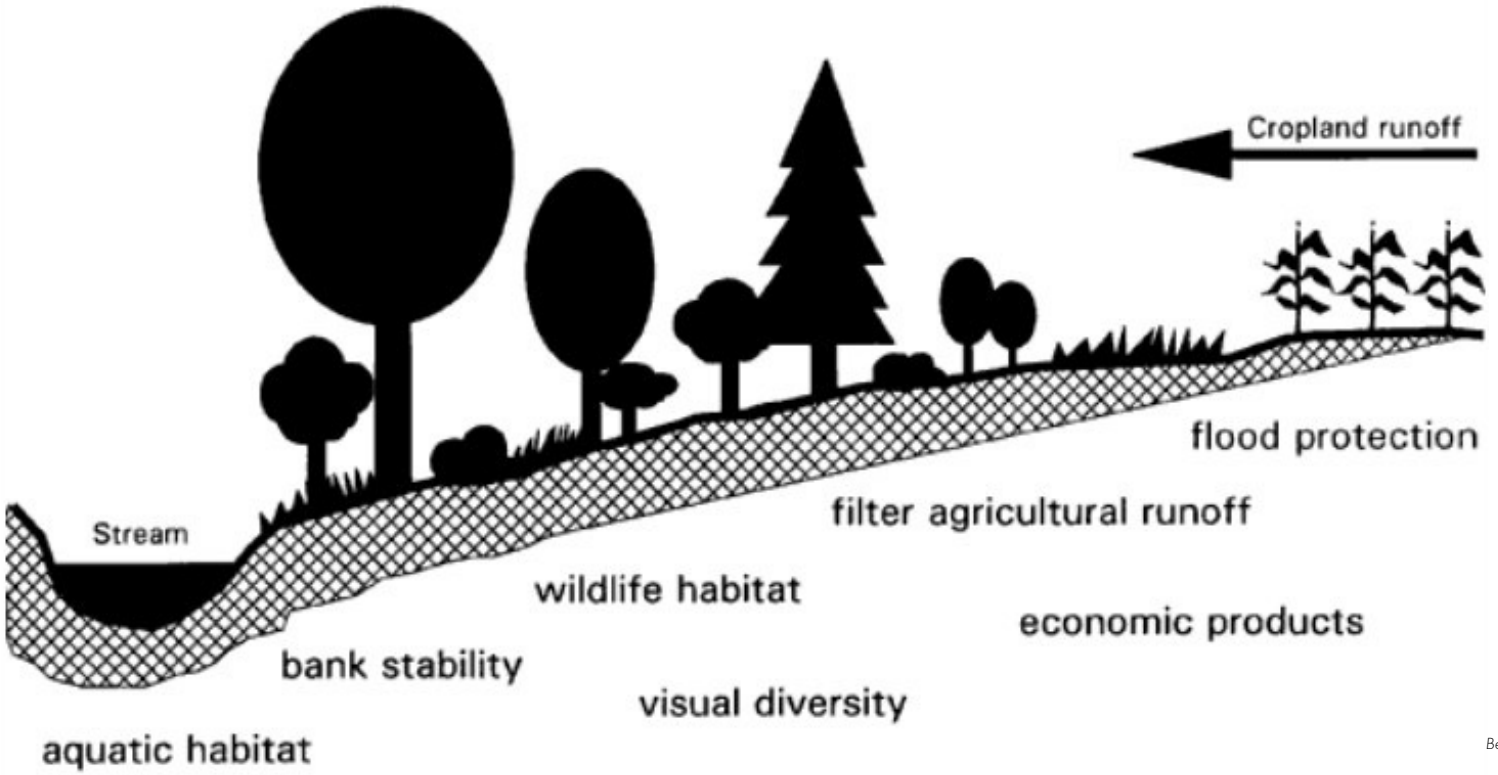


Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station. 110 p.

Economic Impacts in1983

Farmers here in the "black muck" basin on the New York-New Jersey border say they have lost $8 million in damage to their crops and lands from a week of flooding, and more rain is forecast for the weekend.

Farm experts agree that by far the worst damage was here in Orange County and in neighboring Sussex County, N.J.

Malcolm Henning, an official of the United States Department of Agriculture who is this area's chief soil conversationist, put the damage at $8 million.

New York Times, April 23, 1983

Richard. (1983, April 23). Floods in New York area take big crop toll. The New York Times. Retrieved January 31, 2023, from https://www.nytimes.com/1983/04/23/nyregion/floods-in-new-york-area-take-big-crop-toll.html

Hurricane Ida, New Paltz, NY, August 2021. Photo by Robin Weinstein

Economic Impacts in 2020

"Farmers were devastated by (Hurricane) Irene and (Tropical Storm) Lee," said John Lupinski, president of the Orange County Farm Bureau. "With climate change these '50-year floods' are happening more often."

In 2020 New York received $400,000 to help prevent flood-induced crop losses with the Wallkill Floodplain Bench Project. Since 2016, about 15 acres of soil has been removed along the river, helping to create an artificial floodplain that will protect thousands of acres of farmland.

Between $8 million and $10 million more is needed to finish the project, in an area stretching to the New Jersey border.

Times Herald-Record, October 5, 2020

Axelrod, D. (2020, October 5). Farmers, local leaders Hail sen. Metzger for grant to prevent Wallkill River flooding. Record. Retrieved January 31, 2023, from https://www.recordonline.com/story/news/2020/10/05/sen-metzger-secures-funding-help-prevent-wallkill-river-from-flooding-local-farmland/5880951002/

Farms flooded along Walkill River, New Paltz, NY, October 26, 2021. Photo by Daniel Spitzer

Economic Impacts in 2021

On Oct. 26, 2021 another nor'easter barrelled its way through the New Paltz area, causing the Wallkill River to overflow for the second time that fall.

With anthropocentric climate change affecting weather patterns, there is worry amongst farmers that crop loss is going to increase.

Agriculture contributes more than $300 billion to the U.S. economy each year, but millions are lost due to natural disasters.

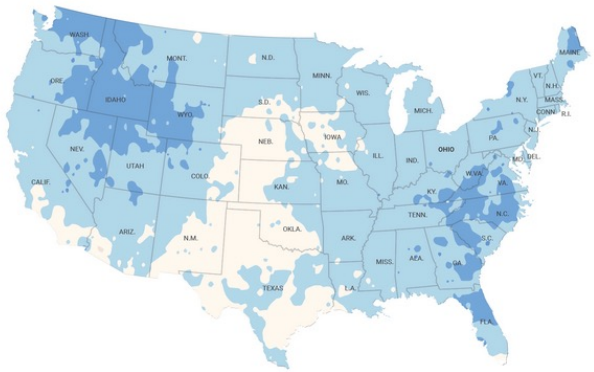
New Paltz Oracle, November 17, 2021

Gagliano, G. (2021, November 17). Wallkill river floods again: Affecting farms. The New Paltz Oracle. Retrieved January 31, 2023, from https://oracle.newpaltz.edu/wallkill-river-floods-again-affecting-farms/

Farms flooded along Walkill River, New Paltz, NY. October 26, 2021. Photo by Daniel Spitzer

Select year of projection

This year | In 15 years | In 30 years



Change in extreme rain events compared to 1980-2010 average.

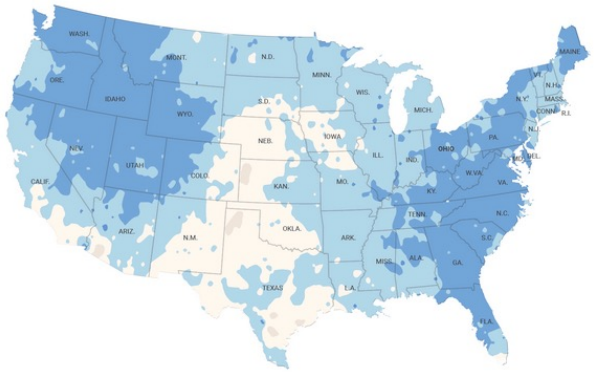
←LIGHTER HEAVIER→

-10% -5% 0% 5% 10%

Source: NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP).

Select year of projection

This year | **In 15 years** | In 30 years



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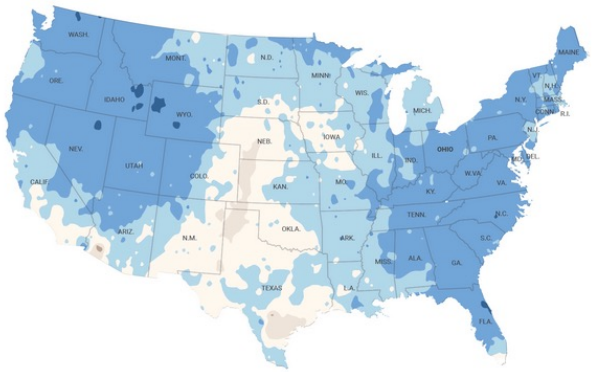
-10% -5% 0% 5% 10%

Source: NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP).

Select year of projection | This year | In 15 years | In 30 years



Change in extreme rain events compared to 1980-2010 average. ⓘ

←LIGHTER HEAVIER→

-10% -5% 0% 5% 10%

Source: NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP).

Climate + Biodiversity: Solve Both or Solve Neither

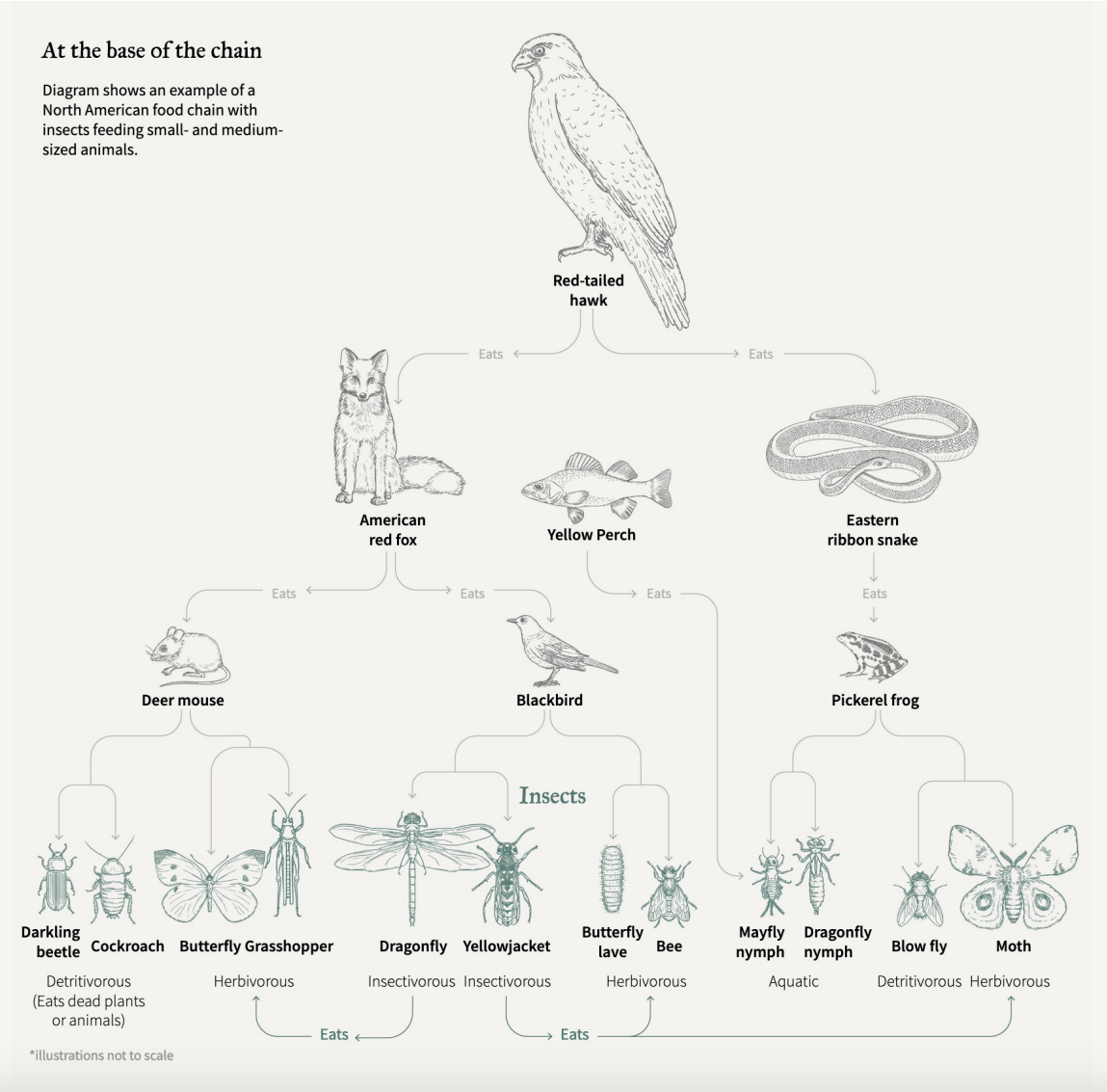
Connected, diverse and extensive ecosystems can help stabilize the climate and will have a better chance of thriving in a world permanently altered by rising emissions.

"Rather than being framed as a victim of climate change, biodiversity can be seen as a key ally in dealing with climate change."

Pettorelli, N., Graham, N. A. J., Seddon, N., Maria da Cunha Bustamante, M., Lowton, M. J., Sutherland, W. J., Koldewey, H. J., Prentice, H. C., & Barlow, J. (2021). Time to integrate global climate change and biodiversity science-policy agendas. Journal of Applied Ecology, 00, 1– 10.

Malhi, Y., Franklin, J., Seddon, N., Solan, M., Turner, M. G., Field, C. B., & Knowlton, N. (2020). Climate change and ecosystems: Threats, opportunities and solutions. Philosophical Transactions of the Royal Society B: Biological Sciences, 375(1794), 20190104.

Illustration by Charlotte Ager/The Guardian



Janicki, J., Dickie, G., Scarr, S., & Chowdhury, J. (2022, December 6). Insect populations are declining at an unprecedented rate. Reuters. Retrieved January 15, 2023, from https://www.reuters.com/graphics/GLOBAL-ENVIRONMENT/INSECT-APOCALYPSE/egpbykdxjvq/

Illustration by Catherine Tai

Bird Declines Linked to Nonnative Plants

Not just pollinators are negatively effected by a lack of native plant diversity. Impacts reach across trophic levels and animal groups.

Insect-eating birds that depend upon caterpillars and spiders to feed their young experienced population declines on properties with over 30 percent nonnative plants, according to a 2018 study.

160 suburban yards in the Washington, D.C. area were surveyed. Yards with less than 70 percent native plants were unable to sustain stable populations of Carolina chickadees.

Because more than 90 percent of herbivorous insects will only eat one or a few native plant species, the use of these plants in landscaping is essential to ensure breeding birds have enough insect prey to eat.

Native plants are also critical for other resident birds, including endangered species and migratory species.

Narango, D. L., Tallamy, D. W., & Marra, P. P. (2018). Nonnative plants reduce population growth of an insectivorous bird. Proceedings of the National Academy of Sciences, 115(45), 11549–11554. https://doi.org/10.1073/pnas.1809259115

Photo: Doug Tallamy

Climate Resiliency through Buffer Planting

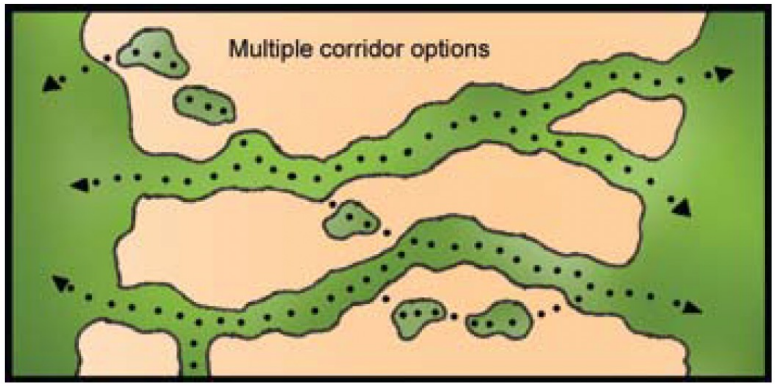
Current and projected climate change may have significant impacts on biodiversity and other ecosystem services. Corridors and buffers may potentially mitigate these impacts in several ways:

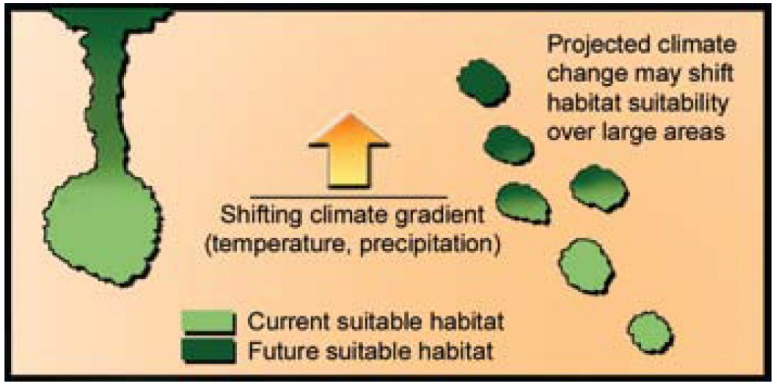
1. Reduce greenhouse gases

2. Allow species to migrate as climate changes

3. Protect sensitive areas from increased climatic events such as floods and storm surges

4. Provide habitat that offers a range of microclimate refugia





Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station. 110 p.

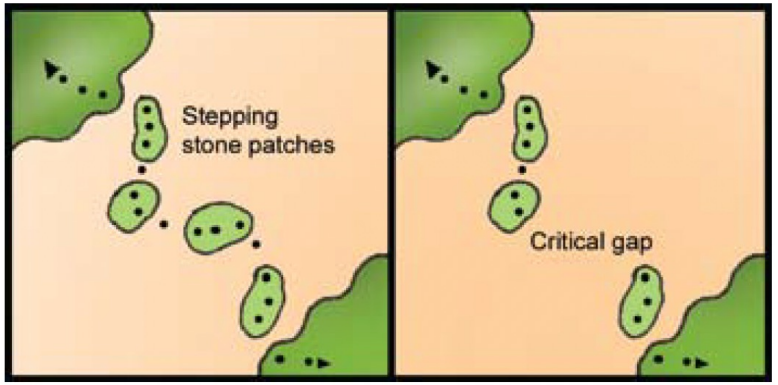
Climate Resiliency through Buffer Planting

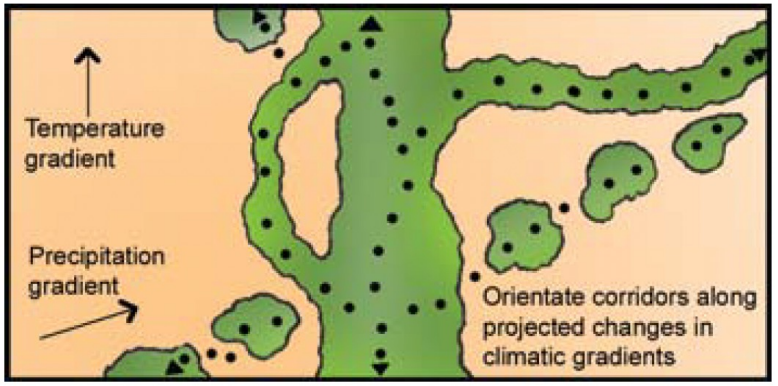
Key design considerations:

- Corridors for climate change may be best suited for landscapes that are less modified by human development.

- Broad connectivity zones may be more effective than distinct and narrow corridors.

- A strategy of stepping stones and corridors may offer the most opportunities for dispersal and migration.





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Climate Resiliency through Buffer Planting

Key design considerations:

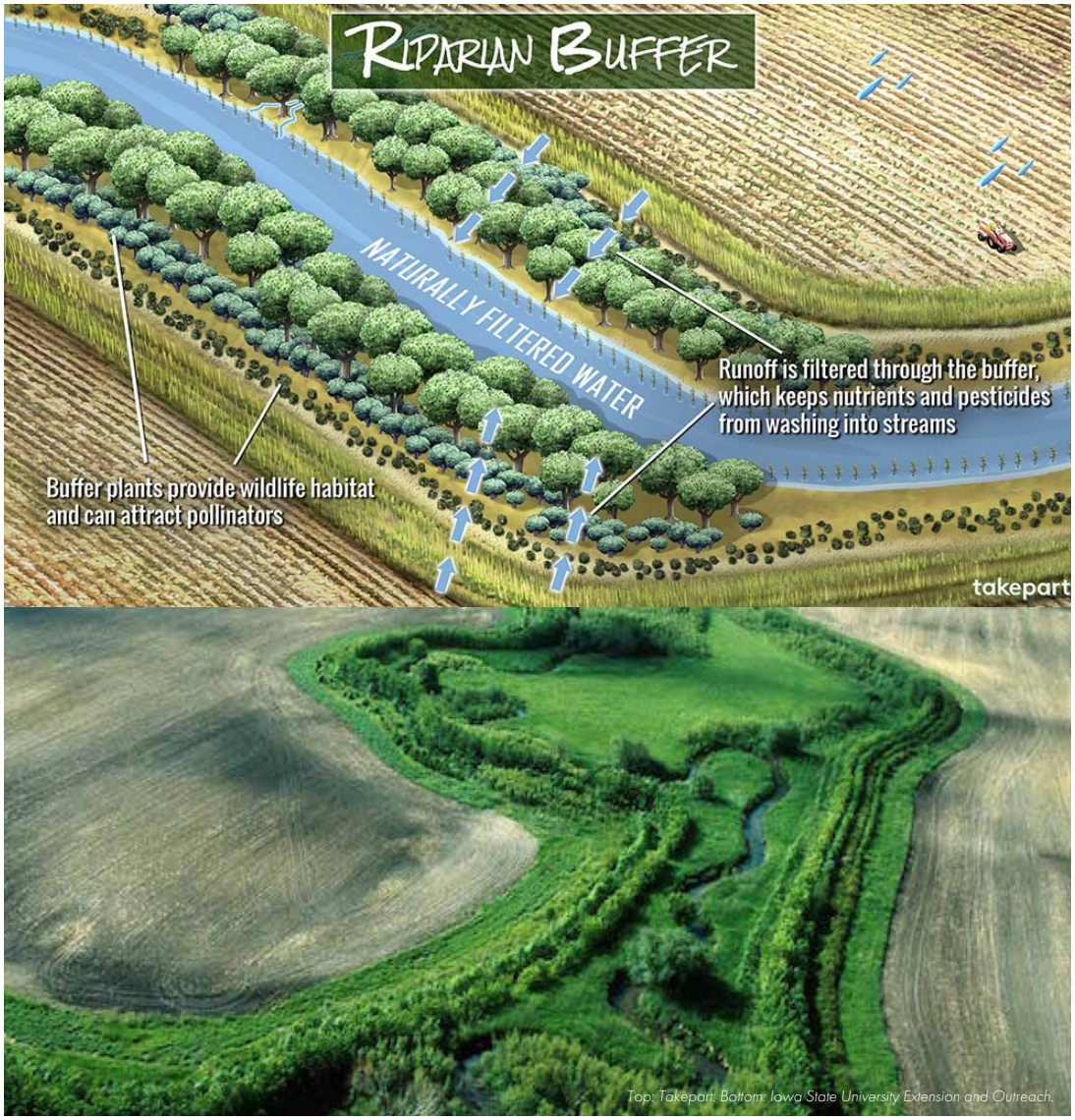
- Corridors that cross elevation zones may allow migration in mountainous landscapes.

- Locate corridors and patches to provide climate refugia at multiple spatial scales.

- Include a range of geological substrates and soils to meet different plant requirements.

- Riparian buffers may help mitigate temperature changes in streams due to climate change.

Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station. 110 p.



Top: Takepart; Bottom: Iowa State University Extension and Outreach.

Climate Resiliency through Buffer Planting

According to NYSDEC's Priority Waterbodies List, silt/sediment is the primary pollutant in the Wallkill.

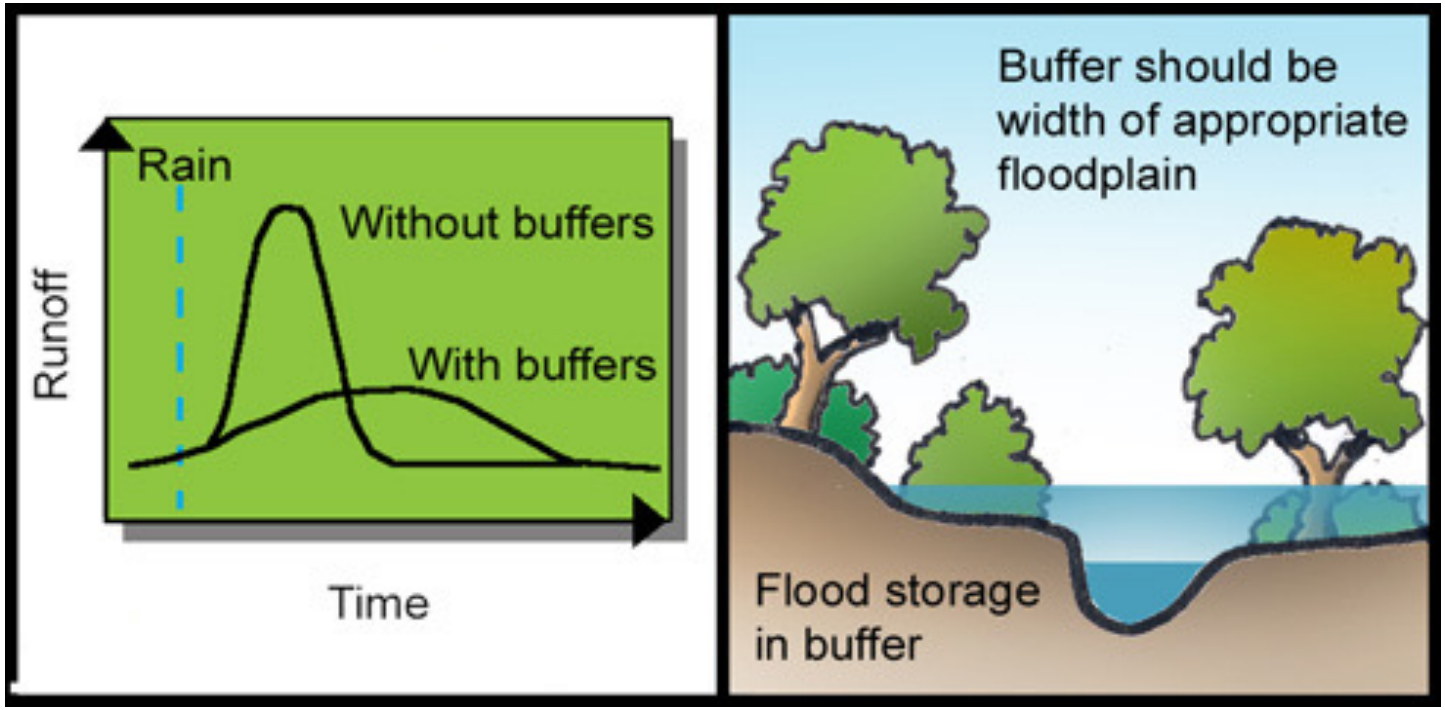
Common sources of excess sediment include cropland, urban construction sites, and streambank erosion.

Research suggests that streambank erosion is the major source of sediment load in the Wallkill.

Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station. 110 p.

Wallkill River Watershed Conservation and Management Plan. New York State Department of Environmental Conservation Hudson River Estuary Program.

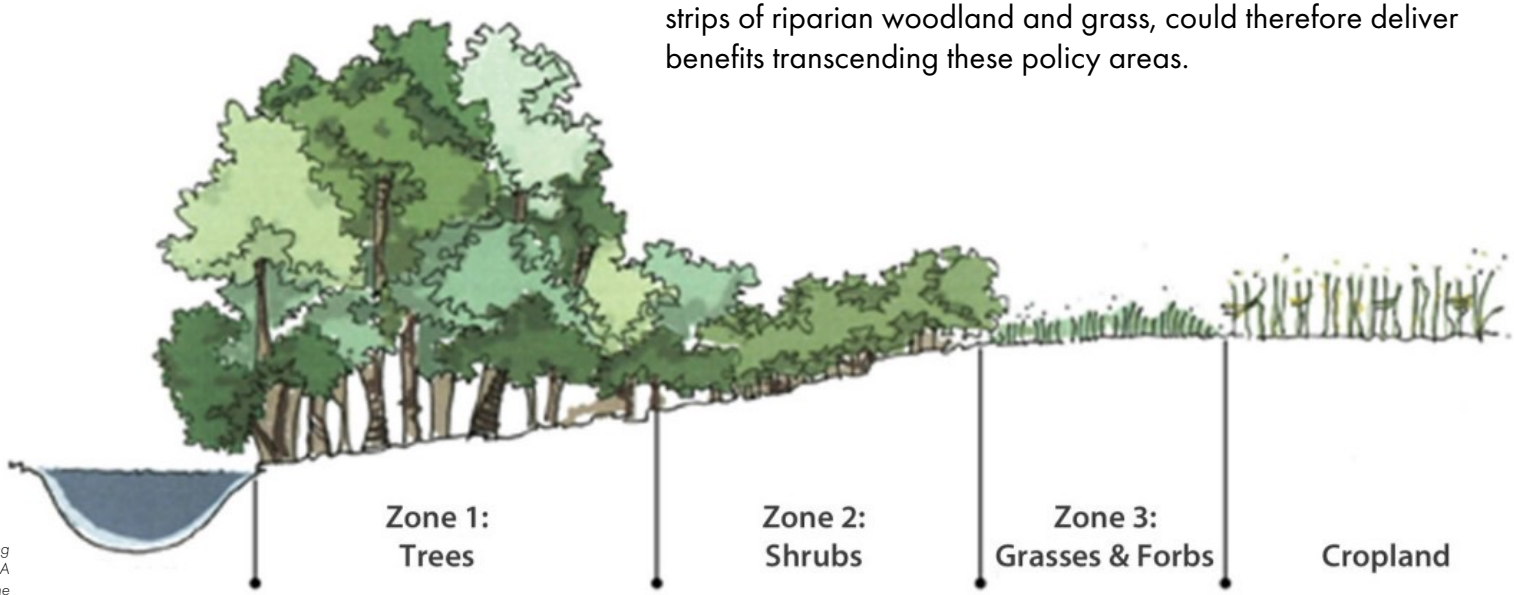
Design Precedents



Bentrup, G. 2008. Conservation buffers: design guidelines for buffers, corridors, and greenways. Gen. Tech. Rep. SRS-109. Asheville, NC: Department of Agriculture, Forest Service, Southern Research Station. 110 p.

Design Precedents

Wooded buffers can be less effective than grass buffers at intercepting sediments and sediment bound pollutants, but provide many benefits associated with mitigating the impacts of climate change (e.g. carbon capture and moderating aquatic temperatures). This highlights potential trade-offs between climate change and water quality objectives. Zoned buffers that combine strips of riparian woodland and grass, could therefore deliver benefits transcending these policy areas.



Lorna J. Cole, Jenni Stockan, Rachel Helliwell. Managing riparian buffer strips to optimise ecosystem services: A review. Agriculture, Ecosystems & Environment, Volume 296, 2020, 106891,ISSN 0167-8809. https://www.sciencedirect.com/science/article/pii/S0167880920300761

Image: University of Kentucky

Design Precedents

A 35-m wide **3-zone riparian forest buffer system** removed 26% of the subsurface nitrate and 43% of the suspended sediments delivered from upslope. **The influence of tree growth on nitrate removal became apparent approximately ten years after planting. The grass filter strip between the forest and the cultivated field,** contoured to disperse concentrated overland flow into the reforested area, **also functioned effectively to remove suspended sediments.** These improvements are critical to the protection of downstream ecosystems.

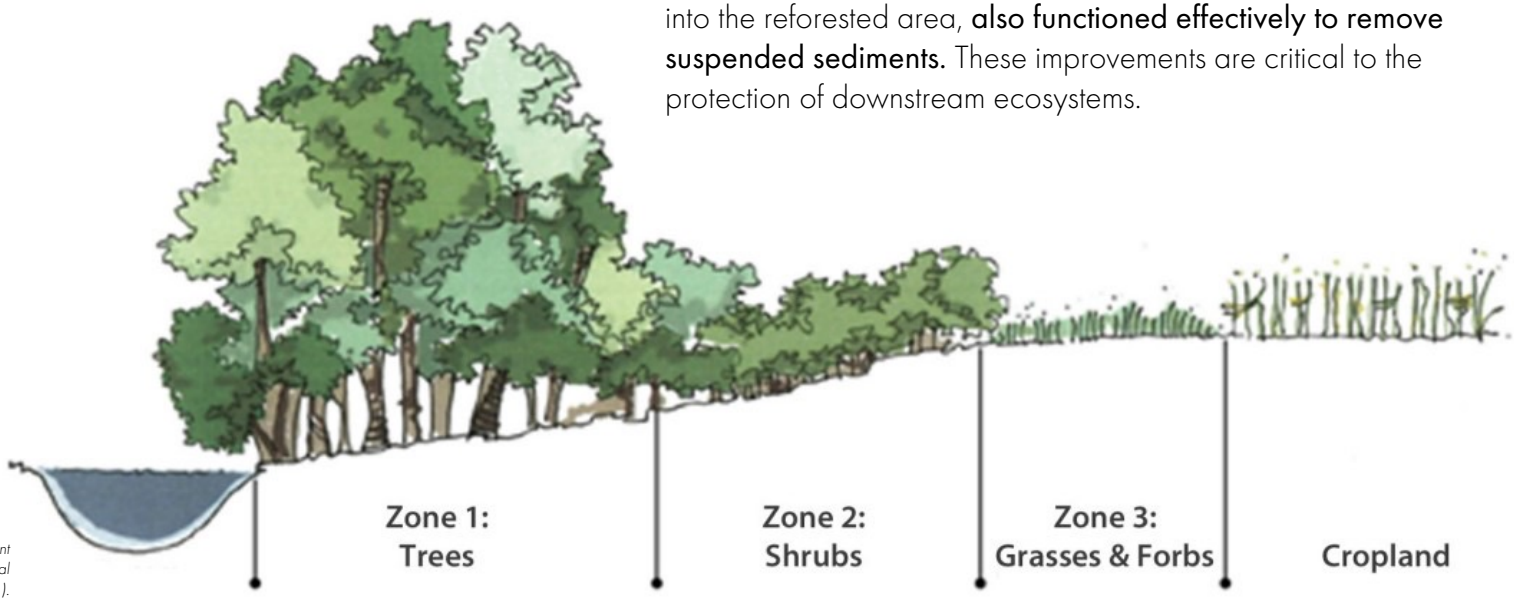
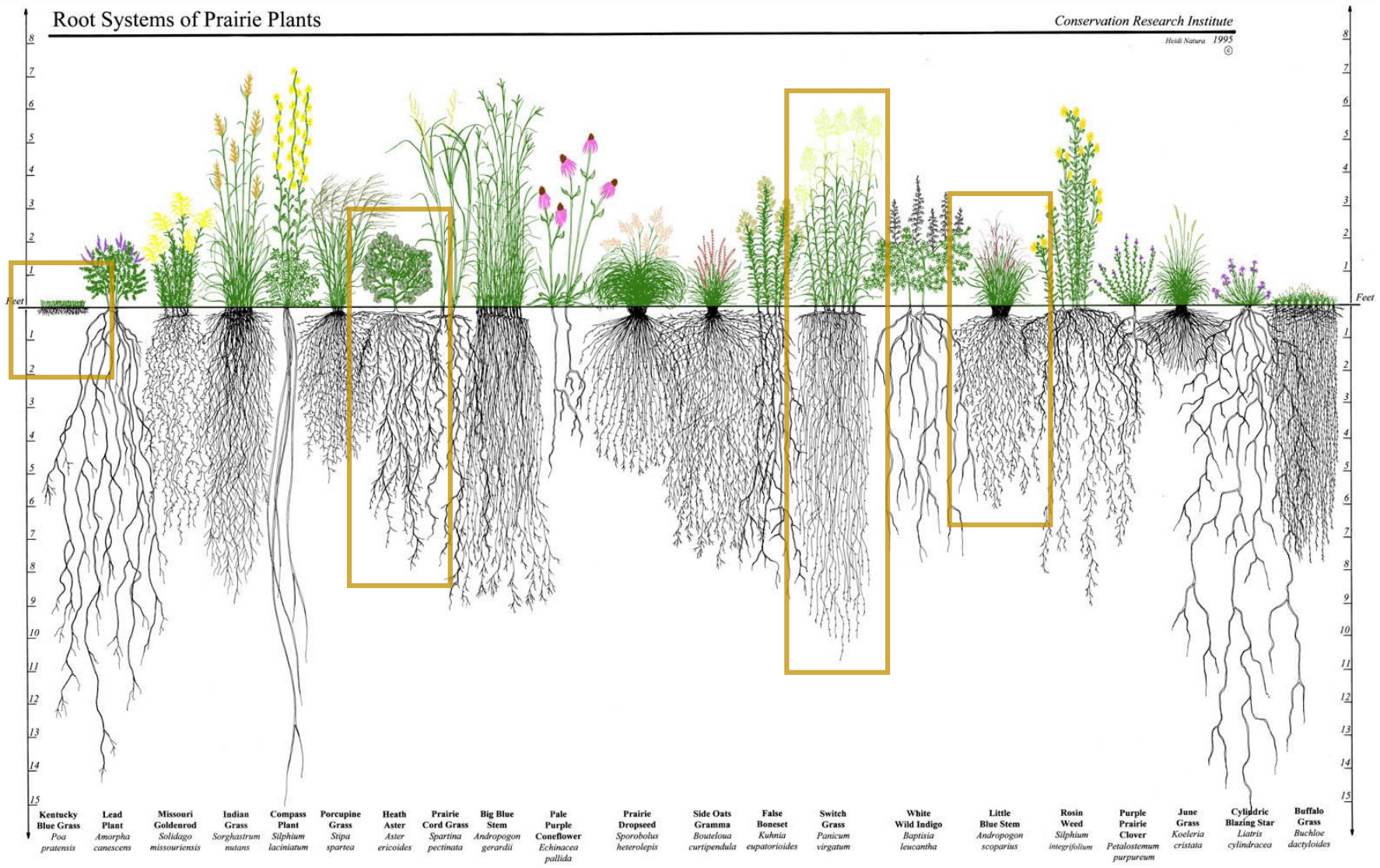


Image: University of Kentucky

Stroud Water Research Center. Mitigation of nonpoint pollution by a riparian forest buffer in an agricultural watershed of the Mid-Atlantic Piedmont. (2019, May 21). https://stroudcenter.org/publications/mitigation-nonpoint-pollution-riparian-forest-buffer/

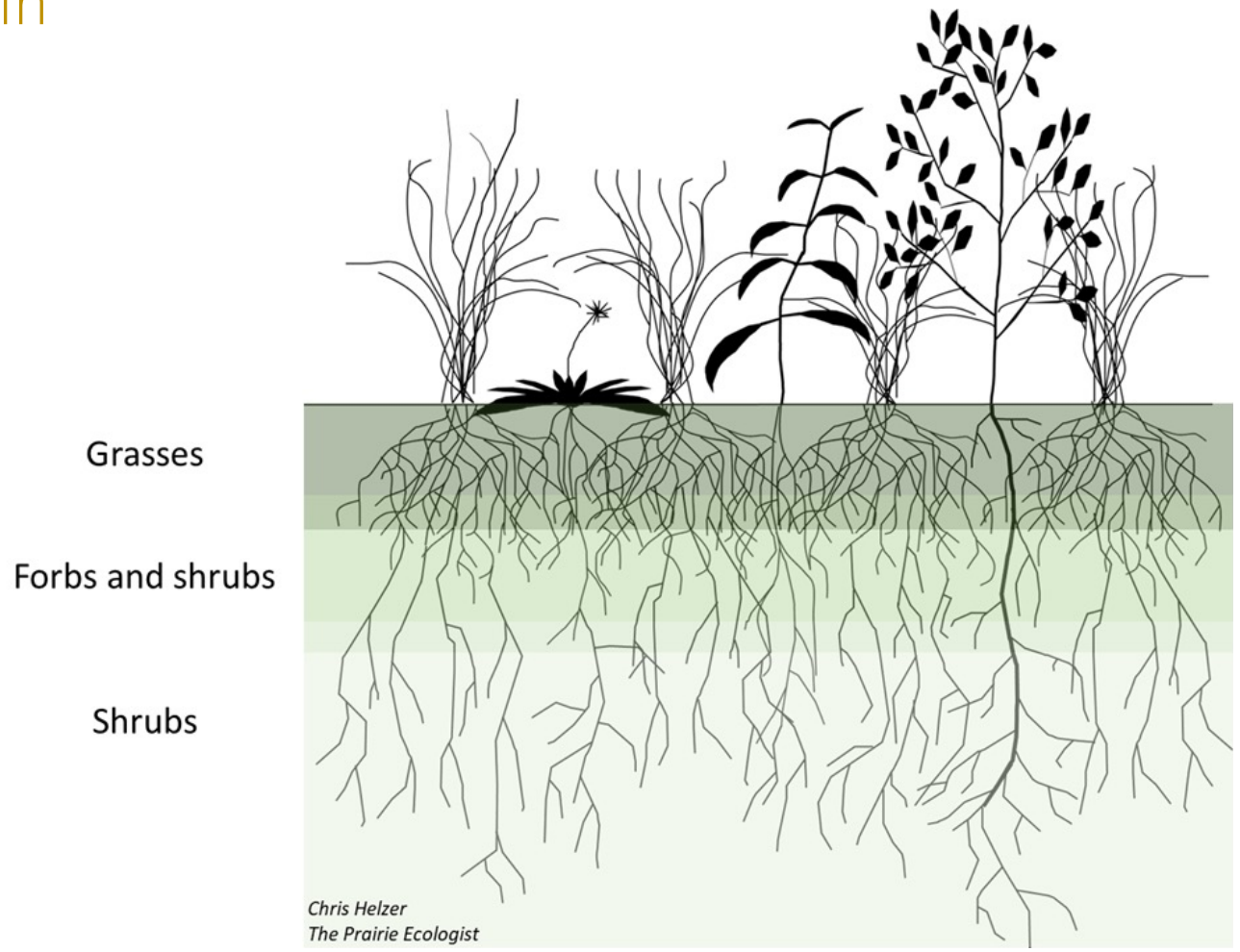

Root Systems of Prairie Plants
Conservation Research Institute
Heidi Natura 1995 ©
Feet
Feet
Kentucky Blue Grass Poa pratensis
Lead Plant Amorpha canescens
Missouri Goldenrod Solidago missouriensis
Indian Grass Sorghastrum nutans
Compass Plant Silphium laciniatum
Porcupine Grass Stipa spartea
Heath Aster Aster ericoides
Prairie Cord Grass Spartina pectinata
Big Blue Stem Andropogon gerardii
Pale Purple Coneflower Echinacea pallida
Prairie Dropseed Sporobolus heterolepis
Side Oats Gramma Bouteloua curtipendula
False Boneset Kuhnia eupatorioides
Switch Grass Panicum virgatum
White Wild Indigo Baptisia leucantha
Little Blue Stem Andropogon scoparius
Rosin Weed Silphium integrifolium
Purple Prairie Clover Petalostemum purpureum
June Grass Koeleria cristata
Cylindric Blazing Star Liatris cylindracea
Buffalo Grass Buchloe dactyloides

A Deep-Rooted Myth

Grasses dominate the uppermost zone of the soil profile with a dense mass of roots and rarely get water from greater depths.

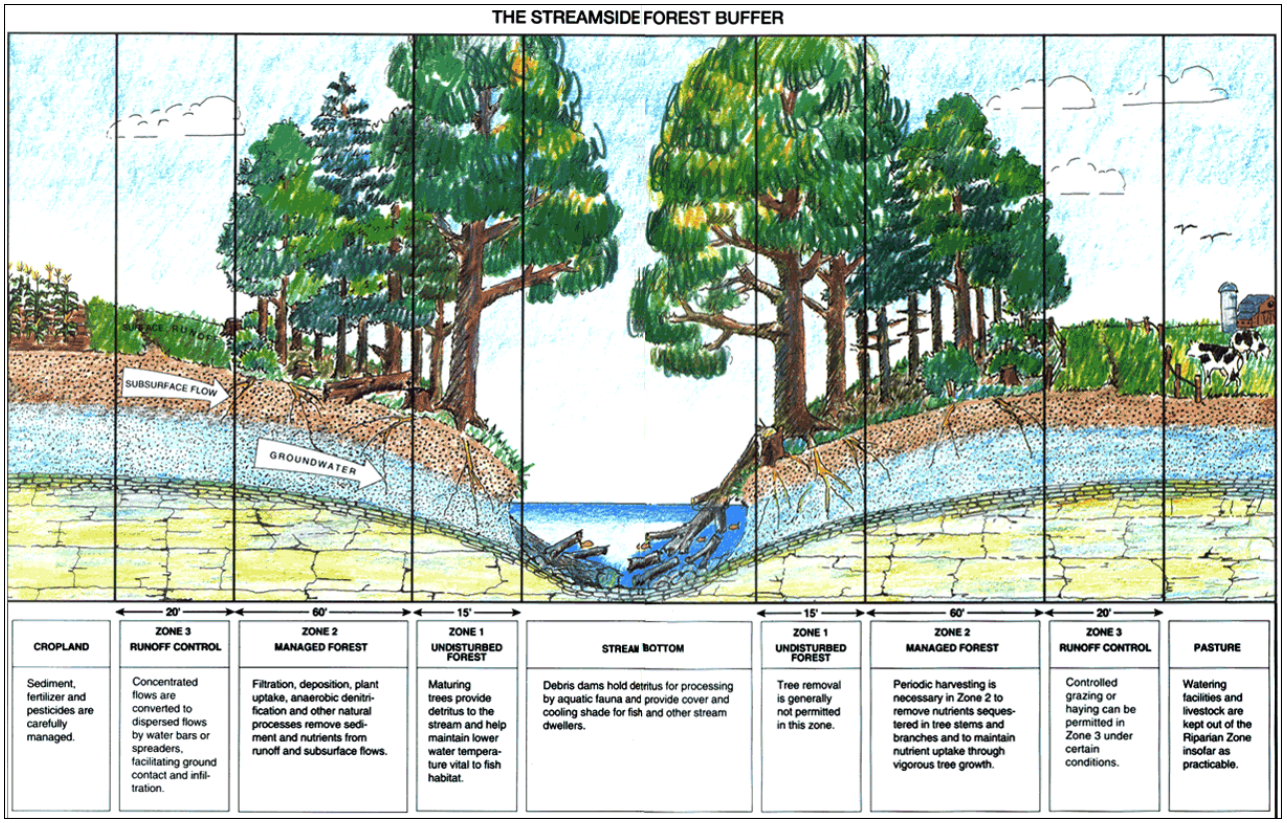
Forbs may pull water from near the surface when it is available, but usually get moisture from below the "grass zone," but still within the top 30 inches.

Shrubs can obtain water from any depth, but mainly get it from 18 inches and below – and down to deep as 8 to 10 feet or more.



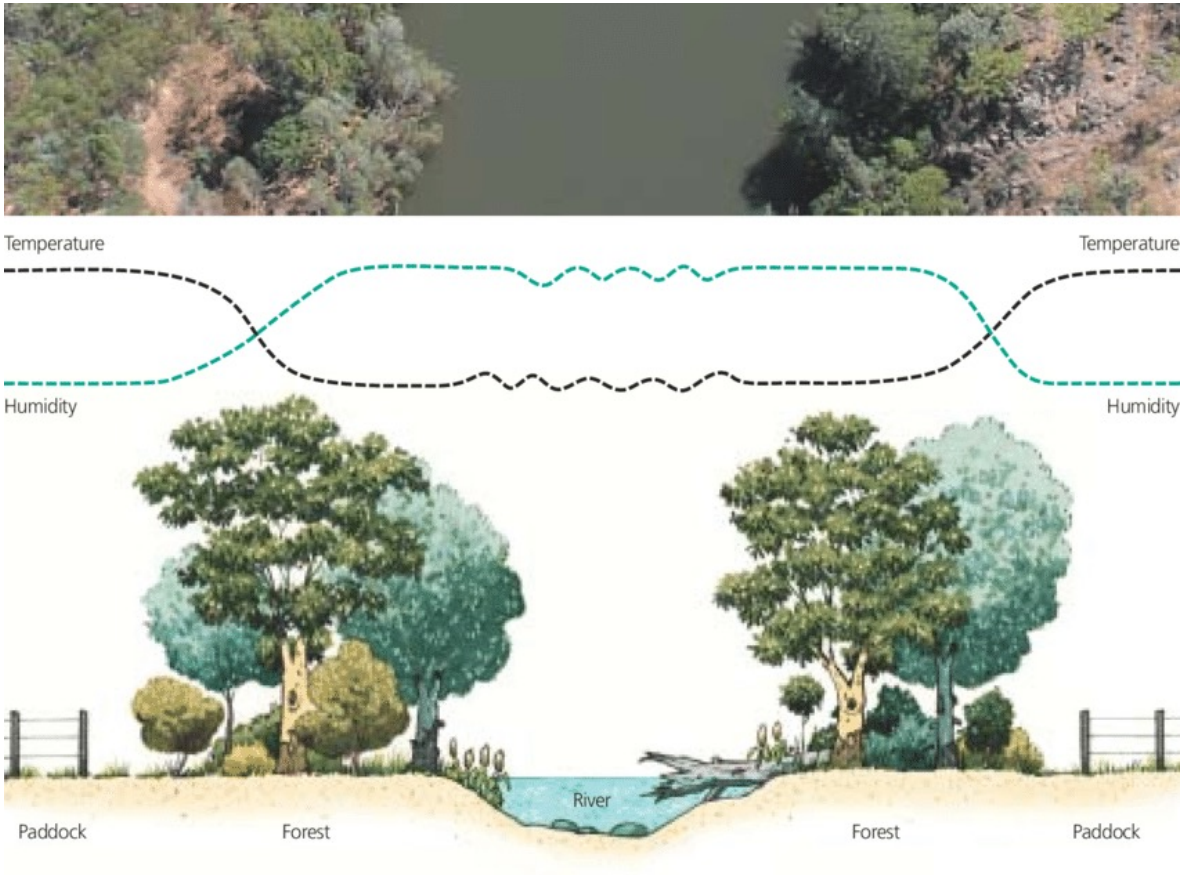
Helzer, Chris. "A Deep-Rooted Prairie Myth." The Prairie Ecologist. 2019, September 17. Web.

Design Precedents



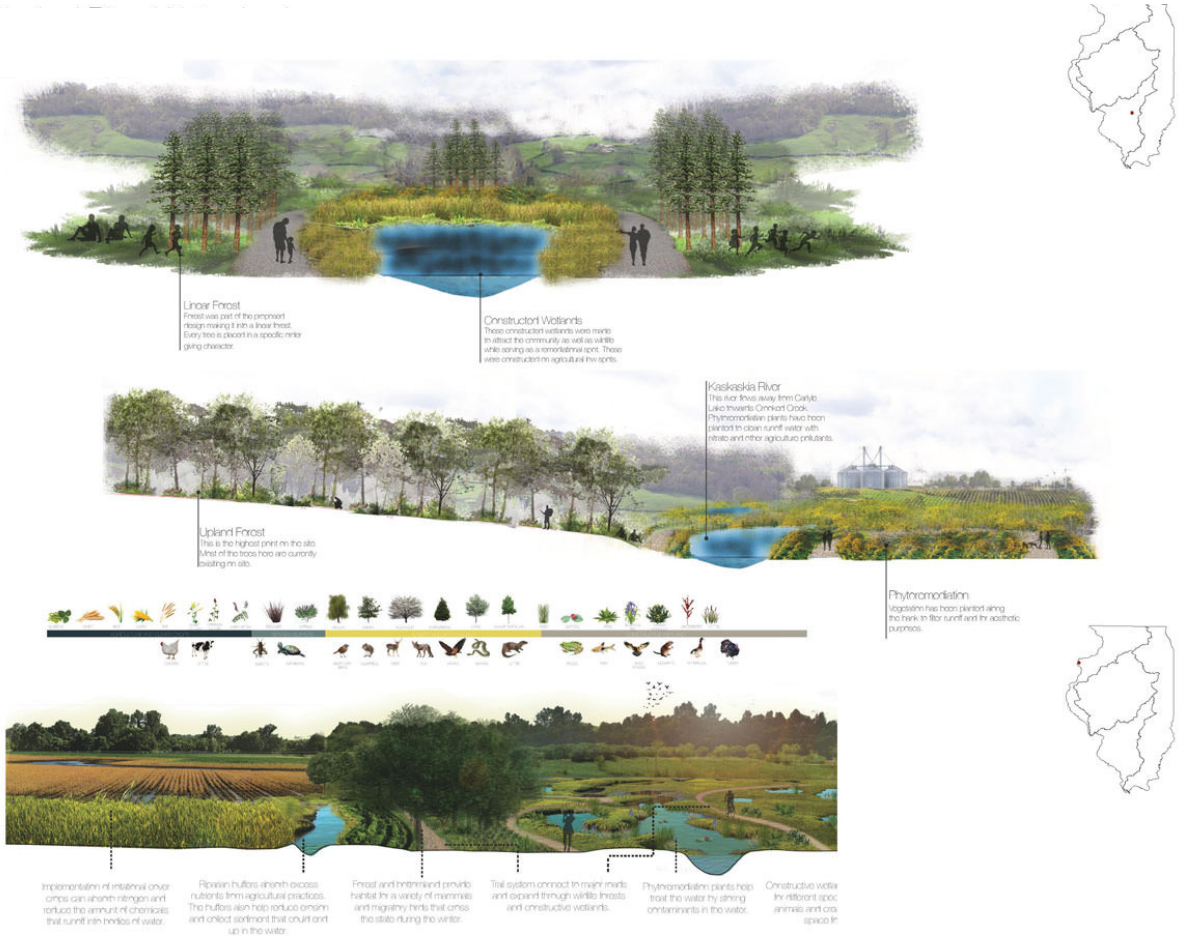
US Forest Service

Design Precedents



Source: Redrawn from Malanson (1993). Illustration Paul Lennon. Photo at top Ian Dixon.

Design Precedents



ASLA 2017 Student Awardees:
Dongqi Kim
Zihao Song
Emma Doyle
Wanhui Zuo
Wei Zing

A Bioregional Perspective

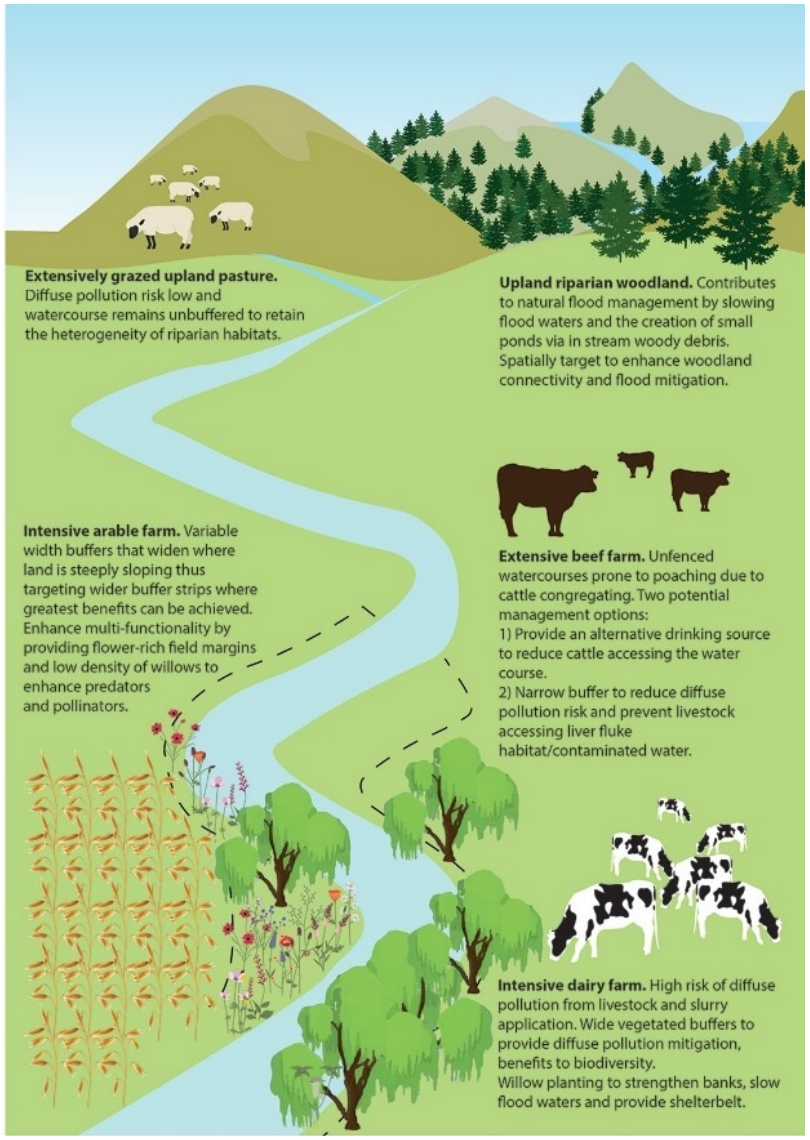
What we do upslope affects others downstream.

Watersheds offer the ideal organizing structure for ecological, social and economic resiliency.

Watersheds provide a level of organization for landscapes as well as communities, and a measure for understanding how natural hydrological patterns, such as flooding, are affected by development and land use decisions at the property, town and watershed scale.

Working together, across political and economic boundaries.

Organizing efforts to improve resiliency at the individual, municipal and regional scale.



A Framework for Resilience: Responding to Climate Change in the Deerfield River Watershed. FRCOG, 2019.

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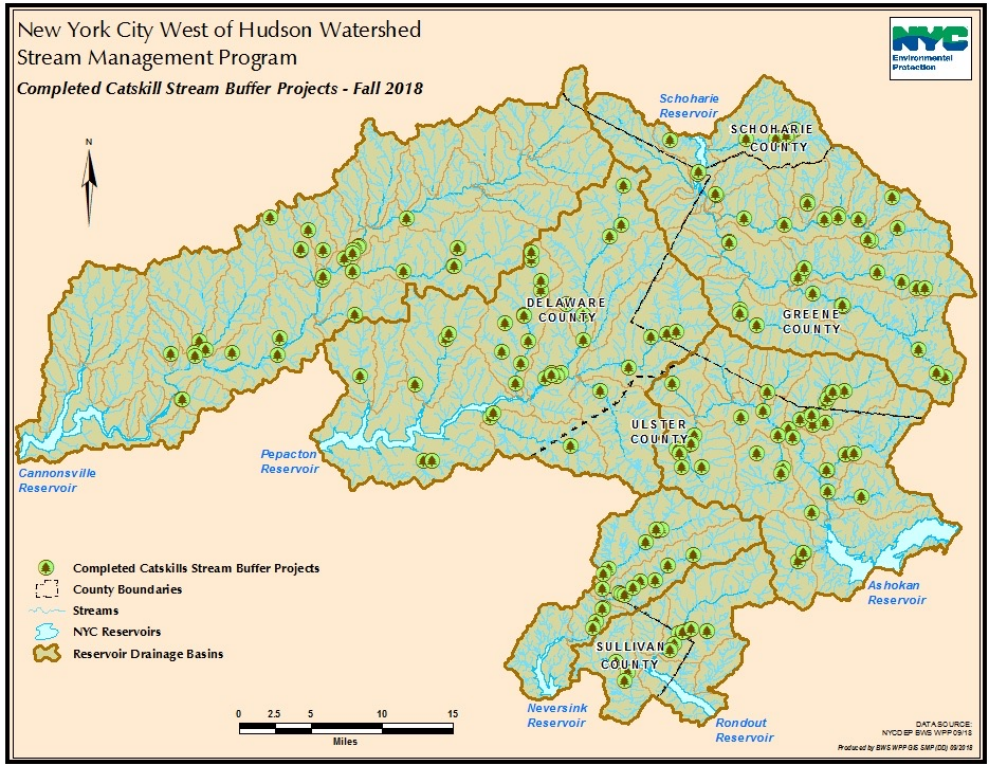
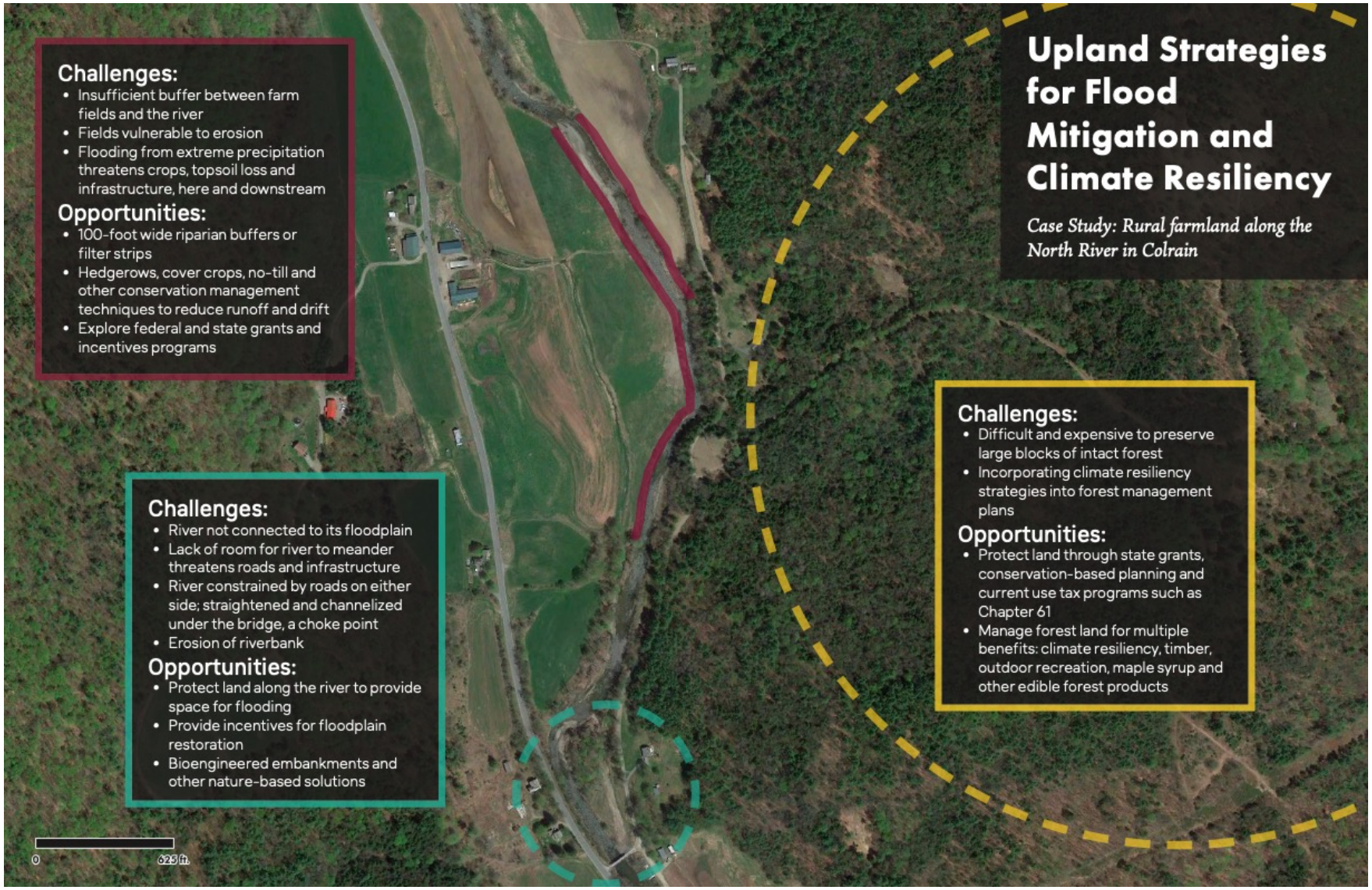
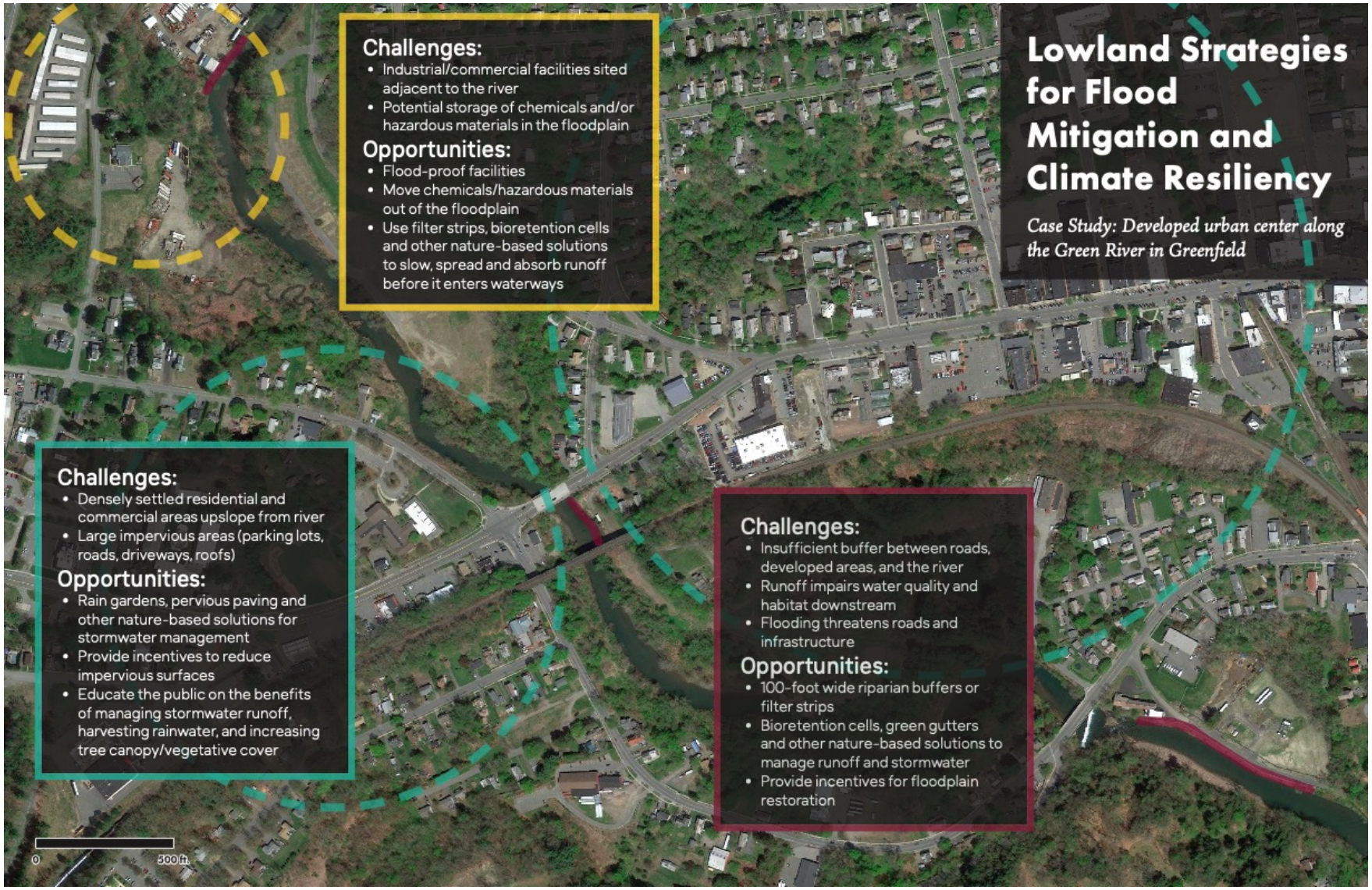


A Framework for Resilience: Responding to Climate Change in the Deerfield River Watershed. FRCOG, 2019.


Upland Strategies for Flood Mitigation and Climate Resiliency
Case Study: Rural farmland along the North River in Colrain
Challenges:
• Insufficient buffer between farm fields and the river
• Fields vulnerable to erosion
• Flooding from extreme precipitation threatens crops, topsoil loss and infrastructure, here and downstream
Opportunities:
• 100-foot wide riparian buffers or filter strips
• Hedgerows, cover crops, no-till and other conservation management techniques to reduce runoff and drift
• Explore federal and state grants and incentives programs
Challenges:
• River not connected to its floodplain
• Lack of room for river to meander threatens roads and infrastructure
• River constrained by roads on either side; straightened and channelized under the bridge, a choke point
• Erosion of riverbank
Opportunities:
• Protect land along the river to provide space for flooding
• Provide incentives for floodplain restoration
• Bioengineered embankments and other nature-based solutions
Challenges:
• Difficult and expensive to preserve large blocks of intact forest
• Incorporating climate resiliency strategies into forest management plans
Opportunities:
• Protect land through state grants, conservation-based planning and current use tax programs such as Chapter 61
• Manage forest land for multiple benefits: climate resiliency, timber, outdoor recreation, maple syrup and other edible forest products
0
623 ft.


Challenges:
• Industrial/commercial facilities sited adjacent to the river
• Potential storage of chemicals and/or hazardous materials in the floodplain
Opportunities:
• Flood-proof facilities
• Move chemicals/hazardous materials out of the floodplain
• Use filter strips, bioretention cells and other nature-based solutions to slow, spread and absorb runoff before it enters waterways
Lowland Strategies for Flood Mitigation and Climate Resiliency
Case Study: Developed urban center along the Green River in Greenfield
Challenges:
• Densely settled residential and commercial areas upslope from river
• Large impervious areas (parking lots, roads, driveways, roofs)
Opportunities:
• Rain gardens, pervious paving and other nature-based solutions for stormwater management
• Provide incentives to reduce impervious surfaces
• Educate the public on the benefits of managing stormwater runoff, harvesting rainwater, and increasing tree canopy/vegetative cover
Challenges:
• Insufficient buffer between roads, developed areas, and the river
• Runoff impairs water quality and habitat downstream
• Flooding threatens roads and infrastructure
Opportunities:
• 100-foot wide riparian buffers or filter strips
• Bioretention cells, green gutters and other nature-based solutions to manage runoff and stormwater
• Provide incentives for floodplain restoration
0
500 ft

2: Design

Project context

Pollinators and plants

Site context

Site analysis

Design

Zones of habitat

Site preparation, installation and maintenance

Photo: Vals Osborne

Pollinate Now

BIOREGIONAL STRATEGY FOR HABITAT RESTORATION IN THE HUDSON RIVER ESTUARY WATERSHED

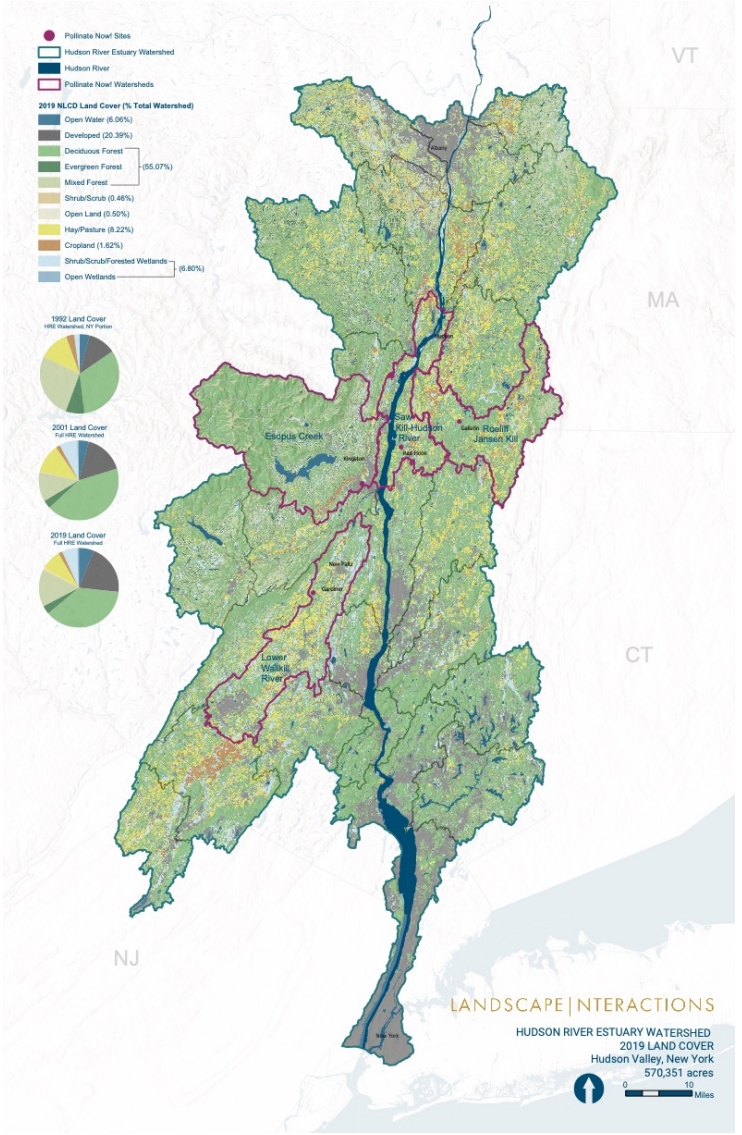
Landscape Interactions in collaboration with Partners for Climate Action Hudson Valley, a local non-profit.

Regional pollinator action plan as well as four site-specific landscape designs, all created specifically to target native pollinators in decline.

The recent Empire State Native Pollinator Survey found **24% of native bee species surveyed to be at risk and 11% extirpated, as well as between 38% and 60% of native bees, flies, beetles and moths**.

Over 50 towns and cities involved, including Kingston, Hudson, Red Hook and New Paltz.

In terms of land area and population size, likely the largest pollinator corridor project in the United States.



Pollinate Now

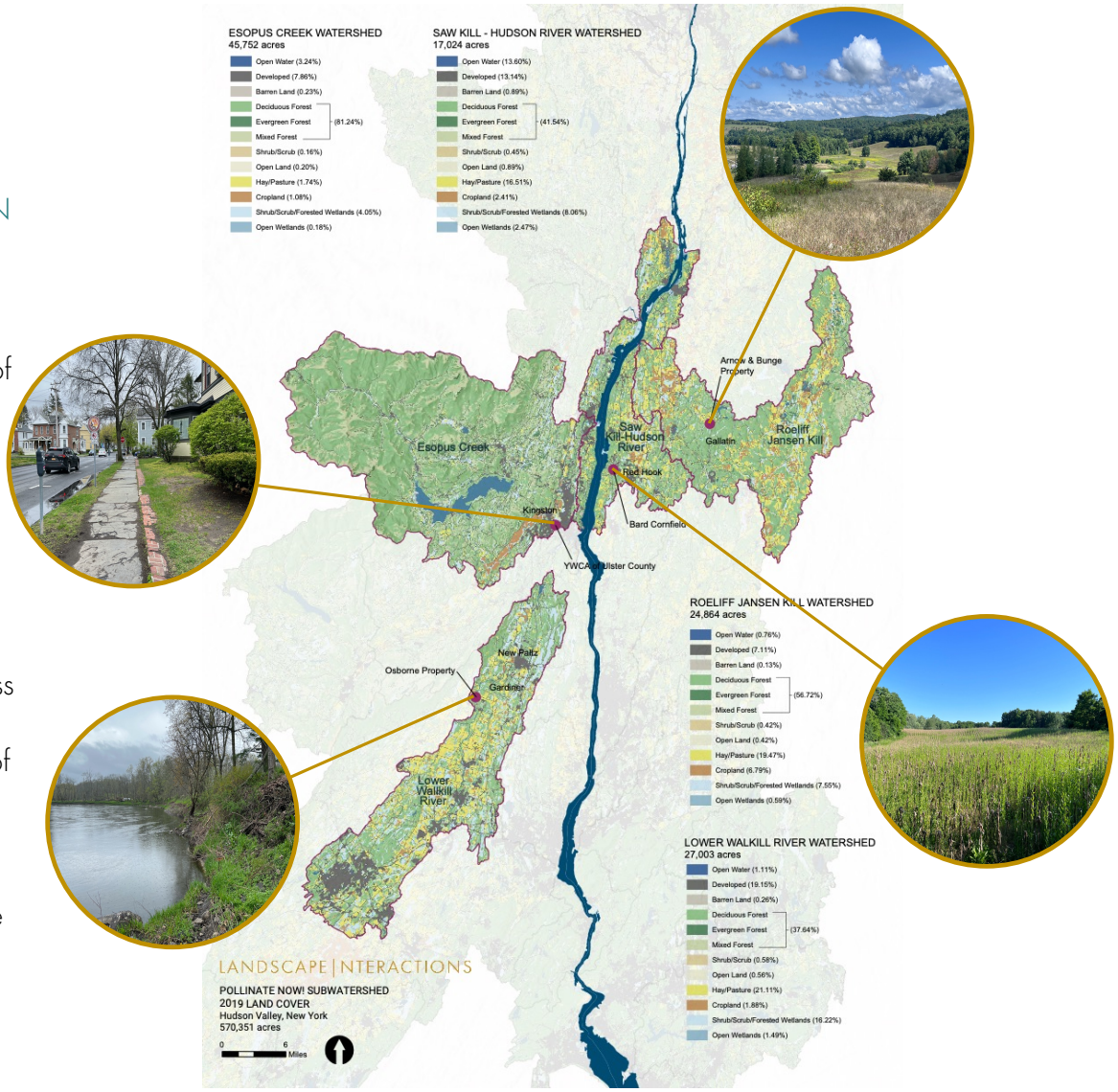
BIOREGIONAL STRATEGY FOR HABITAT RESTORATION IN THE HUDSON RIVER ESTUARY WATERSHED

Four case study sites across four HUC-10 subwatersheds of the Hudson River, representing common landscape typologies found in the Mid-Hudson region: farmland, conservation land, urban-residential and riparian.

Each case study site design created to be scalable and replicable on other similar sites across the region.

All sites surveyed for native bee and butterfly species across the 2022 growing season; follow-up surveys will occur to compare differences two years following implementation of the site designs and management plans.

All landscape designs, plant lists, seed mixes, landscape establishment and management guidelines will be scalable and replicable on other similar sites across the watershed and beyond.



Pollinate Now

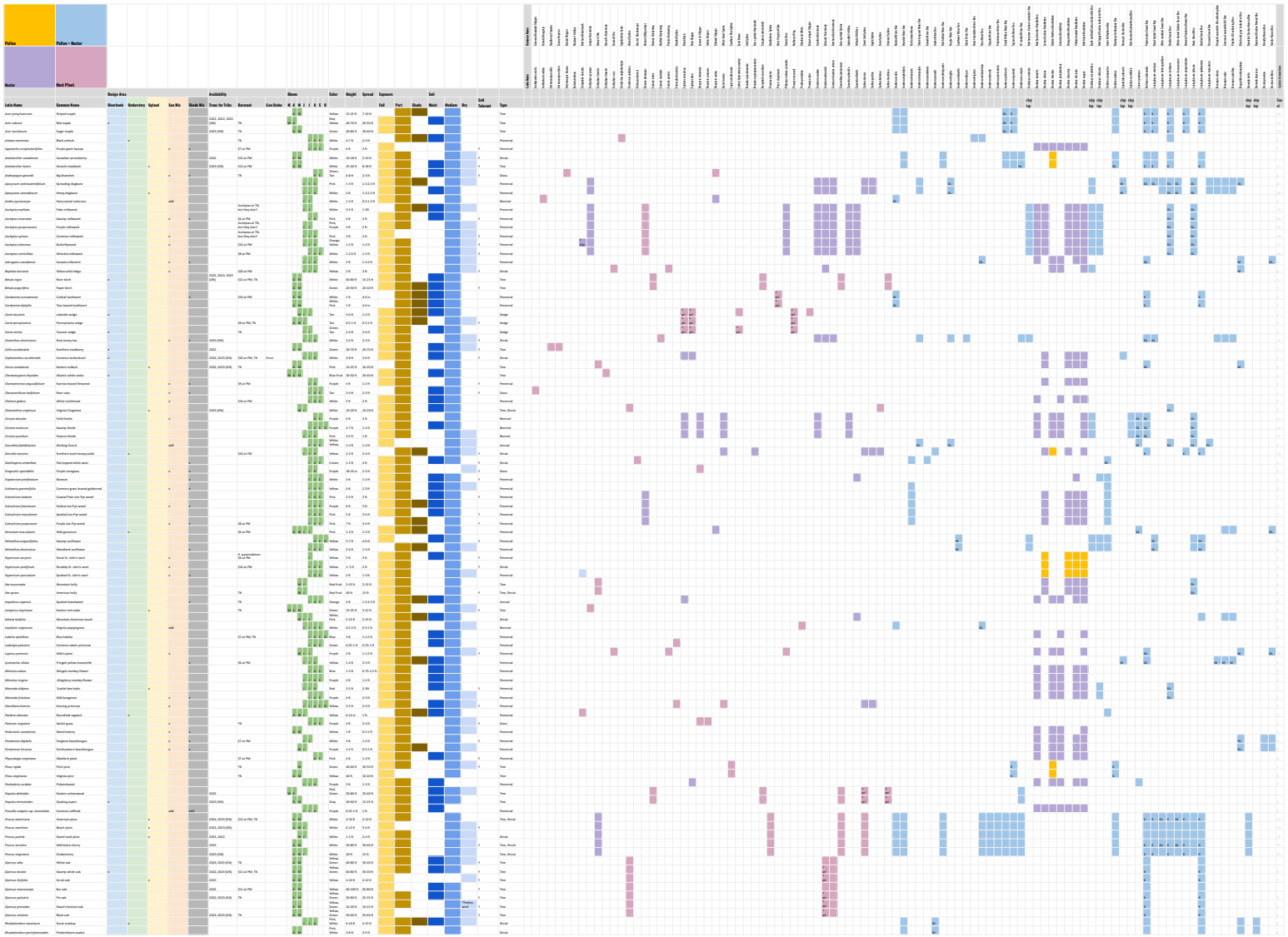
BIOREGIONAL STRATEGY FOR HABITAT RESTORATION IN THE HUDSON RIVER ESTUARY WATERSHED

Target species for the project include all genera of native bee, butterfly and flower-visiting moths that are at risk of local extinction from the Hudson Valley region.

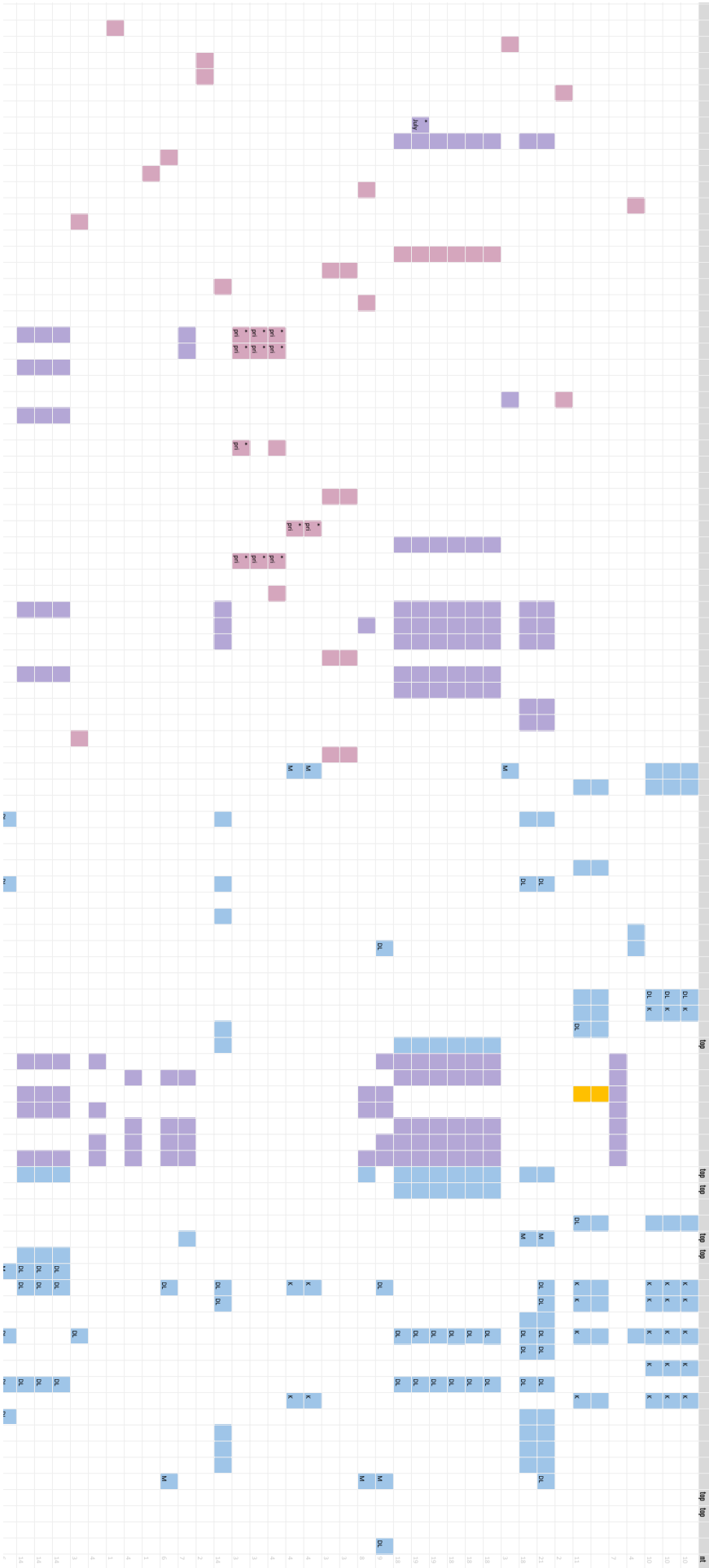
Historical records (pre-2000) for all NY counties within or adjacent to the Hudson River Estuary Watershed compared to contemporary records (2000 to present), including the 2022 Empire State Native Pollinator Survey.

Target species include 49 bees, 31 butterflies and 13 moths.

Comprehensive plant list for the project for all major landscape typologies, including host plants, pollen and nectar plants that support the widest network of species interactions and every individual species' life cycle needs.

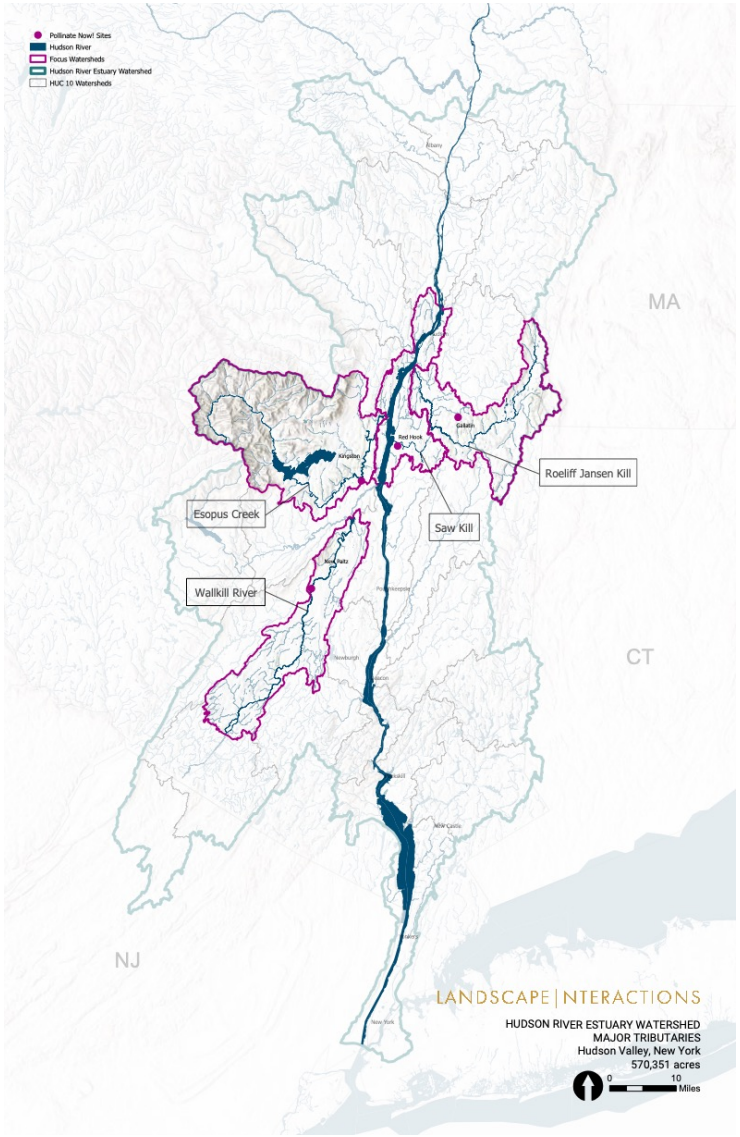

Pollen
Pollen + Nectar
Nectar
Host Plant

		Design Area					Availability			Bloom								Color	Height	Spread	Exposure			Soil				
Latin Name	Common Name	Riverbank	Understory	Upland	Sun Mix	Shade Mix	Trees for Tribs	Bareroot	Live Stake	M	A	M	J	J	A	S	O				Full	Part	Shade	Moist	Medium	Dry	Salt Tolerant	Type
Acer pensylvanicum	Striped maple										A	M						Yellow	15-25 ft	7-10 ft								Tree
Acer rubrum	Red maple	x					2023, 2022, 2023 (ON)	TN		M	A							Red, Yellow	40-70 ft	20-50 ft								Tree
Acer saccharum	Sugar maple						2023 (ON)	TN			A	M						Green	40-80 ft	30-60 ft								Tree
Actaea racemosa	Black cohosh		x					TN					J	A	S			White	4-7 ft	2-3 ft								Perennial
Agastache scrophulariifolia	Purple giant-hyssop				x	x		$7 at PM					J	A	S			Purple	6 ft	2 ft							Y	Perennial
Amelanchier canadensis	Canadian serviceberry						2022	$12 at PM			A	M						White	10-18 ft	5-10 ft							Y	Shrub
Amelanchier laevis	Smooth shadbush			x			2023 (ON)	$12 at PM			A	M						White	25-40 ft	8-18 ft							Y	Tree
Andropogon gerardii	Big bluestem				x	x		TN							A	S		Green, Tan	6-8 ft	2-3 ft							Y	Grass
Apocynum androsaemifolium	Spreading dogbane												J	J	A			Pink	1-3 ft	1.5-2.5 ft								Perennial
Apocynum cannabinum	Hemp dogbane			x									J	J	A			White	4 ft	1.5-2.5 ft								Perennial
Arabis pycnocarpa	Hairy-eared rockcress				add								J	J				White	1-3 ft	0.5-1.5 ft								Biennial
Asclepias exaltata	Poke milkweed							Asclepias at TN, but they don't					J	J				White	3-5 ft	1-3ft								Perennial
Asclepias incarnata	Swamp milkweed				x	x		$6 at PM						J	A			Pink	4 ft	2 ft							Y	Perennial
Asclepias purpurascens	Purple milkweed							Asclepias at TN, but they don't					J	J				Pink, Purple	3 ft	2 ft								Perennial
Asclepias syriaca	Common milkweed				x			Asclepias at TN, but they don't					J	J	A			Pink	3 ft	2 ft							Y	Perennial
Asclepias tuberosa	Butterflyweed				x			$10 at PM					J	J	A			Orange, Yellow	1-2 ft	1-2 ft							Y	Perennial
Asclepias verticillata	Whorled milkweed							$8 at PM						J	A	S		White	1-2.5 ft	1-2 ft							Y	Perennial
Astragalus canadensis	Canada milkvetch				x	x							J	J	A			White	3 ft	1.5-2 ft								Perennial
Baptisia tinctoria	Yellow wild indigo				x			$20 at PM					J	J	A			Yellow	3 ft	3 ft							Y	Shrub
Betula nigra	River birch	x					2023, 2022; 2023 (ON)	$12 at PM; TN			A	M						White	60-80 ft	15-25 ft								Tree
Betula papyrifera	Paper birch										A	M						Green	20-50 ft	20-40 ft							Y	Tree
Cardamine concatenata	Cutleaf toothwort					x		$10 at PM			A	M						White	1 ft	4-6 in								Perennial
Cardamine diphylla	Two-leaved toothwort										A	M						White, Pink	1 ft	4-6 in								Perennial
Carex lacustris	Lakeside sedge	x										M	J	J				Tan	3-6 ft	1-2 ft								Sedge
Carex pensylvanica	Pennsylvania sedge							$8 at PM; TN			A	M	J					Tan	0.5-1 ft	0.5-1 ft							Y	Sedge
Carex stricta	Tussock sedge	x						TN					J	J				Green, Tan	3-4 ft	3-4 ft								Sedge
Ceanothus americanus	New Jersey tea				x	x	2023 (ON)						J	J	A			White	3-4 ft	2-3 ft							Y	Shrub
Celtis occidentalis	Northern hackberry	x					2022				A	M						Green	30-70 ft	20-70 ft							Y	Tree
Cephalanthus occidentalis	Common buttonbush	x					2022; 2023 (ON)	$20 at PM; TN	Ernst				J	J	A			White	3-8 ft	3-6 ft							Y	Shrub
Cercis canadensis	Eastern redbud			x			2022; 2023 (ON)	TN			A	M						Pink	12-25 ft	10-20 ft								Tree
Chamaecyparis thyoides	Atlantic white cedar	x								M	A	M						Blue Fruit	30-50 ft	30-40 ft								Tree
Chamaenerion angustifolium	Narrow-leaved fireweed				x	x		$9 at PM						J	A			Purple	4 ft	1-2 ft							Y	Perennial
Chasmanthium latifolium	River oats				x	x								J	A	S		Tan	3-4 ft	2-3 ft							Y	Grass

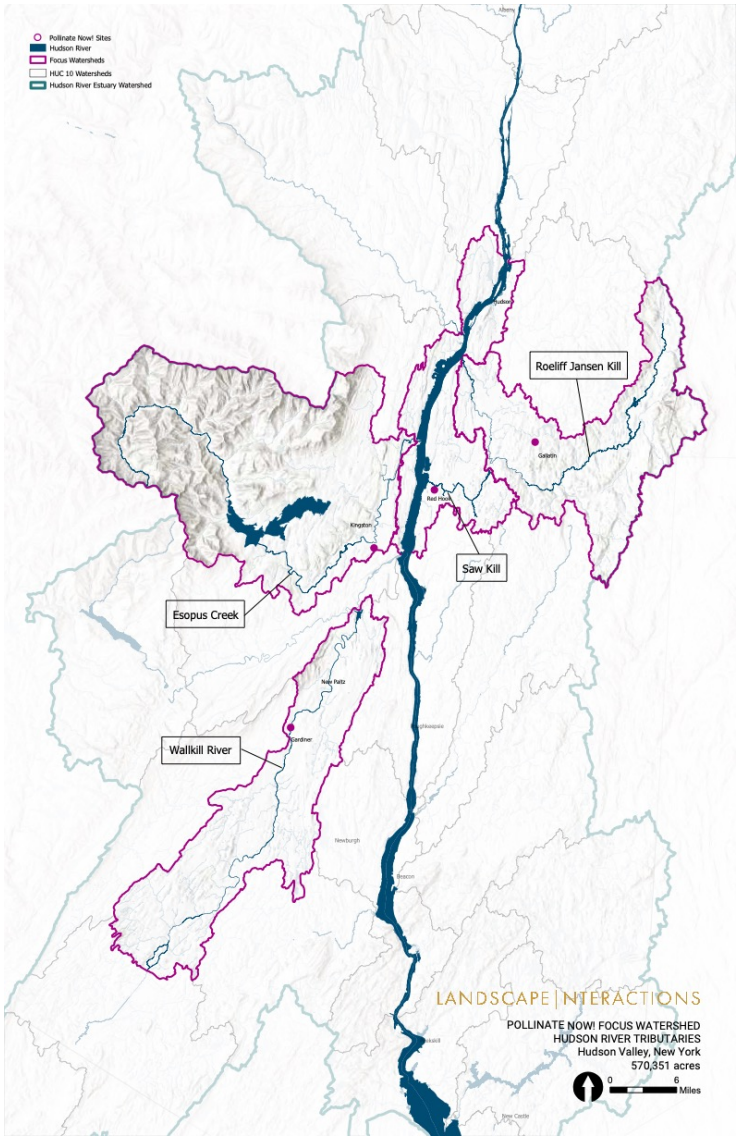


Latin Name	Common Name
Amblyscirtes vialis	Common Roadside-Skipper
Anthocharis midea	Falcate Orangetip
Asterocampa celtis	Hackberry Emperor
Asterocampa clyton	Tawny Emperor
Atrytonopsis hianna	Dusted Skipper
Boloria bellona	Meadow Fritillary
Calephelis borealis	Northern Metalmark
Callophrys gryneus	Juniper Hairstreak
Callophrys henrici	Henry's Elfin
Callophrys hesseli	Hesselʼs Hairstreak
Callophrys irus	Frosted Elfin
Celastrina neglectamajor	Appalachian Azure
Ceratomia undulosa	Waved Sphinx
Chlosyne harrisii	Harrisʼ Checkerspot
Danaus plexippus	Monarch (Migratory)
Erynnis icelus	Dreamy Duskywing
Erynnis martialis	Mottled Duskywing
Erynnis persius	Persius Duskywing
Eumorpha fasciatus	Banded Sphinx
Euphyes conspicua	Black Dash
Euphyes dion	Dion Skipper
Hesperia leonardus	Leonardʼs Skipper
Hesperia sassacus	Indian Skipper
Hesperia metea	Cobweb Skipper
Hyles lineata	White-lined Sphinx
Lapara coniferarum	Southern Pine Sphinx
Lethe [Satyrodes] eurydice	Eyed Brown
Manduca jasminearum	Ash Sphinx
Manduca quinquemaculata	Five-spotted Hawkmoth
Nymphalis vau-album	Compton tortoiseshell
Paonias astylus	Hackleberry Sphinx
Pieris virginiensis	West Virginia White
Plebejus melissa samuelis	Karner Blue
Proanes massasoit	Mulberry Wing
Pontia protodice	Checkered White
Proanes viator	Broad-winged Skipper
Satyrium acadica	Acadian Hairstreak
Satyrium edwardsii	Edwardsʼ Hairstreak
Satyrium favonius ontario	Northern Oak Hairstreak
Smerinthus jamaicensis	Twin-spotted Sphinx
Speyeria aphrodite	Aphrodite Fritillary
Speyeria atlantis	Atlantis Fritillary
Sphinx chersis	Great Ash Sphinx
Sphinx gordius	Apple Sphinx
Sphinx kalmiae	Faun Sphinx
Sphinx luscitiosa	Clemensʼ Sphinx
Andrena arabis	Mustard Miner Bee
Andrena barbilabris	Bearded Miner Bee
Andrena bruccata	No Common Name
Andrena brevipalpis	Short-tongued Miner Bee
Andrena canadensis	Canada Miner Bee
Andrena cornelli	Azalea Miner Bee
Andrena erythrogaster	Red-bellied Miner Bee
Andrena fragilis	Fragile Miner Bee
Andrena helianthi	Sunflower Miner Bee
Andrena integra	Intact Miner Bee
Andrena krigiana	Dwarf-dandelion Miner Bee
Andrena melanochroa	Rose Miner Bee
Andrena miranda	Singular Miner Bee
Andrena persimulata	Protuberance Miner Bee
Andrena salicaria	Small Willow Miner Bee
Andrena sigmundi	Sigmundʼs Miner Bee
Andrena w-scripta	W-marked Miner Bee
Coelioxys modesta	Northeastern Cuckoo Leafcutter Bee
Bombus borealis	Northern Amber Bumble Bee
Bombus citrinus	Lemon Cuckoo Bumblebee
Bombus fervidus	Golden Northern Bumblebee
Bombus pensylvanicus	American Bumblebee
Bombus ternarius	Orange-belted Bumblebee
Bombus terricola	Yellow-banded Bumblebee
Bombus vagans	Half-black Bumblebee
Coelioxys octodentata	Eight-toothed Cuckoo Leafcutter Bee
Coelioxys rufitarsis	Red-legged Cuckoo Leafcutter Bee
Colletes compactus	Aster Cellophane Bee
Colletes validus	Blueberry Cellophane Bee
Epeoloides pilosula	Macropis Cuckoo Bee
Epeolus scutellaris	Red-chested Cuckoo Nomad Bee
Eucera pruinosa	
Halictus rubicundus	Polymorphic Sweat Bee
Lasioglossum cinctipes	Band-footed Sweat Bee
Lasioglossum heterognathum	Wide-mouthed Sweat Bee
Lasioglossum imitatum	Bristle Sweat Bee
Lasioglossum leucocomum	White-haired Golden Sweat Bee
Lasioglossum perpunctatum	Densely Punctured Sweat Bee
Lasioglossum pilosum	Hairy Sweat Bee
Lasioglossum quebecense	Quebec Sweat Bee
Lasioglossum truncatum	Truncate Sweat Bee
Macropis ciliata	Fringed Loosestrife Oil-collecting Bee
Macropis nuda	Common Loosestrife Oil Bee
Macropis patellata	Patellar Oil-collecting Bee
Megachile melanophaea	Black-and-gray Leafcutter Bee
Nomada bella	Beautiful Cuckoo Nomad Bee
Nomada depressa	Depressed Cuckoo Nomad Bee
Osmia proxima	Friendly Mason Bee
Osmia simillima	Similar Mason Bee
Species Connections	

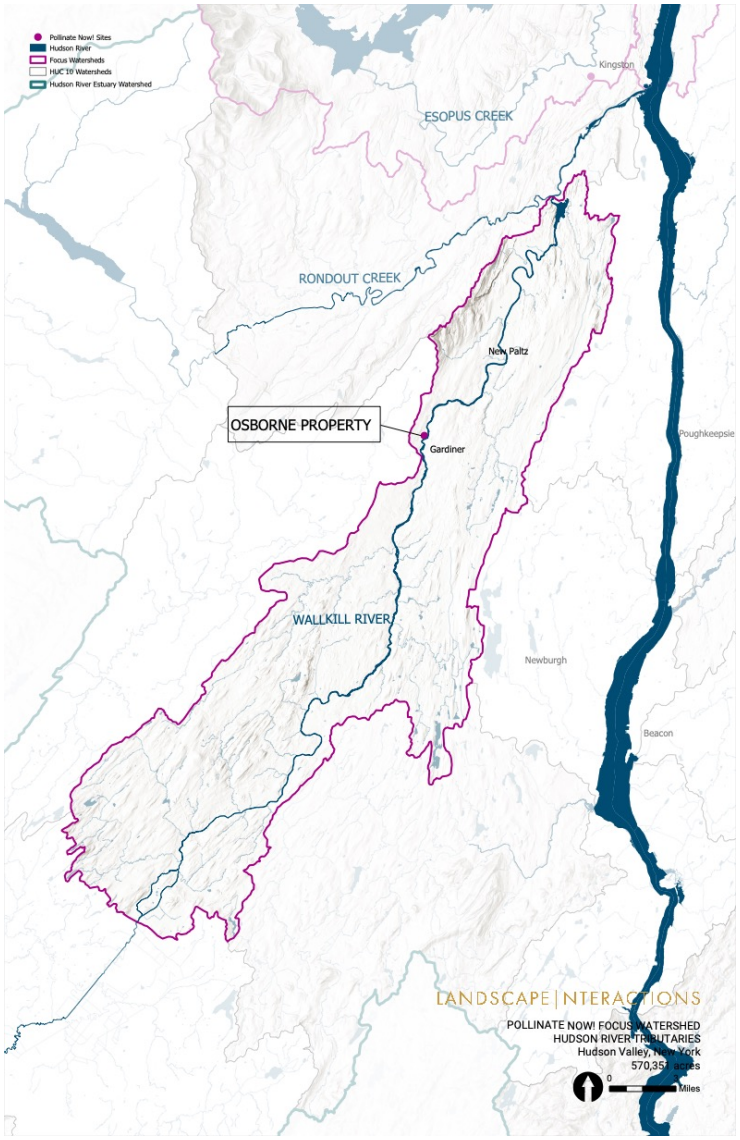
Site Context

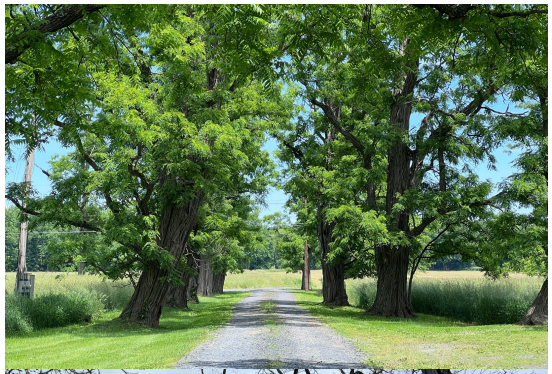


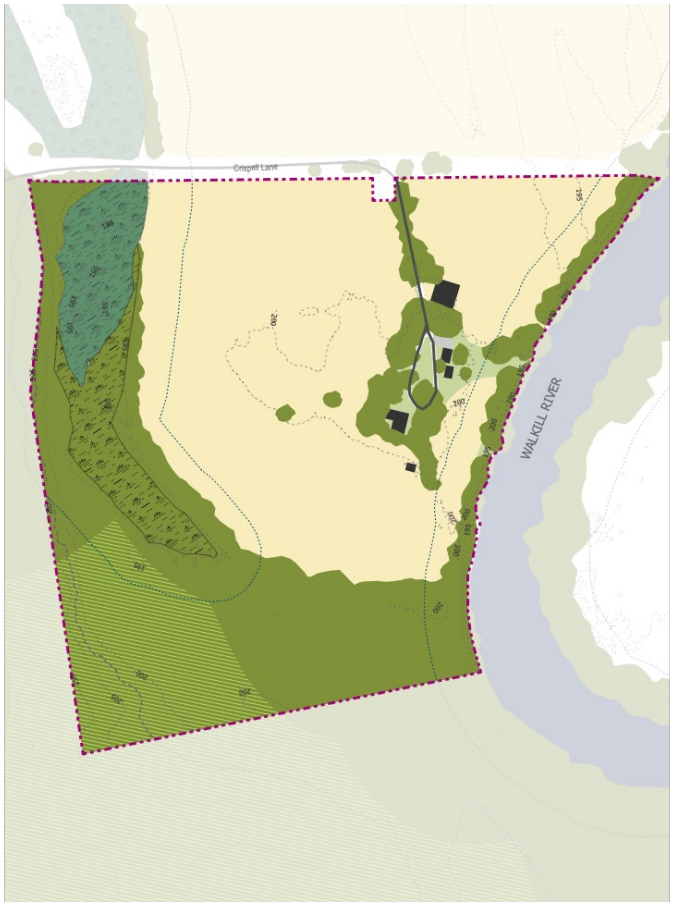
Site Context



Site Context







Osborne Property Boundary
Contour (5ft)
Roads
Buildings
Tree Canopy
Parking Area
Grass
Hayfield
Shrub Swamp
Forested Wetland
Habitat Core
Open Water
Wetland Buffer (100ft)
Flood Zone (100-year)

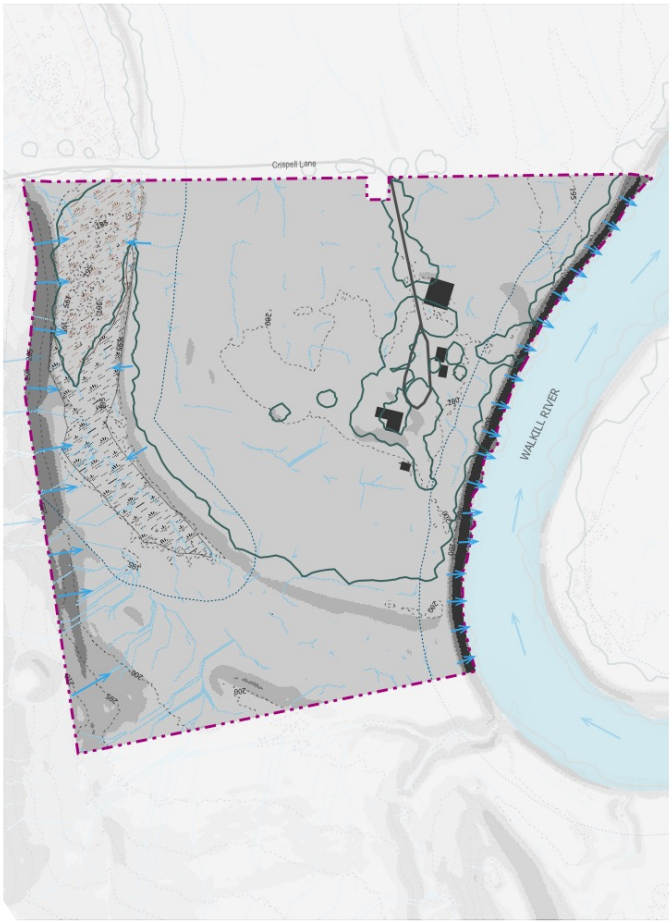
LANDSCAPE | NTERACTIONS

OSBORNE PROPERTY BASEMAP

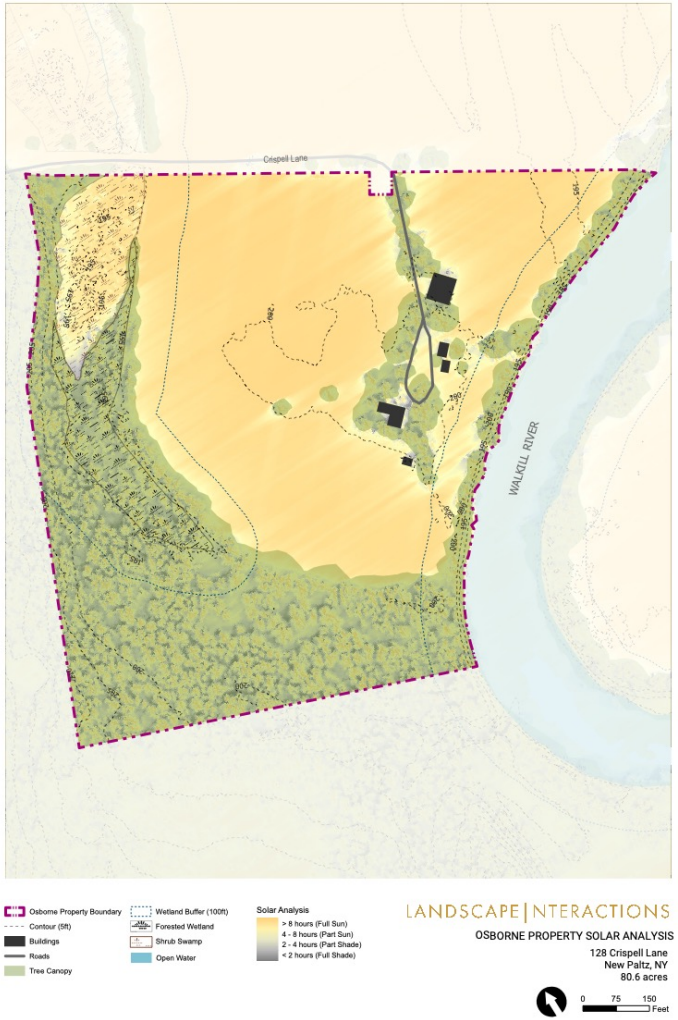
128 Crispell Lane
New Paltz, NY
80.6 acres

0 75 150
Feet

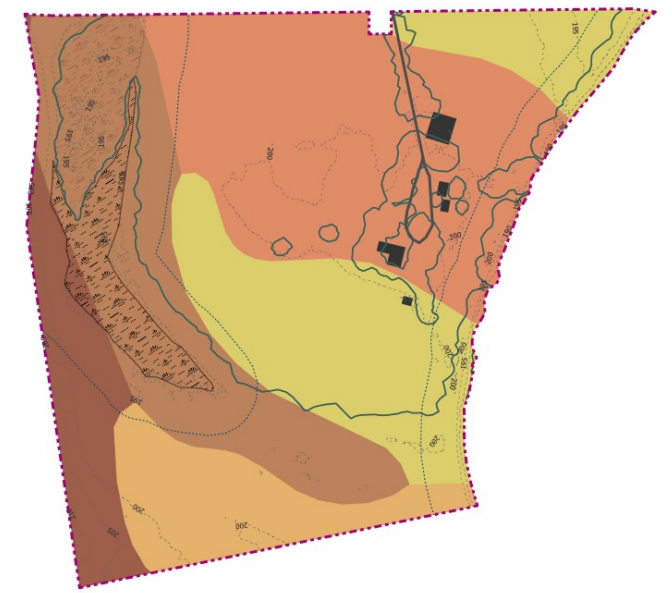
Slopes + Drainage



Sun + Shade


Crispell Lane
WALKILL RIVER
Osborne Property Boundary
Contour (5ft)
Buildings
Roads
Tree Canopy
Wetland Buffer (100ft)
Forested Wetland
Shrub Swamp
Open Water
Solar Analysis
> 8 hours (Full Sun)
4 - 8 hours (Part Sun)
2 - 4 hours (Part Shade)
< 2 hours (Full Shade)
LANDSCAPE | INTERACTIONS
OSBORNE PROPERTY SOLAR ANALYSIS
128 Crispell Lane
New Paltz, NY
80.6 acres
0
75
150
Feet

Soils



Bath and Mardin soils (0.4; 0.5%)
Very deep, moderately well drained soils on glaciated uplands, mostly on broad hilltops, shoulder slopes and backslopes.
Depth to water table: About 13 to 24 inches

Churchville silt loam (2.6; 3.2%)
Very deep, somewhat poorly drained soils that formed in clayey lacustrine sediments overlying loamy till.
Depth to water table: About 6 to 18 inches

Hamlin silt loam (48.7; 60.4%)
Very deep, well drained soils formed in alluvium on flood plains and high bottoms. Permeability is moderate in the solum and substratum.
Depth to water table: More than 80 inches

Wayland mucky silt loam (8.1; 10.0%)
Very deep, poorly drained and very poorly drained, nearly level soils formed in recent alluvium. These soils are in low areas or slackwater areas on flood plains.
Depth to water table: More than 80 inches

Haven loam (12.5; 15.5%)
Very deep, well drained soils formed in loamy over sandy and gravelly outwash. They are nearly level through moderately sloping soils on outwash plains, valley trains, terraces, and water-sorted moraine deposits.
Depth to water table: More than 80 inches

Mardin-Nassau complex (2.3; 2.8%)
The Mardin series consists of very deep, moderately well drained soils on glaciated uplands, mostly on broad hilltops, shoulder slopes and backslopes. These soils formed in loamy till, and have a dense fragipan that starts at a depth of 36 to 66 cm (14 to 26 in) below the soil surface.
The Nassau series consists of shallow, somewhat excessively drained soils formed in channery till derived from acid shale and slate. They are nearly level to very steep soils that overlie shale bedrock at depths of 25 to 50 cm. They are found on summits, shoulders, and backslopes of ridges and hills on glaciated uplands.
Depth to water table: About 13 to 24 inches

Teel silt loam (1.4; 1.8%)
Very deep, moderately well drained soils on flood-plains. They formed in nearly level, silty alluvial deposits. Permeability is moderate throughout the solum.
Depth to water table: About 18 to 24 inches

Unadilla silt loam (1.7; 2.2%)
Deep and very deep, well drained soils formed in silty, lacustrine sediments or old alluvial deposits. These soils are on valley terraces and lacustrine plains.
Depth to water table: More than 80 inches

Wayland soils complex (2.9; 3.6%)
Very deep, poorly drained and very poorly drained, nearly level soils formed in recent alluvium. These soils are in low areas or slackwater areas on flood plains.
Depth to water table: About 0 to 6 inches

Osborne Property Boundary
Contour (5ft)
Shrub Swamp
Forested Wetland
Hydrology Buffer (100ft)
Flood Zone (100-year)

LANDSCAPE | NTERACTIONS

OSBORNE PROPERTY ORTHO BASEMAP
128 Crispell Lane
Gardiner, NY
80.6 acres

0 75 150 Feet

VEGETATION ANALYSIS
OSBORNE PROPERTY

Site Summary:

This 80-acre property in Gardiner, New York features a historic farmhouse surrounded by hayfields and three-quarters of a mile of frontage along the Wallkill River. The hayfields are homogenous, dominated almost exclusively by non-native cool season grasses.

Bordered by forest and wetlands to the west and the south, the site is highly susceptible to flooding, with nearly all of the property within the 100-year flood zone, widely considered to be a 10-year flood zone according to contemporary climate projections. The riverbank showed extensive signs of erosion and land loss, as well as the presence of numerous invasive plant species due to its highly disturbed nature.

A Lining both sides of the driveway is a historic allée of mature Robinia pseudoacacia (Black Locust) trees, including one mature Platanus sp. (Sycamore) and a Juglans nigra (Black Walnut). Closer to the house, several large non-native Syringa vulgaris (Common Lilac) are present, as well as a tree Cornus sp. (Dogwood) of unknown status, and a large dying Juniperus virginiana (Eastern Red Cedar).

B The gardens near the house feature approximately four Hydrangea sp. (Hydrangea), an apple tree, and Physocarpus opulifolius (Ninebark). Tree species behind the guest house to the east of the main house include an apple tree, a Juglans nigra (Black Walnut) and Magnolia sp. (Magnolia). There is Artemisia vulgaris (Mugwort) at the edge of the hayfield at the end of the driveway.

C The hayfields on the site are relatively consistent, dominated by cool-season non-native grasses Dactylis glomerata (Orchard Grass) and Anthoxanthum odoratum (Sweet Vernal Grass) as well as non-native Trifolium pratense (White Clover) and Trifolium repens (Red Clover). Invasive Galium album (Hedge Bedstraw) was present at about 5% cover.

D Approaching the river from the hayfield, the vegetation becomes more complex and hosts more native species. Species in this area included native Dioscorea villosa (Wild Yam), Persicaria virginiana (Jumpseed) and Monarda sp. (Wild Bergamot). Non-native species included the weedy Galium album (Hedge Bedstraw) as well as invasive Rosa multiflora (Multiflora Rose), Artemisia vulgaris (Mugwort) and Elaeagnus umbellata (Autumn Olive).

The area immediately adjacent to the steeply sloping riverbank is under canopy cover, lined mostly with native trees including Acer saccharum (Sugar Maple), Carya sp. (Hickory), Juglans nigra (Black Walnut), Pinus strobus (Eastern White Pine), Quercus rubra (Northern Red Oak) and Prunus serotina (Black Cherry). Also present was Gleditsia triacanthos (Honey Locust).

E The steep upper part of the riverbank mainly supports invasive and weedy non-native species including Rosa multiflora (Multiflora Rose), Elaeagnus umbellata (Autumn Olive), Phalaris arundinacea (Reed Canary Grass), Artemisia vulgaris (Mugwort) and Galium album (Hedge Bedstraw). Natives in the lower part of the bank subject to more frequent erosion included low-density Asclepias syriaca (Common Milkweed), Apios americana (Groundnut) and a long stretch of Carex stricta (Tussock Sedge) at the river's edge. Invasive species in this area included low-density Lythrum salicaria (Purple Loosestrife), Artemisia vulgaris (Mugwort) and Rosa multiflora (Multiflora Rose).

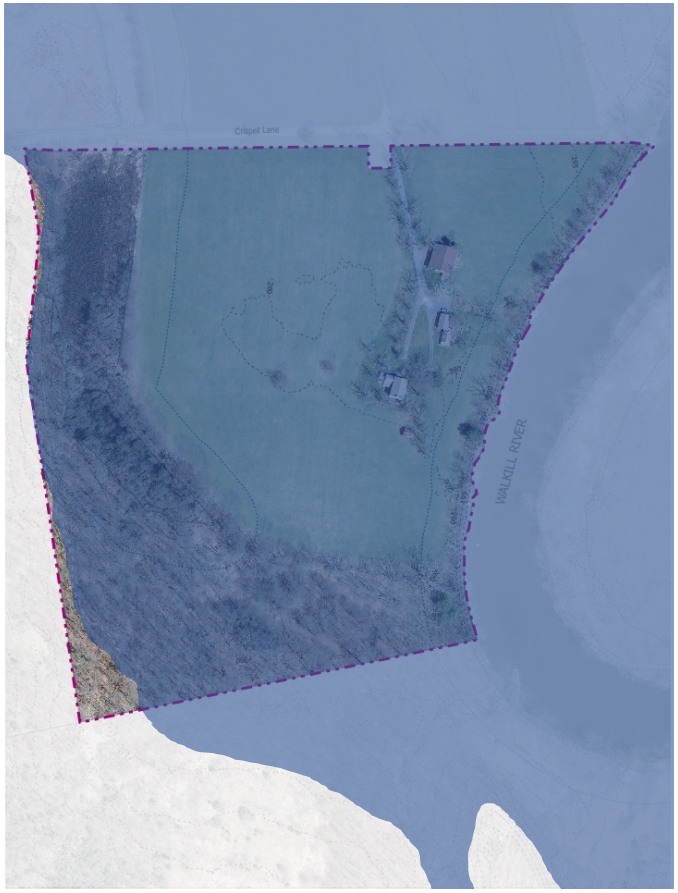
F Walking further south, one small patch of Reynoutria japonica (Japanese Knotweed) was found close to where the upper bank turns to forest, as well as moderate patches of Phalaris arundinacea (Reed Canary Grass).

G At the southeast forest edge closest to the riverbank, native trees include Carya sp. (Hickory) and Juglans nigra (Black Walnut). This area has experienced significant disturbance and the understory contains a diverse, homogeneous mix of invasive Rosa multiflora (Multiflora Rose), Elaeagnus umbellata (Autumn Olive) and Berberis thunbergii (Japanese Barberry). In places the lowest stratum is dominated by nearly 100% cover of invasive Microstegium vimineum (Japanese Stilt Grass).

H Heading northwest in the forest (to the southwest of the house) the soil becomes moister and the forest grades into a higher-quality forested wetland supporting native species including Carex grayi (Gray's Sedge), Cicuta maculata (Spotted Water Hemlock), Carex stricta (Tussock Sedge) and Quercus palustris (Pin Oak).

I Following the forest edge heading north there is a significant population of Penstemon digitalis (Foxglove Beardtongue) spread sparsely along the edge of the field. Here the forested wetland abruptly becomes a shrub swamp dominated by Cephalanthus occidentalis (Buttonbush) and Vaccinium corymbosum (Highbush Blueberry). The shrub swamp continues to the northeast nearly to Crispell Lane.

Flood Risk



Osborne Property Boundary
Contour (5ft)
Shrub Swamp
Forested Wetland
Wetland Buffer (100ft)
Flood Zone (100-year)

LANDSCAPE | NTERACTIONS

OSBORNE PROPERTY ORTHO BASEMAP
128 Crispell Lane
New Paltz, NY
80.6 acres

0 75 150
Feet

Wallkill River at Osborne Farm during Tropical Storm Irene in 2011. Photo by Vals Osborne

Hayfield at Osborne Farm, looking east during Tropical Storm Irene in 2011. Photo by Vals Osborne

Site History

The farm was first established in 1743 by Abraham Hardenburgh. My parents purchased the farm in1949 as a weekend and summer home. On my mother's death in 1997 I inherited the property.

I have been deeply engaged with the farm since childhood, working with the farmer on milking, tilling, haying, brush clearing, and birthing cows until my college years, and thereafter. Farming here has never been continuous and uninterrupted - first in wheat production, later dairy, then beef cattle, and for the last 50 years or so in hay, alfalfa, and corn crops.

There have been several major floods during my lifetime here - twice in 1955 and in 2011, two floods due to Hurricanes Irene and Lee. Hence, our 100-year floodplain could now be called a 55- year flood plain. But there have been many smaller floods in between, sometimes every other year or so, that have resulted in flooding south of us into the wetlands area and north in the fields along the river.

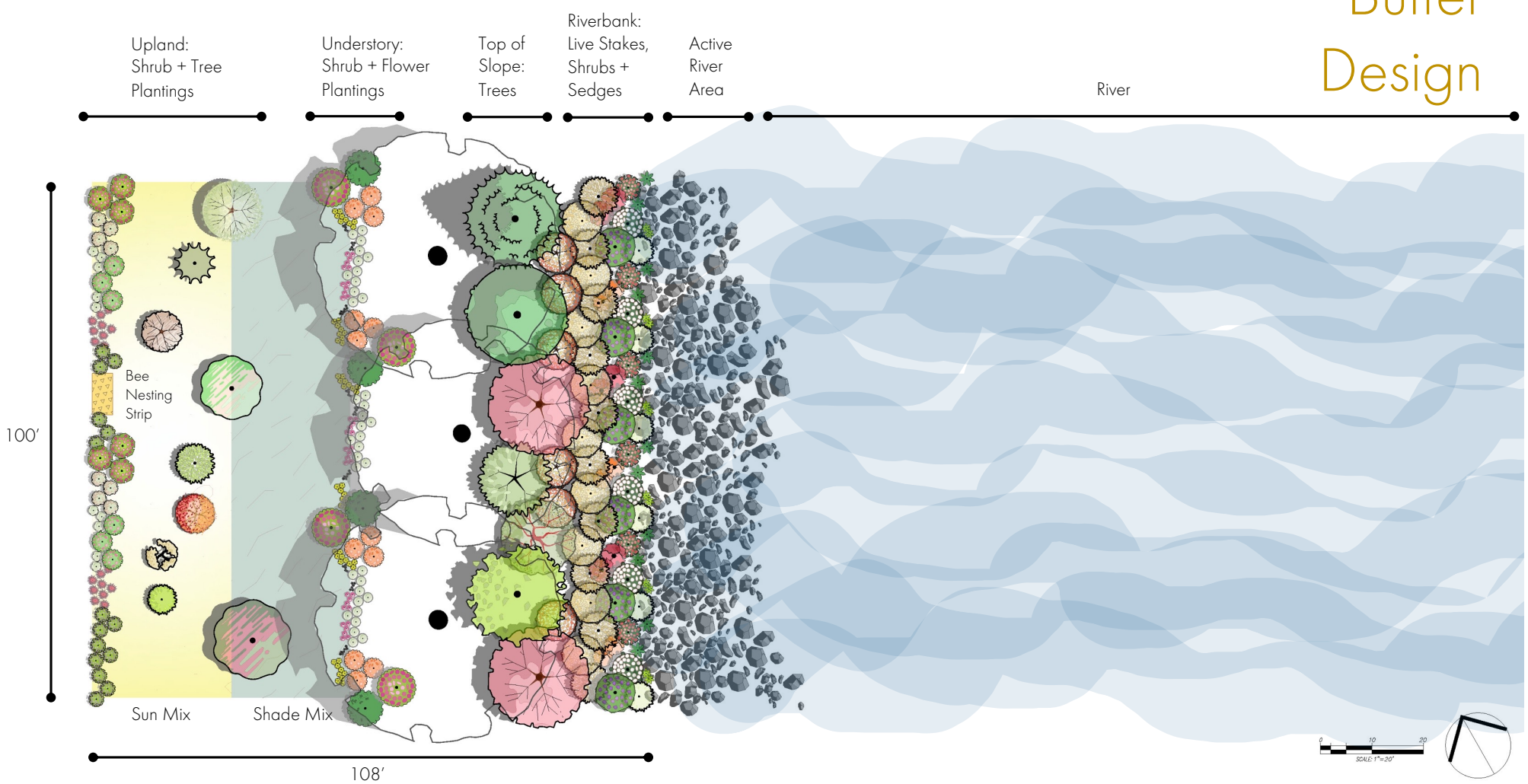
2011 was devasting. The Wallkill bridged the banks at our house, flooded the basement, downed many trees and the whole property became, in fact, a raging torrent. We had to evacuate for 3 days. I swam in the river throughout my childhood from a rock along the banks which is now much farther out in the river. If I had the time to find an old picture of that rock, you'd see how far the bank has eroded since my childhood.

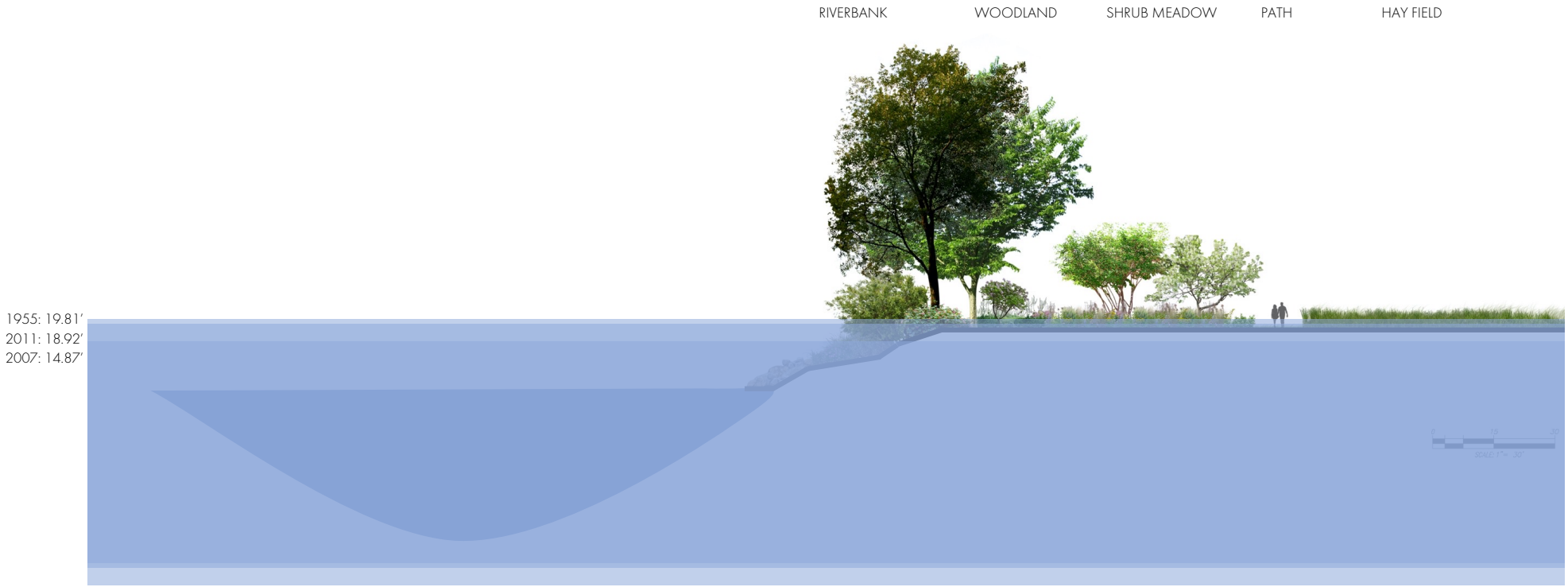
Let me know what else you'd like to know. Vals

Wallkill River at Osborne Farm, July 2022.
Photo by Vals Osborne


Meadow Strips
12' x 250'
(x2)
Riparian Buffer
100' x 300'
Trumpet Honeysuckle on Silo
Design Overview

Buffer Design




RIVERBANK
WOODLAND
SHRUB MEADOW
PATH
HAY FIELD
1955: 19.81'
2011: 18.92'
2007: 14.87'

```
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# Data provided for site 01371500
#    TS_ID       Parameter Description
#    107093      00065     Gage height, feet
#
# Data-value qualification codes included in this output:
#     A  Approved for publication -- Processing and review completed.
#     P  Provisional data subject to revision.
#     Eqp  Value affected by equipment malfunction.
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5s      15s     20d     6s      14n     10s
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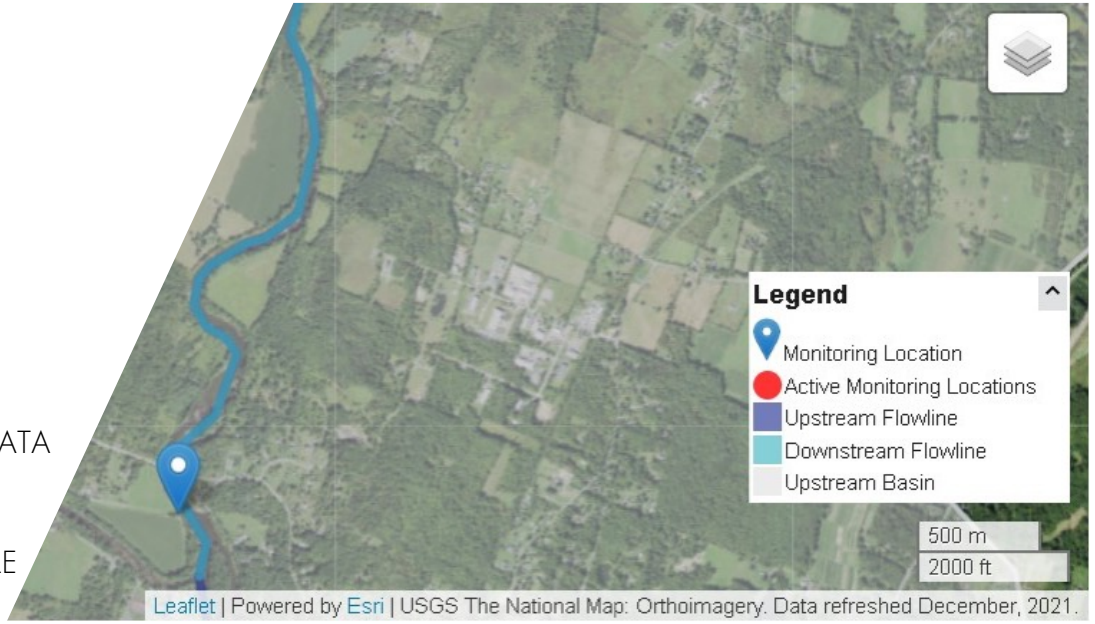
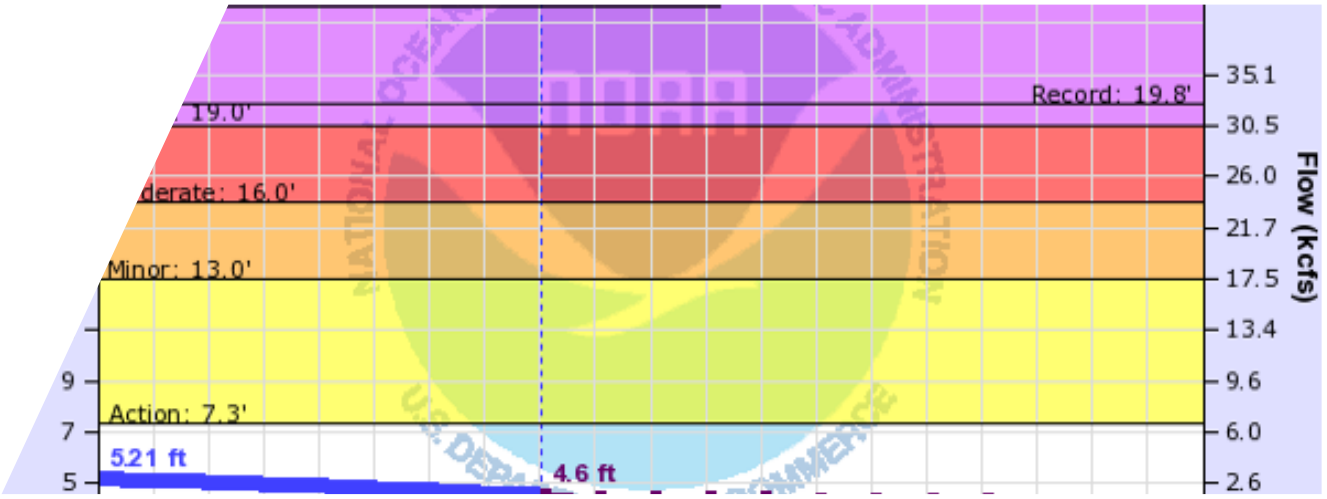
WATER LEVEL DATA FROM USGS MONITORING STATION 1 MILE UPSTREAM





PLANT SCHEDULE RIPARIAN BUFFER

TREES	CODE	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	ACE RUB	Acer rubrum	Red Maple	2	20' wide spacing
	AME LAE	Amelanchier laevis	Smooth Shadbush	1	12' wide spacing
	BET NIG	Betula nigra	River Birch	1	15' wide spacing
	CEL OCC	Celtis occidentalis	Northern Hackberry	1	20' wide spacing
	CER CAN	Cercis canadensis	Eastern Redbud	1	15' wide spacing
	CHA THY	Chamaecyparis thyoides	Atlantic White Cedar	1	20' wide spacing
	CHI VIR	Chionanthus virginicus	Virginia Fringetree	1	12' wide spacing
	JUN VIR	Juniperus virginiana	Eastern Red Cedar	1	8' wide spacing
	POP TRE	Populus tremuloides	Quaking Aspen	1	15' wide spacing
	PRU AME	Prunus americana	American Plum	1	8' wide spacing
	PRU MAR	Prunus maritima	Beach Plum	1	6' wide spacing
	QUE BIC	Quercus bicolor	Swamp White Oak	1	20' wide spacing
	QUE ILI	Quercus ilicifolia	Scrub Oak	1	8' wide spacing
	RHU COP	Rhus copallinum	Winged Sumac	6	8' wide spacing
	SAL DIS	Salix discolor	Pussy Willow	10	8' wide spacing
	SAL EXI	Salix exigua	Sand Bar Willow	6	6' wide spacing
	SAL HUM	Salix humilis	Prairie Willow	1	6' wide spacing
	SAL LUC	Salix lucida	Shining Willow	9	8' wide spacing
	SAL PET	Salix petiolaris	Meadow Willow	1	8' wide spacing

SHRUBS	CODE	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	CEP OCC	Cephalanthus occidentalis	Buttonbush	6	6' wide spacing
	DIE LON	Diervilla lonicera	Northern Bush-honeysuckle	12	4' wide spacing
	PRU PUM	Prunus pumila	Dwarf Sand Plum	8	3' wide spacing
	RHO MAX	Rhododendron maximum	Great Rosebay	4	7' wide spacing
	ROS PAS	Rosa carolina	Carolina Rose	6	4' wide spacing
	ROS PAL	Rosa palustris	Swamp Rose	6	5' wide spacing
	ROS VIR	Rosa virginiana	Virginia Rose	6	5' wide spacing
	RUB ODO	Rubus odoratus	Purple-flowering Raspberry	4	7' wide spacing
	SWI AMO	Swida amomum	Silky Dogwood	6	4' wide spacing
	SWI SER	Swida sericea	Red-osier Dogwood	6	5' wide spacing
	VAC ANG	Vaccinium angustifolium	Lowbush Blueberry	15	3' wide spacing
	VAC COR	Vaccinium corymbosum	Highbush Blueberry	6	8' wide spacing

GRASSES	CODE	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	CAR LAC	Carex lacustris	Lakeside Sedge	12	2' wide spacing
	CAR STR	Carex stricta	Tussock Sedge	12	3' wide spacing

PERENNIALS	CODE	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	ACT RAC	Actaea racemosa	Black Cohosh	36	2' wide spacing
	APO CAN	Apocynum cannabinum	Hemp Dogbane	10	2' wide spacing
	GER MAC	Geranium maculatum	Spotted Crane`s-bill	36	1' wide spacing
	MON DID	Monarda didyma	Scarlet Bee Balm	18	2' wide spacing
	PAC OBO	Packera obovata	Roundleaf Ragwort	54	1' wide spacing
	VIO PAL	Viola pallens	Smooth White Violet	27	0.5' wide spacing
	VIO STR	Viola striata	Cream Violet	27	0.5' wide spacing

GROUND COVERS	CODE	BOTANICAL NAME	COMMON NAME	QTY	REMARKS
	SHD MDW	Understory Meadow	Part-Shade Meadow Seed Mix	2,304 sf	
	UPL MDW	Upland Meadow	Full Sun Meadow Seed Mix	2,708 sf	

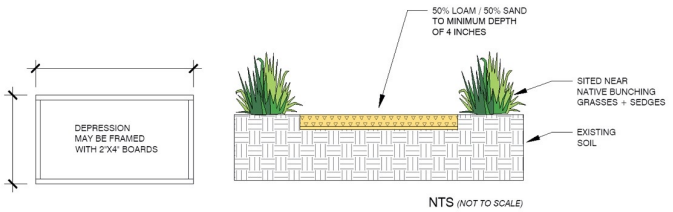
SUN MIX

Latin Name	Common Name
Arabis pycnocarpa	Hairy-eared rockcress
Cucurbita foetidissima	Stinking Gourd
Lepidium virginicum	Virginia peppergrass
Prunella vulgaris ssp. lanceolata	Common selfheal
Agastache scrophulariifolia	Purple giant-hyssop
Andropogon gerardii	Big bluestem
Asclepias incarnata	Swamp milkweed
Asclepias syriaca	Common milkweed
Asclepias tuberosa	Butterflyweed
Astragalus canadensis	Canada milkvetch
Baptisia tinctoria	Yellow wild indigo
Ceanothus americanus	New Jersey tea
Chamaenerion angustifolium	Narrow-leaved fireweed
Chasmanthium latifolium	River oats
Chelone glabra	White turtlehead
Cirsium discolor	Field thistle
Eragrostis spectabilis	Purple Lovegrass
Euthamia graminifolia	Common grass-leaved-goldenrod
Eutrochium fistulosum	Hollow Joe-Pye weed
Eutrochium purpureum	Purple Joe-Pye weed
Hypericum ascyron	Great St. John's-wort
Hypericum prolificum	Shrubby St. John's-wort
Hypericum punctatum	Spotted St. John's-wort
Lupinus perennis	Wild Lupine
Monarda fistulosa	Wild bergamot
Oenothera biennis	Evening primrose
Panicum virgatum	Switch grass
Pedicularis canadensis	Wood betony
Penstemon digitalis	Foxglove beardtongue
Penstemon hirsutus	Northeastern beardtongue
Schizachyrium scoparium	Little bluestem
Solidago juncea	Early goldenrod
Solidago odora	Sweet goldenrod
Solidago speciosa	Showy goldenrod
Spiraea alba	White meadowsweet
Spiraea tomentosa	Steeplebush
Symphyotrichum laeve	Smooth American aster
Symphyotrichum novae-belgii	New York American-aster
Zizia aurea	Golden Alexanders

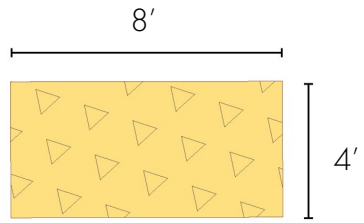
SHADE MIX

Latin Name	Common Name
Prunella vulgaris ssp. lanceolata	Common selfheal
Agastache scrophulariifolia	Purple giant-hyssop
Andropogon gerardii	Big bluestem
Asclepias incarnata	Swamp milkweed
Astragalus canadensis	Canada milkvetch
Cardamine concatenata	Cutleaf toothwort
Ceanothus americanus	New Jersey tea
Chamaenerion angustifolium	Narrow-leaved fireweed
Chasmanthium latifolium	River oats
Doellingeria umbellata	Flat-topped white aster
Eragrostis spectabilis	Purple Lovegrass
Eupatorium perfoliatum	Boneset
Euthamia graminifolia	Common grass-leaved-goldenrod
Eutrochium fistulosum	Hollow Joe-Pye weed
Eutrochium purpureum	Purple Joe-Pye weed
Helianthus divaricatus	Woodland sunflower
Hypericum punctatum	Spotted St. John's-wort
Impatiens capensis	Spotted Jewelweed
Lysimachia ciliata	Fringed yellow-loosestrife
Monarda fistulosa	Wild bergamot
Pedicularis canadensis	Wood betony
Penstemon digitalis	Foxglove beardtongue
Penstemon hirsutus	Northeastern beardtongue
Schizachyrium scoparium	Little bluestem
Solidago juncea	Early goldenrod
Symphyotrichum cordifolium	Heart-leaved American-aster
Symphyotrichum lateriflorum	Calico aster
Zizia aurea	Golden Alexanders

BEE NESTING STRIP DETAIL

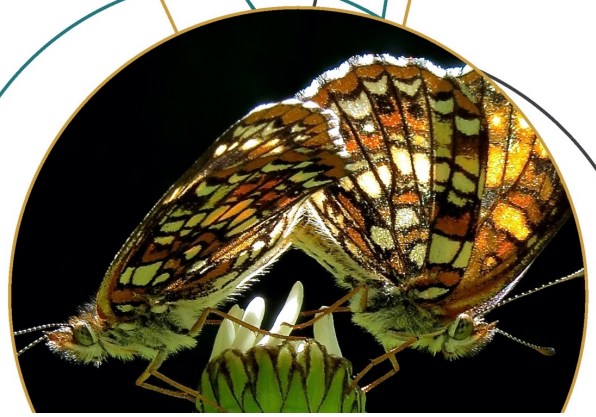


NTS *(NOT TO SCALE)*



BEE NESTING STRIP*

**Bee nesting strips can be installed as a break among hedgerows or field borders, in meadows, or anywhere with sunny, well draining soil.*



Diversity is Resilience

WHAT YOU PLANT MATTERS

SCRUB OAK
(QUERCUS ILLICIFOLIA)

Host plant for multiple lepidoptera, including the at-risk Horace's Duskywing (Erynnis horatius), White-M Hairstreak (Parrhasius m-album) and possibly Oak Hairstreak (Satyrium favionus).

PRAIRIE WILLOW
(SALIX HUMILIS)

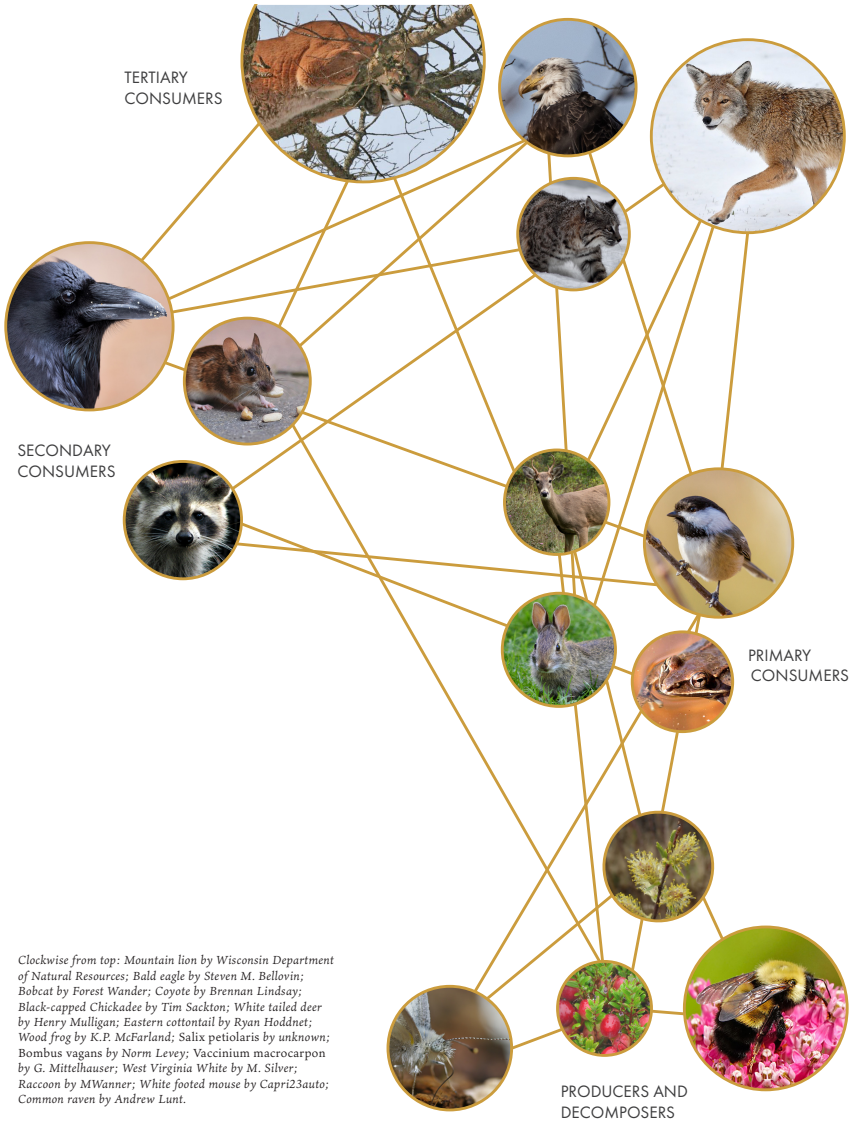
Critical early season pollen and nectar plant for numerous at-risk bees, including Andrena carlini, Andrena crataegi, Andrena forbesii, Andrena miserabilis, Andrena vicina, Bombus fervidus, Bombus vagans, Lasioglossum cinctipes, Lasioglossum imitatum, Lasioglossum pilosum, Lasioglossum quebecense and Osmia atriventris. Host plant for the at-risk Dreamy Duskywing (Erynnis icelus).

WILD BERGAMOT
(MONARDA FISTULOSA)

Highly visited for nectar as well as pollen. Supports several at-risk bees, including Andrena placata, Bombus fervidus, Bombus vagans, Coelioxys rufitarsis, Lasioglossum imitatum, Megachile brevis and Megachile latimanus. Also favored by at-risk butterflies and moths for nectar.

LITTLE BLUESTEM
(SCHIZARIUM SCOPARIUM)

Host plant for the at-risk Leonard's Skipper (Hesperia leonardus) as well as other skipper butterflies.



Clockwise from top: Mountain lion by Wisconsin Department of Natural Resources; Bald eagle by Steven M. Bellovin; Bobcat by Forest Wander; Coyote by Brennan Lindsay; Black-capped Chickadee by Tim Sackton; White tailed deer by Henry Mulligan; Eastern cottontail by Ryan Hoddnet; Wood frog by K.P. McFarland; Salix petiolaris *by unknown;* Bombus vagans *by Norm Levey;* Vaccinium macrocarpon *by G. Mittelhauser; West Virginia White by M. Silver; Raccoon by MWanner; White footed mouse by Capri23auto; Common raven by Andrew Lunt.*

SITE PREPARATION

Adequate site preparation is crucial before attempting to seed or plant native vegetation. Successfully establishing a meadow can be a three-year process, with the first growing season devoted to site preparation. Eliminating competitive weeds or invasive species before planting is essential to long-term success. At Island Grown Farm, we chose to employ two distinct, chemical-free methods of site preparation: smothering with black silage tarp and repeated shallow soil disturbance using pigs.

SMOTHERING

All meadow areas which are to be direct seeded in the fall were smothered with 6-milimeter black plastic silage tarp for 4-5 months beginning in May. This ensures that non-native cool season grasses and perennial weeds are eliminated before seeding. Native flowers and grasses tend to stay small and low to the ground their first year of growth as they develop root systems. This is why a full season of site preparation is critical to success.

Areas to be tarped should be mowed as short as possible beforehand. Any excessive organic matter can be raked off to create a smooth surface. **DO NOT TILL THE SOIL**, as this will only bring more weed seeds to the surface. Leaving a light layer of clippings is okay.

Lay thick (5- or 6-mil) black plastic over the entire area, overlapping the edges by about a foot if you use more than one roll or piece of plastic. All edges must be weighed down with sandbags, rocks, cinderblocks or other materials, every 3 to 6 feet. By excluding light from the vegetation below the plastic, those plants are unable to photosynthesize and will eventually die. Any seeds that germinate under the plastic are likewise unable to survive for long.

Dark tarps, landscape cloth or thick layers of wood chips can also be used instead of plastic. If wood chips are used, it's best to lay down a layer of cardboard underneath so that plants can't grow up through the wood chips. Watering the cardboard first is recommended. All material should be removed before seeding, to avoid enriching soil nutrient levels.

Leave the soil covered from mid-May until late September or October. When you remove the plastic or other materials, you will have bare soil on which to plant. Avoid disturbing this clean seed bed; do not till the prepared area as it will stimulate more weed growth. Do not apply compost or other nitrogen-rich material: native forbs do best in low nutrient soil. If needed, rake lightly to remove dead grasses and surface debris just before spreading the seed mix or planting.

PIGS

Hedgerow and field border areas were cleared of existing vegetation by running a pair of young pigs across the extent of the spaces to be planted. This has the added benefit of providing a product in the form of meat.

In order for this method to be effective, the pigs must stay in each area long enough to root around and consume weed seeds and roots below the surface of the soil. Ideally, the pigs would visit each area twice in the same growing season, with at least 6 weeks between each visit. This would allow any potential regrowth to also be eliminated.

The hedgerow and field border areas are to be installed in the fall using plants in the form of plugs and 1-2 gallon pots, with cardboard squares around each plant and wood chips across the expanse of the planted space in order to ensure establishment is successful. Irrigation drip lines will also be laid down. Weeding will be necessary throughout the first and second growing seasons following planting. In the case of the hedgerows, occasional winter pruning every 2-5 years may also be employed in order to prevent unwanted shading.

SOD CUTTING

In smaller grass-dominated areas you can remove the top layer of vegetation with a sod cutter and plant directly. It is recommended to mow short and wait until soils are dry before cutting, as the weight of the material is a lot less. This method has the benefit of requiring very little time to prepare for planting.

STALE SEED BEDDING

Stale bedding is another chemical-free method that is best suited for a large scale. The process involves repeated shallow tillage every 2-3 weeks from April or May until planting will occur, for a minimum of 60 days. This keeps bringing up new weed seeds and terminating them. Soils should only be disturbed to a depth of 2-3". Seeds or plants can then be installed directly.

Stale bedding is a desirable option for site preparation if soil disturbance is not a barrier and access to equipment is possible. While only two months of this process may be necessary, it is recommended to wait until after mid-October for direct seeding native plant species.

MEADOW SEEDING + MAINTENANCE

It is highly recommended to install native seed mixes in the dormant season, mid-October through January. This is because most native flowering species require between one and three months of cold stratification in order to germinate. Fall and winter naturally provide this opportunity in the Northeast, and are usually followed by rainfall in the spring. It is also possible to sow seeds in the early spring, but many species may not germinate until the following year, and watering may be necessary.

Due to the relatively small scale of the areas at Island Grown Farm that are to be seeded directly (a combined total of 4 acres), it is possible to install all seeds manually by broadcasting the mixes. The process is fairly straightforward: after seed mixes are created and purchased for each area, the mixes are weighed with a food scale and divided into 1/4-acre parts. Each 1/4-acre part is then mixed with a 5 gallon bucket of moistened sand or parboiled rice hulls (PBH) as a carrying agent. The physical areas to be seeded are divided into 1/4 acre sections, and each section is distributed evenly with buckets containing the seed mixes and their carrying agent.

A cover crop should always be included when direct seeding: winter wheat *(Triticum aestivum)* for fall or winter installations, and wild oats *(Avena sativa)* for spring installations, at 100 lbs/acre. When broadcasting, cover crops can be installed separately following the seed mixes.

To give a concrete example, let's say we're seeding the Wet Meadow area at IGI Farm (see page 15). This area will have a unique seed mix, as it's the only wet area on the farm. The total wet meadow area to be seeded is 0.5 acres. When the seed mix arrives, it will be divided in half using a food scale. Each half will be mixed evenly with a 5 gallon bucket of moistened sand or parboiled rice hulls.

The wet meadow area at the farm will then be divided in half with a string. Each half of the wet meadow area will be broadcast evenly with a 5 gallon bucketful of seed mix and sand, followed by 25 lbs of winter wheat cover crop. It is best to walk back-and-forth across the area in two directions (West to East and North to South for example) in order to guarantee even coverage. Refer to the diagram to the right for an example of how to evenly broadcast seeds across a site.

For the first growing season following seeding, at least 1 inch of rain per week is necessary. If there is not adequate precipitation, areas recently seeded should be watered 1-2 times per week.

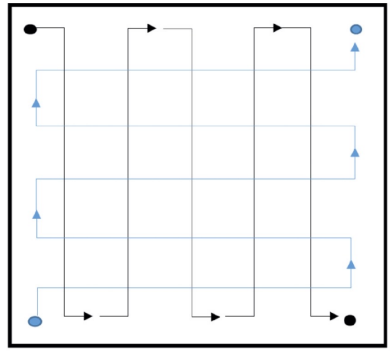
MOWING REGIME

For the first growing season following seeding, all recently seeded areas should be closely monitored for growth. When the average height of vegetation is around 12 inches, the area should be brush hogged or weed whacked down to a height of no less than 5-6 inches. This schedule should continue throughout the first growing season, as most native plants are focusing their energy on establishing root systems, and can easily become outcompeted and shaded out by weeds and non-native cool season grasses.

In the second year, 1-2 mows will be necessary between April and May depending on growth, down to the same height (5-6 inches) as cool season grasses take hold at the beginning of the season. After June 1, the seeded areas should be assessed by a botanist or individual with vetted plant identification skills. **If the majority of vegetation in a given area is native species from the seed mixes**, then mowing for that area can be paused until the end of the season (mid-October), after which all vegetation can be mowed down to 6 inches. **If the majority of vegetation in a given area still appears to remain non-native grasses or weeds**, then continue mowing as described above to keep the overall height of plants consistently between 6 and 12 inches. This regime should be followed until the third growing season.

By the third growing season, the site should transition to one mow every 1-3 years. This should always occur during the dormant season (mid-October to mid-April), after plants have gone to seed or before next season's growth. Doing so allows native pollinators to overwinter safely, and native plants to naturally scatter their seeds. Ideally, the site would be broken up into 2 or 3 sections, with each section cut on a rotational basis. During this dormant season mow, vegetation should be cut to a height of no less than 6 inches.

Invasive species and early successional trees should always be closely monitored and, after mowing becomes less frequent, either manually pulled, cut or mechanically grubbed.



This diagram from the University of New Hampshire illustrates the two directions that should be walked when broadcasting seeds, in order to ensure even coverage.

BEST MANAGEMENT PRACTICES

1. NO CHEMICALS

Eliminate pesticide use, particularly those containing neonicotinoids. Herbicides and chemical lawn treatments can also be highly damaging to pollinators.

Avoid planting in areas previously contaminated by pesticides or without a spatial buffer from areas where pesticides are applied (at least 100 ft. wide forested buffer is recommended).

Ensure plants and seeds come from a clean, pesticide-free source. Many commercial nurseries treat their plants and seeds, oftentimes before retailers receive them. Some pesticides and most neonicotinoids persist in plants and soil for months to years.

2. DIVERSE NATIVE PLANTS

Plant straight native plant species. Cultivars and exotic plants largely do not support the pollen, nectar and host plant preferences of threatened pollinators and tend to be visited by common pollinator species whose populations are stable.

Include a range of plant types (trees, shrubs, forbs, grasses, sedges) with varying bloom times, to ensure pollen, nectar and host plants are available across the entire growing season.

3. CREATE NESTING OPPORTUNITIES

Seventy percent of native bee species are ground nesting. Mulch using compost or natural materials (e.g. chopped leaves, seed-free hay, composted wood chips) and leave bare areas of well-drained soil in sunny locations.

Thirty percent of native bee species are cavity nesting. Allow dead trees, snags and pithy stemmed plants such as raspberries to remain standing.

To benefit bumblebees, maintain small brush piles. This will provide cover for rodents that will in turn create nesting habitat for bumblebees. Where possible, leave leaf litter in gardens and allow it to build up over time. This provides cover for overwintering queens. Barns with unbaled hay or a dry, protected cavity containing hay, straw, clumps of moss or grass located above or below ground are also ideal.

As with other ground nesting bees, limiting or eliminating tillage practices will limit the potential of harming bumblebees.

4. BE MESSY

Skip the fall clean up, allowing dead stems, leaves and seed heads to stand over winter, and wait until evening temperatures consistently reach 50 degrees before raking in the spring.

Don't be overzealous when it comes to tidying up. Some weeds act as host plants for caterpillars, such as lambsquarters *(Chenopodium album)* for Common Sootywing *(Pholisora catullus)* and Queen Anne's lace *(Daucus carota)* for Black Swallowtail *(Papilio polyxenes)*.

5. IT DOESN'T STOP WITH PLANTING

That being said, with new plantings, water and weed regularly for the first two years.

To deter deer and rodents until plants fully establish, it may be helpful to construct temporary fencing or set up netting. Natural repellent sprays such as *Plantskydd* can be effective when applied regularly. Thorny plants such as roses can also deter deer browse and function as natural fences for more vulnerable plants.

6. LAST BUT NOT LEAST

Put something in place to catch rainwater, with a dirt base to simulate a puddle, providing pollinators necessary minerals. Make it last between rainy days.

Keep night skies dark for moths and other nocturnal insects: motion-detecting lights or lamps facing down instead of spotlights on all night.

Some plant species establish best by direct seeding: while late fall or early winter is the best time to sow, early spring seeding is also possible, although some species may not germinate until the following year.

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This material is based upon work supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, through the Northeast SARE program under sub-award number ENE22-177, and managed by a partnership between Berkshire Agricultural Ventures, Propagate, and Landscape Interactions