

HABITAT STRUCTURES



1

Context

Wildlife habitat structures are often installed where habitat features are either deficient or missing, particularly in urban or developed areas. They can also be used to enhance existing natural habitat where essential structural diversity may take longer to develop through natural processes. These structures should not be considered as a substitute for protecting existing natural habitat as those specific conditions are often costly and difficult, if not impossible, to recreate.

Habitat structures can be designed for a diversity of focal species and guilds. Structures can provide opportunities for nesting, roosting, perching, rearing, basking, and cover from predators and/or weather. In densely, developed areas, these structures may provide the only habitat available. Buildings, transmission towers, street lights, and power poles can also be retrofitted to support (or discourage) wildlife, depending on management objectives.

Key Considerations:

- ☑ Identify suitable areas where wildlife can flourish while managing potential wildlife hazards, disturbances, and wildlife-human interactions.
- ☑ Recognize the potential of wildlife structures and features to support undesirable species (e.g., competing invasive species).
- ☑ Ensure wildlife structures are suitable for the target species. Monitor and maintain habitat structures to assess use and ensure structures are in good condition. Use may be higher if structures are situated close to natural habitat and/or features. Consult an appropriately Qualified Environmental Professional (QEP) to verify design, placement, and other requirements.
- ☑ Consider existing and future climate conditions.



Solitary Pollinator Boxes, Green Timbers Urban Forest
Credit: Pamela Zevit

DID YOU KNOW?

Old structures have biodiversity value too! Retaining existing artificial habitat such as old buildings, barns, sheds or bridges, should be encouraged, particularly if they provide niche habitat for Species of Conservation Concern (SCC) like bats or aerial insectivores (e.g., Barn Swallows). If derelict structures must be removed, they should be assessed first to determine what species may be present and what specific habitat features are attracting them to better inform the design of potential replacement habitat.

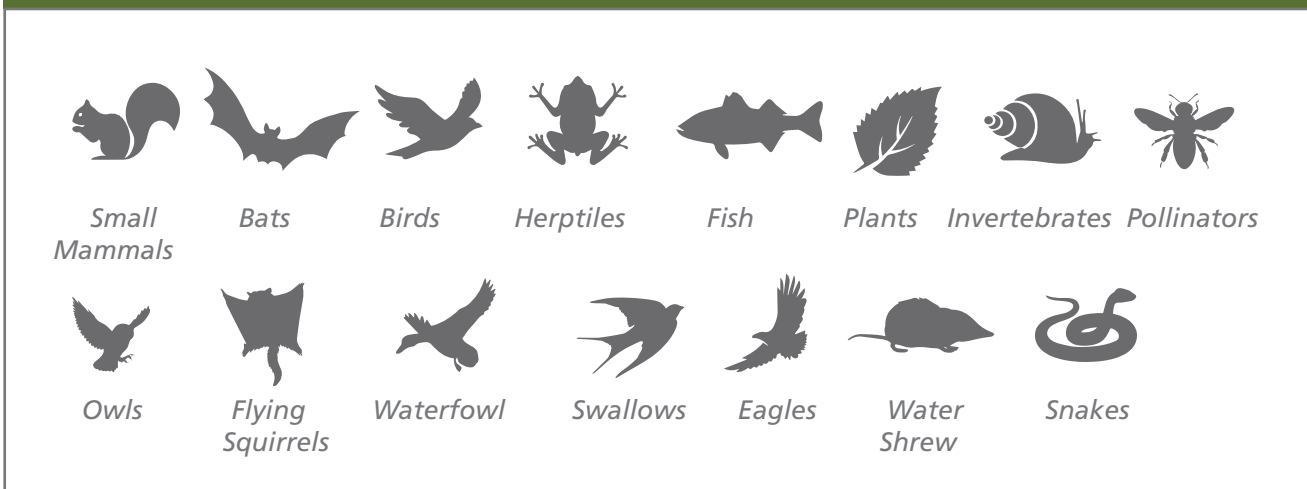


Old Barn
Credit: FotoFlorian

Relevant Surrey Documents:

- Biodiversity Conservation Strategy (2014)
- Official Community Plan (2013)
- Natural Areas Strategic Management Plan (2002)
 - o Coarse Woody Debris Management Strategy (2002)
 - o Fauna Management Strategy (2002)
 - o Tree Hazard Management Strategy (2002)
 - o Vegetation Management Strategy (2002)
- Surrey Parks, Recreation and Culture Strategic Plan (2018-2027)

ICON LEGEND:



Cost Legend: Relative Cost: \$ (low), \$\$ (medium), and \$\$\$ (high).

Module linkages:



1.2 NATURAL AREAS

Overview

Surrey’s natural areas hold a diversity of habitat types including forests, shrublands, wetlands, streams, lakes, estuaries, and marine and freshwater shorelines. A majority of these natural areas have been subject to human disturbances such as land clearing, development, and pollution. The City’s natural areas are generally found on public land within local and regional parks, utility corridors, and riparian areas, as well as scattered across private land. Habitat quality and condition has been degraded due to the impacts of surrounding development, invasive plant species, and other cumulative effects tied to human activities. Despite these challenges, significant enhancement opportunities exist through targeted actions at the site level. Creating features such as wildlife trees and downed wood are example benefits to wildlife species that rely on these micro-habitats for part or all of their life cycle. Many of these features are absent from younger forest types that tend to predominate in Surrey. Habitat enhancements can support greater biodiversity and improve ecosystem function, which provides more recreational and community benefits for people.

Supporting the City’s Green Infrastructure Network:

Section D – Ecosystems from PlanSurrey 2013, the City of Surrey’s Official Community Plan, supports identification, protection, enhancement, and management of the City’s biodiversity and network of significant natural ecosystems. Objectives include improving natural areas connectivity within the Green Infrastructure Network (GIN) and encouraging environmental protection on private land. An OCP amendment in 2016 supported creation of the Sensitive Ecosystem Development Permit Area (SEDPA), which introduced guidelines to protect Green Infrastructure Areas and Streamside Areas.



DID YOU KNOW?

Many natural areas border residential, industrial, and agricultural land that contains community and/or major infrastructure such as parks, facilities, roads, utility lines, and drainage structures. Biodiversity enhancements within these natural area-urban interfaces must consider these other values and potential risks, including wildfire, hazard trees, windthrow, invasive species, and human-wildlife conflicts. Future climate change will also affect vegetation, water, and wildlife. Protecting existing natural areas, increasing connectivity, reducing fragmentation, and introducing wider buffers can increase resiliency and functionality of natural ecosystems, while also providing additional opportunities to enhance and restore habitat.



Mud Bay
Credit: Carla Stewart

1.3 BACKYARD BIODIVERSITY

Overview

Small actions we take to protect, restore, and enhance biodiversity in our own backyards can support big conservation actions on a City-wide scale. Surrey is one of a handful of cities in Canada with a dedicated, long-term plan to protect local biodiversity (see: surrey.ca/biodiversity). From the Fraser River to Boundary Bay and the Salish Sea, the City's rivers, streams, wetlands, forests and farmland connect neighbourhoods through a "Green Infrastructure Network (GIN)." This network is the backbone supporting the City's biodiversity and is included within the Surrey's Sensitive Ecosystem Development Permit Area. The area outside of the GIN is called the urban matrix, and this is where the majority of Surrey's private land (i.e., its residential, commercial, industrial, and agricultural areas) exists. As BC's fastest growing city, there is a desire to ensure that nature continues to hold a special place for residents, businesses, and visitors alike.

While the scale of many developments in the urban matrix, such as a single family home, is small, collectively these "backyard" spaces occupy a significant land area. Collective action to conserve biodiversity at this backyard (i.e., site) level is essential to help bolster the City's green infrastructure and provide sustained benefits to people and wildlife.

1.3.1 DESIGNING FOR BACKYARD BIODIVERSITY

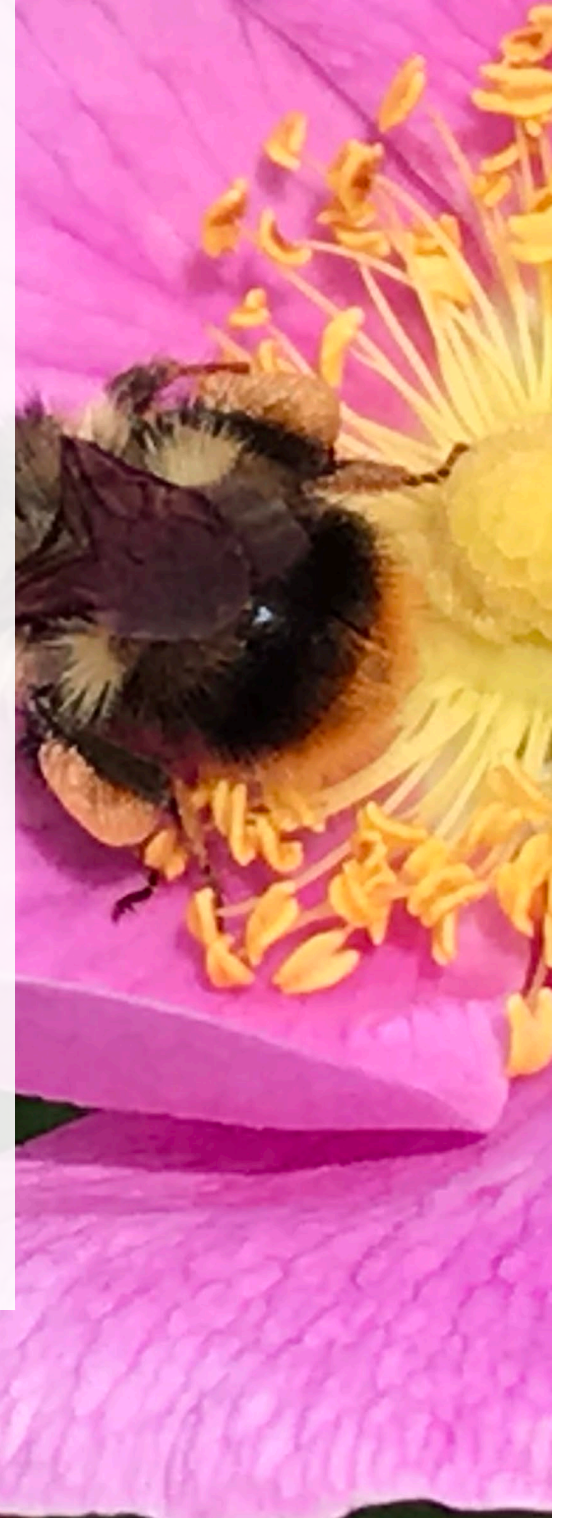
Key Considerations:

- Maintained landscapes often lack the necessary habitat needed to support biodiversity. Converting lawn to flowering habitat and leaving just a small portion of your backyard in a more natural condition can save time on yard maintenance while also supporting biodiversity. If lawn is retained, consider limiting how often you mow or keep sections of unmowed lawn in rotation to allow grasses and other plants to grow taller and flower.
- Vegetation determines how much other life will be present in a particular area. Even minor increases in native vegetation can lead to proportional increases in other animal species.
- Choose native plants where possible. Native plants have long evolutionary relationships with local wildlife, supporting almost 30 times more species than ornamental (non-native) plants they share.¹
- Backyards can provide habitat for common species, but can also support some Species of Conservation Concern found in and around Surrey including the Dun Skipper butterfly, aerial insectivores like the Barn Swallow, and nocturnal species like the

DID YOU KNOW?

Managing Surrey's biodiversity effectively requires knowing what plants and animals are around, what kind of habitats they occur in, and how they are doing over time. Monitoring changes in the population, health, and condition of plants, animals, and ecosystems can help the City identify issues and trends, and develop plans to better protect, restore, and enhance biodiversity. Because City resources are limited, sharing citizen observations through the [City's iNaturalist initiative](#) is an important way to integrate local knowledge and help the City better manage its local flora and fauna, and the ecosystems they are a part of.

Plants and insects are a natural focus for backyard biodiversity projects because they can persist at a relatively small (i.e., backyard) scale and they play a significant ecological role. Plants and animals interact with each other as part of a food web, which essentially describes the natural pecking order of what eats what. Plants are particularly important as they are the basis of this food web and supply energy to all other animals. Invertebrates are also beneficial as they are a major food source for animals that do not eat plants, for example most birds and many mammals, reptiles, and amphibians.¹ Small measures that citizens take to support plant and invertebrate biodiversity in backyards can have significant benefits for other species that require much larger areas to make a living.



Bumble bee
Credit: Pamela Zevit

Little Brown Myotis. The Southwest/Lower Mainland of BC has more than 230 Species at Risk, many of which can be found in the urban matrix and agricultural areas.

- Water is an important backyard habitat feature that can attract and benefit many animals.
- Avoid insecticides, herbicides, and rodenticides to maintain healthy populations of invertebrates. Biodiversity enhancements should not be planned in areas where pesticides are used. The City has a ban on cosmetic pesticides and provides guidelines for appropriate use of approved pesticides.⁶
- Ensure that wildlife structures (e.g., nest boxes) are correctly sized, located, and meet the needs of target species. Maintenance is essential; artificial structures need to be cleaned and monitored annually.
- Be aware of the potential for wildlife structures to attract undesirable species (e.g., rodent pests, invasive insects, and wildlife).

1.4 INVERTEBRATES & WILDLIFE POLLINATORS

Overview

Some of the most important elements of biodiversity are also smallest in size. Invertebrates (animals without spines, like insects, snails and worms) are by far the most common and widespread organisms in the world and can be found in almost every

type of habitat. They are thought to compose no less than 97 percent of all known species on earth.¹⁰ Invertebrates are a key element of the food web as they convert and transfer plant energy. They are an important food source for animals including birds, mammals, fish, herptiles, and other invertebrates. Invertebrates also provide important ecosystem services for humans. These benefits include pollination, nutrient cycling, waste breakdown, soil aeration, and pest control.

Pollinators

Pollinators include invertebrates such as bees, butterflies, moths and other insects. Some birds (e.g., hummingbirds), bats, and other species also provide this beneficial service. Together, these animals play a crucial role in the reproductive cycle of flowering plants. Without the assistance of pollinators, most plants would not be able to produce fruits and seeds, including many of the fruits and vegetables that humans rely upon. Three quarters of the world's flowering plants and one third of food crops are thought to rely on pollinators.¹¹

Human factors such as habitat loss, light pollution, and use of pesticides has impacted insect populations, which has significant implications for biodiversity. Taking actions to support invertebrates and pollinators not only supports healthy plant and animal populations but protects natural processes as well as food production.

DID YOU KNOW?

Pollinator habitat needn't always be intensively managed. In fact, it is preferred to leave habitat as unmanaged as possible. Consider planting ground covers, clovers, and ornamental grass, which require less maintenance than traditional grass lawns. If grass lawns are preferred, minimize the times you mow and avoid mowing at important times of the year for pollinators. Grass lawns mowed once per month produce the highest levels of flowers and nectar sugar; nectar production in lawn alternatives such as Dutch white clover can increase by up to a factor of 10. Keeping patches of your lawn unmowed altogether allows grasses to flower, supporting even more pollinator species.^{1,2} Waiting until the end of August to mow allows most wildflowers time to seed. It doesn't take many flowers to make a difference: eight dandelion flowers provide enough nectar for 15,000 bee visits per day.³

Consider retaining leaf litter and other organic material (in piles) for habitat. Retain some leaf litter as over-wintering habitat for insect pollinators and avoid cutting back floral beds and other landscaped areas until spring. Tall and hollow-stemmed plants also provide winter cover habitat for pollinators and forage for birds. Programs that support pollinators include Plantlife's No Mow May,³ Xerces Society's Leave the Leaves⁴ and the Canadian Wildlife Federation's Grow It!, Don't Mow It!⁵

Clover Lawn
Credit: Robert Couse Baker

Key Considerations:

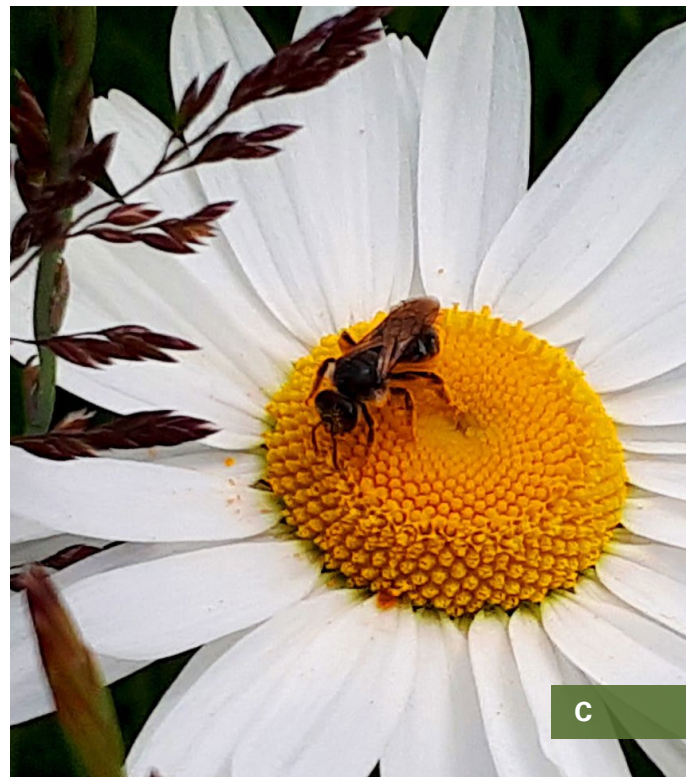
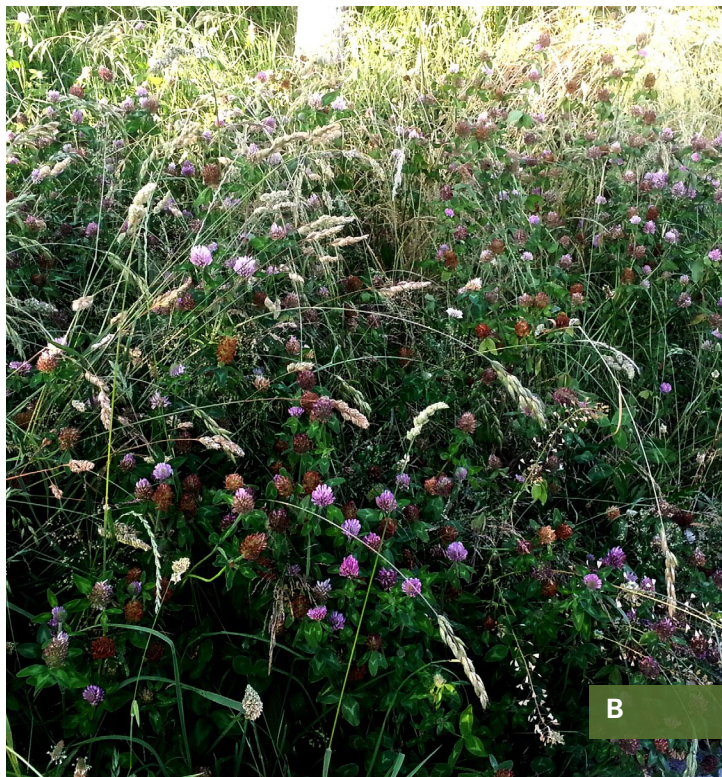
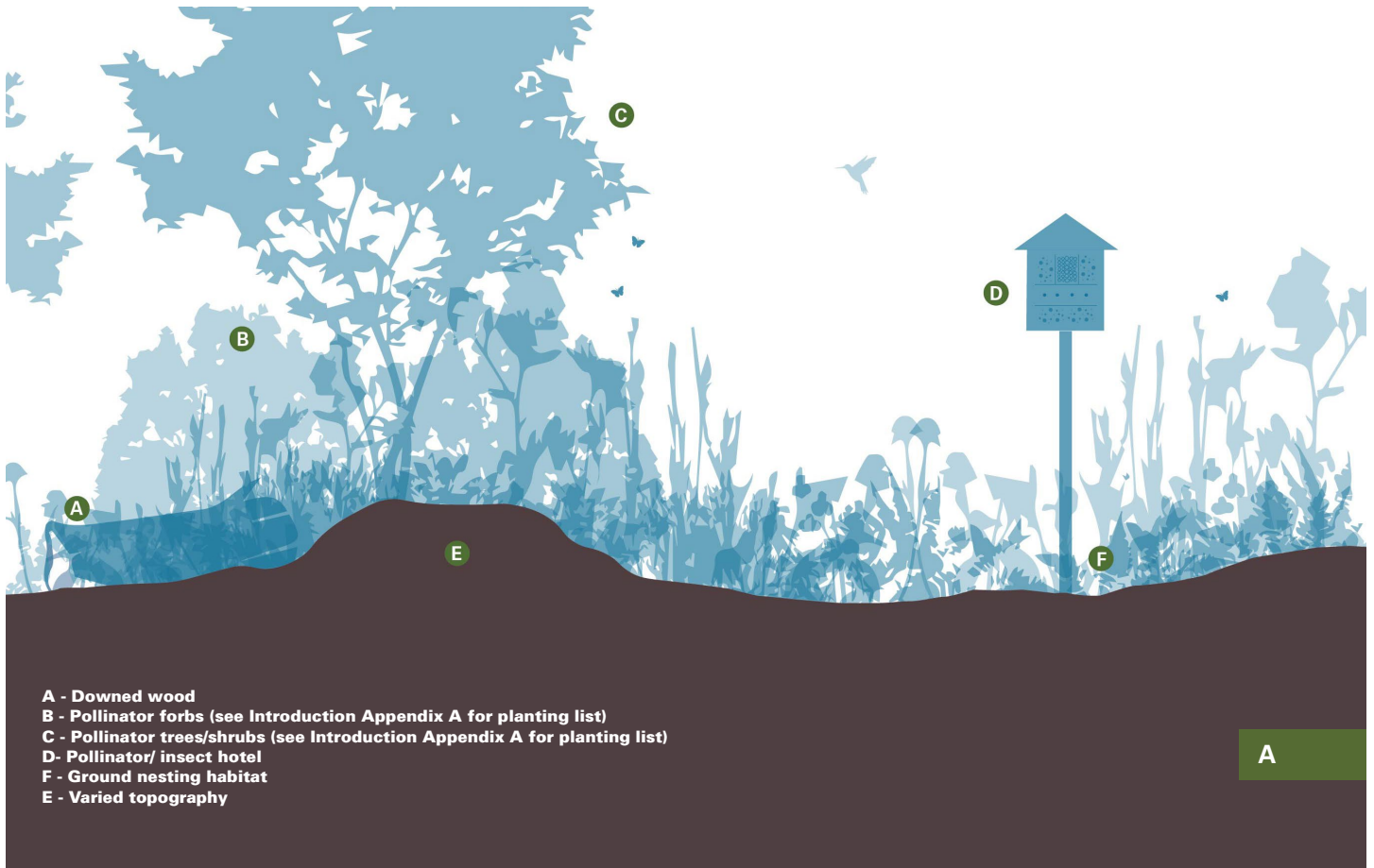
- ☑ Preserve existing and potential pollinator habitat, including those in brownfields, where possible.
- ☑ Allow nature to take its course, where appropriate. Allow self-seeding plants beneficial to pollinators to establish in urban spaces.
- ☑ Maintain a pesticide-free environment.
- ☑ Establish **pollinator gardens** as a small-scale action for offsetting some habitat lost to development. While not a replacement for natural, structurally diverse ecosystems, well-designed pollinator gardens can provide many benefits.

Pollinator Garden Design Guidelines:

- ☑ Establish heterogeneous plant communities (i.e., no one plant should be more than 10 percent of the total species mix) and introduce vertical structure (trees and medium and low growing shrubs and forbs).
- ☑ Native plants should be preferred over ornamental flowering plants. If ornamentals are necessary, they should be selected based on their value for pollinators. Note that some ornamentals have the potential to be invasive and should be managed accordingly.
- ☑ Include a diversity of plants that provide foraging, nesting, and overwintering habitat. Non-flowering species are important, too, as they can act as host plants for larvae. Select plants that are

beneficial for generalist species but also choose specialty plants that host specific or rare species. For example, Pacific Bleeding Heart (*Dicentra Formosa*) is a host plant for the *Clodius Parnassian* butterfly.

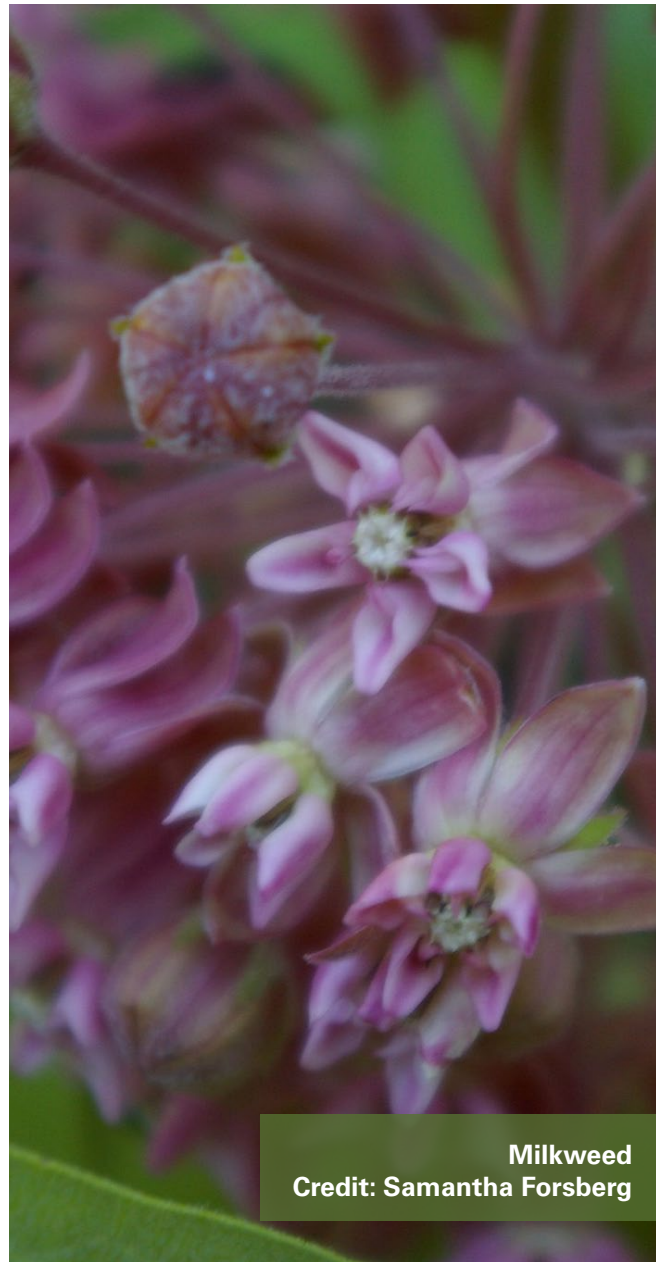
- ☑ Include a mix of early, mid, and late-flowering plants to ensure a continuous pollen source. Seasonal blooming periods (spring, summer, and fall) should guide native plant selection. Flowers should be diverse in shape, colour, and size; clusters of flowers are preferred.
- ☑ Consider existing and future climate conditions. Include low maintenance, drought-tolerant plants that are long-lasting.
- ☑ Integrate topography (e.g., depressions and hummocks), water, variable substrates (e.g., open, bare ground), and biological legacy structures (e.g., wildlife trees, downed wood) where possible.
- ☑ Soil is important for plants and invertebrates. Leave areas of exposed soil for ground nesting bees and other species. Well-drained, sandy soil is best for bees. Loamy soils and those soils with plenty of organic matter are beneficial for invertebrates all around.
- ☑ Provide winter cover and nesting habitat by retaining (not removing) layers and piles of fallen leaves, twigs, branches, and dead wood.
- ☑ Refer to **Appendix A** in the Introduction for Planting Recommendations.



A - Fig. 1: Pollinator Planting
 B - Rough mow for pollinators - Credit: Pamela Zevit
 C - Sweat Bee - Credit: Pamela Zevit

Additional Information on Pollinators and Invertebrates:

- ☑ You've Got Butterflies!¹²
- ☑ Pollinators of BC.¹³
- ☑ Gardening with Native Plants in the Lower Mainland and Fraser Valley.¹⁴
- ☑ Landscaping for Wildlife in the Pacific Northwest.¹⁵
- ☑ Selecting Plants for Pollinators - A Regional Guide for Farmers, Land Managers, and Gardeners in the Lower Mainland including the Greater Vancouver Area, Abbotsford, Chilliwack, Powell River, Harrison Lake, and parts of Similkameen Valley.¹⁶
- ☑ A Guide for Pollinator-friendly Cities: How Can Spatial Planners and Land-use Managers Create Favourable Urban Environments for Pollinators?¹⁷
- ☑ Protecting Pollinators at Home.
- ☑ Wild And Managed Pollinators: Current Status And Strategies To Increase Diversity.¹⁸
- ☑ Pollinator Plants Maritime Northwest Region.¹⁹
- ☑ Butterfly Gardening. ²¹



Milkweed
Credit: Samantha Forsberg

FURTHER READING:

Backyard Enhancement. ⁷

Species at Risk in Our Backyard.⁸

Grow Green: A Guide to Eco-Friendly Lawns and Gardens in Metro Vancouver. ⁹

1.5 ARTIFICIAL NESTS/ BOXES

1.5.1 NEST STRUCTURE - BOX

Nest boxes provide artificial habitat for cavity nesting birds (primary and secondary excavators) and small mammals (e.g., Flying Squirrel). Nest boxes simulate lost/scarce cavity features, particularly in forest habitat that lack mature, dead, and/or dying trees. Design guidelines in this module generally focus on Species of Conservation Concern and provide details regarding placement and monitoring of nest boxes. Links to more detailed design drawings can be found in the Further Reading section below.

Chestnut-backed Chickadee Nest Box:

*Design also suits Bewick's Wren, Red-breasted Nuthatch, and Black-capped Chickadee.

- ☑ Place 2 – 5m high on tree/pole facing E to SE.
- ☑ Direct away from prevailing wind, if possible.
- ☑ Keep nest boxes at least 50m apart.
- ☑ Place to limit disturbance from people and predators (applies to all nest structures).
- ☑ Note that Chickadee boxes can end up being used by Douglas Squirrels or Deer Mice.

Barn Owl Box:

- ☑ Place *inside* a building for extra cover and durability (preferred option), or attach to tree (2nd best option), or post.

- ☑ 3 - 8m above ground.
- ☑ Boxes can be placed facing any direction.
- ☑ Locate boxes within 1km of open habitat (e.g., agricultural field) and keep at least 1km from major roads.
- ☑ Two nest boxes within 250m of each other may be used by individual pairs.

Waterfowl:

- ☑ Choose nest box locations next to deep water or permanent ponds/streams next to a woodland.
- ☑ Target one box per hectare of water.

Flying Squirrel:

- ☑ Place in mature coniferous (preferred) or mixed forest stands.
- ☑ Attach 3 - 8m above ground with access hole facing away from prevailing wind.
- ☑ Install near water or forested wetland sites.
- ☑ Target several boxes per quarter hectare to provide alternate nest sites.

Guilds and Focal Species:



Cost: \$-\$\$

FURTHER READING:

All about Birdhouses.²²

Nest Box Guide for Waterfowl.²³

Building a Flying Squirrel Box.²⁴

The Barn Owl Trust.²⁵

Barn Owls BC.²⁶

Raptor Perches.²⁷

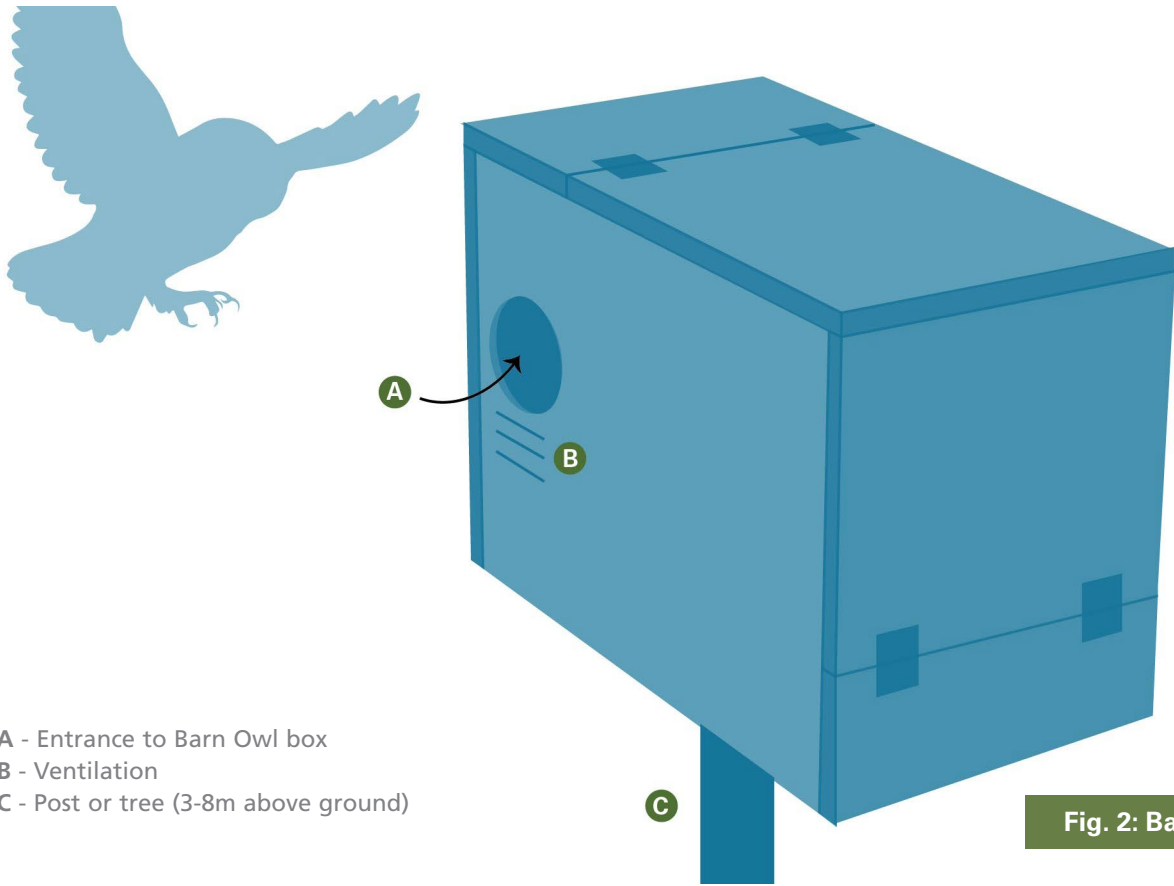
CASE STUDY

Provisional Eagle Nest Tree Modification Project, Surrey, BC

An artificial nest platform was installed close to an existing eagle nest in case the nesting pair of eagles desired an alternative nesting site. Platform placement and design was based on advice from a Qualified Environmental Professional, and considered tree species, tree height, structural stability, habitat availability. The tree was pruned to improve access and visibility for eagles while also maintaining visual buffers above and below the nest to protect against predation. The platform was constructed using L-brackets, wire mesh, and cedar and alder limbs to create a natural base. Perching and fledging limbs extending beyond the platform were also added.



Modified Eagle Nest
Credit: Myles Lamont



- A - Entrance to Barn Owl box
- B - Ventilation
- C - Post or tree (3-8m above ground)

Fig. 2: Barn Owl Box

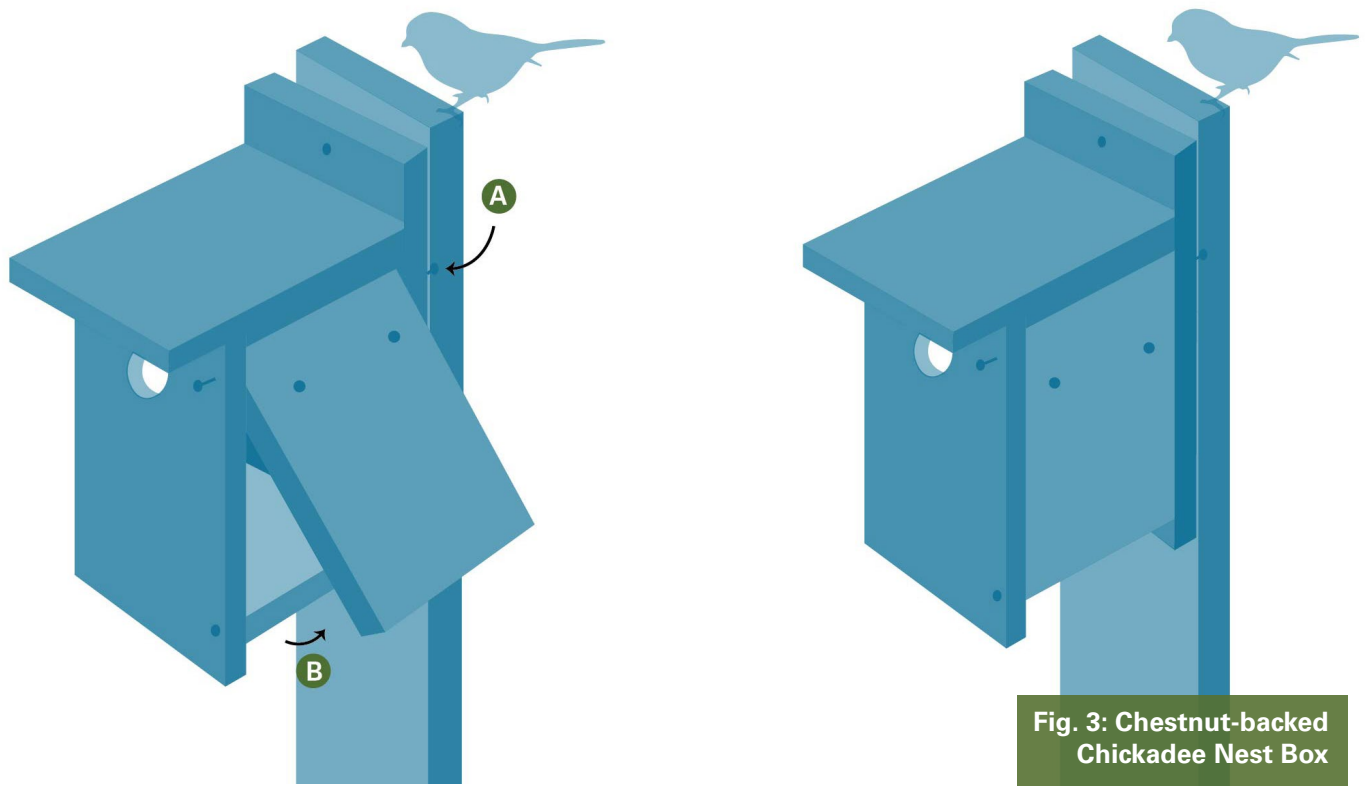


Fig. 3: Chestnut-backed Chickadee Nest Box

- A - Pivot nail
- B - Side of box opens for easy cleaning

*Note: Size of opening is dependant on the species. See [The Cornell Lab of Ornithology](#) for details

*Diagrams adapted from [The Cornell Lab of Ornithology 1, 2](#)

Where to Implement: Field (Open); Forest; Wetland; Riparian; Rivers and Lakes; Marine – Estuarine; Urban Matrix.

What to Watch For: Nest boxes are susceptible to competition (i.e., may support non-target or undesirable species such as Barred Owls, Eastern Grey squirrels, wasps, bees, House Sparrow, European Starling).

Monitoring for Use:

- ☑ Nest boxes may be investigated but not used the first year or two. If nest boxes have not been used after this time, they should be moved to another location.
- ☑ Avoid unnecessary disturbance when monitoring and clean only when vacant.

1.5.2 NEST STRUCTURE - PLATFORM

Nest platforms are flat structures that provide a base for nest construction for some bird species. Platforms can be elevated, hanging, or floating and be modified with tubes, baskets, and cylinders.

BARN SWALLOW:

- ☑ Place 2.5 – 4 m high on sheltered, vertical wall (under eave) of building.
- ☑ Place platform to limit disturbance from people and predators.
- ☑ Add predator guards on posts.

Focal Guilds and Species:



Where to Implement: Field (Open); Wetland; Rivers and Lakes; Marine – Estuarine; Urban Matrix.

What to Watch For:

- ☑ May require regular monitoring for uptake and maintenance.
- ☑ May attract invasive or non-target species.
- ☑ Open water placement suitable for some bird species deters predation but makes access for maintenance more difficult.

1.5.3 RAPTOR PERCH

Artificial perches can increase presence of raptors, particularly in open, agricultural areas where natural perches are less common or absent. Perches use metal or wood poles to replicate snags and may be modified with nest boxes or platforms.

Design Guidelines:

- ☑ Mount perch 5-6m above ground.
- ☑ Attach dual crossbeams a minimum of 1m apart.
- ☑ Orient perches so that crossbeams point east and west.

Place along edge interfaces and close to preferred habitat for target species.

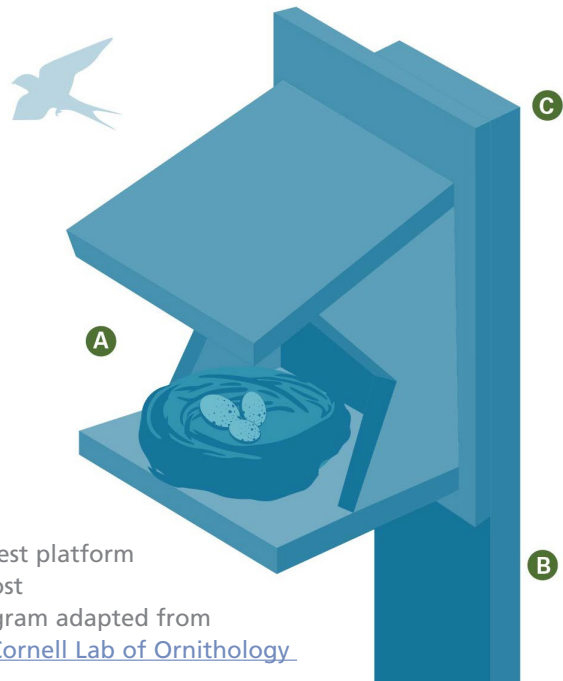


Fig. 4: Barn Swallow Nest Platform



Barn Swallows
 Credit: Vicki DeLoach

Guilds and Focal Species: 
Cost: \$\$

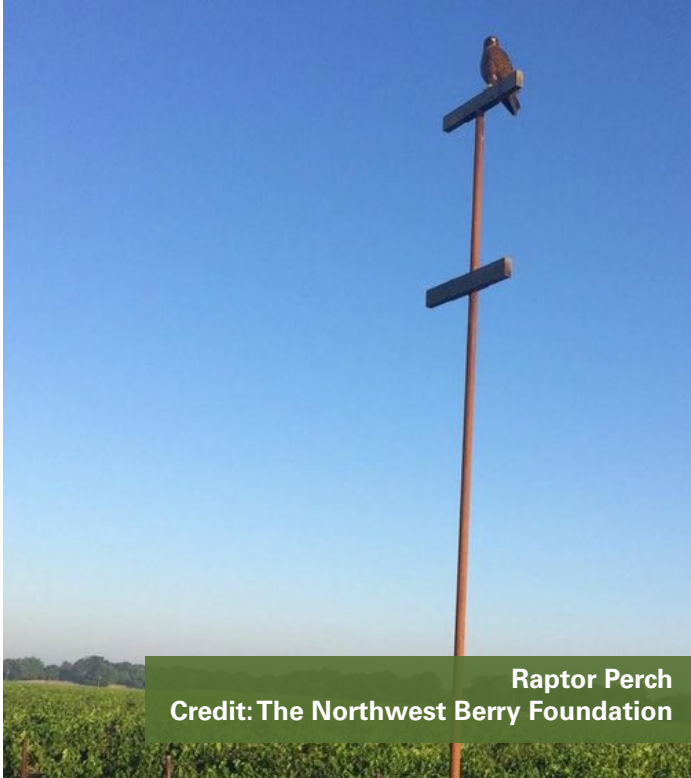
What to Watch For:

- ☑ Raptors prefer perches that provide protection from above and below.
- ☑ Avoid placing close to branches of adjacent trees.

Where to Implement: Field (Open); Wetland; Rivers and Lakes; Marine – Estuarine.

Co-benefits:

- ☑ Pest control (e.g., rats, voles, mice, European Starlings, Rock Doves).



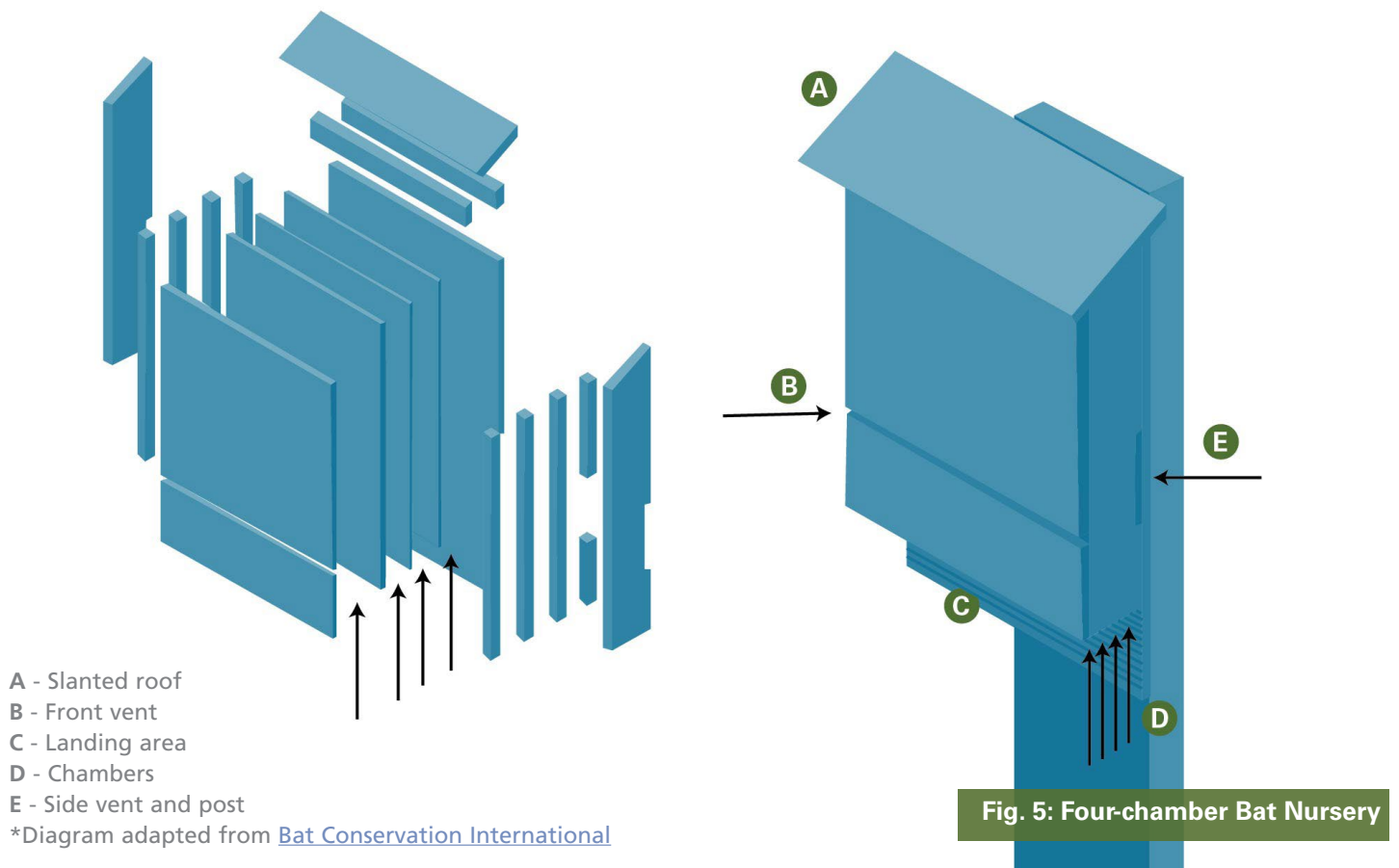
Raptor Perch
 Credit: The Northwest Berry Foundation

CASE STUDY

Community Bat Programs of BC

Community Bat Programs of BC offers a certification program for bat-friendly communities. In 2020, the City of Richmond was designated Metro Vancouver's first bat-certified community. The City recognizes the important role that bats play to control insect populations in agricultural areas and forest ecosystems. Amongst various initiatives to protect bat habitat, the City has erected a bat condo and satellite bat boxes to support species such as the endangered Little Brown Myotis.

See the Community Bat Programs of BC publication *Bat-Friendly Communities: A guide for managing and enhancing bat habitat in British Columbia* for more information.²⁷



1.5.4 BAT HOUSE

Small to large artificial structures designed to provide alternative roost sites for bats, including habitat replacement for maternity colonies. Bat houses attract common species; larger structures can accommodate multiple species and maternity colonies.

Design Guidelines:

- ☑ Mount 4 - 7m high facing S, E, W to maximize sun exposure.
- ☑ Reduce exposure to lights and high wind.
- ☑ Keep clear path to entrance; include rough surfaces to roost.
- ☑ Include a landing strip.
- ☑ Keep waterproof and warm (but not too hot!) and place in a location that will not attract predators.

Focal Guilds and Species: 
Cost: \$-\$\$

Where to Implement: Field (Open); Wetland; Riparian; Rivers and Lakes; Urban Matrix.

What to Watch For:

- ☑ Patience is key! It may take years for bats to discover a bat box.
- ☑ May result in noise, smell or guano in urban areas. Check annually for wasp/bee nests.
- ☑ Bigger is better. Multi-chambered houses allow bats room to move and adjust temperature.

- ☑ Bat boxes require specific design elements to attract and house bats. Many off the shelf designs are not suitable for BC's climate. Expect seasonal use of bat houses as many bat species will either migrate or hibernate elsewhere.
- ☑ May require regular monitoring for uptake.



Little Brown Myotis
Credit: Pamela Zevit

FURTHER READING:

Bat House Designs.²⁸

Building Homes for Bats: A Guide for Bat Houses in BC.²⁹

1.5.5 INSECT/ POLLINATOR HOTEL

Artificial sanctuary for insects and spiders that can offset habitat loss and host other species. Space may be used for shelter, nesting, or hibernation.

Design Guidelines:

- ☑ Designs and dimensions are variable; build to suit using recycled and/or natural materials.
- ☑ Create cracks, crevices, and holes for insects and other wildlife.
- ☑ Place in sheltered location facing the sun.
- ☑ Include sections, shelves, and a roof to keep dry.
- ☑ Surround with pollinator plants and other natural vegetation to attract insects.

- ☑ Avoid treated wood as chemicals will deter insect use.

Focal Guilds and Species:  

Cost: \$

Where to Implement: Urban Matrix, Field (open).

What to Watch For:

- ☑ Poor designs can be unsuitable for insects and/or detrimental to insect health (e.g., increase risk of disease/parasitism).
- ☑ Requires regular maintenance, cleaning, and replacement to ensure suitable condition for insect survival.
- ☑ Avoid planting too close to structures to avoid vegetation encroachment and shading of access.

CASE STUDY

Mason Bee House, Surrey, BC

This mason bee house was installed on parkland received as part of a subdivision agreement. Costs to build and install the mason bee house and a commemorative boulder were donated by a local family whose land was subdivided.



A



B



C

A - Mason Bee House (see case study - previous page) - Credit: Sheena Fisher
 B - Insect Hotel, Rochester Park, Coquitlam - Credit: Pamela Zevit
 C - Pollinator Hotel, Terra Nova Park, Richmond - Credit: Pamela Zevit

1.6 NATURAL HABITAT FEATURES

1.6.1 WILDLIFE TREES

Naturally occurring forest ecosystem components with attributes (e.g., size, age, species, decay class) considered valuable for wildlife.

Design Guidelines:

- ☑ Preserve wildlife trees within 15m of open fields and 30m of water, where appropriate and safe to do so.
- ☑ Retain a minimum of 25 and 40 wildlife trees per hectare in forests adjacent to field and water edge zones.
- ☑ Preserve a mixture of wildlife trees with cavities and without.
- ☑ Prioritize wildlife trees in edge zones; these are areas where wildlife use is often the highest.

Focal Guilds and Species:



Cost: \$-\$\$



Where to Implement: Forest; Wetland; Riparian; Forest (mature).

What to Watch For:

- ☑ Tree height, diameter, species, soundness (live or dead and level of decay), and location will determine what wildlife will use it.
- ☑ Some trees may pose risk to people and property or may be perceived as unsightly. Careful management can help balance risk and value.

1.6.2 DOWNED WOOD

Downed and rotting fallen trees and stumps that provide habitat for plants, insects, and wildlife. Plants and animals dependent on decaying wood are at risk when natural forest floor levels of downed wood fall below 30 percent of what would naturally occur.³⁰

Design Guidelines:

- ☑ Prioritize downed wood in natural areas close (e.g., within 300m) to water and seasonal wet areas to increase biodiversity benefits.
- ☑ Reduce the amount of downed wood in natural areas where fire risk is higher or where in close proximity (i.e., within 100m) to buildings, infrastructure, or other values potentially at risk from wildfire. Prefer softwood (e.g., western redcedar) to hardwoods to increase longevity of downed wood.
- ☑ Include a variety of decay classes and piece sizes. Note that larger pieces last longer, hold more moisture, contribute more organic matter, and support more biodiversity than small pieces.
- ☑ Target 11 large downed wood piles per hectare.

Focal Guilds and Species:



Cost: \$



A



B



C

A - Downed wood - Credit: Pamela Zevit
B - Eagle Mountain - Credit: Pamela Zevit
C - Bose Forest Park Play Area

Where to Implement: Field (Open); Forest; Wetland; Riparian; Forest (mature); Urban Matrix.

What to Watch For:

- ☑ May be perceived as unsightly and can be potential fuel hazard if not managed appropriately.
- ☑ Regular monitoring and maintenance can extend the lifespan of downed wood piles.
- ☑ Can shade out or smother understory vegetation.

Co-benefits:


- ☑ Promote nutrient cycling.
- ☑ Attract beneficial wildlife (e.g., terrestrial amphibians, reptiles, birds, small mammals) that feed on invertebrates and help control pests (e.g., bark beetles, slugs).

1.6.2 BRUSH/LEAF PILES

Managed pile of tree trunks, branches, leaves, and other debris (e.g., rock) that provides habitat (shelter, feeding, breeding, winter cover) for multiple species in areas where natural cover is lacking

Design Guidelines:

- ☑ Retaining whole leaves can reduce maintenance (e.g, leaf removal and shredding).

Local Guilds and Species: 

Cost: \$-\$\$

Where to Implement: Field (Open); Forest; Wetland; Riparian; Forest (mature); Urban Matrix.

Monitoring for Use:

- ☑ Regular monitoring to assess condition, fire risk, and uptake.

1.6.3 EXPOSED SOIL/SAND PILES

Open, bare areas with exposed soil conditions that provide preferred habitat for ground-nesting species, invertebrates, and pollinators.

Focal Guilds and Species: 

Cost: \$

Where to Implement: Field (Open); Urban Matrix.

What to Watch For:

- ☑ May require management for erosion, sedimentation, and clearing of vegetation.

Co-benefits:

- ☑ Slow carbon release.
- ☑ Promote nutrient cycling.
- ☑ Retain moisture.
- ☑ Build soil.
- ☑ Suppress weeds.
- ☑ Control pests.

FURTHER READING:

Wildlife Tree Retention: Management Guidance³¹
Chief Forester Guidance CWD Management.³¹
2020 Fuel Management Prescription Guidance. ³²



A - Leaf Pile - Credit: Pamela Zevit

B - Ground nesting mining bee - Credit: Sankax

1.7 SHORE STABILIZATION

1.7.1 SHORE STABILIZATION WITH PLANTING POCKETS


Standard angular rip-rap is commonly used for stream and shoreline protection but has poor habitat value and can impair wildlife movement. These riparian areas are essential corridors for wildlife movement and are used by a wide range of species because of the access to water and a range of different moisture regimes (dry to wet). Design is generally subject to engineering requirements and public safety considerations, which must take precedence.

Design Guidelines:

- ☑ Use a mix of rock types and sizes to enable movement by a variety of different species.
- ☑ Incorporate rounded boulders and fill larger gaps and holes with less angular rip-rap as angular rock can trap some wildlife, such as amphibians.
- ☑ Create terraces and benches with plantings and align these with wildlife passages through culverts.
- ☑ If planting benches aren't possible, incorporate smaller soil pockets with plantings to provide cover along the bank or shoreline.
- ☑ Maximize overhanging vegetation to provide shade, cover, and nutrients for aquatic habitats.
- ☑ Plant stakes (willow or dogwood) in

between rip-rap. Stakes should be inserted while dormant and be a minimum of 4cm diameter.

- ☑ Plant ecologically-suitable grasses, rushes, and sedges in pockets.
- ☑ Vary size, shape, and density of rock to allow for soil pockets that can be planted, seeded, or naturally regenerated. Add soil pockets only above the high water mark to avoid erosion due to flooding.

Focal Guilds and Species: 

Cost: \$\$

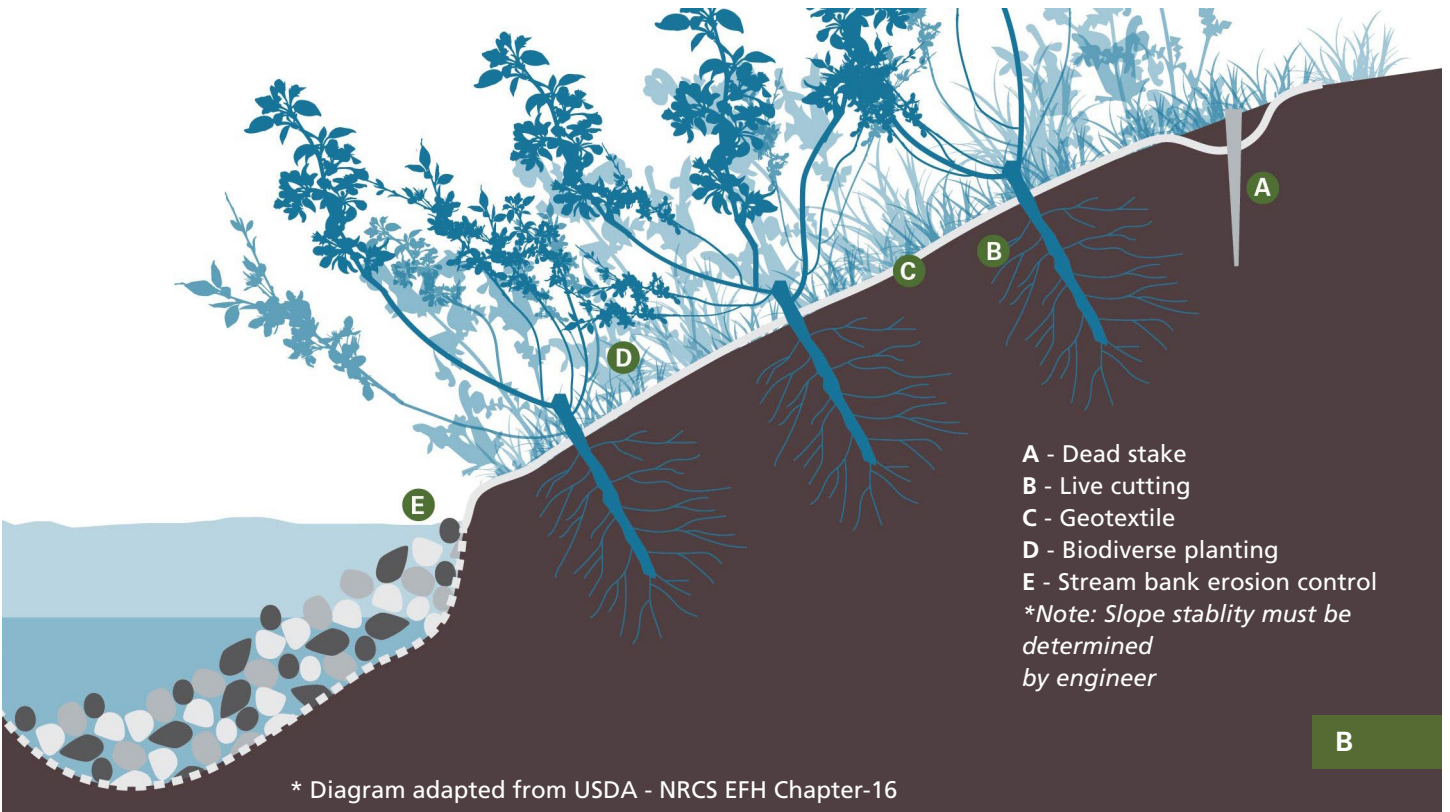
Where to Implement: Rivers and Lakes; Marine – Estuarine.

What to Watch For:

- ☑ Inspections required after high water and floods.
- ☑ Monitoring and repair of slumps and rock displacement.

Co-benefits:

- ☑ Reduce erosion.



A - Country Club Streambank Restoration - Credit: Envirolok
 B - Fig. 6: Live Staking with Woody Plants

1.7.2 COVER STRUCTURE AND ARTIFICIAL HIBERNACULA

Rock structures including piles, walls and embankments provide crevices for shelter. Artificial hibernacula replicates natural conditions (e.g., thermally stable) suitable for wildlife to hibernate over winter.

Design Guidelines:

- ☑ Identify preferred habitat where target species (e.g., snakes, amphibians, small mammals) are known to occur. Multiple species may use the same structure.
- ☑ Hibernacula size can be variable but should be placed in sunny, south-facing, wind-sheltered, upland location that is well drained with sandy or sandy loam soils.
- ☑ Excavate hole so that it extends below the frost line but is above the water table so that it does not flood (i.e., 2 – 7m deep and 4m across).
- ☑ Place 2 to 3 entrance tubes (e.g., concrete drain pipes or any PVC drainage tube with a roughened interior to allow animals to exit without slipping) into hole at ground level.
- ☑ Cut holes in the sides along the length of tube.
- ☑ Fill hole with larger rock, concrete blocks, logs, branches, but create chambers and gaps at different depths to allow snakes to move based on temperature/humidity preferences.

- ☑ Cover pile with rock and soil.
- ☑ Keep hibernacula free of shrubs but place cover objects around hibernacula to reduce exposure to predators.

Focal Guilds and Species:



Cost: \$\$-\$\$\$\$

Where to Implement: Field (Open); Forest; Riparian; Forest (mature); Urban Matrix.

What to Watch For:

- ☑ It can take several years for target species to discover and use hibernacula. Monitor regularly (early spring and fall) for uptake.
- ☑ Maintenance required to replace and move displaced rock.

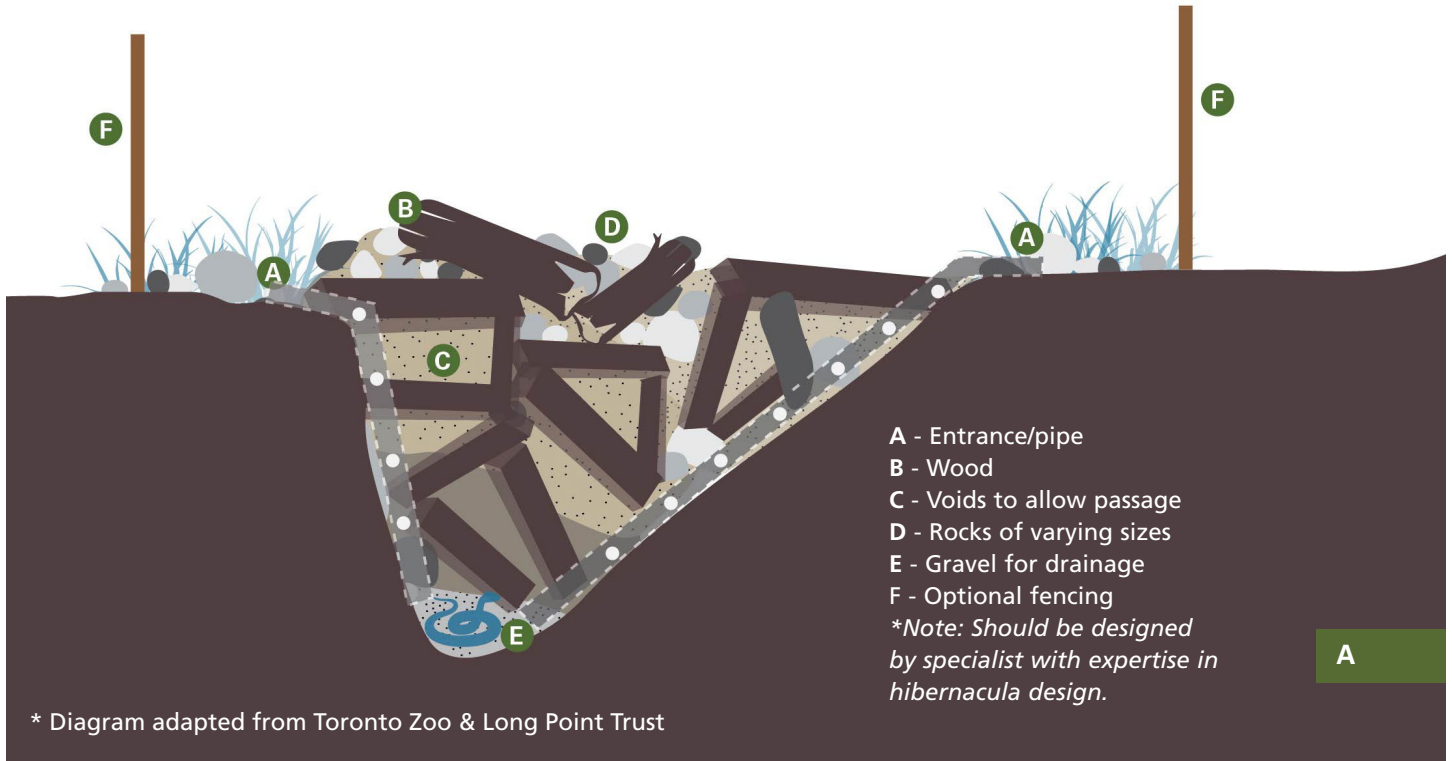
Co-benefits:

- ☑ Increase public awareness and tolerance of snakes.
- ☑ Support snake populations that can help control pests (e.g., Garter Snakes prey on slugs).

FURTHER READING:

[How to Create a Snake Hibernaculum.](#)³³

[Snake Hibernacula.](#)³⁴



A - Fig. 7: Snake Hibernacula

B - Snake Hibernacula construction - Credit: Joe Walton

1.8 AQUATIC HABITAT

1.8.1 VERNAL POOLS

Temporary pools of water fed by rain or snowmelt and often dry by mid-summer. Some amphibian species require vernal pools for reproduction, and many will return to the same vernal pool each year. Due to their temporary nature, vernal pools are usually absent of predators such as bullfrogs and fish.

Design Guidelines:

- ☑ Keep dimensions between 3 and 15m long and up to 1.5m deep.
- ☑ Choose low areas with impermeable soil types (e.g., clay, silty loam).
- ☑ Contour pool to achieve multiple benches and depths that will create different light and temperature gradients for greater biodiversity.
- ☑ Retain and re-apply plants, leaves, topsoil, and other debris to re-establish micro-organisms and fungal communities.

Focal Guilds and Species: 

Cost: \$\$



Where to Implement: Field (Open); Forest; Riparian; Forest (mature).

What to Watch For:

- ☑ Placement is important! Vernal pools can be constructed in almost any habitat; however, the quality of habitat surrounding vernal pools is important. Vernal pools should be surrounded by trees or located within upland forest habitats.
- ☑ Trees provide shade, which will cool the water and reduce evaporation, and permit vernal pools to persist longer into the summer.
- ☑ Vernal pools often have little to no vegetation within them.
- ☑ Vernal pools can become ecological traps if they dry out before important animal life-cycles are completed (e.g. tadpole metamorphosis).
- ☑ Maintenance may be required to manage infilling, sedimentation, and invasive species.

Monitoring for Use:

- ☑ May require regular monitoring for uptake (5 years is recommended to determine if breeding is occurring).

FURTHER READING:

Creating Successful Vernal Pools: A Literature Review and Advice for Practitioners. ³⁵

Community-Level Enhancements of Biodiversity and Ecosystem Services. ³⁶



Vernal Pool
Credit: Tim Ide

1.8.2 LARGE WOOD

Placement of downed wood instream is a natural restoration approach that minimizes the need for hard engineering (i.e., construction of physical structures). Large wood includes tree trunks and root masses of different dimensions. Large wood provides important ecosystem functions that affect fluvial processes (e.g., erosion, sedimentation), channel morphology (shape and direction of a stream), and provides structure, nutrients, and habitat for aquatic/riparian organisms (e.g., juvenile salmonids, fish, birds, mammals, plants). Loss of riparian areas and large trees reduces natural wood inputs (i.e., recruitment) into streams.

Focal Guilds and Species:



Cost: \$\$-\$\$\$\$

Where to Implement: Rivers and Lakes;
Wetlands.

What to Watch For:

- ☑ Regular monitoring for effectiveness and after flood events.
- ☑ Maintenance may be required to manage debris accumulation and/or decay (if there is constant wetting and drying) over time.
- ☑ Regulatory compliance and engineering requirements for projects can be costly and time-consuming.
- ☑ Long-term hydrological effects due to climate change are unknown.

- ☑ Reintroducing large wood is a beneficial restoration strategy; however, it requires careful planning, design and engineering.
- ☑ Maintaining stability of large wood over a longer period of time will provide most ecological benefits.
- ☑ Work must consider fisheries windows and weather conditions.

Co-benefits:

- ☑ Stabilize channels and banks.
- ☑ Control erosion.
- ☑ Moderate stream flow.
- ☑ Help raise water level.

FURTHER READING:

National Large Wood Manual: Assessment, Planning, Design, and Maintenance of Large Wood in Fluvial Ecosystems: Restoring Process, Function, and Structure.³⁷
Diversity by Design. A Guide for Restoring Habitat for Species at Risk on BC's South Coast.³⁸



Large wood in stream
Credit: Rebecca Anderson

1.9 OTHER HABITAT STRUCTURES

1.9.1 BACKYARD PONDS AND WATER FEATURES

Backyard ponds and water features are becoming increasingly important for wildlife including invertebrates, particularly in areas where wetlands and vernal pools are declining. These valuable habitats provide important year-round access to water and breeding/rearing habitat.

Design Guidelines:

- ☑ Position with some direct (but not full) sun, away from trees (to avoid collecting leaves).
- ☑ Add moving water feature (e.g., waterfall) to attract more birds and circulate water.
- ☑ Include a shallow end that is more accessible for birds and other wildlife.
- ☑ Ponds do not have to be large to be of value, 2 to 4 square meters can provide plenty of habitat.
- ☑ Excavate to depth that will ensure pond will collect enough water so that it does not freeze completely over winter or dry out in the summer. Siting a pond in a depression can help with drainage and water collection.

Guilds and Focal Species:

Cost: \$\$

Where to Implement: Urban matrix.



What to Watch For:

- ☑ Avoid introducing fish into ponds as they can feed on invertebrates and amphibians, and may also attract other unwanted predators (e.g., Raccoons).
- ☑ Watch for build-up of dead, organic matter.
- ☑ If safety of children is a concern, consider constructing a more shallow water feature such as a bog garden or add a bird bath.

Co-benefits:

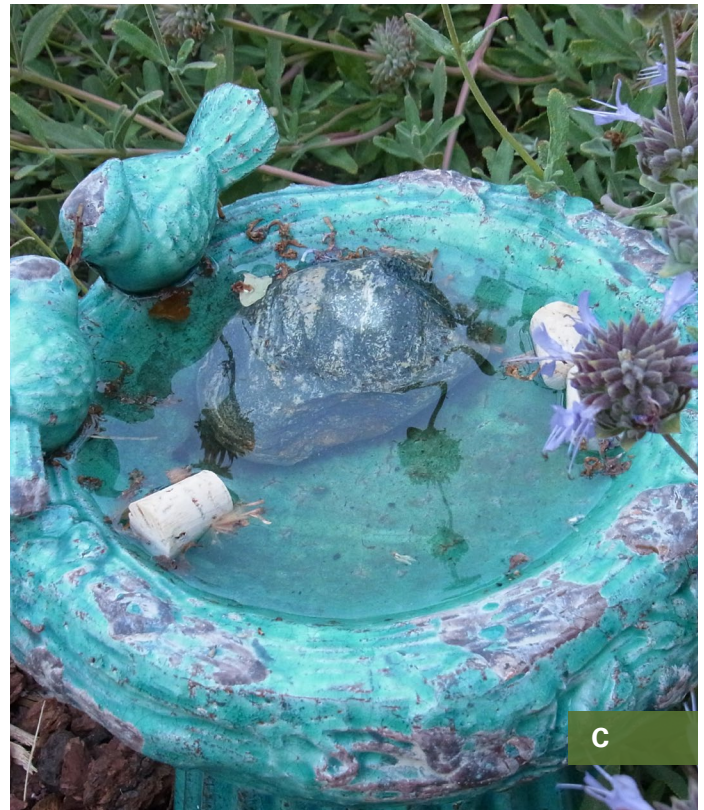
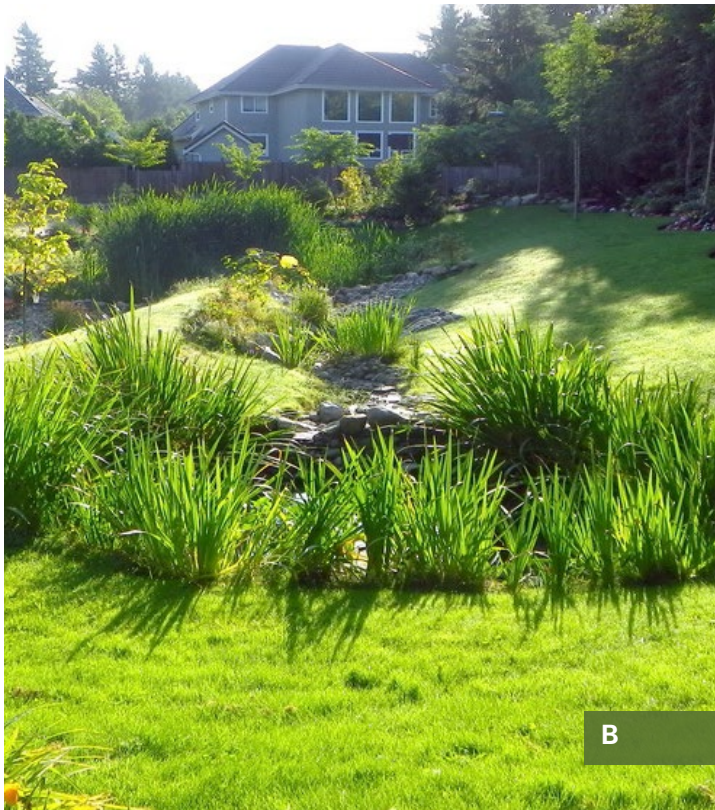
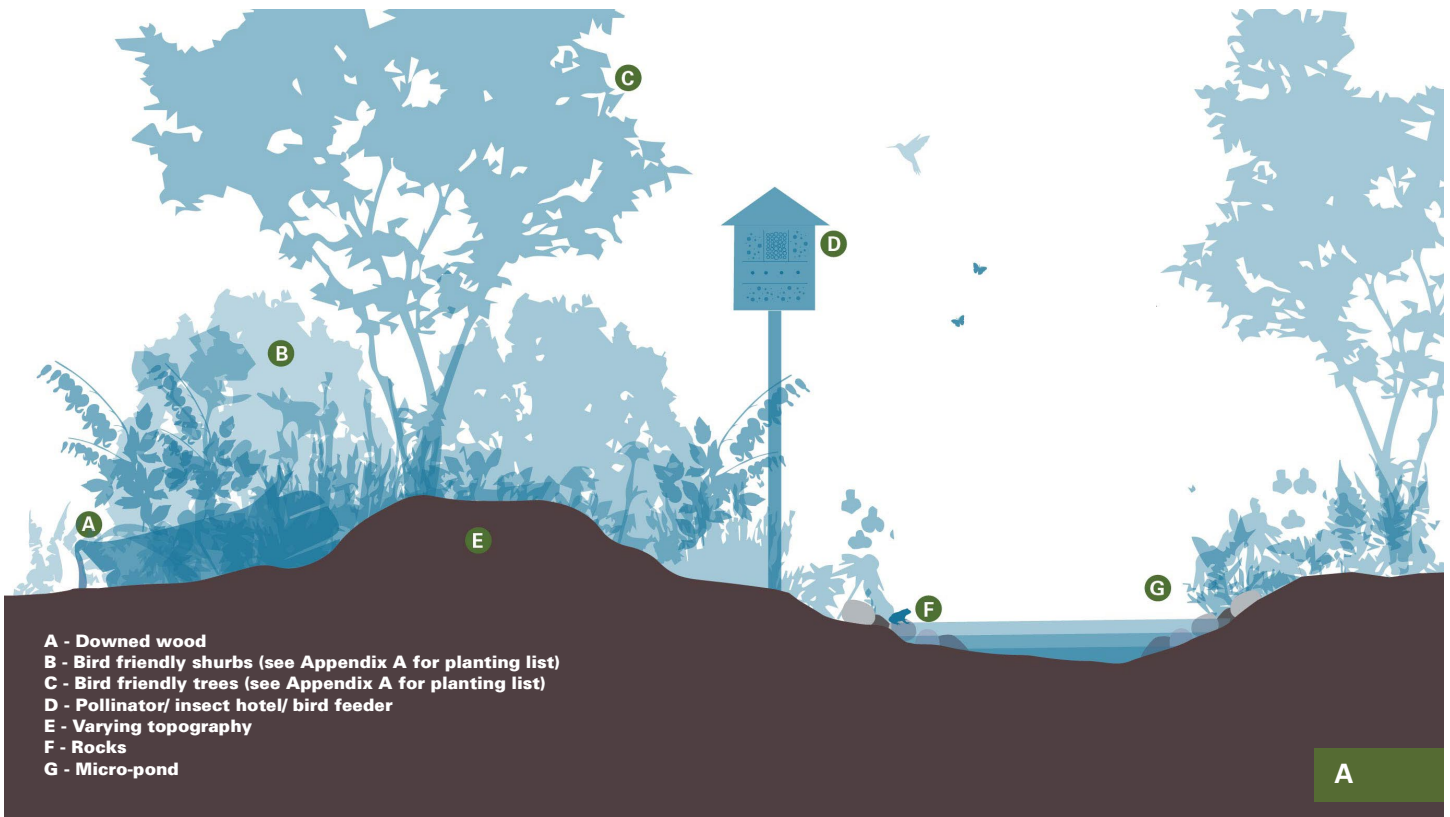
- ☑ Provides visual aesthetic.
- ☑ Cool surrounding air through evapotranspiration.
- ☑ Collect rainwater.

1.9.2 BIRD BATH

Constructed basins located at or above ground level to provide a water source for birds to drink, preen, and keep cool. Multiple design options are available (e.g., ground, pedestal, hanging, electric, solar, battery operated) depending on requirements.

Design Guidelines:

- ☑ Integrate heated designs to prevent freezing.
- ☑ Choose location (ground or elevated) to attract different species.
- ☑ Include fountains to attract more birds.
- ☑ Add river rocks or mounds of pebbles to



A - Fig. 8: Micro Pond
 B - Micro Pond - Credit: ISMP Planning, Surrey
 C - Bird and bee bath - Credit: University of California, Ag & Natural Resources

provide escape for bumblebees and other insects that may use birdbaths as a water source.

Focal Guilds and Species:



Cost: \$

Where to Implement: Urban Matrix

What to Watch For:

- ☑ Design will influence weather resiliency and ease of repositioning.
- ☑ Ground level baths may increase risk of predation.
- ☑ Stagnant and/or contaminated water can result in bacteria, mold, algae, mosquitoes, and increase disease risk for birds.
- ☑ Deep water can increase risk of drowning smaller birds and insects.
- ☑ Metal bird baths can result in hot surface/water that may deter birds.
- ☑ Regular cleaning is required.

1.9.2 BIRD FEEDERS

Feeders come in all shapes and sizes. Using a variety of feeders will attract the most birds. Common designs include ground feeders, hopper feeders, thistle seed feeders, suet feeders, nectar feeders, and sunflower feeders (which are considered the best all around choice if you had to select just one).

Design Guidelines:

- ☑ Place away from windows to reduce collision-risk.

- ☑ Locate different feeders at different levels and use different seed mixes to attract different species of birds.
- ☑ Maintain a fresh supply of water nearby.
- ☑ Provide cover (trees and shrubs).

Focal Guilds and Species:



Cost: \$

Where to Implement: Field (Open); Forest; Riparian; Forest (mature); Urban Matrix.

What to Watch For:

- ☑ Regular cleaning required to prevent disease spread.
- ☑ Ensure proper types of seed sources (e.g., no invasive plants) and proper mix for hummingbirds.

1.9.3 BIRD-FRIENDLY DETERRENTS

Visual markers (e.g., decals, semi-transparent stripes/dots, netting) applied to glass/reflective surfaces and exterior facades to reduce transparency/reflectivity and deter bird collisions. Other types of deterrents such as flight insulators and perch deterrents can be used to decrease bird mortality in areas such as utility corridors where birds may experience a high collision or electrocution risk (refer to Module 2: Light & Noise for more information).



Bird safe glass
Credit: Bell Musuem



Cat Enclosure
Credit: Eileen Mak

Design Guidelines:

- ☑ Markers should meet BirdSafe[®] criteria.
- ☑ Markers should be applied to all glass surfaces from ground level to height of mature canopy or 16m, whichever is greater.
- ☑ Markers should be > 6mm diameter. Marker spacing should not exceed 5cm on horizontal/vertical plane.
- ☑ Secondary treatments such as interior blinds/shades, louvers, mullions, tinting, angled glass can also reduce transparency/reflectivity.




Guilds and Focal Species: 
Cost: \$-\$\$\$

1.9.4 CAT ENCLOSURES

Shelter-based strategies (e.g., catio) that provide access to outdoor space but limit free-roaming and potential predation on wildlife (e.g., small mammals, birds, reptiles, and amphibians).

Design Guidelines:

- ☑ Designs can vary to accommodate space, materials, and budget.

Guilds and Focal Species:   
Cost: \$-\$\$

Where to implement: Urban Matrix.

FURTHER READING:

- 15 ways to a Wilder Garden.³⁹
- Water Features and Bog Gardens.⁴⁰
- Backyard Pond – Garden for Wildlife.⁴¹
- Audubon Guides to Bird Feeders, Bird Seed, and Bird Feeding.⁴²
- Bird Safe.⁴³
- Bird-Safe Standard for Federal Government Buildings - A Synthesis of Bird-Friendly Guidelines and Standards.⁴⁴
- Bird-Friendly Building Design.⁴⁵
- Stewardship Practices for Reducing the Effects of Cats on Birds and Wildlife.⁴⁶
- How to Build a Catio.⁴⁷
- Cats and Birds - Safe Outdoor Options.⁴⁸
- Catio Spaces.⁴⁹
- Solutions for Pet Cats⁵⁰

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