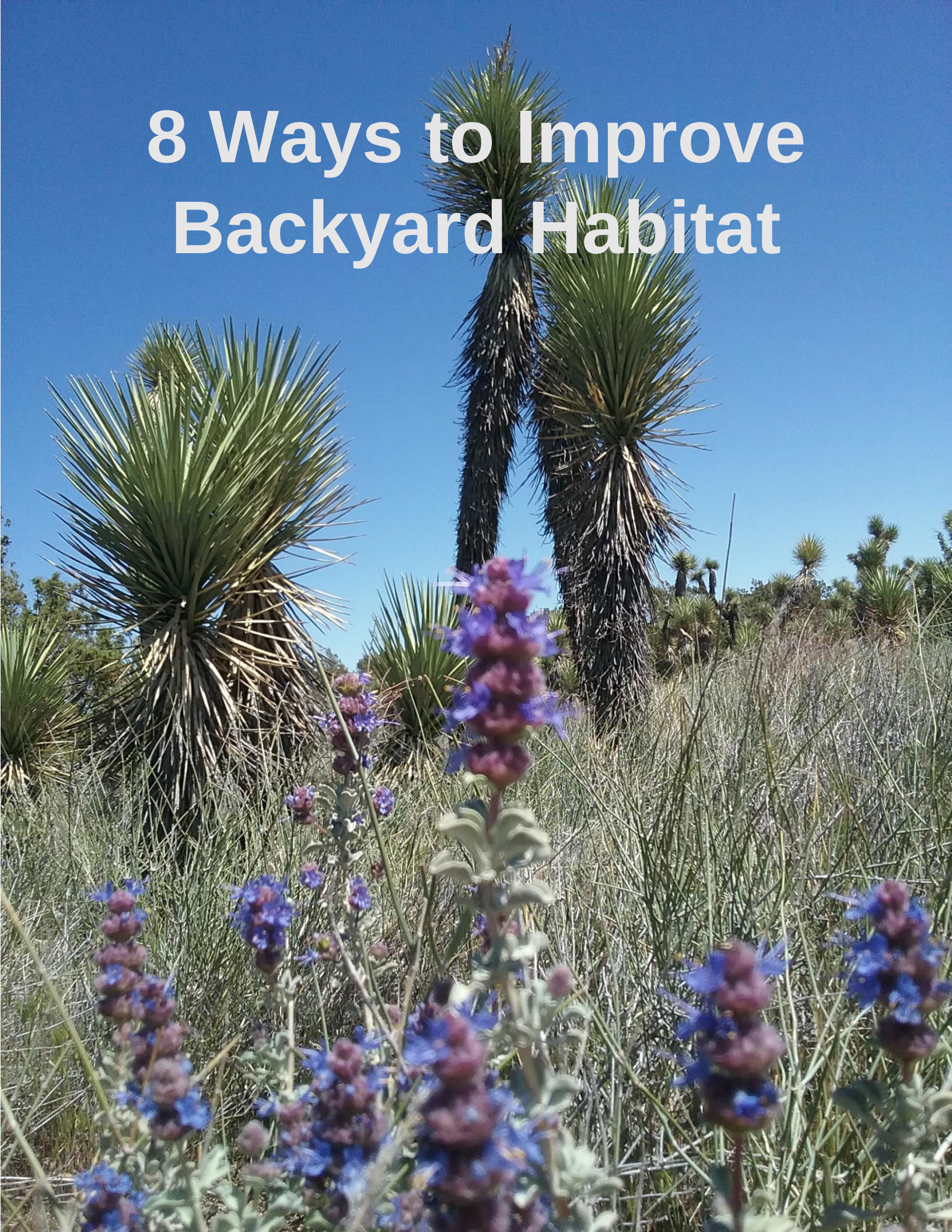
8 Ways to Improve Backyard Habitat



8 Ways to Improve Backyard Habitat

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A Home Sweet Habitat Publication

Introduction: What is Habitat Anyway?

Before we get to the ways you can improve your backyard habitat, it is best to agree on a definition of what habitat even is. The dictionary defines habitat as “the natural home or environment of an animal, plant, or other organism.” However, this definition barely scratches the surface of what habitat is. Is an animal’s stomping ground the only place it needs to survive?

This habitat definition is insufficient for the Greater Sage-Grouse (*Centrocercus urophasianus*), which requires a special breeding ground so it can perform its *lekking* behavior (think of a frat party for quail-like birds, and you’re pretty close). This also fails to capture the complex needs of migratory animals such as Canada Geese (*Branta canadensis*), which require northern habitat to feed and raise young and southern habitat to stay out of the North’s brutal winter conditions. Additionally, migratory birds need suitable food and shelter on every stop along the way, which requires decent wetland vegetation along a very large travel route.

For nomadic species such as Gray Wolves (*Canis lupus* [1]), home is wherever they find on their path that is suitable for shelter, hunting, and mating. To them, habitat is wherever they lay their heads down.

Birds need places to call and attract mates; deer and other mammals need places where the young can challenge each other for dominance; and plants need conditions where they not only can grow, but where their seeds have a good chance of establishing a new generation. Plus, every living thing needs a food source to survive, whether that food is sunlight, vegetation, insects, or meat. A habitat without food is not habitat at all.

If a population of Greater Sage-grouse have their lekking ground but no suitable home range, they will not survive. If they have their home range but no lekking ground, the adults’ survival won’t matter; they will be extinguished in a generation with no way to bear children.

Habitat is so much more than just a “natural home”. Habitat is complex, with many conditions, most of which need to be satisfied for a species to persist. In this way, my definition of habitat more closely resembles the concept of an *ecological niche*. That is, what conditions must be met for a species to thrive on your property?

Temperature, vegetation type, plant density, hiding places, etc. The closer you can get to satisfying these conditions for the species you seek to attract, the better your habitat will function for those species. Maybe your space only satisfies *some* of the conditions needed by a species. This is totally ok! I’d rather have a male deer visit my yard and nibble on a few plants than exhibit his aggressive pre-mating *rutting* behavior in my backyard or bed down for the night!

Regardless of the definition of habitat you operate under, this guide will be a major help for you as you seek to enhance what's in your backyard.

Footnote:

1. Yes, the Gray Wolf and the Domestic Dog are the same species. They can interbreed, so they are different *subspecies*.

Tip #1: Emulate What's Around You

In one of my ecology courses in college, my professor discussed the concept of an *ecological niche.* In short, an ecological niche is the specific set of conditions that allow an organism to thrive; that is, what role does the creature fill in the ecosystem? Is it a consumer, producer, or decomposer? Does it live on the ground in leaf litter, or in a nest buried in tule or cattail plants?

Of course, that's not how my professor described an ecological niche at all. He decided to define the ecological niche as an "*n-dimensional hypervolume".* As if that makes any sense! While I thought he was politely saying "get on my level or you'll fail my class", he was actually making a good point in the most obnoxiously scientific way possible.

An ecological niche has more conditions than we can possibly appreciate. We can plant the right plants, but what about the nutrients in the soil? What if we prune our plants and remove too much shade, changing the temperature and moisture content below a tree on the ground? You can go crazy trying to satisfy every condition, but for every condition you correctly emulate, you make the right species feel more and more at home while discouraging nonnative species. By designing habitat that matches what these creatures are designed to thrive in, you will ensure your habitat is a success.

Still, you have needs! Human constraints will always be present. If you're like most home habitat engineers, you probably want to share your space but not completely surrender it to wildlife. And that's absolutely ok; natural maintenance of your yard will differ from what happens in nature, so it's impossible to capture natural processes perfectly anyway. Even if you un-managed your yard, allowing "nature" to take its course, it still wouldn't happen. Weeds that colonize your space may not even be native species, and wildlife are likely to use your open space differently than a more established park or preserve.

My suggestion is to not stress about checking off all of the boxes. Check off every habitat box you can comfortably achieve and that you already know about, and let nature be your inspiration for the rest.

Natural Areas (Mostly) Satisfy the Ecological Niches of Native Species

Travel to a natural area around your house that most closely resembles the habitat of your region and yard. What does it show you? What plants are represented? How spread out are they? Is there a diversity of plant species, or are there only one or two different types? Are there plants that grow out in the open, or only grow in the shade of other species? What animals are visiting? Can you research their diets and shelters and make sure these needs are being met on your property? Spend some time there, watching the behaviors of creatures using the space. You might want to make a few trips. Many bird species are often the most active around sunrise, while reptiles and

other cold-blooded creatures will likely wait for things to warm up a bit. Other animals are nocturnal or even *crepuscula*r (meaning they are most active during twilight hours).

This Raccoon (*Procyon lotor*) is using this non-natural dirt road within the greater ecological sanctuary of the Yolo Bypass Wildlife Area. Photo Credit: This was taken using a motion-capture camera my team set up during an ecology class in 2014.

Truly natural areas are already going to check off many boxes for multiple species' ecological niches. In the great dance of adaptation, a slow-moving conversation takes place where every living thing adapts a response to every condition it faces, including stresses or benefits created by other living things. This delicate, intimate dance includes many parts that not only may be unknown to you, but unknown to science. By all means, continue learning about habitat so you can continue to refine your own space, but the silver bullet will always be found in nature.

Not all Undeveloped Areas are Natural Areas

One important note: Just because a park or "natural area" exists around your home, it might not be the best representative of what habitat in your area should look like. There may be an invasive grass, vine, or shrub dominating the landscape, or there may have been some other human constraint that kept the area undeveloped.

Invasive Species can Transform an Area

As a young Boy Scout in Southern California, I assisted in a project at the Whittier Narrows Recreational Area where I removed large volumes of nonnative plants from the park. These invasive species can out-compete native species, both threatening the persistence of the native species and altering the landscape considerably. I have included some striking examples below:

Salt Cedar (*Tamarix spp.*) [1]

Salt Cedars are a group of plant species in the genus *Tamarix.* They are native to Europe and Asia but have heavily invaded sections of Southern California's Colorado River. Normally, the Colorado River provides a crucial source of water for plants and animals in this desert habitat. However, Salt Cedars are thirsty, with one plant able to consume the same amount of water as a human family of four. These thirsty plants deplete natural underground water reserves and desert springs. Native plants reliant on these water sources cannot survive a Salt Cedar invasion forever. Once the native vegetation dwindles and the Salt Cedar takes over, many animal species adapted to eating or nesting in specific types of vegetation can no longer survive, resulting in a negative ecological chain reaction.

Salt Cedar. Photo Credit: Robert Sivinski. 2011. Used with permission.

Kudzu (*Pueraria montana*) [2]

Kudzu is an invasive vine that grows in the Southeastern United States. It is native to Asia and was brought to the US in the 1870s. Growing up to one foot a day, Kudzu smothers native plants and blocks their path to sunlight by growing right over them. Kudzu has even been known to kill trees, envelop buildings, and break branches through the weight of its leaves. Anything reliant on native vegetation will find it increasingly harder to live as kudzu invades the area.

Kudzu overtaking a site in Georgia. Photo Credit: Jud McCranie. Used with permission.

Feral Pig *(Sus scrofa)* [3]

Not all invasive species are plants. Feral pigs are formerly domesticated pigs that have returned to their instinctual behaviors. Feral pigs are voracious eaters; they will tear up and eat native vegetation such as acorns, altering the landscape as they prevent native plants from growing to maturity. They also may harm or kill trees by rubbing the bark off as they rub their bodies against the trees.

Natural Areas with a Human Purpose

Many natural areas are kept ‘natural’ because they better serve humankind in an ecological capacity. Often, these areas have been slightly modified to act as flood control basins, fire breaks, etc. Some Northern California examples include the Yolo Bypass Wildlife Area in Yolo County and the Clover Creek Preserve in Shasta County.

Yolo Bypass Wildlife Area

The Yolo Bypass Wildlife Area is a wetland area managed by the California Department of Fish & Wildlife (CDFW) [4a]. The CDFW states that the Yolo Basin itself began as an 80,000-acre wetland, but over time human use altered the landscape dramatically [4b]. This massive wetland area was never developed due to its tendency to flood annually, as wetlands are designed to do. To develop here would be unwise. Instead, much of the basin (59,000 acres) was modified to divert floodwaters away from nearby Sacramento, CA and other flood-prone cities [5]. This region of the basin is now known as the Yolo Bypass.

The Yolo Bypass Wildlife Area constitutes nearly 17,000 acres of the Yolo Bypass that is under ecological restoration, management, or monitoring [4a]. The region supports “fish, waterfowl, shorebirds and wading birds, neotropical migratory birds, raptors [birds of prey], invertebrates, snakes, turtles, toads, and bats” across its seasonal wetland, permanent wetland, and riparian woodland habitats [4a]. Still, each habitat serves a different purpose. The CDFW states that the wildlife area is split into seventeen separate management units, including managed natural wetlands, unmodified natural wetlands, and agricultural wetlands[4b]. Of particular interest, rice is grown within the wildlife area because it provides revenue for the continuance of the project while still providing suitable habitat for ducks and other waterfowl. While this strategy is perfect for the Yolo Bypass Wildlife Area, I would focus on the non-rice parts on your own property!

This Great Egret (Ardea alba) is one of the many aquatic birds that makes use of the habitat found in the Yolo Bypass Wildlife Area. This was another picture taken by the motion-capture camera set up during my ecology class. To be honest, I think the Prius set the camera off.

Clover Creek Preserve [6]

The Clover Creek Preserve is a beautiful park established in Shasta County, California. It is 123 acres of undeveloped land whose primary purpose is flood prevention. The Preserve signage states that it can attenuate a 100-year flood event by storing up to 400 acre-feet of water, protecting residences nearby. It is a fantastic natural area; Clover Creek itself runs through the Preserve, and environmental restoration projects are occurring to create and enhance "…naturally occurring ecosystems including seasonal wetlands, vernal pools, emergent marsh, Blue Oak woodland, and riparian [streamside] communities." Still, it is important to note two things: the first priority is flood mitigation, and the ecological restoration projects are ongoing. In this case, it would be crucial to speak to a park guide to see what areas still need some work. This will enable you to know how to properly emulate the processes occurring at the preserve.

Clover Creek Preserve provides natural habitat in addition to flood mitigation. This seasonal *vernal pool* provides habitat to species that can live in no other habitat type, including the Vernal Pool Fairy Shrimp (*Branchinecta lynchi*).

The Bottom Line

Keep these examples in mind as you seek to create your habitat. I am not downplaying the utility of these areas to wildlife; they are crucial. Even so, they are also works in progress that have been altered by the actions of humankind. So, as you select a natural area to emulate, read the interpretive signage or speak to a park guide/ranger. They can be crucial help for you as you learn the inner workings of the park, including what is functioning as ecologically intended, and what still needs improvement.

Happy hiking! The best research always takes place in the great outdoors.

Footnotes:

1. The description of Salt Cedar and it impacts was taken from *California's Changing Landscapes: Diversity and Conservation of California Vegetation.* The book was written in 1993 by Dr. Michael Barbour, Dr. Bruce Pavlik, Dr. Frank Drysdale, and Dr. Susan Lindstrom. *California's Changing Landscapes* is a publication of the California Native Plant Society.
2. The description of Kudzu and its impacts was taken from the University of Florida's Center for Aquatic and Invasive Plants. You can access the link here: https://plants.ifas.ufl.edu/plant-directory/pueraria-montana/
3. The description of feral pigs and their impacts was taken from the Texas A&M University Agrilife Extension website. The content was authored by Dr. Billy Higginbotham in 2013, and can be found here: https://feralhogs.tamu.edu/frequently-asked-questions/frequently-asked-questions-wild-pigs/
4. a. California Department of Fish & Wildlife. *Yolo Bypass Wildlife Area.* February 9th, 2019. https://www.wildlife.ca.gov/lands/places-to-visit/yolo-bypass-wa#12208220-history
   b. California Department of Fish & Wildlife. *Yolo Bypass WA Land Management Plan.* December 26th, 2018. https://www.wildlife.ca.gov/Lands/Planning/Yolo-Bypass-WA
5. Cloé Garnache and Richard E. Howitt. University of California, Davis Department of Agricultural and Resource Economics. *Species Conservation on a Working Landscape: The Joint Production of Wildlife and Crops in the Yolo Bypass Floodplain.* 2011. http://ageconsearch.umn.edu/bitstream/103973/2/AAEAv4.pdf
6. Information on the Clover Creek Preserve was collected from interpretive signage located around the Preserve itself. The City of Redding, California manages and interprets the preserve, so the information belongs to the City. I observed the signs in late 2018.

Tip #2: Plant *Native* Plants, not “Native” Plants

If you have been working create wildlife habitat on your property for any length of time, you probably have had the concept of planting native plants drilled into you on a routine basis. This concept is certainly valuable, but it is strikingly incomplete. As a native Californian, I have heard my whole life to “plant California natives” in my own backyard habitat. The problem is, California is a massive state filled with dozens of eco-regions and countless microhabitats. The question we have to ask is, native to *what?*

I live at the very northern edge of California’s Central Valley. Here, the general habitat type consists of an oak woodland; native oaks dot the landscape while native annual and perennial grasses fill in the remaining space between trees. Closer to bodies of water such as the Sacramento River or Churn Creek, the habitat changes to *riparian* (river-adapted) species such as Fremont Cottonwoods (*Populus fremontii*), Pacific Blackberry (*Rubus ursinus*), Poison Oak (*Toxicodendron diversilobum*), and a whole host of water-loving shrubs. Head north, south, or east from Redding, and you’ll quickly hit the mountains, with the change in elevation bringing more *conifers* (cone-bearing trees) such as pines, firs, and cypresses.

The point is, *native* vegetation is an intensely relative term, with a plant gaining or losing its native status on a location-by-location basis. I’d love to plant some Joshua Trees (*Yucca brevifolia*) or Coast Redwoods (*Sequoia sempervirens*) on my property; sure, they are California-native, but they aren’t *local* by any stretch of the imagination.

Joshua Trees are beautiful California-native plants that I’d love to plant in my yard. Still, they are native to the Mojave Desert region of California, not the tip of the Central Valley. I took this photo near Lancaster, CA.

Native is Local, No Matter What

If you don't live in an area as ecologically diverse as California, it may be tempting to discount this advice as "not applicable." Nothing could be further from the truth, however. Let's take Arizona as an example. If you live in Arizona, you may be frustrated with your state's reputation as a vast desert. Certainly, the Grand Canyon State has much more to see than just the vast desert land as portrayed in films. Not that the desert is bad. I love the desert! But I digress…

The point is, Arizona is filled with distinct, ecologically diverse ecosystems. At the top of the Grand Canyon, you will find different ecosystems on the canyon's north and south rims. The National Park Service reports that on average, the South Rim is 7°F warmer during the day and 5°F during the night than the North Rim. Furthermore, the South Rim receives nearly 10 inches less precipitation than the North Rim. This is despite an average distance of only 10 miles between the two rims, and a minimum distance of only 600 feet! [1]

Thousands of feet below the rims, the rushing Colorado River creates its own riparian environment, filled with thirsty plants such as Catclaw (*Senegalia greggii*) and Honey Mesquite (*Prosopis glandulosa*) [3]. The Catclaw provides needed food for mammals who eat its seeds [4a], while the mesquite acts as a host plant to various butterfly species [4b]. At this elevation, the canyon's average temperature is hotter than both rims at 82°F during the day and 57°F at night. With less than 9 inches of precipitation every year, riparian plants rely heavily on the river itself as a constant source of water [1].

The dramatic ecological balancing act seen in the Grand Canyon is surrounded not by desert, but by the Kaibab National Forest. As reported by the U.S. Forest Service, this region features conifers such as various pine, juniper, fir, spruce, and aspen trees. This ecosystem can only be supported with heavy late summer rainfall (known as the *monsoon*) and winter snowfall [2].

To find the Sonoran Desert climate synonymous with the state of Arizona, you have to travel southwest from the Grand Canyon Area to places like Phoenix, Tucson, and Yuma [5]. Here, you will see the Saguaro Cactus (*Carnegiea gigantea*) and Organ Pipe Cactus (*Stenocereus thurberi*) you've come to know and love from television.

Coast Redwoods are absolutely stunning, but the only way they can reach these gargantuan heights is through the moderate temperatures, frequent rain, and near-constant fog conditions found along the Northern California coast. This photo is from the Arcata Community Forest, 2018.

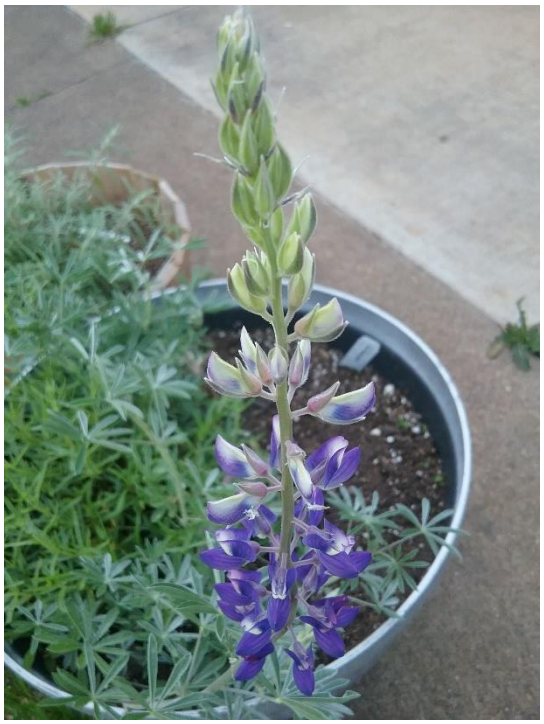
How do I Find Truly Native Plants?

No matter where you live, the truly native habitat you will want to emulate depends not just on your state or even city. It depends on the conditions of your parcel of land. Figuring this out is no easy task, but there are resources available that can help. Of course, as mentioned in the previous chapter, a quick visit to a nearby natural area is a great place to start.

Definitely take advantage of online resources. If you live in the United States or Canada, the U.S. Department of Agriculture has a PLANTS database that will show you if a desired plant is native, at least to the state or province level. In many cases, however, you can zoom in and find if the plant is native to your specific county. It's not perfect, but it's a great place to start. You can access the PLANTS database here: https://plants.usda.gov/checklist.html. To use it, select the state you live in and search for the full list of plants. From there, click on the name of the plant you're interested in, and the plant-specific map will open.

If you live in California, more refined resources are available. Head to www.calscape.org to reach a powerful native plant database managed by the California Native Plant Society. With this website, you can search for individual plants, plant types, or locations to the city level. Each plant has a range map that will further refine your knowledge. I myself have made many decisions on “local” plants by examining if they grow in my oak woodland environment, or if they are more aptly located in the mountain foothills nearby. Additionally, CalScape has copious planting tips for each plant it features, including plant type, growth form, growth rate, flowering season, water needs, and ease of care. And that only scratches the surface. If you are serious about truly native plants, CalScape is a must.

Other local resources that can be immensely helpful include whatever local nature groups organize in your area. Your local chapter of the Audubon Society or your state’s native plant society will be happy to share the habitat conditions required to make their creatures of interest thrive.



CalScape and the California Master Gardeners helped me identify this Silver Lupine (*Lupinus albifrons*) as a good native species for my habitat. It needs very little water and produces stunning purple flowers when in bloom.

The Benefits of Truly Native Plants

Planting native plants in their proper local context can make maintaining your backyard habitat orders of magnitude easier than trying to use non-native vegetation, or even planting the right plants in the wrong conditions. The ecology is pretty simple: when you

plant species that are *supposed* to grow in your local conditions, and you plant them in the specific micro-habitats they are *supposed* to exist in, you have passively removed 90 percent of the work normally associated with gardening. Once your plants are established (which can take a year or so), you don't have to worry about watering them much, if at all, because they are *supposed* to get the amount of water your climate provides them! You won't need sun-shades or artificial light, because the sunlight and temperature associated with your area will be exactly what the plants need. If you have ever had to baby an ornamental flower or bush, you will know this can be more trouble than it is worth. The constant monitoring and watering can take a huge chunk out of your time and your paycheck. What about soils? How expensive is it if you have to keep treating your soil with nitrogen-based fertilizer because your plants aren't growing well? As long as your topsoil hasn't been eroded or massively converted by human activities, the crucial nutrients required for native plants should be present in your soil in the proper ratios.

Budget aside, native plants are much better for the wildlife you seek to provide a home for. While nonnative species can fill some of the roles *some* native species need, many native species have specific needs that only one plant or physical condition can satisfy. While any shrub can provide shelter, any grass can provide groundcover, and any tree can provide a perch, what will support the needs of the *struggling* wildlife in your community? No matter where you live, I am sure that wildlife may be able to find a landscaping tree or shrub within your area. Many *urban-adapted* species thrive in human-dominated environments and do not need our help. It is the *specialist* species that are dwindling and require our assistance. Specialist species have very specific needs and can only thrive in the narrow situations they were designed for.

As an example, here in Redding we have a local butterfly called the Pipevine Swallowtail (*Battus philenor*). This species of butterfly is so-named because its life cycle is entirely dependent on the California Pipevine *(Aristolochia californica)* plant. Mature adult butterflies lay their eggs on the Pipevine; hatched caterpillars feed and grow on Pipevine leaves. Mature caterpillars form their chrysalises on the Pipevine; and most amazingly, the toxic compounds found in the Pipevine make the Pipevine Swallowtail unpalatable for most predators. After ingesting these toxic compounds as a caterpillar, the Pipevine Swallowtail gains protection for life. Without Pipevine, there will be few Pipevine Swallowtails on your property.

Pipevine Swallowtails are local to Shasta County and require the California Pipevine plant to survive.

Reliance on a *host plant* is a reality for many native and *endemic* (found only in one area) species. If you want your habitat to be more than just a pretty sight, native plants are the simplest way to accomplish this.

In addition to helping specialists, truly native plants complement every species in a disproportionate fashion over nonnative species. If local bees and other pollinating insects are expecting flowers to bloom at a specific time, native flowering plants have a much better chance of being on schedule (more on this in chapter 5). The migratory birds that stop in your area to rest or raise young will need the proper seeds, fruits, and insects to be present at the right time. An introduced plant species may fruit or attract insects at the wrong time, or worse, it could be toxic to native wildlife. A truly native garden empowers you to chip away at many of the world's most pressing ecological problems, even if that wasn't your original intention.

Avoid Invasive Plants Like the Plague

At this point, it is clear that locally native plants in their proper context carry some big advantages over anything else in terms of engineering your backyard habitat. Still, it is important to talk about the disadvantages of introduced, ornamental, and invasive species.

Ornamental Plants are specially bred to be showy or fragrant. Roses, tulips, etc. represent ornamental plants. In general, ornamental plants are not harmful to your habitat as long as they don't take over an area or spread where you do not intend them to go. If you have a preference for certain ornamental plants, dedicate them to a specific section of your habitat so you may enjoy them while providing more fitting habitat for wildlife elsewhere.

This ornamental *Euphorbia* species grows outside my house and still attracts pollinators like this honeybee.

Introduced Plants are plants you may find in the wild, but were not originally present in your area. As the name suggests, they were introduced by humans—intentionally or not—at some point in the past. Introduced plants may do quite well in your local area, and they may even serve a critical role in your backyard habitat. However, as we discussed above, there is usually a native plant that can do the job better. As time allows, identify which native plant should fill this role and replace the introduced plant accordingly.

Invasive Plants are plants that have expanded beyond their own range and are causing ecological harm in the places where they spread. Invasive species don't technically have to be non-native, though most are. All it takes is an invasive plant to be in the wrong place at the wrong time and to thrive to the detriment of the natural ecosystem surrounding it. Head back to the previous chapter for a few examples of invasive plants and the damage they cause.

While ornamental and introduced species can be present without creating harm to your habitat, it is essential that you do not cultivate invasive species on your property. Sometimes these transplants from other areas grow even better in your area than similar native plants. This might make it seem like they are a good fit, but local vegetation generally has not adapted a response to an invasive species' aggressive spread and will suffer in competition with of such a plant.

Invasive species generally spread at a high rate, beyond the intended range of whoever introduced them. This is why they are so difficult to control. If you think you have an invasive plant on your property, it is best to remove it right away and plant something in its place to compete with whatever seeds it may have left behind. But before you remove the plant, consult the USDA's invasive weed guide to inform you on how best to prevent its spread: https://plants.sc.egov.usda.gov/java/noxiousDriver

If you live in California, the California Invasive Plant Commission has an informative website that you can use to guide both your planting and removal efforts: https://www.cal-ipc.org/. This site has an invasive plant inventory, a list of common landscaping plants to avoid, and great native alternatives.

Knowing what to plant, what not to plant, and *where* to plant will take your backyard habitat to a new level of success. Ideally, your ecosystem should have species that will work together. This is easiest if your species are all fulfilling their natural role.

Footnotes:

1. All Grand Canyon statistics taken from: National Park Service. Grand Canyon National Park, Arizona. *Park Statistics*. November 2018. https://www.nps.gov/grca/learn/management/statistics.htm
2. Kaibab National Forest statistics taken from: United States Department of Agriculture. Forest Service. Kaibab National Forest. *About the Forest.* https://www.fs.usda.gov/main/kaibab/about-forest
3. Joy Cookingham. UC Davis Center for Watershed Sciences. *Chapter 10: Historical Ecology of the Grand Canyon Terrestrial River Corridor Prior to Glen Canyon Dam*. https://watershed.ucdavis.edu/education/classes/files/content/page/Ch10_HistoricalEcology_Cookingham.pdf
4. a. California Native Plant Society. CalScape. *Catclaw: Senegalia greggii*. https://calscape.org/Senegalia-greggii-(Catclaw)?srchcr=sc5cb38b9b7df29
   b. California Native Plant Society. CalScape. *Honey Mesquite: Prosopis glandulosa.* https://calscape.org/Prosopis-glandulosa-(Honey-Mesquite)?srchcr=sc5cb38c3b933e7
5. University of Nevada, Las Vegas. *North American Deserts.* http://landau.faculty.unlv.edu//northamericandeserts.htm

Tip #3: Add Complexity to your Habitat, both Vertically and Horizontally

As creatures that spend the vast majority of our time with our feet on the ground, we tend to think of habitat as a two-dimensional world. In reality, however, habitat is just as vertical as it is horizontal. This is not just for flying creatures, either. Whether that vertical dimension is created by trees, cacti, or sheer-faced cliffs, plants and wildlife must take this third dimension into account.

Vertical Creatures

Squirrels (various species)

Arboreal (tree-climbing) creatures such as squirrels are incredibly adapted to live high above ground. Squirrels are among the only mammals who have the ability to rotate their back limbs 180 degrees around [1]. This incredible flexibility enables them to sprint *down* a tree headfirst just as effectively as they would sprint *up* one. Many squirrel species also nest in trees just like we'd expect birds to.

Cactus Wren (*Campylorhynchus brunneicapillus*)

You don't have to live in a forested area to keep this tip in mind. The Cactus Wren is an example of an animal that uses vertical real estate in a non-tree environment. A female Cactus Wren will build her nest on a cactus or thorny desert shrub, giving predators a very challenging task if they want to prey on her eggs or juvenile offspring [2].

A Cactus Wren sitting on a nest in Arizona. Photo Credit: Douglas Bruns, 2013. Used with Permission.

Alpine Ibex (*Capra ibex*)
Alpine Ibexes also use vertical habitat to their advantage, though their feet are always planted firmly on the "ground". Expert climbers, alpine ibexes live in steep mountainous environments in Europe and can easily scale cliffs that most animals wouldn't even attempt [3]. Where others may be limited by topography, these mammals have found their niche. National Geographic produced a video clip in 2016 that shows these creatures in their element.

Two-Dimensional Habitat Lacks Depth

When engineering habitat, it is tempting to think of the job as simply a gardening project. This approach isn't wrong by any measure; it's just incomplete. Plant *some* plants, and *some* visitors will follow. Plant *native* plants, and *native* visitors will be close behind. Naturally, enhance your *vertical* habitat, and those who benefit most from it will seek to use it.

A flat habitat is lacking in different ways depending on the animal considering your yard. For quick, arboreal creatures, vertical habitat provides a route of escape from threats on the ground. Trees, tall shrubs, and cacti act as a perch for many birds, providing excellent visibility in all directions from a relatively safe location [2]. Living vertical habitat usually also provides food, whether it is the cones and sap of a pine tree [4, 5], the nectar and fruit of a flowering cactus [6], or the acorns [7] and *galls* [8] (see footnote) of an oak tree. Some birds will even get drunk on fermented berries [9]! And many animals, not just ones who actively leave the ground, will benefit from the shade and cover that vertical habitat provides.

Oaks and other trees provide perching spots for climbing and flying animals, while also providing a source of food and shelter.

Height matters. This is the same reason why we place bird feeders, baths, and houses above ground rather than just setting them down. If I had to stoop down to my 2-foot fridge every day to get food, I might end up losing my mind. Rather than get frustrated, wildlife will just find a different spot to hang out.

Depending on your area, the vertical dimension you should add will vary. If you live in a Southwestern desert, a nice Mojave Yucca (*Yucca schidigera*), cholla (*Cylindropuntia spp.*), or Joshua Tree (*Yucca brevifolia*) would be a great fit. If you are in a forested region, consider a pine (*Pinus spp.*), fir (*Abies spp.*), or other cone-bearing species that would be right for your region and yard capacity. Here in Redding's oak woodland environment, a Valley Oak (*Quercus lobata*) or Blue Oak (*Quercus douglasii*) would be the way to go.

Species that grow large vertically often take years to reach a substantial height. This is especially true of desert species, which limit their growth to what they are capable of maintaining in their ultra-low-water environments [10]. Fortunately, many plant nurseries (or your local home improvement store) sell young trees and cactuses. These plants are much further along than the sapling stage, but will still fit in your car. If you want to save a year (or ten), I'd recommend purchasing a young plant.

Mojave Yuccas are notoriously slow-growing plants. This photo was taken near Lancaster, CA in 2018.

The Great (Flat) Plains

Of course, where there are rules, there are exceptions. If you live in a true grassland or on the plain, with no vertical vegetation for as far as the eye can see, then you might have a free pass on vertical habitat.

To Some Degree, All Habitat is Horizontal

Before there were humans, habitat had much fewer barriers on the horizontal plane than it does now. There were still obstacles such as steep cliffs, wide rivers, and impenetrable vegetation layers, but movement was generally much easier without artificial fences, walls, roads, and dams.

What barriers do you have in your yard? If you're like most homeowners or renters, the answer would be "none", save maybe a chlorinated pool or gated off garden. You might have some *around* your yard (more on that in Chapter 6), but in terms of physical barriers, you probably don't have much to worry about for your habitat. That is, to our human perceptions.

Let's morph into a small lizard or bird for a second. Abrupt changes in vegetation can be as forbidding as a concrete wall. Different animals are adapted to different *micro-habitats*, and as such have varying levels of fear when entering from one habitat type to another. If I'm a small bird, I am relatively safe when I am near thick vegetation or I can hide under ground cover. When I'm out in the open, such as on a nice, freshly mowed lawn, I am more exposed than I may prefer. On the other hand, if I'm a lizard, I need open spaces to bask and absorb the sun's warmth. My cold-blooded body doesn't heat itself like the bird's does. Still, I wouldn't mind a few spots where I can dash for cover if I sense a threat.

In addition to stabilizing the sandy beach soil, these bunchgrasses provide some of the only hiding places on the wide-open shore.

Animals see the world in different ways based on what they were designed to endure, excel at, and fear. This unique perspective is called the *umwelt* of the animal. Back to the well-manicured lawn. It provides little shelter or hiding spots, it feeds few herbivores, it takes up more than its fair share of water [11], and any flowers that it produces are mowed away before pollinators have a chance to do their work. If you are serious about making your habitat a sanctuary for wildlife, it might be time to trade your lawn out for something more supportive to the ecological tapestry you are weaving.

Find a plant native to your area that is classified as a *groundcover*. As their name suggests, groundcovers spread out from their original planted location, dropping roots every so often into the ground and spreading until they are stopped by another plant, an herbivore, or pruning shears. Because a regularly-mowed lawn is so ecologically inert, switching to just about *any* ground cover will provide your habitat benefits such as extra flowers for pollinators and extra hiding places for skittish creatures.

I strongly urge you to seek local groundcovers for your habitat. As I've said, native plants will always support your local wildlife the best. That being said, if you just can't live without a mainstream lawn, let me offer you a fantastic all-around alternative: Yarrow.

I finally was able to remove my Yarrow from its pot and plant it in my yard. Drought-resistant lawn, here we come!

Common Yarrow (*Achillea millefolium*) is a groundcover that spreads somewhat like grass. Like other groundcovers, it flowers in the spring and can provide some nice hiding spots for creatures who need it. What sets yarrow apart, however, is its ability to handle the stresses of a typical lawn. Once established, yarrow does well in drought-tolerant gardens [12] (Pacific Northwesters might want to pass on this one). It can even handle some level of trampling stress; as long as you're not walking on the yarrow every day, it should hold up well from occasional outdoor use [13]. Even better, it can be mowed on occasion [14]. Remember, though, that yarrow's usefulness to your habitat depends on how well it hides small creatures and produces flowers; don't cut it too short!

One final note about yarrow: the plant contains compounds that, if ingested in large quantities, can be toxic to dogs; still, these compounds make yarrow taste bad to dogs, so poisoning by this plant is quite rare [15, 16]. If you have a pregnant/nursing dog, puppies, or a compulsive plant-nibbler, yarrow might not be for you. Otherwise, it is probably fine.

Xeriscaping: The Ground Un-Covers

If you live in the desert and the natural ground around you is barren in most places, this is a good sign that a tastefully *xeriscaped* space might be the proper choice. Xeriscaping is a shorthand term for *xeric* (very low water) landscaping. Those cold-blooded lizards need some nice hot dirt or rocks to bask on! If this is you and you have a conventional lawn, you can do your local wildlife (and monthly utility bill) some serious good by swapping it out for a xeriscaped environment.

Xeriscaped gardens are very drought-tolerant. Note the rock instead of grass, and the cactus and juniper species.

Footnotes:

1. The ankle flexibility in squirrels is something I first learned in my undergraduate coursework, but I felt the technical scientific fact should be appropriately cited. Laura Schultz (University of Illinois, Urbana-Champaign, 2018) comments on this phenomenon in eastern gray squirrels here: https://will.illinois.edu/environmentalalmanac/program/in-defense-of-the-eastern-gray-squirrel; Nicole Elmer (University of Texas, Austin, 2018) discusses it in the context of the fox squirrel: https://biodiversity.utexas.edu/news/entry/fox-squirrels
2. Cornell University. *Cornell Lab of Ornithology.* All About Birds. *Cactus Wren: Life History*. 2017. https://www.allaboutbirds.org/guide/Cactus_Wren/lifehistory
3. Clemson University. *Antelope Sheep and Goats.* 2019. https://www.clemson.edu/science/departments/biosci/research/museum/exhibit4/index.html
4. The unique beaks of Red Crossbills enable them to extract seeds from the cones of confer trees such as pines and firs. Information retrieved from: National Park Service. Rocky Mountain National Park. *Red Crossbill.* May 2018. https://www.nps.gov/romo/learn/nature/red_crossbill.htm
5. Many species of woodpeckers and sapsuckers include sap in their diet. One example is the Yellow-bellied Sapsucker: Cornell University. Cornell Lab of Ornithology. All About Birds. *Yellow-bellied Sapsucker. Life History.* 2017. https://www.allaboutbirds.org/guide/Yellow-bellied_Sapsucker/lifehistory
6. Many bat species pollinate blooming cactuses when they feed on their nectar. The Mexican long-tongued bat is one example: Stephen Buchmann. *Nectar-Feeding Bats? The Mexican Long-Tongued Bat.* US Department of Agriculture. Forest Service. https://www.fs.fed.us/wildflowers/pollinators/pollinator-of-the-month/mexican-long-tongued-bat.shtml
7. Over 100 vertebrate species eat acorns, according to the National Wildlife Federation: Roger Di Silvestro. *The Wildlife Benefits of Acorns and Oaks*. National Wildlife Federation. October 2013. https://blog.nwf.org/2013/10/the-wildlife-benefits-of-acorns-and-oaks/
8. Specialized wasps lay their eggs in oak leaves or bark, creating swelling called “galls”. While growing in these galls, wasp larvae feed on the transformed oak tissue: Gregory A. Hoover. *Galls on Oak.* Penn State University College of Agricultural Sciences. Department of Entomology. 2019. https://ento.psu.edu/extension/factsheets/galls-oak
9. Cedar Waxwings are known to occasionally become intoxicated from consuming fermented berries. This has even led to some news-worthy events: Nicole L Elmer. *CAMPUS BIODIVERSITY: Cedar Waxwings, the Beautiful Visitors.* The University of Texas at Austin Biodiversity Center. February 2019. https://biodiversity.utexas.edu/news/entry/cedar-waxwings
10. At 0.5 – 3 in per year, Joshua trees are fast-growing desert plants: Jane Rodgers. *Joshua Trees*. National Park Service. Joshua Tree National Park. March 2016. https://www.nps.gov/jotr/learn/nature/jtrees.htm

11. Lakis Polycarpou. *The Problem of Lawns.* Columbia University Earth Institute. State of the Planet. June 2010. https://blogs.ei.columbia.edu/2010/06/04/the-problem-of-lawns/
12. California Native Plant Society. CalScape. *Common Yarrow*. https://calscape.org/Achillea-millefolium-()
13. Deva Luna. *Alternatives to Lawns*. California Native Plant Society. September 2017. https://www.cnps.org/gardening/alternatives-to-lawns-5323
14. University of California Agriculture & Natural Resources. Statewide Integrated Pest Management Program. *Common Yarrow (Achillea millefolium)*. 2019. http://ipm.ucanr.edu/PMG/WEEDS/common_Yarrow.html
15. Your Old Dog. *Yarrow for Dogs and how to Safely Use it*. 2018. https://yourolddog.com/yarrow-for-dogs-and-how-to-safely-use-it/
16. Adding support to citation #15, my in-person discussions with the Turtle Bay Exploration Park Horticulture Department confirmed that the concern about yarrow toxicity is overstated.

Tip #4: Get Past Bird Feeders

So often in creating a wildlife-friendly property, we will expend all of our efforts getting *something* to enjoy our space. We buy or build a generic hummingbird feeder, bird bath, or birdhouse. Increasing the abundance of an abundant population is nice, but we can do better. It's time to get the *right* creatures to enjoy our space. *Species of least concern*, as they are called, don't really need our help.

Many Declining Species Need Exact Conditions to Survive

Many species rely not just on space to live, but on very specific habitat conditions or a particular host species:

The Wood Duck *(Aix sponsa)*

The Wood Duck and other *cavity nesters* rely on dead or rotting trees to make their nests. When a tree dies or a tree branch falls off, the inner heartwood of the tree may rot away, leaving a sizeable hole that female Wood Ducks will use as a nest [1]. Wood Ducks are powerless to carve out their own nests, meaning without these natural cavities they will not be able to successfully incubate their eggs. Fortunately, when female Wood Ducks do find a suitable cavity, they gain decent protection from nest predators. The entrance to the cavity is often much smaller than the actual space inside, making a raid on the nest extremely difficult [2]. As a college student at UC Davis I was able to participate in a research program in which we supported the species using "duck boxes" as artificial nest cavities. Affixed to trees near the edge of Putah Creek, these boxes enabled the local Wood Duck population to increase substantially. Do you live near a stream and also in the native range of the Wood Duck? If you do, adding a duck box or two is an easy way to support these beautiful waterfowl. The best part is you don't even have to water anything! (More information below).

This dead oak limb contains multiple cavities which may be used for feeding and/or nesting, depending on the species.

Black-Backed Woodpecker (*Picoides arcticus*) [3]

Black-Backed Woodpeckers must also rely on an event outside of their control: wildfire. When a wildfire kills trees in a section of the forest, the “standing dead” attract large populations of wood-boring beetles. These wood-boring beetles make up the majority of the Black-Backed Woodpecker’s diet. These woodpeckers can feed in a particular burned area for an average of seven years before beetle populations decline too sharply. After seven years, another wildfire is necessary somewhere within flying distance for that particular population of woodpeckers to thrive. Caution: this species is best left to be managed by trained forest ecologists in remote swaths of land.

I took this photo of a Black-Backed Woodpecker on a standing burned tree. This was a phone-through-the-binoculars type of shot!

Monarch Butterfly (*Danaus plexippus*) [4]

Remember the Pipevine Swallowtail butterfly from earlier? They aren’t the only butterflies that rely on a host plant. In fact, many butterflies and other insects require host plants. Monarch Butterflies, in particular, need milkweeds (*Asclepias spp.)* to survive. Similar to the Pipevine Swallowtail, Monarchs lay their eggs on a suitable milkweed plant. In addition, adult Monarchs drink the nectar of various

flowering plants for sustenance as they make their over 1,000-mile journey from the US to central Mexico in the fall. Unfortunately, milkweeds are in decline across North America as agricultural operations become better at excluding these weed-like plants. As homeowners, we can help Monarch butterflies by planting milkweeds in our own yards, ensuring these butterflies have a host to lay their eggs on.

We Can Engineer the Perfect Conditions to Boost Threatened Species

We can emulate these conditions on our own properties, giving threatened or declining species more habitat custom-engineered to their needs. If you're reading this book, then I can be sure you are ready for a more complex challenge than buying a one-size-fits-all habitat tool. Is there a native bird, bat, or pollinator in decline in your area? A little research can bring results pretty quickly. Check with your local Audubon society or native plant society to see if there are species of interest that you can plant or build habitat for. Is there a specialist species that, while doing fine, could use an extra host plant?

The Cornell University Lab of Ornithology (the absolute authority on birds in the nation) has an interactive birdhouse building guide that will let you search for birds by region and habitat type. The site will flag a species if it is in decline in your region, and it will also give you specific guidelines to build the perfect nest box for each species you select. Rather than getting the same sparrows and mockingbirds, you can build the perfect conditions to suit your selected species' adaptations and inclinations. Check it out here: https://nestwatch.org/learn/all-about-birdhouses/right-bird-right-house/

This Wood Duck box near the Sacramento River provides an artificial nest cavity for nesting mothers.

Your local native plant society will be happy to share which plant species are in decline in your area. Often, they actually sell the very plants they hope to protect! Native plant societies usually have spring and/or fall plant sales in which they will give you good prices on native plants they have been raising. Plus, just talking with these local experts will give you tips and tricks to care for the plants and choose which plants work best for your lifestyle. They can also point you to which plants act as hosts or important food sources for any struggling species in your area.

Bat Boxes are a Thing

It might seem odd to *invite* bats to your property, but doing just that can be immensely helpful for your habitat, especially if local bats are in decline. Bats are fantastic at eating insects –such as mosquitoes– that might drive you crazy. Forget the tiki torches and citronella candles with bats flying around. Additionally, bats are important pollinators. Many white-hued flowers lack color because they are pollinated by bats. With their poor vision and nocturnal habits, bats don't care about flashy colors when choosing a flower to feed on.

Building a bat box can attract bats to your property and establish an important level of complexity to your habitat. It is comforting to know that your private habitat is still doing its work while you sleep. While the visual rewards may be less, improving the habitat for these nocturnal creatures will help daytime creatures thrive too.

The National Wildlife Federation has a how-to guide to build your own bat box here: https://www.nwf.org/Garden-for-Wildlife/Cover/Build-a-Bat-House

Footnotes:

1. Personal Citation: As a member of the UC Davis Wood Duck Project from 2012-2014, I monitored Wood Duck nest boxes, weighed eggs, and tagged chicks. From 2014-2015 I educated 6-12th grade students on Wood Duck ecology.
2. Cornell University. Cornell Lab of Ornithology. All About Birds. *Wood Duck: Life History.* 2017. https://www.allaboutbirds.org/guide/Wood_Duck/lifehistory
3. All Black-backed Woodpecker information was gathered from: Dennis C. Odion & Chad T. Hanson. *Projecting Impacts of Fire Management on a Biodiversity Indicator in the Sierra Nevada and Cascades, USA: The Black-Backed Woodpecker.* The Open Forest Science Journal. 2013. https://pdfs.semanticscholar.org/1118/e0a7163c78ba1f45475527b198a9c0082f20.pdf?_ga=2.181737121.76371456.1555469552-758900877.1554782010
4. All Monarch butterfly information taken from: Erwin 'Duke' Elsner. *Smart gardening to support monarchs*. Michigan State University Extension. January 2017. https://www.canr.msu.edu/resources/smart_gardening_to_support_monarchs

Tip # 5: Get Timing Right

I have stressed the importance of planting native plants to provide suitable habitat for the wildlife in your area. In today's climate (no pun intended), this is no longer sufficient. Due to changes in climate caused by carbon emissions, ecosystems around the world are experiencing shifts in *phenology*.

What is Phenology?

Phenology is the timing of ecological events tied to seasonal shifts in weather. Phenology is what compels migratory birds to fly "south for the winter", flowers to bloom, leaves to fall, Sage Grouse to mate, and groundhogs to overcome the fear of their shadows (ok, that last one is a joke). This crucial ecological timing is what gives the world its awe-inspiring seasonal changes and make it such a wondrous place to live; but this timing is regulated by a multiple of conditions, and it is in danger of being hijacked by human activities.

Why did the Coots cross the road? Because they're not chicken! The American Coot is a migratory bird that is intensely dependent on phenology to survive. Photo Credit: This is another motion-capture picture from my ecology course in 2014 at the Yolo Bypass Wildlife Area.

If Times are Changing, Timing can Change

Imagine you're an insect larva. As you develop in your pre-adult state, environmental cues are hardwired into these developmental processes so that you mature at the correct rate and become an adult at the right time. When the right conditions are met,

ambient temperatures and the length of days in your area indicate that it is time to leave the cocoon, chrysalis, egg, etc. Imagine if the timing was off and you matured during a frigid, inhospitable winter where none of the leaves of your host plant had regenerated yet. Your fate would be sealed before you were ever given a chance to do anything about it!

If you are a wildflower, water availability also dictates when you will develop from a seed into a mature adult. If the climate in your region changes enough to where you receive more or less rainfall than normal, your timing may also shift from historical norms. In fact, if conditions aren't right, you may remain dormant for an extra year or even die as a seed [1].

Lastly, imagine you're a Canada Goose. You endure the grueling journey every year flying north from your winter home in Sunny Southern California to take advantage of the massive population of insects of a typical Canada springtime. That thousand-mile journey is unimaginably draining; if you can't properly refuel along the way, you may be too weak to successfully reproduce. You could even die! Even if you do make it, if the insect populations are not enough to sustain your offspring, then the brutal trip was still in vain [2].

Death Valley is such an unforgiving habitat that seeds can go for over ten years without growing into a flower. Then, when the right amount of rain falls at the right times, super-blooms can occur.

When Times Change, Times Change Differently for Different Groups

Insects rely on flowers to eat, and flowers rely on insects to reproduce. Canada Geese and other migratory birds rely on insects to feed themselves and their offspring. A mismatch in the blooming of flowers, the maturation of insects, and the migration of birds could lead to catastrophic changes in the ecosystem. Unfortunately, we are beginning to see this exact phenomenon take place across the world. As global temperatures warm and weather patterns shift from historical norms, it appears that flowers and insects are adapting to the shifts more quickly than migratory birds and other vertebrate animal species [2]. This means that year after year, migratory animals will find themselves further and further behind the plants and animals they rely on to survive. We will have a very slow-motion disaster unfold before our eyes if we do not mitigate this problem. Fortunately, there is a long-game and short-game solution to prevent unnecessary extinctions.

Pollinators and flowers must mature at the same time, or ecological collapse will occur. This flowering Prickly Pear Cactus was found in Death Valley in 2016.

The Long Game: Mitigate Climate Change

Climate change is an intensely multi-faceted issue and it is not going to be solved overnight. Furthermore, you can't be expected to solve this problem alone; frankly, neither can any of us! What we can do is work to reduce the carbon emissions we produce in our own homes by living more sustainably, reducing our energy use, not wasting food, etc. We can all make progress on this issue to slow down the phenology mismatch and avoid the worst-case scenarios.

The Short Game: Your Habitat can Delay the Phenology Mismatch

In Chapter 2, I mentioned how native plants are uniquely suited to bloom at the right time for native pollinators. What happens if climate change messes that up? The beauty of native plants is, in most areas, there isn't just one or two species…there are dozens! Use this to your advantage. Different native plants may bloom at different times of the year, depending on their unique adaptations. This can turn your backyard habitat into not only a mini wildlife sanctuary, but a mini ecosystem to fight the timing mismatch. By planting native plants with different blooming dates, you can ensure that whenever insects arrive, they will have a source of food and a flower to pollinate. By ensuring the survival of these insects, you can ensure the survival of the vertebrates that rely on them. This will not stop the coming phenological mismatch, but it can slow the process down enough to give the world time to address it at a larger scale. You can be a part of the solution, one backyard at a time.

An additional benefit to planting flowers that bloom at different times is the ability to support insects, birds, and other pollinators that migrate. The Monarch butterfly from chapter 4 takes months to make its thousand-mile-long migration, and not all butterflies will do it at the same rate. By picking plants with different blooming periods, you give these migratory pollinators a reliable space to stop and refuel.

As mentioned earlier, two great resources for finding plants include your native plant society and, if you live in California, Calscape (www.calscape.org). Both will be able to give you information on the typical blooming season of a plant you are looking at, ensuring your success at staggered blooming periods.

For more information on phenology, check out my blog post on the topic: https://www.homesweethabitat.com/blog/death-valley-national-park-timing-is-everything

Footnotes:

1. National Park Service. Death Valley National Park. Wildflowers. 2018. https://www.nps.gov/deva/learn/nature/wildflowers.htm#weatherandblooming
2. Madeleine Rubenstein. United States Geological Survey. When Timing is Everything: Migratory Bird Phenology in a Changing Climate. 2017. https://casc.usgs.gov/content/when-timing-everything-migratory-bird-phenology-changing-climate
3. Erwin 'Duke' Elsner. Smart gardening to support monarchs. Michigan State University Extension. January 2017. https://www.canr.msu.edu/resources/smart_gardening_to_support_monarchs

Tip #6: Where Possible, Reduce or Alter Barriers

We all encounter barriers and signs that inform us where we can and cannot go. Lines at Disneyland, medians on the freeway, safe viewing zones at the zoo, and fences. Fences are a natural part of being human, but they disrupt the natural movement of land-based animals. Simply put, an animal that cannot travel into your habitat is an animal that will not use your habitat. So what do we do about this?

Fences serve one of two purposes. Either they are designed for safety, or they are designed for aesthetic appeal. We will probably have to concede that security fences won't be removed. Furthermore, you might want to keep your pets *in* just like you want to keep intruders *out*. Fair enough. But what about the fences you don't really need?

You may have a front yard fence that stands about chest height. Is this really keeping anyone out of your yard? Someone sufficiently fit and motivated could parkour over your barrier. But that's not the point if the fence looks good! The single easiest way you can aid wildlife is simply to swap it for a fence that still looks great but provides room for the squirrels, foxes, and small mammals of the world to join your wildlife sanctuary.

Otherwise, you're just stuck with whatever can fly over, scale the fence, or squeeze through the cracks. Something like a lizard or a frog could pull this off. I think they're great, but my habitat would definitely be more dynamic with more representation.

If you have impenetrable barriers, frogs might be the only creatures that will benefit from your habitat! What else can squeeze under a fence?

Another legitimate option is to completely remove a fence that is not needed. This opens up your home to the natural migration and daily movements of various kinds of species.

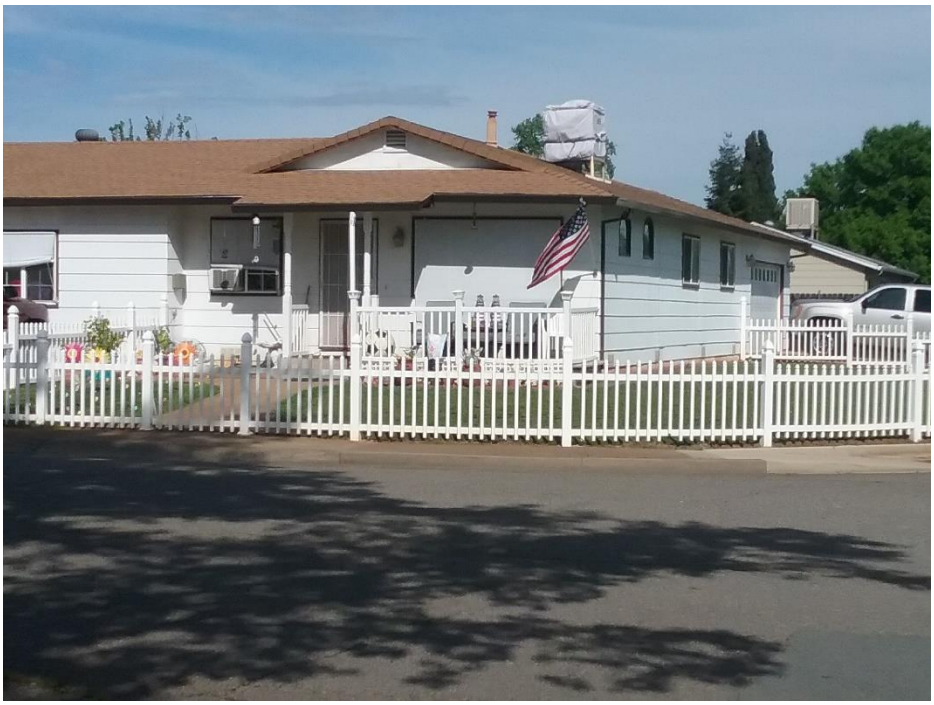
Why Wildlife Movement is So Critical

Reducing fencing is not just about opening up your habitat to outsiders; it is about connecting isolated patches of habitat into larger, contiguous networks. Creating habitat continuity is a major piece of the puzzle in the movement to protect biodiversity and prevent extinction. Without large-scale, continuous habitat, species who rely on those large tracts of land will be unable to survive.

Let's travel for a second to Downieville, California. I briefly lived in this small town of under 300 people, and it was an experience unlike any other. Reno, NV, the nearest major city, is 90 miles away. Life is different here. People prioritize the great outdoors far above any amenities that would make a city or suburb preferable. As such, there are few services in this alpine town. Gas stations, when they work, charge high prices. Grocery stores might not have what you're looking for, so you may have to make a trip to Reno or Sacramento every month or two. Conditions in Downieville are livable, but only just. Jobs are scarce unless you work for the US Forest Service, Bureau of Land Management, or (frankly) the cannabis industry. Many of these jobs require you to drive long distances on difficult roads in inclement weather, either as a commute or as part of the job description.

If Downieville were to become inaccessible to Reno and Sacramento, its citizens would suffer greatly. Quality of life would drop, as they would be cut off from the conveniences the larger cities offered to them.

In the context of wildlife, being cut off from essential services is a life-and-death situation for animals. This is why access to the larger habitat matrix is essential for your backyard habitat. As humans with human needs, we can't expect to make our spaces perfectly natural. All we can do is enhance them to the best of our abilities.



This fence restricts the movement of some wildlife, but it still allows smaller creatures to move through.

The Island Effect

Ecologically speaking, an isolated backyard habitat is similar to an island. Islands are known to have very fragile ecosystems that, when disrupted, lead to high levels of extinctions [1]. The introduction of invasive species such as rats, cats [2], or snakes [3] can lead to the decimation of plant and animal groups not adapted to the new threat of grazing, predation, competition, etc. Islands do not have a good way to rebound if a species is wiped out. Because there is a limit in the availability of habitat, the maximum population of a given species (called the *carrying capacity*) is limited, and no reinforcements can come from a neighboring region to repopulate an area.

If your backyard habitat is an island, it will inevitably be a less healthy part of the ecosystem than one which is connected. If only birds and pollinators can freely move beyond the sanctuary you create, then the benefit your habitat creates for the land-bound creatures is marginal at best. If an animal raises offspring while living on your habitat but the offspring cannot branch out and establish their own home ranges, the success is contained and minimized. Remove these barriers, and your habitat will not only be reinforced by the greater habitat surrounding it, it will also contribute to the preservation of biodiversity, protection of species, and flourishing of nature.

The Wildlife Corridors Keeping Habitat connected

Don't take my word for it; wildlife professionals in charge of managing massive tracts of land have also embraced the concept of habitat connectivity. Especially for wildlife who are nomadic or who migrate great distances, the more habitat that is uninterrupted by human disturbance, the better. To that end, wildlife *corridors* are being increasingly used as a way to restore connections between large areas of habitat. Not all of these corridors have been a smash hit or have worked as intended, but with the proper research and due diligence, large successes have occurred.

The Sundial Bridge in Redding, CA is similar to a wildlife corridor, but it's for people. The architect Santiago Calatrava designed the bridge so that no piers would enter the Sacramento River, preserving a corridor rather than restoring it.

Banff National Park's Wildlife Corridors:

In Alberta, Canada, Banff National Park has sought to mitigate the barrier created by large highways that cut through the park. Before habitat corridors were placed through Banff National Park, levels of death and road kill on the highways were very high. But since 1996, a system of wildlife overpasses and underpasses have been developed to facilitate wildlife crossings. These aren't just concrete bridges; wildlife would find it difficult to use these unnatural structures. These fantastic bridges include soil and vegetation planted on top of the overpasses. This pseudo-natural corridor allows even large mammals like Grizzly Bears (*Ursus arctos*) to cross the highways safely. Strategic fencing supplements these corridors, compelling wildlife to safely cross the overpasses rather than make the dangerous trip across traffic [4]. As a result, wildlife deaths

have dropped immensely, and the two regions separated by highways share a higher level of ecological communication.

Banff National Park in Alberta, Canada has gone to great lengths to safely restore habitat connectivity within the park. This overpass enables safe passage of wildlife across the Trans-Canada Highway, which bisects the park. Photo Credit: Dr. Adam Ford. Used with permission.

Tucson's Oracle Road Wildlife Crossings:

Inspired by earlier successes in restoring wildlife movement, the city of Tucson, Arizona has followed suit in protecting its land animals from traffic-related deaths. The City of Tucson created strategic fencing, a wildlife overpass, and a wildlife underpass for State Route 77, a highly-traveled highway in the Tucson region [5]. These connections are crucial for the Sonoran Desert animals crossing the highway, including the threatened Sonoran Desert Tortoise (*Gopherus morafkai*). Like with Banff National Park, the Oracle Road crossings include native desert vegetation fitting for the Sonoran Desert ecosystem. The data on this crossing's success is not conclusive yet, since the corridors were only put in place in 2016. Still, the research and collaboration on this issue has been robust, and as the data continues to come in, I anticipate a major success for wildlife connectivity.

Maintaining the Corridor: Yellowstone to Yukon:

Restoring habitat connectivity will always play second fiddle to conserving habitat connectivity. With this concept in mind, the minds behind the Yellowstone to Yukon Conservation Initiative have set an ambitious plan. Over nearly thirty years, Yellowstone to Yukon has slowly but surely worked with private landowners and public governments to protect habitat from Alaska's Yukon region, through Canada, and into the Greater Yellowstone ecosystem in Wyoming, Montana, and Idaho [6a]. Through land purchases and cooperative land use agreements, much of this region has now been guaranteed a future compatible with wildlife. At the start of the project in 1993, only about 11 percent of the region was protected. These areas included Yellowstone National Park in the US and Banff in Canada. Today, nearly 50% of the area is either fully protected or under conservation-oriented management plans ensuring responsible use of the area [6b]. This connectivity is crucially important in this remote region of the world. Many large mammals with massive home ranges call the area home, including Grizzly Bears, American Bison (*Bison bison*), Moose (*Alces alces*), and Gray Wolves (*Canis Lupus*). In fact, a radio-tagged wolf in the region was tracked traveling an area ten times larger than Yellowstone National Park! [6c] And Y2Y isn't anywhere close to being done. See their progress at www.y2y.net.

Connectivity on Your Space:

For some species, connectivity is nice; for others, it is absolutely crucial. For each plot of land we re-open to wildlife movement, the more these wide-ranging species can survive and thrive in our human environment. If you are able, try for a little bit of connectivity.

Footnotes:

1. Paul R. Ehrlich, David S. Dobkin, and Darryl Wheye. *Island Biogeography*. Stanford University. 1988. https://web.stanford.edu/group/stanfordbirds/text/essays/Island_Biogeography.html
2. Peggy Townsend. *Averting Extinction.* UC Santa Cruz Newscenter. May 2014. https://news.ucsc.edu/2014/05/rev-spring-14-averting-extinction.html
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4. Andrew Evans. *The Alberta Story: Wildlife Crossing in Banff.* National Geographic. August 2013. https://www.nationalgeographic.com/travel/digital-nomad/2013/08/23/the-alberta-story-wildlife-crossing-in-banff/
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6. a. Yukon to Yellowstone Conservation Initiative. *Y2Y: The Geography of Hope.* https://y2y.net/vision/y2y-the-geography-of-hope
   b. Yukon to Yellowstone Conservation Initiative. *Our Progress*. 2013. https://y2y.net/vision/our-progress
   c. Yukon to Yellowstone Conservation Initiative. *Wildlife's Need to Roam.* https://y2y.net/vision/y2y-the-geography-of-hope/wildlifes-need-to-roam

Tip #7: Prevent Bird/Window Collisions

We've all done it: at your house or a friend's house, you excitedly run inside from an outdoor barbecue to grab more mustard or show friends your new tablet. Yet when you try to enter inside, you find yourself rebuffed by an impenetrable, invisible barrier: the sliding glass door. Dazed and embarrassed, you find yourself on YouTube a week later, eclipsing the one million view mark.

Of course, if we could actually *see* the glass, this would never have been an issue! Those window-cleaning products actually do a fantastic job at making windows not just streak-free, but essentially invisible. A popular marketing campaign for a popular window cleaner shows talking birds lamenting the effectiveness of the product, even remarking "a bird could get hurt running into a window like that!"

That commercial is actually quite perceptive. While it is funny for the occasional human run-in with the sliding glass door, collisions with windows kill an estimated one to ten birds per year per building in the united states. Add that up, and windows extinguish 100 million to 1 billion birds per year across the nation [1].

Birds die from window collisions for the same reason we run into them; they do not perceive the invisible, physical barrier that exists in that space. Birds may be attempting to fly to safety, to search for food, or to explore the area inside your house, but all end up flying head-first into a deadly situation [2a]. It is estimated that one out of every two birds that strikes a window dies from the impact; this is true even if you see the bird fly away from the collision [1]. A broken neck will incapacitate a bird instantly, but a brain bleed will not.

Complicating the matters further, birds did not encounter invisible barriers in their adaptive history. Until humans invented fully transparent glass panes, birds had no reason to respond to such a threat. As such, they are woefully unprepared genetically.

Fortunately, there are several ways to reduce or eliminate window collisions on your house. These vary widely in price, level of effort required, and aesthetic appeal.

High Price, Low Effort: Ultraviolet Windows

The absolute best way to prevent bird collisions is to install new windows with an ultraviolet signature on them. Birds have the ability to see more of the light spectrum than humans do, and this includes ultraviolet light. Birds' eyes, which helps them see patterns on flowers we will never notice, also helps them see colors on a window we would never notice. With an ultraviolet window, your view of the outside world will not be changed over a normal window, but it will be very easy for any bird who comes along to see it. Hands down, this is the most effective way to prevent bird collisions if you can

pay for it or are due for a remodel. If this solution may work for you, visit http://ornilux.com/ to learn more.

Low Price, High Effort: Trim Your Hedges and Adjust Your Behavior

If you can't drop that kind of money on windows, don't fret. There are still plenty of ways you can reduce window collisions [2b]. The first one is pretty simple: keep your blinds closed or down. Small birds like hummingbirds will try to fly through spaces as small as 2 inches by 2 inches if they do not perceive a barrier like a window. It's hard to cover each 2"x2" space without your window looking a little eccentric in the process. However, if you keep your blinds down but in the open position, you can still see outside, and the bird can still see *something*.

Keep in mind, this method isn't perfect. Barriers on the inside of a window are not as effective as those on the outside; they do not prevent reflections of light onto a window. You can have your window blinds in the right position but still encounter bird collisions due to vegetation reflecting onto the window [2a]. Imagine a bird seeing a nice shrub to land on or berry to pick, and instead of getting a soft landing spot, it gets a face full of glass.

The best way to prevent bird collisions with the cost-free method is to trim your backyard vegetation away from your windows. By preventing reflections of your plant materials from showing up on your windows, you will eliminate the largest risk for window collisions. Birds may use vegetation for shelter, a hiding place, or a food source. Remove these three illusions with some quick pruning, and your yard will be much safer.

Additionally, place your bird attractors (such as bird feeders, bird baths, etc) away from windows. Even if they do not cast a reflection in the windows, attracting a large number of birds near an invisible barrier will lead to higher numbers of collisions, and therefore fatalities.

Keeping your blinds down and open makes your windows more visible, but it clearly doesn't eliminate reflections like this massive oak!

Cheap & Effective: Window Decals

Window decals are another effective way to eliminate collision risk. These decals essentially act in the same way your blinds would, making your window visible in certain places. The decals come in a variety of colors and in different shapes, including transparent versions that are sufficient for birds to see but less opaque in the human vision spectrum.

In general, however, shape doesn't matter nearly as much as coverage area. As I noted before, window obstructions are the most effective if your window has uninterrupted views no bigger than 2 inches by 2 inches. This ultimately means you will need quite a

few decals to pull this look off, and your window will definitely look a bit odd when you have finished bird-proofing it. I would recommend getting small, dot-shaped bird barriers that you can place two inches apart. If you follow the spacing of your blinds when they are horizontal, you can prevent your own views from being diminished. If you have a sliding glass door without blinds, you will just have to bite the bullet and get it covered with decals. A good choice in dot-shaped decals are called Feather Friendly Window Markers: https://www.conveniencegroup.com/featherfriendly/feather-friendly/

Remember to place these decals on the *outside* surface of your windows. As mentioned earlier, decals offer an improvement to just using your window blinds in that they can disrupt the deadly reflections of plants in your windows. Placing decals on the inside surface, therefore, will offer no advantage over what you could do for free with a few turns of your window blind rod.

Cheap, Cool, but Not Effective:

You may see “Raptor Decals” advertised as scaring devices for birds. These decals are so named for birds of prey, (called *Raptors*). Raptor decals theoretically mimic the silhouettes of various birds of prey, and therefore scare songbirds and other non-predator birds to stay away from your windows. In practice, raptor decals work much like scarecrows. They generally do not work, and even if they do, the effect wears off very quickly once birds realize they never move. At that point, raptor decals work just like regular decals; they obstruct that specific section of window but leave the rest of the window wide open to collisions. Stay away from raptor decals unless you plan on covering your whole window with them.

Raptor decals simply don’t work. Take it from Mr. Stuffed Canada Goose. He is undeterred.

The jury is still out on whether *Velociraptor* decals (decals of our favorite prehistoric friends) unleash primal fear and avoidance in birds…

Just kidding. Stick to the other decals.

The American Bird Conservancy has taken the lead in researching and developing solutions to reduce bird-window collisions. You can find a much wider list of bird-safe products for both personal residences and commercial buildings here: https://abcbirds.org/get-involved/bird-smart-glass/

Footnotes:

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2. a. American Bird Conservancy. *Why Birds Hit Glass*. 2019. https://abcbirds.org/program/glass-collisions/why-birds-hit-glass/
   b. American Bird Conservancy. *Solutions to Birds Hitting Windows.* 2019. https://abcbirds.org/program/glass-collisions/bird-friendly-window-solutions/

Tip #8: Keep Your Cats Inside:

One of the worst things a would-be conservationist can do for native wildlife is to create a beautiful, functional habitat that leads creatures to their deaths. Rather than staying in established habitat, a bird, mammal, or reptile may migrate from its home range only to have its life extinguished by a foreign, invasive predator. It would be better if the deceptive habitat did not exist at all.

There are a few threats that we humans can inadvertently create for wildlife as we augment our backyard habitat. Fortunately, most of these threats require only small adjustments on our part to greatly mitigate or completely eliminate the risks. One of the greatest risks we create has to do with our pet cats.

Feral and domesticated cats are known to catch and kill upwards of 2 billion birds annually in the United States alone [1]. It gets worse—feral and domesticated cats are implicated in the deaths of reptiles, amphibians, and mammals as well and in greater numbers!

Before we proceed, I should address the obvious objection: “That’s terrible, Jake, but *my* cat is way too sweet to kill anything. It wouldn’t hurt a fly!” Unfortunately, this is just not what the research shows. Study after study shows that cats are genetically *hardwired* to have a hunting instinct. For a species that has adapted over countless generations to hunt, domestication will not magically turn them harmless. In fact, a study in Sweden found that even well-fed house cats relied on native wildlife for an average of 15% of their diets! [2]

Even if you do not find any evidence of your cat’s predatory behaviors, that does not mean they aren’t killing things. Cats often abandon their kills rather than bringing them into the house or near the back door. Other times, cats eat their kills entirely.

Mr. Knightley is sweet and cuddly, but he does have instincts. Keep your Mr. Knightley inside.

Here at Home Sweet Habitat, we are not anti-cat; we simply do not want your cats to ruin the efforts your habitat enhancement is creating. It is in cats' nature to stalk, pounce, and kill. We need to remember that this is not the cats' fault; they do not know they are doing anything wrong. They do not realize that they are acting out their instincts in an ecologically damaging way. For this reason, it is up to us as pet owners to take responsibility for the damage they may cause. The solution is quite simple: keep your cats inside!

Keeping your cat inside will eliminate the biggest danger to birds, mammals, reptiles, and amphibians that you have created your habitat for. While this may be an adjustment for your cat, it is important to remember that you ultimately are in control of your cat's life, and therefore you are responsible for what the cat drags in. To enhance backyard habitat and attract wildlife to your property just to lead them to an untimely, unnatural death will only make matters worse for our local ecosystems.

Are there Other Methods that will Keep Animals Safe from My Cat?

If your cat must go outside for any reason, it is crucial the cat is supervised. This is the only way to keep your cat's natural instincts in check. There are products—such as colorful collars and "cat bibs" that you can make your cat wear—that do increase the likelihood of birds escaping from your cat. The bird collars are designed to make your cat more visible to a bird that might not otherwise notice it, while the bibs are designed to keep a bird outside of the "strike distance" of a cat's paws. However, these products were only designed with birds in mind (for example, many mammals are colorblind), and even then, they are not 100% effective. This is worrisome, because according to the American Bird Conservancy, "Cats have contributed to the extinction of 63 species of birds, mammals, and reptiles in the wild and continue to adversely impact a wide variety of other species…" [1].

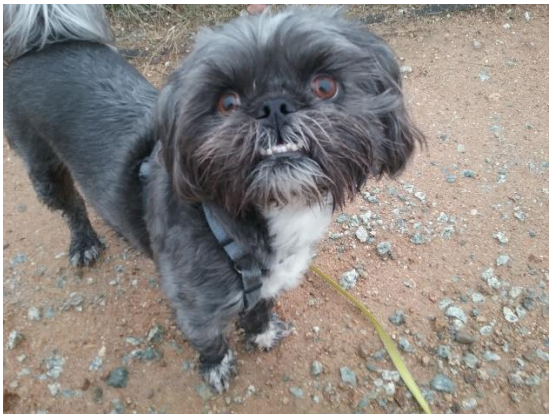
What about Dogs?

If cats are such a problem, what about dogs? Does Fido have instincts that make him ready to pounce any time something unexpected finds its way into your backyard? The answer is, it's a little bit complicated. In short, you have much less to worry about with your dog than your cat, but let's unpack that a bit.

The domestic dog (*Canis lupus familiaris)* is considered a subspecies of the gray wolf (*Canis lupus*). Similar to the cat, thousands of years of domestication turned a ferocious predator into the domestic pets we know and love today. That alone tells us that dogs do have the potential to pursue and kill smaller animals. Depending your dog's breed and its own unique personality, these instincts may be expressed to a greater or lesser degree. However, overall the scientific literature does not implicate domestic dogs in widespread wildlife kills. It appears that by and large the predatory instinct takes a

backseat to the behaviors that were selected for by our wolf-taming ancestors, such as companionship with and loyalty to humans.

This is fortunate, since dogs would be a bit trickier to keep inside. Large breeds would be especially difficult to confine to the inside, and it would be hard to train a dog to use a litter box! Nevertheless, you may have seen your dog take down a skunk, squirrel, or even a bird. If this is the case, your dog also poses a threat to the wildlife in your backyard. Again, supervision is key for a dog you know expresses this instinct.



For whatever reason, dogs are not nearly as deadly to wildlife as cats. Still, supervise as necessary.

Pets as Rodent Control:

It is common, especially in rural areas, for homeowners to capitalize on cats' hunting prowess to reduce any rodent problems that they might be struggling with. This idea makes sense on the surface, but research shows cats do not affect rodent populations very much. The reason is pretty simple: yes, your cat is catching and killing any house mice, black rats, and native rodents that come its way. However, they are also excluding other natural rodent predators such as raccoons, foxes, and coyotes from the area. Furthermore, up to 67% of the rodents cats kill are native species, not the pests that plague our livelihoods [2].

Feral Animals

If domesticated cats kill out of instinct, then feral cats with no owners can be expected to do the same thing. In fact, studies show that feral cats make up the majority of wildlife deaths caused by the cat population [3]. So where does that leave you if a feral cat decides to take up residence in or near your backyard habitat? First, let's talk about what not to do.

Do not feed a feral or stray cat. It might be tempting to satiate the cat with cat food, but as I mentioned earlier, cats will still kill for sport regardless of their hunger. Plus, feeding

cats will only lead to more problems. If you begin feeding a cat on your property, you will likely attract more cats. This only creates a larger problem for any wildlife utilizing your backyard habitat.

Your options are limited when working with feral/stray cats. Unless you want a new pet, you obviously can't bring them inside, and good luck trying to get a bird-friendly collar or bib onto a wild animal with claws!

The same goes for stray dogs. Even if dogs are compelled by that instinct to a much smaller degree, all bets are off if a stray or feral dog is hungry. Again, leaving food out might satiate *that* dog, but you can easily attract more stray dogs or cats, or even undesirable wildlife like raccoons or opossums.

For any stray/feral animal, the only effective solution is to catch and remove them. Call your local animal control and see if they can come out to catch the animal or if they can provide traps for you to catch it.

A valid concern with this method is that your feral friend may end up getting euthanized if it is overlooked at the pound or animal shelter. Some animal shelters will adopt out feral cats for a very low fee due to their un-tame nature, but finding a willing pet owner can be difficult.

Trap-Neuter-Release (TNR) programs will definitely help reduce feral cat populations over time, and this is a good option if the risk of euthanasia creates a burden on you. However, if you have a problem cat in your wildlife habitat, then removal is a must.

It is important to note that not doing anything is not a valid option. If you significantly alter your backyard habitat and lure creatures to their deaths, then they would have been better off without the habitat modification at all. Additionally, feral animals are not living their best life. Studies show that while house cats with owners can live in excess of 15 years, feral cats live only about 3-5 years due to the stresses of living in the wild [2]. Feral cats also can carry diseases such as toxoplasmosis that lower their quality of life and end up infecting native wildlife (or your pets!) as cats move from place to place [2]. The absolute best thing you can do for a feral animal and for wildlife is to trap it and take it to a shelter. Euthanasia may be in its future, but it is better than the brutal life it is currently living.

Dealing with a Neighbor's Pet

If you end up finding a backyard intruder with a collar on, it is best to have an open and frank discussion with the owner about what you are trying to accomplish and how their pet is harming wildlife. All of the reasons I've listed are great talking points about why your neighbor should keep a closer eye on his/her pet. Feel free to cite this book (or the sources I have drawn from) to make your point. If your neighbor will not listen, you *could* always threaten to trap the pet, or actually do it. A fine from the local animal control

might persuade your neighbor to meet your requests, but he or she probably won't like you very much when all is said and done.

Give Wildlife a Fighting Chance

Another major protective step you can take to eliminate pet-related wildlife deaths is to design your habitat accordingly. If you are using bird boxes, feeders, or baths, place them in areas higher up and away from vegetation. Locations that are high up or are out in the open prevent your pet (or a feral animal) from being able to sneak up on your backyard visitors. One note of caution: don't eliminate ground covers and other hiding places completely. Remember that many animals, especially lizards and small birds, use thick vegetation or ground covers as a way to stealthily move through the environment. The point here is to place wildlife-attracting elements out of reach of your domesticated friends.

Footnotes:

1. American Bird Conservancy. *Cats and Birds*. 2019. https://abcbirds.org/program/cats-indoors/cats-and-birds/
2. Aaron M. Hildreth, Stephen M. Vantassel, and Scott E. Hygnstrom. *Feral Cats and their Management*. University of Nebraska, Lincoln Extension. 2010. http://extensionpublications.unl.edu/assets/pdf/ec1781.pdf
3. Peter Blancher. 2013. *Estimated number of birds killed by house cats (Felis catus) in Canada*. Avian Conservation and Ecology 8(2): 3. http://dx.doi.org/10.5751/ACE-00557-080203

Bonus Tip: Lay Down Your Arms

The scientific and religious communities are at each other's throats more and more as the years go by. Friends, this should not be so; we should be able to coexist. I am a Bible-believing Christian who finds the scientific model of evolution to be compelling, and I am in good company: Francis Collins (former director of the Human Genome Project) similarly believes both science and Scripture to be true. In fact, the more I research the topic, the more I find prominent religious academics from multiple faiths.

Before you write me off as a "Heathen" or "Bible Thumper", let me take a different approach. What you may see in the media about militant evolutionists or militant Christians does not represent the truth. As a student at UC Davis during the infamous 2011 pepper spray incident, I saw firsthand how "truth" was edited and clipped in a video to portray a vastly different situation than what actually occurred. The world was led to believe that a police officer brutally pepper-sprayed a group of innocent protestors sitting in a circle on the ground. In reality, these protestors had encircled another police officer and refused to let him out until they were left alone by law enforcement. That part of the video was never shown by the media.

In a similar fashion, religious people are smeared as ignorant, while scientific thinkers are smeared as condescending. I would know; I belong to both groups. It is time for this to stop.

Why Laying Down Your Arms Helps Habitat and Humanity

There will always be religious and non-religious people. The more we use science as a cudgel to attack the other side, the greater our society and planet will suffer for it. How many religious people would stop being weary of science and at least consider the concept of climate change (which alters all habitat) if their embrace of science didn't suggest an abandonment of their values? How many Richard Dawkinses could get back to actually protecting the earth if they didn't feel the need to convince people of an entirely different worldview?

Even better, how much more could we focus on curing cancer or increasing crop yields or purifying water if all of the atheists would stop attacking religious people based on a logical fallacy (see below)? How many more brilliant-minded Jews, Christians, and Muslims would enter the scientific community and come up with marvelous breakthroughs if we would stop telling our children in church that science and faith are fundamentally opposed? How many of us, sandwiched firmly in the middle, could actually make change if we spoke up about this and showed people that there is no conflict? People are literally dying because of the delay of progress caused by this unnecessary conflict. Whether by our own pride, arrogance, or timidity, blood is on our hands. We are all responsible.

To my religious friends: I am not here to convince you that evolution is real and true; all I seek to do is show you that it does not threaten your worldview. It is my hope if I show you that evolution and the scriptures you adhere to are not at odds, you may lay down your metaphorical arms, seek the evidence out yourself, and make your decision. At the very least, the fighting can stop.

To my atheistic scientific friends: I am not here to shove Jesus down your throat. Let me be clear: as a Christian nothing would make me happier than you coming to Christ, and I hope this will help you consider that choice. However, my focus here is to show you the "Science disproves God" approach unnecessarily alienates potential Christians/religious folk from entering the scientific field.

Why Science Does Not (and Never Can) Disprove God:

I have wanted to be a wildlife biologist since I was twelve years old. I have read quite a few Biology, Chemistry, Physics, and Genetics textbooks. The introductory ones all say some version of the same thing: "The scientific method does not make appeals to a higher power." God is completely off-limits to the scientific method. The scientific method is only able to function off of observed, natural phenomena. From these observations, we make our inferences, design our experiments, and either strengthen, modify, or throw out our scientific models.

But here's the rub. God is, by definition, a *supernatural* being. The scientific method, by definition, *assumes* atheism. Rhetorical theory informs us that if your conclusions and your assumptions are equivalent, you have engaged in the logical fallacy known as circular reasoning. If your method refuses to consider a supernatural explanation in your calculations, you cannot say your calculations disprove the supernatural.

The scientific method cannot *prove* God either. All we can do as inquisitive humans is take what information we have gained from science, philosophy, and our own experiences and infer whether or not God exists. From there, we search Who God Is (if He is there), and then decide how we should live based on our conclusions.

This is not to say the scientific method is flawed; far from it! The scientific method has given us cures to abhorrent diseases, taught us about bacteria, and enabled us to travel far distances on rails, wheels, and in the air. I am simply reminding everyone that while it is the premier mechanism for understanding the natural, it is completely powerless to speak to the supernatural.

Let's think about the precarious position this puts non-religious folk when they inaccurately credit the scientific method for their beliefs. The typical dialogue goes like this: "Science explains so much that there remains very little for God to explain. As the years go by, we will find God's place in the universe shrink, constantly moving towards zero." This is the so-called *God of the Gaps* concept. This idea falls short in at least three ways.

First, God of the Gaps is not the experience that scientists are having in the explanation of the universe. The scientific method has explained a great deal of phenomena, but it has also revealed exponentially more questions that need answering. Before the scientific method we were absolutely sure what shape the earth was, where it belonged in our solar system, just how big our universe was, and whether our entire universe is actually alone. These gaps, while some are being closed, are being widened on the back-end. We know what shape the earth actually is now, but our universe might live in a multiverse! For a fun and profound read on this subject, I recommend *We Have No Idea* by Dr. Jorge Cham and Dr. Daniel Whiteson.

Second, in light of this assumed atheism, the only way the God of the Gaps explanation works is if *everything* can be explained via natural mechanisms. Certainly, this is the premise of the scientific method, and I do not challenge it. Still, while we have even *one* gap in our knowledge, the logical fallacy of circular reasoning cannot be honestly discarded. And by "closing the gap" I don't mean having *some* explanation. I mean a well-documented, well-supported model based on a robust body of evidence. In the scientific world, as soon as we have *some* experiment, however incomplete, we can generate a basic explanatory model. Once you put a dot onto a blank sheet of paper, that's where you're going to look until more dots are added. Just because we have an explanation does not mean the matter is settled. In fact, modern scientific papers won't ever say "we don't know." Instead, they say "the mechanism is poorly understood."

Third, why is it that once something becomes explained it ceases to be miraculous? Sure, there are supernatural miracles that one must believe to be supernatural; both logically and *theologically*, Jesus must have literally died and literally raised Himself from the dead for any of this to make sense. But what about evolution? Is it not entirely possible that the *mechanism* God used to create life could be explained in natural terms? Does that make it any less miraculous? I think not.

As a wildlife biologist, I am awestruck by the tremendous complexity of life on earth and the plethora of mechanisms required to keep even the simplest organisms alive. Despite all of human history's attempts to outdo the complexity that exists right outside our doors, we still have not even come close. Where we have begun to approach that complexity, it has been via observing and attempting to copy what has already existed in nature! The airfoils of flying machines mimic the airfoils found on bird wings and feathers; clean battery technology mimics self-assembly phenomena found in nature [1]; even water-resistant pants were inspired by the lotus flower [2]! As Dr. John Lennox said, asking people to choose between God and science is "…like asking people to choose between Henry Ford and engineering as an explanation of the motorcar." [3]

Lastly, faith does not mean "belief in spite of contrary evidence" to a religious person. Faith is not formed in the absence of knowledge; it is formed in addition to it, and often because of it. Because I believe in God, this frees me to act in ways that may not be in my best interest; I have faith that my loving Father will enable me to do what is morally upright and either avoid or endure the consequences. I once gave a homeless person a

ride to a local homeless shelter, knowing full well that to do so might have consequences. I had faith that if I found myself in a threatening situation, God would either resolve it peacefully, create some form of intervention to protect me, or in the worst-case scenario, welcome me into His Kingdom. Sure, there's no scientific evidence for Heaven, but like I've said, the scientific method has no power to inform on that issue.

Faith gives me the ability to love just as Jesus Christ loved me. I'm nowhere near perfect, but faith enables me to do much better than I, personally, would be able to in acting like Christ. If you think about it, you rely on faith just as much as I do. If you have faith in your spouse, you can trust that they have your best interests in mind and are not out to harm you or leave you. Because you have faith in your spouse, you can trust them to act honorably when interacting with individuals they may find attractive. This does not supersede evidence to the contrary, such as compromising emails or texts. Faith enables you to sleep easy at night without having to actively monitor your spouse.

Faith is crucial. All I ask is that you do not antagonize those who recognize this.

Why Evolution is Not a Threat to Your Beliefs [4]:

It is not necessary to choose between Henry Ford and engineering. In fact, it is damaging to our cause as Christians to do so. When we use the Bible or other scripture to dismiss scientific conclusions, we commit the same logical fallacy I just exposed. That is, if our model (world created by a supernatural God) *assumes* theism, then we commit circular reasoning when we say, "The Bible testifies that God created all living creatures; therefore, evolution must be incorrect".

Let me be clear. I am not trying to dismantle Genesis or the Bible. I am also not trying to convince you that evolution is accurate. That decision is something you will have to study on your own, once you give yourself permission to try. My only assertion is that evolution can never be a threat to Biblical Christianity. All I ask is that you lay down your arms with a little bit of perspective.

Is it possible that God was speaking metaphorically in Genesis? Absolutely. Is it possible that our scientific method will come up with an alternative model that explains all we can observe in biology, when in reality God's six-day creation left the universe with the "appearance of age"? Absolutely. The mechanism does not replace the mechanic. The mechanic does not replace the mechanism.

I personally understand the world to be created by God over billions of years. I will not ask you to accept this viewpoint, but merely to see the harmony embedded within it. To do that, we need the book of Genesis. There are not one, but two, creation stories contained within it.

Genesis 1:1 – 2:3: The seven days of creation are as follows:

1. God separates light from darkness, creating night and day.

2. God separates the Heavens from the Earth.
3. God gathers the waters under the heavens into one space, creating oceans and dry land. God also creates plants.
4. God creates the sun, moon, and the stars.
5. God creates creatures of the sea, followed by birds of the air.
6. God creates land creatures, such as “beasts of the earth”/livestock (mammals) and “creeping things” (reptiles/amphibians). God creates man and woman, giving them dominion over the creatures of the earth.
7. God rests.

This is the typical seven-day creation story we are taught in Sunday School. The second story contains critical differences.

Genesis 2:4 – 2:24:

- **2:4-7:** The lord creates the man Adam (but not woman) “When no bush of the field was yet in the land and no plant of the field had yet sprung up…” In the first story, plants were created on day 3, *before* humans were created on day 6.
- **2:8-9**: God places Adam in the Garden of Eden.
- **2:18-23:** Man gets to name all of the animals God has created, but he is alone. To give him a companion, God creates woman. This is after plants and animals, placing woman’s creation on day 6. Of course, on day 6 God created Man *and* woman in the first creation story.

We have two apparent contradictions between the two creation stories. However, the author of Genesis placed these stories adjacent to each other in the Bible, meaning the contradiction would have been easily noticed. Maybe there is no contradiction after all. As Christians, we believe God does not lie, so both stories must be true. In my estimation this can be the case in one of three ways.

1. **Both stories are literally true:** Can two contradicting accounts be literally true at the same time? God is omnipotent, so if we set aside this logical inconsistency, then why stop at two? Couldn’t scientific theory be the truth?
2. **Both stories are metaphorically true**: It is possible that these two stories are both metaphorical, expressing theological truths. Considering God is vastly more concerned with our spiritual well-being than the clarity of our head-knowledge, I believe this option to be the most likely. Having read as many scientific textbooks as I have, it is clear the Bible would be substantially larger to add all of science into it…and it’s already huge! Regardless, two metaphorical truths still leave room for one literal truth.
3. **One story is literally true, while the other is metaphorically true**: I will admit that this option is the hardest to explain. If one story is the literal truth, with the other being theologically informative, then there would be no room for evolution to join the list of explanations. But that raises the question: which account is

> literal, and which is metaphorical? How do we decide? Furthermore, if we readily concede that at least *one* of these stories must be metaphorical in nature, this compels us to let go of the absolute need for the entire Bible to be the literal truth. Don't misunderstand: I believe every word of the Bible to be true. I merely think sometimes what we read as history was meant to be morally instructive. Don't ask me when and where. I am not a Bible scholar, and I would be wrong more often than I was right. However, I have no issue with saying that God created the heavens and the earth, whether by evolution or some other mechanism.

As a Christian, I have always found beauty in God's creation. As a scientist, I have had the unparalleled privilege of learning how these beautiful creatures work. While I stand awestruck and fulfilled by both perspectives on biology, I also watch in horror as the same scientific discipline tears our society apart. Lay down your arms so we can get back to loving and saving the creatures that inspire us all.

- Jacob Ewald, Home Sweet Habitat

Footnotes:

1. Dr. Angela Belcher is the James Mason Crafts Professor of Biological Engineering and Materials Science and Engineering at the Massachusetts Institute of Technology (MIT). Her work on virus-created batteries inspired me as a teenager, and still does to this day. You can listen to her TED talk on the subject here: https://www.ted.com/talks/angela_belcher_using_nature_to_grow_batteries?language=en#t-422649
2. This particular example comes from my time as an educator at Turtle Bay Exploration Park. Essentially, the whisker-like nano-appendages on "waterproof" pants causes water to roll off the clothing fibers rather than being absorbed into the pants. This is similar to the "waterproof" leaves of the lotus plant, which has waxy bumps enabling water (and grime) to slide off the leaves rather than stick to them. The activity was created by the National Informal Science Education Network, or NISENet. For more information, follow these links: http://www.nisenet.org/sites/default/files/catalog/uploads/2767/productsfabric_guide_15nov10.pdf and http://www.nisenet.org/catalog/exploring-products-nano-fabrics
3. Dr. John Lennox is an emeritus professor of mathematics at Oxford University. This quote was taken from an oxford union debate on the existence of God, published on YouTube in 2012. You may watch it here: https://www.youtube.com/watch?v=otrqzITuSqE. If you are interested, there are five more clips from that debate. In total, three atheists and three theists argue their side. It is a worthwhile investment to listen to them all, but in my opinion, Lennox argues the most effectively.
4. I have heard of the two creation stories from multiple sources over many years, but the source which most clearly informed my analysis was an honest reading of the first two chapters of Genesis. You can find it here: https://www.biblegateway.com/passage/?search=Genesis+1-2&version=NIV. My *next* most informative source on the matter was written by Dr. Pete Enns of Eastern University, published on the site BioLogos in 2010. It is called *Israel's Two Creation Stories* and can be found here: https://biologos.org/articles/israels-two-creation-stories/

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Communication is hard. If you say the right thing in the wrong way, you can end up undermining your goals, or worse, setting progress back. Likewise, education is hard. It is one thing to study and master a topic; it is quite another to keep the questions and difficulties you had while learning in mind, to shorten the learning curve for others. Third, science is hard. There would be nothing to educate on without the continuous ecological research making our world more understandable.

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About the Author

Jacob has had an interest in wildlife since he was a young child. An encounter with an unusually friendly Swell Shark on Catalina Island and a trip to the Costa Rican rainforest left Jacob changed. These experiences ignited an unquenchable passion within him to study the natural areas of the world. Jacob earned his Bachelor of Science in Wildlife, Fish & Conservation Biology from UC Davis in 2015 and followed up with a certificate in Geographic Information Systems from UC San Diego in 2017. Along the way, Jacob has hooted with Spotted Owls, ticked off a nesting Northern Goshawk, UFO'd some Wood Ducks, snuck up on Black Bears (on accident!), combatted Sea Turtle poaching, and kayak-raced Giant Garter Snakes. Despite falling into a few ponds and getting a few vehicles stuck, Jacob has had a blast in this line of work. He will gladly earn a few scrapes and bruises as he continues to promote functional habitat.

About Home Sweet Habitat:

Home Sweet Habitat is a movement to take land used for human needs and recapture it for wildlife. Because habitat loss is the largest driver of biodiversity loss in the world today, restoring land that has been converted to human uses may make the difference between extinction and persistence for many species. One of the easiest ways to accomplish this restoration is in the millions of yards that just need a few tweaks to support wildlife. At the moment, Home Sweet Habitat is just a blog. With your help, it can become a movement that will save wildlife everywhere. Learn more at www.homesweethabitat.com/blog.