

Appendix 4: Food Web on the Living Roof

All photos were taken on the roof by survey participants

Seeds

Many species of grasses, shrubs, wildflowers and trees planted on the roof produce seeds. Birds are frequently observed foraging for the seeds in the vegetation and on the ground.

Coneflowers and other perennial and annual flowering plants produce seeds and nectar, attracting sparrows, goldfinches, hummingbirds, and butterflies to the roof. Allowed to mature and senesce, flower heads containing seed provide food for birds.



Birds benefit from the variety of grasses dispersed through the roof gardens. These grasses produce nutritious seeds and provide cover for beneficial insects.



Mourning Dove foraging for grass seeds

Shrubs and small trees also attract seed-dependent birds to the roof gardens. Low flying birds such as White-and Golden-crowned sparrows and California Towhees are often seen foraging through the understory plantings and leaf litter in search of seeds.



Lesser Goldfinch feeding on seeds produced by shrubs



California Towhee foraging for fallen seed on the ground

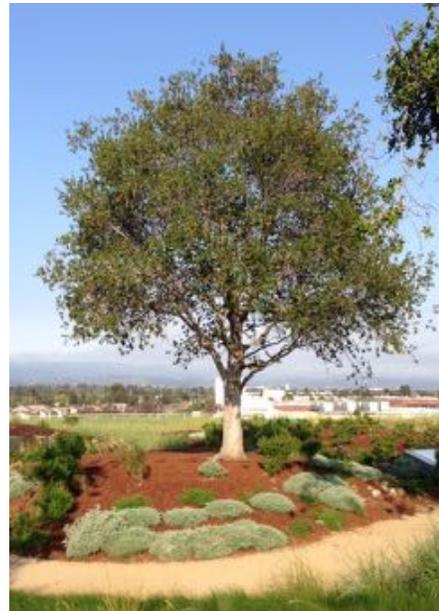


Acorns

Coast Live Oak trees and Valley Oak trees planted on the Facebook roof produce acorns that are sought after by many birds. We observed American Crows and California Scrub Jays collect acorns on the roof.



California Scrub Jay perched on one of the roofs Coast Live Oaks



Acorns play an important ecological role in California's native oak woodlands. Rich with protein, carbohydrates, fats, and minerals, acorns are a preferred diet choice for many birds and mammals. Jays and squirrels are known to collect thousands of acorns and cache them underground for future consumption. Forgotten caches of acorns germinate and grow into new trees, producing the next generation of oaks and continuing the cycle.

An American Crow collects fallen acorns



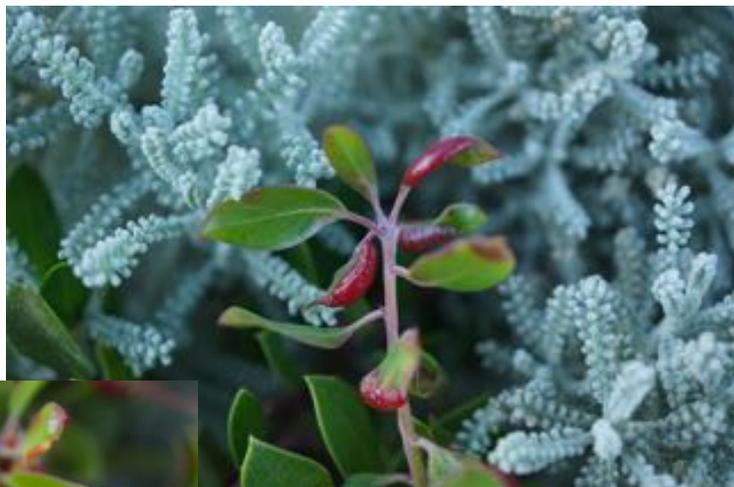
Galls

Galls are irregular plant growth hormones that are induced by the reaction of plant tissue to growth regulating chemicals produced by species of insects and mites that lay their eggs into the plant tissue. The immature insect larvae, confined within the gall, feed on the plant tissue and secrete hormones until they mature and emerge.



Galls on oak twigs

Galls may occur on leaves, bark, flowers, buds, acorns, or roots and generally do not affect the health of the host plant. Leaf and twig galls are most noticeable. Each gall is unique and they can vary in shape, size and even color. Birds use their strong beaks to penetrate the tiny holes in the galls, opening up a buffet of protein-rich insect larvae inside.



Leaf galls on Manzanita



Insects and spiders

Small insects in large numbers are essential to the survival of many songbirds. Birds have high metabolisms, requiring them to eat more food in relation to their body weight than most mammals. One way of meeting this demand is to supplement their diets with insects. Regardless of their adult diets, many birds will also feed insects to their nestlings and fledglings as a way of providing high calorie and protein meals that aid development.



Southern green stink bug (Nezara viridula) nymph (left) and adult (right)



The mixture of plantings in the roofs gardens supports a wide array of insects at different life stages. Eggs, larvae, nymphs, and mature insects have been found in the vegetation during each survey. Common sightings include true bugs (Hemiptera) beetles (Coleoptera), butterflies (Lepidoptera), flies (Diptera), Bees, wasps and ants (Hymenoptera).

Ladybug (Coccinella septempunctata) nymph (left) and adult (right)





Oleander aphids are often found covering the leaves of milkweed plants in the roof gardens. These tiny insects suck sap out of the leaves and excrete sugar (honeydew). Ants often tend to the aphids, protecting them from predators (such as ladybug larvae) and feeding on the honeydew. Birds, in turn, will glean plant leaves for insects, including ants.

Ants tending to aphids

Birds aren't the only ones to benefit from insects that inhabit the roof vegetation. An entire ecosystem is supported by the nutrients that small insects provide. In order to reproduce, flowering plants are dependent on insects to spread their pollen from one plant to another. Many insects also act as decomposers, breaking down waste products and decaying material that might normally accumulate quickly in the gardens.



Unidentified beetle (left) and common land slug (right)



Butterflies

Several species of butterflies have been spotted fluttering about the Facebook roof during. In summer, we found larvae of endangered Monarch butterflies (*Danaus plexippus*) feeding on milkweed plants in the gardens.

Milkweed plays an integral role in the life cycle of Monarchs. Mildly toxic to predators, milkweed serves as the only nursery selected by adult monarchs. Adults lay their eggs on the underside of milkweed leaves and the caterpillars will eat the plant as they grow. Extermination of milkweed plants across North America has been attributed as the leading cause of the decline in Monarch populations.

Like the milkweed they inhabit, Monarch larvae and adults are toxic to birds - a method of defense that keeps them safe on Facebook's roof.



Brightly colored passion butterflies (*Agraulis vanillae*) have also been seen utilizing the roof habitat. Similar to the Monarch, these butterflies consume poisonous plants, accumulating toxins within their bodies. Black and orange stripes warn predators of their toxic nature, and birds learn from a young age to avoid them.

Spiders

Spiders and their inconspicuous webs have been noticed in the gardens during several roof surveys. Spiders belong to the arachnid family along with mites, ticks and scorpions. Arachnids have 8 legs and two body parts, whereas insects have 6 legs, 3 body parts, and typically have wings. Nonetheless, birds will often eat small, non-venomous spiders or feed them to their young. Sparrows, blackbirds, crows, and wrens are known for regularly consuming spiders. Many birds, including Anna's hummingbirds, use spider webs in construction of their nests.



Trashline Orb Weaver spiders (*Cyclosa turbinata*) have been found in the ground level park during several surveys. These cryptic spiders spin vertical orb webs, creating intricate spirals around the center of the web and even organizing their dead prey based on when they were captured. Why? Orb weavers use their captured prey as a disguise, making it difficult for birds or other predators to differentiate the spider from the rest of the debris.



Pollen and Nectar

A palette of blooming native and non-native plants on the roof attracts Anna's Hummingbirds and other pollinators to the gardens on the roof. Bees, butterflies, and hummingbirds fly from flower to flower, extracting the sugary liquid using specialized structures on their bodies. While they feed, insects and birds collect pollen produced by the male anther of a flower and transfer it to the female stigma, assisting in the reproduction process.



Hummingbirds have evolved thin, narrow bills that are designed to probe deep into flowers. It is believed that many plant species have coevolved along with hummingbirds, producing colorful, tubular flowers that attract the birds. Contrary to what many may think, hummingbirds don't actually suck the nectar through their beak like a straw, but rather use their tongues to lap up the sweet substance.



Although hummingbirds can consume twice their body weight in nectar in one day, they also rely on insects and spiders to balance out their diet. Given the plethora of food sources available on the Facebook roof, Anna's Hummingbirds were sighted utilizing the gardens during every survey.

Anna's Hummingbird searching for nectar in Penstemon flowers

Other birds (doves and pigeons)

Cooper's Hawks, Red-tailed Hawks, and Red-shouldered Hawks have been seen perched on the roof and on pylons in the vicinity of the building. We believe these raptors may be preying upon the pigeons and doves that congregate on the roof and nearby power lines. During several surveys, we have noticed remnants and feathers of these birds on the roof, indicating that they may have fallen victim to raptors.



Rock pigeon feathers (left) and Mourning Dove (right) on the roof

