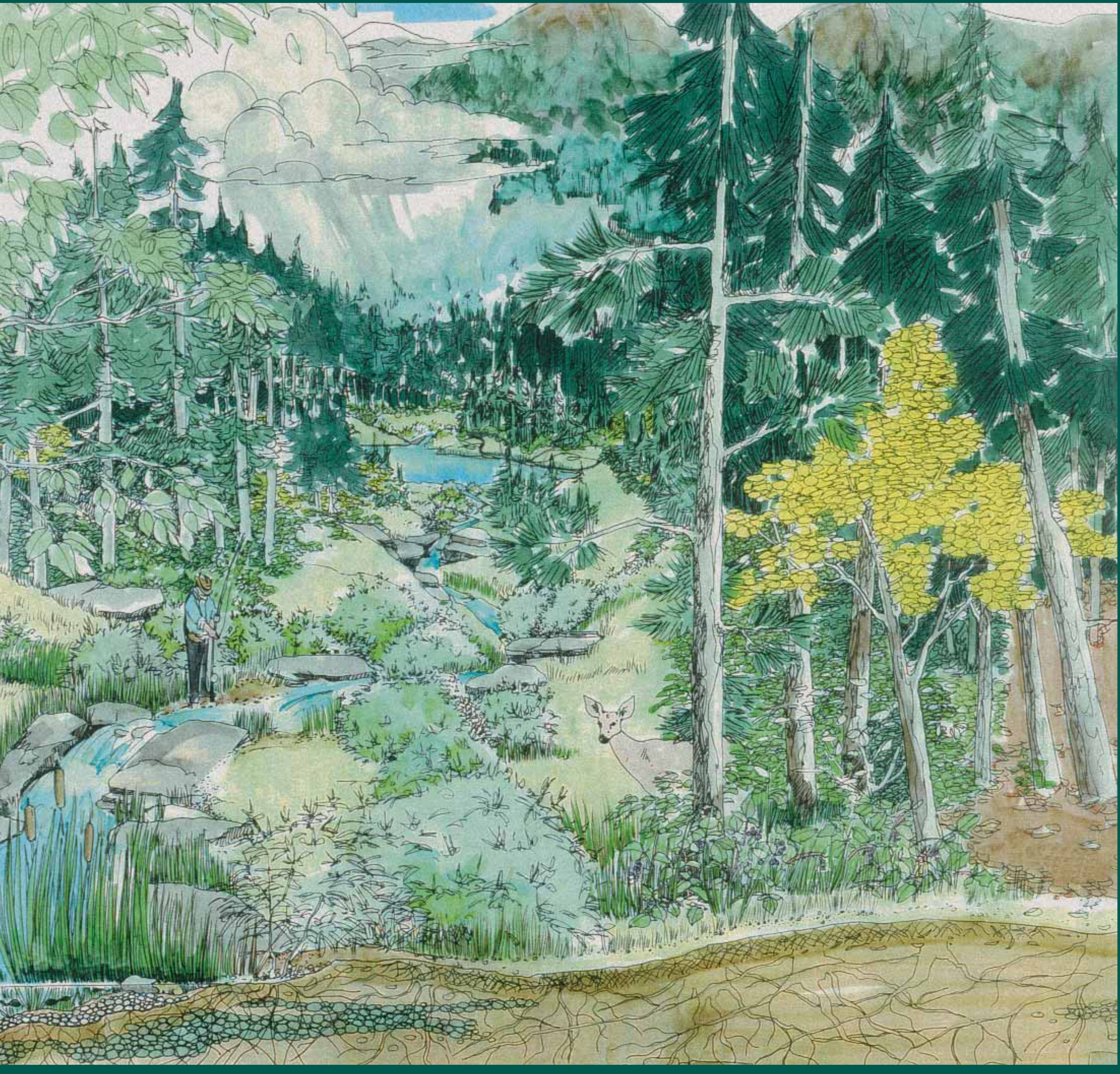
CHAPTER 2

The Riparian Ecosystem



This chapter discusses the value of the riparian ecosystem. It offers a different approach for using the riparian ecosystem as an indicator of what has gone wrong or what is functioning well, as well as what is important to protect. It also discusses the structural and functional characteristics of the riparian ecosystem and how these characteristics are the key links to maintaining ecological integrity.

Anything and everything that has an influence on the structure and/or function of the riparian ecosystem affects its integrity. Riparian ecosystems are the most sought-after forested areas by both humans and other animals. Any plant communities associated with water, whether they are in deserts, foothills, or mountains, are considered riparian. They offer major creature comforts such as food, water, and shelter. Yet they are the most misused, misunderstood, and abused portions of our landscape.

Riparian ecosystems are the canaries in the coal mine. They give warnings of erosion and pollution problems that threaten forest streams, rivers, lakes, and ocean-fronts across the Nation. They further warn that when water quality is impacted, the fundamental ecology is deeply disturbed.

All across the country, this Nation's riparian areas flourish with bountiful populations of wildlife and diverse plant communities. They serve as a classroom for complex ecology and show how interrelated and interdependent ecosystems are. Even the most innocent or invisible acts impact the riparian ecosystem and, ultimately, the water we drink. Examples of these disruptive acts include fertilizing farm lands; mowing beside lakes, rivers, and streams; removing shrubs and trees; constructing access roads and trails for recreation, logging, and mining; fishing from streambanks; camping at the water's edge; and other recreation activities.

Typical Mixed Conifer and Hardwood Riparian Ecosystem

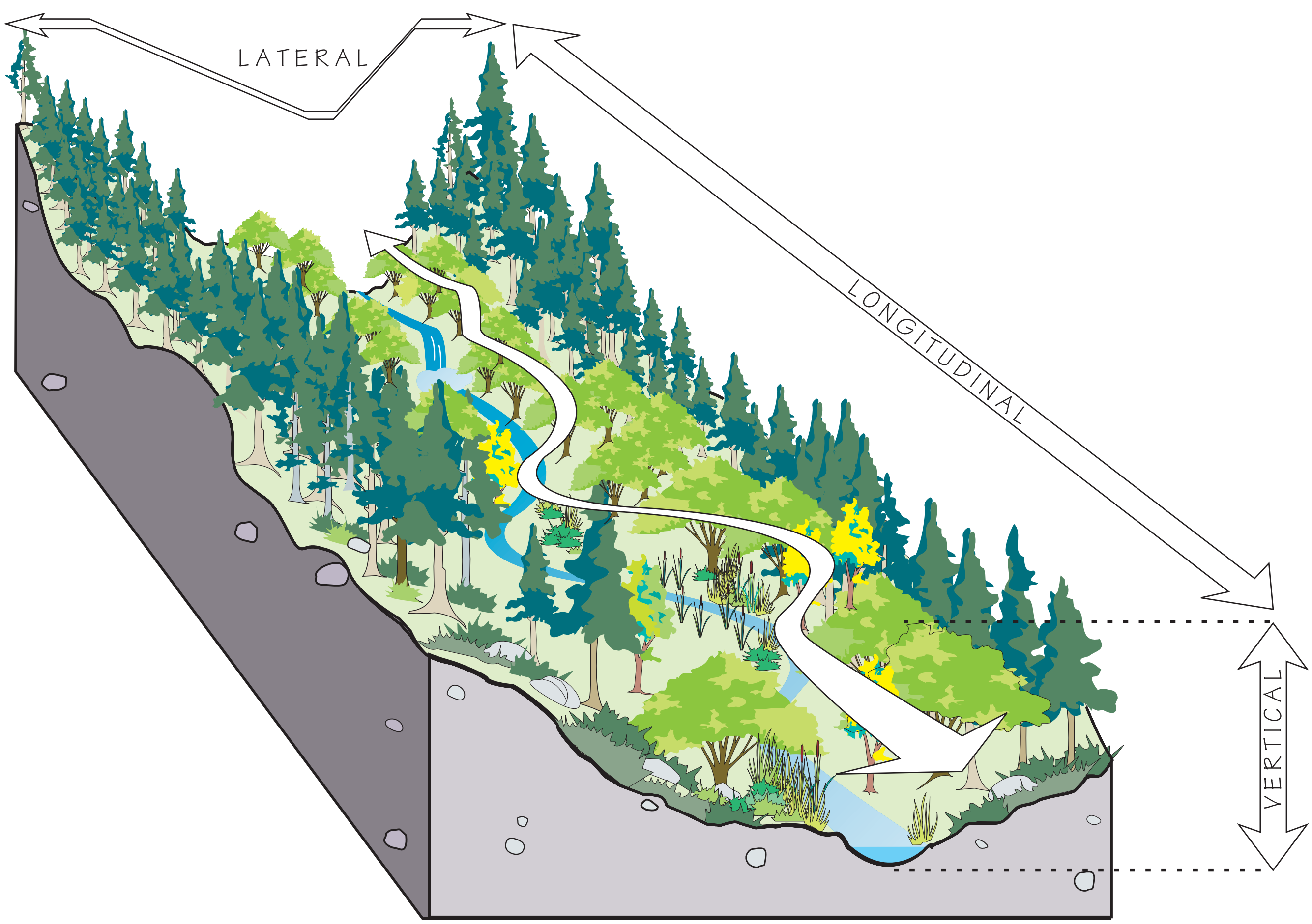
At the same time, we truly value riparian ecosystems more than any other type of forested environment. They offer recreation opportunities that are parallel to none. They are important for flood mitigation; water quality control; and regulating the movement of water, sediment, minerals, and woody debris between terrestrial and aquatic ecosystems. They offer critical habitat and food sources to a diverse population of wildlife, including fish, fowl, and plant species, as well as to humans.

Riparian Integrity

The structural and functional characteristics of the riparian ecosystem are the key links to maintaining ecological integrity. Quite often riparian forests are described as land and vegetated areas associated with lakes, streams, rivers, and wetlands that have complex ecosystems and provide food, lodging, and travel corridors for both aquatic and terrestrial species. The riparian concept suggested here is broadened to include surrounding influences.

The influences on the riparian ecosystem should be viewed topographically from upstream to downstream, from upslope to downslope, from subsurface through the vegetated canopy, and over time. This is better expressed as longitudinal, lateral, vertical, and temporal influences.

- The longitudinal influence extends the length of the stream.
- The lateral influence begins in the water body and extends through the riparian vegetation, through the transitional ecotones, into the upland forest or dry land vegetation, to the point where overland flow (runoff) is initiated.
- The vertical influence extends below the dry-season water table and up through the canopy of mature vegetation. In certain ecosystems, grass may be the naturally mature vegetation; in others, it may be cacti or scrubby trees.
- Temporal influences are changes to the ecology over time.



Riparian areas are not tied to a set number of meters (m) from the stream but rather to changes in vegetation types, soil moisture, and other ecological characteristics. If the structure or function is compromised, the consequences may become apparent in habitat degradation.

A Different Planning Approach

A different planning approach mandates a clear delineation of riparian characteristics through actual field assessments. In the early stages of project planning, a field assessment conducted by a team of specialists can lead to a clear identification of the riparian ecosystem and the outside influences that contribute to its health or infirmity. The field assessment clearly defines which ecological functions and processes must remain undisturbed during and after construction projects, or during other ground disturbing activities in the forest, such as logging, grazing, or recreating.

Potential impacts (longitudinal, lateral, vertical, and temporal) to watershed and riparian functions are discovered in the early planning phase. Alternatives to protect ecological functions can then be developed. Assessment and protection of riparian characteristics automatically become a part of the planning and design processes.

Structure and Function

Riparian ecosystems are the most important link between the upland forest and the aquatic habitat with a unique array of functions in the natural environment. The structure and seral ages of the riparian forest are complex and diverse.

Canopies of large trees mesh to create a microclimate that functions to cool the riparian ecosystem, maintain the water temperature, and shelter wet areas. In the absence of trees, low-growing plants and grasses provide shade as do undercut banks. Canopies of riparian forests produce particulate matter, primarily leaf litter. This is an important energy base for aquatic food webs. Palik (1998) found that one-third of leaf litter in streams comes from more than 30 m away.

Litter and standing biomass are also necessary for soil regeneration. Without the cycle of litter and biodegrading, flooding, and plant growth, the soil would not be replenished. Without soil, plants cannot grow; without plants, the soil is washed away. When soil is impaired or the topsoil is threatened, plants are less plentiful, have smaller basal areas, and have more space between them. Such poor vegetation cover leaves the soil even more exposed to sheet runoff and erosion. As little or no moisture is held in the ground, the water table becomes lower, water quality suffers, and fewer plants survive. Stream surface flow may cease.

The plant structure (standing and down), leaf litter, and uneven ground capture sediment and slow runoff by adding friction to deenergize overland flows. For example, plants with flexible stems and rhizomatous root systems lie flat against the ground as floodwaters wash over them, shielding the bank from erosion. Such plants and upright shrubs trap sediment. Tree species slow water flow, and their roots hold the soil together. Root systems create an interwoven structure that holds soils together, stabilizing streambanks. They catch and hold pollutants, use phosphates adhering to the soil and sediment particles deposited by runoff or floodwater, and hold harmful or toxic substances in place by minimizing soil movement. (Natural Channel Systems 1994)

Large woody debris (LWD) affects the configuration of a stream by diverting water flow and forming pools. The debris help regulate storage of sediment, particulate, and organic matter, and provide aquatic habitat. (Murphy 1995) LWD also affects lakeshores by providing aquatic habitat and by forming natural revetments that shelter the shore, causing beaches to form.

LWD is generated from several sources. Generally, the main source is from large trees falling into a stream when soil has been eroded away from the roots by stream flow. Murphy and Koski (1989) suggest that as much as 50 percent of LWD originates from within 1 m of the stream. Another source indicates that a 30-m uncut buffer zone is needed to maintain long-term LWD input. (Murphy 1995) In mature and old-growth forests in Oregon and Washington, for example, LWD is generated from within 20 m of the stream. (Dolloff 1994) In arid climates, woody debris is generated by shrubs catching on and piling up against a rock or outcropping and from sporadic stands of trees such as cottonwood or green ash.

Riparian ecosystems regulate not only the movement of water between terrestrial and aquatic ecosystems, but also the movement of nutrients, sediments, and particulate organic matter. Floodplains, another important part of the riparian forest, trap sediment and particulate organic matter outside the active channel during overbank flows. Without this access riparian function declines, as does streambank stability. (Swanson et al. 1982; Harmon et al. 1986) "... Non-floodplain forests trap sediment in overland flows, before they enter the aquatic system. Tree boles, coarse woody debris, herbaceous vegetation, and litter all trap sediment in overland flow." (Palik et al. 1998)

STRUCTURE AND FUNCTION

The riparian ecosystem is the most important link between the upland ecosystem and the aquatic habitat. The structures of the riparian ecosystem are complex and diverse and, as such, provide an array of functions that are typical only of that ecosystem.

Canopies of large trees mesh to create a microclimate that cools the riparian forest beneath. Canopies provide cover.

Riparian vegetation is an important food source for both animals and benthic macroinvertebrates, and is used as travel corridors for certain species. (Forman 1995)

Leaf litter and standing biomass are necessary for soil regeneration. Without the cycle of litter and biodegrading, flooding, and plant growth, the soil would not be replenished.

Floodplains trap sediments and particulate organic matter outside the active channel during over bank flows. (Swanson et al. 1982; Harmon et al. 1986)

LWD affects the configuration of a stream by diverting flow and forming pools. It helps regulate storage of sediment and particulate and organic matter and provides aquatic habitat. (Murphy 1995) It also promotes the protection of lakeshores and the formation of beaches.

Root systems create an interwoven structure that holds soils together, stabilizing streambanks.

Structure and Function Chart

STRUCTURAL COMPONENTS	FUNCTION	EXAMPLES
Roots– Interwoven infrastructure	Capture overland flow and nutrients. Remove nitrogen from soil. Stabilize banks by holding the soil together. Trap and retain pollutants. Use phosphates adhering to soil and sediments.	 USDA Forest Service
Soil	Holds moisture. Offers a growing medium for plants. Promotes good water quality by acting as a filter.	 USDA Forest Service
Canopy– Trees, shrubs, grasses	Provides food. Creates microclimates Shade ■ provides cool forest. ■ provides cool water. ■ shelters wet areas. Creates migration corridors. Provides shelter and protection.	 USDA Forest Service
Floodplain	Traps sediment and particulate matter during floods. Slows velocity of flood waters. Holds nutrients and sediments deposited during floods to enrich soil.	 USDA Forest Service

Structure and Function Chart

STRUCTURAL COMPONENTS	FUNCTION	EXAMPLES
Standing and downed vegetation, foliage, branches, leaf litter, uneven ground, and stream substrate	Aids water infiltration by slowing flow. Provides bank protection–plants lay against banks during high flows. Provides habitat. Reduces near bank velocity and redirects flow. Traps sediment by slowing down and stopping runoff and floodwaters (the sediment drops out).	 USDA Forest Service
Large Woody Debris (LWD)–large trees, tree branches, shrubs caught in streams, and log jams	Aids in floodplain development. Affects: ■ formation of pools and riffles ■ formation of beaches and seedbeds on lakes. Provides habitat. Provides resting and hiding cover for fish. Stores sediment and organic matter.	 USDA Forest Service
Litter– leaves, twigs, needles, blossoms, seeds, snags, rotting logs, and tree cavities	Provides food and habitat: Benthic and macroinvertebrates feed on litter. Provides food for fish and other aquatic species. Insects incubate on plants, then drop into water as food. Biodegrades into new topsoil.	 USDA Forest Service
Stream, river, lake basin, wetland, vernal pool, and ground water level	Carries away or impounds excess water. Provides food and water for animals. Water percolates into streams during low flow periods. Affects the microclimate.	 USDA Forest Service

Nonfunctioning Riparian Ecosystems

Failing riparian ecosystems cannot buffer streams against mud and pollutants from runoff and floods. These failed areas do not have the resiliency of healthy plants to hold soils in place, enabling streambanks and lakeshores to rebound after a flood.

Changes in the natural discharge rate of lakes, rivers, and streams can cause the water table to drop. Little or no flooding is detrimental to riparian vegetation. As the water table drops, riparian plant species die, allowing upland plant species to move in. These upland species do not filter out toxins or absorb water as well as the riparian plant species do. The upland plants are not equipped with the tenacious root systems that hold the streambanks together and withstand the impacts of flooding. They do not have the habitat value for wildlife or aquatic life found in healthy riparian ecosystems. When the riparian structure is compromised, the banks will begin to fail.

A minimally functioning riparian ecosystem cannot do its job of catching sediment before it enters a stream. It is of the utmost importance to hold soil in place, to trap sediment before it reaches the stream, and to hold flood-waters on a floodplain to allow the sediments to settle out before the nutrients and pollutants they carry enter the stream.

The following photographs demonstrate what can happen when the integrity of riparian ecosystems is compromised.

These two photographs show upstream and downstream damage caused when a road installation interrupted flow.

USDA Forest Service

Upstream

USDA Forest Service

Downstream

USDA Forest Service

The South Fork of the Flambeau River was altered by logging and log drives during the 19th century. Just upstream from this site was a dam built specifically to hold water and logs; a sufficient burst of water was necessary to transport massive amounts of water and logs downstream. (The river's gradient is 0.057 percent.) This tore up the riverbanks.

Shorelines have been reforested with nonnative pine plantations that lack riparian root characteristics.

USDA Forest Service

The area surrounding the Oconee River, in Georgia, was cleared and planted in cotton up to the edge of the river. A succession of floods ended agriculture and drove the farmers out. In the 1930's, the native hardwoods and riparian plant species began to grow again, and fish began to repopulate the river. The banks carry the scars of flooding.

These three photographs show trail damage leading to and alongside the Situk River, AK. The area is a temperate rain forest.

USDA Forest Service

Although soil on this trail is a sandy loam and gravel composition, it is so compacted that water will not percolate.

USDA Forest Service

Anglers have trampled and loosened the ground, exposing the roots of riparian plants and causing soil to erode into the river.

USDA Forest Service

Eventually, trees topple over into the river, releasing more soil and leaving a hole in the bank.

Exploring Riparian Attributes

Although riparian forests can be found in almost any landscape, all have the following attributes:

- Water above and below the ground surface.
- Water-dependent plants, even if they appear to be alive only part of the year.
- Ability to support a greater biodiversity of plants and structural complexity as compared to adjacent areas.
- Available food sources.
- Periodic flooding.

The following photographs from various watersheds across the country illustrate characteristics common to riparian ecosystems.

USDA Forest Service

This is a second growth hardwood forest; riparian understory is hobblebush, striped maple, mountain wood sorrel, painted and red trillium, ferns, and currant. A spruce/fir forest is visible in the upland. Zealand River, White Mountain NF.

USDA Forest Service

Mixed conifer, hardwood forest on the tidal Neuse River. Croatan NF.

Pipestem is the small tree in the left foreground. Background trees include hophornbeam, red maple, sweetbay, redbay, red mulberry, swamp laurel oak, and water oak. Leaning across the creek is a cabbage palm (future woody debris). Stream at Juniper Springs, Florida. Ocala NF.

USDA Forest Service

Choctafaula Creek drainage supports remnants of the swamp chestnut oak–cherrybark oak ecosystem whose plants include water oak, willow oak, sugarberry, American elm, river birch, sycamore, red maple, yellow poplar, green ash, switch cane, needle palm (endangered species) bluestem (spp andropogon), dwarf palmetto grasses, high bush and low bush varieties of blueberry, wax myrtle, dogwood, blackberry, and muscadine. Tuskegee NF.

USDA Forest Service

USDA Forest Service

The upland to the right is mixed deciduous/coniferous forest, with willows near the water. On the left is lowland mixed hardwood and shrub. At water's edge is primarily reed canary grass. South Fork of the Flambeau River, Chequamegon NF.

USDA Forest Service

Aspen and alder can be seen on the left and jack pine and alder on the right of this shallow lake. Sedges rim the water and yellow water lilies grow in it. Dead flooded timber, aspen, and red pine can be seen in the background. Chippewa NF.

Woody draw in grassland. Typical trees are green ash and American elm with an understory of western snowberry, Woods rose, spiny currant, Saskatoon serviceberry, silver buffaloberry, common chokecherry, American plum, hawthorn, and raspberry. Badlands NP.

USDA Forest Service

Sheep Creek runs through this wet meadow ecosystem. The meadow grasses are sedges and reeds. Lodgepole pines are in the foreground of this mixed conifer watershed. Wallowa-Whitman NF.

USDA Forest Service

USDA Forest Service

This riparian community is termed "Interior and California Riparian Deciduous Forests and Woodlands." The deciduous tree species are sycamore, ash, cottonwood, Arizona alder, Arizona walnut, and willow. The upland communities are Great Basin Conifer Woodland, juniper-pinyon; Relict Conifer Forest and Woodlands, Arizona cypress; and Interior Chaparral, shrub live oak, desert ceanothus, and manzanita. Sedona Creek, Coconino NF.

USDA Forest Service

Grasses and sycamore streamside at Madera Canyon Recreation Area, Coronado NF.

The tops of sycamore and cottonwood trees are visible in this photograph. They grow alongside the stream and up its incised banks. Madera Canyon Recreation Area, Coronado NF.

USDA Forest Service

The east-facing slope to the left is inland sage scrub and chamise; the west-facing slope, to the right above the creek, is scrub oak chaparral. Arroyo willow scrub grows along the creek. Pine Creek, Cleveland NF.

USDA Forest Service

USDA Forest Service

Mendenhall Glacier is in the background and is reflected in this post-glacial successional bog. Plants are willow, alder, spruce, and sedges. Tongass-Chatham Area, Juneau NF.

USDA Forest Service

Temperate rain forest. Hemlock, Sitka spruce, and alder line this creek. Devil's club (the large leaf on the left near the water) and berries are visible in the understory. Tongass-Sitkine Area, Tongass NF.