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Processes

Lessons from Lookout Creek 1996

Young red alders trapped debris during the flood. Note newly deposited gravels have buried the original surface and plant community behind the alder barrier.

Riparian communities are subject to the same natural processes as other plant communities. Pacific Northwest riparian areas experience competition, invasion, succession, insect and disease outbreaks, wind storms, and wildfire. What sets them apart, though, are fluvial—flood—processes. There's nothing like walking down a big creek after a major flood to illustrate how fast water spilling out of the channel and rushing down the drainage affects the landforms along the creek and the vegetation growing there. (*See Johnson and others (2000) for further discussion on the 1996 flood in Lookout Creek.*)

Fluvial processes interact with plant communities

Floods are high energy flows that entrain particles as they sweep downstream. The bigger the flood, the higher the energy, and the bigger the particles the flood picks up. When water flows onto the floodplains or terraces, fast-moving water can strip off organic matter and soil, and sometimes erode underlying gravel and cobble substrates. Logs and boulders swept into the stream can batter away standing shrubs and trees. Undercut banks can collapse, dumping more trees, rock, and soil into the channel and rerouting flow.

When water slows down, sediments drop out of the flow. Heaviest particles drop out first, then as the flow slows even more, the fines are deposited. Flow can slow as the flood subsides, but also wherever quieter backwater conditions occur. Such conditions can be found behind natural barriers, bedrock outcrops, log jams, or on surfaces where standing vegetation creates enough roughness to bring down the speed of the current.

Erosion and deposition during a flood have direct effects on substrates controlling rooting conditions for the plant communities. Height above flow, drainage, nutrient and moisture holding capacity, fertility—all these critical site characteristics can be substantially altered after a flood.

The surface that today supports a floodplain community may become a well-drained upper terrace if the channel cuts down and the water table drops

Gravels and fine sediments from a tributary were deposited on an older floodplain. The new surface is a complex of coarse cobbles, shallow fine sediments and deeper fine sediments on the levee to the right. Each variation can be associated with different riparian communities.

significantly. Likewise, the forested terrace that is experiencing succession from hardwoods to conifers may be transformed into a floodplain when a debris flow just downstream blocks the creek and raises the whole valley floor level.

Floods also have direct effects on the vegetation, as it is scoured, battered, or buried. Flood effects are also extremely variable. Portions of a pre-flood geomorphic surface can receive different kinds and degrees of impact. The same is true of different components of the plant community; overstory trees may be stripped away on one patch, while only the understory may be scoured off or buried on another beneath an intact tree canopy.

Huge logs swept downstream to mow down the red alder on this boulder bar, but left the understory nearly intact. (Macrae Creek, Lookout Creek drainage)

New individuals may be added to the site. Tangles of vegetation may raft in, bringing in several species at once. These include willow, coltsfoot, and oxalis. Single individuals may surf in and land alone. Fresh, unoccupied seedbeds may be created, which can favor species such as black cottonwood, red alder, and other weedy species, native or not. Each combination of effects will create new competitive environments which control composition of plant communities.

Larger landscape conditions also affect what happens after a flood. Previous disturbances (fire, wind, flood, timber harvest, roading, agricultural or residential development) in the watershed will determine which species are available to colonize a reach. Landscape conditions can increase incidence of land slides or debris flows during major storms, which contribute large wood and sediments to the flood waters.

Debris deposit comes alive as species adapted to dispersal by floods sprout where they rafterd to shore.

Burial/survival:

At the site scale, the interval since the last major disturbance will influence vegetation conditions two major ways. The first is the species composition resulting from succession, as pioneer species are overtaken by competitors. This can be replacement of herb communities by shrub communities, shrub communities by tree communities, or deciduous communities by mixed/coniferous communities, depending on the environment. The stage of community succession will control the “survivor” species pool as well as the “invader” species poised on site to capture the growing space. The second influence is the interplay of floods and stand structure. The size and density of the woody plants, controlled by time since disturbance, in turn interact with flood waters. Live trees can act as barriers or fences, catching drifting wood.

Willows present before the flood pop through newly deposited cobbles.

This can protect the community from further battering, slow waters, decrease erosion, and promote deposition. However, larger trees can be undercut and topple. Bank collapse can accelerate further erosion. Once in the torrent, the trees can become battering rams, form jams, or wash up on another floodplain to become armor for some downstream community. Larger trees can anchor a new geomorphic surface, or cause another to unravel.

Conditions at the geormorphic surface, reach, and landscape scales not only affect flood water movement and energy, but also affect vegetation interactions during the flood. They also affect vegetative response after the event. All of these factors, mixed with pure chance, make for a lot of variability in the riparian area.

<u>Plant community successional status</u>

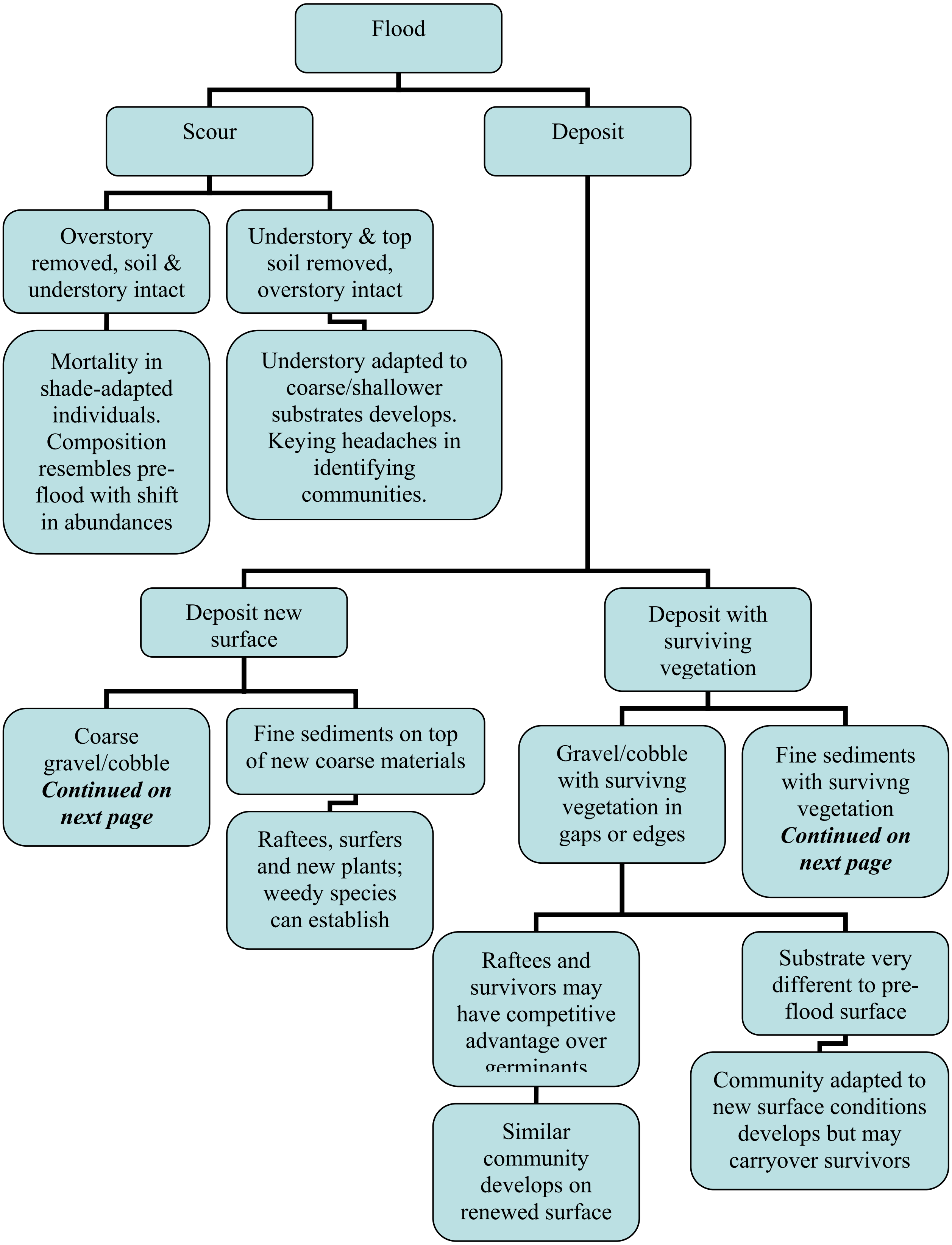
Successional status has not been emphasized in this guide. In upland communities, successional status goes from pioneer community to mature/old growth composition and structure. It is used to predict what a particular location can be expected to look like over time. The assumption is that the site stays the same, but the vegetation changes. That doesn't seem to apply well in the riparian context. Floods can change not only the vegetation, but the site itself.

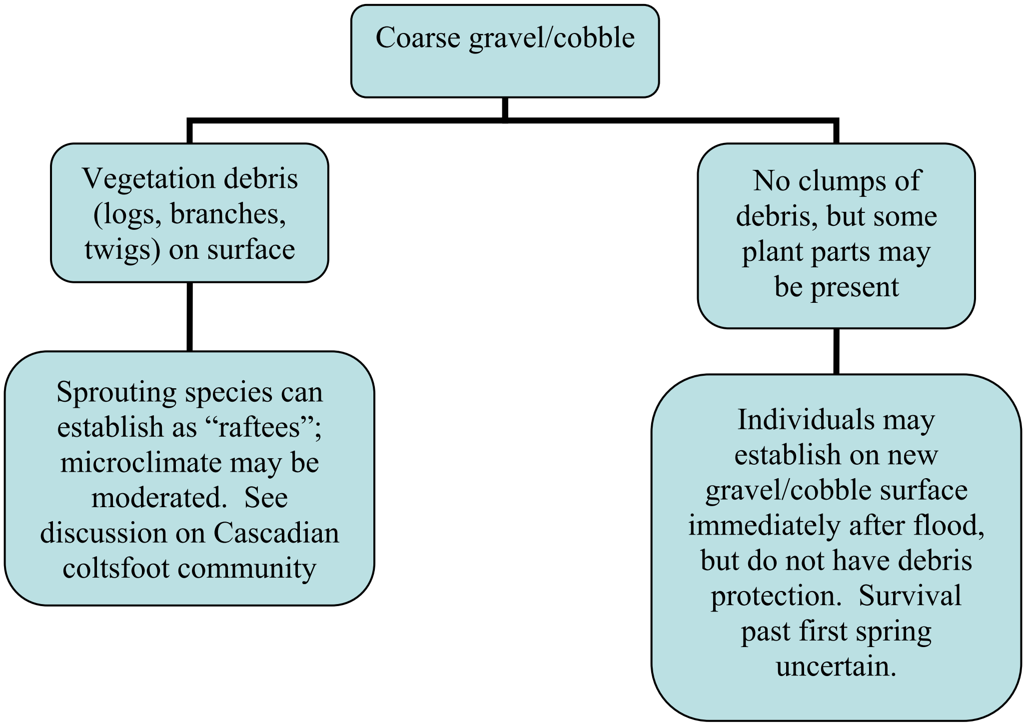
During the flood, red alder accumulated a shield made of roots and branches. Sorrel survived at the base of the trees.

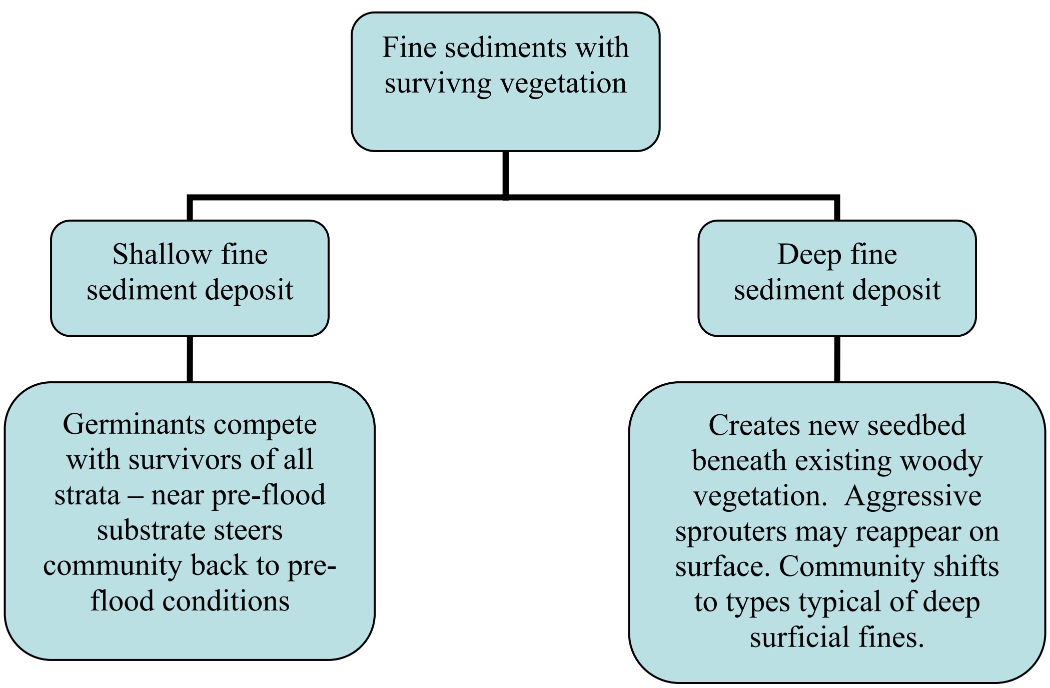
Succession can certainly be observed in riparian settings. Where overall conditions (geomorphic surface, substrate, flooding regime) are unchanged after a flood, the community recovers through resprouting or colonization. The gentle drama of competition reestablishes the same basic community type, adapted to growing conditions characterizing that geomorphic surface. But what happens when the surface itself is redefined during the flood?

Levee from a tributary creates a temporary pond on the floodplain. Coltsfoot has staked a claim to the water margins.

The following chart, developed in the Cascades after a 100 year flood in 1996, presents some possible relationships.


Flood
Scour
Deposit
Overstory removed, soil & understory intact
Understory & top soil removed, overstory intact
Mortality in shade-adapted individuals. Composition resembles pre-flood with shift in abundances
Understory adapted to coarse/shallower substrates develops. Keying headaches in identifying communities.
Deposit new surface
Deposit with surviving vegetation
Coarse gravel/cobble ***Continued on next page***
Fine sediments on top of new coarse materials
Raftees, surfers and new plants; weedy species can establish
Gravel/cobble with survivng vegetation in gaps or edges
Fine sediments with survivng vegetation ***Continued on next page***
Raftees and survivors may have competitive advantage over germinants
Substrate very different to pre-flood surface
Similar community develops on renewed surface
Community adapted to new surface conditions develops but may carryover survivors


Coarse gravel/cobble
Vegetation debris (logs, branches, twigs) on surface
No clumps of debris, but some plant parts may be present
Sprouting species can establish as "raftees"; microclimate may be moderated. See discussion on Cascadian coltsfoot community
Individuals may establish on new gravel/cobble surface immediately after flood, but do not have debris protection. Survival past first spring uncertain.

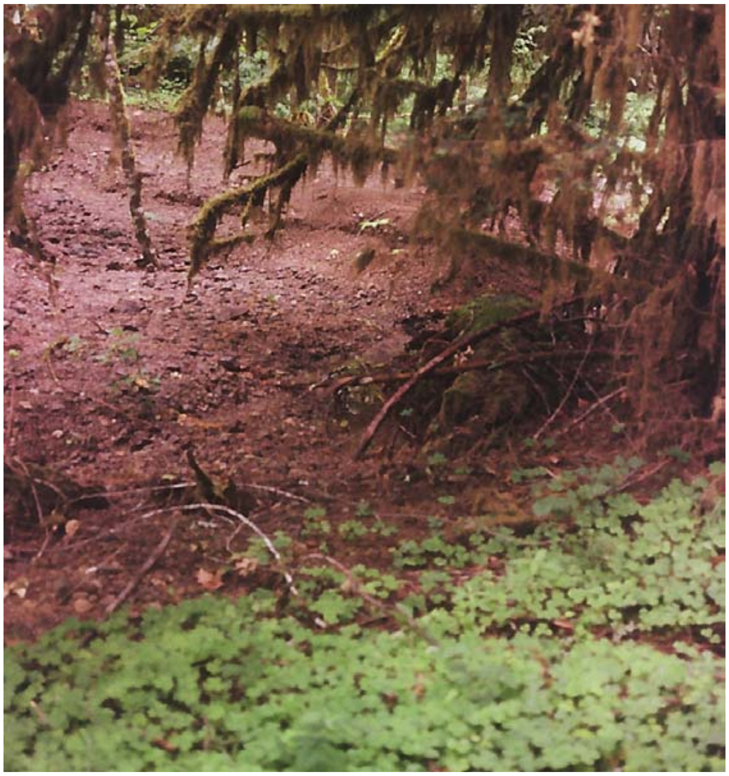

Fine sediments with survivng vegetation
Shallow fine sediment deposit
Deep fine sediment deposit
Germinants compete with survivors of all strata – near pre-flood substrate steers community back to pre-flood conditions
Creates new seedbed beneath existing woody vegetation. Aggressive sprouters may reappear on surface. Community shifts to types typical of deep surficial fines.

Weedy pioneers occupy new seedbed created by deep deposit of gravels and fine sediments.

Thin layer of fine sediment is only an inconvenience to the pre-flood community

Will big trees grow here?

A major question for riparian managers is potential for a site to support large trees, especially conifers. Growing large trees in riparian areas is an objective in watershed projects to increase levels of large wood in streams as critical channel features for aquatic habitats. Which sites are suitable for planting trees? In northwest Oregon's upland forests, red alder is often a member of early successional communities that can eventually become conifer stands. However, in riparian settings, a stand of red alder often flourishes where conifers such as Douglas fir or western hemlock won't do well. Possibly drainage is poor and/or inundation frequent. A key point is to determine whether a hardwood stand is successional or not. Is the geomorphic setting a site that most likely will allow conifers to establish, outcompete the hardwoods, and survive to maturity?



Red alder is the most likely tree species to colonize this alluvial fan. Does it have the potential to support large conifers?

One use for this guide is to determine whether the plant community on the site is often associated with conifers. But in the field, the best clue is evidence of conifers on the geomorphic surface. In some cases, presence of mature trees may be misleading, since pre-flood trees can persist on a geomorphic surface even when overall growing conditions have changed dramatically. Also, on many surfaces, upland conifers establish on nurse logs or small hummocks which create well drained microsites. These situations create an illusion that the geomorphic surfaces are suitable for conifers which require well-drained soils.

Western hemlock seedling survived in a protected pocket. Most conifers on active floodplains do not reach maturity. This can be due to limited rooting depths or to flood frequency.

Knowledge of indicator plants and communities, as well as an eye for geomorphic surfaces and likely disturbance regimes, will prove useful for selecting appropriate conifer restoration sites. When in doubt, though, digging to find out substrate, drainage, and soil depth may be most informative.