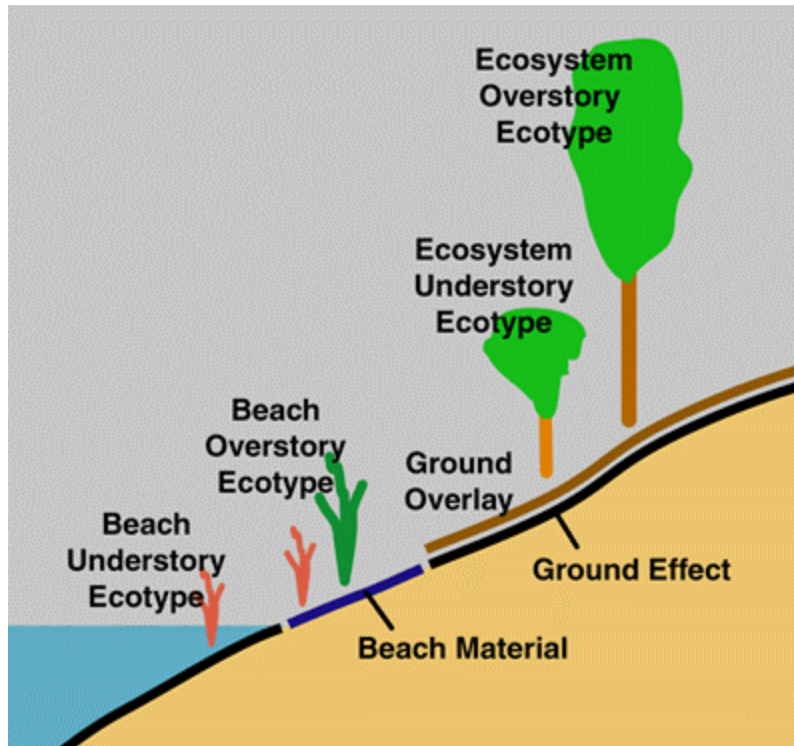


Recreating the Natural World

WCS and VNS were created to allow users to recreate the natural world using data readily (and not so readily) available. Since it's the natural world we're simulating, the toolset reflects those roots. This will take getting used to if you're familiar with the way other applications work.



The Basics

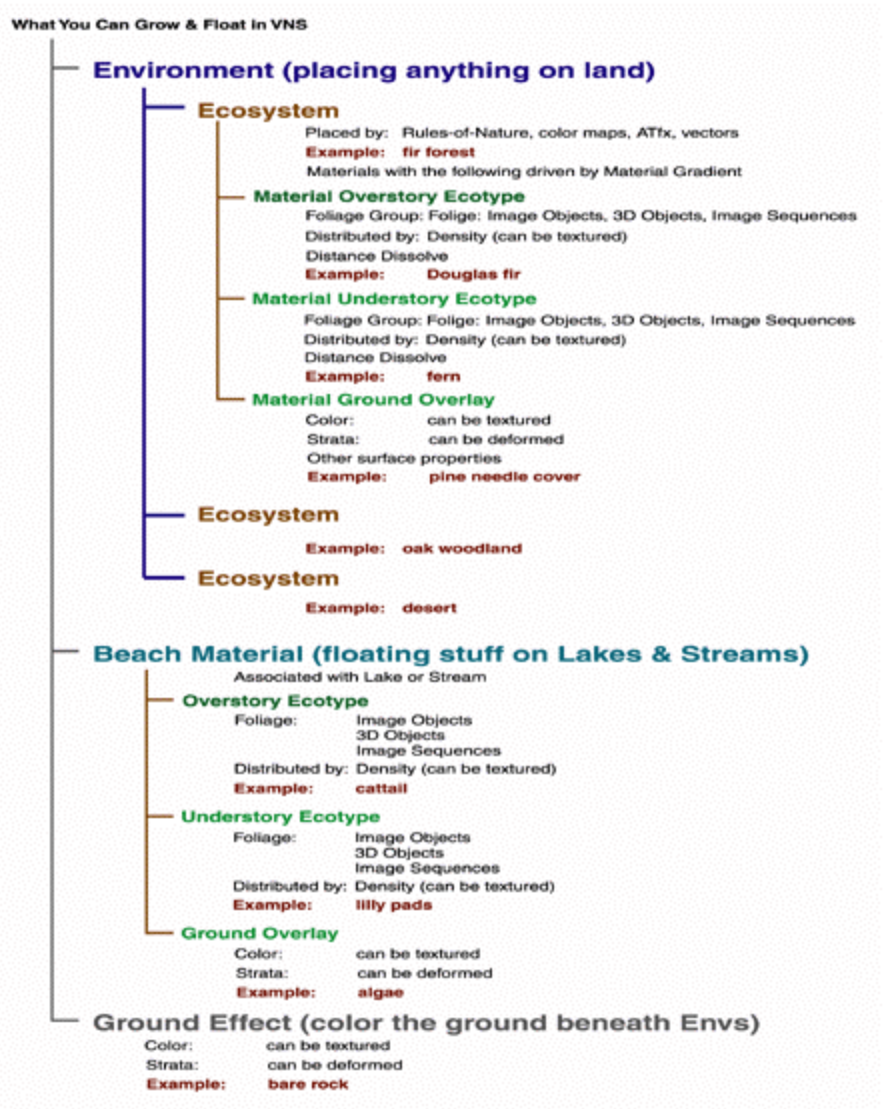
Terrain is made up of polygons. Before each polygon is rendered VNS must decide what to put on it. Land Cover includes the following in order of increasing render priority. Ground Effect is a texture that colors the polygon

Ecosystems have a texture (Ground Overlay) and place Foliage with Ecotypes

Snow covers polygon texture

(While not a part of VNS Land Cover, **Lakes** and **Streams** should not be forgotten.

Their Beaches override Land Cover.)



Ground Effect

A **Ground Effect** is under everything and every project must have one enabled. Every new project created has one. If no Ground Effect is enabled, VNS will create a new default one. Vector Ground Effects have priority over unbounded Ground Effects. Ground is the last component rendered but a good place to start. We'll use the Grand Canyon as a setting for this exploration so open the **GCNP** project from the GCNP ZPE project folder.



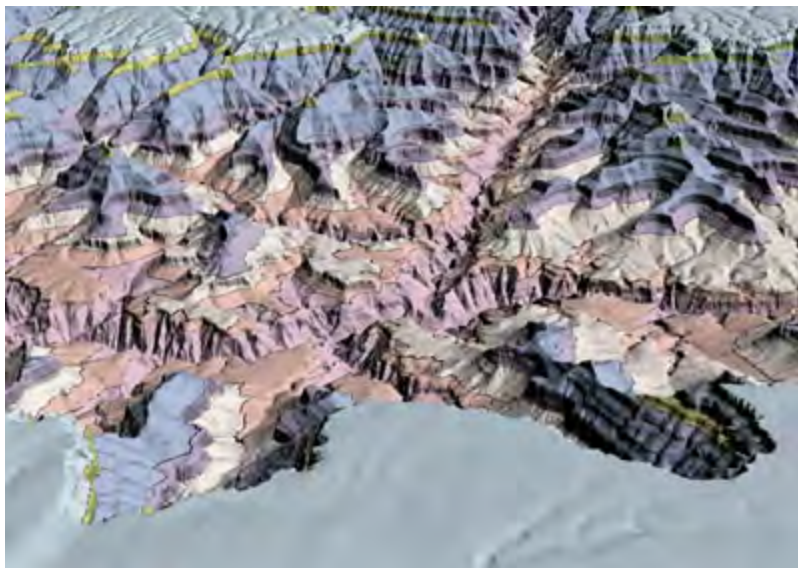
While the terrain data is from the Grand Canyon, the Ground Effect and water are definitely not. This is the Western Desert component that comes with VNS. The Grand Canyon of the Colorado River has what is often referred to as "layercake" geology. Paleozoic sediments are stacked for most of the canyon's vertical relief. These rocks have eroded into cliffs and slopes according to their resistance to erosion.



"Layercake" geology as viewed north from the Bright Angel Trail

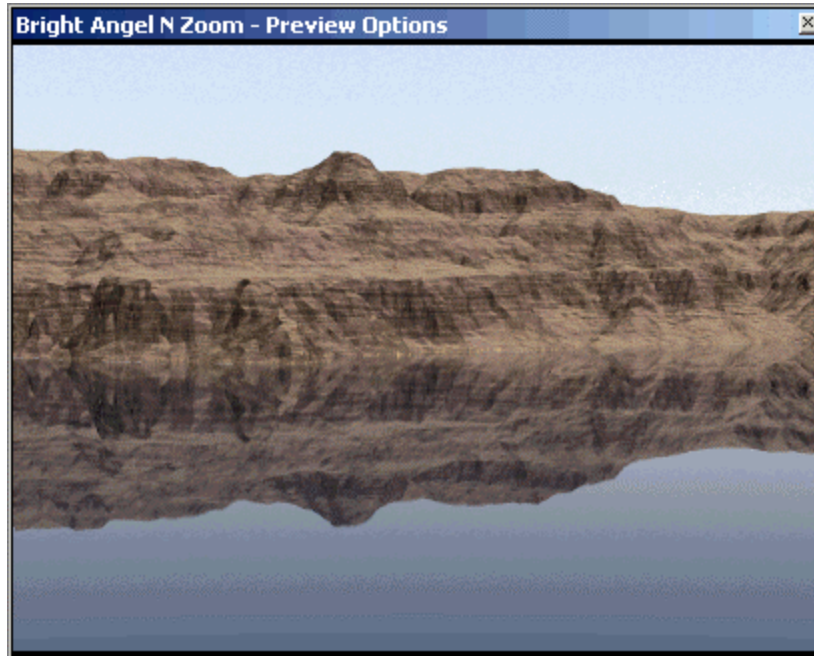


Late afternoon view west from Desert View on the South Rim



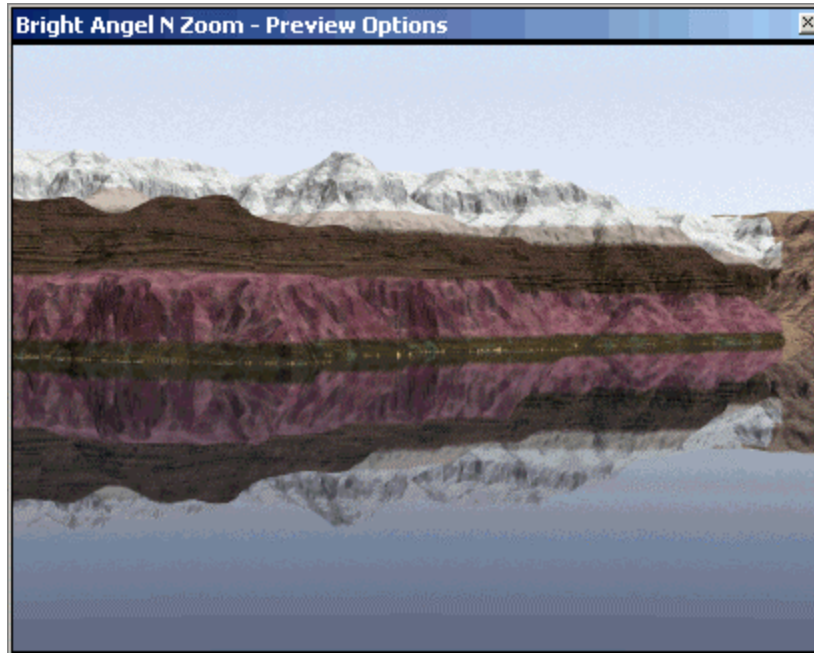
Simplified geology rendered in VNS as viewed north along the Bright Angel Fault

Increase the Lake elevation to **1400** meters.

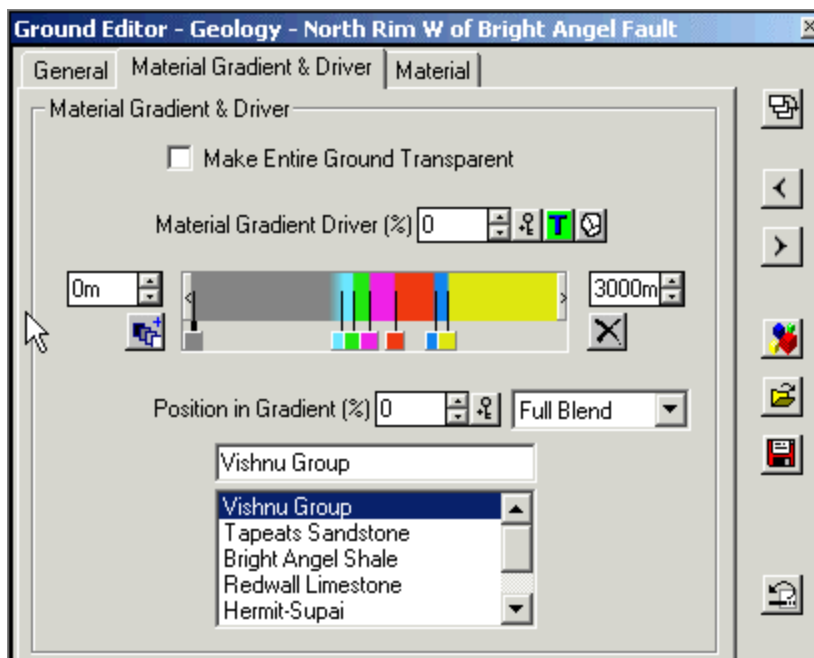


The base of the foreground cliff is at water level nearest the camera but increases in elevation with distance. While we may have layercake stratigraphy, the cake is not flat. We'll reproduce this slightly tilted geology with the Ground Effect.

Enable the **Geology - North Rim W of Bright Angel Fault** Ground Effect and render a preview. The component is linked to a vector that encompasses the area north of the Colorado River and west of the Bright Angel Fault. We'll talk about this later on.



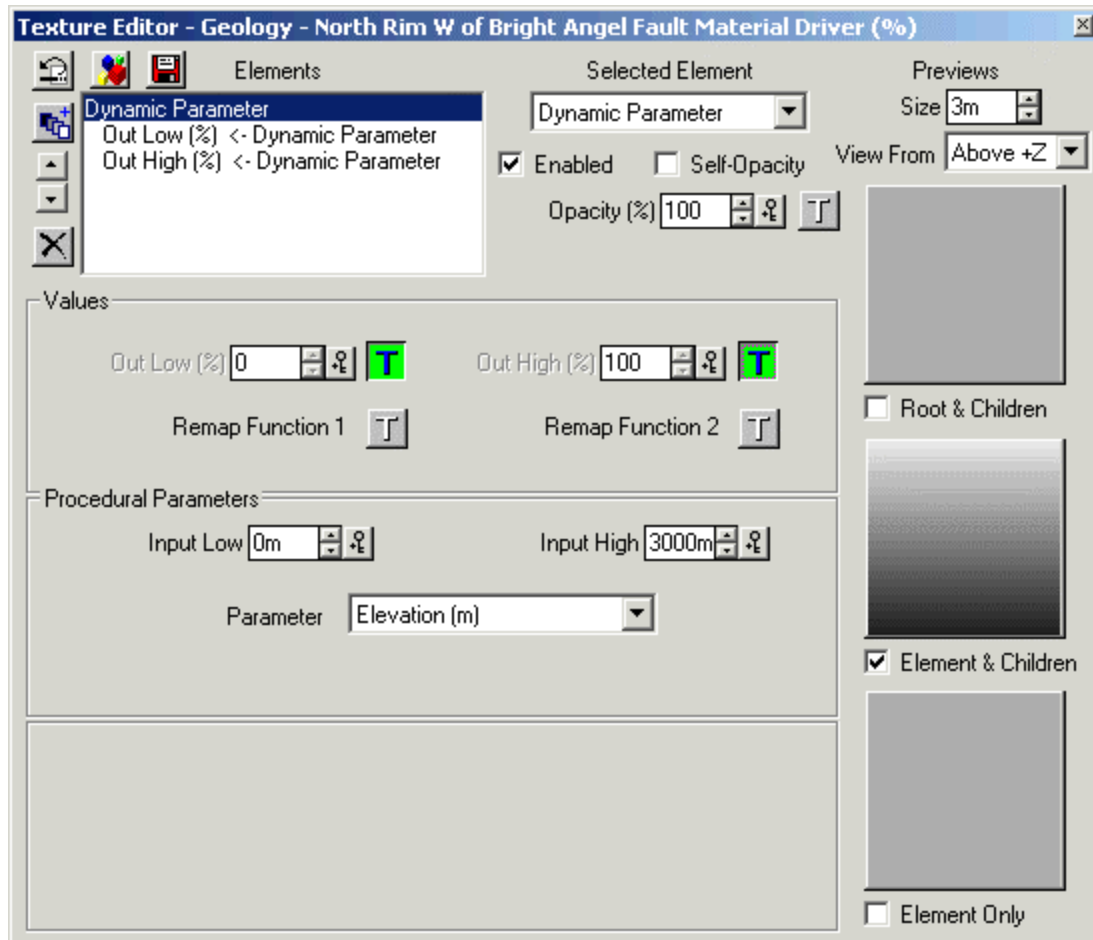
The Ground component is made of 7 Materials, each one representing a cliff- or slope-forming rock unit. Placement of the Materials is controlled by a Material Gradient using the elevation.



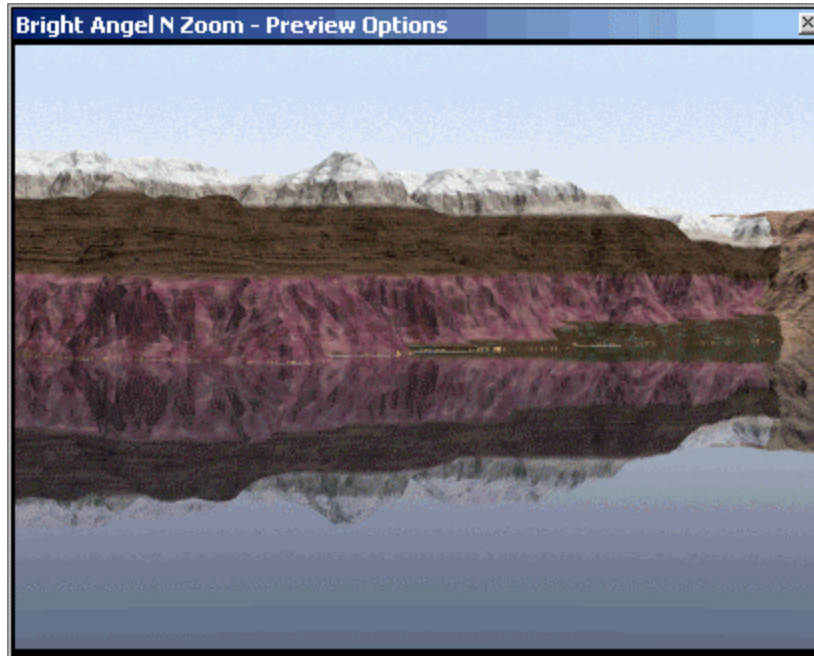
Strata discussion. Change the Hermit-Supai Strata dips to large numbers (try 50,000) and render a preview. This changes the dip of strata within the Material. Return the values to 0 when you're done.



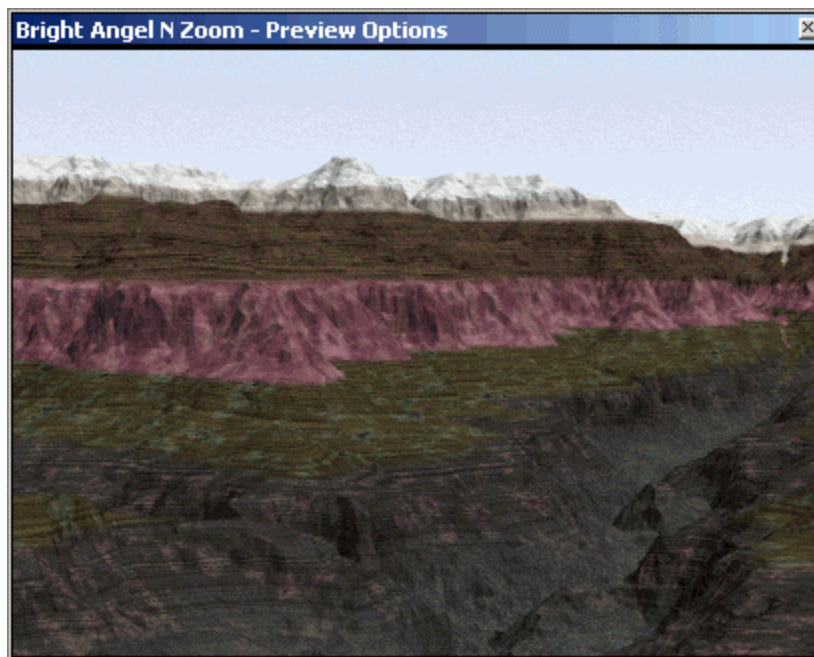
Open the Material Gradient Driver texture. The gradient is controlled by a Dynamic Parameter, Elevation, operating from a low of 0 m to a high of 3000 m. With horizontal layers, the Out Low is 0% and the Out High is 100%. To create the strata dip, the Out Low and Out High are modulated by terrain based textures. There was no secret formula to determining the Values texture numbers; it was done by trial and error.



Enable these textures and render a preview to see the effect. The strata now follow the topography.



Disable our reference Lake and enable the remaining **Geology** Ground components.





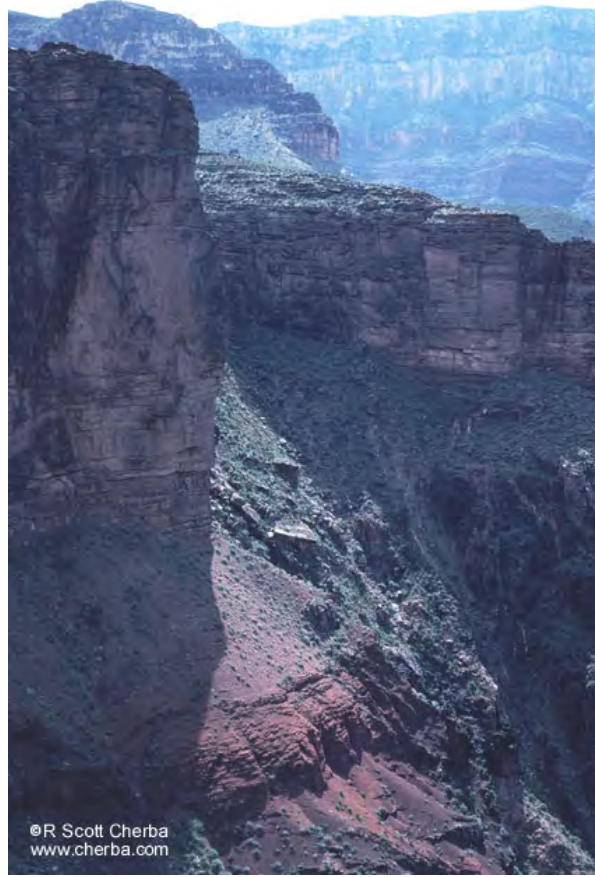
Vishnu Schist in the Inner Gorge



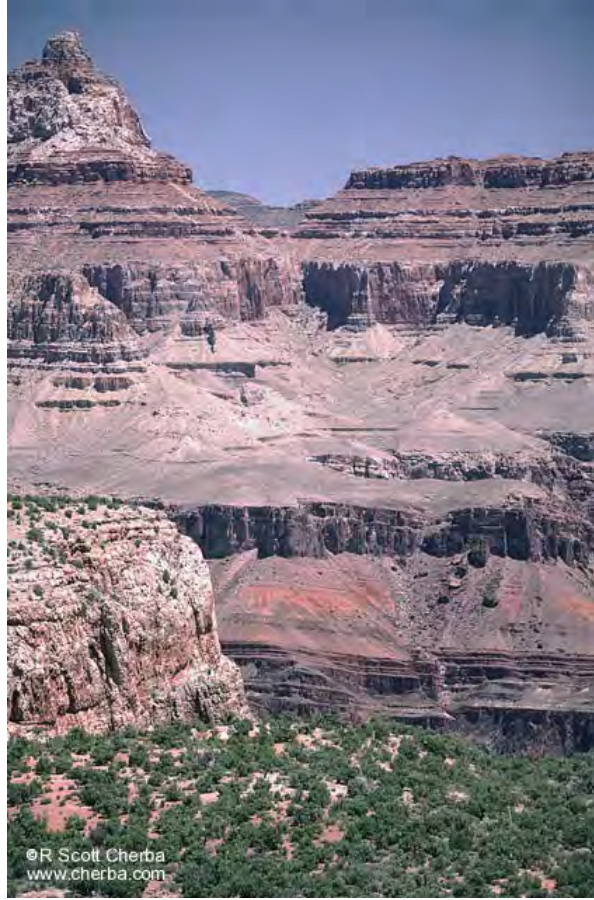
Vishnu Schist from Tonto Plateau



Vishnu Schist color and texture varies with light and viewing angles

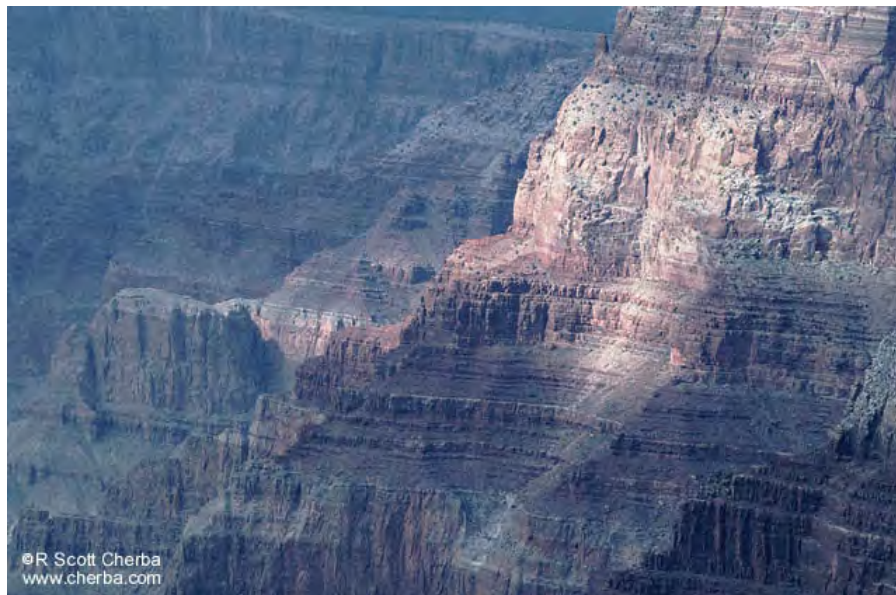


Tapeats Sandstone





*Redwall Limestone along the Bright Angel Trail.
Note vertical streaks and rock spalls.*



Redwall Limestone north of Desert View



Supai Group



Hermit Shale with Coconino Sandstone filling mudcracks



Coconino Sandstone

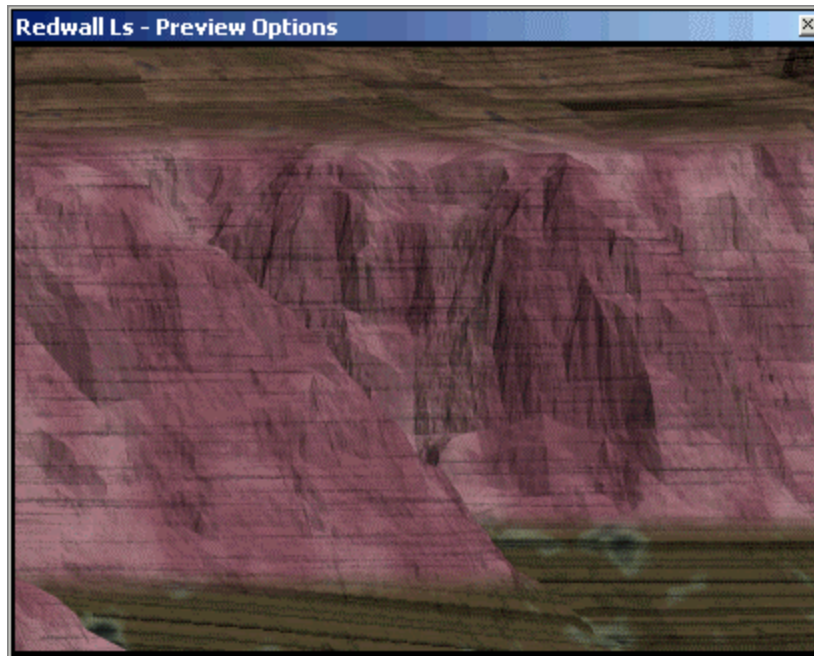


Kaibab Limestone



Kaibab Limestone in different light

Rock texture discussion. Look at a texture in detail: Redwall Limestone



Ground Effect Hierarchy

Ground

Material Gradient Driver controls Material placement

Material Gradient contains Materials

Material with properties like Diffuse Color, Specular Exponent (size of highlight), etc.

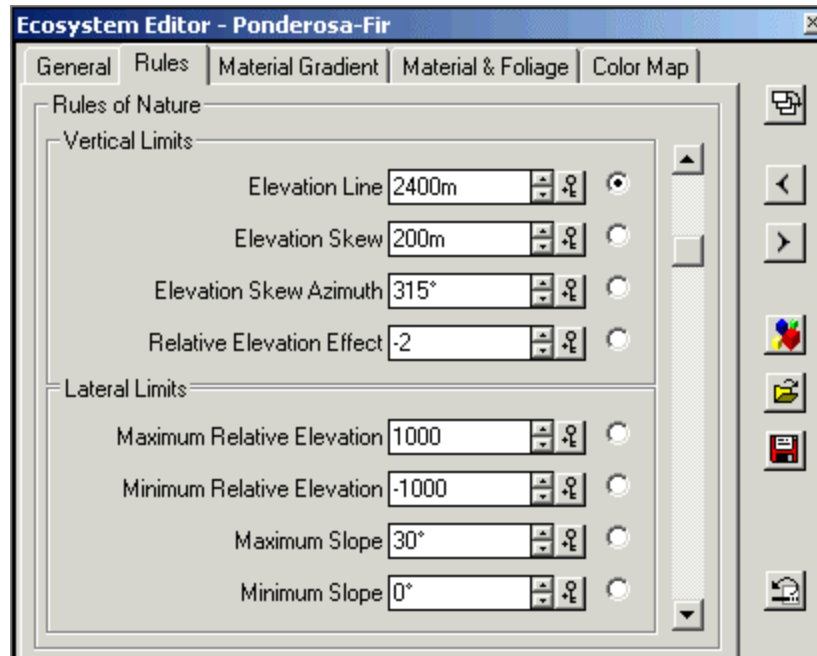
Ecosystems

At its simplest level, an **Ecosystem** is comprised of a Material with one or two Ecotypes and a Ground Overlay that covers the ground between. Ecosystems can have more than one Material placed by a Material Gradient Texture.

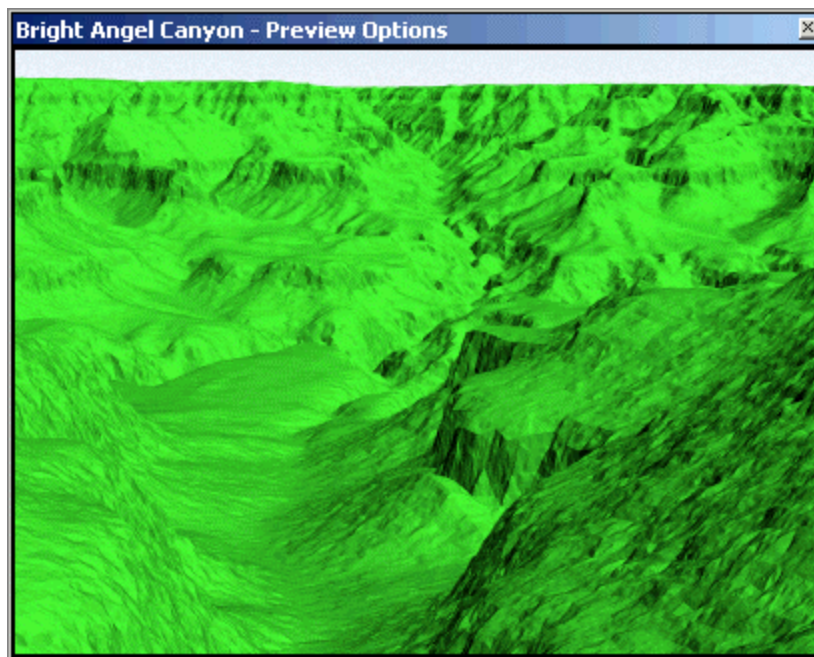
In order of render priority, Ecosystems can be placed in the following ways:

1. **Terrafactor Profile** and **Approach Slope**. Priority among Terrafactors is based on Terrafactors priority, evaluation order, and segment priority.
2. **Vector-bounded Ecosystems**, hard linked or dynamic link. Ecosystem Priority controls placement when more than one vector-bounded Ecosystems is present. This is covered in detail in the Blending Ecosystems section.
3. **Color Map Ecosystem** matching up to 15 million different Ecosystems from one image. Color Maps can overlap with each linked to many Ecosystems.
4. **Rules of Nature** via **Environments**. Render order within Environment control placement. Can be vector-bounded.

Rules of Nature

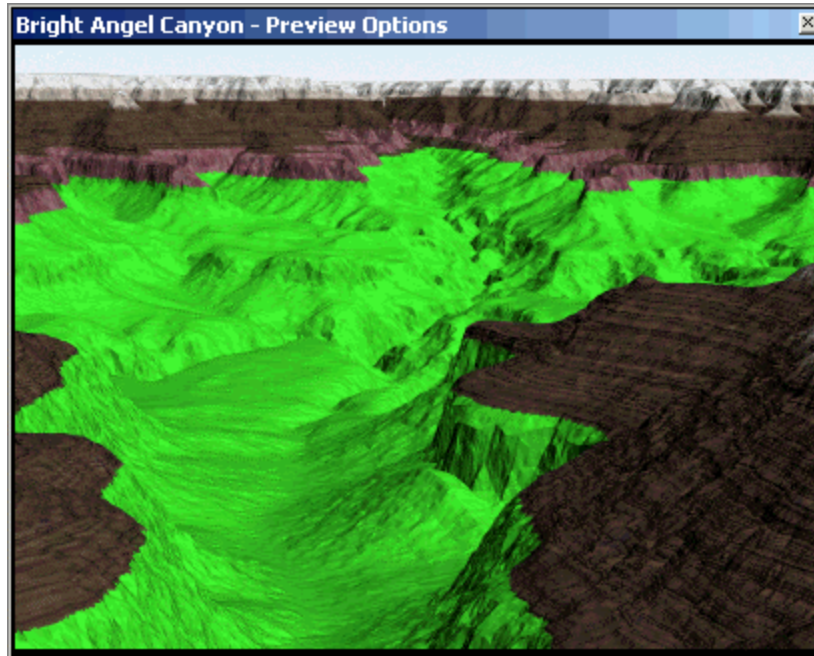


Rules of Nature define polygon parameters for Ecosystem placement. Create a new Ecosystem and add it to the existing Environment. Render.

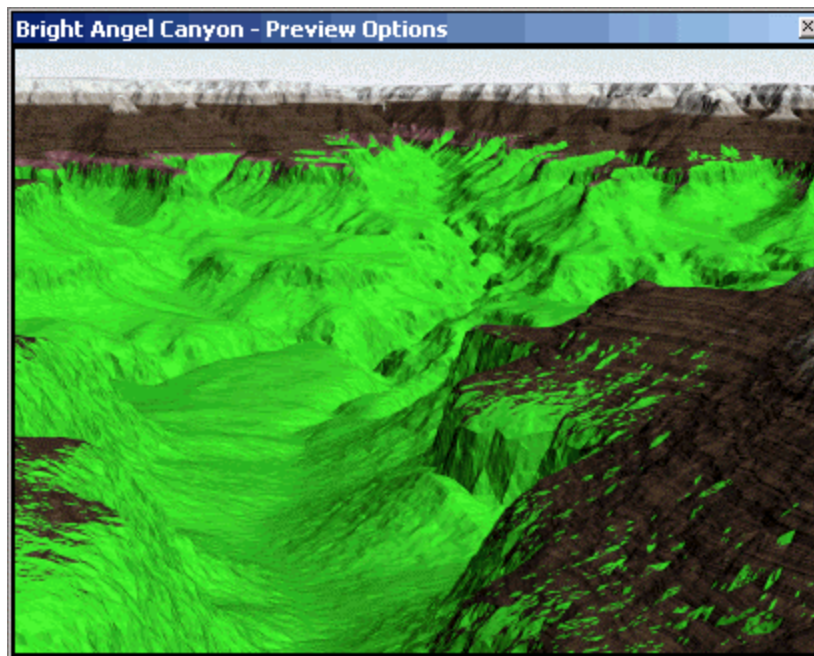


New Ecosystems always default to rendering everywhere. The **Elevation Line** is the upper limit for Ecosystem rendering. Open the Diagnostic Data window and find the elevation of the top of the Redwall Limestone in the foreground, about 1450 meters.

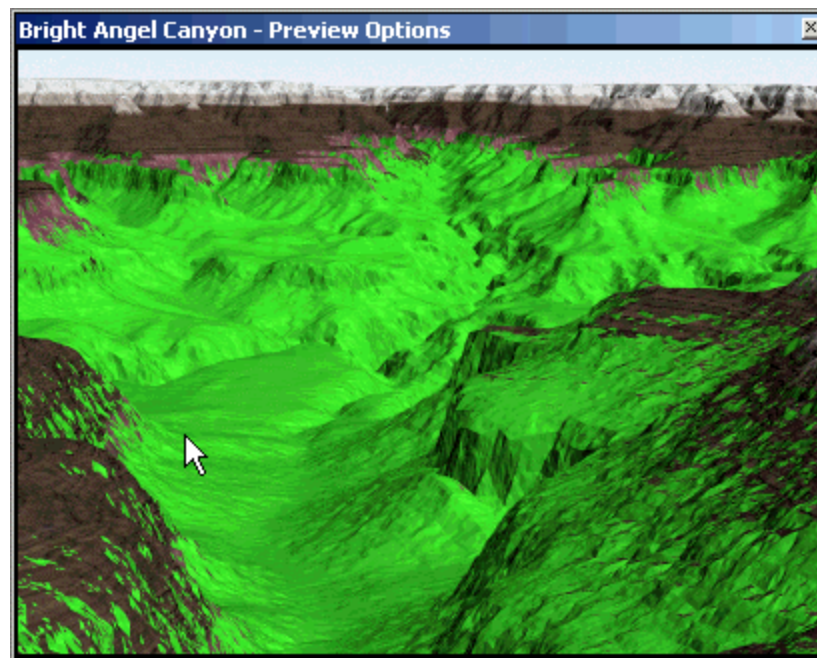
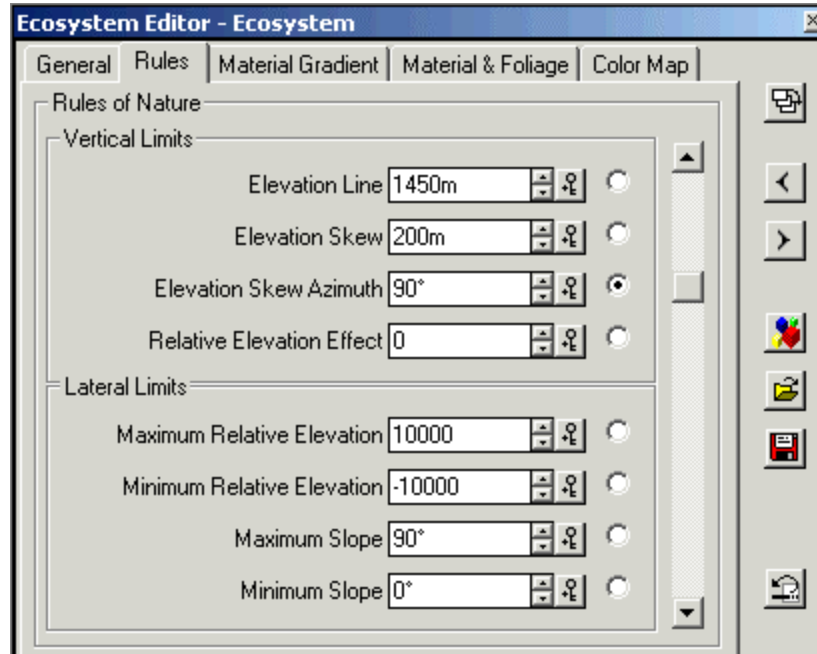
Change the Elevation Line to **1450**. The Elevation Line is the upper limit of the Ecosystem. Ground Effect renders everywhere else. (With Snow, the Elevation Line is the lower limit).



Increase the **Elevation Skew** to **200** meters. This skews the Elevation Line by lowering it on Elevation Skew Azimuth-facing slopes and raising it on slopes in the opposite direction. The Elevation Skew Azimuth is currently 0° . North facing slopes have the Elevation Line lowered and south facing slopes have a higher Elevation Line.



Change the **Elevation Skew Azimuth** to **90°**, east.

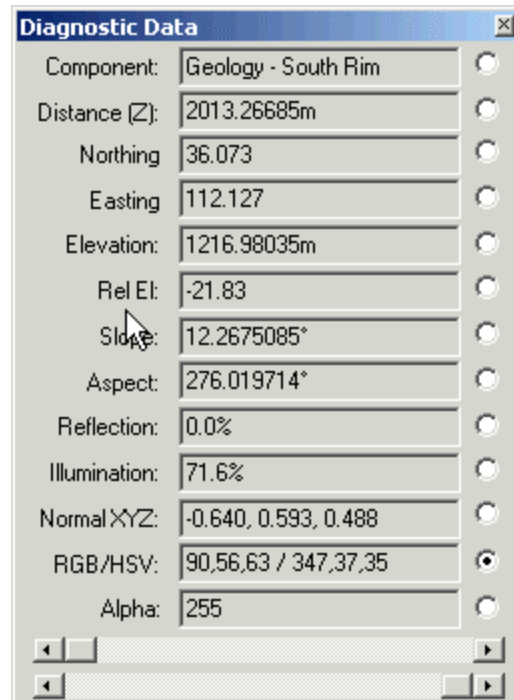


Depending on where you are, an Elevation Skew Azimuth other than 0° may be appropriate. Explanation.

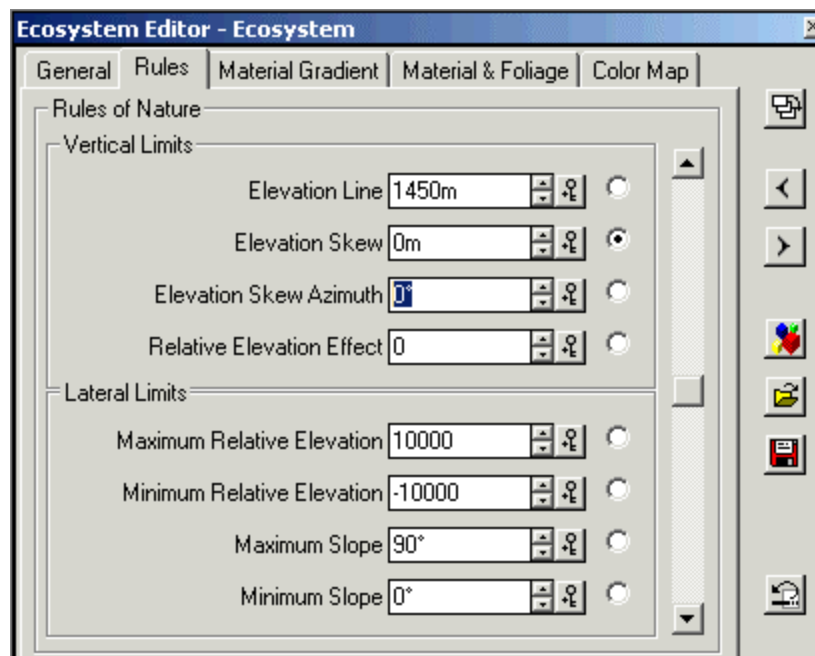


*Douglas-fir on the cooler and wetter north-facing slope below the South Rim.
These trees cannot tolerate the warmer and drier plateau above.*

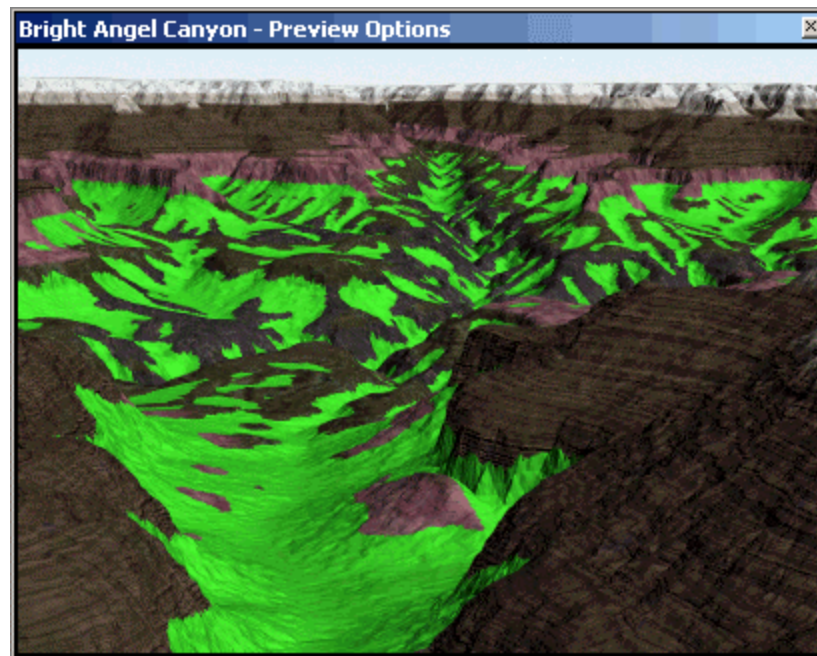
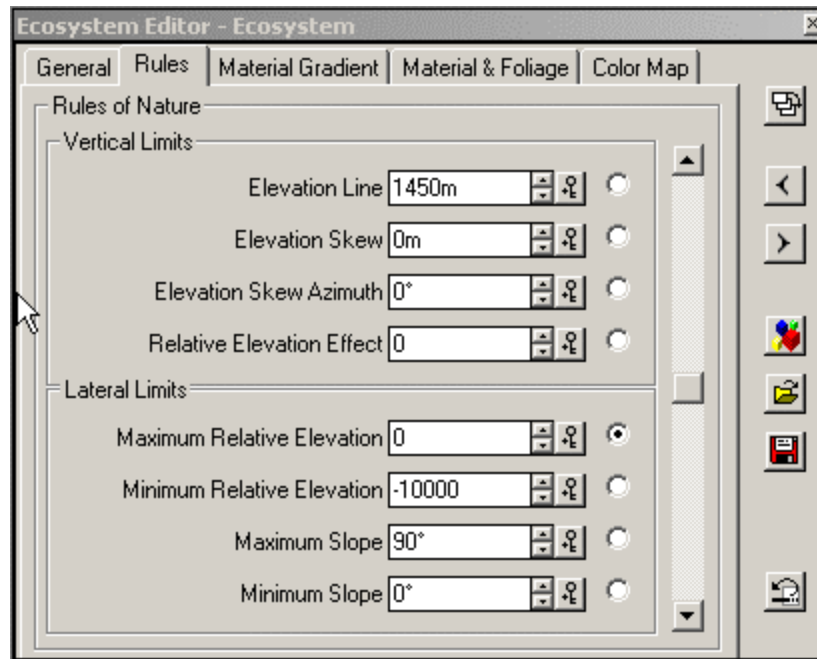
Relative Elevation is a measure of the curvature of the terrain. It's the elevation of poly elevation to surrounding poly elevations. A valley has a negative Relative Elevation and a hill has a positive Relative Elevation. Flat terrain has a 0 Rel El. Open the Diagnostic Data window and sample anywhere to get an idea of Rel El range.



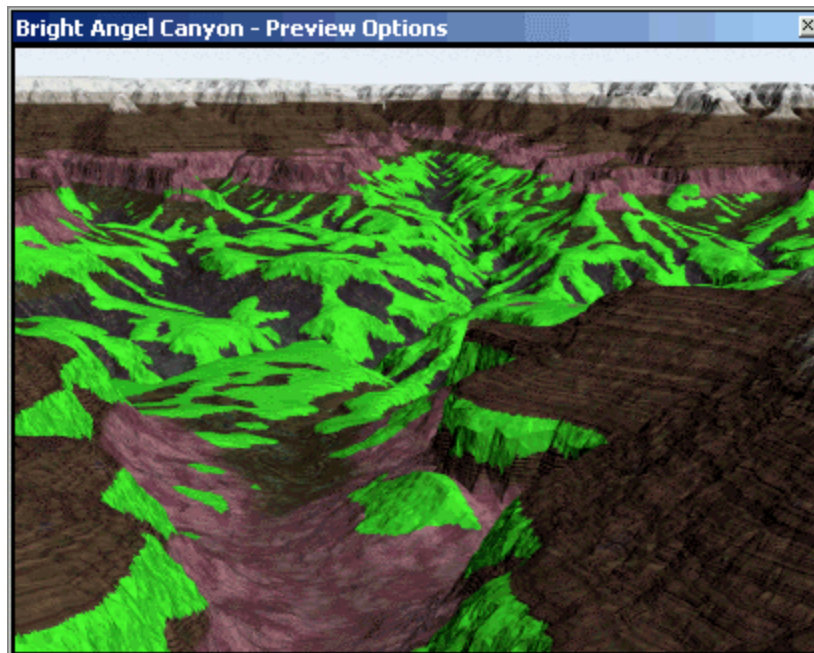
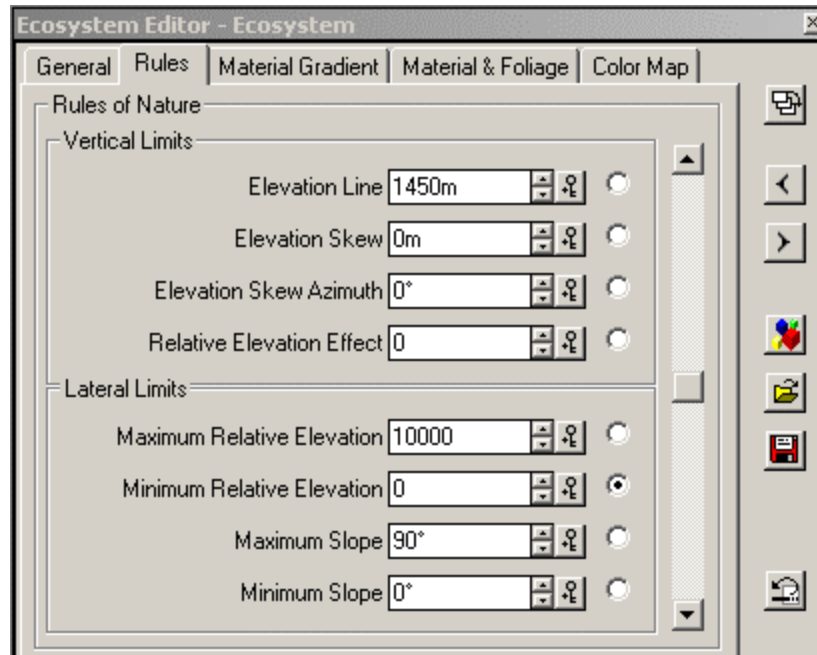
Return the Elevation Skew values to **0**.



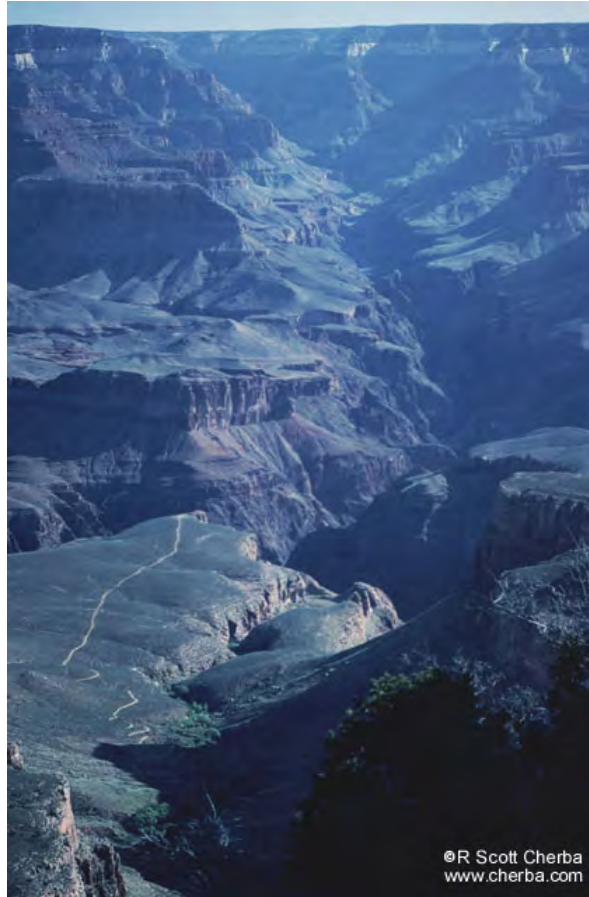
If we change the **Maximum Relative Elevation Effect** to **0**, we tell VNS not to render the Ecosystem on any concave downward terrain, i.e., hills or ridges. The Ecosystem will only render in depressions.



Return the Maximum Relative Elevation Effect to **10000** and change the **Minimum Relative Elevation Effect** to **0**. This will render the Ecosystem on any concave downward terrain only.



In the natural world some plants grow better in well drained soils (ridges) while others prefer high root moisture (valleys). Change the Rel El values to create this effect.

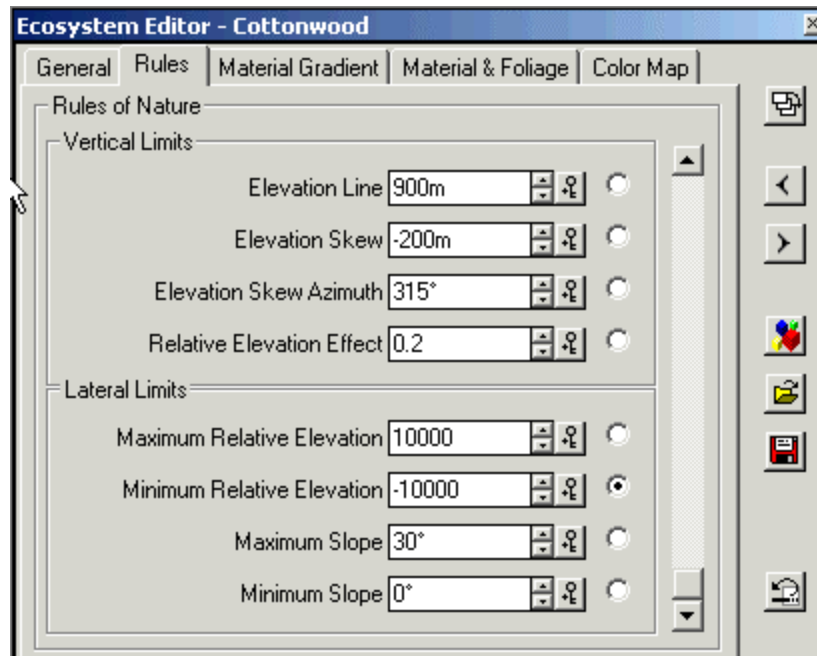
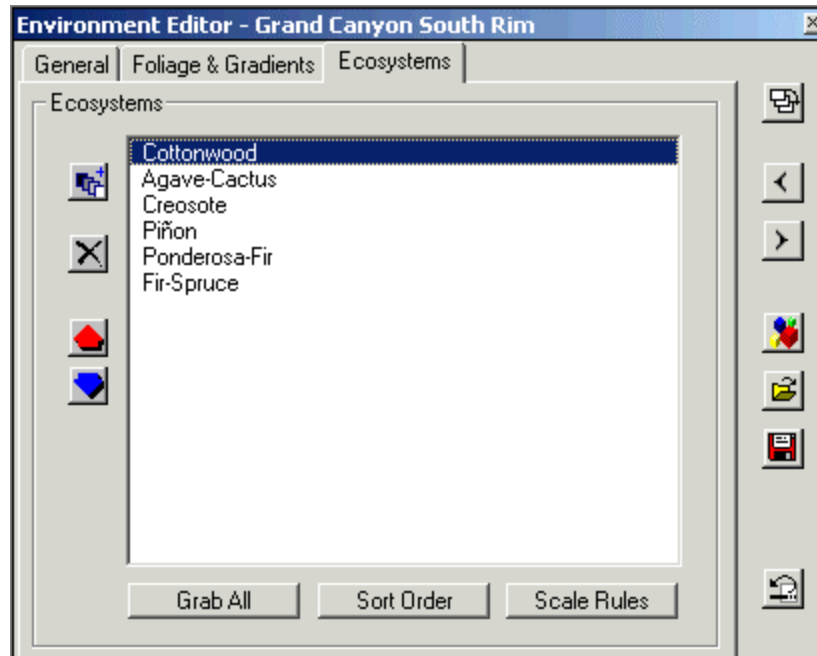


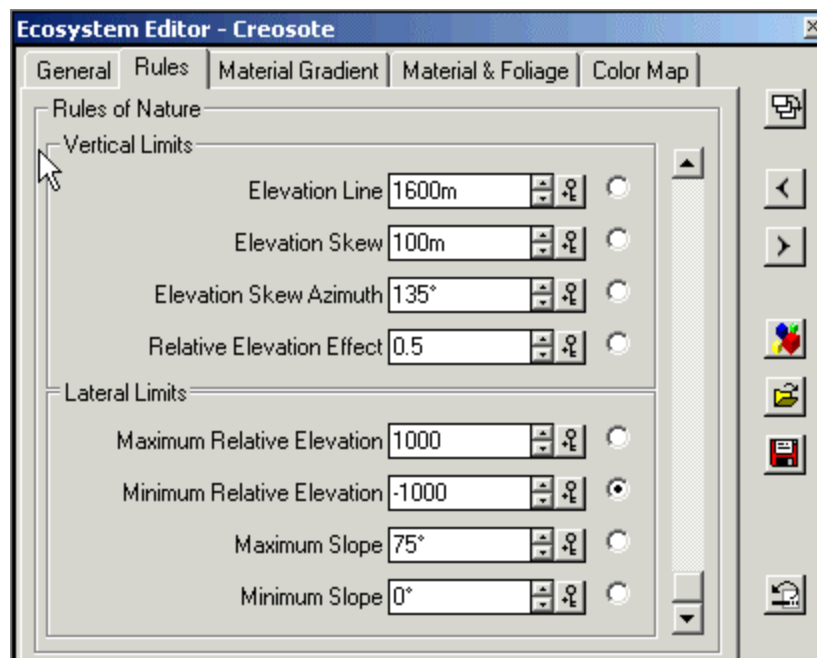
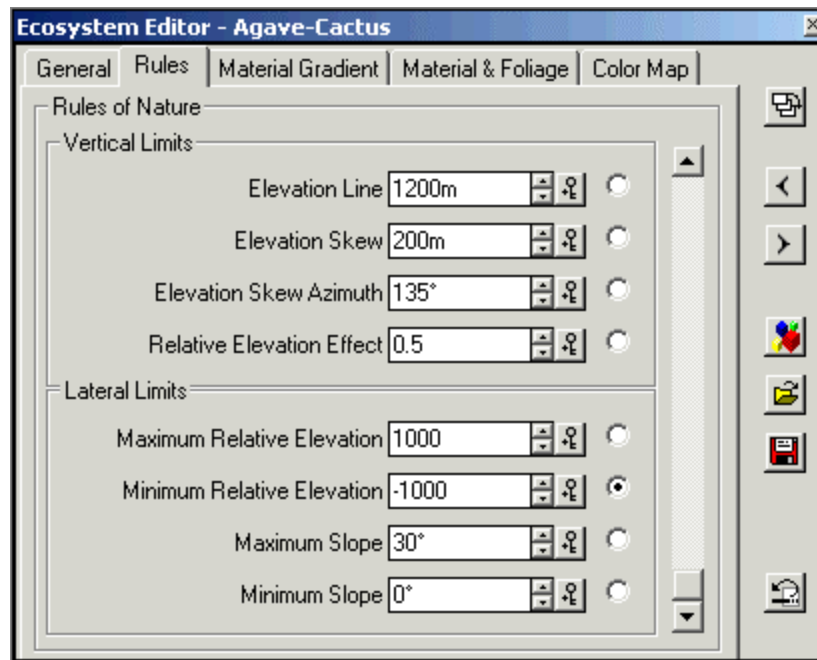
The Riparian Community is restricted to moist and shaded canyon floors like Indian Gardens in Bright Angel Canyon.

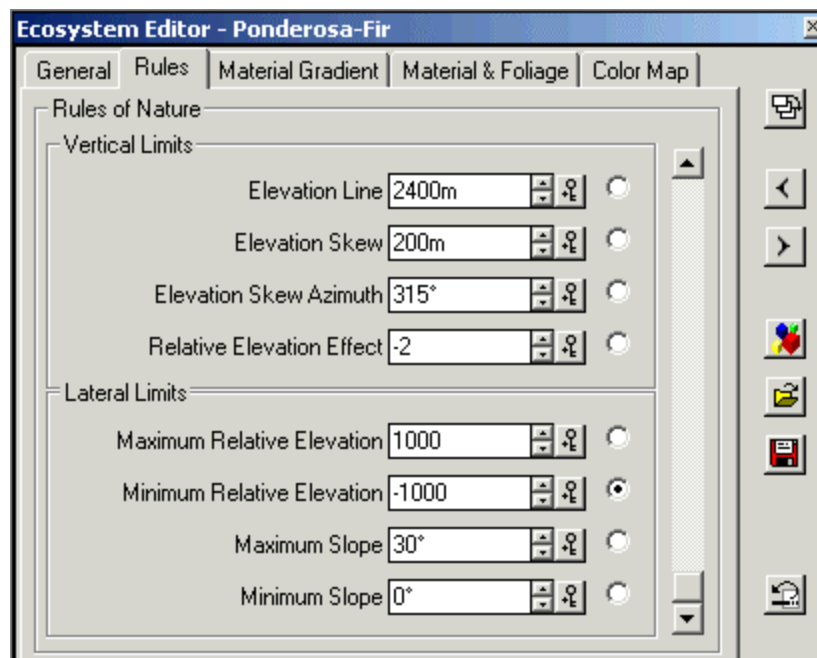
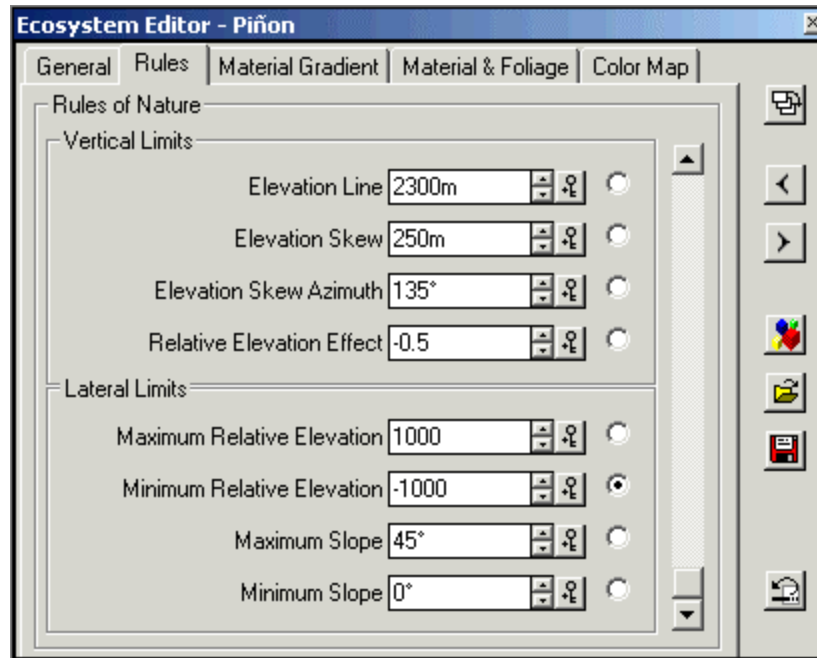
Maximum Slope is limits Ecosystems to polys with slopes less than or equal to the value. **Minimum Slope** limits them to polys with slopes greater than or equal to the value. (These values work the same way with Snow).

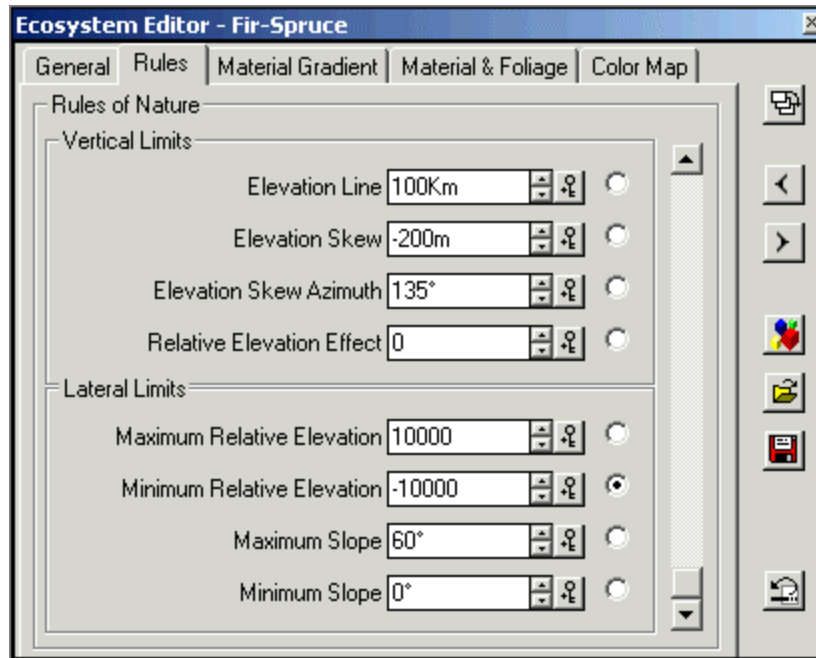
Keep in mind that the Rules of Nature operate anywhere an Ecosystem is rendered, not just for those Ecosystems placed by an Environment.

Environment explanation and discussion.

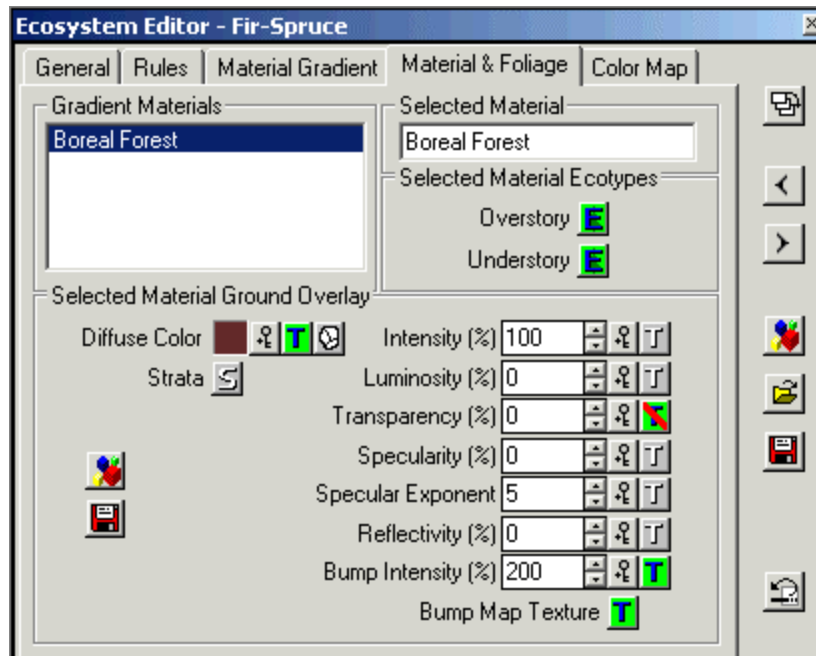








While we're here, let's look more at Ecosystems (discussion).



Ecosystem Hierarchy

Ecosystem - as many as you want

Rules of Nature determine vertical and lateral extent

Material Gradient Driver controls Material placement

Material Gradient contains Materials

Material - as many as you want

Ground Overlay with properties like Diffuse Color, Bump, etc.

Overstory Ecotype for foliage, usually bigger stuff

Height

Density

Absolute stems per area recommended, with caveat

Foliage Group, as many as you want, usually by species

Height

Density. Foliage Group percents don't have to add to 100; will be normalized to 100%. For example, a Foliage Group Density of 25% and another of 50% total 75%. The first will render 1/3 of the time, the second 2/3.

Foliage Object, as many as you want, the more the more varied

Height

Density

Object, Image Object or 3D Object

Image Object

Random Flip X

Apply 3D Shading

Back Light %

Replace Gray

3D Object

XYZ Rotation

Understory Ecotype for foliage, usually undergrowth

Same as Overstory

Discrete Ecosystems vs. a single Ecosystem with multiple Materials

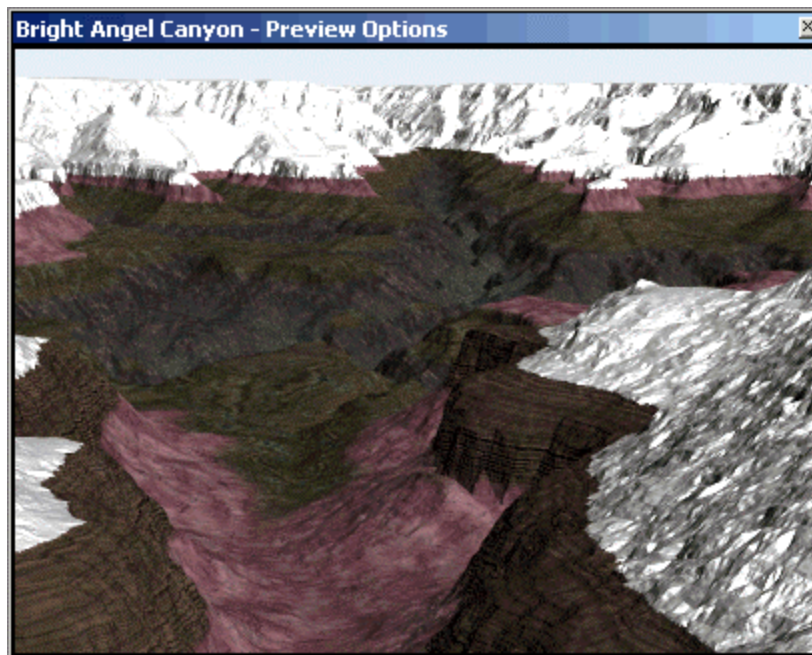
Separate Ecosystems are placed by the Rules of Nature. The Texture Editor offers complex controls different from the Rules of Nature. These can be very useful, especially when only one Ecosystem can be rendered as in Terrafactor profile segments and approach slopes.

Snow

Snow covers Ecosystem Ground Overlay and Ground Effects. Foliage is not affected. Ecosystems can override snow priority with **Snow Cannot Cover this Ecosystem** parameter. Snow Rules of Nature are similar to Ecosystems except:

- Elevation Line is lower limit of Snow coverage
- Elevation Skew works the opposite of Ecosystems, raising it on Elevation Skew Azimuth slopes.

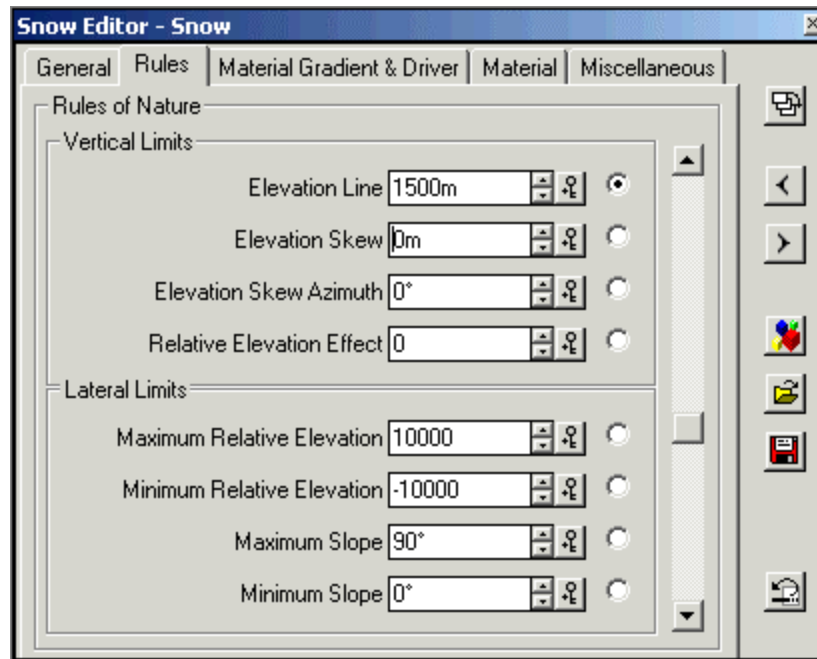
Snow placed by vectors honor lateral but not vertical limits (?, check). Create a new Snow component and set the Elevation Line to **1500** meters.



Try the following:

- Maximum Relative Elevation to 5
- Elevation Skew to 500 m
- Maximum Slope to 60°
- Create vector for Snow. Does it honor vertical limits?

Return the Snow Component to its original values and unlink the vector. To soften the edges, set Feather Edges to **100%** on the Miscellaneous page. Render a preview.



For patchy snow, go to the Material page and increase the Transparency to **100%**. Create a texture, change the size to **200** meters in all directions and increase the Preview size. Try an Octaves value to 2 and render another preview.

Snow Hierarchy

Snow Component - as many as you want

Rules of Nature determine vertical and lateral extent

Material Gradient Driver controls Material placement

Material Gradient contains Materials

Material with properties like Diffuse Color, Specular Exponent (size of highlight), etc.

Rendering

The polygon is the smallest unit of terrain rendering. As VNS renders each polygon, it looks for the following.

Note

Only one Ecosystem can be rendered per polygon although a Material Gradient can vary Material placement.

Is there a Terrafector with Ecosystem?

Does the polygon fall within a vector-bounded Ecosystem?

Is the polygon part of a Color Map that defines an Ecosystem?

If CM resolution exceeds FD subdivision, some pixel info will be ignored because pixel at centroid of poly is used for Ecosystem placement

Is there an Environment with Ecosystem Rules of Nature that define cover?

After determining which Ecosystem applies to the polygon, if any, color goes on the polygon in the following order.

Overstory Ecotype Distance Dissolve

Snow

Snow takes render priority over Ecosystems with the exception of Overstory Dissolve, so the Ecosystem check precedes Snow.

Understory Ecotype Distance Dissolve

Ecosystem Material Ground Overlay

Transparency is not see-through; it's % of Ground Overlay that will be replaced by Ground Effect.

Ground Effect