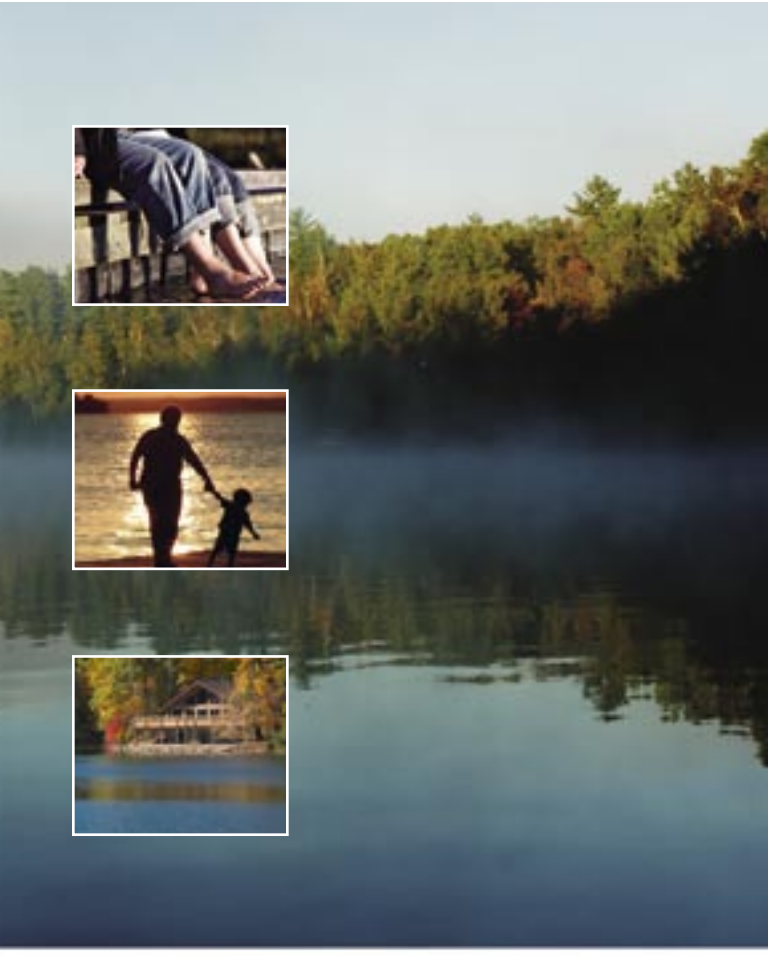
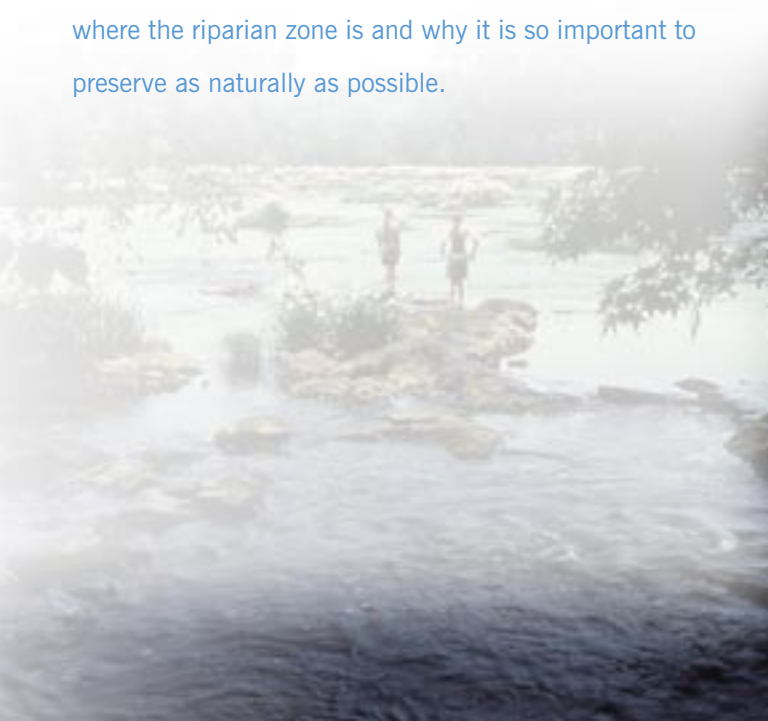


STABILIZING YOUR SHORELINE

CONGRATULATIONS!

You are living near one of the most precious resources on earth – water! Here, where the water meets the land, you'll find a microcosmic world teeming with life and beauty. How you treat this area will make the most difference in how your property looks, endures, functions and continues to bring enjoyment for years to come. And, now that one of the most serene and natural vistas on earth is in your backyard, Duke Energy wants to help you keep it that way. But first, you need to understand where the riparian zone is and why it is so important to preserve as naturally as possible.



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WHAT IS THE RIPARIAN ZONE?

No, it's not a new Dinosaur movie. It's the shoreline of your property, where water and land touch. On lakes, the riparian zone is divided into four distinct zones: submersed (which is always under water); emergent (which is usually under water); shrub (which is only under water part of the time) and terrace (rarely underwater, but usually saturated).

The riparian zone:

- Provides valuable habitat for plants and animals. Fish spawn in the riparian zone; birds and other animals feed and nest in plants growing there.
- Makes a difference in erosion. Erosion leads to poor water quality, decreases the lake's volume and "eats" your property.
- Filters and reduces runoff of sediment, fertilizer, herbicides, oil and grease into the water.

Because the Riparian Zone is so vital to the lake's health, those interested in protecting water quality and wildlife restrict what you can do to it. Duke Energy is interested in how this zone is managed, too, since the zone is usually inside the "project boundary, " or the land the Federal Energy Regulatory Commission (FERC) licenses the company to use in the production of electricity. Other regulators include:

- US Army Corps of Engineers (dredging).

- US Fish and Wildlife Service (endangered species protection).
- State Cultural Resources office.
- Local counties and cities.
- Other entities that protect water quality, wildlife and public safety.

ZONE 1 The submersed aquatic zone. Defines as the annual low water level in the lake and is usually continuously submerged.

ZONE 2 The emergent zone. Defined to be between the mean water level and low water level and is usually under water for most of the growing season.

ZONE 3 The emergent/shrub zone. Defined to be between the mean water level and high water level and is underwater for short periods during the growing season.

ZONE 4 The terrace zone. This zone is rarely underwater, but the soil is typically saturated.

Duke Energy's license allows the company to delay, refuse or cancel lake use permit approval when adjoining property owners violate buffer restrictions, vegetation removal or erosion control criteria within local buffer ordinances. Buffers are strips of land around the shoreline that state agencies, counties or local government can protect from disturbance or development. Buffer widths vary from county to county, and may include land outside the project boundary, as well. Ownership of property adjoining a Duke Energy lake does not bestow the right to undertake construction, remove or place any material (including soil, rock, vegetation, etc.) anywhere within the project boundary or Duke Energy property. Keep these points in mind as you plan your shoreline.

PROTECTING THE RIPARIAN ZONE

The riparian zone is also where erosion occurs. The best way to prevent it is through "shoreline stabilization" – structural systems, vegetative systems or a combination of the two. Stabilization techniques will either reduce the strength of water against a shoreline or increase the shoreline's resistance to erosion. The best and most cost-efficient ways to do that are also the most natural, aesthetically pleasing and environmentally friendly.

Here's how:

BIOENGINEERING

Bioengineering uses live plant materials to control erosion. These systems offer soil protection and reinforcement and create resistance to sloughing and erosion. They also provide a productive shoreline for wildlife, improved aesthetics and water quality. Soil bioengineering systems are suitable for most sites, but they are most successful when installed in sunny locations and constructed during plant dormant periods, usually in the late fall to early spring. The slope of the bank should be 2- feet horizontal to 1- foot vertical or flatter.

- **Live staking** is the insertion of live, rootable, vegetation cuttings into the shoreline. Live staking alone will not provide immediate protection from erosion but over time can provide excellent erosion control. To provide immediate protection, live staking can be combined with other techniques such as a geotextile

fabric or a jute mesh, a porous fabric that is used to hold the ground material. Buttonbush, silky dogwood and alder are best suited for live staking.

- **Live fascines** are bundles of live branches bound together and placed in shallow contour ditches parallel to the shoreline, usually with a geotextile fabric. The bundles need to be buried in shallow trenches with the top of the bundle exposed. When installed properly, there is little site disturbance. Silky dogwood, buttonbush and alder can be established by live fascines.

- **Brushmattresses** are combinations of live stacking, live fascines and branch cuttings that provide immediate protection from erosion. They are most effective within lake areas that have fluctuating water levels. They filter incoming water because they establish dense, healthy shoreline vegetation. Be advised that a brushmattress system can be complicated to construct.

- **Crib walls** are box-like, interlocking arrangements of untreated logs or filled with suitable growing soil and layers of live branch cuttings rooted inside the structure. The live cuttings will become established and eventually take over the structural components. Crib walls are useful when space is limited or a small area needs to be stabilized. Crib wall construction tends to be complex and more expensive than other techniques.

- **Reed clumps** are root divisions wrapped in geotextile fabric and staked down in trenches at the water's edge. Reed clumps offer immediate protection from shoreline erosion and can grow and survive in fluctuating water levels, where they enhance natural vegetation growth.

- **Coconut fiber rolls, hay bales and ply wood fencing** are used in systems to break water. Since the rolls and bales are used to reduce the energy of the water reaching the shore, they provide quiet water to nurture vegetation. Coconut fiber rolls are cylindrical rolls made of coconut fibers bound together and are typically found in 12-inch diameters. The coconut fiber roll or hay bales are effective in lakes that have a fluctuating water table because it can still protect the shoreline during high and low water levels. The fiber roll can also be molded to fit the curvature of the shore.

- **Hay bales** are staked down in shallow water, 8 to 10 inches deep, becoming water logged and immobile. The coconut fiber rolls last about 6 to 10 years while the hay bales last about 2 to 3 years – long enough to establish a wetland community.

VEGETATION

Vegetation is the least expensive stabilization method you can use. If vegetation is already a part of your shoreline, you can add similar plants. Woody vegetation is usually best suited for upper shoreline management, but ground over can provide protection in lower areas with marginal erosion. Perennial grasses produce an extensive root system, while emergent aquatic plants protect woody shoreline vegetation from wave or current action. The vegetation root systems help hold the soil particles together, increasing bank stability. A healthy, vegetation stabilized shoreline has grasses and rushes at the water line, proceeds inland to woody, emergent, flood tolerant shrubs and then to flood tolerant, moist soil trees.

Your shoreline's characteristics determine whether plants can be used. Plants will need to be protected with some type of armoring device in order to become established when:

- Sites are located on reservoirs that fluctuate more than two feet.
- Shoreline slopes are steeper than 3-feet horizontal to 1-foot vertical.
- Sties are located on a peninsula or high wave impact areas.
- Shorelines consist of soil types not conducive for plant growth.

A jute mesh or geotextile fabric can be used with vegetation or in more extreme circumstances, rock riprap or a crib wall may be needed.

HARD STRUCTURES

"Hard" stabilization structures increase shoreline and bank resistance to erosive forces such as waves or wind. These structures don't reduce the energy of the water, but redirect the energy to another area. Consider hard structures where:

- There is excessive wave action, either from boat traffic or wind.
- The soil is unsuitable for plant growth and it is not cost effective to add topsoil.
- Sunlight is not adequate for plant growth.
- The bank is not or cannot be regarded to a minimum slope of 2-feet horizontal to 1-foot vertical.

Bulkheads and seawalls are vertical timbers or concrete structures installed parallel to the shoreline. They're used when the shoreline is nearly vertical or the toe, or bottom, of the bank has been severely eroded and the bank cannot be modified to a flatter slope. The bulkhead might redirect wave action to the bottom of the structure. Duke Energy requires that all bulkheads and seawalls have riprap at the toe of the structure. Unfortunately, sea walls aren't the most environmentally friendly choice. They allow lawns to extend right up against the

water, so when lawns are fertilized or treated with herbicide, there is no buffer to filter out pollutants before they enter the reservoir. Bulkheads and seawalls are typically the most expensive stabilization methods.

Revetments, or riprap, are protective structures of rock, concrete or other materials constructed to fit the slope of the bank. Revetments are flexible, do not require special equipment, and damage or loss of rock is easily repaired. The construction, though, is complex and expensive. The slope of the shoreline needs to be 2-feet horizontal to 1-foot vertical or flatter. Revetments are particularly useful in shaded areas where vegetation may be difficult to establish. Riprap provides better aquatic habitat, but, like sea walls, riprap allows lawns to extend to the water without any buffering vegetation.

Rock riprap revetment consists of stones sized to the site and shoreline characteristics. Exposed soil between the rocks on the shoreline can accommodate live stakes or vegetative planting or the riprap can be completely covered with topsoil and planted with suitable vegetation to produce a natural looking, protected shoreline.

Gabions are seawalls constructed of wire cages filled with riprap – are another hard stabilization alternative.

DO I NEED TO STABILIZE MY SHORELINE?

If your property is in the back of a cove, probably not. Or, if the height of your shoreline is one foot or less above the normal elevation of the lake and you haven't been losing property, you most likely don't need to stabilize. If your property doesn't fall within these descriptions, then you may need to stabilize. Here's what you need to do:

- Call Duke Energy's Lake Management office at 1-800-443-5193 to apply for a lake use permit. You and a lake management representative can discuss your shoreline's permitting classification and determine any stabilization restrictions.
- Identify your shoreline's characteristics. Wind, waves, gravity and currents cause erosion on lakes. When stabilizing, consider these characteristics of your shoreline:
- Existing vegetation.
- Fluctuating water levels.
- Wave energy (from boat traffic and/or wind).
- Slope configuration above and below the waterline.
- Soil type and condition above and below the waterline (soil type and condition can be analyzed free by the North Carolina Department of Agriculture). Your local county agriculture extension agent can provide materials and instructions on taking the sample.

- Primary source of erosion.

- Hire a contractor. After you determine that you do need to stabilize your shoreline, you and your contractor need to determine the most cost-effective, environmentally sound and aesthetically pleasing technique. This brochure also provides a partial list of plant suppliers on this area that are experienced in shoreline stabilization vegetation.

AQUATIC "WEEDS"

While many plants can enhance the Riparian Zone, certain species are just downright harmful. "Aquatic weeds" are typically aggressive, non-native species that out-complete other plants for light, water and nutrients, while threatening wildlife and endangered species. They can impede navigation on the lakes, choke water intakes and hydro facilities and ultimately even reduce water availability. Generally, aquatic weeds are introduced to a reservoir by animals that have ingested the plants or seeds; plants that are carried between lakes on boat propellers and boat trailers water gardens or from home aquariums that have been "dumped" in the lake. Because some aquatic weeds are dangerous to reservoirs, federal and state governments have made it illegal to own, buy or sell certain species. Here's a partial list of illegal aquatic plants you should always avoid – and are NOT allowed in the Duke Energy project.

Federally listed illegal aquatic plants

- mosquito fern *(Azolla pinnata)*
- culaer paceae *(Caulerpa taxifolia)*
- anchored water hyacinth *(Eichhornia azurea)*
- hydrilla *(Hydrilla verticillata)*
- Miramar weed *(Hygrophila polysperma)*
- Chinese water spinach *(Ipomoea aquatica)*
- African oxygen weed *(Lagarosiphon major)*
- ambulia *(Limnophila sessiflora)*
- myrtaeae *(Melaleuca quinquenervia)*
- monchoria *(Monochoria hastate)*
- pickerel weed *(Monochoria vaginalis)*
- duck lettuce *(Ottelia alismoides)*
- arrowhead *(Sagittaria sagittifolia)*
- giant salvania *(Salvinia spp.)*
- wetland nightshade *(Solanum tampicense)*
- exotic bur-reed *(Sparganium erectum)*

Also illegal to plant in North Carolina:

- alligatorweed *(Alternanthera philoxeroides)*
- swamp stone crop *(Crassila helmsii)*
- Brazillian elodea *(Egeria densa)*
- African oxygen weed *(Lagarosiphon spp.)*
- paterprimrose *(Ludwugua hexapetala)*
- Purple loosestrife *(Lythrum salicaria)*
- common reed *(Phragmites australis)*
- Eurasian watermilfoil *(Myriophyllum spicatum)*
- brittleleaf naid *(Najas minor)*
- water chestnut (*Trapa spp.)*

Also illegal to plant in South Carolina:

- Alligatorweed *(Alternanthera philoxeroides)*
- brazillian elodea *(Egeria densa)*
- water hyacinth *(Eichhornia crassipes)*
- hydrilla *(Hydrilla verticallata)*
- water primrose *(Ludwigia hexapetala)*
- common reed *(Phragmites australis)*
- Eurasian watermilfoil *(Myriophyllum spicatum)*
- Slender niad *(Najas minor)*
- Water chestnut *(Trapa spp.)*

Other problem plants

- parrot feather *(Myriphyllum aquaticum)*
- water lettuce *(Pistia stratiotes)*

Always call Duke Energy Lake Management at **800-443-5193** or **704-382-8086** before planting anything within the project boundary.

LANDSCAPING A STABILIZED SHORELINE

A stabilized shoreline benefits from the color and personality native flowering plants offer. Although they may not be useful for erosion control, they can attract waterfowl, marshbird and songbird species. Just as any other plants used for shoreline stabilization, your landscaping choices must be native plants, which typically have a better chance of surviving. Here are some landscaping species Duke Energy recommends.

Wetland herbs

- American lotus *(Nelumbo lutea)*
- Arrowhead *(Sagittaria latifolia)*
- Blueflag *(Iris versicolor)*
- Cardinal flower *(Lobelia cardinalis)*
- Lizard's tail *(Saururus cernuss)*
- Marsh marigold *(Caltha palistris)*
- New England aster *(Aster novae-angliae)*
- Small jack-in-the-pulpit *(Arisaema triphyllum)*
- Swamp lily *(Crinum americanum)*
- Virginia blueflag (Iris virginica)
- Water smartweed *(Polygonum amphibium)*
- Yellow cow lily *(Nuphar luteum)*
- Yellow water iris *(Iris pseudacorus)*

Fern

- Cinnamon fern *(Osmunda cinnamomea)*
- Royal fern *(Osmunda regalis)*
- Sensitive fern *(Onoclea sensibilis)*

Grasses

- Broom sedge *(Andropogon virginicus)*
- Creeping spikerush *(Elocharis palustris)*
- Hop sedge *(Carex lupulina)*
- Porcupine sedge *(Carex hystricina)*
- Square-stem Spikerush *(Eleocharis quadrangulata)*
- Three-swuare Bulrush *(Scirpus americanus)*
- Tussock sedge *(Carex stricta)*

Shrubs

- Black chokeberry *(Aronia melanocarpa)*
- Bushy St. Johnswort *(Hypercum densiflorum)*
- Carolina willow *(Salix caroliniana)*
- Elderberry *(Sambucus Canadensis)*
- Silky willow *(Salix sericea)*
- Spicebush *(Lindera benzoin)*
- Southern arrowwood *(Viburnum dentatum)*

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SHORELINE STABILIZATION WITH PLANTS

Plants are a natural solution to erosion. They also create cover and food for fish, nesting areas for waterfowl, and food and bedding materials for a variety of animals.

Duke Energy requires you to use only native plants for your stabilization project. Non-native vegetation competes with native vegetation and threatens diversity. Some non-native aquatic species can clog waterways, disrupt groundwater flow, degrade water quality, restrict boat traffic and recreational water use. Native plants are also less expensive and have a better chance of surviving. Plants used for shoreline stabilization should:

- Have an extensive root system
- Be able to spread and colonize
- Live year-round (perennials are more suitable than annuals)
- Be hardy enough to survive varying and harsh conditions
- Survive in high water and drawdown conditions
- Absorb or withstand waves
- Vary in species and classes

Here are some species Duke Energy recommends:

Wetland herbs

- Arrow arum *(Peltandra virginica)*
- Pennsylvania smartweed *(Polygonum pensylvanicum)*
- Redtop *(Agrostis alba)*
- Swamp rose *(Rosa palustris)*
- Swamp rose mallow *(Hibiscus moscheutos)*
- Water willow *(Justicia americana)*

Grasses

- Blue maidencane *(Amphiscarpum muhlenbergianum)*
- Giant cane *(Arundinaria gigantean)*
- Maidencane *(Panicum hemitomon)*
- Prairie cordgrass *(Spartina pectinata)*
- Reed grass *(Calamagrostis canadensis)*
- Slender spikerush *(eleocharis acicularis)*
- Soft rush *(Juncus effuses)*
- Soft stem bulrush *(Scirpus validus)*
- Switch grass *(Panicum virgatum)*

Shrubs

- Brookside Alder *(Alnus serrulata)*
- Buttonbush *(Cephalanthus occidentalis)*
- Gray stem dogwood *(Cornus foemina racemosa)*
- Silky dogwood *(Cornus amomum)*
- Red chokeberry *(Aronia arbutifolia)*
- Red-twig dogwood *(Cornus sericea)*
- Wax myrtle *(Myrica cerifera)*

Trees

- Bald cypress *(Taxodium distichum)*
- Black willow *(Salix nigra)*
- River birch *(Betula nigra)*
- Sycamore *(Plantanus occidentalis)*
- Water oak *(Quercus nigra)*
- Willow oak *(Quercus phellos)*

Always call Duke Energy Lake Management at **800-443-5193** or **704-382-8086** before planting anything within the project boundary.

WHERE TO GET MORE INFORMATION

There's a wealth of information about natural erosion control with wetland and aquatic plants on the Internet. Here's a partial list of sites that can help with your bio-engineering project:

Aquatic Plant Management Society
http://www.apms.org/

Focuses on management control and prevention of aquatic weeds and how to establish native vegetation.

Bioengineering for Hillslopes, Streambanks and Lakeshores
http://ianrpubs.unl.edu/Soil/g1307.htm

University of Nebraska's co-operative extension service site describes natural erosion control for hill slopes, stream banks and lakeshores.

Environmental Concern, Inc.
http://wetland.org/

Non-profit organization for wetlands restoration, research and education; information about wetlands and purchasing wetlands restoration plants; educational courses on wetlands and wetlands restorations.

Lady Bird Johnson Wildflower Center
http://www.wildflower.org/

Educates visitors about the environmental necessity, economic value and natural beauty of native plants; lists native plants by state and links to other sites.

Minnesota Lakes Association
http://www.mnlakes.org/

Information about lake management issues, including shoreline erosion and stabilization.

Native Plants for Conservation Restoration and Landscaping
http://www.dcr.state.va.us/dnh/native.htm

Information about native plant restoration and the benefits of using native plants for landscaping and conservation projects.

North American Lake Management Society
http://www.nalms.org/

Non-profit organization dedicated to improving the management of lakes.

North Carolina Department of Agriculture
http://www.agr.state.nc.us/

Information and contacts for aquatic weeds and soil testing services.

South Carolina of Natural Resources
http://water.dnr.state.sc.us/

Information about aquatic weeds and wetland aquatic plants in South Carolina.

United States Department of Agriculture
Natural Resources Conservation Service
Plants National Database
http://plants.usda.gov/

Single source of standardized information about plants, featuring plant names, symbols, attributes and photographs.

USDA Animal and Plant Health Inspection Service
http://www.aphis.usda.gov/index.html

Information on pest species, including aquatic weeds.

Center for Aquatic and Invasive Plants USGS
http://water.usgs.gov/

Water quality, stream and river data and aquatic weed management.

Always call Duke Energy Lake Management at **800-443-5193** or **704-382-8086** before planting anything within the project boundary.

SUPPLIERS

Where can you get what you need? Since "bioengineering" is relatively a new concept, resources may be limited. While Duke Energy does not intend to endorse suppliers and vendors, we understand your eagerness to start your project quickly. We have provided the names of these Carolinas vendors from USDA's Landscape Restoration Handbook, which features a directory of wetland plants vendors, and the North Carolina Department of Agriculture and consumer Services' Certified Nurseries and Plant Collectors of North Carolina.

Request a list of certified nurseries and plant collectors from:

Gene B. Cross
NC Department of Agriculture
Plant Industry Division 1 Plant Protection Section
PO Box 27647
Raleigh, NC 27611
919-733-3933 Fax 919-733-1041

H.B. Jackson
SC Department of Agriculture
Plant Industry
511 Westinghouse Road
Pendleton, SC 29670
864-646-2178 Fax 864-646-2178

www.duke-energy.com

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