REGIONAL CHANNEL CHARACTERISTICS FOR MAINTAINING NATURAL FLUVIAL GEOMORPHOLOGY IN FLORIDA STREAMS

PROBLEM STATEMENT

The traditional approach to designing highway structures over water crossings has been based on rigid, one-dimensional channel hydraulics. This approach has limitations and may affect stream stability, causing reduced meanders, costly upstream and downstream erosion problems, water quality impacts, and barriers to fish passage, and altering associated wetland and floodplain function. Increasingly, engineers and environmental professionals are turning toward design procedures that minimize disruption of stable stream channels. They are beginning to design in accordance with the natural fluvial geomorphology of rivers. These principles can also be used to restore the physical, biological, and aesthetic characteristics of degraded rivers or help to maintain the natural stream properties for newly constructed projects. Nationwide, there is strong support for this natural stability approach from federal and state regulatory agencies involved in the review of highway projects.

OBJECTIVES

The goal of this research was to develop regional curves for two hydro-physiographic regions in the Florida Coastal Plain. Regional curves are mathematical relationships of bankfull channel dimension and discharge versus drainage area. These mathematical relationships are used by engineers and channel designers to identify bankfull stage in un-gaged/project watersheds and to design stable stream channels. The research focused on studying naturally stable stream channels that were created by rainfall, stream flow, geology, soils, and vegetation.

FINDINGS AND CONCLUSIONS

The U.S. Fish and Wildlife Service collected information on 23 U.S. Geological Survey (USGS) gage stations that met the following criteria: 1) the gage operation had at least ten years of continuous or peak discharge measurements; 2) there were no major impoundments upstream of the gage site; 3) land use had not significantly changed over the past ten years; and 4) less than 10% impervious surface covered the watershed area. To supplement data collected in gaged watersheds, three stable reference reaches in un-gaged watersheds were also selected. These reaches had no major impoundments, no significant change in land use over the past ten years, and less than 10% impervious surface covering the watershed area.

A series of field measurements were conducted at each selected gage stream reach to classify the stream and to measure the hydraulic geometry for development of the regional curves. These data include cross-sectional and longitudinal surveys which determined channel dimension, pattern, and profile. Bed material analyses were conducted to assist in stream classification and characterization. In addition, bankfull discharge was estimated for each reach, using Manning's equation and/or USGS stage-discharge rating curves.

Hydraulic geometry was plotted against drainage area for each of the surveyed sites and analyzed from a statistical and geographic viewpoint. A distinct break between the data is apparent around the Tallahassee area, where mean annual runoff rates quickly change from 15 inches to 20 inches, moving from east to west. A set of relationships for bankfull discharge, cross-sectional area, width, and mean depth as functions of watershed area were developed for the Northwest Florida Coastal Plain Region (NWFCP), consisting of 14 of the 26 surveyed sites, and for the North Florida Coastal Plain Region (NFCP), consisting of the 12 remaining surveyed sites. The resulting relationships were found to be linear on a log scale; therefore, a power function was fit to the raw data. The 95% confidence intervals were also calculated for the regression equations.

This study found a significant relationship between bankfull cross-sectional area and drainage area, and between bankfull discharge and drainage area. The relationships between both mean depth and drainage area and bankfull width and drainage area were less significant. When used with appropriate caution and supported by other data, these regional curves can support stream assessment and restoration design.

Bankfull relationships of channel dimension developed in Northwest Florida and North Florida are significantly different. Streams in Northwest Florida demonstrate much larger bankfull areas and discharges. This difference is based on precipitation and geologic runoff factors, as mean annual runoff in Northwest Florida is approximately double that in North Florida. The differences in bankfull width and depth were less consistent between the two regions.

When compared to other coastal plain regional curves, the Northwest Florida Regional Curve predicts a substantially larger bankfull discharge and bankfull area. Comparison of the North Florida Regional Curve with other coastal plain regional curves indicates statistically similar relationships with the Georgia Coastal Plain curve, predicting a smaller bankfull discharge and cross sectional area than in the Northwest Florida curve. These data are also smaller than regional curves developed in Maryland and North Carolina. All the coastal plain regional curves predict lower bankfull discharges and cross-sectional areas than the North Carolina Piedmont Regional Curve.

BENEFITS

This report is intended to support the assessment and restoration of Florida Panhandle streams with empirical relationships of bankfull discharge and channel dimension. The research focused on studying naturally stable stream channels that were created by rainfall, stream flow, geology, soils, and vegetation. These mathematical relationships are used by engineers and channel designers to identify bankfull stage in un-gaged/project watersheds and to design stable stream channels. The development of regional curves helps in converting unstable channels into naturally stable stream corridors, with the goal of creating an ecosystem that functions at its highest biological and physical potential.

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