

A GIS–based Assessment of Land Cover within Stream and River Riparian Buffers of the Southeastern United States

A publication of the Science and Data Committee,
Southeast Aquatic Resources Partnership

Prepared in cooperation with Georgia Department of Natural Resources and the US Fish and Wildlife Service



This publication was funded by the Multistate Conservation Grant Program (grant # FL-M-2-C), a program supported with funds from the Sport Fish Restoration Program of the U.S. Fish & Wildlife Service and jointly managed with the Association of Fish & Wildlife Agencies.

A GIS–based Assessment of Land Cover within Stream and River Riparian Buffers of the Southeastern United States

Adam J. Kaeser and Emily Watson, principal authors

A publication of the Science and Data Committee,
Southeast Aquatic Resources Partnership

Prepared in cooperation with Georgia Department of Natural Resources and the US Fish and Wildlife Service

Suggested Citation: Kaeser, A. J., and E. Watson. 2011. A GIS–based Assessment of Land Cover within Stream and River Riparian Buffers of the Southeastern United States. A publication of the Science and Data Committee, Southeast Aquatic Resources Partnership.

Habitat Assessment Committee members that contributed to the riparian assessment include Mark Cantrell (USFWS), Will Duncan (USFWS), Mary Davis (TNC), Dan Everson (USFWS), Ryan Smith (TNC), Mark Sramek (NOAA), Scott Robinson (SARP), Roger Pugliese (SAMFC), and Jason Duke (USFWS)

Cover Photograph: The image on the cover is the Etowah River, near Dahlonega in north Georgia. This part of the river harbors imperiled fishes such as the Etowah Darter (*Etheostoma etowahae*), a species that inhabits silt-free gravel and cobble sediments. The intact riparian buffer helps maintain natural rates of sediment input and quality instream habitat. Photo courtesy of Will Duncan, USFWS.

For additional information, visit www.southeastaquatics.net and www.fishhabitat.org.

Table of Contents

| | |
|---|----|
| Executive Summary..... | 5 |
| Background..... | 6 |
| Habitat Assessment Committee - Mission and Strategy | 6 |
| Introduction | 7 |
| Assessment Tasks | 7 |
| Methods..... | 8 |
| Study Area | 8 |
| Land Cover Data | 8 |
| Hydrography Data | 8 |
| Riparian Area..... | 9 |
| Cross-tabulating Land Cover Data within Riparian Buffers..... | 9 |
| Generating Percent Ag+Urb Riparian Land Cover Statistics | 10 |
| Treatment of Open Water (Class 11)..... | 10 |
| Assessment Results and Discussion | 11 |
| Part I. Spatial Coverage of Assessment NHD Features..... | 11 |
| Part II. Riparian Buffer Condition Summary | 15 |
| Part III. Visualizing Riparian Disturbance at Multiple Spatial Scales..... | 18 |
| Validation..... | 24 |
| Evaluating the Effect of 30 meter Vs. 60 Meter Riparian Buffers | 25 |
| Data Availability and Potential Applications..... | 27 |
| Data Availability - How and Where Data can be Accessed | 27 |
| Potential Applications | 27 |
| Appendices..... | 29 |
| Appendix A – Habitat Assessment Process conceptual flowchart | 29 |
| Appendix B - Intermittent, Perennial, and Artificial Path Flowlines..... | 30 |
| Appendix C – Steps to Prepare Land Use Raster for Riparian Assessment | 36 |
| Appendix D - Why Open Water Appears in Riparian Buffers..... | 39 |
| Habitat Assessment Committee Members | 43 |

List of Maps

| | |
|---|----|
| Map A. Selected NHD features included in the assessment. | 11 |
| Map B. Geographic coverage of unassessed features. | 13 |
| Map C. Percent Ag+Urb Riparian Land Cover of all assessed stream and river segments. .. | 18 |
| Map D. Visualizing Disturbance Intensity - Percent Ag+Urb Riparian Land Cover of stream and river segments. | 19 |
| Map E. Spatial Distribution of Agricultural Classes - Riparian buffers predominately modified by agricultural practices. | 20 |
| Map F. Riparian buffers predominantly modified by Urban Development or Mixed Urban/Agricultural Sources. | 21 |
| Map G. Visualizing Modification by Summing Local Reach data to the 8-digit HUC Spatial Unit..... | 22 |
| Map H. Cartogram: Weighting size of the HUC based on total hectares of riparian buffer within HUC. | 23 |
| Map I. Paired reaches selected for the comparative analysis. | 25 |
| Map J. Illustrates flowlines classified as intermittent (light blue), perennial (dark blue), and artificial path flowlines (red). | 30 |
| Map K. Illustrating changes over time using aerial photography and NHD. | 31 |
| Map L. New impoundment not found in NHD. | 31 |

| | |
|--|----|
| Map M. Exclusion of Intermittent Streams. | 32 |
| Map N. Intermittent Streams and USGS Quad Grids | 33 |
| Map O. Effect of exclusion of some intermittent streams. | 33 |
| Map P. Illustrating inconsistencies in perennial stream density caused by NHD data stewards. | 34 |
| Map Q. Variation in stream density and how it can affect interpretation of disturbance intensity..... | 35 |
| Map R. Illustrating Open Water within buffers using aerial photography | 39 |
| Map S. Illustrating Open Water within buffers using land cover data. | 40 |
| Map T. Open Water in buffers from over extended raster cells. | 41 |
| Map U. Spatial congruency of High Resolution NHD and 2001 NLCD..... | 42 |

List of Figures

| | |
|--|----|
| Figure 1. Pie charts of land cover class summaries | 16 |
| Figure 2. Comparison of MoRAP approach and SARP approach. | 26 |
| Figure 3. SARP's Riparian Assessment Model for Lines | 37 |
| Figure 4. SARP's Riparian Assessment Model for Polygons | 37 |

List of Tables

| | |
|--|----|
| Table 1. Riparian Land Cover Class Summary | 15 |
| Table 2. Reach and Riparian Summary Statistics | 15 |
| Table 3. Data Dictionary..... | 38 |

Executive Summary

The Southeast Aquatic Resources Partnership is comprised of 14 states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, Tennessee, Texas, South Carolina, and Virginia. Several major river systems are found in these states, such as the Red, the Rio Grande, the Canadian, the Arkansas, the Platte, the Mississippi, the Ohio, the Tennessee, the Mobile, and the Chattahoochee. There are 24 freshwater ecoregions and 721 8-digit Hydrologic Unit Codes that occur throughout the SARP region.

The principal objective of the Southeast Aquatic Resources Partnership (SARP) Habitat Assessment Committee is to complete regional habitat assessments that specifically address the eight objectives of the Southeast Aquatic Habitat Plan (SAHP), the first of which is to improve or maintain adequate riparian areas in the Southeast. The SARP Riparian Assessment analysis will assess the current condition of riparian habitat within a 30 m buffer along streams and rivers throughout the SARP region and provide a baseline against which to measure future progress toward achieving riparian habitat conservation/restoration goals.

The 1:24,000 National Hydrography Dataset (NHD) was used to represent the perennial streams and rivers in the SARP region. A 30 meter buffer was generated around each reach in the NHD. Tabulations of each land cover class in the 2001 National Land Cover Dataset (NLCD) found within the riparian buffer were used to calculate the percentage of disturbed riparian land cover for each river segment. Disturbed riparian land cover was defined as the agricultural and urban land cover classes defined in the 2001 NLCD.

We found that approximately 22.4% of the riparian land cover in the SARP region was classified as agricultural or urban, meaning that we are on our way toward meeting our conservation target established in the SAHP. Of the disturbed riparian land cover, agriculture made up approximately 75% of the overall 22.4% disturbed land cover classes. The highest concentration of the disturbed riparian can be found in the Mississippi valley, and the least disturbed in the coastal plain. Deciduous forests and wooded wetlands make up approximately half of the riparian area in the SARP region.

We provide an example of a validation of the data outputs and propose several potential applications of the data including: quantifying change over time toward target achievement; strategic habitat conservation of riparian buffers; and contributing to the National Fish Habitat Action Plan's National Assessment.

Objective 1

Establish, improve and maintain riparian zones

The land areas along either side of streams, lakes and rivers are referred to as riparian zones. When they contain vegetation such as grasses, woody plants, shrubs, and trees, they help buffer the impacts of land use activities like farming, construction, or mining. Since these buffers help trap sediment (the number one cause of water pollution) carried in run-off, they play an important role in protecting water quality. They also provide vital habitat, travel corridors, and feeding grounds for both aquatic and terrestrial (land-based) wildlife.

The challenge is to maintain, conserve, permanently protect, construct or restore riparian zones in the Southeastern region that can support healthy aquatic habitats.



Background

Habitat Assessment Committee - Mission and Strategy

In May 2009, the Southeast Aquatic Resources Partnership (SARP) Science and Data Committee initiated a smaller, focused group called the Habitat Assessment Committee (HAC). The principal objective of the SARP HAC is to complete regional habitat assessments that specifically address the eight objectives of the Southeast Aquatic Habitat Plan (SAHP) (Southeast Region, as defined as 14 SARP states). The SAHP has specific objectives to establish, improve, maintain, and/or restore elements of aquatic habitat such as riparian buffers, water quality, connectivity, hydrologic integrity, sediment flows, and physical habitat, to restore or improve ecological balance in systems invaded by non-indigenous species, and to conserve, restore, and create coastal and marine habitats. The plan identifies specific, quantitative targets to measure progress towards the conservation of these habitat elements. A comprehensive habitat assessment of each element is critical to establish a baseline (i.e., current status), to objectively measure progress, and to provide spatial information on condition of aquatic habitat elements throughout the Southeast.

Ideally, the assessment analyses will provide a benchmark (a target baseline) for evaluating progress toward target achievement for each objective listed in the SAHP. In the event that requisite data are not currently available, a list of data needs will be provided to the National Science and Data Committee, to individual states, and to other SARP committees to facilitate the acquisition or development of necessary data. If the SAHP targets cannot be adequately evaluated, or are no longer the most relevant to the habitat objective, the committee will recommend revision of targets during updates to the SAHP.

Several principles define and guide science-based habitat assessment. Assessments should use available data sets that best serve as direct measures or indicators of habitat condition. Assessments should be as accurate, reproducible, standardized, and objective as possible for the entire Southeast region. Assessments should provide quantitative information pertinent to each target at multiple spatial scales (e.g., stream reach, watershed, region) to facilitate spatial aggregation and to aid in the design and implementation of strategic conservation actions across the landscape at multiple spatial scales. Assessments should be designed with the inherent flexibility to incorporate newer, more current data sources as they become available. The assessment strategy, in general, leads to the production of multiple data layers that can be integrated and analyzed within geographic information systems (GIS) to provide a deeply informed perspective of the condition of aquatic habitat throughout the Southeast.

Introduction

The Habitat Assessment Committee has initiated an evaluation of the status of aquatic habitat throughout the Southeast region in order to fulfill requirements of the [National Fish Habitat Action Plan](#) (NFHAP), to support and enhance the national assessment effort, and to provide a condition assessment of the objectives of the SAHP.

The first objective of the Southeast Aquatic Habitat Plan is to establish, improve, and maintain riparian buffers. For the purpose of this assessment, adequate riparian buffer is defined as non-urban and non-agricultural land cover. The specific targets identified in the Plan are:

Target 1A. Ensure that adequate non-urban/non-agricultural riparian buffer habitats exist on at least 85% of the lands within 100 feet of rivers and streams in the Southeast by 2022.

- By 2012 ensure that at least 78% of the lands within 100 feet of rivers and streams in the Southeast have adequate riparian buffers.
- By 2017 ensure that at least 81% of the lands within 100 feet of rivers and streams in the Southeast have adequate riparian buffers.
- By 2022 ensure that at least 85% of the lands within 100 feet of rivers and streams in the Southeast have adequate riparian buffers.

The Habitat Assessment Committee chose to focus on this objective first, and initiated work on the assessment of riparian corridor condition along all rivers and streams in the Southeast in May 2009. Target 1A of the Plan focuses exclusively on rivers and streams, thus, the assessment did not examine the riparian areas of ponds, lakes, reservoirs, holding ponds, or any other artificial impoundment of otherwise naturally flowing systems.

The goal of this project is to assess the current condition of riparian habitat within a 30 m buffer along streams and rivers throughout the SARP region and provide a baseline against which to measure future progress toward achieving riparian habitat conservation/restoration goals.

Assessment Tasks

- 1) Establish a summary baseline percentage of urban and agricultural (%Ag+Urb) riparian land cover representing overall condition of riparian buffers throughout the SARP region.
- 2) Generate a GIS database containing land cover within a 30 meter (100 ft) buffer of every stream and river feature in the SARP region.
- 3) Aggregate riparian buffer condition scores (%Ag+Urb) at larger spatial scales for visualization.
- 4) Investigate, conduct, and/or discuss approaches to qualitative and quantitative validation of the results of the assessment.
- 5) Prepare a summary report.

Methods

Study Area

The Southeast Aquatic Resources Partnership is comprised of 14 states: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, Tennessee, Texas, South Carolina, and Virginia. Several major river systems are found in these states, such as the Red, the Rio Grande, the Canadian, the Arkansas, the Platte, the Mississippi, the Ohio, the Tennessee, and the Chattahoochee. There are 24 [freshwater ecoregions](#) and 721 8-digit [Hydrologic Unit Codes](#) that occur throughout the SARP region.

Land Cover Data

The 2001 National Land Cover Database (2001 NLCD) provides the Nation with nationally complete and consistent public domain information on the Nation's land use and land cover (see 2001 NLCD fact sheet and http://www.mrlc.gov/pdf/July_PERS.pdf). When the project started, the 2001 NLCD was the most current dataset available on land cover for the entire Nation. As newer versions of this data set are available, the riparian data can be processed again and compared to the 2001 version of the data. The database is derived from Landsat 2/7 aerial imagery, as well as other ancillary data (such as Digital Elevation Models), and uses a [modified Anderson Level II land cover classification system](#). The 2001 NLCD is a 30 meter pixel raster format. Data were obtained for sections covering the entire SARP region. The rasters were clipped and extracted to 4-digit Hydrologic Unit Codes (HUC4s) to serve as processing sub-units. We subdivided all 30 meter cells into 5 meter subunits to improve data precision when extracting landcover data within 30 meter riparian buffers of all stream segments. The land cover value of the original cell was retained in each 5 meter subunit. See Appendix C for detailed instructions for preparing the 2001 NLCD for use in the Riparian Assessment Model.

Hydrography Data

The National Hydrography Dataset (NHD) is a set of digital spatial data representing the surface waters of the United States using common features such as lakes, ponds, streams, rivers, canals, impoundments, embayments, and oceans. The basic spatial unit of the NHD is a reach, which is defined as a confluence-to-confluence segment of a stream or river. The NHD is available in both a medium and a high resolution version, requiring a selection of one of the versions for the assessment.

The medium resolution NHD was prepared at the 1:100,000 scale, while the high resolution NHD was prepared at the 1:24,000 scale. As a consequence, the two datasets differ greatly with respect to inherent detail and number of stream reaches included. For example, in HUC 0307 the medium resolution dataset contains ~26,000 stream reaches whereas the high resolution dataset contains ~128,000 reaches. Preliminary work indicated that the two datasets also differed in the degree of spatial co-registration, or spatial congruency, with the 2001 NLCD. The high resolution NHD appeared to provide a better match to the "Open Water" land cover class in the NLCD than the medium resolution NHD. On the other hand, the medium resolution NHD is compatible with the NHDPlus dataset, a set of additional data attributes compiled for all stream or river segments not available in the high resolution NHD. These attributes provide pertinent information on aspects such as stream flow volume, flow direction, and slope. Despite the availability of additional information in the medium resolution version, the NHD high resolution version was selected for the assessment because it permitted the generation of summary information on riparian buffer land cover at the finest possible spatial resolution (i.e., to assess the greatest number of

stream reaches in the SARP region). On-the-ground projects aimed at protecting or restoring riparian buffers are likely to be undertaken at a spatial scale equivalent to, or finer than, that provided by the high resolution NHD. Therefore, the use of the high resolution NHD for the assessment provided a means for generating reach-level information at a scale closest to the project or decision making level. Moreover, data generated at finer scales (stream reaches) could easily be aggregated at larger spatial units (e.g., watersheds, basins) for additional applications and analysis.

The NHD datasets are designed to be used in general mapping and in the analysis of surface-water systems using geographic information systems (GIS). The features in the NHD are organized into polygons, lines, and points. The polygons typically portray waterbodies such as lakes and larger streams; the lines typically portray smaller streams. In the high resolution dataset, streams represented by lines transition into polygon representation when channels reach and exceed 50 feet (15 meters) in width. All stream lines are subdivided into segments representing confluence-to-confluence reaches, while polygons are generally delineated using their name found in the Geographic Names Information System database. Polygon features do not necessarily represent confluence-to-confluence reaches, and may incorporate several reaches into a single feature. In this report, we refer to line and polygons collectively as "features."

****Only those reaches classified as perennial rivers or streams OR which were classified as a river or stream with a GNIS Name in the high res NHD were analyzed during the extraction of land cover data within riparian buffers.**

For additional discussion of the distinction between intermittent, perennial, and artificial flow path stream segments, and the relationship of these features to the assessment, please review Appendix B.

Riparian Area

A dataset displaying riparian areas for rivers and streams did not exist for the entire SARP region. We created this data set by generating a 30 meter buffer (i.e., a polygon shapefile) for each assessed reach in the NHD using the ArcGIS 9.3.1 Buffer Tool. The 30 meter buffer (~100 feet) size was specifically identified in the Targets for Objective 1 of the SAHP. Simply put, the 30 meter buffer size was selected to remain true to Objective 1 and the targets articulated in the SAHP. When generating the buffer for stream lines, we specified flat, rather than round, buffer ends to minimize overlap between adjacent segment buffers. When generating buffers for polygon features (i.e., larger streams), any portion of the buffer that overlapped the polygon feature was erased (using the Erase Tool), leaving only the riparian area outside of the polygon feature - the riparian area of interest (See Appendix C).

Cross-tabulating Land Cover Data within Riparian Buffers

The Tabulate Area (Spatial Analyst Extension, ArcMap 9.3.1) tool was used to extract (clip) the land cover data contained within each riparian buffer and then calculate the amount of each land cover type within each riparian buffer. The tabular results were joined to the original NHD lines or polygon features. The output values representing the area of each land cover type were in square meter units, and were converted to hectares in output tables.

Generating Percent Ag+Urb Riparian Land Cover Statistics

The 2001 NLCD land cover classes were evaluated, using guidance in the SAHP, to determine which classes were considered *agricultural* and *urban* riparian land cover. The target identifies all "non-urban/non-agricultural" land cover as "adequate" riparian buffer habitat, therefore, all urban or agricultural land cover classes constituted "modified" riparian buffer habitat. According to definitions of the 2001 NLCD Land Cover Classes, we identified the following classes as "Ag+Urb": Developed, Open Space (21), Developed, Low Intensity (22), Developed, Medium Intensity (23), Developed, High Intensity (24), Pasture Hay (81), and Cultivated Crops (82). Barren land is a naturally occurring land cover class, thus was not included in the "Ag+Urb" category.

Equation 1. To calculate the Percent Ag+Urb Riparian Land Cover associated with each stream segment, this formula was used.

$$\left[\frac{\sum(\text{AgUrbRiparianLandCoverClasses}(ha))}{\sum(\text{AllLandCoverClasses}(ha))} \right] \times 100 =$$

% AgUrbRiparianLandCover

Treatment of Open Water (Class 11)

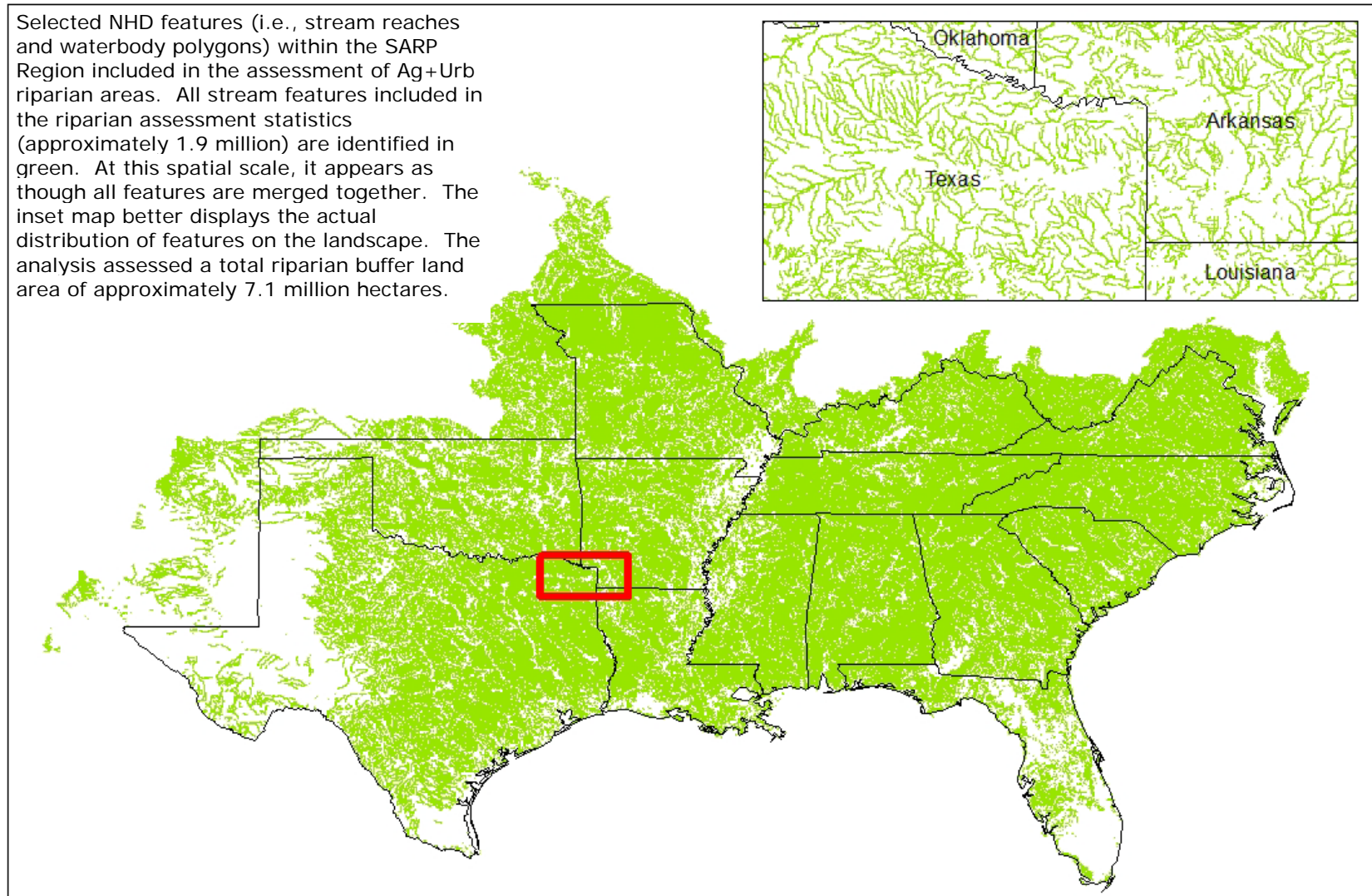
The NLCD includes a class representing Open Water (11). During development of the assessment process, we identified several possible mechanisms by which a stream buffer might include Open Water. For example, if an NHD-designated stream reach actually extended into an area classified in the 2001 NLCD as impounded water (e.g., a small farm pond), then the buffer generated around this reach would include some proportion of Open Water land cover (see Appendix D). The inclusion of Open Water in the riparian land cover extracted for a stream segment was an indicator that our assessment of that particular buffer was inaccurate/incomplete, and potentially biased. To minimize error introduced by the inclusion of Open Water, we established a cut-off value of $\geq 10\%$ Open Water in the buffer for exclusion of a stream segment from the assessment. Any stream segment with $\geq 10\%$ Open Water defaulted to an "Unassessed feature" category.

*Note: The "Unassessed feature" layer effectively represents the set of "open water" errors associated with the integrated spatial analysis of the high resolution NHD and 2001 NLCD. Such errors were anticipated, and are inherent in any spatial analysis conducted across a large regional scale. Our goal was to identify, quantify, and account for such errors in the assessment. Correcting spatial incongruencies in the data sets exceeded the scope and capacity of SARP's regional assessment effort, thus, we made no attempt to do so. Information on the total number and extent of unassessed features is provided in Part II of this section of the report.

Assessment Results and Discussion

Part I. Spatial Coverage of Assessment NHD Features

Selected NHD features (i.e., stream reaches and waterbody polygons) within the SARP Region included in the assessment of Ag+Urb riparian areas. All stream features included in the riparian assessment statistics (approximately 1.9 million) are identified in green. At this spatial scale, it appears as though all features are merged together. The inset map better displays the actual distribution of features on the landscape. The analysis assessed a total riparian buffer land area of approximately 7.1 million hectares.

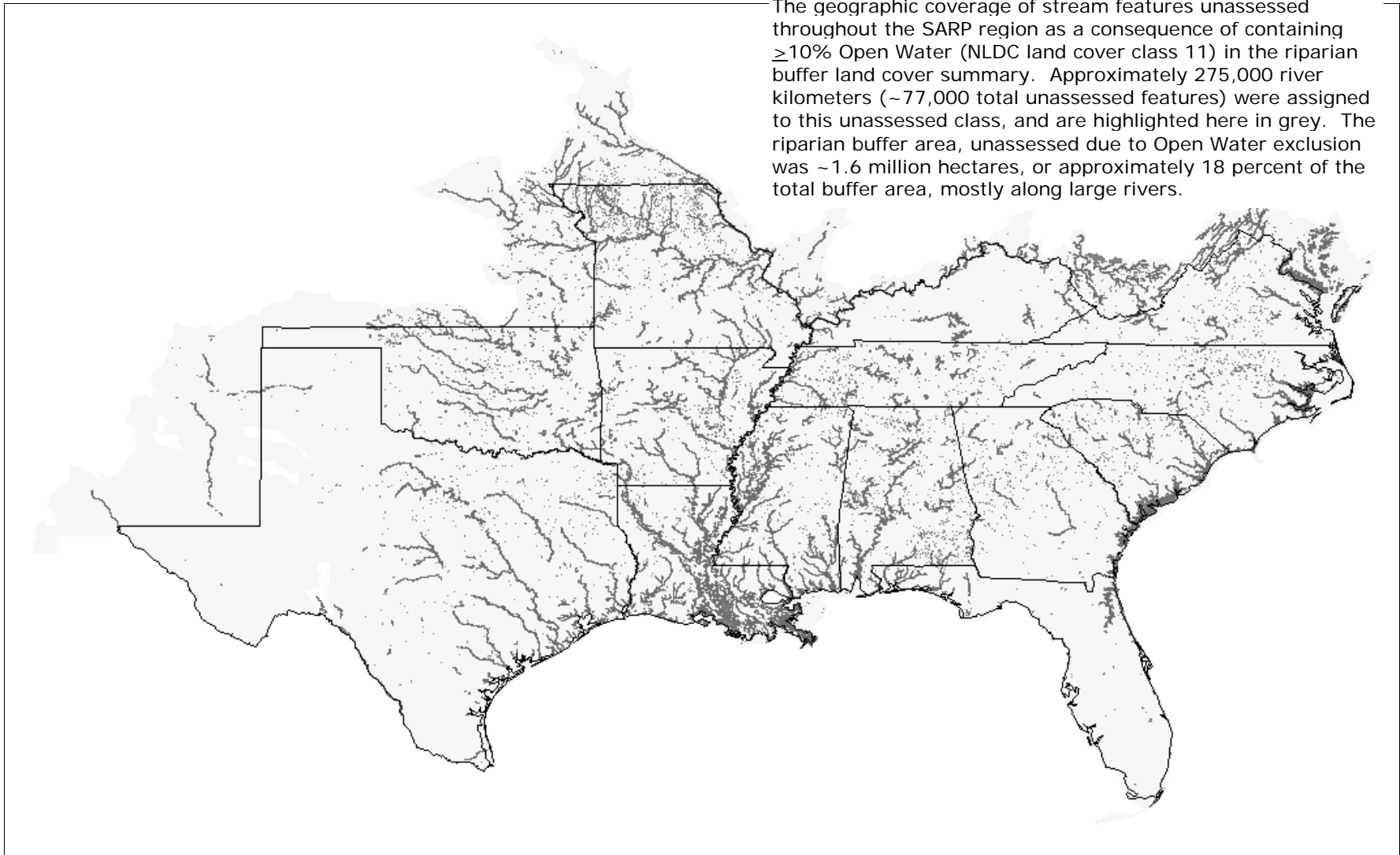


Map A. Selected NHD features included in the assessment.

Comments – Map A

- Most SARP states were widely covered in the assessment of riparian disturbance, although a few areas do stand out as not assessed. On the following page, a map of the stream segments excluded from the assessment due to $\geq 10\%$ Open Water class in the riparian buffer area is provided. This phenomenon accounts for some, but not all, of the gaps in assessment coverage.
- Some of the gaps in coverage exist in areas where natural, surface water drainage networks are sparse. For example, the Dougherty Plain of Southwest Georgia and the north central region of Florida are regions where drainage density is very low, simply because most of the water in the area is found below ground, flowing through vast aquifer systems.
- Swampy lowlands, such as the Florida Everglades, are areas that were also not assessed, as stream networks in these areas are poorly defined and not present in the NHD.
- The arid western portion of Texas was not assessed due to lack of surface streams, or data missing from the NHD.

The geographic coverage of stream features unassessed throughout the SARP region as a consequence of containing $\geq 10\%$ Open Water (NLDC land cover class 11) in the riparian buffer land cover summary. Approximately 275,000 river kilometers (~77,000 total unassessed features) were assigned to this unassessed class, and are highlighted here in grey. The riparian buffer area, unassessed due to Open Water exclusion was ~1.6 million hectares, or approximately 18 percent of the total buffer area, mostly along large rivers.



Map B. Geographic coverage of unassessed features.

Comments – Map B

- Of the total number of features identified in the NHD database as perennial rivers or stream within the SARP region (approximately 2 million), ~96% met our criteria for inclusion in the assessment of riparian buffer condition.
- This map indicates that a fair number of large river segments were not assessed, a result that we attribute in part to the crude definition of river channels as polygon features in the NHD (i.e., river polygons that did not accurately delineate the channel margins), but mostly to the coarse rasterization of the National Land Cover Dataset relative to the fine scale at which riparian buffer data were extracted. Attention should be devoted to the assessment of these unassessed waters in the future if restoration plans target such waters.
- A future approach to assessing riparian buffers on larger streams and rivers might consider the application of a larger riparian buffer (e.g., 60 meter or 100 meter), especially to larger streams (i.e., those represented by polygons in the high resolution NHD). Doing so would likely decrease the number of river features excluded from the assessment due to open water.
- The criterion of $\geq 10\%$ Open water in a buffer is only one of the ways a flowing stream might have been excluded from the assessment. Streams that were channelized, for example, were often not identified in the NHD as river or stream flowlines, but as canals or ditches, and thus, were excluded from the assessment (discussed earlier). Our summaries for total number of features, stream kilometers, and hectares unassessed (Table 2) does not include streams excluded for reasons other than the open water in buffer issue; these figures are thus underestimates of the total number of unassessed flowing waterways.

Part II. Riparian Buffer Condition Summary

Table 1. Riparian Land Cover Class Summary

| Land Cover Class | Total (hectares) |
|---|------------------|
| Barren Land | 17,148 |
| Open Water | 32,927 |
| Herbaceous Wetlands | 203,689 |
| Mixed Forest | 291,867 |
| Shrub | 420,792 |
| Evergreen Forest | 425,137 |
| Grassland | 434,230 |
| Woody Wetlands | 1,394,684 |
| Deciduous Forest | 2,347,695 |
| Developed, High | 3,998 |
| Developed, Medium | 19,415 |
| Developed, Low | 84,760 |
| Developed, Open | 304,048 |
| Cultivated Crops | 439,559 |
| Pasture/Hay | 745,384 |
| Total Riparian Area (minus Open Water) | 7,165,333 |

Table 2. Reach and Riparian Summary Statistics

| | |
|---------------------------------------|-----------|
| # Features Assessed | 1,929,062 |
| # Features Unassessed | 76,987 |
| % Unassessed Reaches | 3.8% |
| | |
| Length (km) Features Assessed | 1,341,619 |
| Length (km) Features Unassessed | 275,196 |
| % Length (km) Unassessed | 17% |
| | |
| Total Riparian Area Assessed (ha) | 7,132,329 |
| Total Riparian Area Unassessed (ha) | 1,635,175 |
| % hectares Unassessed | 18.6% |
| | |
| Total Ag+Urb Riparian Land Cover (ha) | 1,597,086 |
| | |
| Baseline % Ag+Urb Riparian Land Cover | 22.39% |

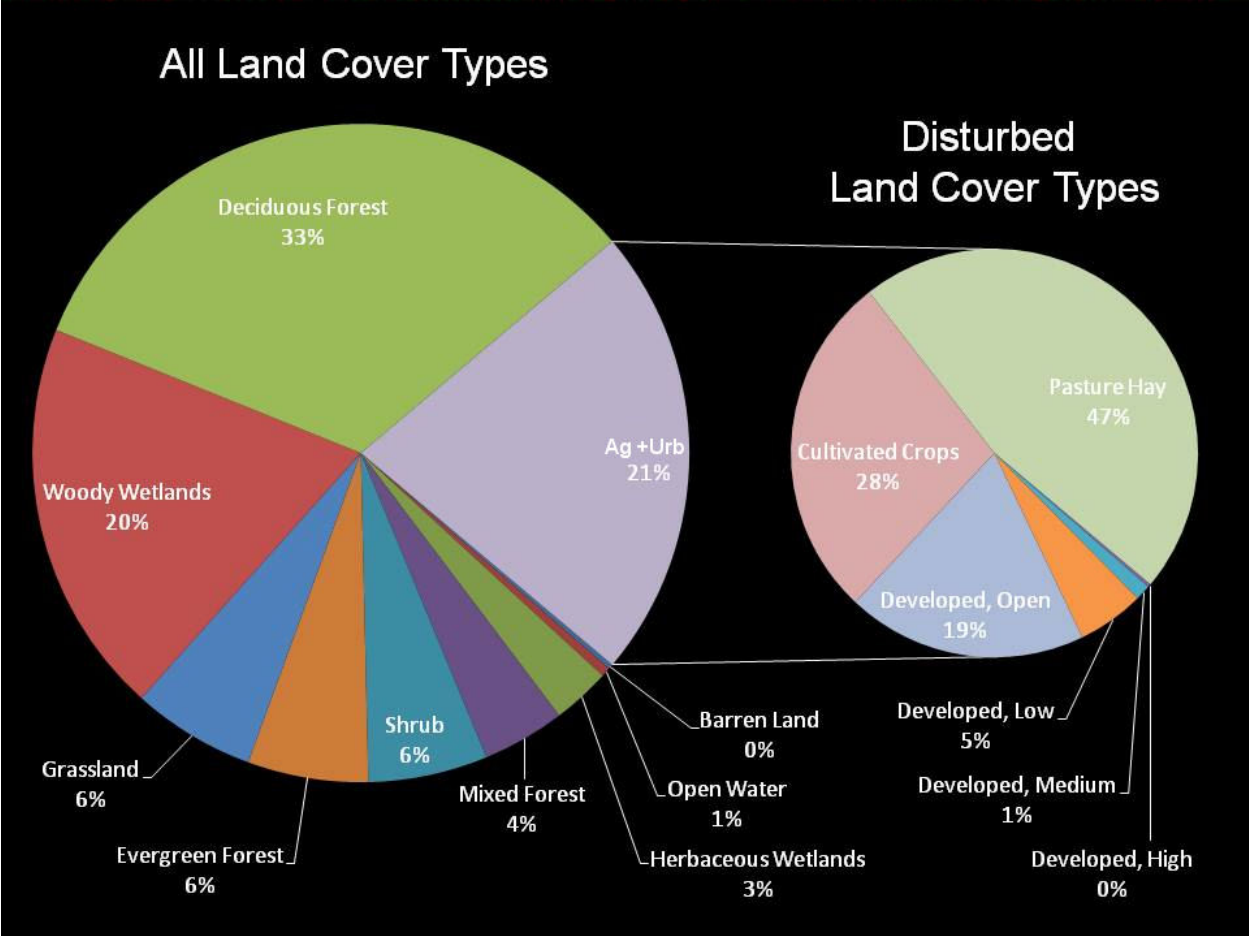


Figure 1. Pie charts of land cover class summaries

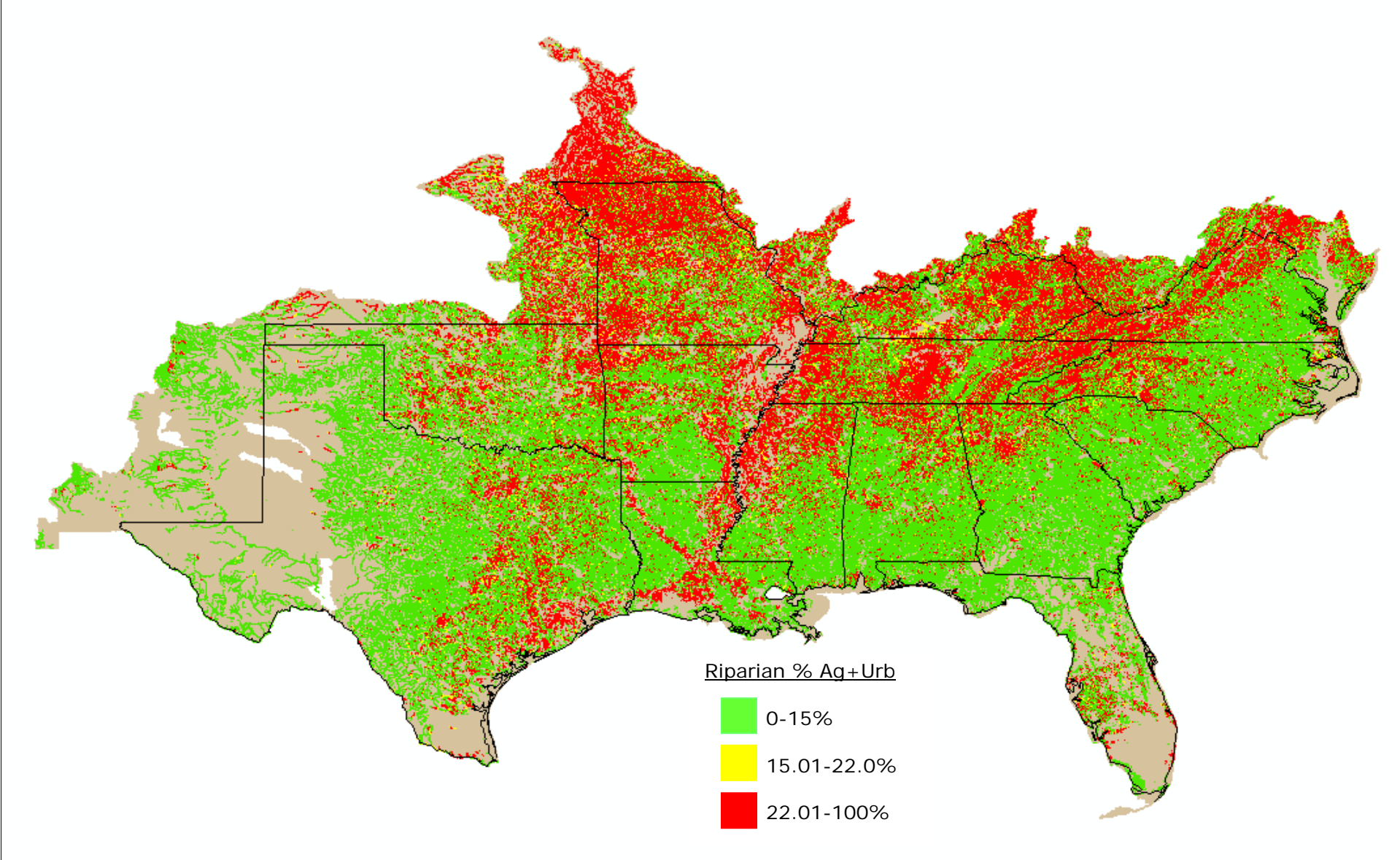
The large pie chart in Figure 1 represents the proportions of land cover classes summarized within assessed riparian buffers (Data from Table 1 above). The small pie breaks down the 21% from the large pie chart to illustrate the proportional representation of the %Ag+Urb land cover classes within riparian areas.

Comments – Part II

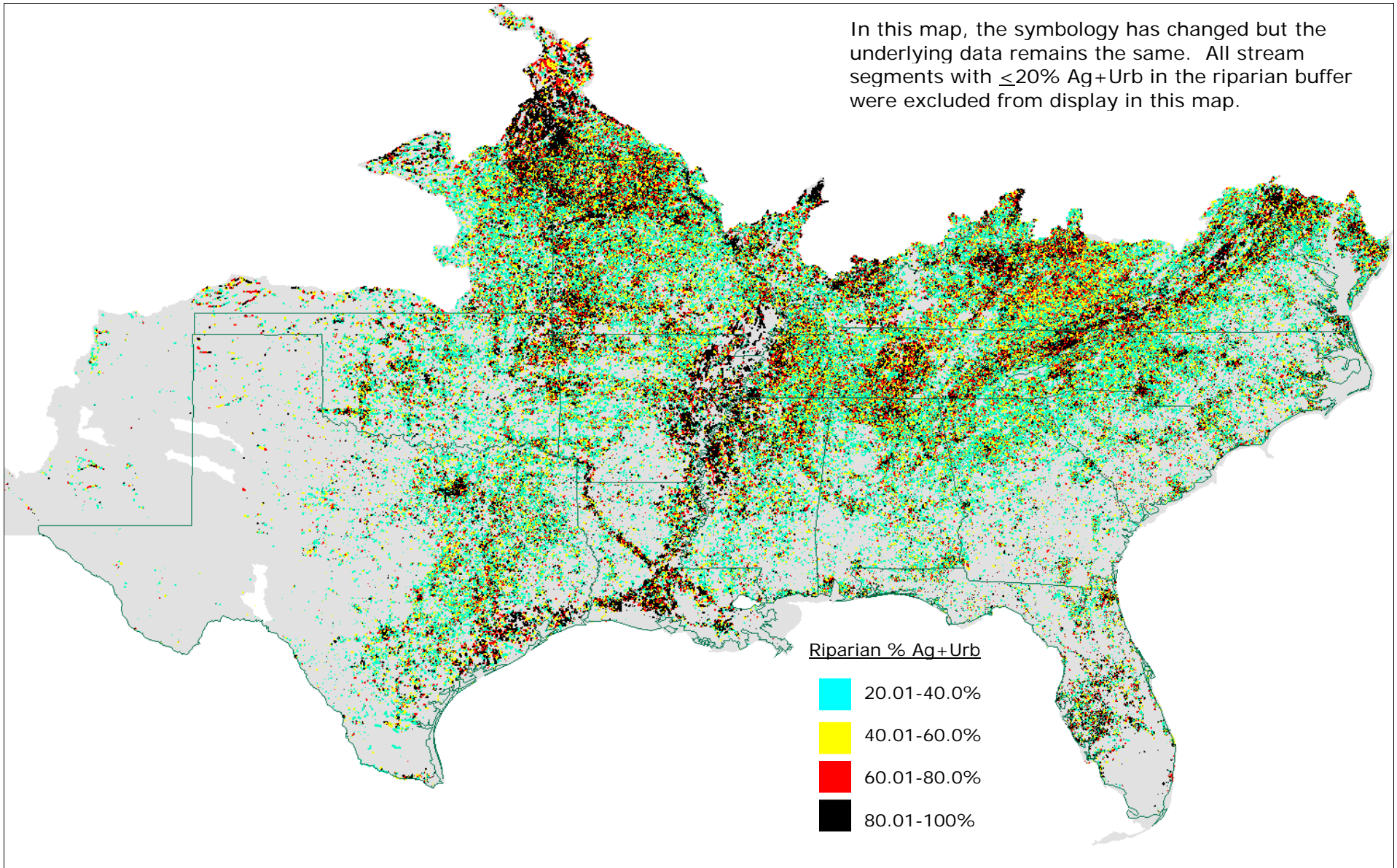
% Ag+Urb Riparian Land Cover and the SAHP Targets

- The Southeast Aquatic Habitat Plan (SAHP 2008, <http://southeastaquatics.net/documents/southeast-aquatic-habitat-plan>) cites a 2002 Heinz Center analysis that estimated 23% modification to riparian areas (% urban+agricultural) nationwide. Although the authors of the SAHP speculated that the nationwide estimate might be low for the Southeast, our estimate of 22.4% %Ag+Urb riparian land cover for assessed features in the region is nearly identical. This finding suggests that the original SAHP baseline condition for this objective is viable.
- Our results indicate that the % Ag+Urb for assessed features from the year 2001 (i.e., the year the National Land Cover data were collected) were close to the SAHP 2012 target of 22%.
- To meet the upcoming 2017 goal of 19% Ag+Urb, an additional 3.4% of riparian lands must be converted into a natural (i.e., non-athropogenically-modified) condition. This goal (3.4% conversion) represents ~243,000 hectares, ~40,500 km, or 25,000 miles of stream buffers (corridors).
- To reach the 2017 goal (assuming 6 years from now), riparian buffers must be converted to healthy buffers at a rate of 34,670 ha / 5,778 km / 3,594 miles per year throughout the Southeast region. If each of the 14 SARP states restored buffers at an equal rate over the next 6 years, the target could be met through restoration of ~260 miles per year per state. Such statistics may be useful when evaluating whether SARP is facilitating the achievement of these goals through funding decisions, technical support, or data development.
- This baseline riparian assessment provides not only numeric targets, but also geographically explicit information about where riparian habitats are inadequate and could be improved.

Part III. Visualizing Riparian Disturbance at Multiple Spatial Scales

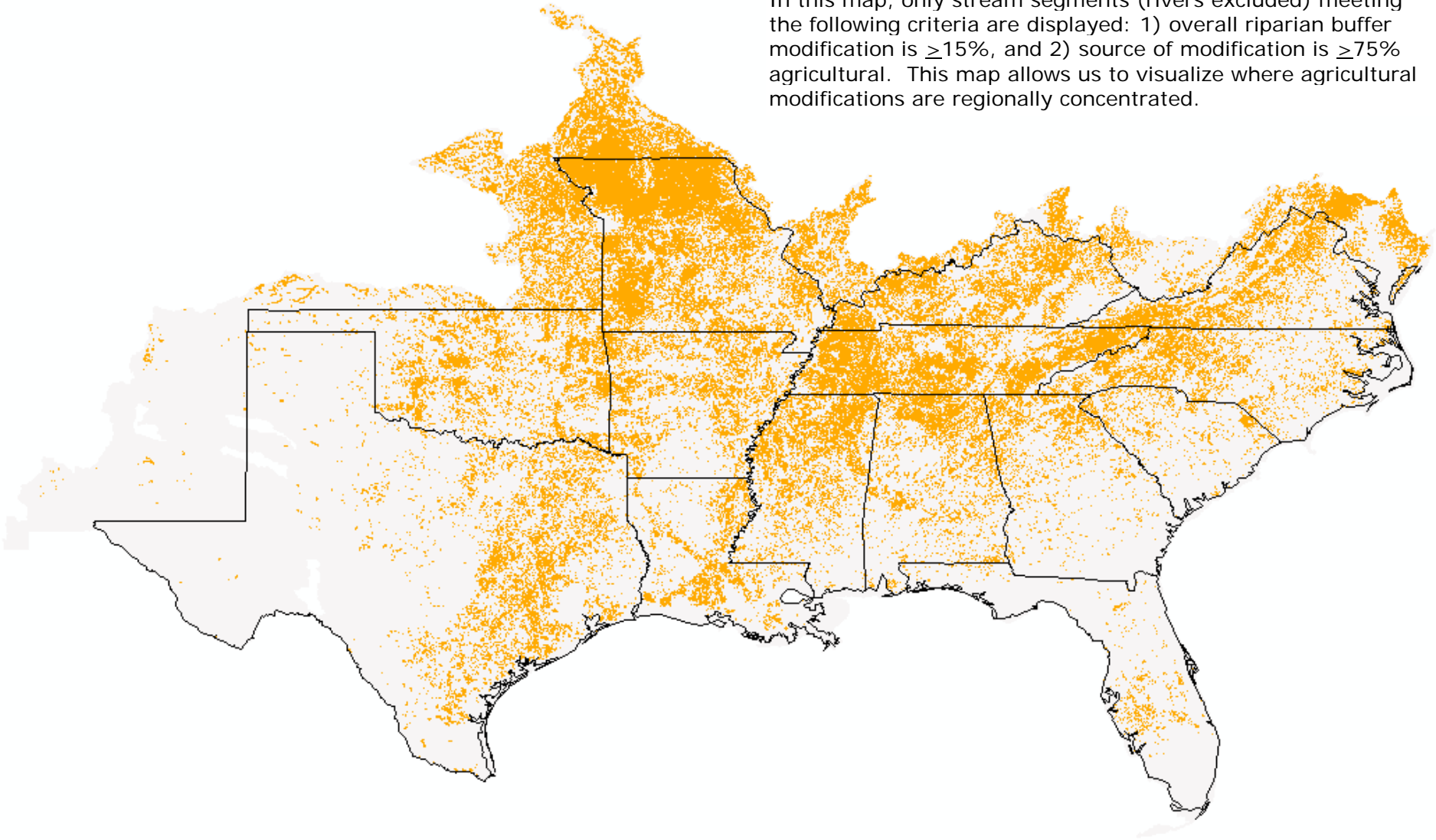


Map C. Percent Ag+Urb Riparian Land Cover of all assessed stream and river segments.



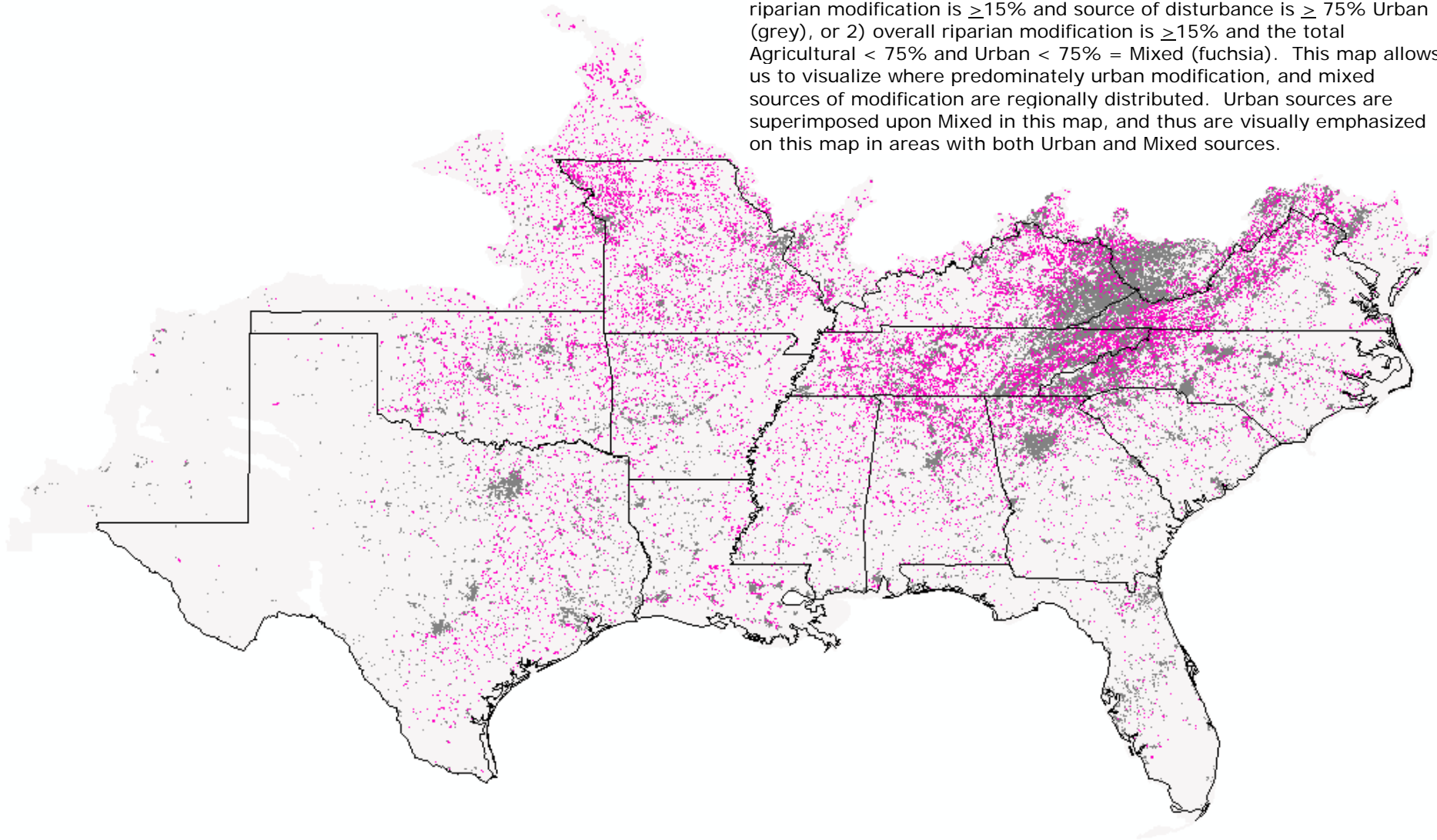
Map D. Visualizing Disturbance Intensity - Percent Ag+Urb Riparian Land Cover of stream and river segments.

In this map, only stream segments (rivers excluded) meeting the following criteria are displayed: 1) overall riparian buffer modification is $\geq 15\%$, and 2) source of modification is $\geq 75\%$ agricultural. This map allows us to visualize where agricultural modifications are regionally concentrated.



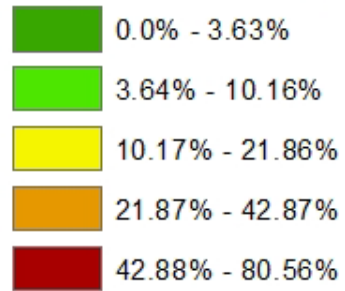
Map E. Spatial Distribution of Agricultural Classes - Riparian buffers predominately modified by agricultural practices.

Stream segments meeting the following criteria are displayed: 1) Overall riparian modification is $\geq 15\%$ and source of disturbance is $\geq 75\%$ Urban (grey), or 2) overall riparian modification is $\geq 15\%$ and the total Agricultural $< 75\%$ and Urban $< 75\%$ = Mixed (fuchsia). This map allows us to visualize where predominately urban modification, and mixed sources of modification are regionally distributed. Urban sources are superimposed upon Mixed in this map, and thus are visually emphasized on this map in areas with both Urban and Mixed sources.

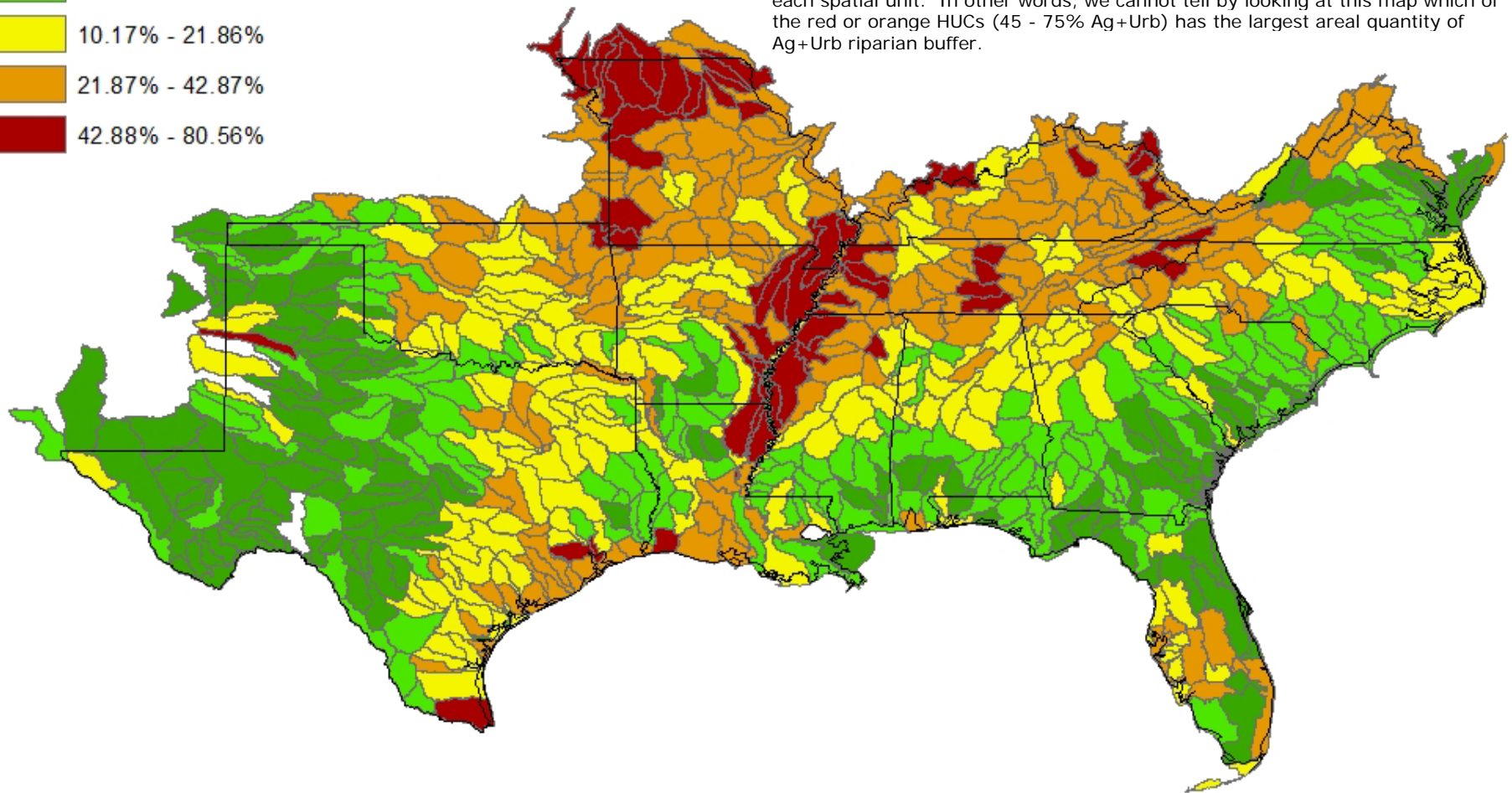


Map F. Riparian buffers predominantly modified by Urban Development or Mixed Urban/Agricultural Sources.

8-digit HUC Percent Ag+Urb

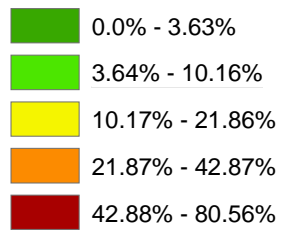


This map portrays the assessment results by summing the Ag+Urb riparian land cover and dividing it by the total riparian land cover at the 8-digit HUC spatial unit. Although this map serves to identify relative differences among HUCs, it does not illustrate absolute differences among HUCs in terms of the total quantity of stream kilometers (i.e., the total riparian buffer area) present within each spatial unit. In other words, we cannot tell by looking at this map which of the red or orange HUCs (45 - 75% Ag+Urb) has the largest areal quantity of Ag+Urb riparian buffer.

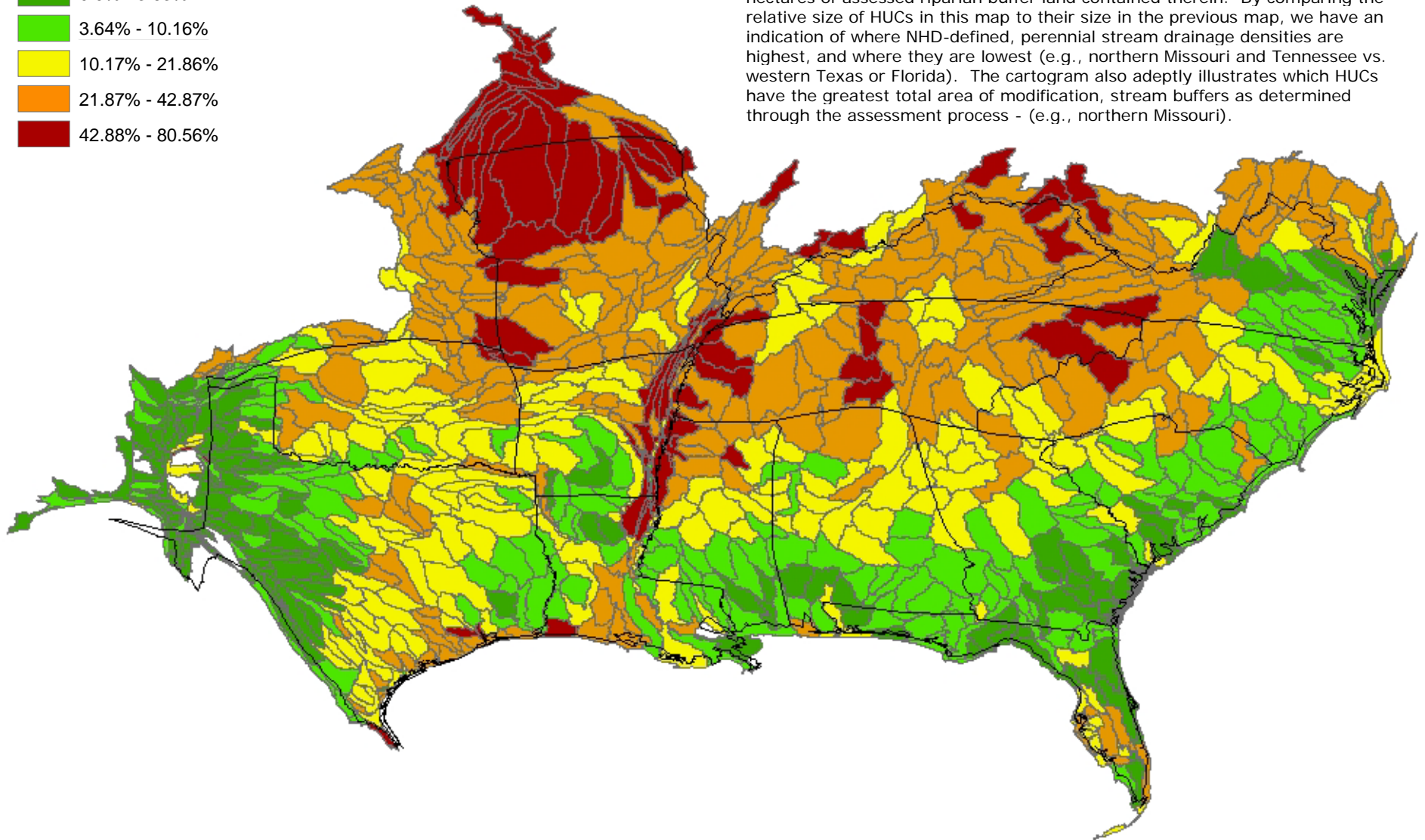


Map G. Visualizing Modification by Summing Local Reach data to the 8-digit HUC Spatial Unit.

8-digit HUC Percent Ag+Urb Cartogram



This cartogram transforms the physical size of each HUC to represent the total hectares of assessed riparian buffer land contained therein. By comparing the relative size of HUCs in this map to their size in the previous map, we have an indication of where NHD-defined, perennial stream drainage densities are highest, and where they are lowest (e.g., northern Missouri and Tennessee vs. western Texas or Florida). The cartogram also adeptly illustrates which HUCs have the greatest total area of modification, stream buffers as determined through the assessment process - (e.g., northern Missouri).



Map H. Cartogram: Weighting size of the HUC based on total hectares of riparian buffer within HUC.

Validation

The concrete and tangible nature of a map makes it easy to forget that every map is a model - an abstraction of reality. Several important issues and relevant questions must be considered when evaluating the results and applying these data. Are the estimated values of % Ag+Urb riparian land cover accurate and reproducible? How much error is inherent in this analysis, and how does scale and intended application influence a user's level of tolerance for error? Are the errors randomly distributed throughout the Southeast, or are they concentrated in particular areas?

The prospect of evaluating the accuracy of riparian buffer land cover estimates across the entire SARP region poses a variety of issues. An obvious issue is the scope of the analysis. It is logistically infeasible to visit a statistically valid sample of the assessed stream reaches in the field to obtain reference (ground-truth) data used to evaluate the accuracy of the 2001 NLCD and the riparian buffer estimates. For example, inspecting only 1/10th of 1% of the assessed reaches, randomly distributed throughout the region, would require the visitation and inspection of ~2,000 reaches. Doing so in 2011 would risk identifying land cover change, or failing to identify an error because of change in land cover (i.e., both Type I and Type II errors) that have occurred since the 2001 data were generated. For example, consider a riparian buffer that was denuded of vegetation by livestock in 2001 when the NLCD imagery was captured, that had since been converted back to native vegetation due to efforts to fence out livestock. If this reach was randomly selected for inspection, results from this area would incorrectly suggest the riparian assessment results based on the 2001 NLCD were incorrect. Even if such field visits were possible, the ability to objectively evaluate disturbance within a 30 meter buffer on either side of a stream poses a scale issue - the entire stream segment (in some cases many kilometers) must be assessed to verify the accuracy of the riparian buffer land cover estimates generated using our assessment approach.

The accuracy assessment of the 2001 NLCD is (according to EPA's website) still underway (<http://www.epa.gov/mrlc/accuracy-2001.html>; accessed Jan 11, 2011), but the assessment of the 1992 NLCD is complete. Information about the 1992 NLCD (mapping methodology and classification accuracy) including an extensive list of scientific publications is provided at the USEPA website at the following links:

<http://www.epa.gov/mrlc/nlcd.html>

<http://www.epa.gov/mrlc/aa.html>

The reported accuracy of the 6 Ag+Urb land cover classes in the 1992 NLCD for Regions 4 and 6 (southeastern and south central US) was 86.8%. The USEPA reports an expectation for improved accuracy for the 2001 NLCD (see Vogelmann et al. pdf available at <http://www.epa.gov/mrlc/nlcd-2001.html>).

Information on the development and accuracy of the high-resolution National Hydrography Dataset can be obtained at: <http://nhd.usgs.gov/index.html>

Analysis of this data set has yielded riparian disturbance estimates that are effectively constrained by the underlying classification accuracy of these two data sets. The low overall percent of open water (Class 11) in the assessment summary statistics, and the relatively low proportion of streams that were unassessed due to $\geq 10\%$ water in the buffer are

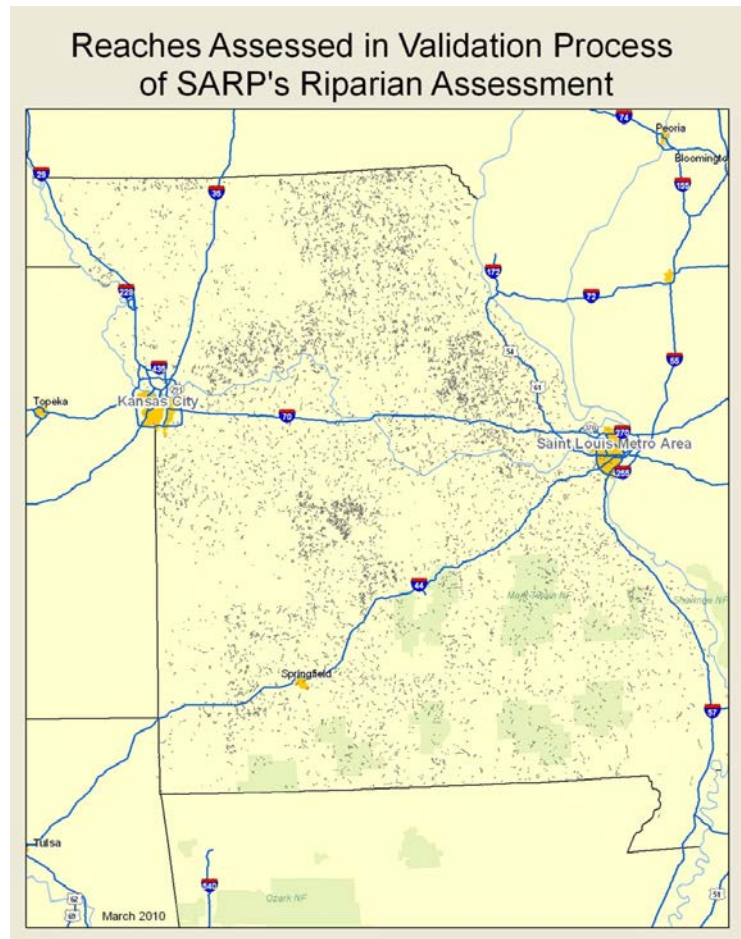
indicators of a high degree of spatial congruency between the 2001 NLCD and high resolution NHD.

Evaluating the Effect of 30 meter Vs. 60 Meter Riparian Buffers

One source of data identified for use in cross-validating our results and evaluating the effect of a larger buffer width was a dataset generated by the Missouri Resource Assessment Partnership (MoRAP) that estimated % Ag+Urb in riparian buffers on streams throughout Missouri. The MoRAP assessment examined the same land cover dataset (2001 NLCD), and considered the same land cover classes as Ag+Urb.

Unlike our 30 meter buffer assessment, however, MoRAP examined 60 meter buffers, and used a improved version of the 1:100K NHD. To ensure that results from near-identical reaches would be compared, we first paired up all stream reaches and filtered out all reaches that differed in total length by more than 10%. This step did filter out many reaches from the analysis, yet the spatial coverage of paired reaches is widespread and uniform across the state (see Map I.).

The difference in buffer width (30 meter vs. 60 meter) used in both analyses provided an interesting opportunity to examine how assessment results might differ based on this variable. Indeed, the buffer width selected in our assessment was debated during the planning phase, and concerns were raised that a 30 meter buffer might be too narrow considering the resolution of the 2001 NLCD (i.e., a 30 meter pixel). Nevertheless, the SAHP targets specifically identified a buffer area of 100 feet (30 meters), and we decided to analyze the NLCD at the finest resolution available.



Map I. Paired reaches selected for the comparative analysis.

To compare results of both assessments we simply summarized the difference in % Ag+Urb areas assigned to paired stream reaches from the MoRAP and SARP analyses. Figure 2 illustrates the frequency distribution of reaches by the difference in % Ag+Urb areas. Remarkably, of the thousands of paired reaches, nearly all had estimates of riparian disturbance within 20% correspondence; most had disturbance within 10% difference.

This analysis does not in any way validate the accuracy of the disturbance percentages estimated by the assessments with respect to actual on-the-ground land cover, but it does

allow us to compare the results generated using our GIS methodology to those generated independently. The high comparability with the MoRAP results suggest that our methods effectively extracted and summarized the land cover data in a fashion similar to the MoRAP approach. It also suggests that the use of a 30 meter buffer versus a 60 meter buffer does not create a problem.

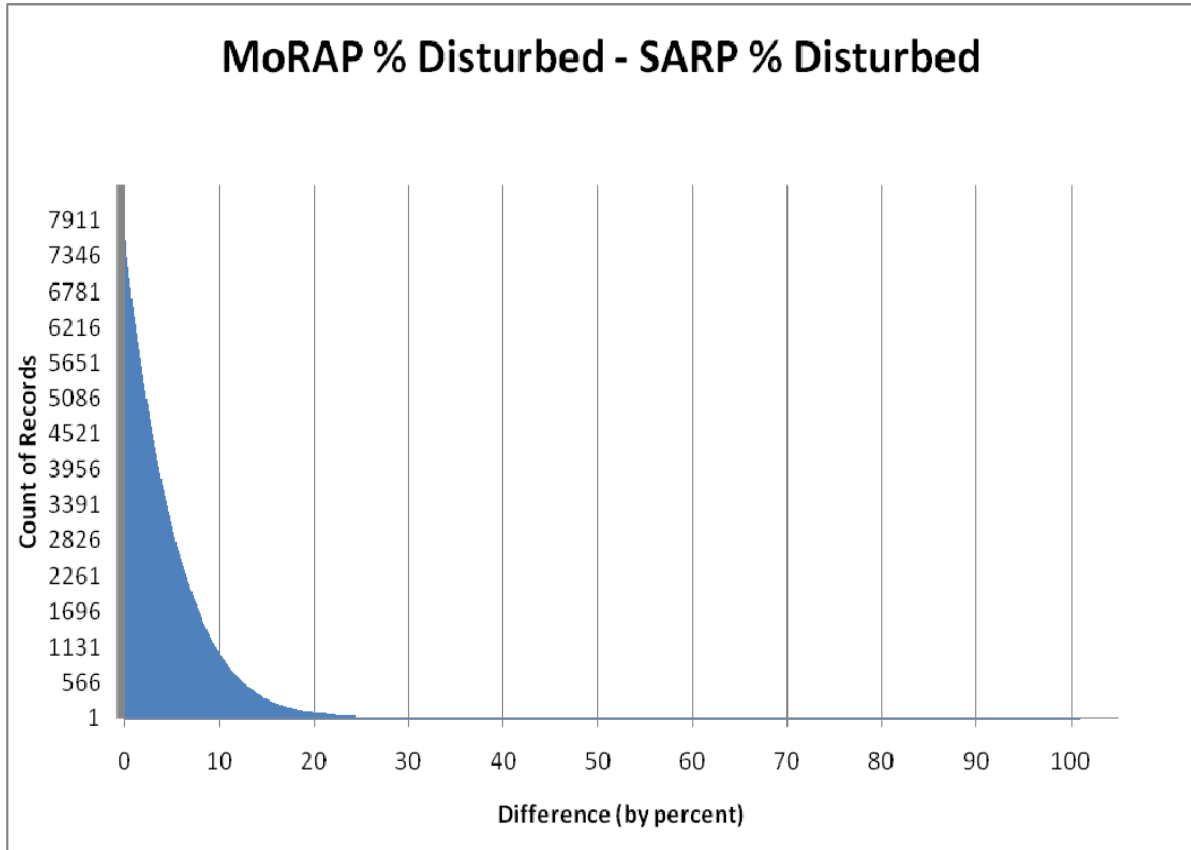


Figure 2. Comparison of MoRAP approach and SARP approach.

Data Availability and Potential Applications

Data Availability - How and Where Data can be Accessed

The National Hydrography Dataset can be downloaded from the NHD FTP site. The geodatabases for the High Resolution NHD can be downloaded as pre-staged subregions or by state at: <ftp://nhdftp.usgs.gov/DataSets/Staged/>

To learn more about the NHD, go to their website: nhd.usgs.gov

The 2001 National Land Cover Dataset can be downloaded from the Multi-Resolution Land Characteristics Consortium website.

http://www.mrlc.gov/nlcd_multizone_map.php

To learn more about the 2001 NLCD and other MRLC products, go to:

<ftp://nhdftp.usgs.gov/DataSets/Staged/>

To obtain the data created in this assessment, contact SARP (sarp@southeastaquatics.net).

Potential Applications

Quantifying change over time toward target achievement

This assessment provides a baseline estimate from 2001 of the quantity of Ag+Urb riparian buffers throughout the SARP region. We have generated estimates of the number of riparian hectares that must be restored in order to meet targets in the SAHP, and have developed and documented an approach to the extraction and analysis of land cover data across the region that can be applied to future data sets as they become available. These are important accomplishments that provide the foundation necessary for tackling Objective 1 of the SAHP.

Strategic habitat conservation of riparian buffers

This database may be used to help identify areas best suited for riparian restoration, areas most in need of protection, and areas where riparian restoration is a weak investment. To address these goals, we should consider the need to ecologically reference or standardize the riparian results using available biological data. What is the relationship between % Ag+Urb riparian land cover and fish habitat? Do agricultural and urban riparian land cover have different impacts (either type or intensity) on fish habitat? Which metrics are available that reflect the integrity of fish habitat at the stream segment (reach) scale? Is the relationship between % Ag+Urb and fish habitat integrity linear or otherwise? How do these relationships change across freshwater ecoregions or physiographic provinces? How do the answers to these questions inform the use of the riparian assessment results to guide restoration of stream buffers and decision making?

Contribution to the national assessment (NFHAP)

The current nationwide assessment of fish habitat does not include an assessment of riparian buffer condition, and utilizes the medium resolution National Hydrography Dataset. Our efforts to develop GIS models and an approach to this assessment can relatively easily be shared among partnerships and with the national assessment team to incorporate/adopt if deemed appropriate. Considering the sheer magnitude of the SARP area, a portion of the assessment of riparian buffers for the entire nation is now complete.

Future Analyses

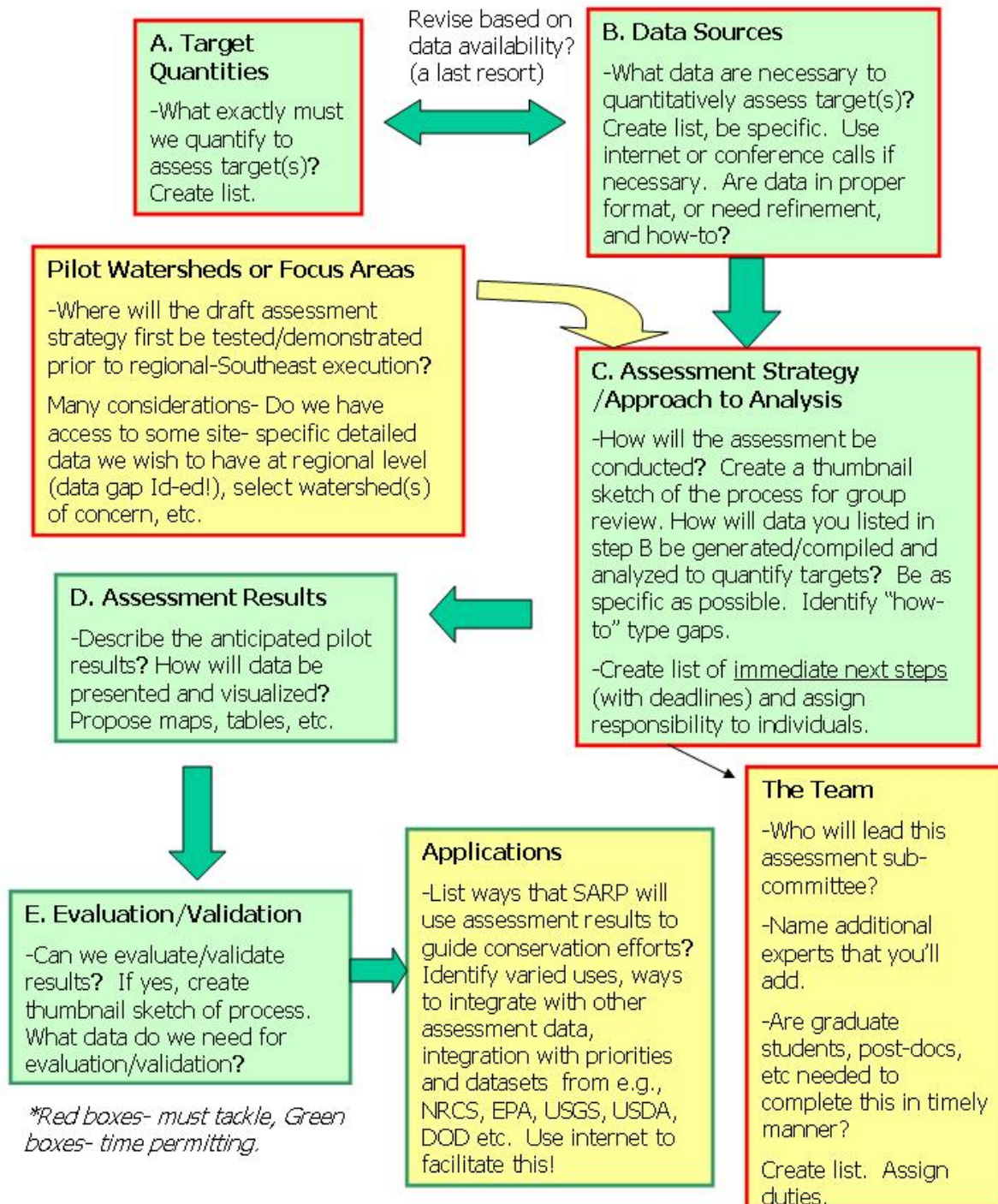
This report only scratches the surface in terms of the variety of analyses that could to be conducted using the riparian assessment results. We expect that readers/users will generate specific questions that require data mining and extraction at a variety of spatial scales, from states to watersheds to stream segments. These tasks can be accomplished by viewing the data on an internet mapping application soon to be released, by connecting to geospatial services through ArcGIS, or by contacting SARP to receive a copy of the geodatabase.

Appendices

Appendix A – Habitat Assessment Process conceptual flowchart

Assessment Objective: _____

Principal Steps of the Assessment Process



Appendix B - Intermittent, Perennial, and Artificial Path Flowlines

Data Standards for Stream/River Classification in the High Resolution NHD

Feature Delineation

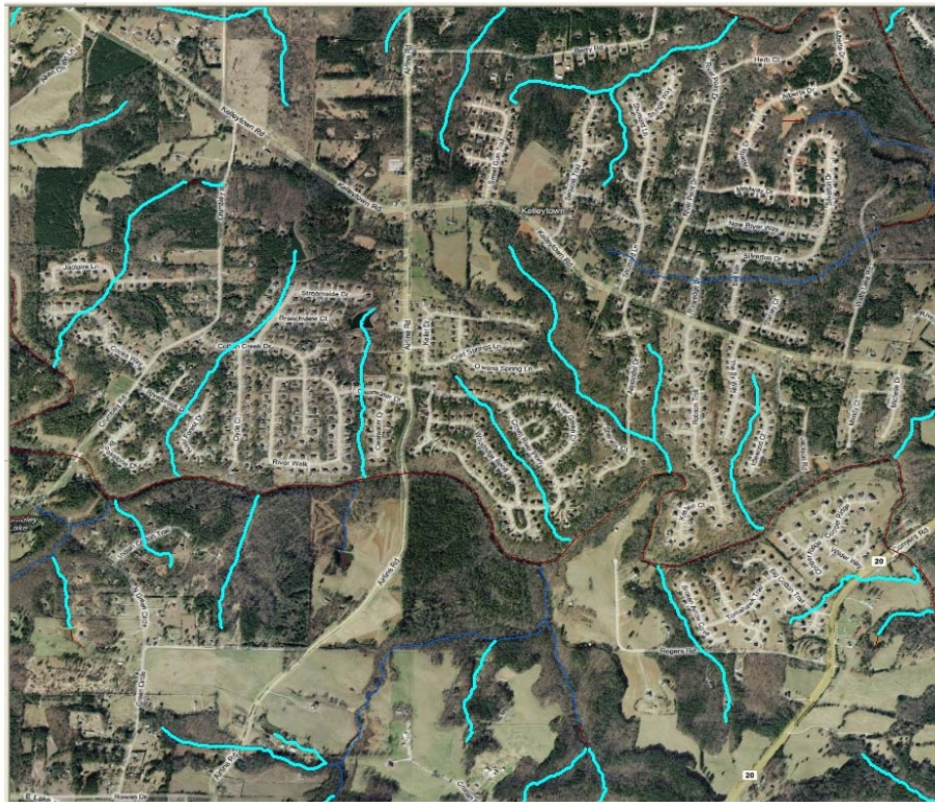
- Upper limit of feature is where feature first becomes evident as a channel
- Boundary or feature where it enters the Sea or Ocean is where conformation of land and water makes the division obvious, or where the stream reaches a width of 1 nautical mile with no further constrictions
- Boundary of the feature where it enters or leaves a Lake/Pond is determined by conformation of the land

Representation of the feature

- The feature is represented as a line if the width of the channel measures less than 0.025" on the aerial photo, or 50 linear feet
- The feature is represented as a polygon if the width of the channel measures greater than or equal to 0.025" on the aerial photo, or 50 linear feet

Visualizing differences in NHD feature classifications

The following series of images illustrates the difference between stream line segments classified as intermittent, perennial, and artificial path flowlines. Although several artificial flowlines appear in Map J, those associated with polygon shapes in the dataset (i.e., the stream channels >50 feet wide) were included in the assessment.



Map J. Illustrates flowlines classified as intermittent (light blue), perennial (dark blue), and artificial path flowlines (red).

Changes Over Time

Map K clearly illustrates the distinction between artificial paths in red, intermittent stream channels in light blue (not included in the assessment), and perennial stream channels in dark blue (those assessed). Note the red artificial flowline in yellow box.



Map K. Illustrating changes over time using aerial photography and NHD.

Map L was taken from currently available Google Earth imagery, and represents the area within the yellow box above (Map K). Note that the small, red artificial flowline within the yellow box in Map K accurately represents an impounded reach of this small stream. To the east, however, a new impoundment has been built (post high-res NHD development) as is shown within the yellow box in Map L. In the NHD, this segment was classified as an intermittent stream.

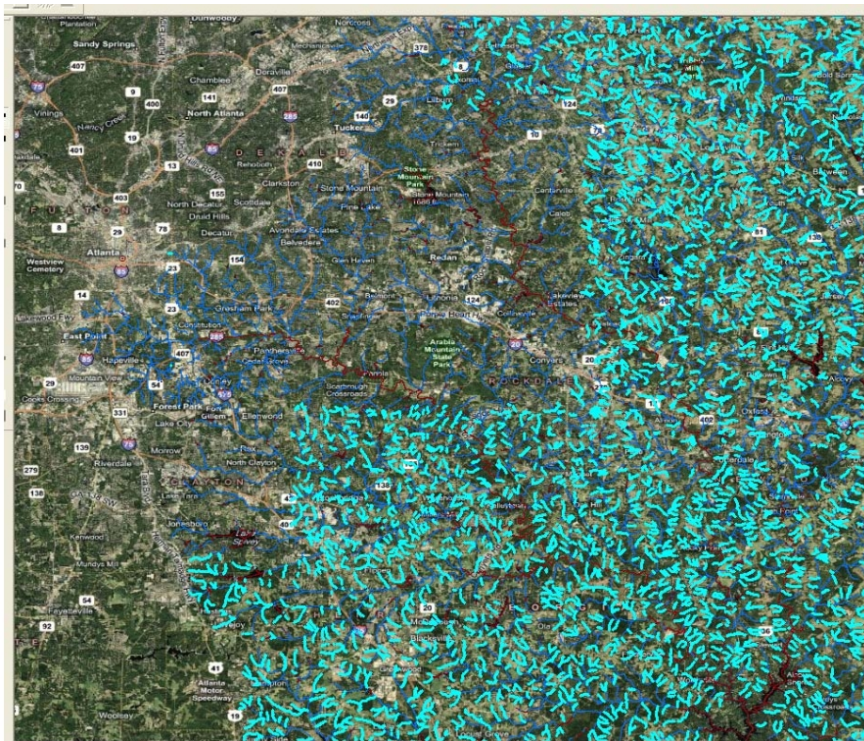


Map L. New impoundment not found in NHD.

Exclusion of Intermittent Streams

Given the apparently large number of intermittent stream channels, why did we choose to exclude this class of streams from the assessment?

Intermittent streams are those that do not hold water throughout the year, thus, would not support a stable community of aquatic biota. The NHD high resolution dataset was prepared by a large group of data stewards; as a result, some inconsistencies in terms of drainage density (i.e., stream networks) are apparent throughout the region. The patterns suggest that drainage density was influenced by the decisions made by different data stewards to either include or to exclude small channels in the intermittent stream class (an effect that is mostly confined to the very narrow and extremely numerous headwater channels). Given the inconsistency in coverage, the lack of aquatic habitat for part of the year, and the magnitude of reaches, we chose to exclude intermittent channels from our analyses to prevent introducing undue bias in the assessment. See Map M for an example of this issue.



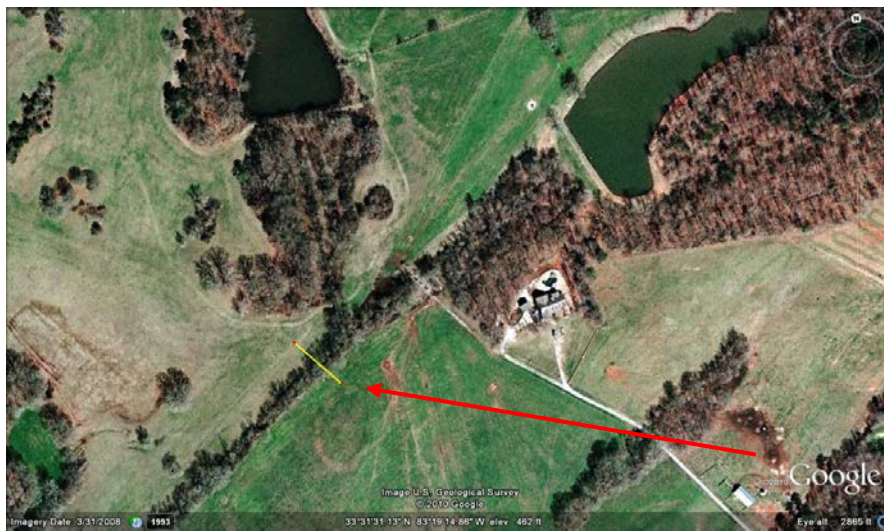
Map M. Exclusion of Intermittent Streams.

In the northwest corner of Map M is the city of Atlanta. To the immediate east, a network of perennial channels (in dark blue) appears in the NHD. Farther east and south, however, a large number of intermittent channels (light blue) appear. Why aren't these channels also found adjacent to Atlanta? As the following image illustrates, it seems most likely that different data stewards working on neighboring quadrangle maps chose to digitize and classify intermittent channels quite differently (colors reversed - perennial streams in light blue and intermittent in dark blue). The patterns are strongly related to the artificial grid representing the quadrangle maps used to produce the NHD.



Map N. Intermittent Streams and USGS Quad Grids

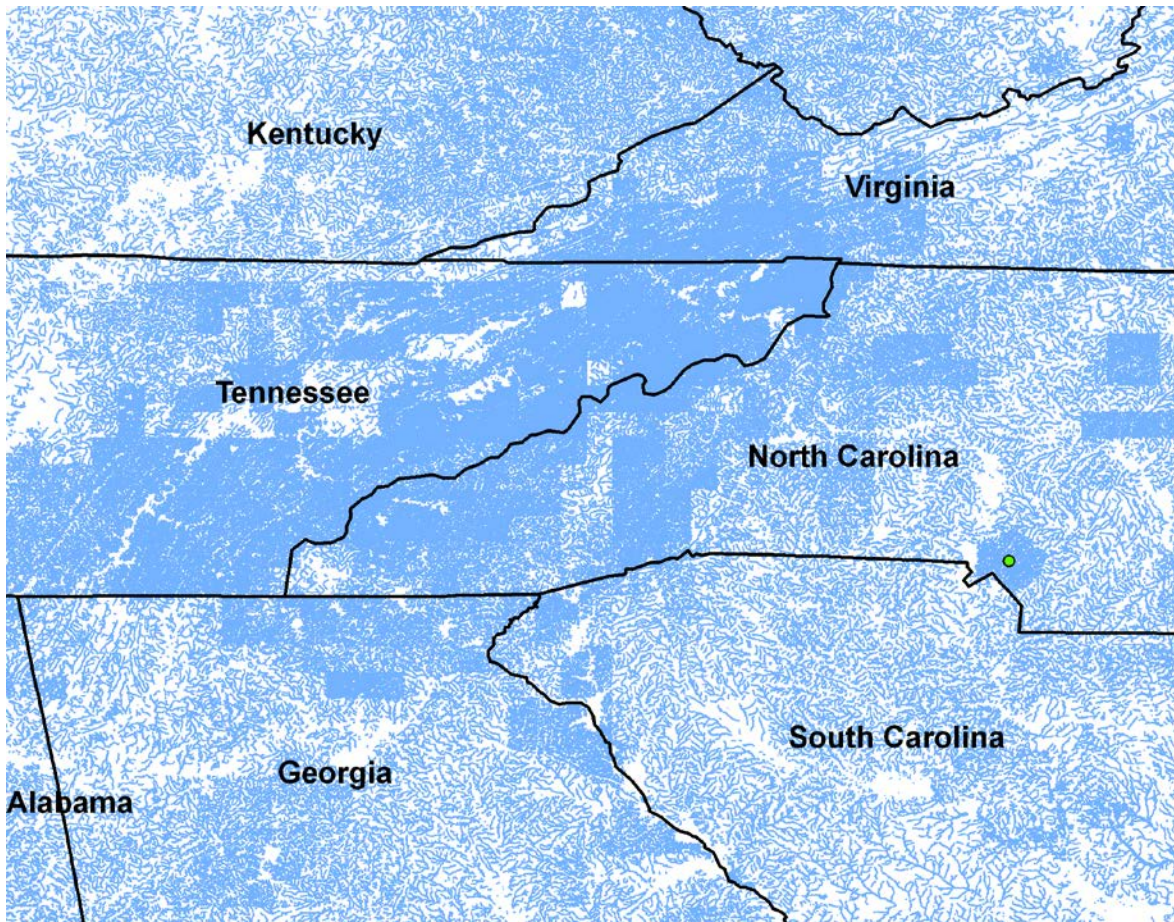
Returning to the area outlined in the yellow box in Map K - The small intermittent channel that drains the two impoundments runs southwest through a narrow strip of trees. The natural buffer here is much less than 30 meters per side, thus, this channel would likely be assessed as a high percentage of Ag+Urb if included in the overall assessment. (Line drawn is 60 meters across).



Map O. Effect of exclusion of some intermittent streams.

Thus, the inclusion of intermittent channels in the assessment would introduce tremendous regional biases due to the inconsistent digitization of these channels.

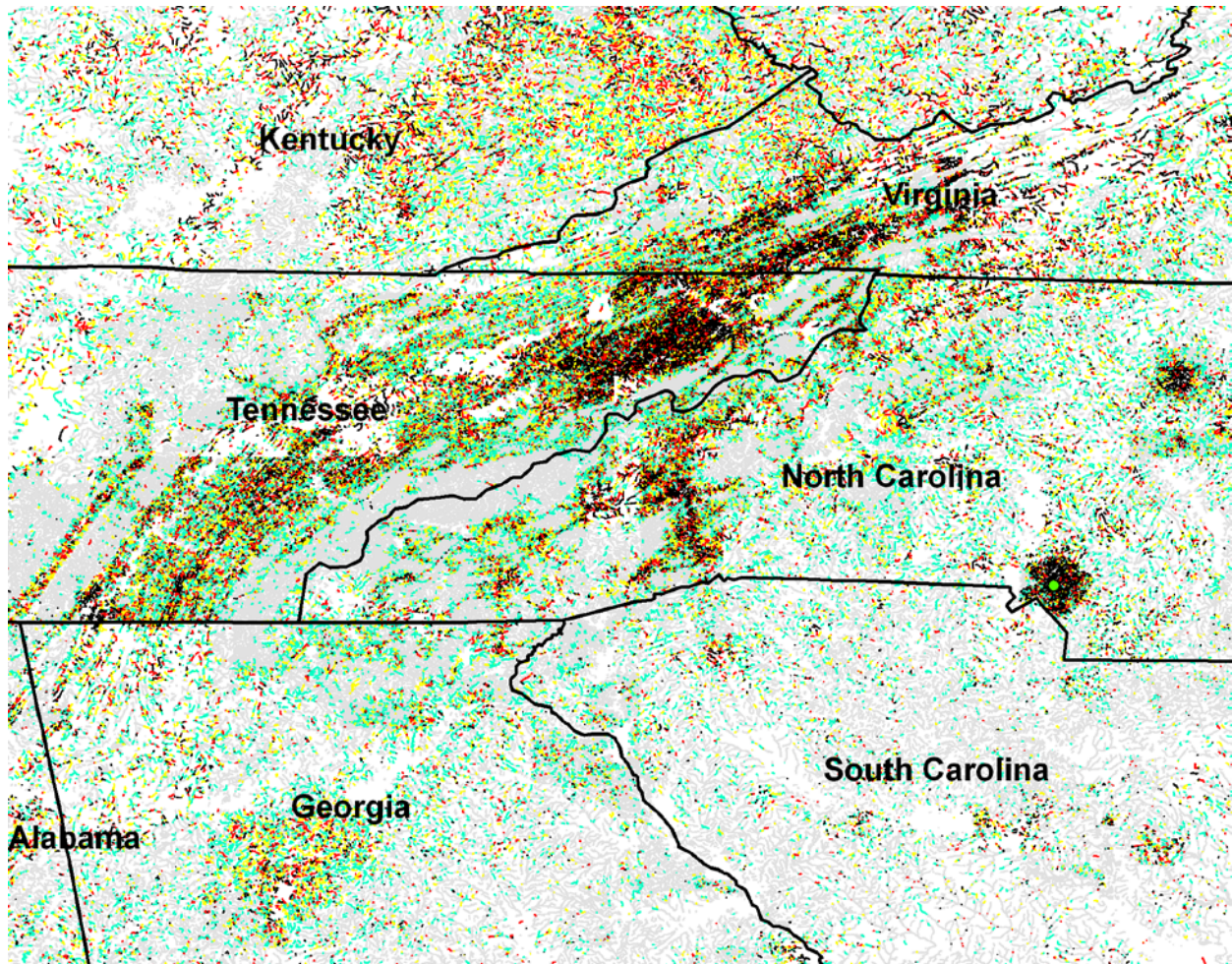
Despite our efforts to minimize bias in the assessment by excluding intermittent stream channels, we still encountered a measure of cartographic inconsistency among regions at the level of perennial stream channels. These inconsistencies must be taken into account when interpreting and working with the assessment data, and lead to one of the largest caveats to be addressed.



Map P. Illustrating inconsistencies in perennial stream density caused by NHD data stewards.

The map above (Map P) portrays all assessed stream and river segments in blue. Why should eastern Tennessee have such a higher perennial stream drainage density than just across the border in Georgia? Why do some high density areas appear as blocks of blue on the map? Again, we have the problem of inconsistency among data stewards leading to higher than average drainage density in certain places. This effect on assessment results can be striking and must be taken into account. Not surprisingly, some of the high drainage density areas that were “liberally digitized” are the same areas that display prominently as areas that have high levels of riparian disturbance. This may be because the additional streams included in the NHD may have been small, intermittent channels and mistakenly included in the perennial class. It seems plausible many of these are subject to high levels

of disturbance (as several of our previous image examples have demonstrated). Let's have a look at the disturbance intensity of this area in Map Q.



Map Q. Variation in stream density and how it can affect interpretation of disturbance intensity.

It is now possible to visualize the effects of NHD inconsistencies on the results of the riparian assessment. The area in northeast Tennessee, for example, seems more modified than the metropolitan Atlanta area most likely because a high number of very small channels were assessed in northeast Tennessee, but not in the Atlanta area. A similar effect appears to explain the high level of modification in the metropolitan Charlotte, North Carolina region. Notice that this area has a higher density of flowlines than its adjacent areas, and shows a high degree of riparian disturbance.

Appendix C – Steps to Prepare Land Use Raster for Riparian Assessment

Steps to Prepare Land Use Raster for Riparian Assessment Model

1. Use detailed 4-digit HUC/Subregion as area boundary or feature mask data
2. Use the Extract by Mask tool
 - a. Input raster is the landcover raster
 - b. Input raster or feature mask data is the 4-digit HUC/Subregion
 - c. Under Environments > General Settings > Snap raster to original dataset
3. If the 4-digit HUC (or your study area) falls in more than one land cover image:
 - a. Extract each one by mask
 - i. Mosaic to New Raster tool
 - ii. Cellsize = 30
 - iii. Mosaic Method - Minimum
 - iv. Environments > General > snap raster to original land cover raster
 - v. Convert 30 meter land cover to 5 meter cells
 - vi. Spatial Analyst > Options
 - vii. Extent tab > same as new extracted 30m land cover
 - viii. Cell size tab > cell size as specified below, 5m cells
4. Raster Calculator > % new 5 meter land cover name% = new extracted 30m land cover
 - a. Evaluate

Steps to Run Riparian Assessment Model for Line Features

1. Input the NHDFlowline feature class from the NHD geodatabase
2. Input the land cover raster (produced in Steps to *Prepare Landcover Raster for Riparian Assessment Model*)
3. Select a buffer width
 - a. This model uses 30 meter riparian buffers.
4. Name the Rivers/Streams Output, which will have the flowline geometry/attributes and the raw riparian buffer land cover output at the end of the model.
 - a. It is suggested that these outputs have their own folder separate from the other outputs.
5. Name the output that represents the 30 meter buffer area.
 - a. It is suggested that these outputs have their own folder separate from the other outputs.
6. Name the table output from the Tabulate Area process.
 - a. This table will be joined to the final output feature using the FID field.

Model Builder Tools

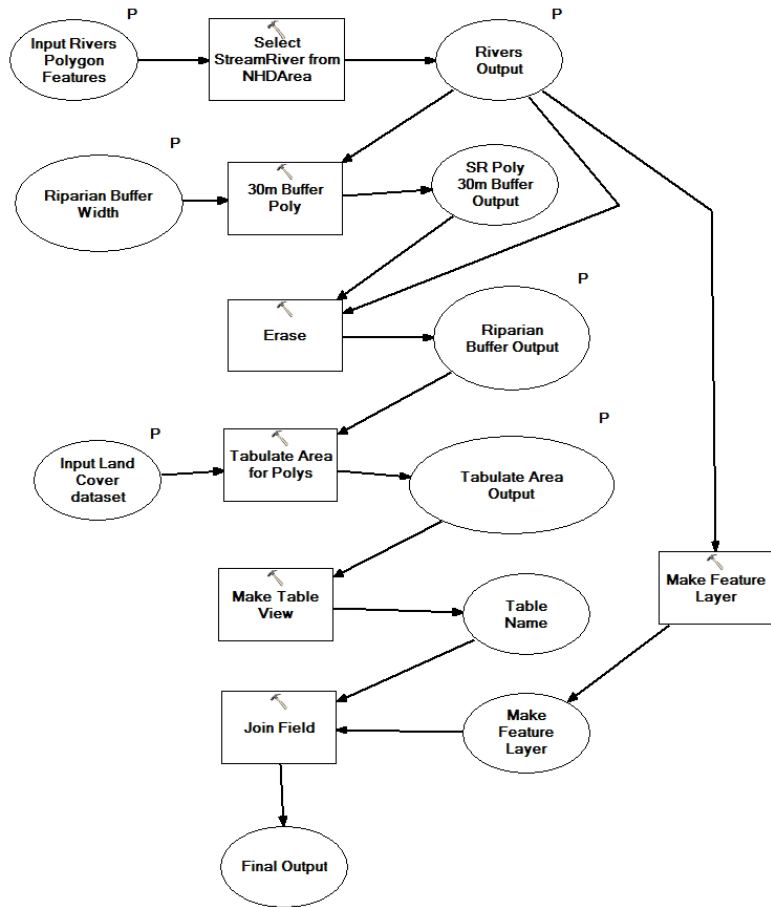


Figure 3. SARP's Riparian Assessment Model for Lines

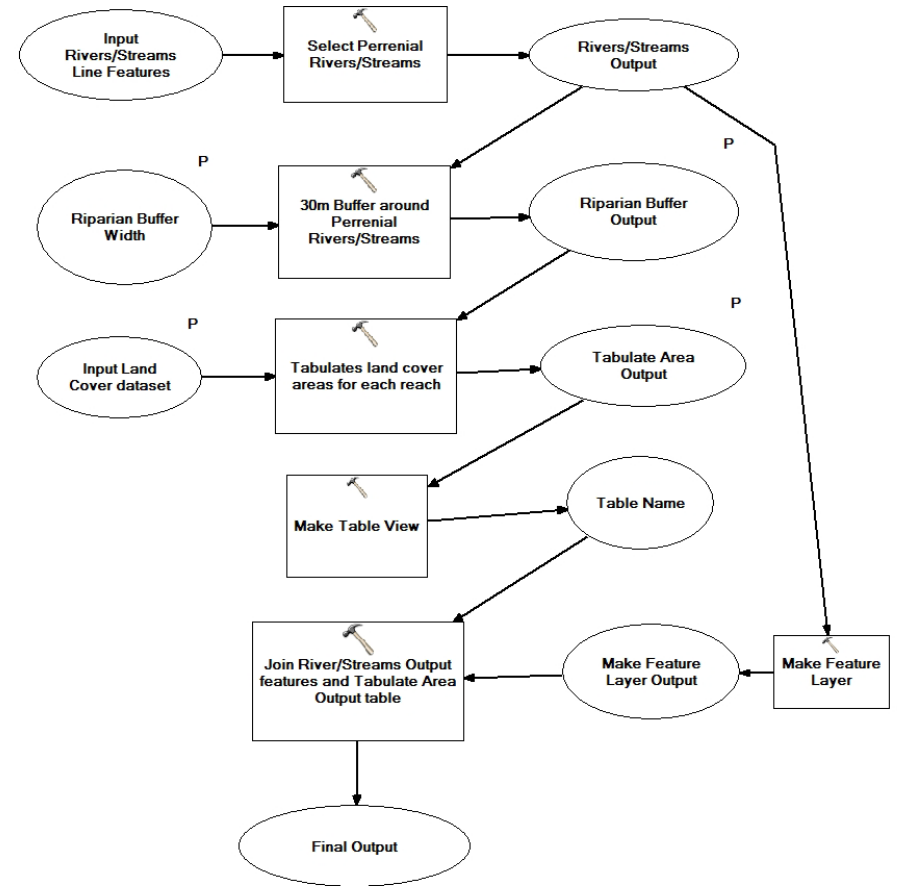


Figure 4. SARP's Riparian Assessment Model for Polygons

Table 3. Data Dictionary

| Field | Definition |
|-------------|---|
| COMID | Uniquely identifies the occurrence of each feature length |
| Fdate | Date of late feature modification |
| Resolution | Code for Source resolution, 1=Local resolution,2=high resolution,3=medium resolution |
| GNIS_ID | Unique identifier assigned by GNIS |
| GNIS_Name | Proper name, specific term, or expression by which a particular geographic entity is known |
| LengthKM | Length (in kilometers) in Albers Equal Area |
| ReachCode | Unique identifier, first 8-digits = HUC8 Code, next 6 digits are randomly assigned sequential numbers within a cataloging unit |
| FlowDir | Direction of the flow relative to coordinate order |
| WBAreaCOMI | COMID of the waterbody through which the flowline (Artificial Path) flows |
| Ftype | Three digit integer type value unique to a feature (in this assessment, it will be 460-River/Stream) |
| Fcode | Five digit integer value comprised of a feature type and a combination of characteristics and values (in this assessment, all will be 46006 - perennial River/Stream) |
| | |
| Value_11 | hectares of Open Water Class |
| Value_21 | hectares of Developed, Open Space Class |
| Value_22 | hectares of Developed, Low Intensity Class |
| Value_23 | hectares of Developed, Medium Intensity Class |
| Value_24 | hectares of Developed, High Intensity Class |
| Value_31 | hectares of Barren Land Class |
| Value_41 | hectares of Deciduous Forest Class |
| Value_42 | hectares of Evergreen Forest Class |
| Value_43 | hectares of Mixed Forest Class |
| Value_52 | hectares of Shrub/Scrub Class |
| Value_71 | hectares of Grassland/Herbaceous Class |
| Value_81 | hectares of Pasture Hay Class |
| Value_82 | hectares of Cultivated Crops Class |
| Value_90 | hectares of Woody Wetlands Class |
| Value_95 | hectares of Emergent Herbaceous Wetlands Class |
| TotalLand | Sum total of fields: Value_21, Value_22, Value_23, Value_24, Value_31, Value_41, Value_42, Value_43, Value_52, Value_71, Value_72, Value_81, Value_82, Value_90, Value_95 (in hectares) |
| Perc11 | Percentage of Open Water found within the Riparian Buffer: $[(Value_11) / (Total_Land)] * 100$ |
| PercDisturb | Percentage of Ag+Urb Riparian: $[(Value_21 + Value_22 + Value_23 + Value_24 + Value_81 + Value_82) / (Total_Land)] * 100$ |
| HUC4 | 4-digit HUC that the feature is found in |
| HUC8 | 8-digit HUC that the feature is found in |
| | |
| | Attribution from High Resolution National Hydrography Dataset |
| | Attribution from SARP's Riparian Assessment |

Appendix D - Why Open Water Appears in Riparian Buffers

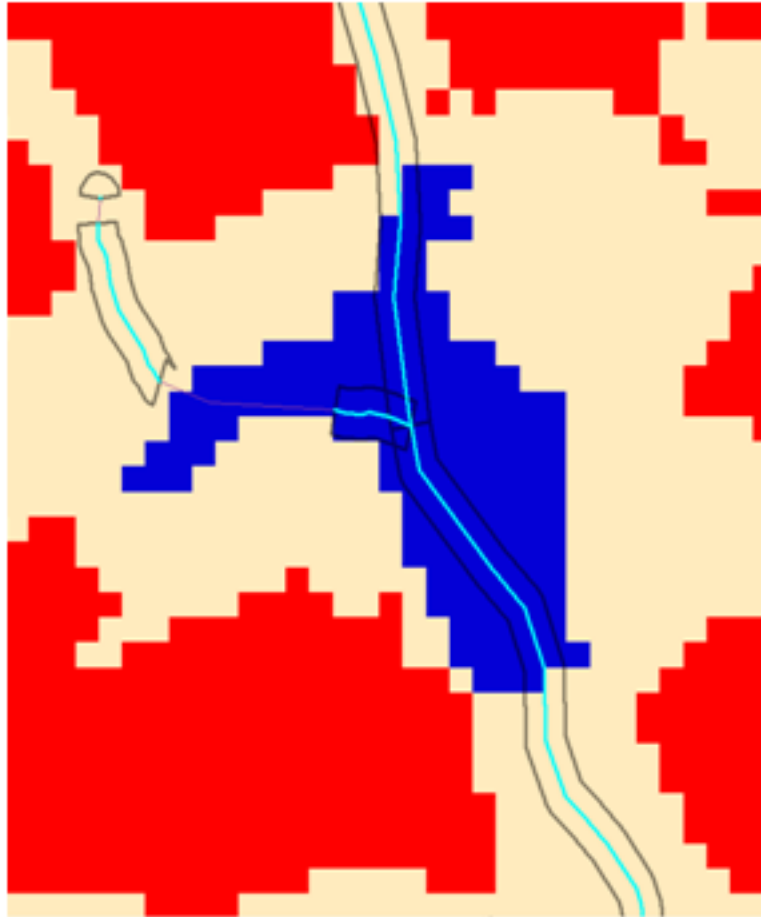
The High Resolution National Hydrography Dataset (High Res NHD) is a standardized dataset that represents hydrography data at the 1:24,000 scale. Its level of detail and data-rich attribution make it a valuable dataset when representing the Nation's existing aquatic infrastructure. The 2001 National Land Cover Dataset provides the Nation with nationally complete, current, and consistent public domain information on the Nation's land use and land cover.

These two datasets were created independently, using slightly different sources, approaches, and personnel; therefore, we expected to find inconsistencies when conducting integrated overlay spatial analyses. For example, in some cases flowlines representing "old" streams in the NHD have recently become impounded or channelized, but were not updated in the dataset (Figure 1). In the 2001 NLCD, the impoundment is represented as a land use class called Open Water. So when the "old" stream feature overlaid on the 2001 NLCD, the inconsistency between the 2 datasets can be visualized (Figure 2). In such cases, when a 30 meter buffer is generated around the flowline to represent the riparian corridor and the land use types are tabulated within the buffer, pixels representing Open Water will be found within the buffer.



Map R. Illustrating Open Water within buffers using aerial photography

In Map R, the blue flowline, representing an "old" stream channel is surrounded by a 30 meter buffer (black lines). A recent impoundment is shown in the aerial photography. Note that a portion of the western branch of this stream system was correctly classified as a impounded reach, and thus did not receive a buffer.



Map S. Illustrating Open Water within buffers using land cover data.

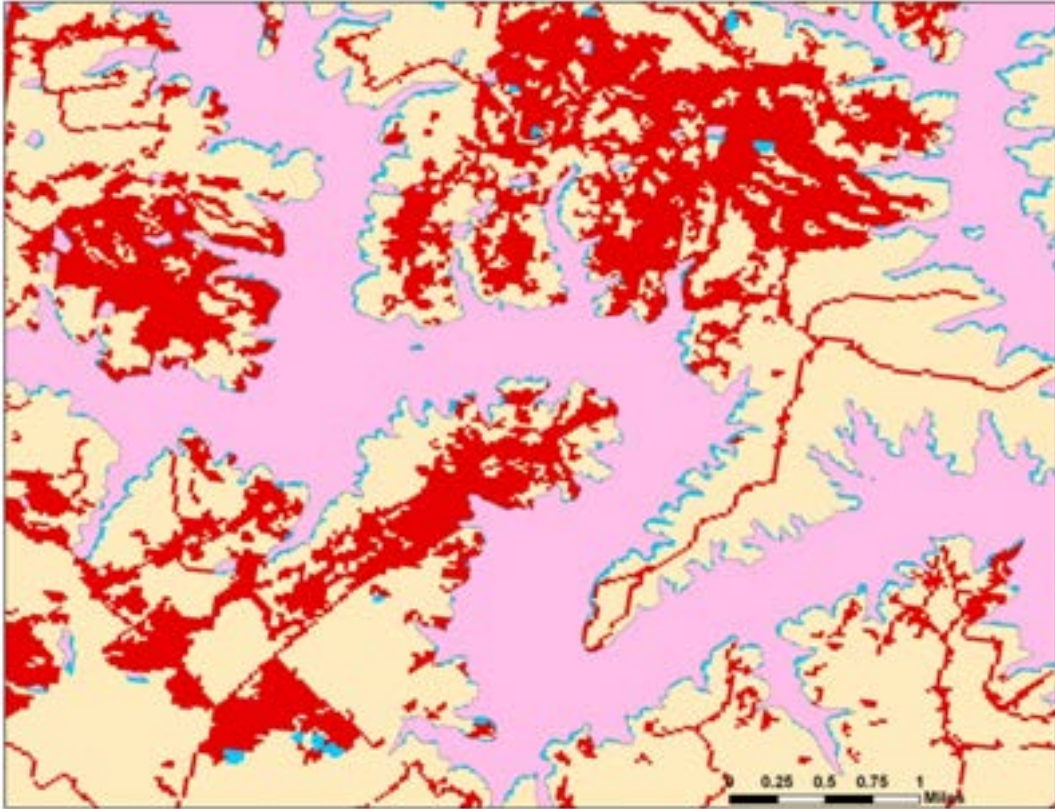
Using the same geographic extent as Map R, the impoundment in Map S is represented as 30 meter Open Water cells in the 2001 NLCD.

Since the 2001 NLCD is a somewhat coarse dataset for the entire nation, it generalizes land cover across the landscape using a 30 meter cell grid pattern. As a rule, cells are assigned the majority land use value. For example, if a cell is 50.1% forested and 49.9% open water, then the cell is assigned the forested land use value. Because the dataset assigns generalized land use values to cells and since the grid pattern in the dataset does not follow the smoothness of some features on the landscape, there will be some cells that “extend” land use types past their natural edge on the landscape. See Figures 3 and 4 for examples of this situation.



Map T. Open Water in buffers from over extended raster cells.

In Map T, the grey areas represent the riparian buffer around the streams and rivers. Open Water cells can be identified as blue square in the raster layer. The light blue lines and polygons represent stream channels and river edges from the High Res NHD. If you look closely, you can see where Open Water cells (small blue pixels) appear within the grey buffer.



Map U. Spatial congruency of High Resolution NHD and 2001 NLCD.

In Map U, the reservoir is represented as the pink polygon on top of the 2001 NLCD. The polygon accurately represents the natural edge of the reservoir at average pool. Blue Open Water cells appears around the outside of the reservoir polygon.

When conducting a riparian analysis, it is important to have accurate land use types depicted within the riparian area. In our analysis, we accounted for Open Water data within the riparian area by not including it in our Total Land Area Formula and Percentage Ag+Urb Formula. We also calculated the percentage of Open Water within each riparian area. If the total percentage of Open Water was $\geq 10\%$, then the reach was excluded from the overall summary statistics and marked as “unassessed” within the dataset. We plan to follow up on “unassessed” reaches in later iterations of the SARP Habitat Assessment.

Habitat Assessment Committee Members

- ▶ Mark Cantrell – USFWS
- ▶ Will Duncan – USFWS
- ▶ Mary Davis – TNC
- ▶ Dan Everson – USFWS
- ▶ Ryan Smith – TNC
- ▶ Mark Sramek – NOAA
- ▶ Scott Robinson – SARP
- ▶ Roger Pugliese – South Atlantic Marine Fisheries Council
- ▶ Jason Duke - USFWS
- ▶ Emily Watson – USFWS
- ▶ Adam Kaeser, Chair – GA DNR