

NCDENR  
Division of Water Quality  
SAV Ground-Truthing Study 2007

## **OBJECTIVE**

Submerged aquatic vegetation (SAV) has been found to be an important primary producer in shallow coastal environments and estuaries. The North Carolina Marine Fisheries Commission has by rule [15A NCAC 31 (20)] designated SAV as a critical habitat in coastal waters. The EPA Region 4 funded a collaborative study with DWQ and NOAA in 1998 that characterized and mapped SAV in the Neuse River. Results indicated a diverse range of SAV along the Neuse and Tar-Pamlico River main stems in shallow, low energy areas ([DWQ, 1998](#)). DWQ staff has compiled and completed three years of SAV survey data. In concert with the goals of the Coastal Habitat Protection Plan, these data will be available for public use through DWQ's website, and will serve as an important tool in the permit review process across multiple agencies, resulting in potential habitat protection.

The 2007 study was a continuation of the 2005-2006 SAV Ground-Truthing Studies initiated during the summer of 2005. This report discusses the ground-truthing methods used, modifications considered, and lessons learned from SAV survey experiences in the western Pamlico Sound and its tributaries.

## **GROUND-TRUTHING METHODS**

The 2007 SAV inventory was conducted utilizing the Garmin 60Csx hand-held GPS. The tracking and marking capability allowed for a greater detailed description of the shorelines surveyed as well as provided the ability to notate waypoints upon observance of changes in SAV composition. Surveying started in May as SAV had begun to 'top out' on the surface waters, allowing for more accurate SAV bed location information and more efficient use of staff time and resources. A minimum of two survey personnel were used per boat. Sampling time was selected to include the combination of both low wind (less than 10mph) and high light to ensure good visibility. No precipitation within 24 hours of the area of study is recommended.

Boat and crew traveled from the starting location, probing for SAV along the shoreline with a garden rake. The rake was equipped with an extendable pole demarcated in increments of half meters. This eliminated the need for an additional depth pole and allowed for accurate depth measurements in shallow water. The garden rake was dragged across the bottom to determine the presence and abundance of SAV present at a specific site. The use of a garden rake also enabled staff to obtain additional information on bottom composition across the expanse of the shorelines. When the survey staff encountered SAV or changes in SAV composition a GPS coordinate was recorded on the field sheet and saved in to GPS memory. This memory also enabled staff to detail each individual trip at day's end by exporting the track from the GPS unit into Google Earth (MapSource also used). This would help avoid redundant subsequent trips ([Fig 1](#)).

The SAV collected during the inventory was removed from the end of the rake and identified by survey staff to genus and species. Unidentified SAV species were placed in plastic bags with a wet paper towel and stored in an iced cooler for identification at a later time. SAV Coverage was recorded as either sparse or dense. Sparse coverage was considered to be less than 50% coverage of the garden rake. Dense coverage was over 50% coverage of the rake. Experienced survey staff frequently noted additional density descriptions such as

moderate or very sparse, but in the interest of maintaining simplicity only dense and sparse were used in final data analysis.

GPS waypoints (coordinates) were recorded in decimal degrees. Waypoints recorded in the field ultimately provided SAV composition, bed dimensions, and location. The use of the GPS in conjunction with the field sheet allowed staff to record waypoints as 'beginning', 'end', 'start', 'stop', 'width', or 'turnaround'. Beginning/End recorded the physical location of the beginning and end of the entire sampling day. Therefore if a trip ended early due to weather conditions, staff had a position to begin once the weather improved. Start and Stop waypoints recorded the SAV bed length. Width marks were recorded every 500 meters to provide accuracy of a SAV bed location at its furthest extent perpendicular to the shoreline. A distance finder was used simultaneously with the GPS width marks to determine bed width. Finally, turnaround waypoints were collected when staff could no longer continue mapping due to constricted access, shallow channel depth, or SAV density (clogging of prop). Notes were made in the comments section as to whether SAV existed at the time of turnaround. Patches were defined in this study as one geographic point (latitude, longitude, and a width waypoint from the shoreline, usually less than 50 meters in length). All waypoints recorded with the GPS were handwritten on the field sheet.

Survey staff recorded the riparian vegetation type (if any) along the surveyed shorelines and made comments to any additional environmental conditions or location of ground control points. The collection of shoreline vegetation allowed for possible correlations between adjacent riparian wetlands and the presence or absence of SAV. These data should be considered ancillary, as there may not be sufficient data to make substantial conclusions on these correlations. To date, the participating survey staff has made no effort to further analyze the shoreline vegetation data. Comments recorded to the field sheet during the SAV inventory included information on location of marinas, sediment composition, or environmental conditions that may have appeared extraordinary at the time of the survey. This data is considered secondary to the SAV inventory, as no specific protocol was designed for data collection of this kind.

## **GROUND-TRUTHING MODIFICATIONS**

The SAV field data sheet and data collection was altered again in 2007 to reflect staff suggestions made after the first three years of ground-truthing. Two specific changes were made to meet the survey staff's requests to use the metric system and to create a shorthand version for recording SAV species to the field sheet. Both the width and depth data had been changed from measurements in feet to measurements in meters. This modification also permitted staff to collect data directly from the range finder, thereby avoiding errors with conversion calculations. The development of the SAV shorthand was created to provide survey staff a more rapid way for recording SAV species data ([Fig 2](#)). This aid to the collection methods has proved to be a more efficient use of staff resources and has made better use of limited space on the field collection sheet ([Fig 3](#)).

Survey staff anticipated that the stored data could be downloaded from the GPS into a spreadsheet after the workday was completed to further eliminate keying errors. No efficient means of data downloads were completed due to complications between Map Source (GPS software) and Microsoft Excel. Thus data was manually keyed into Microsoft Excel.

## **GIS METHODS**

The GIS methods were consistent with the methods used in "SAV Final Report 2006". A greater number of GPS points collected in 2007 enabled more accurate mapping of bed dimensions and locations. This allowed for

a more realistic SAV bed (polygon) area to be calculated. USGS topographic digital raster graphics ([DRG's](#)) were imported into ArcGIS. These are standard series, geo-referenced topographic maps, and were used for shoreline references during the digitizing process. The use of aerial photographic data from 1998 Digital Orthographic Quarter Quadrangles (<http://www.lib.ncsu.edu/gis/doqq.html>) were used when mapping staff encountered problems interpreting shoreline references, such as unmapped creeks and streams. The use of updated aerial imagery indicated shoreline movement in some areas. Staff will need to consider weighing the benefits of a widely-used topographic map (USGS) versus more updated, rectified aerial imagery.

Software complications between the tab-delimited files from Microsoft Excel 2000 and ArcGIS 9.0 would not successfully create a 'join' based on 'attributes' alone. Spatial joins were implemented to 'attach' point data closest in proximity to the nearest SAV bed polygon. The spatial join successfully merged the two sets of data based on their proximity to one another. Challenges using the spatial join were also noted, as some of the desired SAV species data were not entirely merged. This complication was overcome by cross checking and manually entering in the missing data. Staff will have updated programs of ArcGIS 9.2 and Microsoft Office 2003 by the spring of 2008, which will avoid this conflict in the future.

## RESULTS

The 2007 SAV ground-truthing data were digitized in ArcGIS for the Neuse River ([Fig 4](#)), Pamlico River ([Fig 5](#)) and their associated tributaries. The tributaries of the Neuse and Pamlico Rivers were surveyed during the summer of 2007 and predominantly consisted of shallow (less than 1 meter) beds within low energy areas of major waterbodies or in adjacent headwater systems. The winter of 2006 was mild, with very few prolonged cold snaps and freezing weather. *Zannichellia palustris* was found to be the first dominant SAV species to emerge from dormancy during late spring. This species is fast growing and can top out along the surface of headwater streams as early as April when the previous winter is mild. As temperatures increased, *Z. palustris* was eventually replaced by *Ruppia maritima* for the remainder of the growing season. Staff has observed this similar pattern of species succession in the SAV surveys of 2005 and 2006.

The 2007 SAV ground truthing surveys were initiated in early May. SAV had emerged and became very dense in headwater creeks as early as April. This may have been due to a mild winter. SAV species documented (Table 1) were similar to the previous year's surveys, with the exception of *Potamogeton perfoliatus*, *Vallisneria Americana*, and *Najas guadalupensis*. Although these species were not encountered in the 2007 SAV survey area, these species were routinely encountered during fieldwork unrelated to the survey.

Available SAV data was utilized by permitting agencies within the NC DENR. Survey and mapping staff are working with DWQ GIS specialists to develop SAV polygon shapefiles that will be available for public use through a link through DWQ's website. To date, several SAV data requests have been made by Division of Coastal Management, Division of Marine Fisheries, and DWQ Surface Water Protection on a per-site basis. These data requests have been fulfilled by the current Response Team survey and mapping staff, and were generally performed within one day.

Table 1. List of SAV observed during 2007 surveys.

Common Name	Genus	Species	Salinity Ranges (ppt)
Horned Pondweed	Zannichellia	palustris	0 - 10
Wild Celery*	Vallisneria	americana	0 - 10
Slender Pondweed	Potamogeton	pusillus	0 - 10
Southern Naiad, Bush Pondweed*	Najas	guadalupensis	0 - 10
Coontail	Ceratophyllum	demersum	0 - 10
Redhead Pondweed*	Potamogeton	perfoliatus	0 - 20
Widgeongrass	Ruppia	maritima	0 - 36

Taken from [Street et al, 2005](#)

\*These species were not accounted for during the 2007 SAV inventory, but had been noted as present outside the 2007 SAV survey areas.

### Neuse River Tributaries

The tributaries surveyed during the summer of 2007 were situated both along the northern shore and along the mouth of the Neuse River. One of the five Neuse River tributaries surveyed, an unnamed tributary east of Dawson Creek, is defined as small creek (< 3 miles of shoreline). A majority of this creek's shoreline is adjacent to wetlands with SAV beds along the entire shoreline with an average depth of 0.9 meters (Table 2). The mouth of this river was also narrow in comparison to most tributaries that join the Neuse River. This creek was surveyed earliest in the growing season where only *Zannichellia palustris* was observed.

Orchard Creek, Broad Creek, Bay River and Trent Creek are long in shoreline mileage. Staff surveyed over 6.5 miles of the Orchard Creek's shoreline towards the confluence with the Neuse River. Beds of *Ruppia maritima* were documented along the headwater portions of the adjoining creeks. SAV beds were found to extend to 5 meters from the shoreline to depths near 0.5 meters (Table 2). Broad Creek's shoreline accounted for approximately 40 miles of shoreline. Although SAV species were located in the main stem of Broad Creek, a majority of the beds were also located in the headwater areas of the adjacent tributaries. Beds in this system were found to be 5 meters from the shoreline, averaged 0.6 meters in depth, and contained only *Ruppia maritima*. The southern shore of Bay River and Trent Creek accounted for over 70 miles of surveyed shoreline. This inventory accounted for the largest SAV bed widths to date averaging 58 meters with an observed maximum of 500 meters wide near the mouth of the Neuse River. *Ruppia maritima* was found to be the only species present within the Bay River survey area.

Table 2. List of Neuse River Basin Tributaries surveyed.

NEUSE TRIBUTARIES	Date Surveyed	Species <sup>a</sup>	Coverage <sup>b</sup>	Avg SAV	
				Width <sup>c</sup>	Depth <sup>d</sup>
UT east of Dawson Creek	5/11/2007	ZP	Dense	8 (17)	0.9 (17)
Orchard Creek	7/5/2007	RM	sparse-dense	5 (23)	0.5 (23)
Broad Creek	7/13/2007	RM	sparse-dense	5 (94)	0.6 (94)
Bay River	8/10/2007	RM	dense	58 (62)	0.5 (62)
Trent Creek	8/20/2007	RM	Sparse	2 (8)	0.4 (8)

a RM: *Ruppia maritima*, ZP: *Zannichellia palustris*.

b 1-50% of rake is covered = sparse; 51-100% of rake is covered = dense.

c Average SAV width was the total distance perpendicular from the shoreline of the tributary specified / N (N= Number of width profiles taken).

Width from the shoreline was recorded in feet and obtained with a distance finder at the furthest point perpendicular from shore where SAV was observed.

d Average SAV depth was calculated along the entire tributary specified / N (N= number of depth profiles taken). Depth was measured in feet and obtained using a demarcated garden rake with an extendable pole.

### Pamlico River Tributaries

The Pamlico tributaries surveyed during the summer of 2007 predominantly consisted of beds, within low energy areas or headwaters of surveyed waterbodies. SAV bed depth remained near or under 1 meter (Table 3). One of the seven Pamlico River tributaries surveyed, Jack Creek, is defined as small creek (< 3 miles of shoreline). A majority of this creek's shoreline is adjacent to wetlands with SAV beds along the entire shoreline with an average depth of 1.1 meters (Table 3). This river was narrow and met Nevil Creek very close to its confluence with the Pamlico River. This creek was surveyed earliest in the growing season and contained an array of species including *Zannichellia palustris*, *Ceratophyllum demersum*, and *Potamogeton pusillus*.

Nevil Creek, Lower Spring Creek, Pantego Creek, Durham Creek, Campbells Creek and Fortescue Creek are long in shoreline mileage. Staff surveyed over 6 miles of the Nevil Creek's shoreline towards the confluence with the Pamlico River. Beds of *Zannichellia palustris*, *Ceratophyllum demersum*, and *Potamogeton pusillus* were documented along the entire creek (Fig. 13). SAV beds were found to extend to 10 meters from the shoreline to depths near 1 meter (Table 3). Lower Spring Creek accounted for approximately 10 miles of surveyed shoreline. SAV species were located in the main stem of Lower Spring Creek with a majority of the beds situated in the headwater areas of adjacent tributaries. Beds in this system were found to be 10 meters from the shoreline, averaged 0.8 meters in depth, and contained *Zannichellia palustris* and *Ruppia maritima*. The Pantego Creek inventory produced no evidence of SAV beds, despite surveying over 25 miles of shoreline. The southern shores of Campbell Creek and Lower Spring Creek were also part of the SAV study and accounted for over 13 miles of surveyed shoreline. This inventory accounted SAV bed widths averaging 7 meters with an average depth of 0.6 meters. *Ruppia maritima* was discovered to be the only species present within the Campbells Creek survey area. Fortescue Creek was found to have extensive *Ruppia* beds within this 18 mile shoreline survey. Average bed width is 7 meters found at a depth of 0.6 meters or less.

Table 3. List of Pamlico River Basin Tributaries surveyed.

PAMLICO TRIBUTARIES	Date Surveyed	Species <sup>a</sup>	Coverage <sup>b</sup>	Avg SAV	
				Width <sup>c</sup>	Depth <sup>d</sup>
Nevil Creek	5/7/2007	ZP, CD, PP	dense	10 (31)	1 (31)
Jack Creek	5/7/2007	ZP, CD, PP	dense	12 (2)	1.1 (2)
Lower Spring Creek	6/13/2007	ZP, RM	sparse - dense	10 (42)	0.8 (42)
Pantego Creek	8/9/2007	None Present	Na	Na	Na
Durham Creek	8/29/2007	RM, PP, CD	Sparse	8 (47)	0.7 (47)
Campbells Creek	8/30/2007	RM	sparse - dense	9 (20)	0.9 (20)
Fortescue Creek	9/6/2007	RM	sparse - dense	7 (46)	0.6 (46)

a RM: *Ruppia maritima*, ZP: *Zannichellia palustris*, VA: *Vallisneria americana*, PP: *Potamogeton pusillus*, CD: *Ceratophyllum demersum*,

b 1-50% of rake is covered = sparse; 51-100% of rake is covered = dense.

c Average SAV width was the total distance perpendicular from the shoreline of the tributary specified / N (N= Number of width profiles taken). Width from the shoreline was recorded in feet and obtained with a distance finder at the furthest point perpendicular from shore where SAV was observed.

d Average SAV depth was calculated along the entire tributary specified / N (N= number of depth profiles taken). Depth was measured in feet and obtained using a demarcated garden rake with an extendable pole.

Figure 1. Survey from Broad Creek (near Whortonsville) downloaded into Google Earth. Blue line indicates track survey completed. White boxed flags with numbers indicate waypoint marked. Details were recorded onto field data sheet.





Figure 3. Broad Creek fieldsheet filled in with shorthand adds to overall team efficiency.

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Date: 7-25-07 Waterbody: Broad Creek Staff: T. Bartz J. Beckelmeier

Start or End <sup>a</sup>	GPS Waypoint #	Latitude (dd)	Longitude (dd)	SAV Species <sup>b</sup>	Coverage: Sparse or Dense	Bed Width (m)	Depth (m)	Veg. Type (grass, sand cypress, juncus)	Comments
BT	01	35.08354	-76.65594					Spartina juncus	Water level higher than previous days
AB	02	35.08386	-76.65609	RM	Sparse	.5	.5		
T	03	35.08444	-76.65498	RM	Sparse	1.0	.5		
OB	04	35.08474	-76.65367	RM	Sparse	.4	.3		
AB	05	35.08802	-76.65046	RM	Sparse	1.0	.5		
T	06	35.08925	-76.64989	RM	Sparse	.5	.5		
OB	07	35.08772	-76.65088	RM	Sparse	1.0	.4		
AB	08	35.09240	-76.63796	RM	Sparse	1.2	.6		Soft bottom
W	09	35.09275	-76.63895	RM	Sparse	1.5	.4		
W	10	35.09275	-76.63895	RM	Dense	2.0	1.0		Across entire reach
T	11	35.09417	-76.64160	RM	Dense	4	1.0		Across entire reach
OB	12	35.09136	-76.63786	RM	Sparse	1	.5	Spartina juncus	
AB	13	35.10143	-76.63989	RM	Sparse	1	.5	Spartina myrtle/pine	
T	14	35.10154	-76.64045		Dense	1.2	.5	trees	across entire reach

<sup>a</sup>SAV: NG: Najas guadalupensis, RM: Ruppia maritima, ZP: Zannichellia palustris, VA: Vallisneria americana, PP: Potamogeton pusillus, PF: Potamogeton perfoliatus, CD: Ceratophyllum demersum, MS: Myriophyllum spicatum, SP: Stuckenia pectinatus.

<sup>b</sup>BT: Beginning trip; ET: End trip; AB: start bed; OB: stop bed; T: turnaround; W: width point

1 of 2

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Figure 4. Neuse River tributaries. Digitized SAV bed locations: Red 2007, Orange (2006), and Pink (2005). Scale of bed locations enlarged for visual purposes in this report only.

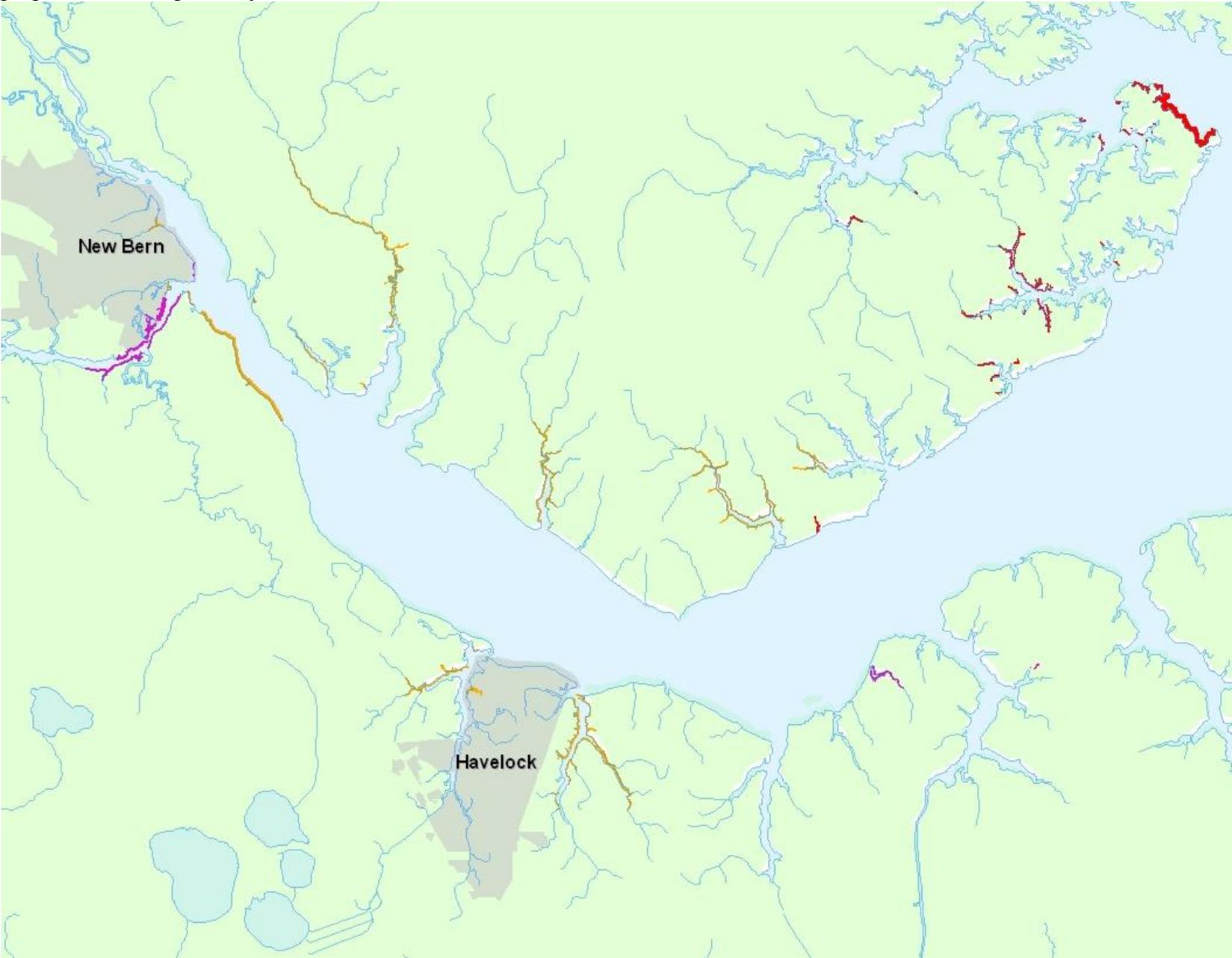
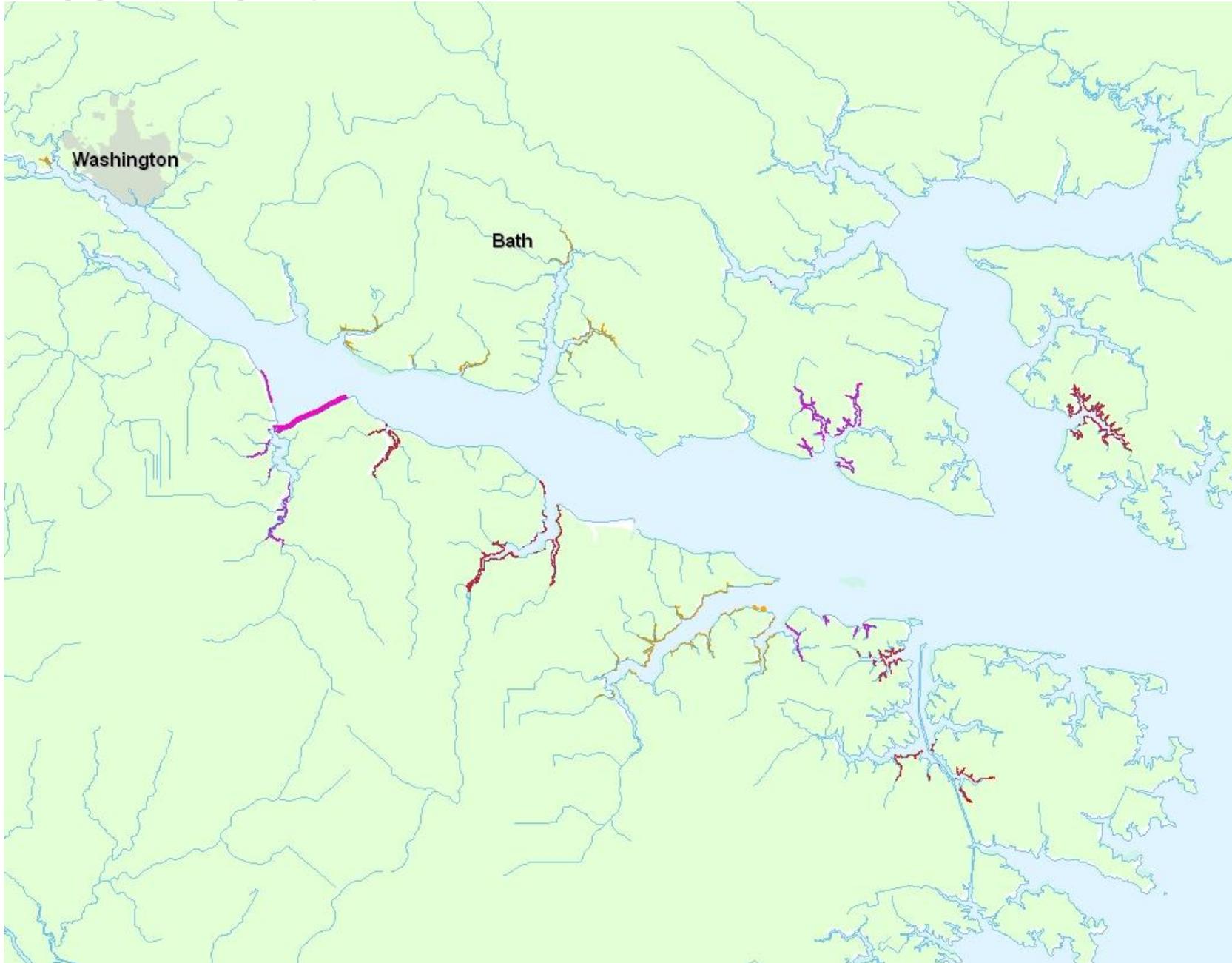


Figure 5. Pamlico River tributaries. Digitized SAV bed locations: Red 2007, Orange (2006), and Pink (2005). Scale of bed locations enlarged for visual purposes in this report only.



## LITERATURE CITED

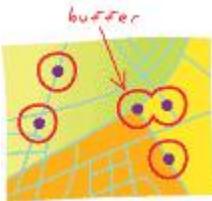
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## APPENDIX

Digital Raster Graphic Standards: USGS National Mapping Information Standards:  
<http://rockyweb.cr.usgs.gov/nmpstds/drgstds.html>

Buffer definition:

1. [spatial analysis] A zone around a map feature measured in units of distance or time. A buffer is useful for proximity analysis.



Relate definition:

See Also : [joining](#), [key](#)

1. [database structures] An operation that establishes a temporary connection between records in two tables using a key common to both.

Spatial join definition:

1. [spatial analysis] A type of table join operation in which fields from one layer's attribute table are appended to another layer's attribute table based on the relative locations of the features in the two layers.