Appendix 9.A. Submerged Aquatic Vegetation Patterns in the Lower St. Johns River Basin

Prepared by

Lori Morris

Dean Dobberfuhl

Division of Water Resources
St. Johns River Water Management District

This section describes the variation of submerged aquatic vegetation (SAV) species among four sites from Jacksonville to Palatka (Figure 1) and the temporal variability of SAV species composition at those four sites.

The SAV sites monitored are Bolles School, Buckman Bridge, Moccasin Slough, and Scratch Ankle (Figure 1) from the years 1998-2008. There were up to 12 SAV species present however, the number of species varied by site and time. The species are: *Vallisneria americana, Ruppia maritima, Najas guadalupensis, Zannichellia palustris, Ceratophyllum demersum, Charophyte* sp.*, Eleocharis* sp., *Hydrilla verticillata, Micranthemum* sp., *Potamogeton pusillus, Potamogeton illinoensis,* and *Sagittaria subulata* (Figure 2). The number and diversity of SAV species present at a site increased with distance upstream. This increase in SAV species is partially due to the lower variability in salinity upstream. Thus, SAV diversity and coverage increases as salinity becomes lower and less variable.

METHODS

All SAV surveys occurred during four seasons: winter (January – March), spring (April – June), summer (July – September) and fall (October – December). Quarterly surveys of sites occurred within the same month for each season when possible (February, May, August, and November) to ensure consistency with previous sampling dates and consistent spacing across the year.

At each permanent monitoring network (PMN) site, five transects were placed perpendicular to the shore, extending from the shoreline towards the river channel. Transects were positioned parallel to each other at a distance of 0, 12, 25, 38, or 50 m from a stationary benchmark at each site (Sagan 2009). Data was collected at 1-m intervals along each transect, from which discrete changes in SAV parameters such as canopy height, cover, bed length, maximum water depth distribution and salinity (practical salinity units – psu), could be compared from sampling event to sampling event.

During each sampling event, an additional five, randomly positioned transects, measured linear cover of all SAV species. Linear cover was obtained by recording the length of tape intercepted by each species and by bare ground along the entire length of the SAV bed (Sagan 2009). If not visible through the water column, SAV was hand collected at 5 cm-increments along the transect to ensure detection of all species. Interception of the tape included both interception by the plant and interception of SAV canopy foliage perpendicular to the tape.

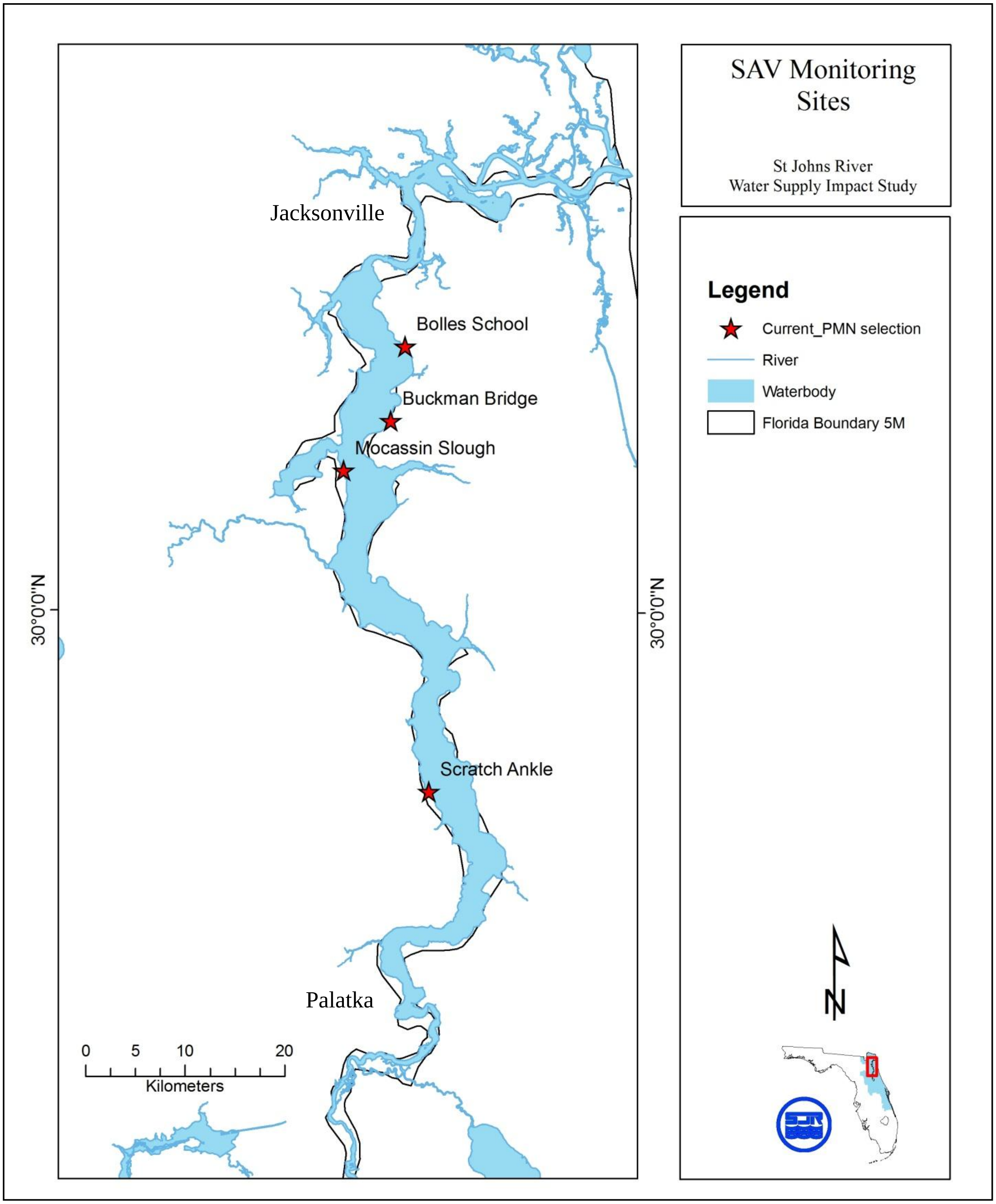


Figure 1. The Lower St. Johns River from Palatka to the mouth in Jacksonville. The red stars mark the site locations for the four permanent monitoring network (PMN) sites.

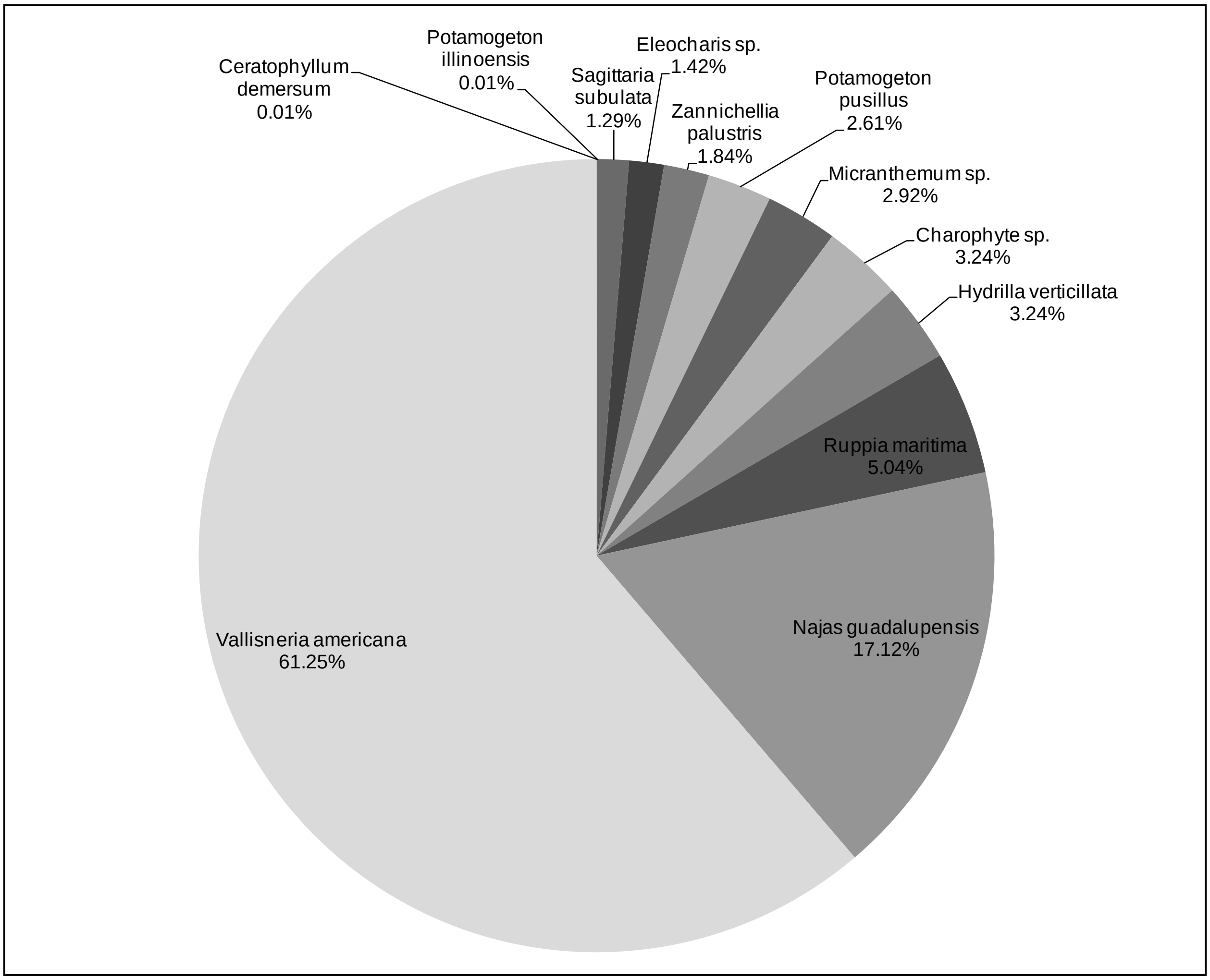


Figure 2. Relative abundance of SAV species in the Lower St. Johns River (Jacksonville to Palatka – see map). These data summarize sampling from 1996 – 2008 (N = 103,466).

RESULTS

The SAV species data presented in this report is from the transects measuring linear cover, which we use as a measure of abundance. This data summarizes total linear presence of SAV species and bare areas, in meters, at the four monitoring sites – Bolles School, Buckman Bridge, Moccasin Slough, and Scratch Ankle (Figure 1). Throughout the decade-plus long study, extremes of climatic events have occurred which have had negative affected SAV. A 3-year drought occurred from 1999 – 2001; drought-induced increases in salinity had deleterious effects on the SAV in the lower reach of the river and in other systems as well (Sagan 2002, Sagan

2009). In September 2001, a tropical storm swept through the Lower St. Johns River (LSJR), and in 2004 three hurricanes (Frances, Ivan, and Jeanne) passed through northeast Florida. Another drought, which began in 2006, has also been having a large impact on the LSJR.

The Bolles School transects had only four persistent SAV species: *Zannichellia palustris, Vallisneria americana, Ruppia maritima, and Najas guadalupensis,* and two other species with sporadic occurrences, *Potamogeton pusillus* and *Charophyte* sp. (Figure 3). All six species were present at some time during the sampling from 1998 through 2000. However, when salinity concentration and variability increased (from 0 to 17 psu) in 2000 through February 2003, only *V. americana* and *R. maritima* persisted. Not until summer 2003 did *Z. palustris* and *N. guadalupensis* return as salinity stabilized at a lower concentration, although their presence was sporadic between sampling events. They became completely absent following the salinity increase in 2006 and were not present thereafter. *Vallisneria americana* was the only species present after the hurricanes in 2004. *Zannichellia palustris*, *R. maritima* and *N. guadalupensis* returned during summer 2005. However, after an increase in salinity in 2006 (to 10 – 11 psu) and a large spike in May 2007 (to 23 psu), *R. maritima* was the only remaining species through the end of 2007.

Vallisneria americana appears to withstand salinity up to 10 and 12 psu, but the salinity spike (17 psu) that occurred during the summer 2002 caused a greater than 80% reduction in occurrence and took almost a year to return to previous coverage. *R. maritima* was present at low density during each sampling event, except following the fall hurricanes of 2004, after which it was absent for a year, possibly due in part to low light condition initially associated with storm runoff. *Ruppia maritima* may be more sensitive to light reduction then some other SAV, including *V. americana* (Ruppia Appendix_).

The total bed length in linear meters is another way to monitor the expansion and recession of the SAV bed at Bolles School. Figure 4, in combination with Figure 3, shows that when the SAV dies-back along the transect so does the transect length. Also, following some of the larger die-backs the total area of bare, or exposed bottom, increases, suggesting greater patchiness. For example, after the salinity spikes in 2000, the total transect length went from over 90 m to 50 m, with 40 m of bare area. The same pattern occurred again in 2002, but the SAV was able to recover each time. Most noticeable is the successive loss or decline in total bed length. After numerous salinity spikes, the overall bed length never recovered to pre-2000 lengths.

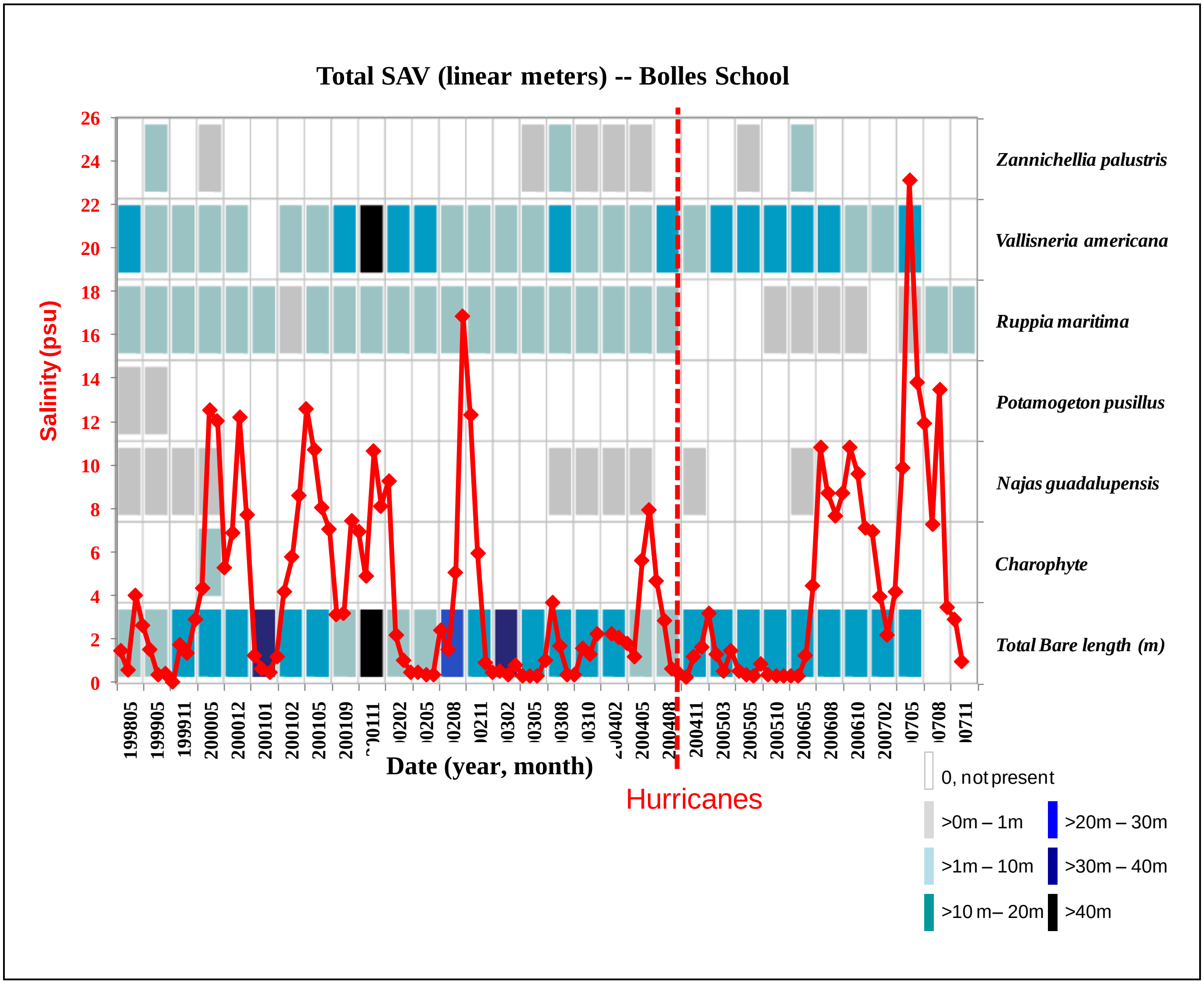


Figure 3. Total linear presence, in meters, of each SAV species at Bolles School from May 1998 through November 2007. The range for binned blocks, 0 - >40 m, represents the total linear meters of each SAV species present as well as total bare area. (The darker the bin color the more linear meters of each species.) Average monthly salinity on the y-axis was also recorded during the same time period. Note the large variability in salinity (from 0 to 12 psu, and 17 psu) from 2000-2003 and again from 2006-2007, with a very large spike (23 psu) in June 2007.

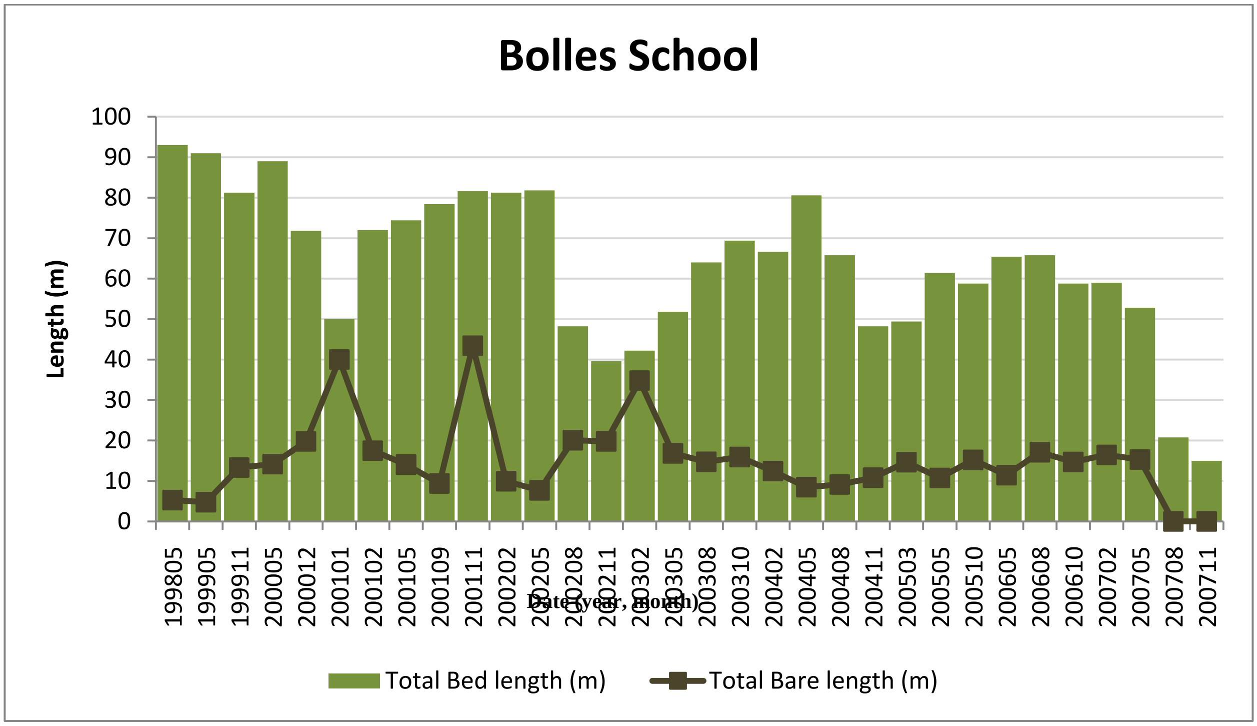
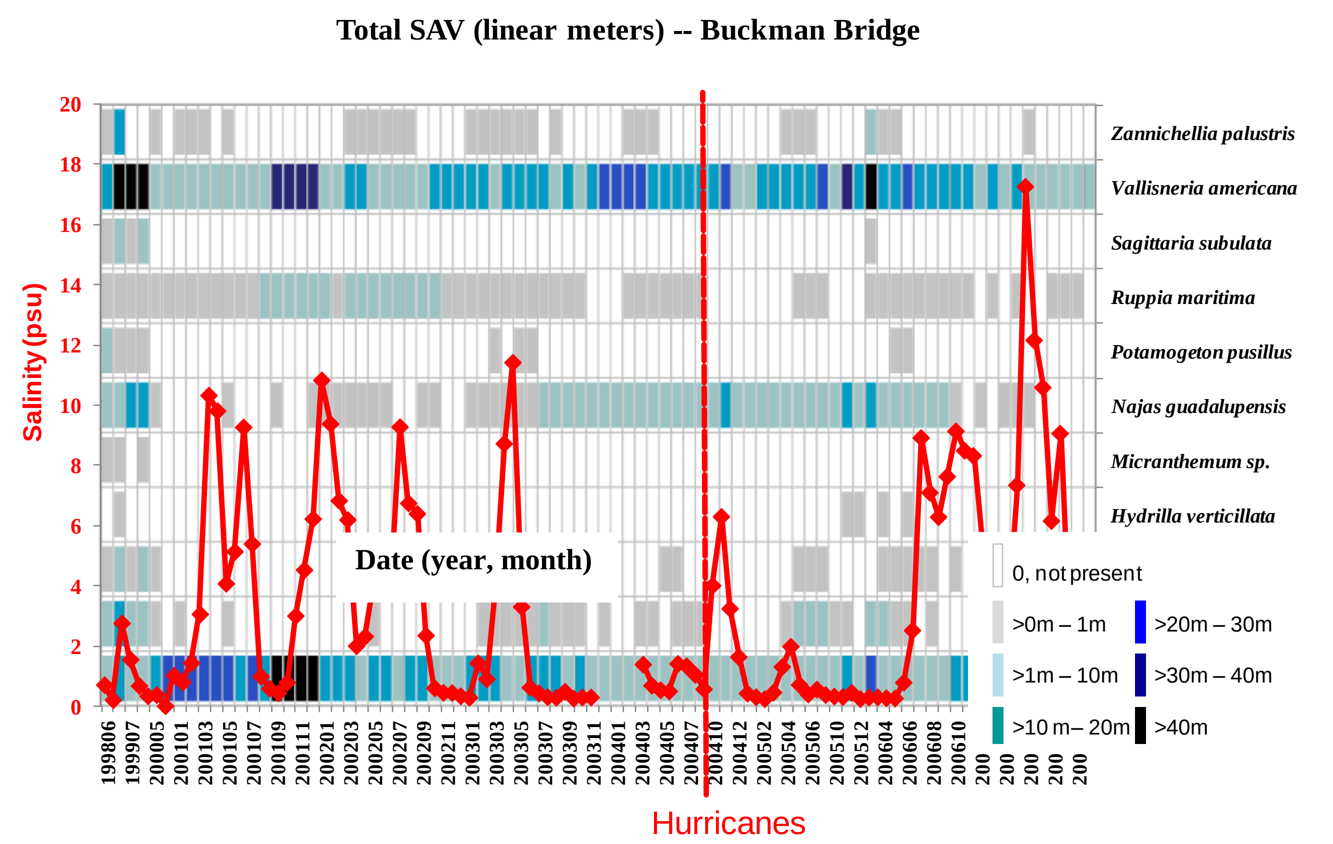


Figure 4. Total linear meters of transect length. Total Bed length is the sum of all linear meters of SAV present and the bare areas. The total Bare length reflects periods of die-back along the transect as the proportion of bed length becomes more bare. The SAV die-back is specifically seen in January 2001 (200101), November 2001 (200111), and February 2003 (200302).

The Buckman Bridge transects had 10 of the 11 SAV species present (*Zannichellia palustris, Vallisneria americana*, *Ruppia maritima, Najas guadalupensis, Potamogeton pusillus, Charophyte* sp., *Eleocharis* sp., *Hydrilla verticillata, Micranthemum* sp., and *Sagittaria subulata*) but only six were consistently present during the sampling period (Figure 5). Similar to the Bolles School site, all ten species were present from 1998 to 2001, but *V. americana* and *R. maritima* were the only two species to remain during the fluctuating salinity (from 0 – 11 psu) from 2001 to 2003. The *V. americana* cover declined more than 50% during this time. *Najas guadalupensis* was routinely absent during periods of high salinity (2001-2003 and 2007) (Sagan 2009). Some of the other species began to return by fall 2003, and by 2004 all but *S. subulata, H. verticillata,* and *Micranthemum* sp. returned. During the fall 2003, *R. maritima* almost completely disappeared and was replaced by *N. guadalupensis*. The 2004 hurricanes did not affect *V. americana* or *N. guadalupensis* as much as the other species. However, after the salinity peaks (6-9 psu) during summer and fall 2006 and the large spike (17 psu) in 2007 only *V. americana* and *R. maritima* remained.



Fi

The total bed length and bare area in linear meters at Buckman Bridge also reflects the salinity spikes in 2000 (Figure 6). Even though the total bed length only receded by 15m at the end of 2001, the total bare area grew from 30m to over 50m.

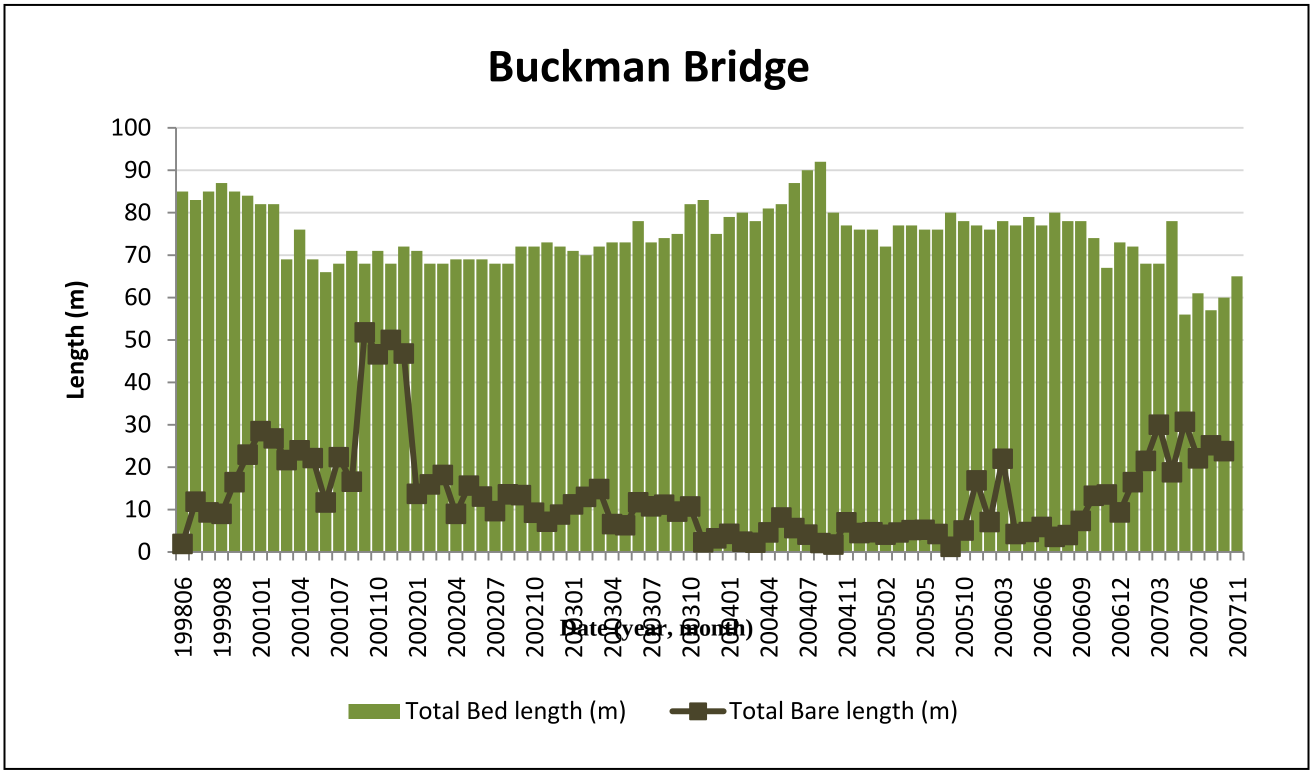


Figure 6. Total linear meters of transect length. Total Bed length is the sum of all linear meters of SAV present and the bare areas. The total Bare length reflects periods of die-back along the transect as the ratio of bed length becomes proportionally bare. The SAV die-back is specifically seen in January 2001 (200101), but the large increase in Bare area, from September to December 2001, is most notable.

The Moccasin Slough transects had 9 of the 11 SAV species present, (*Zannichellia palustris, Vallisneria americana, Ruppia maritima, Najas guadalupensis, Potamogeton pusillus, Charophyte* sp., *Eleocharis* sp., *Micranthemum* sp., and *Sagittaria subulata*) (Figure 7). The SAV patterns were very similar to the Buckman transect with *V. americana, R. maritima,* and *N. guadalupensis* being the dominant species present and *Z. palustris and Charophyte* sp. returning each spring and summer, until the 2004 hurricanes. The remaining species (*Eleocharis* sp., *Micranthemum* sp., *Potamogeton pusillus,* and *Sagittaria subulata*) were only present during two to four survey events and at occurrences less than 5% (Sagan 2009). All 9 species were affected by the hurricanes, *V. americana,* and *N. guadalupensis* declined by 60% and 97%, respectively, and *R. maritima* disappeared completely until 2006. By March 2006, all SAV species returned except for *Micranthemum* sp. However, the salinity spike (16 psu) during the summer 2007 brought about another die back and only 3 species remained by the end of 2007.

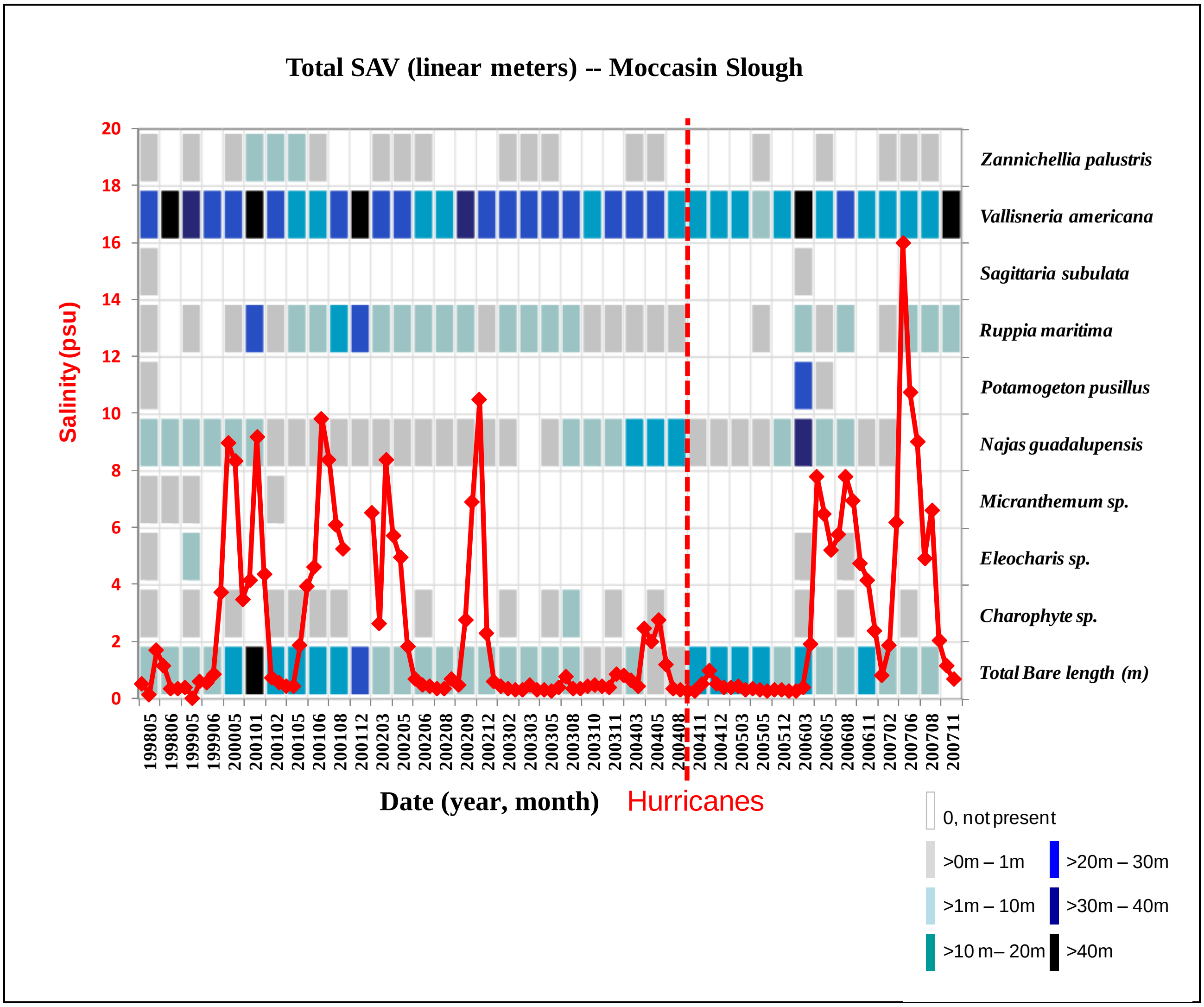


Figure 7. Total linear presence, in meters, of each species of SAV at the Moccasin Slough site from May 1998 through 2007. The range for binned blocks, 0 - >40 m, represents the total linear meters of each SAV species present as well as total bare area. (The darker the bin color the more linear meters of each species.) Average monthly salinity on the y-axis was also recorded during the same time period. Note the large variability in salinity (from 0 to 10 psu) in 1999-2003 and again from 2006-2007, with a very large spike (16 psu) in June 2007.

Moccasin Slough transects had relatively stable bed lengths and bare areas compared to the other two sites over the 10-yr period (Figure 8). There was a noticeable, but short, die-back in January 2001 that reflected some spikes in salinity. These spikes caused the total bed length to recede from 170 m to 85 m. However, the SAV almost fully recovered by February.

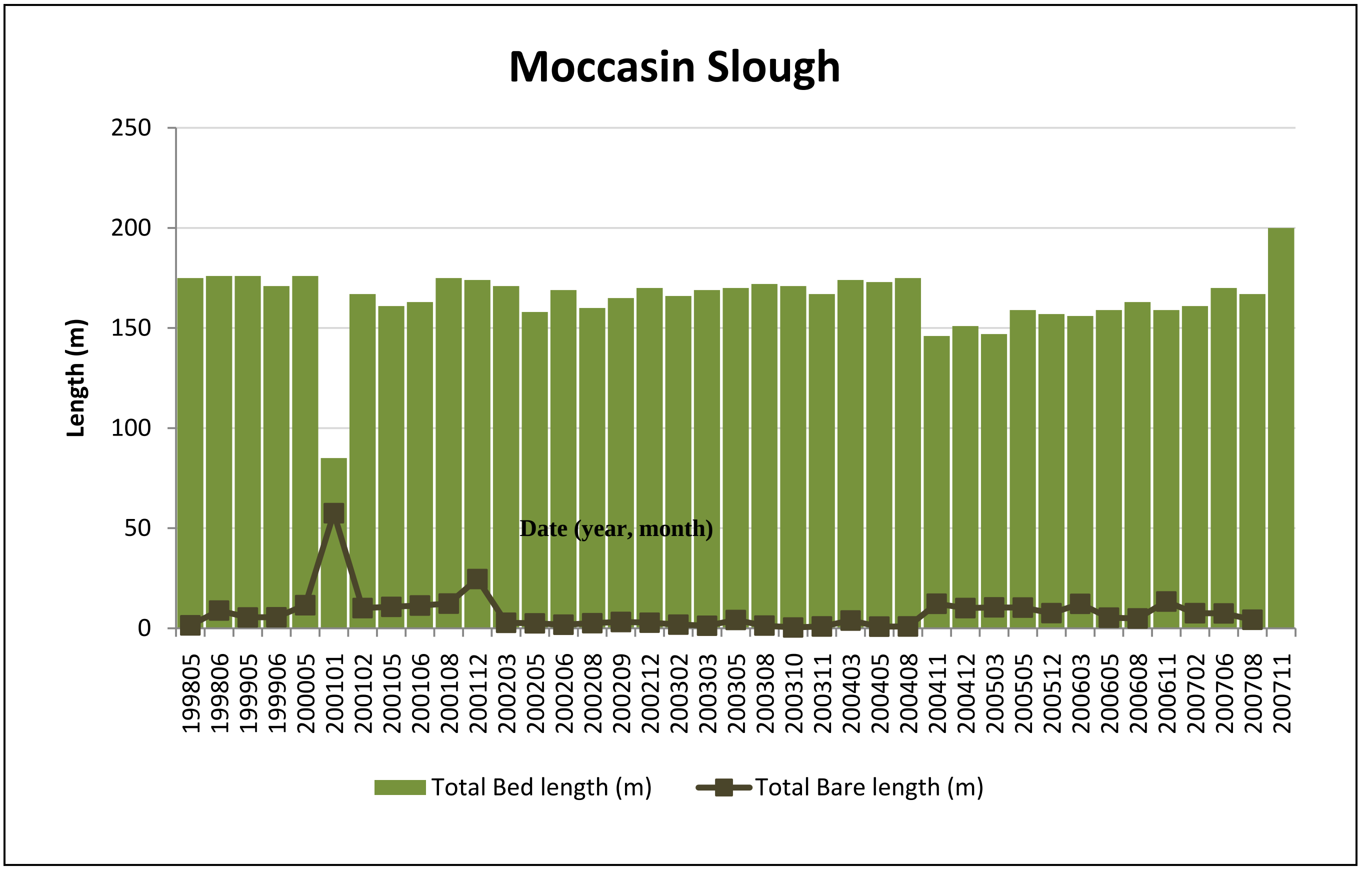


Figure 8. Total linear meters of transect length. Total Bed length is the sum of all linear meters of SAV present and the bare areas. The total Bare length reflects periods of die-back along the transect as the ratio of bed length becomes proportionally bare. The SAV die-back is specifically seen in January 2001 (200101), but quickly recovered by the next month.

The Scratch ankle transects, the furthest upstream of the four sites, had all 11 species present (Figure 9). *Vallisneria americana* was the dominant species throughout the period, but was mixed with all other 10 species during most of the time. *Ruppia maritima* was predominantly absent during the low salinity times between 2003 and 2007 (Sagan 2009). The variable salinity spikes seen at the other sites during 2000-2003 are hardly noticeable and had very little effect this far upstream with peaks of 1.7, 1.3, and 2.7 psu. The SAV species that declined during this period quickly recovered within 1-2 months. The largest impact at this site was caused by the 2004 hurricanes, when 8 of the 11 species died-back. However, all species recovered by the end of 2005 and were hardly affected by the salinity spike of 2.5 psu in May 2007. It is also worth noting that the exotic species, *Hydrilla*, incrementally expanded at this site starting in 2003, and has out competed other native species (Sagan 2009).

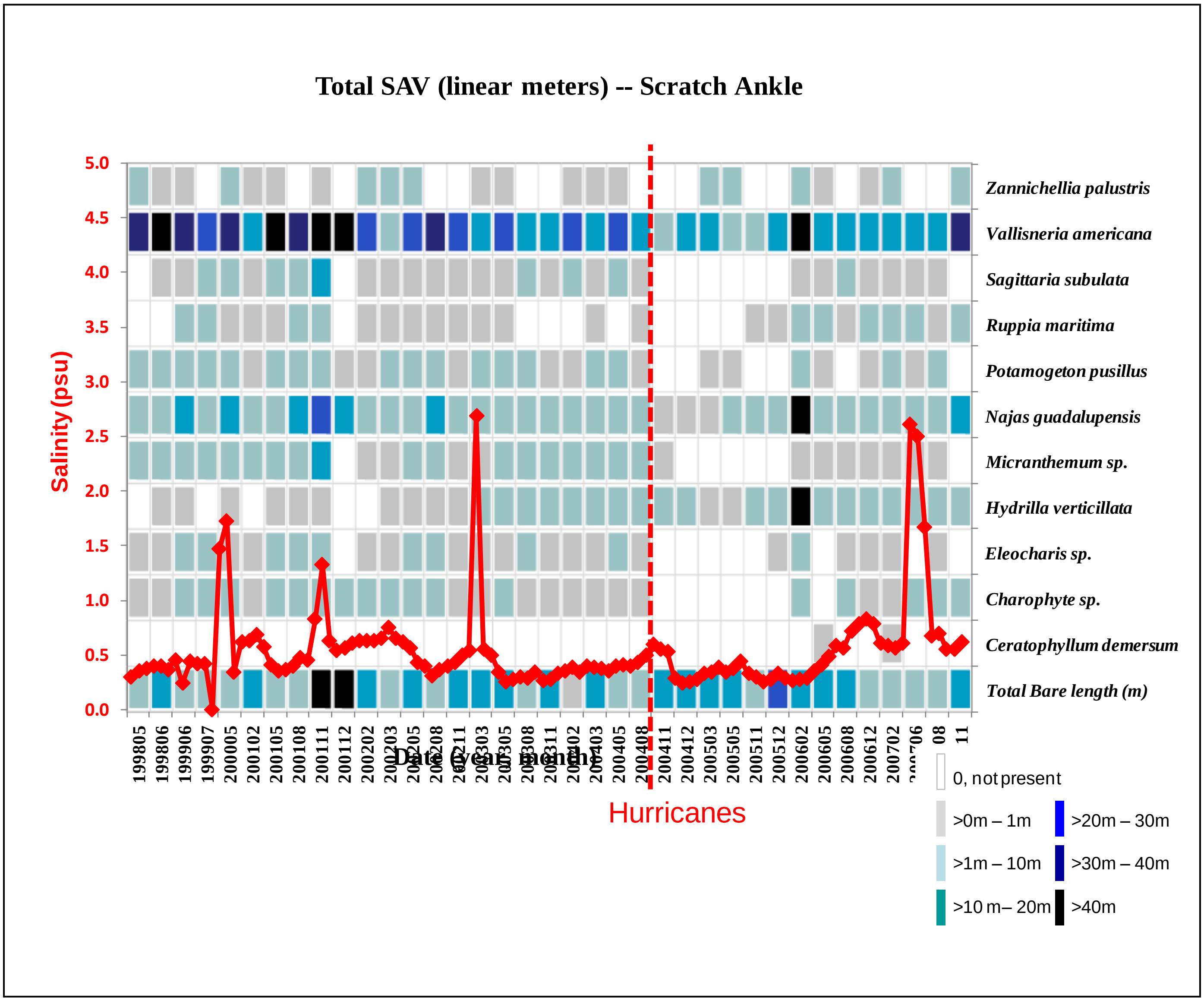


Figure 9. Total linear presence, in meters, of each species of SAV at the Scratch Ankle site from 2001 through 2006. The range for binned blocks, 0-600 m, represents the total linear meters of each SAV species present as well as total bare area. (The darker the bin color the more linear meters of each species.) Average monthly salinity on the y-axis was also recorded during the same time period. Note the peak in salinity in June 2002 (20020604) – although < 2 psu, the V. americana did decline for 1 month, but seemed to make a full recovery.

Scratch Ankle transects had the longest bed length of all other sites, averaging over 230 m from 1998-2003 (Figure 10). The total bed length was relatively stable during this time period. In contrast, this area was one of the most heavily affected by the hurricanes in 2004, when the average bed length declined back to 175 m for almost 2 years.

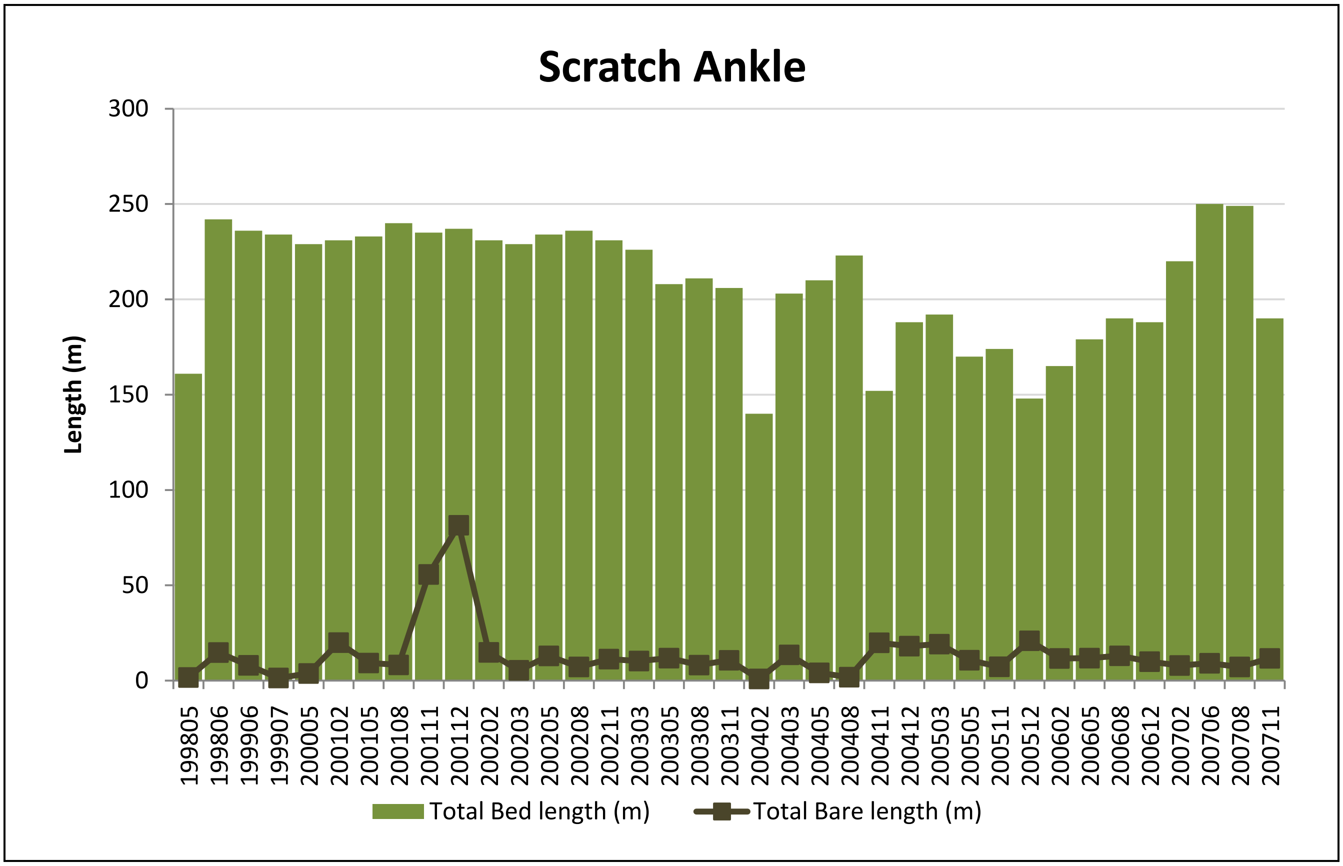


Figure 10. Total linear meters of transect length. Total Bed length is the sum of all linear meters of SAV present and the bare areas. The total Bare length reflects periods of die-back along the transect as the ratio of bed length becomes proportionally bare. The SAV die-back from the salinity spikes is hardly noticeable, except for an increase in the bare area at the end of 2001 until February 2002.

SUMMARY

All but the most upstream site, Scratch Ankle, responded to salinity, based on a 9-year record of SAV monitoring. The three downstream sites, Bolles School, Buckman Bridge, and Mocassin Slough, all respond similarly to exposure to salinity. Two species, *Vallisneria americana, Ruppia maritima*, are able to withstand some pulses in salinity, up to 12 and 16 psu, but once exposed, can die-back up to 50% in cover. However, salinity values greater than 20 psu at Bolles School in 2007 appeared to exceed *V. americana's* tolerance levels (Figure 3). Bolles School was the only site where *V. americana* completely died-back and did not recover during this monitoring period. *Zannichellia palustris* and *Najas guadalupensis* seem to be more sensitive to salinity fluctuations and have an ephemeral presence when salinity reaches 10 psu (Figure 5). The remaining 7 species, *Ceratophyllum demersum, Charophyte* sp., *Eleocharis* sp., *Hydrilla verticillata, Micranthemum* sp., *Potamogeton pusillus,* and *Sagittaria subulata*, are much more sensitive to salinity and start showing signs of stress and die-back once salinity reaches 2 psu (Figures 7 and 9). The die-back at all sites following the 2004 hurricanes does not appear to be from high salinity, but likely low light conditions that persisted after the large rainfall amounts that caused darker and deeper water than usual for several months.

REFERENCES

Sagan, J. J. 2002. Lower St. Johns River Basin Submerged Aquatic Vegetation (SAV) Monitoring: 1998 - 2002. Final Report for the St. Johns River Water Management District, Palatka, FL.

Sagan, J. J. 2009. A summary of Submerged Aquatic Vegetation (SAV) Status within the Lower St. Johns River: 1996 – 2007. Final Report for the St. Johns River Water Management District, Palatka, FL.