Appendix 9.G. Potential for Replacement of *Vallisneria* by *Ruppia Maritima*

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The submersed angiosperm *Ruppia maritima* L. (Ruppiaceae) is found on both the Atlantic and Gulf coasts of Florida. While it is often considered as one of the "seagrasses", Zieman (1982 – p. 10) considers *Ruppia* to be "a freshwater plant that has a pronounced salinity tolerance." On the Florida Atlantic Coast, *Ruppia* is found in the lower St. Johns River and estuary (Sagan 2009), in low-salinity areas of the Indian River Lagoon (Woodward-Clyde Consultants et al. 1994), in Biscayne Bay (Barnes, Ferland and Associates et al. 2004), and in low-salinity areas of Florida Bay (Fourqurean et al. 2002). In the estuaries of southwest Florida (Tampa Bay, Sarasota Bay, Charlotte Harbor), *Ruppia* is found adjacent to river mouths or in low salinity bay areas heavily influenced by freshwater inflow (Lewis et al. 1985; Corbett and Madley 2007; Tomasko and Raulerson 2007). Along Florida's Gulf coast, *Ruppia* predominates in inshore regions and estuarine bays, where it is found adjacent to the mouths of rivers and large creeks or in bayous with low salinities (Phillips 1960; Mattson et al. 2007; Ruth and Handley 2007; Schwenning et al. 2007).

As part of the analyses conducted by the Littoral Zone Working Group, the question of whether *Ruppia* would replace *Vallisneria americana* if the latter plant were reduced in coverage by salinity increases (due to upstream water withdrawals) was addressed. Data from the SJRWMD submerged aquatic vegetation (SAV) monitoring program in the lower St. Johns River and estuary were examined (described in Appendix 9.A). Data were analyzed from four long-term monitoring sites (Appendix 1): Bolles School, Buckman Bridge, Moccasin Slough, and Scratch Ankle. Data were drawn from Sagan (2009) and they generally encompassed the period from 1998-2007. Two types of data were used; (1) the proportion of mean linear *Ruppia* cover (out of total mean SAV linear cover, expressed as 0-1.0) vs. measured depth at time of sampling from replicate samples along five transects established at each site (number of replicates varied depending upon total length of transect; data obtained as EXCEL files from J. Sagan, AMEC/BCI Engineers and Scientists), and (2) mean linear cover of *Ruppia* vs. water column extinction coefficient (K_d) for the years 1998-2003 (obtained from Tables 3 and 4 in Sagan 2009).

Proportion of mean linear cover of *Ruppia* and *Vallisneria* on the SAV monitoring transects at each of these sites was compared to the mean measured depth at the time of sampling (meters; m). At three of the four locations (Bolles, Buckman, and Moccasin), mean linear cover of *Ruppia* declined with increasing mean transect depth (Figure 1). None of these correlations was statistically significant (Bolles Pearson r= -0.254, p=0.089; Buckman Pearson r= -0.122, p=0.535; Moccasin Pearson r= -0.189, p=0.081). *Vallisneria* exhibited a decline in cover with depth at one of the four sites (Bolles), which was statistically significant (Pearson's r= -0.325, p=0.009). At the other three transects, *Vallisneria* exhibited no correlation or an increase in cover with depth. At Buckman and Moccasin Slough, *Vallisneria* exhibited no correlation (Buckman Pearson's r= 0.004, p=0.976; Moccasin Pearson's r= 0.157, p=0.073). At Scratch Ankle, both *Ruppia* and *Vallisneria* linear cover increased with depth (Appendix 9.G, Figure 1).

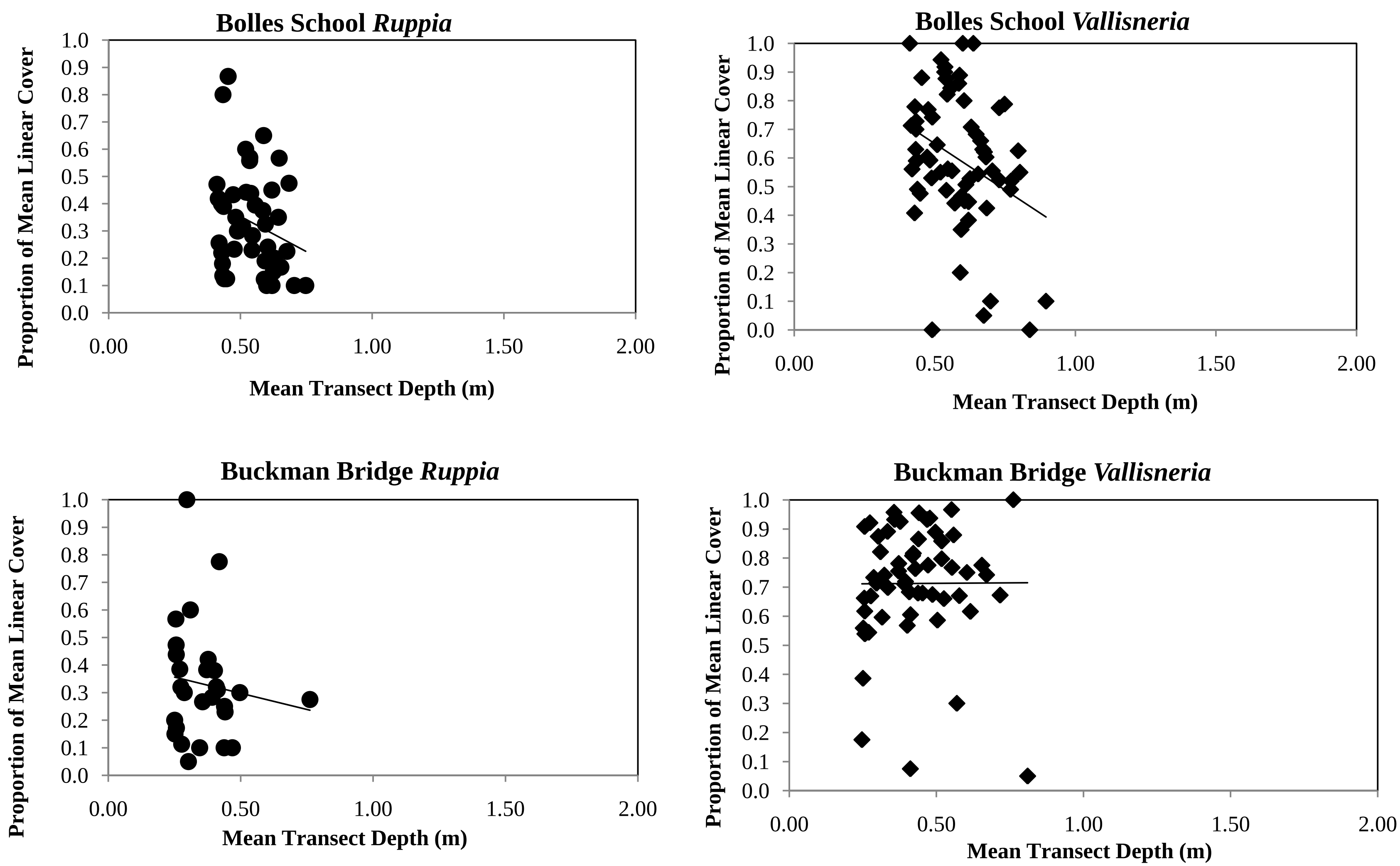


Figure 1. Plots of mean linear cover of *Ruppia* and *Vallisneria* vs. mean transect depth measured at time of sampling at three long-term SAV monitoring locations on the lower St. Johns River.

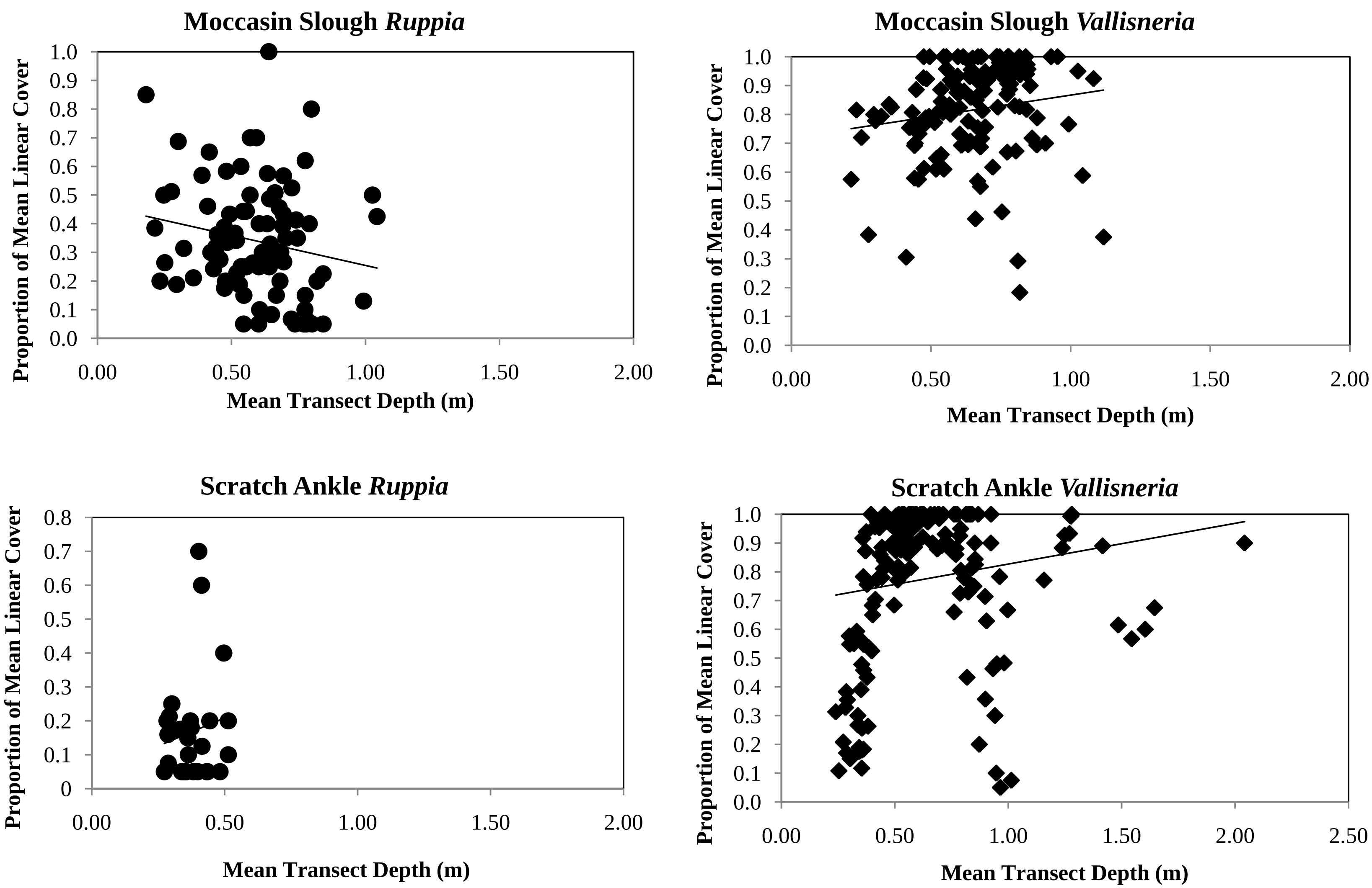


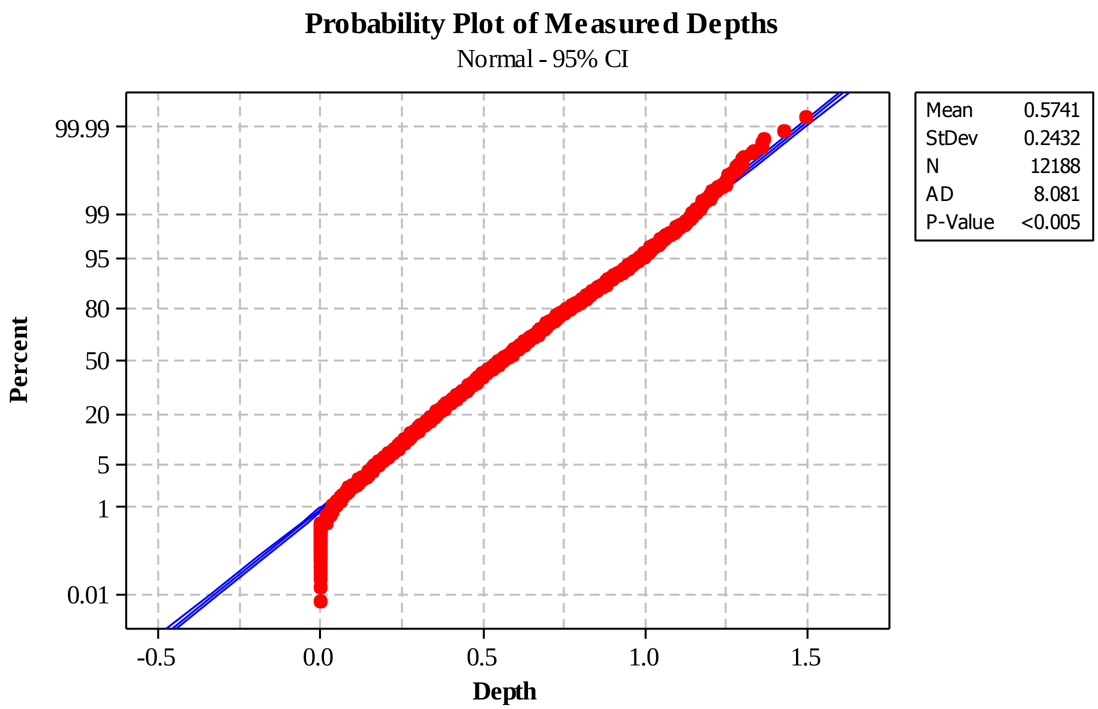
Figure 1—*Continued*.

This trend was not statistically significant for *Ruppia* (Pearson's r=0.148, p=0.453), but was significant for *Vallisneria* (Pearson's r= 0.156, p=0.039). Despite the lack of statistical significance, it appears that maximum cover of *Ruppia* is generally confined to the shallower portions of the SAV beds in the lower river and estuary, based on the negative relationship of *Ruppia* cover with depth seen at three of the four sites. *Vallisneria*, in contrast, exhibits high cover (up to 100%) in areas up to and above 1 m in depth, and exhibited an increase in cover with depth at two of the four sampling sites.

This association of higher cover of *Ruppia* with shallower depths appears to be a result of its requirement for higher light intensities for growth. In a review of the literature on *Ruppia maritima* life history and environmental requirements, Kantrud (1991) indicates that *Ruppia* is considered a "sun" or "high light" plant and is not well adapted to low-light environments. Evidence came from experimental studies on *Ruppia* photosynthetic activity in relation to light and from pigment analyses of the plant. Kantrud summarized depth distribution of *Ruppia* in a table (his Table 4) in his review. *Ruppia* occured at a wide range of depths, but many of the cited studies indicated an "optimum" depth of 0.2-0.6 m. The high color routinely measured in the lower St. Johns River limits light penetration to depth and appears to confine *Ruppia* to shallower areas, generally <0.5 m (Appendix 9.G, Figure 1), where its light requirements are met.

The distribution of measured depths on the SAV monitoring transects indicates that about 60% of the measured depths exceed 0.5 m (Appendix 9.G, Figure 2). *Ruppia* generally accounted for the highest proportion of mean linear cover mostly at depths <0.5 m (Appendix 9.G, Figure 1). Although *Ruppia* does occur at deeper depths on the SAV transects (down to a maximum of about 1 m), in general it appears that much of the area occupied by *Vallisneria* is at depths which would not support extensive cover of *Ruppia*, even if *Vallisneria* were to be extirpated by increased salinities. Sagan (2004) came to a similar conclusion that *Ruppia* would not replace *Vallisneria* killed by salinity stress. She observed that *Ruppia* did not fill areas where *Vallisneria* died back, and also observed that *Ruppia* was most abundant in the shallowest areas of the SAV beds in the lower St. Johns River.

In addition, highest mean linear cover of *Ruppia* is associated with the lowest mean water column extinction coefficient (K_d); that is, highest cover occurs in clearest water (Figure 3). Interestingly, during low-flow years (e.g., 2007), *Ruppia* occurs more frequently at upstream locations (Appendix 9.G, Figure 4). Salinity cannot be the primary factor causing this trend, which is more likely due to reduced water color and enhanced light penetration at lower flows (Appendix 9.H). During years with more rainfall and higher flows (e.g., 2004), color in the lower river is substantially higher (Appendix 9.H), and *Ruppia* is more restricted to downstream reaches where influx of clearer ocean water dilutes the higher colored river water (Appendix 9.G, Figure 4).



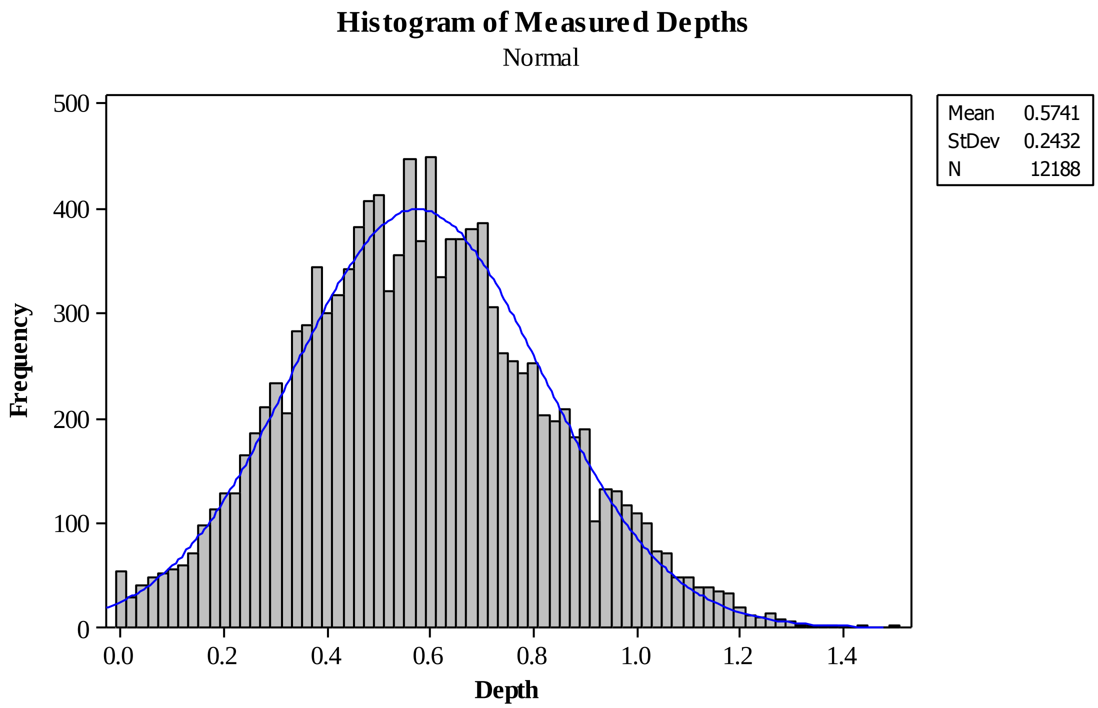


Figure 2. Plots of distribution of measured depths on the SAV monitoring transects used in the *Ruppia* analysis.

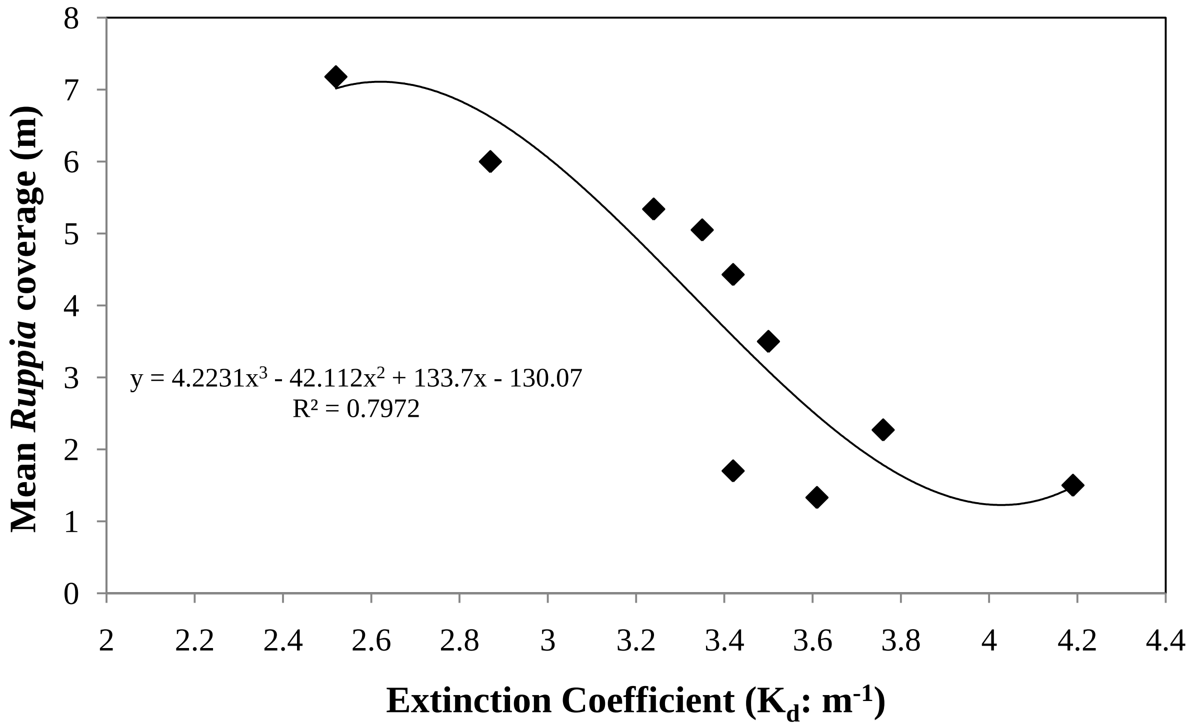


Figure 3. *Ruppia* mean linear cover vs. water column extinction coefficient (K_d) from the lower St. Johns River SAV monitoring transects. Data from Sagan (2009)

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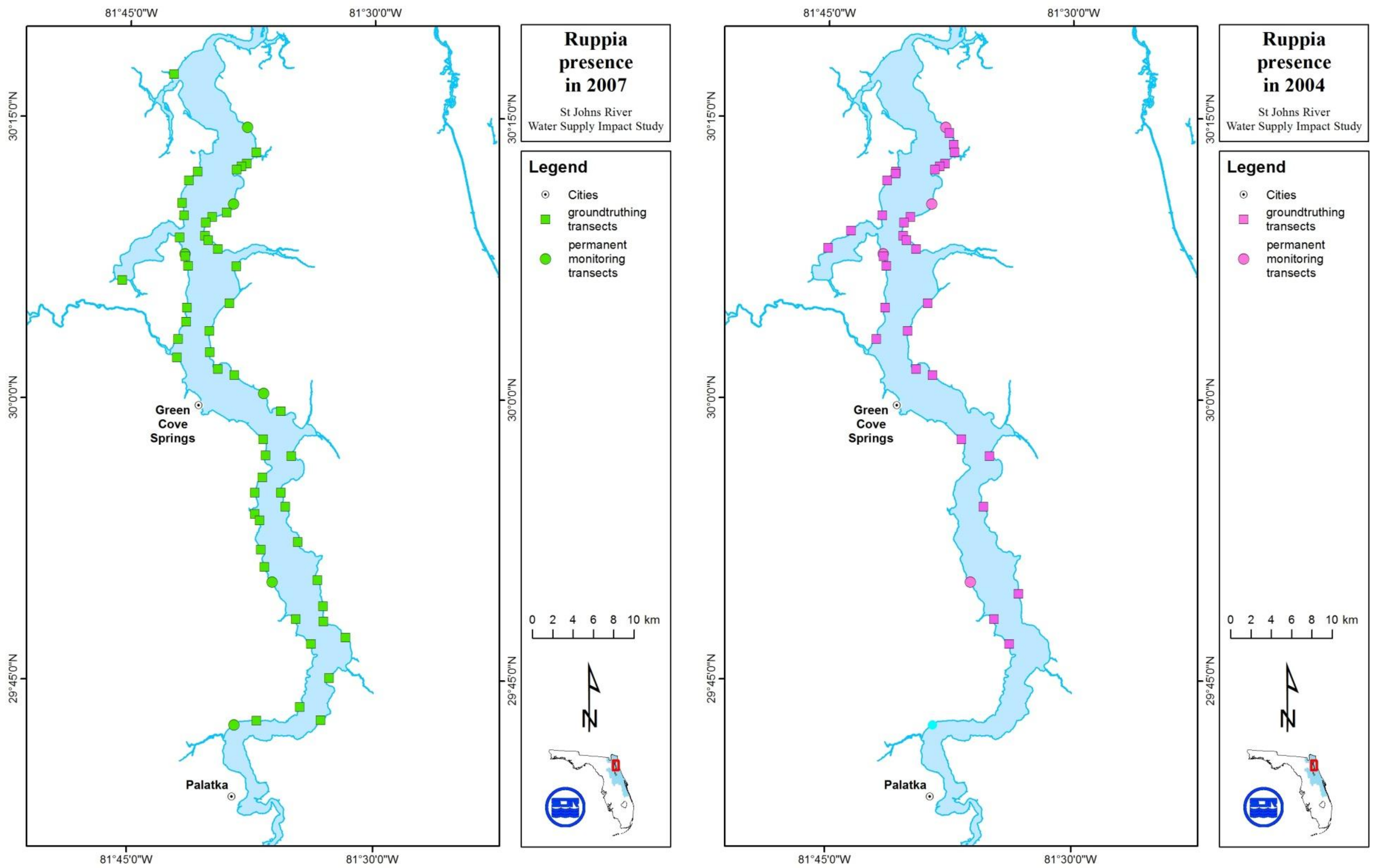

Figure 4. Occurrence of *Ruppia* at SAV mapping groundtruthing sites and the long-term monitoring sites during a dry year (2007) and a wet year (2004).

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